Urban Development Directorate

Baseline Report

for

Strategic Environmental Assessment

under

Preparation of Payra-Kuakata Comprehensive Plan Focusing on Eco-Tourism

2nd October 2022

Center for Environmental and Geographic Information Services

Baseline Report

on

Strategic Environmental Assessment under the Preparation of Payra-Kuakata Comprehensive Plan Focusing on Eco-tourism

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Executive Summary

Land Use

The baseline information on land resources (agro-ecological characters, land use, major challenges, trend analyses-related land use patterns, land degradation, erosion, accretion, coastal land management, land governance) have been collected, mainly from secondary sources. The data were screened, verified, collected, co-related and analyzed, and presented in the baseline situation of Payra Kuakata Coastal Region. The present land resource policies/strategy documents/plans in Bangladesh have been evaluated. The land sector policies include those related to land use policy, coastal zone policy (CZPo), National agricultural policy, national water policy, environmental policy, national rural development policy and Coastal development strategy.

About 49% of land is covered with agricultural land and other agricultural related land use like forest, mangrove, river, lake, beel and haor, aquaculture is covered by 31% of total land of Payra-Kuakata Coastal Region. And the rest 21% is used under non-agricultural land (rural and urban settlement, industrial zone, and accreted) of the Payra-Kuakata Region. The land form is mainly floodplains. Agro-ecological regions of Bangladesh have been incorporated with their main features, characteristics and indications of existing agro-ecological constraints. Distribution of land type throughout the Region has been furnished in the report.

Analyses on land use pattern or trends of various land use scenarios with drivers have been incorporated in the report. Land covering maps of Payra- Kuakata region were estimated by using and Landsat 5 TM 2010 and Landsat 5 TM 2020. The findings indicated that the land use pattern is continuously changing, while the suitability of land is also changing. The percentages of the total land mass area lost in 10 years from agricultural land. In 10 years about 566 hectares' area has been lost. The cropland area was around 146357 hectares in 2010 and has decreased by 565.71 hectares during the past ten years. The highest decreased land is wetland. A total of 6363.66 hectares of wetlands have been degraded during the last 10 years.

Ecosystem and Biodiversity Conservation including Forests

Bangladesh is situated in between the Indo-Himalayas and Indo-Chinese sub-regions with distinct physiographic characteristics, variations in hydrological and climatic conditions. The combined effects of sea-level rise, increased intensity of cyclone and associated storm surge, coastal erosion, and salinity intrusion pose a threat to the natural resources and livelihood opportunities of coastal communities that has been anticipated be greater risk in the future.

The landscapes of the study area comprise different features like forests, rivers, mudflats, beaches and sand dunes. According to Bangladesh Forest Department, 5 categories of forested land (Reserved Forests, Protected Forests, acquired forest/Vested forests, Unclassified State Forest, Unclassified Revenue Forest) are maintained with a total area of 25,79,387.9 acre or 10,43,843 ha. The study area consists about 19,000 ha of mangrove forest coverage and most are lies within the intertidal zone and south facing along the coastal part. Patuakhali total 1164.5 seedling kilometer plantation had been raised under social forestry program in the recent 5 years. Other than forest ecosystem, there are, mudflats and intertidal area, sand dune and sandy beaches, inland waterbodies, homestead and other natural habitats including marine and estuaries, protected area, reserved forests, Ecopark, wildlife sanctuaries, national parks exist. Of the other designated area as Important Birds and Biodiversity Areas (IBAs), Key Biodiversity Areas (KBAs), Ecologically Critical Areas (ECAs) also exist. Recent study found that there are 190 species of flora exists in these two districts with different life-forms like herbs, shrubs, climbers and trees. Distribution of these floral species are in homestead, cropland,

roadside, shorelines, canals, rivers and small water bodies like fish culture ponds. Several threats to flora and fauna also identified like urbanization on the natural habitat, extension of agricultural practices to forestland including the mangrove ecosystem, pollution on air and waterways, increasing of grazing/pasture land to forest peripheries, hunting pressures, and degradation of forestland through felling trees. According to IUCN- Bangladesh (2015), Greater Flameback (NT), Grey-headed Fisheagle (NT), Fishing Cat (EN), Smooth-coated Otter (CR), and Irrawaddy Dolphin (NT) categorized as threatened species.

Ecosystem management practice of this area are executing by different line agencies including Bangladesh Forest Department (BFD), Department of Environment (DoE), District Administration, Police Department, Judiciary department, and support agencies- Rapid Action Battalion (RAB), Coast Guard, Bangladesh Navy, Payra Port Authority, Bangladesh Tourism Board (BTB), Department of Fisheries (DoF), Department of Environment (DoE), Department of Livestock (DLS), Zilla Parishads of Patuakhali and Barguna. Moreover, the following plan, policy and strategies have developed to safeguard and conservation of the ecosystem/biodiversity through habitat improvement initiatives, awareness build-up, afforestation and reforestation at degraded land and newly accreted char land. Bangladesh is also the signatory of some international treaties.

- The National Environment Policy 1992 (updated 2013)
- National Environment Policy, 2018
- National Biodiversity Strategy and Action Plan for Bangladesh (NBSAP, B), 2016-2021
- Country Investment Plan (CIP) for Environment Forestry and Climate Change, 2016-2021
- Bangladesh Wildlife Master Plan, 2015-35
- National Environmental Management Action Plan 1995
- National Conservation Strategy 1992
- National Forest Policy 1994
- National Forest Policy, 2016 (Draft)
- Coastal Zone Policy 2005
- Coastal Development Strategy 2006
- Bangladesh Delta Plan 2100
- National Adaptation Plan of Action (NAPA) - for Climate Change 2005 (updated 2009)
- National Tourism Policy, 2010
- Convention on Biological Diversity (1992)
- Convention on International Trade in Endangered Species of Wild Fauna and Flora (Washington 1973) – also known as CITES
- The International Plant Protection Convention (IPPC), 1951
- Convention on Wetlands of International Importance ("Ramsar Convention 1971").
- Convention on the Conservation of Migratory species of wild Animals (Bonn 1979)
- UN Convention to Combat Desertification (UNCCD) 1994

To protect biodiversity and the prosperity of communities around this region and the country has essentially needs to adopt and shoot demand for more responsible and sustainable practices that safeguard soil, water, forests, and wildlife. Hence, it is very important to protect or conserve the regular services even enhance the service in every possible way.

Delta Morphology, River Dynamics, and Water Resources Management

Delta Morphology and River Dynamics

Major rivers (Baleshwar, Bishkhali, Burishwar-Payra, Andharmank, Lohalia, Rabnabad and Tentulia) of the study area are morphologically dynamic as most of the rivers are in development phase. It was observed that, significant changes in river system of this area happened after the joining of Brahmaputra River with the Ganges River after its avulsion in the nineteenth century. Presently, riverbank erosion is the main concerned issues. Additionally, sedimentation, delta pro-gradation, shifting of the banklines, subsidence etc. are some key changes in the study region.

Furthermore, Ministry of Water Resources, Ministry of Shipping, Ministry of Local Government, Rural Development and Co-operatives, Ministry of Road Transport and Bridges, Ministry of Disaster Relief and Rehabilitation and Public Private Partnership are the primary competent authority from governmental body. Besides, there is a good number of legislations, plan and policy for river management and water resources management in Bangladesh. Although some projects have been implemented in the study area according to the plans and policies, but it is important to implement the rules and legislation properly in order to take projects in a planned and integrated way. Hence to minimize the conflicts of interest among different stakeholders due to the construction of man-made interventions.

Water Resources Management

The coastal zone of Bangladesh is highly dynamic and is vulnerable to a number of natural and human-induced hazards. Sometimes the level of its vulnerability towards these factors are under-estimated. Moreover, the diversity of natural resources it possesses is often overlooked. Failure to recognize this has led to serious misconceptions about the tentative impacts these factors may have on the sustainability and inter-balance of the existing resources. Water is one of the resources that need special attention. On this backdrop, this paper describes the present condition of the water resources at the south-central region of coastal zone and the risks that may arise in the future based on secondary data. The overall rainfall has a decreasing pattern in this region and from the analysis it can be depicted that the decrease is 18.2 mm per year. In a year, 22% and 62% of the total rainfall occurs during pre-monsoon and monsoon respectively and only 4% rainfall occurs in dry period. The temperature has been observed to decrease at the rate of 0.02 degree Celsius per year. The trend of freshwater inflow from upstream into this zone is declining whereas the water level at different stations show increasing trend indicating sea level rise. The groundwater recharge process has evidently been slowed down compared to the past as the groundwater level trend shows slight decreasing trend with an approximate rate of 0.002 m per year. The estimated flood level for 50-year return period has been observed to be above 3.5 mPWD at the analyzed water level stations. This can be concerning as the south-central region is low-lying and has increased land subsidence along with poor natural drainage. Tidal flood is dominant in SC region and tidal inundation is estimated to increase by 10.3% for the year 2050 with respect to ordinary flooding condition. Cyclones and subsequent storm surge can be considered the main natural hazard and future risk of this region. Since May 2019, Bangladesh has been hit by three surges. They are due to Cyclones Fani on May 04, 2019, Cyclone Bulbul on November 09, 2019 and Cyclone Amphan on May 20, 2020 and left a negative aftermath. Salinity intrusion has made water supply more difficult than before. Change in coastal morphology has caused siltation in many rivers and diverted their course and consequently, water logging has been included in one of the present challenges of south-central region. The policies lack the indication of a framework to implement sustainable use of water resources and need to be addressed.

Fisheries and Aquaculture

This agricultural baseline report reflects an agricultural overview of the project area. The primary information was collected from seven (7) Upazila Agriculture Offices and local farmers of PKCP. AEZ, Land use, Land type, Soil texture and Drainage data were collected from different secondary sources. Medium highland is the dominant land type in all seven Upazilas of the PKCP area. Agriculture is the main livelihood in the area although the maximum amount of land cannot use for cultivation due to drainage constraints. Transplanted Aman rice followed by pulses is the main cropping pattern of this region. Nowadays, the Department of Agricultural Extension (DAE) emphasizes oil crops (sunflower, soybean, etc.) production to meet up-country demand. Due to their coastal locality, all seven (7) Upazilas of the PKCP area are vulnerable to natural disasters such as floods, cyclones, tidal surges, salinity, etc. Recently, climate change triggered these natural disasters both in terms of occurrence and intensity. Climate-smart crop varieties, crop diversification, agricultural mechanization, use of modern technologies, etc. interventions are needed to combat climate change as well as sustainable crop production.

Agriculture

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Marine Resources and Blue Economy

Unlike many developing countries natural resources in the ocean and blue economy was unused Bangladesh for decades. In recent years, government has started incorporating the contribution of the blue economy, aligned with the SDGs goals, in the economic development. The initiative of the government was accelerated after the winning of the maritime boundaries with the neighboring country India. So far, few gas stocks including the Sangu, were explored in the economic zone of the Bay of Bengal. To optimize the use of the ocean and blue economy, Bangladesh has introduced a specialized 'Blue Economy Cell' under the Ministry of Foreign Affairs. The Blue Economic Development Plan of the MoFA has identified 26 various sectors, which Bangladesh can emphasize to strengthening its economic activities to achieve higher growth and development.

However, the use of the marine resources is yet to plan properly though the government has a clear vision of maximizing their uses. This baseline report on Marine Resources and Blue Economy is an endeavor to documenting the existing plans, policies and projects in the blue economic zones. This report also summarizes the potentials and challenges of the plans, policies and projects pertaining to the marine resources. The documentation of this report will guide the policy makers to enhance the proper policies to ensure the optimal use of the marine resources and reduce external effects to the marine ecosystem.

Tourism

Payra-Kuakata region is very prospective in terms of practicing various forms of tourism where nature-based tourism is mostly prospective considering its natural resources, landscapes, seascapes and local rich culture. Moreover, the area is rich in its heritage and traditional culture. However, there are many challenges to promote sustainable tourism in this region which may be resolved with the active assistance of different stakeholders. Tourism has various impacts (both positive and negative) in this area which require special attention to continue positive impacts and reduce the negative impacts of tourism. There are various legislatives and regulations tools to manage and control tourism in Bangladesh. Further actions are required to enforce these legal tools properly.

Climate and Climate Change

Bangladesh is vulnerable to geophysical and climatic hazards, including climate change. Its climate characteristics include high temperatures, heavy and highly variable (spatially and temporally) rainfall. Physical and climatic settings of the region, as well as the severity and duration of hazards, are significantly influenced by changes in these climatic variables. Planning for improved water management, agricultural growth and disaster management will be more effective by a better understanding of the characteristics and distribution of climatic patterns. The coastal area of Bangladesh is facing most climatic hazards and disasters. Due to climate change, sea level rise and associated increase in salinity and cyclonic storms is threatening the study area. Bangladesh has been in process of preparing National Adaptation Plan and has already prepared the Bangladesh Delta Plan 2100, 8th Five Year Plan, Sector Action Plan and is updating the Bangladesh Climate Change Strategy and Action Plan. Based on these policies and plans the future development in the study area will be guided. This baseline report presents an overall scenario of climate and hazards in the study area along with potential future impacts. The proposed activities in the study area will have to follow the national level plans and keep in mind the potential climate impacts in the area due to climate change.

Disaster Management

SEA is considered to be an opportunity to mainstream DRR and Resilience Building into strategic planning. Thus, this SEA explored disaster management policy and planning issues and screened which disasters are to be strategically important. The PKCP area is typically exposed to cyclone, storm surge, erosion, lightning, drought, etc. According to the INFORM sub-national risk index of 2022 Barguna district is ranked at 4th and Patuakhali is ranked at 11th according to the multi-hazard risk level within the country. For the PKCP area, cyclone, storm surge, are river bank erosion are strategically important natural hazards. The DRR against these disasters must be integrated into the regional plan of the PKCP area.

Social Issues and Challenges

The study area has been demarcated based on the effective zone of this Strategic Environmental Assessment (SEA), thus seven (07) upazila of Patuakhali and Barguna district has been taken into consideration. For demographic assessment the last census 2011 was taken as the base year as the newly completed census 2022 full report is not published yet. But for population projection latest data so far published is used accordingly and projected output has been generated using component method which is called Cohort Component Method. The base year population of theses seven upazila was 12.82 million while projection data accounts for there are 14.30 million populations. The preliminary Census Report 2022, the annual growth rate of Barisal division is found 0.79% while the 8th five-year plan assumed that annual growth rate of the country will 1.18% by 2025. Population policy 2012 formed aiming the lower fertility rate 2.1 by increasing the rate of contraceptive user to 72%, and achieve NRR=1 by 2015. Apart from that family planning methods and people consciousness

helps to reduce to reduce infant and maternal mortality and to ensure gender and women's empowerment. Life expectancy has improved from 70.7 in 2014 to 72.8 in 2020 as well. In the study area the average aged population is 5.7% of total population, low TFR and higher life expectancy eventually will lead to aged society while Bangladesh is assumed to move aging society to aged society by 2047.

Agriculture is the dominant mode of livelihood in the study area. Most households have a single earner. The majority of households earn less than BDT 16000 annually. Since livelihood is a cross-cutting issue, its problems and solutions lie in several sectors. Therefore, livelihoods should be approached in a multi-disciplinary way. As this report outlines, land acquisition should be discouraged, especially, in the field land. Training and cash flow for entrepreneurship are required. A special initiative should be taken for the poor, the powerless and the marginal section of society.

The basic facilities for education in every Upazila of the area under study are not similar though every Upazilas have Primary and Secondary Schools, Colleges, and Alia Madrashas. Each Upazila is improving in terms of access to education as well as retention of students in education along with gender parity. The literacy rate of males is higher than females in both urban and rural areas. On the other hand, the overall dropout rate from secondary education for boys also tends to be slightly higher than girls

Rural to urban migration is common, mainly for economic reasons, to find employment and a chance to remit money back home. Internal migration within the same region/ territory is very common in Bangladesh, about two thirds of total migration is treated as internal migration. Internal migration occurs mainly economic reasons. According to Bivariate distribution of birth place and current residence of lifetime migrants by division, it is found that 7.62% of the total population of Bangladesh born in Barisal out of which 3.24 percent migrated to other divisions (largest 1.62% in Dhaka and second largest 1.09% in Khulna division). On the contrary in terms of out migration 57.67% of people are born in Barisal division are currently living in Barisal and the remaining people migrated to other divisions. The Bangladesh economy has become more integrated with the global market, largely due to the substantial out-migration of labour and consequent remittance inflows, etc. About 68921 no of international migration were took place from Barguna and Patuakhali in between the time frame of 2005-2018.

In Bangladesh, Gender Status is defined as differentiated social standards for men and women separately. Women and girls in the study area are disadvantaged because of gender-based inequalities which include wage discrimination; limited mobility; limited decision-making authority within the household; risks of exploitation; abuse and violence; limited access to basic services and social and legal protections; and limited visibility in society. For improving gender status and empowering women, the Govt. adopted legislation, policy and programs. Regarding the policies and govt. mission and vision, different programs and projects implemented for upgrading decision making and women empowerment status. However, Bangladesh has achieved some targets but still there are some gaps that require equitable practices and governance through different policies and programs targeting the vision 2041.

The Study area has a rich cultural heritage. Folklore in this region is famous for Jari and Bhatiali. The following literary and cultural organizations exist in this district. About more than 31 cultural organizations like Patuakhali Theater, Sabuj Sangha, Shaheed Smriti Pathagar, Patua Sahitya Parishad etc. are exist in this district.

Bangladesh govt adopted policies for protecting culture and heritage practices nationally. In this aspect, national archiving is storing database for the restoration of cultural practices, and different

artifacts. Till now, there are some gaps which are required to be addressed for sustainable management of cultural practices and heritages of that area

Infrastructural development can be of different types including transportation, energy, water, social and green infrastructure etc. About 242 number of cyclone shelters are found in the study area. Proper distribution of cyclone shelters is not possible as shelters are insufficient than demand. Consequently, primary schools are used as cyclone shelters to meet the demand during crisis period. Apart from this Killa is used for saving the livestock during hazard. In the PKCP area there are total 42 growth centres and 226 rural markets.

Infrastructure and Navigation

Sustainable infrastructure is playing an important role to change socio-economic development of Bangladesh as well as facilitates investment decision making. Infrastructure development has been accelerated due to demographic and economic needs. Ministry of housing and public works, roads and highway department, Bangladesh railway, Ministry of civil and aviation, department of disaster management, Local government engineering department, Payra port authority, BIWTA, BREB, WZPDCL, BEPZA, BEZA are the major government organization responsible for infrastructural development. Integrated Multi-Model Transport Policy 2013, national land transport policy 2004, road master plan 2009, railways master plan (2016-2045), Bangladesh delta plan 2100, Building construction act, 1952 are key PPPs relating to infrastructure which have been reviewed and described in terms of major environmental and socio-economic impacts. Having inadequate direction in some PPPs relating to infrastructure need to update in some aspects.

According to RHD and LGED road database, total regional road, zila road of Payra-Kuakata region are 80.95 km and 81.52 km respectively. Some National and Regional Highways of Bangladesh is indirectly influenced this PKCP area. Regional highways (R881) and national highways (N8) relate to Asian highways (AH1 & AH41). Railway network of PKCP area is under construction which will connect this area to capital. PKCPA is a riverine region having a navigable network (river and canal combined) varying from 2432 km round the year to 2676 km during the monsoon. There have only one sea port which is Payra sea port.

There are 1222 educational institutes in PKCP area. But the number of colleges, technical and vocational institutions are not adequate when the population per educational institutes is examined. Health care facilities of this PKCP area is not sufficient in terms of populations.

Basically, Payra-Kuakata is a tourism area where is home to unique flora, fauna, many panoramic beauties, forests, lakes, rivers that make the region ideal place for ecotourism development. The main tourist attractions in the PKCP area are Sonakata ecopark, Shuvo Shondha beach, Misripara Buddhist temple, Kuakata sea beach, Laldia forest, Haringhata forest, and Bohongo island.

Some mega infrastructure project has been planned and some have under construction in Payra-Kuakata region that will improve energy efficiency, domestic and international road, rail connectivity, create employment, industry etc. This infrastructure development leads rapid urbanization. Padma multipurpose bridge, Bhaga-Payra rail link, ship construction and improvement, Payra port development, different power plan development, costal town improvement, construction of fire service and civil defense building are the major project of this PKCP area. This baseline report on infrastructure and navigation will provide an overview of the historical background and information on the baseline standing of infrastructure of the Payra-Kuakata area, predicts for the growth of traffic (passengers and freight), other infrastructure, describes role and responsibility of related organizations/Agencies. It also describes drivers of changes, projects, the main legislation and relevant government policies, plans and programmers (PPPs) and their possible influences and outlines the key aspect, its competent authority and their roles.

Pollution and Waste

This part of the report deals with the environmental quality of water, air, noise, soil, and the solid wastes the area currently is facing. The south-central region is located in the coastal area of Bangladesh. Several tidal-influenced rivers are the main water system in the area including some low-land areas and pond systems. The water quality of the surface and groundwater system is hence slightly saline, especially during the dry period. In addition to that, high sodium is found both in the surface and groundwater because of tidal influence. Therefore, this tidal characteristic enriches the TDS and EC quality of water particularly the river system that lies very close to the Bay of Bengal such as the Andarmanik River. As high nutrients and salt ions are fed by the Bay of Bengal continuously, the water is a bit hard enough in this region naturally. Regarding the limiting nutrients, nitrogen is comparatively higher in the major river systems of the area whereas phosphate is within the range of acceptable limits. Marine influence usually makes this system nitrogen-dependent which is also true as nitrogen is the limiting nutrient for the marine environment. In addition, agricultural practices add nitrogen to the system as well. No metal pollution is present in the major rivers except iron. Iron is found quite high in the rivers in this area. Groundwater has some saline and high EC and TDS issues only. No metal issues were also found in the groundwater so far.

Regarding soil quality, there is only pH issue that has been found in the urban and peri-urban areas as soil pH scored very low. Organic waste from markets and households is dumped near the city/pourashavas areas which later reduces the soil pH by composed. In addition, construction wastes may have influences as well for reducing the soil pH, especially at the dumping areas.

The air quality of the area still stands within the permissible limit. No serious threats have been found raised from the air pollutants. However, as industrialization is taking place currently, there might have local air quality issues shortly. On the other hand, noise quality is found quite high in the area. Tourism, industrial activities, transportation system, and markets are the prime sources of noise pollution. All kinds of setups like commercial, residential, and mixed zones show high noise pollution in the area. The evening is noisier than the morning in all the Upazilas. Noise in the protected Ecosystems and Mangrove forests is comparatively lower.

Solid waste management is very traditional in the area. Only, city corporations and the pourashavas are collecting and managing solid wastes partially. Usually, three-wheelers are used to collect the solid wastes, and trucks are used to open dump the wastes near the riverside and low lands areas. No other recycling or reusing practices are seen in the study area. Regarding management, very locally some of the vendors collect plastics and sell them to a third party who transports them to the recycling units where available.

Power and Energy

Energy and electric power consumption is expected to increase significantly in line with GDP growth. The Government's Power & Energy System Master Plan 2016 expects to generate 40 GW of Electricity by 2030, and 60 GW by 2041. Around 35% of the country's power generation will be from renewable energy sources or clean power imports by 2041. In the SEA Study Area, the energy and power system structure is more complex due to a number of issues (socio-economic challenges, rapid industrial development, demand-supply imbalances, infrastructure and power transmission challenges and environmental stress). The government has adopted a wide range of development policies, plans and programs including the power and energy sector to increase the power generation and uninterrupted power supply.

1. Introduction

Local authorities need to prepare and maintain an up-to-date information base on key aspects of the social, economic and environmental characteristics of their area, to enable the preparation of sound Local Development Documents which can deliver sustainable development objectives (PAS, 2008).

The production of a sound evidence base is not just the requirement of Environmental Impact Assessment (EIA), but also as part of Sustainability Appraisal (SA) and the Strategic Environmental Assessment (SEA) of plans and programmes. The requirement for SA and SEA emanates from a high level national and international commitment to sustainable development. The European Directive 2001/42/EC "on the assessment of the effects of certain plans and programmes on the environment" (the 'SEA Directive') was adopted in June 2001 with a view to increase the level of protection for the environment, integrate environmental considerations into the preparation and adoption of plans and programmes and to promote sustainable development.

The Directive was transposed into English legislation by the Environmental Assessment of Plans and Programmes Regulations 2004 (the 'SEA Regulation'), which came into force on 21 July 2004. It requires a Strategic Environmental Assessment to be carried out for all plans and programmes which are:

'subject to preparation and/or adoption by an authority at national, regional or local level or which are prepared by an authority for adoption, through a legislative procedure by Parliament or Government, and required by legislative, regulatory or administrative provisions'.

The aim of the SEA is to identify potentially significant environmental effects created as a result of the implementation of the plan or programme on issues such as biodiversity, population, human health, fauna, flora, soil, water, air, climatic factors, material assets, cultural heritage including architectural and archaeological heritage, landscape and the interrelationship between these factors. Sustainability Appraisals examine the effects of proposed plans and programmes in a wider context, taking into account economic and social considerations together with environmental considerations required by the SEA Directive in order to promote sustainable development. SA is mandatory for all Development Plan Documents and Regional Spatial Strategies. The Urban Development Directorate (UDD) has entered into the south central region to develop the area along with the local Government Institutions (LGIs) and their line agencies.

The information is used in the report is collected from the direct data generation (as per the RFP) and the sources of relevant line agencies and other stakeholders active at the area. Total fifteen (15) arena are covered in the baseline report. The thematic arena based list is given below.

1. *Land Use* 2. *Ecosystem and Biodiversity Conservation including Forests* 3. *Delta Morphology, River Dynamics, and Water Resources Management* 4. *Fisheries and Aquaculture* 5. *Agriculture Resources* 6. *Marine Resources and Blue Economy* 7. *Infrastructure and Navigation*	8. *Power and Energy* 9. *Tourism* 10. *Economic and Industrial Development* 11. *Climate and Climate Change* 12. *Disaster Management* 13. *Social Issues and Challenges* 14. *Pollution and Waste* 15. *Institutional Governance*

2. Land Use

2.1 Introduction

The coastal zone of Bangladesh is different in a number of aspects from the rest of the country. It has several other issues that are different in the five coastal hydrological regions like the urgencies, coastal dynamics, and the interactions among people, water and lands are different in each of the hydrological region. Many sectors influence these interactions. Reinforcement of benefits from multiple sectors is the anticipated result of regional planning. Multi-sectoral planning in the coastal zone may be done in accordance with change trends and diversity of its (a) natural features, (b) erosion and accretion, (b) the distribution of natural, human made, and human resources, (c) demography and poverty, (c) exposure to hazards, and (d) potential risks. The risks shall be aggravated by predicted impacts of climate change. Furthermore, it contains several ecosystems upon which the livelihoods of millions of people are dependent. The coastal zone has immense development opportunities and needs integrated management of resources. Throughout the coastal zone, development is observed to be taking place to a certain extent depending on regional differences, as well as diverse development strategies and their impacts. A development strategy may focus on the worst areas in terms of development and human deprivations, or it may focus on areas with high growth potentials possessing better infrastructures, or a combination of both.

The uncertainties related to decision making pertaining to social values, the coastal environment and related decision have been addressed in varying degrees during the past two decades. Coastal zone policy (CZPo) in 2005 and the Coastal Development Strategy (CDS) in 2006 provide a general guidance to all concerned for the management and development of the coastal zone in a manner so that the coastal people are able to pursue their life and livelihoods within secure and conducive environment.

The CDS is based on the approved Coastal Zone Policy (CZPo). It is the linking pin between the CZPo and concrete interventions. It prepares for coordinated priority actions and arrangements for their implementation through selecting strategic priorities and setting targets. The CDS represents a departure from 'business as usual' in the management of the coastal zone towards utilizing its potentials. It attempts to get maximum benefit. CDS has nine strategic priorities for ensuring fresh and safe water availability; safety from man-made and natural hazards; optimizing the use of coastal lands; promoting economic growth emphasizing non-farm rural employment; sustainable and equitable management of natural resources: exploiting untapped and less explored opportunities; improving livelihood conditions of people; especially women; environmental conservation; and empowerment through knowledge management.

At several places of the CDS the idea of regional studies is promoted. Regional planning studies should be aimed at increasing the understanding of the complex processes that characterize the coastal zone. At the same time such studies can form a firm body of knowledge base on which future interventions can be based.

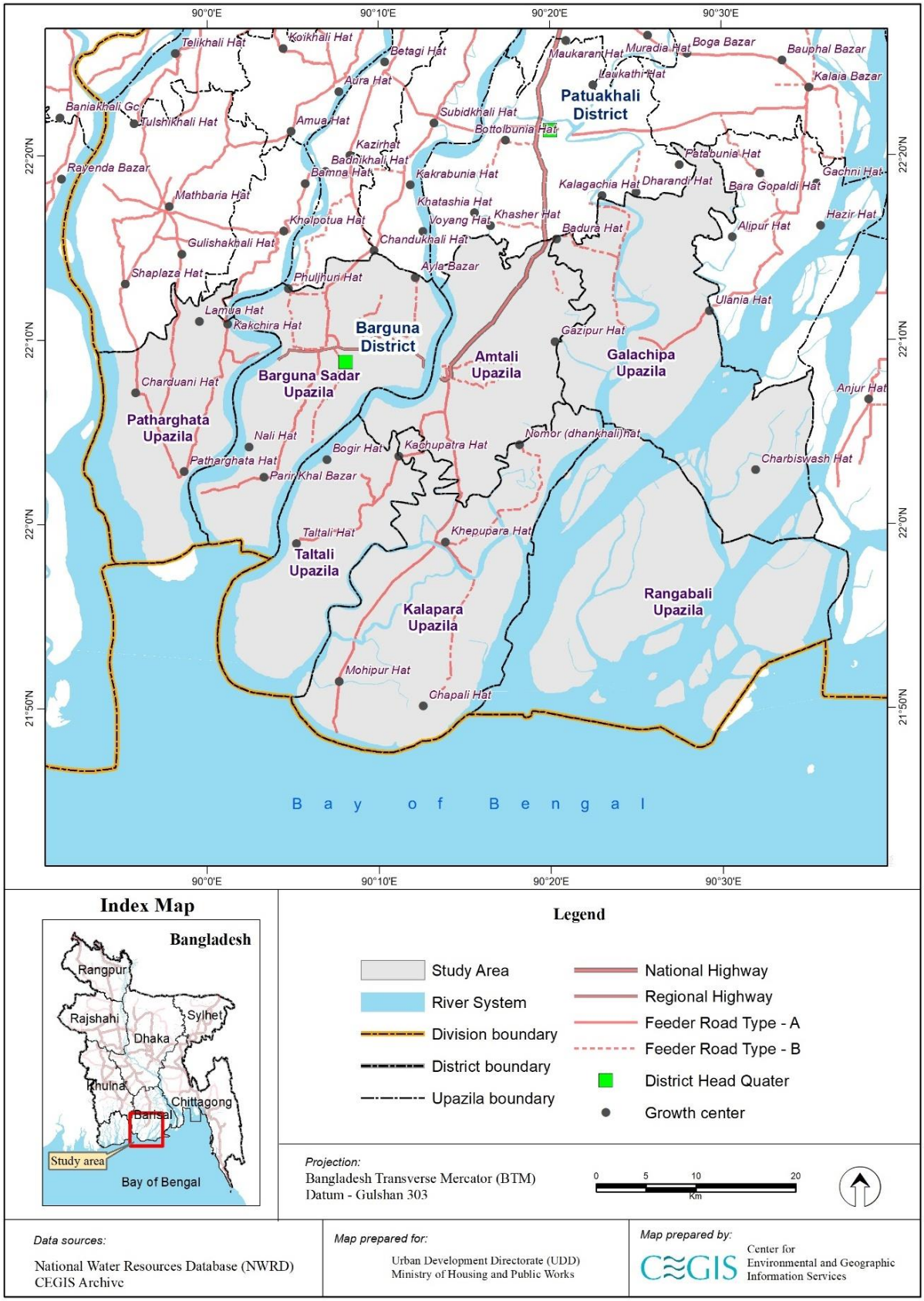


Figure 2.1: Study Area

2.2 Administration/Agencies/Institutions under the Ministers and Other Organizations

2.2.1 Ministry of Housing and Public Works

The Ministry of Housing and Public Works is a ministry of the government of the People's Republic of Bangladesh which provides housing and regulates the state construction activities in the country. The Ministry of Housing and Public Works provides housing and regulates the state construction activities in the country. This ministry was formed on 12 January 1972. Its head office is situated in in the Secretariat, Dhaka. The directories under this ministry are Khulna Development Authority, Public Works Department, Chittagong Development Authority, National Housing Authority, Urban Development Directorate, Capital Development Authority (RAJUK), Rajshahi Development Authority, Department of Architecture, Housing and Building Research Institute and; Directorate of Government Accommodation.

Vision

Safe, affordable, habitable housing and facilitative working environment.

Mission

To provide housing facilities for standard living of the people in urban areas and better working environment for public offices through planning, research and proper use of land.

Functions

- Formulation and amendment of housing policies, Laws, codes and rules.
- Research and technological innovation on housing, building construction, urban development.
- Preparation of architectural and structural design of public buildings and other infrastructure.
- Collection of revenues.
- Allotment of government offices and residents.
- Management of abandoned property and acquired land.
- Preparation of master plan

Roles & responsibilities

The Ministry of Housing and Public Works (MoHPW) is responsible for carrying out public sector construction and looking after urban and city development housing settlements across the country. The State-owned House Building Finance Corporation is designed to ensure adequate and accessible credit flow to this sector.

The Ministry of Housing and Public Works has developed a number of different polices, including the Bangladesh Housing Policy (BHP) and Land Acquisition Policy (LAP) designed to ensure better housing to the landless and helpless people across Bangladesh.

2.2.2 Ministry of Local Government, Rural Development and Co-operatives

The Ministry of Local Government, Rural Development and Co-operatives is a ministry in the cabinet of the government of the People's Republic of Bangladesh. It is responsible for the housing and building, regional and rural policy, municipal and cities administration and finances, and the conduct

of elections. Mr. MD. Tazul Islam, MP is the honorable minister and Mr. Swapan Bhattacharjee, MP is the honorable state minister of this ministry at present.

The Ministry of Local Government, Rural Development and Co-operatives contains two divisions:

- Local Government Division
- Rural Development and Co-operatives Division

Local Government Division

Local Government Division is implementing various development and service-oriented activities for poverty alleviation and to make the rural people's life more comfortable, sound and meaningful. The activities of the LGD is extended up to the grass- root level of the country. The Union Parishad, Upazila Parishad, Zila Parishad, Municipalities and City Corporations are the Local Government Institutions under this division. In addition, the Local Government Engineering Department (LGED), Department of Public Health Engineering (DPHE), Dhaka WASA, Chittagong WASA, Khulna WASA and National Institute of Local Government (NILG) are the different Department /Directorate/Institutions of this Division.

Mission of LGD is – "Improving the standard of living of the people by strengthening local government systems and institutions and implement activities for social, economic and infrastructure development".

LGD performs the following Major Functions:

- Manage all matters relating to local government and local government institutions
- Finance, control and inspect local government institutions established for the running of local government and local administration
- Manage all matters relating to drinking water
- Develop water supply, sanitation and sewerage facilities in rural and urban areas
- Construct, maintain and manage Upazila, union and village roads including the roads of towns and municipal areas and bridges/ culverts
- Manage matters relating to village police
- Develop, maintain and manage growth centers and hats-bazaars connected via Upazila, union and village roads
- Develop, maintain and manage small scale water resource infrastructures within the limit determined by the government

Local Government Engineering Department

Local Government Engineering Department (LGED) is one the largest engineering agencies of the country. It began its journey in 60s as Rural Works Programme and with the passage of time its activities expanded from remotest corner of the country up to the cities.

Vision

LGED would continue to remain professionally competent, efficient and effective public sector agency for performing the interrelated and complementary functions of:

Developing, maintaining and managing transport, trading and small scale water resources infrastructure at the local level by ensuring LGI and community participation and taking care of environmental and social issues.

Providing technical and institutional support to strengthen the local government institutions and serving local communities and other stakeholders.

Mission

- Development and management of local infrastructure for increasing farm/non-farm production,
- Generating employment, improving socio-economic condition, promoting local governance,
- Reducing poverty and
- Acting as agent of change at the local level.

Major Activities

- Rural Infrastructure:
  - Construction/ Rehabilitation / Maintenance of Rural Road Bridge/ Culvert
  - Development and Maintenance of Growth Centre/ Hat Bazar
  - Construction of Landing Station (Ghat)/ Jetty
  - Construction of Union Parishad Complex
  - Construction of Upazila Parishad Complex and Upazila Parishad Extension Administration Building with hall room
  - Construction of Multi-Purpose Cyclone Shelter
  - Tree Plantation
  - Implementing labor Intensive activities through Labor Contracting Society (LCS)
- Urban Infrastructure:
  - Construction/ Rehabilitation / Maintenance of Rural Road Bridge/ Culvert
  - Development and Maintenance of Growth Centre/ Hat Bazar
  - Construction of Landing Station (Ghat)/ Jetty
  - Construction of Union Parishad Complex
  - Construction of Upazila Parishad Complex and Upazila Parishad Extension Administration Building with hall room
  - Construction of Multi-Purpose Cyclone Shelter
  - Tree Plantation
  - Implementing labor Intensive activities through Labor Contracting Society (LCS)
- Small Scale Water Resource Development:
  - Construction of Sluicegate
  - Construction Rubber Dam
  - Excavation and Re-excavation of Canals
  - Construction and Re-Construction Embankment
  - Formation of Water Management Cooperative Society (WMCA)
  - Excavation of Pond
  - Micro Credit Program
  - Income Generation related Training Program

Rural Development and Co-operatives Division

Mission Statement of RDCD is "To reduce poverty and improve the socio-economic conditions of the poor people living in rural areas through rural development, cooperative based activities and conducting continuous research on rural development."

Mandates of RDCD are presented below:

- Formulation of rural development policy and laws, rules and policy relating to cooperatives;
- Formulation and implementation of programmes/and projects to alleviate rural poverty;
- Assist entrepreneurs through micro-credit, agricultural credit, co-operative based small and cottage industries, co-operative bank, co-operative insurance, co-operative based farming and marketing, milk and other cooperative enterprises;
- Initiate human resource development programmes for members of the cooperatives, provide education, training and conduct research programmes on rural development and cooperatives;
- Innovate new model/strategy on rural development through action research;
- Assist in the socio-economic development and empowerment of rural women through formation of formal and informal groups under cooperative programmes;

Rural Development and CO-operatives Division transacts through following departments-

- Department of Cooperatives
- Bangladesh Rural Development Board (BRDB)
- Bangladesh Academy for Rural Development (BARD)
- Rural Development Academy (RDA)
- Bangabandhu Academy for Poverty Alleviation and Rural Development (BAPARD)
- Bangladesh Milk Producers' Cooperative Union Limited (Milkvita)
- Palli Daridro Bimochon Foundation (PDBF)
- Small Farmer Development Foundation (SFDF)
- Bangladesh Samabaya Bank Ltd.
- Bangladesh National Cooperative Federation for Rural Development (BNCFRD)

2.2.3 Ministry of Land

In Bangladesh, personal possession of land is considered as a symbol of social prestige and security. A large number of the total population is dependent on land-based agricultural activities for their livelihood. In addition, land still plays a very important role in both financial and social life in various ways. In view of the scarcity of land, proper importance should be given on the use of land. Considering the dependency of poor and underprivileged families on land, the Ministry of Land is conducting a range of activities to protect agricultural land and ensure the planned use of land. The main activities of the ministry are to update records of government owned khas lands, Sairat Mahal (water bodies, sand bodies, shrimp cultivated lands etc.), distribution and management of vested and abandoned lands, undertaking land surveys and establishing the ownership of land. Besides, land acquisition and requisition, distribution of khas land among the landless are also prioritized activities of this ministry.

Activities of the Ministry of Land are guided by policies like 'National Land Use Policy, 2001'; 'Khas Land Settlement Policy, 1997'; 'Non-agricultural Khas Land Settlement Policy, 1995'; 'Khas Land

Settlement Policy for Hotel-Motel, 1998'; 'BaluMohal and Sand Management Rules, 2011'; 'Chringri-Mahal Management Policy, 1998'; 'Jal-Mahal Management Policy, 2009'; 'Salt Mahal Management Policy, 1992'; 'Vested Property (Amendment) Law, 2011'; and 'The Acquisition and Requisition of Immovable Properties Ordinance, 1982'. The main objectives of 'National Land Use Policy 2011' are criteria based uses of land, providing guidelines for usage of land for the purpose of agriculture (Crop production, fish cultivation and rearing of ducks and chickens), housing, afforestation, commercial and industrial establishments and providing guidance on the establishment of rail and highway and for tea and rubber gardens.

Vision

Efficient, transparent, Accountable and people friendly land management system.

Mission

To ensure the best possible use of land and provide pro-people land services through efficient, modern, and sustainable land management

Major Activities

- Preservation of land rights and ownership on behalf of the Government
- Assessment of land revenue and its collection and direction and supervision of land administration
- Management of Khas lands, vested and abandoned properties
- Land surveys and preparation of land maps and records, their preservation and publication
- Demarcation of domestic and international boundaries and repair and preservation of boundary pillars
- Management of Sairat Mahal (Jal-Mahal, Sand Mahal, Stone Mahal, Shrimp Mahal etc.)
- Management of activities relating to the acquisition and requisition of land
- Implementation of land reform and land use policy

2.2.4 The Ministry of Water Resources

The Ministry of Water Resources is the apex body of the Government of the People's Republic of Bangladesh for development and management of the whole water resources of the country. It formulates policies, plans, strategies, guidelines, instructions and acts, rules, regulations, etc. relating to the development and management of water resources, and regulation and control of the institutions reporting to it. It prepares and implements development projects relating to flood control and drainage (FCD); flood control, drainage and irrigation (FCDI); riverbank erosion control; delta development and land reclamation; etc. and provides irrigation, drainage, flood protection, bank erosion protection, land reclamation facilities by constructing barrages, regulators, sluices, canals, cross-dams, embankments and sea-dykes along the banks of the rivers and the coast, etc. The Ministry, through its implementing arm -the Bangladesh Water Development Board (BWDB), implements the FCD/FCDI and other development projects. It also collects, processes, stores and disseminates hydrological and hydraulic data and information through BWDB. It provides flood forecasting and warning information through Flood Forecasting and Warning Center (FFWC) of BWDB. The Ministry prepared the Guidelines for Participatory Water Management (GPWM) and that is being widely followed by the stakeholders at all levels.

Major Activities

- Exercise water allocation power in identified scarcity zones on the basis of specified priorities and determine the priority for allocating water during critical periods;
- Sustain shallow groundwater aquifers, regulating the extraction of water in identified scarcity zones with full public knowledge;
- Prepare specific drought monitoring and contingency plans for each region experiencing recurrent seasonal shortage of water etc;
- Empower local government or any other body, to allocate water in scarcity zones during periods of severe drought, monitor the water regimes and enforce the regulations etc;
- Confer water rights on private and community bodies to provide secure, defensible and enforceable rights to ground/surface water etc;
- Ensure the minimum requirement of stream-flows for maintaining the conveyance of the channel.

2.2.5 Summary of Prime Authorities and Its Performances

The primary competent authority (ministries/agencies) responsible for managing resources/issues, and their roles, mandates and performance are briefly summarized in the following table:

Table 2.1: A List of Key aspect, its Primary competent authority and its performances

Key aspect	Primary competent authority (CA)– and their mandates	Key support organisations (govt, NGO, donor, CBO, etc.)	Performance of CA and support organisations
Sustainable Housing	MoHPW	• GoB, • UNICEF • BHBFC	• Upgrading of Slum • Safe housing for everyone
Achieving rural and local needs	Bangladesh Local Goverment, Rural develpment and Co-operatives	• LGED • WASA • NILG • RDCD	• The industry sector is not developed; industry has to be built. • Excavating wetlands or ponds • Land acquisition for development
Sustainable Land Management	Ministry of Land	• LRB • LATC	• prevent unplanned infrastructural development • Contribute infertile lands for local economic development
Development of water resource	Ministry of water resource	• BWDB • WARPO • IWM • CEGIS	• allocate water in scarcity zones during periods of severe drought • Ensure the minimum requirement of stream-flows

2.3 Relevant Plan, Policy and Programs

Coastal zone of Bangladesh includes 19 districts facing the Bay of Bengal or near to the Sea, and the Bay's exclusive economic zone (EEZ) is commonly seen as a region with many vulnerabilities. The Government of Bangladesh has already identified the zone as "vulnerable to adverse ecological processes" (ERD, 2003). But the zone possesses immense possibility. Coastal zones are rich in natural resources and its economy is mainly natural resources based. To reduce the free-riding problem of

natural resources of this zone, the government has developed several strategies, plans, policies and acts.

The following are a brief on strategy, plan, policy and acts related to the coastal area management:

- Bangladesh Delta Plan 2100
- Perspective Plan 2021-2041
- 8th Five Year Plan (July 2020-June 2025)
- Bangladesh National Conservation Strategy (2016-2031)
- 7th Five Year Plan (7thFYP) 2016-2021
- Bangladesh Climate Change Strategy and Action Plan (BCCSAP) 2009
- National Adaptation Programme of Action (NAPA) 2009
- National Food Policy 2008
- Coastal Development Strategy, 2006
- Coastal Zone Policy 2005
- Land Use Policy 2001
- The Environmental Court Act 2000
- National Agriculture Policy 1999
- National Water Policy, 1999
- National Environmental Management Plan, 1995
- Environmental Conservation Act, 1995
- Environment Policy and Implementation Plan 1992
- National Environmental Policy, 1992
- Coastal Environmental Management Plan for Bangladesh 1988

2.3.1 Policies

Land Use Policy 2001

The Ministry of Land enacted the Land Use Policy in 2001 focusing on importance of afforestation, environment and mutual sustainability of land use. The main objective is to ensure best possible use of laud resources and delivery of land related services to the people through modernized and efficient land administration for sustainable development with accelerated poverty reduction. It especially highlighted the need for land zoning in the coast. Subsequently, the Ministry of Land has taken up a pilot project on the study of detailed coastal land zoning in two districts of plain land. Because of increased demand, resource utilization for agricultural, housing and forestry sectors (these sectors comprise most of the land of Bangladesh) has increased significantly. Wetland areas are being degraded due to sedimentation, landfilling and development of infrastructures (roads, dams, embankments).

The objectives of this policy are to prevent arbitrary use of land and ensure that land use is compatible with the natural environment. The policy focus is on land and agricultural productivity, forest, housing, industrialization and wetlands.

Coastal Zone Policy 2005

The Coastal Zone Policy aims to provide a general guidance to all agencies and institutions concerned for the management and development of the coastal zone in a manner that provides a secure and conducive environment for coastal communities to pursue their life and livelihoods. Sustainable use of coastal resources is one of the recommended measures, limiting harvesting, extraction or utilization to the corresponding regeneration cycles. Efforts will be given to make sustainable use of natural resources.

This policy provides for management and support to the coastal region in a manner so that the people of the region can lead their life and livelihoods within a secure and conducive environment.

These PPPs jointly promote socio-economic development, disaster safety, preventing deterioration of natural environment and enhancing potential of coastal region to contribute national development.

National Food Policy 2008

National Food Policy provides strategic guidance on the way to address the key challenges facing Bangladesh in achieving food security in all its dimensions, including food supply and availability, physical, social and economic access to food, as well as nutrition/utilization of food. This policy focus on an adequate and stable supply of safe and nutritious food through the intervention of technology, use and management of water resources, supply and sustainable use of agricultural inputs, crop diversification and market infrastructure development.

Coastal Development Strategy, 2006

The Coastal Development Strategy (CDS) is based on the approved Coastal Zone Policy (CZPo) 2005. By identifying organizational goals and setting targets, CDS plans for organized priority activities and preparations for their execution. Strategies include ensuring fresh and safe water availability; safety from man-made and natural hazards; optimizing use of coastal lands; promoting economic growth emphasizing non-farm rural employment; sustainable management of natural resources: exploiting untapped and less explored opportunities; improving livelihood conditions of people-especially women; environmental conservation; empowerment through knowledge management; creating an enabling institutional environment.

National Agriculture Policy 1999

This policy emphasized on regional agriculture development. It states that target-oriented research and extension programs would be conducted for region-wise adaptations. It supports climate change adaptation investment in agriculture to mitigate the environmental vulnerability. Subsequently, the Ministry of Agriculture has prepared a Draft National Agriculture Policy 2012. The draft policy emphasizes agricultural marketing linkage, infrastructure development and many other areas.

National Water Policy, 1999

The National Water Policy, 1999 has about 50 clauses relevant to the environment and it anticipates that compliance with the policy will ensure protection, restoration and preservation of natural habitats, particularly wetlands, mangroves, other forests and endangered species that depend on them. It considers framing rules, procedures and guidelines for combining water use and land use planning for agriculture. It highlights the importance of preparing and implementing sub-regional and local level water management plans. It calls for the improvement of resource utilization through conjunctive use of all forms of surface water and groundwater.

Industrial Policy, 2010

Industrial policy 2010 has envisaged a strategy for attaining economic growth through rapid industrialization in an environment friendly ambience. The main objective of this policy is to increase the GDP through industrialization to 40 percent by 2021 from the present 28 percent and to augment the proportion of workforce of industries to 25 percent of the country's total labor force by 2021 from present 16 percent.

The overall objective of the Industrial Policy 2010 is to provide a policy and institutional framework that will help achieve economic growth through industrialization, create employment opportunities on a long and sustained basis, and improve the standard of living in line with the vision laid out earlier.

The policy is focused on Expansion of industrial sector, agro-based food processing and labour intensive industries will be prioritized, establishment of economic Zones, industrial parks, high-tech parks, and private EPZs and development of risk funds.

National Land Transport Policy, 2004

A Land Transport Policy is essential to ensure the proper physical and institutional infrastructure transport in order to achieve national development. The Land Transport Policy has been formulated in the light of the Government pledge to establish a transport system which is a safe, cheap, modern, technologically dependable, environment friendly and acceptable in the light of globalisation.

The Government of Bangladesh has the objective of establishing a safe and dependable transportation system by making appropriate laws and ensuring accountability. The goal of the Government is to create an environment in which the transport industry can operate efficiently. One of the goals of this policy is poverty alleviation. Government will follow a balanced policy which will allow removal of unnecessary controls, and allow the application of rules and regulations which are formulated to protect the interests of the passengers and the customers. The specific objectives are as follows:

- To provide a safe and dependable transport service
- To remove unnecessary control and formulation of laws and regulations conducive to providing service; allows the application of rules and regulation to protect the interest of the passenger and customers;
- Controlling fare for the interest of the people;
- Determining the roles of the government and private sector in respect transport sector;
- Mainataining economic and environmental balance to improve through the intervention of other transportation like waterways and railways;
- Ensuring maximum good utilisation of Government funds. Encouraging investment safeguarding the environment;
- Expansion of the role of transport in the ever increasing economic activities. New vehicle and equipment that best suit the modern and public worthy of twenty-first-century;
- Reduction of transport cost of goods for export;
- Controlling the number of vehicles commensurate with the economic activities;
- Reducing traffic congestions creating fly-over, elevated expressways, etc.;
- Introduction of an integrated transport systems;
- Provision of alternate transport systems;
- Creating of awareness regarding better standard of life and safety
- Poverty alleviation.

The transport sector will be highlighted within the overall planning and programme of the Government so that lower income groups also enjoy the fruits of development. The policy focus is on greater private sector participation, effective coordination in transport, promoting role of transport users, user to pay cost for transport services, subsidies, creating public awareness for the policy, proper utilization of transport resources and better integration with inland water transport policy.

National Housing Policy-2016

Housing is a fundamental human right. The human right to housing is the right to live in adequate shelter in security, peace, and dignity. The right to housing is integrally linked to other human rights. Without a right to housing, many other fundamental human rights will be compromised.

Right to Housing has been guaranteed under-The Universal Declaration of Human Rights (UDHR); The International Covenant on Economic, Social and Cultural Rights (ICESCR); The International Convention on the Rights of the Child (CRC); and the International Convention on the Elimination of all forms of Discrimination against Women (CEDAW)

Basic objective of the National Housing policy 2016 is to provide guidelines from the political, economic, social, environmental, technical, moral and psychological viewpoint to ensure suitable housing for all.;

To ensure economic growth, social development, conservation of environment, equitable distribution of housing, optimum utilization of resources, protection of biodiversity and cultural diversity and well-being and conservation of right of present and future generation. To elevate all human rights, fundamental freedoms and the right to housing and other development showing respect for historical, cultural and religious backgrounds. Optimum utilization of land in housing sector needs to be guaranteed through proper land management in order to improve the socio-economic condition of the country. Development of a cooperative based society by a conglomeration of population through creation of cooperatives and to address housing need of mass population with minimum use of land and other basic needs.

The policy focus is on housing planning, land selection and planning, infrastructure management, building construction material and technology, slum and squatter settlement, rural housing and social housing (reconstruction and rehabilitation in environmentally disaster affected areas).

National Environmental Policy, 1992

This Policy aims to provide protection and sustainable management of the environment. The Policy emphasized maintaining the ecological balance and overall development through protection and improvement of the environment; identifying and regulate polluting and environmentally degrading activities; ensuring environmentally sound development; ensuring sustainable and environmentally sound use of all-natural resources and actively remaining associated with all international environmental initiatives.

National Rural Development Policy, 2001

The overall development of Bangladesh is subjected to development of rural areas, for whose development the Government and non-governmental organizations have implemented many programmes and plans. Among the programmes the significant ones are rural development, agro-based economy, development of rural housing and others. In 2001, the National Rural Policy of Bangladesh has been implemented with the rules and policies so that the programmes can be formulated in an orchestrated manner and based on clear declaration. The objectives of this policy are to ensure stable social and economic development of Bangladesh through poverty alleviation; ensure

the development of physical infrastructure in rural areas, balanced distribution of resources among people and marketing of the products; create skilled human resources in the rural areas through imparting education, vocational education and training; and take all possible and effective measures for economic development of landless and marginal farmers;

The policy focus is on rural infrastructure development, agro-based rural economy development of rural housing, land use and development, rural industries development, rural environment promotion and power and fuel energy.

Bangladesh National Conservation Strategy (2016-2031)

This strategy is the key government document to guide natural resource use and conservation. The main goal of this strategy is to foster development through conservation, development and enhancement of natural resources in the country within the framework of Sustainable Development Goals (SDG). Sectors under this strategy are human resources, gender, health and sanitation, disaster and disaster management, environment and international obligations, environmental education and awareness, information and communication technology, monitoring and coordination mechanism for NCS implementation, legal aspects of NCS etc.

2.3.2 Plans

Bangladesh Delta Plan 2100

BDP 2100 seeks to integrate the medium to long term aspirations of Bangladesh to achieve upper middle income (UMIC) status and eliminate extreme poverty by 2030 and being a prosperous country beyond 2041 with the longer-term challenge of sustainable management of water, ecology, environment and land resources in the context of their interaction with natural disasters and climate change. The mission of this plan is to ensure long term water and food security, economic growth and environmental sustainability while effectively reducing vulnerability to natural disasters and building resilience to climate change and other delta challenges through robust, adaptive and integrated strategies and equitable water governance. The whole of Bangladesh has been divided into six zones termed as Hotspots. Coastal Zone is one of the six hotspots. This plan provides specific strategies for solving the problems and addressing the challenges of the Coastal Zone. Those strategies are effective management of existing polders, increase drainage capacity and reduce flood risks, balancing water supply and demand for sustainable growth, reclaim new land in the coastal zone, Sundarbans conservation, increasing supply of freshwater through the restoration of rivers. This plan also puts emphasis on advancing the blue economy.

Perspective Plan 2021-2041

'Making Vision 2041 a reality: Perspective Plan of Bangladesh 2021-2041' (PP2041) is a long term Development Vision charting a path for two decades of transformation towards becoming an upper middle income country by 2031 and a prosperous country by 2041. The vision document consists of twelve chapters- including topics ranging from governance, human development, industry and trade, agriculture, power and energy to ICT and climate change and environment. The Strategic Goals and milestones of the Plan include industrialization with export-oriented manufacturing; paradigm shifts in Agriculture to enhance productivity, a service sector of the future-providing the bridge for the transformation of the rural agrarian economy to a primarily industrial and digital economy; the urban transition - an essential part of the strategy to move to a high-income economy primarily motivated by the agenda of the government -"our village, our town"; efficient energy and infrastructure; building a Bangladesh resilient to climate change and other environmental challenges; and establishing

Bangladesh as a knowledge hub country. It also includes macroeconomic framework which gives targets in each financial year of important macro indicators in more detail.

The PP2041 Vision for the environmental sector is to ensure a proper balance between ecology, the natural environment and needs of the population. In particular, the productivity of land is preserved, forest resources are conserved and enriched, bio-diversity is improved and water resources are properly managed to prevent flooding and water shortages, and the country is equipped to respond fully and quickly to any incidence of natural disasters.

8th Five Year Plan (July 2020-June 2025)

The Eighth Five Year Plan centers around six core themes, which are (i) rapid recovery from COVID-19; (ii) GDP growth acceleration, employment generation and rapid poverty reduction; (iii) a broad-based strategy of inclusiveness; (iv) a sustainable development pathway that is resilient to disaster and climate change; (v) improvement of critical institutions necessary to lead the economy to Upper Middle Income Country status by 2031; and (vi) attaining SDGs targets and mitigating the impact of LDC graduation. The plan document has been organized around two broad parts. The first part delineates the macroeconomic framework for the plan period (July 2020-June 2025) along with strategic directions and policy framework for promoting inclusiveness, reducing poverty and inequality. It also describes the resource envelop and overall fiscal management tools of the government and specifies the Development Results Framework (DRF) for proper monitoring and evaluation. The second part sets out the sectoral strategies for thirteen sectors (except defense) with some specific targets to attain by FY 2025. The ministries/divisions are expected to follow these sectoral strategies and action measures while preparing their sector specific projects and programs to achieve their respective targets set in the Eighth Five Year Plan.

Overall goal is to attain SDG targets and also eliminate extreme poverty by FY2031 and achieve High-Income Country (HIC) status by FY2041. Specific objectives are:

- To achieve GDP growth acceleration, employment generation and rapid poverty reduction;
- To restore human health, confidence, employment, income and economic activities;
- To empower every citizen to participate fully in, and benefit from, the development process;
- To provide a sustainable development pathway that is resilient to disaster and climate change, entails sustainable use of natural resources and successfully manages the inevitable urbanization transition.

7th Five Year Plan (7thFYP) 2016-2021

The 7th Five Year Plan (7thFYP) has been developed as a strategic and indicative plan that provides strategy, framework and guidelines for reducing regional disparity, developing human capacity, managing land constraints, using natural resources, increasing agricultural productivity, household income and employment, and ensuring food security. "Ensuring food security" has been outlined as a key strategy in the 7thFYP. In the case of food production, climate change adaptation strategy in the agriculture sector will be prioritized. Particular attention would be given to develop and adopt technologies and improved agricultural practices in ecologically vulnerable areas such as saline prone areas, flood-prone locations, and drought- prone locations. Special emphasis is given to the development of agro-processing and non-farm economic activities in the backward regions. Master Plan for agricultural development in the southern region of Bangladesh has particularly been mentioned for integrated development in agriculture in southern regions.

Bangladesh Climate Change Strategy and Action Plan (BCCSAP) 2009

BCCSAP aims to formulate a strategy for pro-poor, climate-resilient and low carbon development. Key pillars of this action plan are: (a) food security, social protection and health; (b) comprehensive disaster management; (c) infrastructure development; (d) research and knowledge management; (e) mitigation and low carbon development; and (f) capacity building and institutional strengthening.

National Adaptation Programme of Action (NAPA) 2009

NAPA has recognized the necessity of addressing the environmental issue and natural resource management with the participation of stakeholders in bargaining over resource use, allocation and distribution. This action plan identified 15 priority activities including general awareness- raising, capacity building, and project implementation in vulnerable regions with special focus on agriculture and water resources and identified 45 adaptation measures with 18 immediate and medium-term adaptation measures.

National Environmental Management Plan, 1995.

The National Environmental Management Plan (NEMAP) activities attempt to lead to better management of scarce resources, reducing the rate of environmental degradation, improving the natural and manmade environment, conserving habitats and biodiversity, promoting sustainable development and improving quality indicators of human life. NEMAP proposed actions and interventions for government agencies, NGOs and wider civil society and included activities relating to fisheries and agriculture.

Environment Policy and Implementation Plan 1992

The Ministry of Environment and Forest pronounced the environment policy and implementation program in 1992. Consideration was given in the policy to favour investment to adaptation for coping with adverse impacts of natural calamity, salinity intrusions in rivers, land erosion, rapid reduction of forest area, variable climate and weather conditions and other environmental problems.

Coastal Environmental Management Plan for Bangladesh 1988

In the late 1980s, the Economic and Social Commission for Asia and the Pacific (ESCAP) took the first initiative to formulate a coastal management policy in Bangladesh. A report titled "Coastal Environmental Management Plan for Bangladesh" was produced that addressed the most obvious problems of the coastal zone. The integration of socio-economic considerations into environmental issues was one aspect of the study.

2.3.3 Summary of Key PPPs, Main Projects, and Its Environmental, Socio-economic Impacts

Main relevant PPPs and their consequent environmental, social or economic impacts and why they arise, are briefly discussed in the Table shown below:

Table 2.2: A List of Key PPPs, main projects and environmental, socio-economic impacts from those projects

Key PPPs relating to the theme	Main projects emanating from the PPPs	Main negative environmental impacts emanating from the projects	Main negative socio-economic impacts emanating from the projects
National Rural Development Policy, 2001	• Padma multi-purpose bridge project • Bhanga-Payra Rail Link project	• Increased noise and air pollution due to traffic movement; • Increased risk of health hazards (e g from pollution); • Habitat fragmentation may cause biodiversity loss; • Increased marine pollution due to inadequate waste management;	• Increased migration from rural to urban area due to better facilities; • Increased conflict over ownership of land/property in roadside areas. • Increased slum-dwelling due to migration of displaced people to urban areas; • Loss of agricultural land; • Displacement of people
National Land Transport Policy 2004	• Padma multi-purpose bridge project • Bhanga-Payra Rail Link project • Road Construction Project	• Conversion of roadside agricultural land to commercial land/ industrial land – due to improving road accessibility; • Increased noise and air pollution (with consequent health issues) due to increased traffic and congestion.	• Change or loss of livelihoods for boatmen due to construction of new bridges in the rural areas; • The use of natural gas in domestic purpose has been cut down by Government due to increasing CNG use in vehicles which are creating • Increased urban fire accident due to increased illegal connection of gas.
Land use Policy, 2001	• Padma multi-purpose bridge project • Bhanga-Payra Rail Link project • Navy Land Acquisition • Payra Port Land Acquisition • Sena Kollan Organization Power Plant Land Acquisition	• Low lying land is higher in flood risk compare to high elevated land. • Payra Port Authority requires land to build infrastructures. It may cause loss of natural and recreational areas. • Number of unplanned infrastructures are increasing.	Poor individuals have to abandon their homes due to land reclamation

Key PPPs relating to the theme	Main projects emanating from the PPPs	Main negative environmental impacts emanating from the projects	Main negative socio-economic impacts emanating from the projects
	• 1320 Mega Watt Super Thermal Power Plant based on Coal at Patuakhali • Ashugonj 1320-Megawatt Super Thermal Power Plant	• Change in land use required under this policy might cause land degradation	
National Environmental Policy, 1992	• Padma multi-purpose bridge project • Sena Kollan Organization Power Plant Land Acquisition • 132/33kv Grid Power Plant • 1320 Mega Watt Super Thermal Power Plant based on Coal at Patuakhali • Payra Port Land Acquisition	• There is no solid waste, liquid waste management scheme, there is no system to make tourists aware. • Conversion of agricultural land and loss of wetlands due to construction of new railway corridors • Environmental pollution may increase. • Decreased wetland • Loss of agriculture and forest land • Destruction of natural habitant of wildlife.	• Involuntary resettlement, migration, and urbanization • Increse health risk for noise and air pollution
Environment Policy and Implementation Plan 1992	• Padma multi-purpose bridge project • Bhanga-Payra Rail Link project • Navy Land Acquisition • Payra Port Land Acquisition • Sena Kollan Organization Power Plant Land Acquisition • 1320 Mega Watt Super Thermal Power Plant based on Coal at Patuakhali • Ashugonj 1320-Megawatt Super Thermal Power Plant	• Air and water pollution may increase • Destruction of natural habitant of wildlife. • Land degradation may increase	
Coastal Environmental Management Plan, 1988	• Payra Port Land Acquisition • Navy Land Acquisition	• Increased navigation may disturb aquatic habitats	Establishment of new facilities and improvement/ modernization of existing infrastructure will harm the river and coastal ecosystem

2.4 Relevant Legislation and Regulations

2.4.1 The Environmental Court Act 2000

The Environmental Court Act 2000 recommends the establishment of environmental courts for the trial of offenses relating to environmental pollution. It includes protocols for the establishment of the court, and defines the court's jurisdiction, appropriate penalties, powers of search and entry, and procedures for investigation, trial and appeal.

2.4.2 Environmental Conservation Act, 1995

The Bangladesh Environmental Conservation Act and the accompanying Rules are arguably the most important legislative documents for addressing industrial water pollution. The Act is dedicated to the "conservation, improvement of quality standards, and control through mitigation of pollution of the environment". The Environmental Conservation Act (1995) deals mainly with processes and activities that result in pollution. This Act also makes provision for the protection of ecosystems. Under the Act, the government can declare "ecologically critical areas" in any area likely to reach environmentally critical conditions and can specify operations and processes that cannot be initiated or continued in those areas. The Act also confers power to the DoE to order corrective measures to be taken by any person believed to be responsible directly or indirectly for causing damage to the ecosystem.

2.5 Drivers of Change

Land resources changes are often governed by the use of land and other development activities happening in and around any stipulated area. Previously the people of Bangladesh were mostly dependent on agricultural practice. Things are also similar in the study area too. But it appears from land use analysis that agricultural land shrank. The remaining area is covered by built up area where industrial activities, urban and rural settlement expands. Decrement of agricultural land depends on three factors-

- Population pressure
- Degradation of land

2.5.1 Population Pressure

The population pressure in the study region is in the middle to high range. Our study area includes the upazilas of Patharghata, Barguna, Taltali, Amtali, Kalapara, Galachipa, and Rangabali. The Sadar upazila is where most people live. Although rural settlements occupy the majority of the area, there are more people than typical in the southern half of Kalapara Upazila. Many tourists visit every year to watch dawn and sunsets. In Kuakata, there are typically 4,000 to 5,000 visitors every day, but during the winter, when vacation time is at its peak, those numbers increase by three to four times. Additionally, a lot of hotels and resorts have been constructed close to the seashore to improve the visitor amenities. And it is estimated that in future the population number will increase in the projected area. At Kalapara, there is also a Payra Sea port that is now under construction. Because of the sea port, Patuakhali's economy will rise significantly, as will that of the south-western region of Bangladesh.

The likelihood of land degradation is growing as built-in areas encompass more and more of the landscape. The fast changes in social and economic development will affect how much land is covered. Additionally, a lot of the land resources would suffer from overpopulation.

2.5.2 Degradation of Land

As for the economic growth and the population density the land coverage is changing faster than usual. The agricultural lands and wetlands shrank and the settlement and other building area increased.

2.5.3 Summary of Drivers of Change

The following table lists the key changes and main external and internal drivers behind the changes occurring due to infrastructural development.

Table 2.3: List of Key Changes and Main External and Internal Drivers behind the Changes

Key change	Main external drivers	Main internal drivers	Main actions to "fuel" or "brake" the drivers, depending on whether the change is good or bad
Frequent Flooding	Intervention of river flow by Bridge, culvert and dam, Climate change	Unplanned Infrastructure development	Flood Protection, adaptation and mitigation measures Planned development
Vibrant economic growth	construction of regional road connectivity	Local Investment	Controlled development
Agricultural and forest land use change	High population growth	unplanned infrastructure development	Roadside tree plantation
Rapid Urbanization	development of regional transport system	Local demand of housing	Controlled development
Decrease of Aquaculture	Urbanization, Industrialization	Land use change	Wetland Conservation

2.6 Baseline Condition of Land Use

2.6.1 Physical Conditions

Geography

Our study area is located middle of south extended coastal zone of Bangladesh. This area is bounded in the south by Bay of Bengal. The Bay of Bengal is well-known for its cyclones, which whip up its water, sending them crashing onto the coastal plains of the offshore islands, occasionally causing floods. Also there are many scattered mangrove forest area on the Patharghata, Talali, Galachipa and Rangabali upazila.

Physiography

Bangladesh is located at the lowermost position of three giant river system - the Ganges – Padma river system, Brahmaputra – Jamuna river system and Surma – Meghna river system. Quaternary Sediments deposited from these three-river systems has formed this delta plain through which numerous rivers and distributaries of the three-river system runs. Most of the country is below 10 m contour line. As such, the water from melting ice of the Himalayas goes through the rivers of Bangladesh, and to the Bay of Bengal, located south of the country. In terms of physiography the country has been divided into three distinct regions - (a) floodplains, (b) terraces, and (c) hills. These regions have been divided into 24 sub regions and 54 units. The major sub-regions are as follows:

1. Old Himalayan Piedmont Plain
2. Tista Floodplain
3. Old Brahmaputra Floodplain
4. Jamuna (Young Brahmaputra) Floodplain
5. Haor Basin
6. Surma-Kushiyara Floodplain
7. Meghna Floodplain
8. Ganges Tidal Floodplain
9. Sundarbans
10. Lower Atrai Basin
11. Arial Beel
12. Gopalganj-Khulna Peat Basin
13. Chittagong Coastal Plain
14. Northern and Eastern Piedmont Plain
15. Pleistocene Uplands
16. Northern and Eastern Hill

Patuakhali and Barguna district fall in the Ganges tidal floodplain classified the coastal areas of Bangladesh under two broad categories viz. interior coast and exterior coast. Amtali, Taltali, Barguna Sadar, and Patharghata upazila of Barguna district and Galachipa, Rangabali, and Kalapara upazilas of Patuakhali district are among the exposed areas.

The tidal landscape of the Ganges Tidal Floodplain has a low ridge and a basin relief crossed by innumerable tidal rivers and creeks. Local differences in elevation generally are less than 1m compared with 2-3m on the Ganges floodplain. The sediments are mainly non-calcareous clays, but they are silty and slightly calcareous on riverbanks and in a transitional zone in the east adjoining the lower Meghna. As the upazilas are low-lying coastal areas, they are at risk of being affected by the sea level rise due to climate change (Brammer, 2014). The rivers going through the districts are The Andharmanik, Agunmukha, Payra, Lohalia, Patuakhali, and Tentulia of Patuakhali and Payra, Bishkhali, Khagdum and Baleshwar of Barguna.

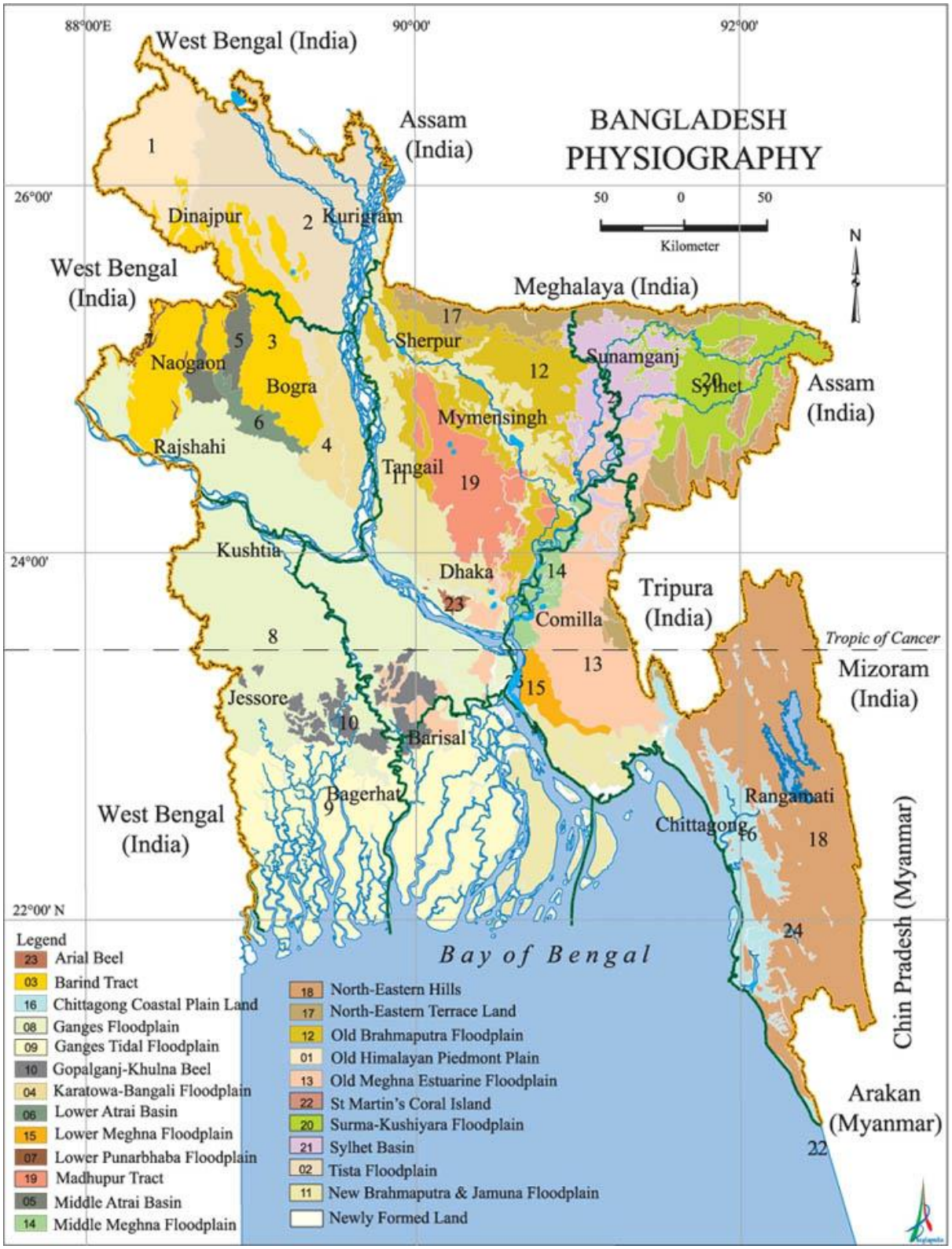


Figure 2.2: Physiography of Bangladesh

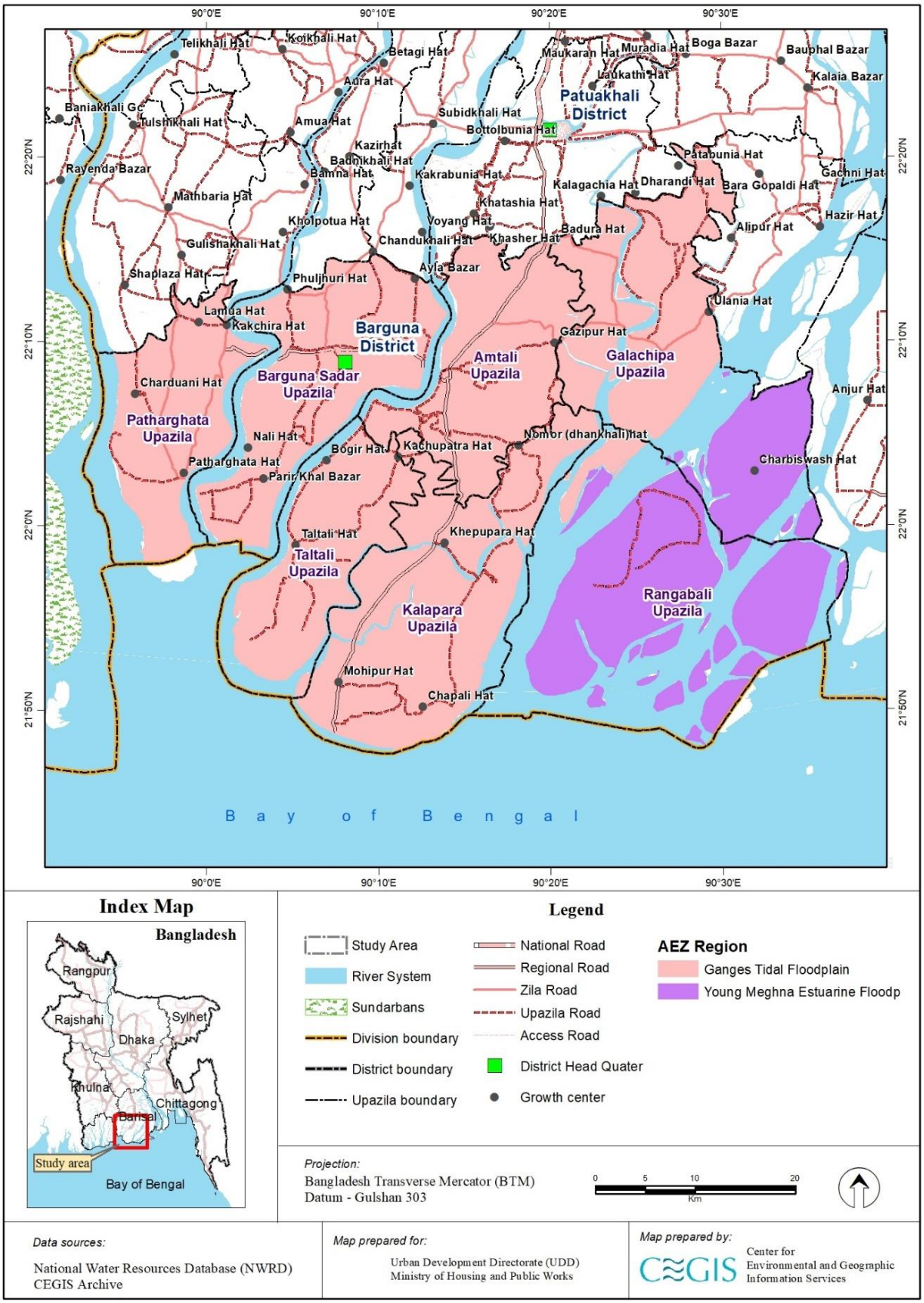


Figure 2.3: AEZ Map of the Study Area

Land Use

Data of upazila-wise land area distribution are presented in Table 1-3. Kalapara has the highest percentage of land area compared to its total area. Patharghata has lowest land area. Rivers are seen mostly in Galachipa upazila as it has a 44.89% river area. Amtali upazila also has the highest percentage (53.14%) of reserve forest area among the seven Upazilas. Lowest reserve forest is in Galachipa Upazila.

Table 2.4: Land Area Distribution of the Upazilas (sq.km)

Upazila	Land Area	(%)	Reserve Forest	(%)	River Area	(%)
Galachipa	463.06	51.79	29.68	3.32	401.31	44.89
Kalapara	467.11	94.96	21.05	4.28	3.73	0.76
Rangabali	260.4	69.57	20.6	5.5	93.32	24.93
Patharghata	234.11	17.54	37.29	38.37	115.96	29.01
Barguna Sadar	311.67	23.36	8.26	8.5	134.45	33.63
Amtali	539.3	40.42	51.64	53.14	129.81	32.47

Most part of the planning area falls under medium land meaning its flat. Galachipa upazila stands out as the flattest area having no high or low land. Amtali and Taltali upazila's some part is low lying areas, while Amtali has the largest area of high land among the seven upazilas. Other upazilas are mostly flat with little or no high or low land.

Figure 2.4: Existing Land Use of Upazilas

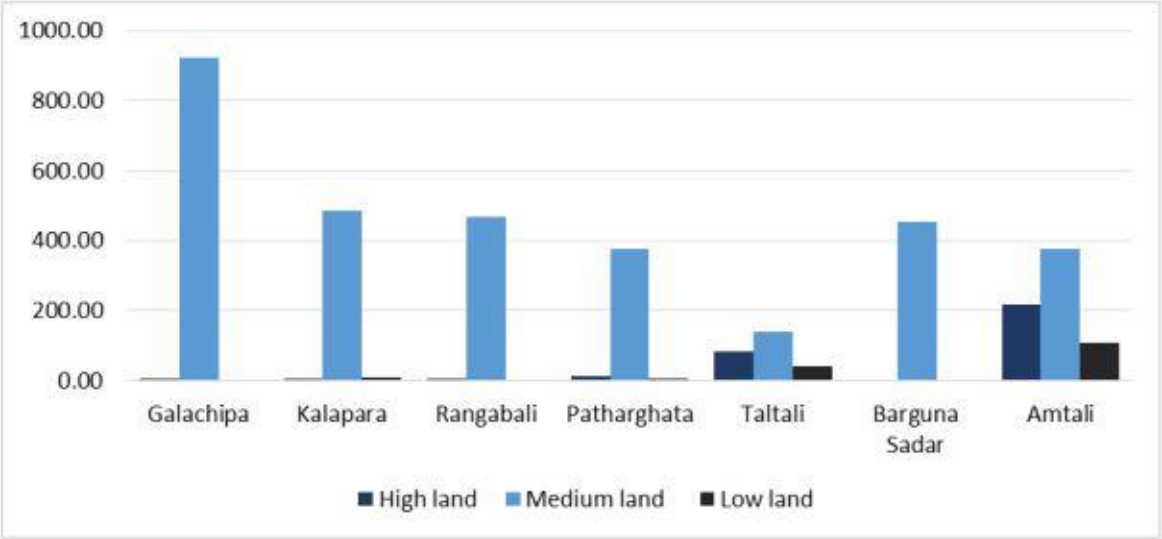


Figure 2.5: Area of High, Medium and Low Land

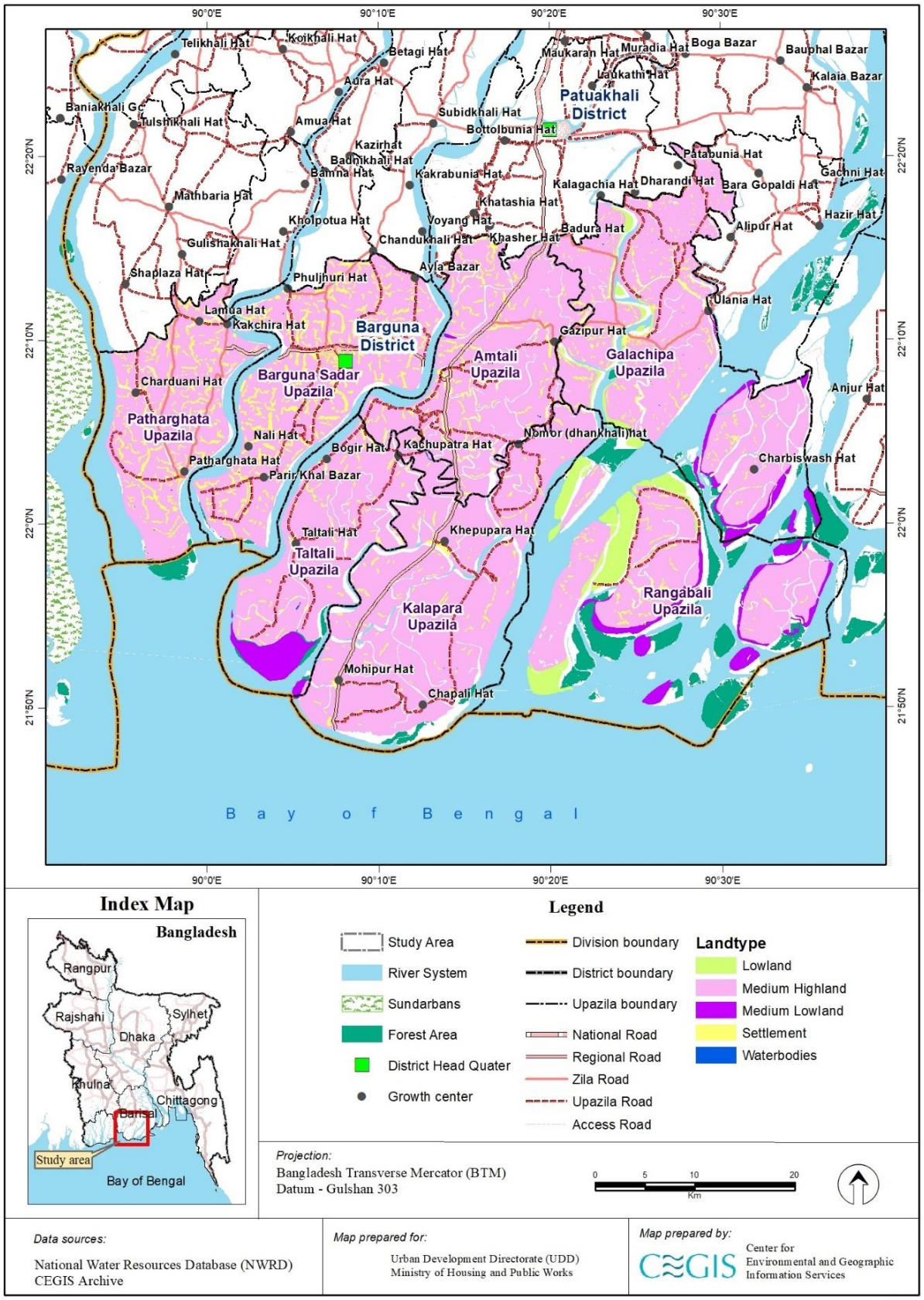


Figure 2.6: Land Type of Study area

Soil

Soil structure of the planning area is classified into four categories – Doash, Bele, Etel, Kankar and Others. Most parts of the planning area have Doash soil with highest areas in Galachipa and Amtali upazilas (Figure 1-7). Amtali and Taltali upazilas contain some Bele soil. Other upazilas are mostly characterized by Doash and Etel soil.

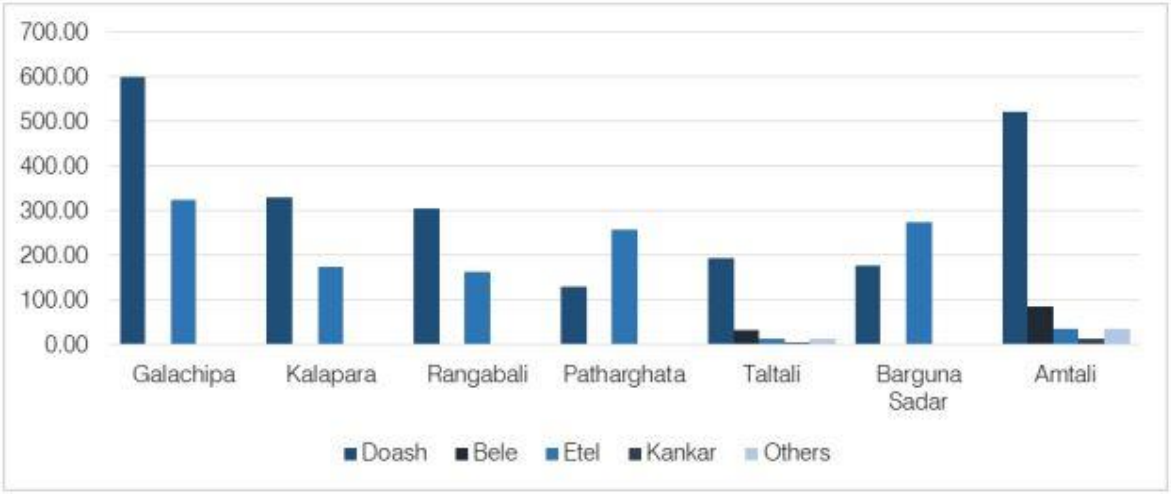


Figure 2.7: Soil Type

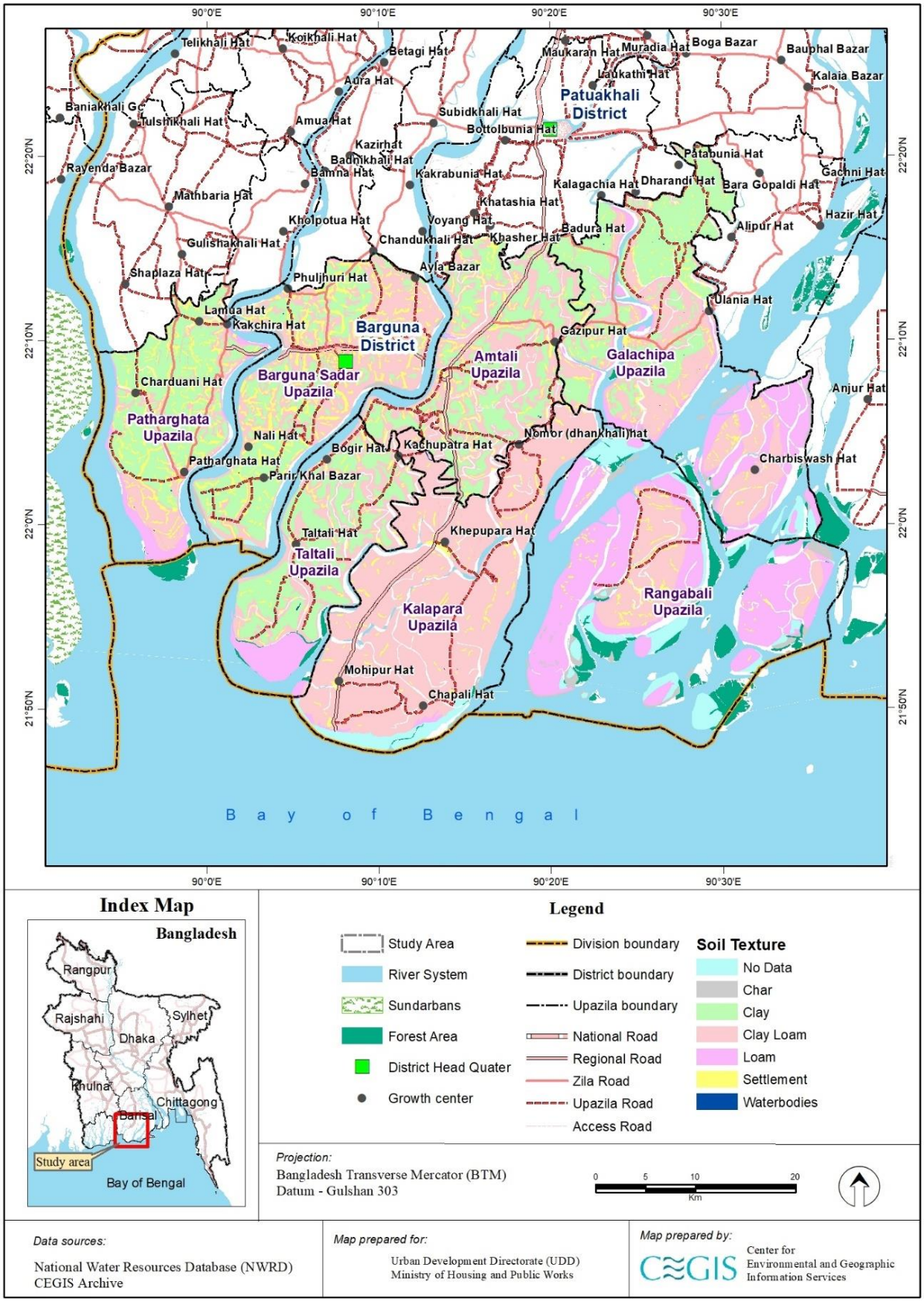


Figure 2.8: Soil Texture Map

Agro-and Bio-ecological Regions and Land Cover

AEZ-13: Ganges Tidal Floodplain

This region occupies an extensive area of tidal floodplain land in south-west of the country. The greater part of this region has smooth relief.

There is a general pattern of grey, slightly calcareous, heavy soils on river banks and grey to dark grey, noncalcareous, heavy silty clays in the extensive basins. Noncalcareous Grey Floodplain soil is the major component of general soil types. Acid Sulphate soil also occupies significant part of the area where it is extremely acidic during dry season. In general, most of the topsoils are acidic and subsoils are neutral to mildly alkaline. Soils of Sundarban area are strongly alkaline. General fertility level is high with medium to high organic matter content. AEZ-13 area are consisted most of Barishal, Jhalakathi, Pirojpur, Patuakhali, Barguna, Bagerhat, Khulna, Satkhira districts including Khulna and Bagerhat Sundarban Reserved Forests.

AEZ-18: Young Meghna Estuarine Floodplain

This region occupies young alluvial land in and adjoining the Meghna estuary. It is almost level with very low ridges and broad depressions. The major soils are grey to olive, deep, calcareous silt loam and silty clay loams and are stratified either throughout or at shallow depth. Calcareous Alluvium and Noncalcareous Grey Floodplain soils are the dominant general type. The soils in the south become saline in dry season. Top soils and subsoils of the area are mildly alkaline. General fertility is medium but low in organic matter. Chattogram, Feni, Noakhali, Lakshmipur, Bhola, Barishal, Patuakhali and Barguna districts are remained in AEZ-18 area (*Yearbook of Agricultural Statistics 2021*).

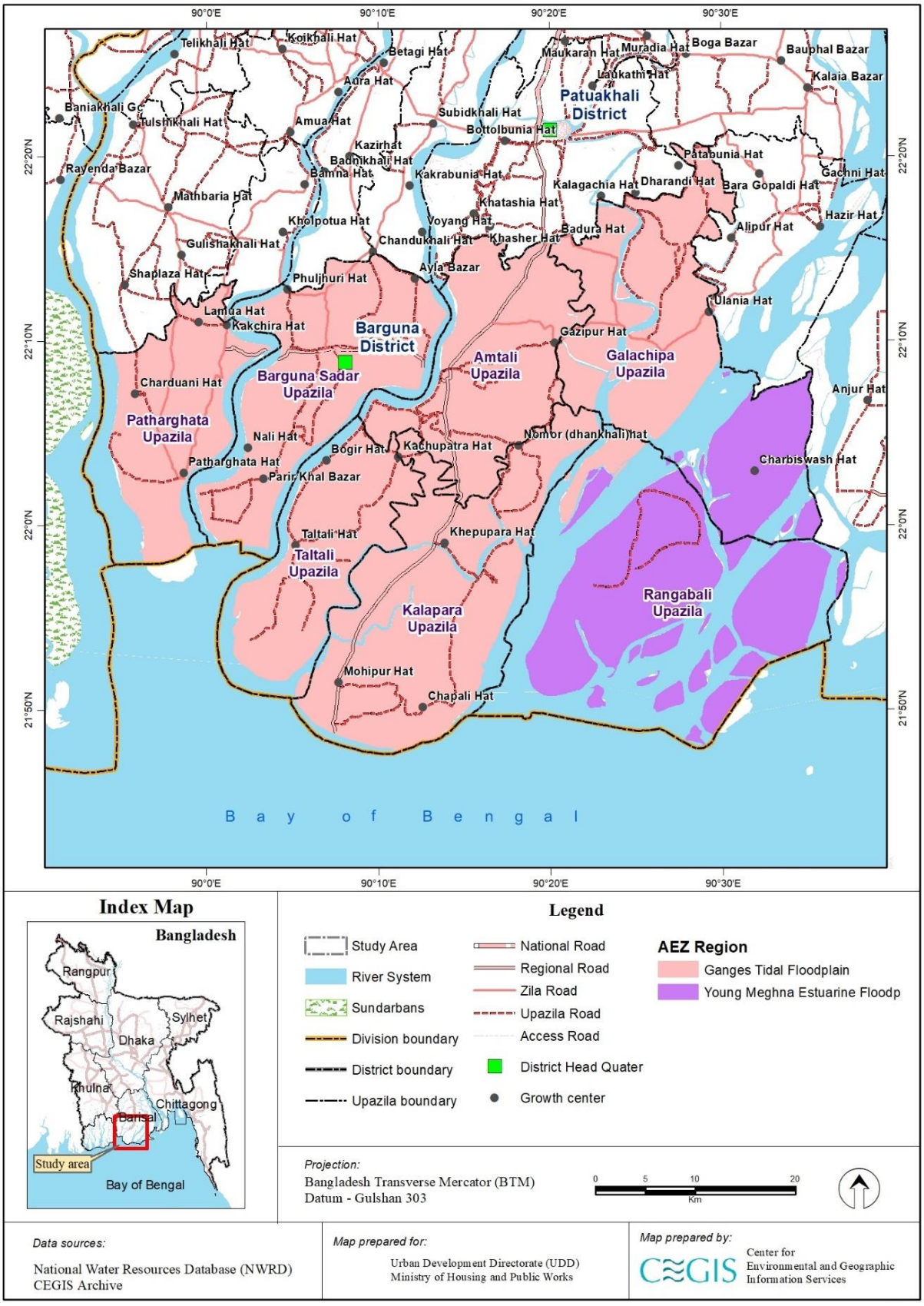


Figure 2.9: AEZ Area Map

Land Resources Management Practices

Current Scenarios

A union level multi-criteria analysis shows the potential areas for development and the criteria are- Road length in the union, Structure frequency in the union, Number of various socio-economic facilities available in the union, and Population size of the union. By combining these criteria, an index value was developed and based on the index values, 14 unions or pourashavas were found to be of high development potential. 18 pourashavas or union were found to be moderately potential for development. A further analysis was performed to identify the potential location for eco-town development. All eco-towns should comply with planning policy statements including those relating to sustainable development such as: climate change adaptation, pollution control, open space, biodiversity, transport, and flooding, housing and economic development. Excluding Payra port area and 10-minute walking distance buffer area, flowing suitable areas has been identified.

A field study was carried out, to determine the present state of the project's onsite and off-site areas. Seven initial sectors have chosen, including land development, social infrastructure, tourism demand, transportation, the environment & ecology, land use, and on-site and off-site activities. The effects of the development and other activities on the study region were comprehended according to this field survey. The current situation of the land-use is showing in the following Table 2.5.

Table 2.5: Issues and Relevant Current Land Use

SL	Issue/Sector	Current Situation of land use
1.	Land Development	
	• Urban area • Utility facilities (Water, Electricity, etc.)	• There are hotels, resorts, growth centers, educational institutions, markets, stationary, cyclone centers etc. Since this is a cyclone-prone area, more cyclone centers are needed in urban areas. • The industry sector is not developed; industry has to be built. • Electricity facilities are available everywhere, but water facilities are not available everywhere except in the municipality.
2.	Social Infrastructure	
	• Livelihood pattern • Ethnic group • Economic status of inhabitants • Social Security system	• Their main occupations are: agriculture, fishing, grocery shop, selling vegetables in the market, selling tea/coffee, hotel business. • There are some Rankine in Kuakata. • Religious institution: Buddha, Muslim, Hindu • There are Police, Ansar, Administration, village police, Meyor, Chairman, Commissioner etc. But social security needs to be increased.
3.	Tourism Demand	
	• People's choice of tourism for their livelihood • Tourism based knowledge • Impact of tourism on environmental elements • Impact of tourism on ecosystem • Security system	• People want mangrove based eco-tourism if communication can be improved. • Tourism based knowledge is very low. There is no institutional training, Training can be arranged with the help of jubo unnayan proshikhyon Kendra. • There is no solid waste, liquid waste management scheme, there is no system to make tourists aware. • The security system is not well developed. • Lack of adequate police, watch tower. • If tourism develops, pressure may increase on the eco-system • Environmental pollution may increase.

SL	Issue/Sector	Current Situation of land use
4.	Transportation	
	• Road network • Rail network • Waterways • Navigation • Network • Sea port • River port	• The road network from district to district is good, but road network is not good at upazila level. • There is no rail network yet, Payra-Dhaka has a proposed rail network. • There are at least 2 ferry ghats in all the upazila, however the number of ferries must be increased. • Water navigation network: Good • Sea port: Payra port • River port: Patuakhali port
5.	Environmental and Ecosystem	
	• Agricultural • System • Fisheries • Flora • Fauna	• Agricultural land is good here, watermelon, sunflower, mugdal are the main crops here. • Cold storage needs to be increased. • River ecosystem, lowland ecosystem, mudflow/ charland & mangrove ecosystem. • Flora: Shundari, Golpata
6.	Land use	
	• Aquaculture • Cropland • Grassland • Forest land • Settlements • Wetlands	• Less aquaculture, more open water. • Cropping intensity more than 200%. • Grass land: Few • Forest land: Mangrove forest, Social forest • Wetland: Khal, Canal

2.6.2 Major Challenges and Issues

People in the Payra-Kuakata region live in an extremely dynamic estuarine environment facing such threats as: cyclone and storm surge, land erosion, flood, drainage congestion, salinity intrusion, drought, tectonic process and deteriorating coastal ecosystems. Besides, there are threats of climate change and upstream land, and water uses. These threats affect almost every aspect of life and limit livelihood choices of the people. These vulnerabilities create a context of insecurity, which in turn, discourage investments, limit economic activities and squeeze employment opportunities. An effective disaster warning system is being developed and comprehensive disaster management program (CDMP) is being implemented.

Agricultural activities suffer greatly by different degree of water and soil salinity as well as lack of safe drinking water. The water supply sector has achieved commendable success over the last few decades; overall about 95 percent of the population now has access to water from tube-wells, taps or ring-wells. The coastal zone of Bangladesh experiences extensive ecosystem degradation, e.g drainage for agriculture; dredging and canalization for navigation and flood protection; filling for solid waste disposal; land use for commercial, industrial or residential purposes; conversion of land for aquaculture; construction of dykes for flood control and irrigation; discharge of pesticides and herbicides; domestic and industrial waste; agricultural runoff and sediment; deep channels and other structures; hydrological alternation by canals; roads and other structures; and subsidence due to extraction of groundwater.

Cyclone and Storm Surge

Records of last 200 years show that at least 70 major cyclones hit the coastal belt of Bangladesh. The Khulna/Sundarban and Barisal-Noakhali coasts received about 30 percent of the cyclones. Figure 2-1 shows the cyclone affected areas in Bangladesh. Payra-Kuakata region falls in the high risk area. In order to minimize fatal consequences of cyclones, construction of cyclone shelters commenced in the 1960s and subsequently increased following the severe cyclone in 1991. The existing shelter capacity can accommodate only about a quarter of the population at risk. In the backdrop of increasing population, 100 additional cyclone shelters are needed annually. An effective disaster warning system is being developed. A comprehensive disaster management program (CDMP), under the auspices of the Disaster Management Bureau (DMB) and the Bangladesh Red Crescent Society, is being implemented.

Land Erosion

Land erosion is a common natural phenomenon in the coastal zone. Massive changes have occurred in the coastline over the last two centuries due to land erosion, coupled with land accretion. Boundaries of islands undergo major changes due to land erosion and simultaneous accretion. Erosion victims are a disadvantaged group in coastal areas subject to both social and economic distress. Besides the erosion of the riverbanks, the foreshore and the embankment systems are posing a continuous problem in the coastal areas. This exposes interior lands to the threats of cyclone surges and salt-water intrusion. River erosion has taken a serious turn in Patuakhali and Barguna, districts, and many families have become homeless. Some 30,000 houses, many commercial establishments, hundreds of educational institutions, and over thousands of hectares of cropland have been devoured by different rivers in the southern districts during last 10 years.

Water Logging and Drainage Congestion

Water logging is especially experienced in the southwest (Khulna-Jessore) and south- central (Noakhali-Lakshmipur) areas. In the southwest, Khulna-Jessore Drainage Rehabilitation Project (KJDRP) was taken to reduce drainage congestion. The concept of Tidal River Management (TRM) has been reinforced from this project. Localized drainage congestions are reported throughout the coastal zone. All congestions affect livelihoods because of crop damage, water borne diseases, etc. Most affected districts are Bhola, Patuakhali, Pirojpur and Barguna.

Salinity Intrusion

Water and soil salinity is a common hazard in many parts of the coastal zone. Agricultural activities suffer greatly. Seventy percent of 2.35 million hectares within the Khulna and Barisal Divisions is affected by different degree of soil salinity. This reduces the crop area. It restricts the cultivation of aus (summer rice), boro (dry season rice) and other rabi (dry season) crops. There is a seasonal salinity interface in the estuaries, with the threshold limit for agriculture moving further inward from the coast in May in the southern part of the coastal zone. In the southwest region, surface water salinity has been accentuated by the reduction in the dry season upland flows entering the Gorai distributaries. Salinity now reaches as far as Khulna city, creating problems to normal agricultural practices and affecting the supply of clean water for industrial use. Coastal polders were designed to prevent salt-water intrusion. Many polders have lost their function because of both undesired breaching causing crop damage, and "desired breaching" facilitating shrimp farming. Land use conflicts exist in the area. Salinity intrusion inhibits industrialization. For example, a number of industrial units in Khulna are facing shortage of fresh water during the dry season. As a consequence, no new heavy industry has been set up in the recent years in the Khulna region despite increasing infrastructure facilities (road, seaport, etc.).

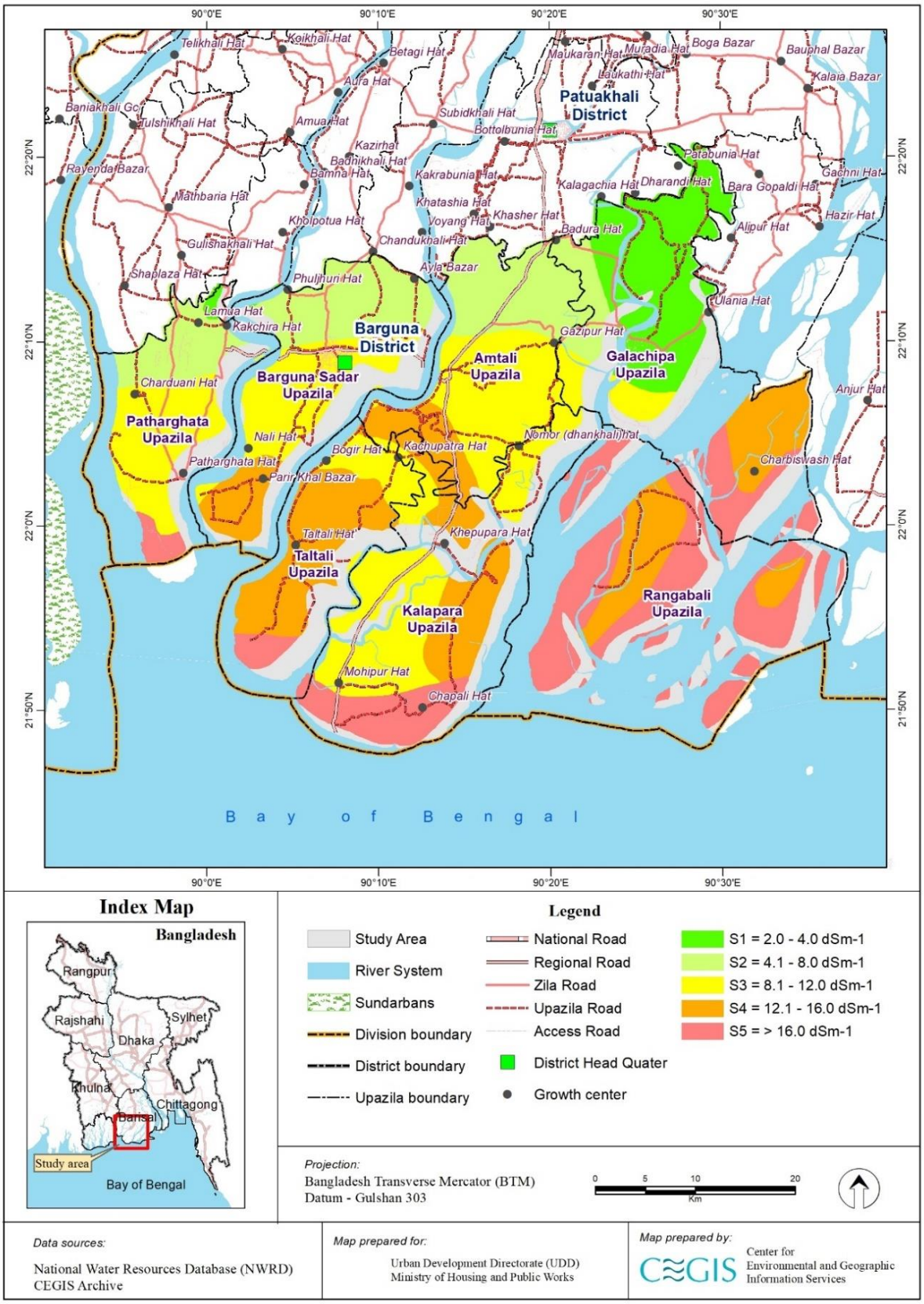


Figure 2.10: Soil Salinity Map

Drinking Water & Arsenic Contamination

Lack of safe drinking water has been identified as the number one issue in the daily life of the coastal population. The water supply sector has achieved commendable success over the last few decades; overall about 95 percent of the population now has access to water from tube-wells, taps or ring-wells. Rural water supply is mainly dependent on tube-wells. Pond water is also in use, especially where groundwater is either saline or beyond affordability. There are 316,686 tube-wells in the coastal zone, which is 29 percent of total tube-wells in the country. According to latest DPHE data (unpublished DPHE database), the tube well-population ratio is slightly higher in the coastal zone: 111 persons per running tube well, compared to 115 nationally. The districts in the region, that is, Patuakhali and Barguna have lower than average density of tube-wells nationally. But in recent years, groundwater-based water supply in coastal areas is suffering from a number of major problems, main ones being arsenic contamination, lowering of the water table, salinity, and non-availability of suitable aquifers. Most of the coastal districts are affected by arsenic contamination. The UNICEF-funded DPHE program tested 51,000 tube wells in 61 districts and found arsenic in 48 districts. Around 29 percent tube-wells were contaminated with arsenic above the permissible level. The Government has initiated extensive program of tube well testing and public awareness of the possible danger. Low-cost preventive measures are known but yet to be available at the household level all over the coast. Rainwater harvesting and pond sand filtering (PSF) are being advocated and are practiced in some areas.

Ecosystem Degradation

The coastal zone of Bangladesh experiences extensive ecosystem degradation. Some of the interventions to cause degradation are: drainage for agriculture; dredging and canalization for navigation and flood protection; filling for solid waste disposal; land use for commercial, industrial or residential purposes; conversion of land for aquaculture; construction of dykes for flood control and irrigation; discharge of pesticides and herbicides; domestic and industrial waste; agricultural runoff and sediment; deep channels and other structures; hydrological alternation by canals; roads and other structures; and subsidence due to extraction of groundwater. Although the rate of destruction of mangroves is less as compared to the overall destruction of forests, comparison of aerial photographs from mid-eighties to early nineties shows destruction at annual rate over 2,000 ha (UNEP website). Factors responsible for the destruction of the mangrove forests are the removal of forest products for fuel, high pressure of grazing, haphazard fishing activities, human settlement, salt production and shrimp farming. Some initiatives have been taken for conservation and restoration of the ecosystems. But these are not linked with livelihoods of traditional users. Comprehensive ecosystem management plan does not exist.

Climate Change

Given the extremely low elevation of the coastal zone, the threat of sea level rise is high. The likely impacts of climate change are:

- change in water levels and induced inundation and water logging;
- increased salinity in ground and surface water, and corresponding impact on soil salinity;
- increased coastal morphological dynamics (subsidence, erosion and accretion)
- increased incidence of natural hazards;

Drainage congestion may become an even more serious threat than higher flood risks. Due to siltation and poor maintenance of the drainage channel networks in many parts of the coastal zone, drainage congestion is already a grave problem, and the problem is likely to increase considerably. Saline water intrusion is highly seasonal. It is at its minimum during the monsoon (June - October) when the main

rivers discharge about 80 percent of the annual fresh water flow. In dry season months, the saline front begins to penetrate inland, and the affected areas rise sharply from 10 percent in the monsoon to over 40 percent. Extreme weather events induced by climate change, especially low flow conditions in the dry season, will accentuate the saline intrusion in the coastal areas. Climate change is expected to increase the intensity of cyclones, resulting in the penetration of storm surges further inland, causing higher damages. Coastal polders offer the first line of defense against sea level rise. But maintenance of sea dykes of polders has to be continued.

2.7 Development Potentials

2.7.1 Tourism Development Potential

Payra-Kuakata region offers ample opportunities for creating facilities for tourists. The region is home to unique flora and fauna and possesses many panoramic beauties. Forests, beaches, lakes and rivers make the region ideal place for ecotourism development. Based on various locations that could be attractive for tourists, a composite tourist zoning map has been prepared that identifies 13 zones which have important characteristics that may attract tourists both domestic and international. Three of these locations are attractive because of high quality beach, five have a combination of forest and char (small island) and another five have both beach and mangrove forest. For proper development of these zones recommendations have been made for provision of adequate and proper Tourist Service Infrastructure for attracting tourists from home and abroad.

2.7.2 Developing the Transportation System

A comprehensive plan is to promote tourism and to enhance socio-economic and infrastructural development as the transportation model suggests the proposed land use change will significantly increase vehicular movement in the network for the future scenario, i.e., expansion of road network can handle the future traffic demand and the network will not overly have congested, i.e., decent operating speed can be achieved. This also justifies that the proposed road network is sufficient. Recommendations have also been made to improve the water transportation system by addressing the problems related to (i) siltation, (ii) day & night navigational problems, (iii) shortage of passenger & cargo handling facilities including transit shed at river ports, (iv) Presence of manual loading/unloading of cargo at river ports, (v) underdeveloped rural launch landing stations, inadequate number of watercrafts etc.

2.7.3 Land Zoning

Figure 2.11 shows upazila-wise existing land use while Table 2.6 presents percentage distribution of areas by land use. Table 2.6 shows that more than 99% of the land in all the seven upazilas are used for non-urban use that includes parts of Bay of Bengal, Boro T-Aman, fallow land, mangrove forest, pond, Rabi, river/canal, Robi T-Aman, settlement with homestead forest, T-Aman, tidal flood plain, and tidal flat/sea beach. Around 1% of the land is used as urban area in Patharghata and Taltali; whereas, urban area in Amtali and Galachipa is about 0.70% of the total land. Only few portions of the total land are used as urban area in Kalapara (0.41%) and Barguna Sadar (0.15%).

Table 2.6: Existing Land Use of the Study Area by Percentage Distribution

Land Use	Upazila						
	Amtali	Barguna Sadar	Galachipa	Kalapara	Patharghata	Rangabali	Taltali
Bay of Bengal	0.00	0.82	0.00	2.66	1.92	2.70	4.57
Boro T-Aman	20.84	21.84	0.00	0.00	47.94	11.15	7.86
Fallow Land	1.65	0.00	2.32	2.53	0.00	2.52	3.07
Mangrove Forest	0.00	1.10	11.39	2.11	0.87	15.65	4.11
Pond	9.26	0.00	0.00	2.15	0.00	0.00	1.82
Rabi	27.03	28.57	0.00	0.00	29.08	0.00	43.50
River/Canal	21.38	10.80	9.92	21.39	7.62	14.69	14.81
Robi T-Aman	0.00	0.00	0.00	20.03	0.00	0.00	0.00
Settlement with Homestead Forest	18.33	36.27	61.94	21.76	9.69	36.00	15.07
T-Aman	0.75	0.00	10.68	22.08	0.00	9.44	0.00
Tidal Flood Plain	0.00	0.00	3.05	0.00	0.00	7.86	0.00
Tidal Flat/Sea Beach	0.00	0.26	0.00	4.85	0.00	0.00	2.97
Urban Area	0.75	0.15	0.70	0.42	0.96	0.00	1.00
Undefined Use	0.00	0.18	0.00	0.00	1.92	0.00	1.23
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

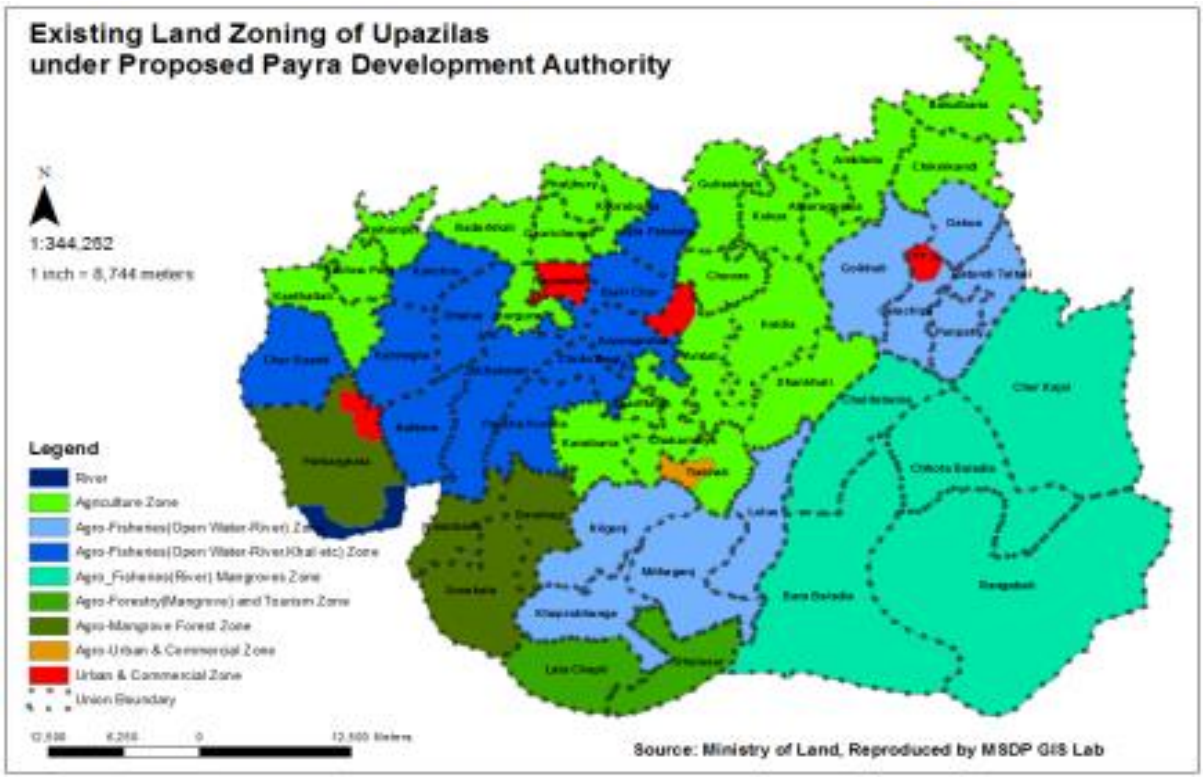


Figure 2.11: Existing Land Zoning of Upazilas by Ministry of Land

2.7.4 Development Plan of the Design

Development plans for PKCP land-use are mentioning in Table 2.7.

Table 2.7: PKCP Development Plan

Plans	Facilities development	Land use
Socio-economic conditions development	Educational institution Health centers Growth centers and markets Cyclone shelters	• Land use changes are arising due to population and economic growth of this area, examples: infrastructures & urbanization, etc. Impacts of this include loss of biodiversity, reduced soil productivity and loss of livelihood opportunities. • Exploring Geomorphological, Geological, Engineering, Geophysical properties of the surface and subsurface condition of the study area to rank suitable sites for physical development and to prepare risk sensitive land use plan. • For socio-economic conditions development, some educated people will move to urban areas/ overseas for employment. Migrant remittances can supplement family incomes and contribute national economy. • Industrialization of the inland parts of this area can create air & water pollution as well as other potential impacts on biodiversity & livelihoods of the region. • Rapid urbanization can affect the existing land use pattern and agricultural productivity. • Rural growth centers will be plotted in the plan to specify particular areas to perform rural hat-bazar activity. These centres will be connected by major transport network and serve as rural urban linkage centers.
Regional land-use development	Commercial area development Residential area development Agricultural zone Park and recreation Wetlands Rural settlement	• Creation of proper and affordable accommodation along with related facilities is very important. • These may include the following: Accommodation: hotels, restaurants, homestays, Catering and food services: coffee/ tea shops, fast food shops etc., Souvenir shops, recreation facilities, parking facilities. • Short-term rental bungalows that are cheap and clean, but cozy in design are ideal for international tourists. Setting up tourist-friendly villages will entice backpackers and adventures. • The government has an opportunity through public/private partnerships to construct bungalows, tourist complex in attractive spots. • Homestays with double-room cabins made from wood and thatched roofs would be ideal and ecofriendly for this area. • Realizing the tourism potentiality of Sonar Char in Rangabali upazila, Bangladesh Parjatan Corporation (BPC) proposed a tourist complex at Sonar Char. This is an excellent tourist location but cannot be attractive unless electricity supply is ensured. • Steps should be taken to prevent unplanned infrastructural development and undertaking of unplanned activities in the defined restricted tourism areas and special tourism zones. • Most of the lands in this area are under agricultural use and contribute to local economic development. The fertile land characteristics and availability of water channels have made this

Plans	Facilities development	Land use
		area prospective for agriculture, fishery, poultry and livestock rearing. • Watermelon, Sunflower, Mugdal are the highest yields here, so building industry based on these products would be more profitable. The amount of cold storage should be increased.
Tourism development	Transportation Utilities Accommodation Marketing and management Safety and security of tourists Environmental safeguards	• Transportation linkage to different tourism spots by road, rail, air and water is not sufficient. A master plan of transportation network should be prepared and implemented so as to enhance the accessibility of tourists to existing tourism attractions of the region. • Special attention should be given to establish connectivity of Rangabali upazila with the mainland, especially with Galachipa and Kalapara Upazilas by providing ferry service. • Feasibility of undertaking a project should be explored to supply electricity produced in non-grid Bhola Island to Rangabali by setting up a gridline from Bhola. • For facilitating communication with international tourists the government could take up programs to educate the owners with basic hospitality-level English, enough to set their guests up and to give them directions around the village to nearby hot spots. • Website of the Bangladesh Parjatan Corporation (BPC) should be well developed with adequate information such as Photographs of renowned places, accommodation facilities, modes of transportation, distance from capital city etc. • Waste water management system needs to be improved. • Safety and security should be increased for tourists. Already the government of 'Bangladesh has formulated "Tourist Police". But their capacity in terms of human resources and infrastructure need to be strengthened. • People want mangrove based ecotourism when communication is improved.
Transportation	Road network development Navigation route development	• The transportation model developed under this project will optimize the overall transportation system and business activities associated with the major transportation hubs like Payra port and kuakata Sea beach as well as other small to medium growth centers in the project area. • The road network comprising of road category of zila road and regional roads exhibit high operating speed and the local road networks are operating at lower speed. Also, bottle necks in the study area can only be seen at points where there is a ferry, i.c., construction of bridges will alleviate that congestion. • The proposed land use change in the study area will significantly increase vehicular movement in the network for the future scenario, i.e., an indication that the proposed expansion of road network can be justified to handle the future traffic demand.
Payra port development	Port navigation development Warehouse development	• Payra Port Authority requires land to build infrastructures. It may cause loss of natural and recreational areas.

Plans	Facilities development	Land use
	Terminals development	• Infrastructure development of Payra port may be reduced access to culturally important areas and landscapes, reduced viability of commercial fishing land, reduced road and marine safety. • Physical displacement of people and their settlements may occur. • Economic displacements of agricultural and fisheries livelihoods. • It can create primary employment, business opportunities, property values and marketability, demand for housing which can contribute to the economy.
	Jetty development	
	Four lane connecting roads	
	Airport development	
	Railway network	
	Exclusive economic zone	
	Power plant development	
	LNG terminals	
	Shipyards	
Payra Development Authority and integrated Development	Beach conservation	• Conservation zone set asides ecological sensitive spaces in order to ensure sustainable use of space. • Post-centric urban zone and a township need to be developed adjacent to the port area. • A number of beaches and chars are important zone for conservation with potentiality for tourism and forest for their scenic beauty. • Low lying land is higher in flood risk compare to high elevated land. This is the depression area which needs to be identified based on its level of inundation to reduce environmental risk and mandatory loss of establishment as well as human livelihood. • Mangrove and other natural and man-made forest areas will be identified to develop forest-based tourism activity as part of comprehensive tourism development in the coastal region. • Char lands need an eco-friendly development strategy so that physical structures do not interrupt natural environment. • There are a number of beaches, historic visiting places and tribe community in the mainland of the project area which can be interesting sites for tourists for visiting.

2.8 Land-use Change and Impacts

2.8.1 Land Use Change

Data from the CEGIS archive has been used to analyse changes in land use. Wetland and cropland areas steadily decline in size over the course of nine years, according to the results of landuse data. The cropland area was around 146357 hectares in 2010 and has decreased by 565.71 hectares during the past ten years. The highest decreased land is wetland. A total of 6363.66 hectares of wetlands have been degraded during the last 10 years.

Table 2.8: Land-use Change

Class Name	Area in Ha 2019	Area in Ha 2010	Change
Aquaculture	129.2659	29.47	99.79
Cropland	145791.3	146357	-565.71
Forest Land	16716.07	16045.81	670.26
Grassland	1225.699	929.52	296.18
Orchard and Other Plantation (Tree)	141.538	43.45	98.09
Other Lands	6401.318	2397.84	4003.47
Settlements	61987.1	60225.54	1761.56
Wetlands	66318.86	72682.52	-6363.66

Source: CEGIS data source

2.8.2 Potential Land-use Impact

Potential Impact assessment will be assessment will be starting through the land-use classes namely Aquaculture, Cropland, Forest Land, Grassland, Orchard and other plantation, other lands (including, built in, sandbar, waste land), settlements and wetlands. Impacts will be identified in depth to the environment and social settings depending on the temporal and spatial basis. Some of the potential common impacts and their determination methods have been discussed below:

Aquaculture

The size of the impact is minor since the aquaculture area rose by 99.79 hectares in 2019, which is a negligible change. Shrimp and fish farming are not very prominent in this area.

Cropland

By the year 2019, the farmland area was down by about 565 hectares, and the range is clearly changing. In a short amount of time, the amount of growth centers and other commercial centers are growing, while agricultural land is disappearing. The majority of the locals in this study region are engaged in business rather than farming. However, a reduction in farmland area could hinder food productivity and raise food insecurity.

Forest Land

By 2019, 670 hectares in forest land increased. The government focused on establishing an eco-friendly tourism region and reserving the forests in this area because it is a popular tourist destination. To safeguard the region against cyclones and strong storm surges, numerous tree planting programs were carried out by various NGOs and groups.

Grassland

In 2019, grassland was more prevalent, especially in the char-land region. The majority of the undeveloped char lands are covered in grassland towards the south, where there are many char lands growing. Natural char lands could be used for agriculture, but artificial char fields could obstruct a river's natural flow. Flooding and water logging could result from blocking the river's natural flow.

Settlement

In ten years, the study area's population grew. However, the population of study area is expected to increase rapidly in the future as because it becoming economic zone and tourists place. The ecosystem will be at risk if the government is unable to regulate the amount of resettlements in tourist zones. The fauna and flora will vanish.

Figure 2.12: Land Use Map of 2010

Figure 2.13: Land Use Map of 2019

3. Ecosystem and Biodiversity Conservation including Forests

3.1 Ecological Importance of the Study Area

Ecological resources are natural resources that provide certain necessary but overlooked system maintenance functions within ecosystems. They are important to most aspects of our lives. We value ecological resources for many reasons, some utilitarian, some intrinsic. Utilitarian values include many basic needs humans obtain from ecosystems such as food, fuel, shelter, and medicine. Ecological resources also hold value for potential benefits that have not yet been recognized. Ecosystem services, on the other hand, are generally "improvements in the condition or location of things of value". These include things like the maintenance of hydrological cycles, cleaning air and water, the maintenance of oxygen in the atmosphere, crop pollination and even things like beauty, inspiration and opportunities for research.

Bangladesh is situated in between the Indo-Himalayas and Indo-Chinese sub-regions with distinct physiographic characteristics, variations in hydrological and climatic conditions and differences in the soil properties contribute in developing diverse forms of ecosystems with rich flora and fauna. This country enjoys a diverse array of ecosystems and natural resources within a relatively small geographic boundary thus the biological environment is pretty enriched here. The study area falls in the coastal part of the country that is vulnerable to the coastal hazards but also houses one of the world's richest ecosystems characterized by fertile soils and mangrove forests. The combined effects of sea-level rise, increased intensity of cyclone and associated storm surge, coastal erosion, and salinity intrusion pose a rising threat to these natural resource base and livelihood opportunities of coastal communities that is likely to be greater in the future. And the coastal populations are mostly poor, some of them are landless and they earn their livelihood through agriculture, fishing, shrimp farming, salt farming etc. As most of the livelihood is dependent on natural resources therefore it is very important to protect or conserve the regular services even enhance the service in every possible way.

The study area consists of different types of ecosystems that possess diversified floral and faunal species. Some areas are ecologically very important for residents as well as migratory birds. Water bodies and channels, rivers and tributaries support good habitat for flora and fauna. Homestead, aquatic vegetation and reed-land supports the wild birds as their feeding and roosting place. Major groups of the oriental birds are represented in this zone by many species. Aquatic ecosystem is directly related and important for many birds breeding, feeding, and roosting grounds. The landscape of the region consists of a mix of floodplains, inland water bodies, tidal swamps etc. that holds important aquatic habitat for different water dependent flora and fauna that make up a complex ecosystem. This aquatic ecosystem performs countless significant environmental functions such as it recycles nutrients, purifies water, attenuates floods, recharge groundwater and provides habitats for different wildlife.

Thus the overall biological environment of the study area has great ecological importance that supports a rich floral and faunal diversity in its unique geo-physical location, tropical climate and fertile land mass. It is very important to take proper initiative to conserve the existing ecosystem services of the area.

3.2 Landscapes

The landscapes of the study area comprise different features like forests, rivers, mudflats, beaches and sand dunes. All the features create ecosystems to survive the natural biota and provide different kinds

of ecosystem services to the human beings. Following sections represent the major landscape features of the study area (See Table 3.1).

Table 3.1: Major landscape Features of Study Area

Upazila Name	Landscapes Area (ha)			
	Mangrove Coverage	**Mudflats**	**Sand Dunes and Beaches**	**Water bodies**
Barguna Sadar	631	-	-	-
Galachipa	2,334	322	-	-
Kalapara	895	-	244	212
Patharghata	2,216	-	1	3
Rangabali	9,609	706	195	86
Taltali	3,123		61	230
Total	**18,809**	**1,028**	**501**	**531**

Note=The above figures are generated through analysis of present landcover using available recent satellite image; Government forest land is much more than these figures

3.2.1 Forests Including Social Forestry

It is considered as Forest area, the land having the spanning more than 0.5 hectares with trees higher than 5 meters (exception for the *Ceriops decandra* with height of 2 meters) and a canopy cover of more than 10 percent, or trees able to reach these thresholds in situ. It does not include land that is predominantly under rural settlement, agricultural or urban land use therefore trees grow outside forest land are considered as non-forest trees (BFD, 2017) [1] . According to Bangladesh Forest Department, 5 categories of forested land (Reserved Forests, Protected Forests, Acquired forest/Vested forests, Unclassified State Forest, Unclassified Revenue Forest) are maintained by the department with an total area of 25,79,387.9 acre or 10,43,843 ha (BFD 2016)2.

The study area consists about 19,000 ha of mangrove forest coverage (CEGIS Landuse Analysis, 2022). Most of the forests are lies within the intertidal area and south facing along the coastal part. Map xx1 indicates the forest area of the PKCP (Figure 3.1).

Social Forestry a forestry which aims at ensuring economic, ecological, and social benefits to the people, particularly to the rural masses and those living below poverty line, specially by involving the beneficiaries right from the planning stage to the harvesting stage. The target of the social forestry is the 'rural poor' and not the 'tree' alone. This support, however, is not just to ensure that the trees get planted and survive but rather to ensure that the people who plant the trees receive adequate sustenance to live with dignity before reaping the harvest from the raised crops.

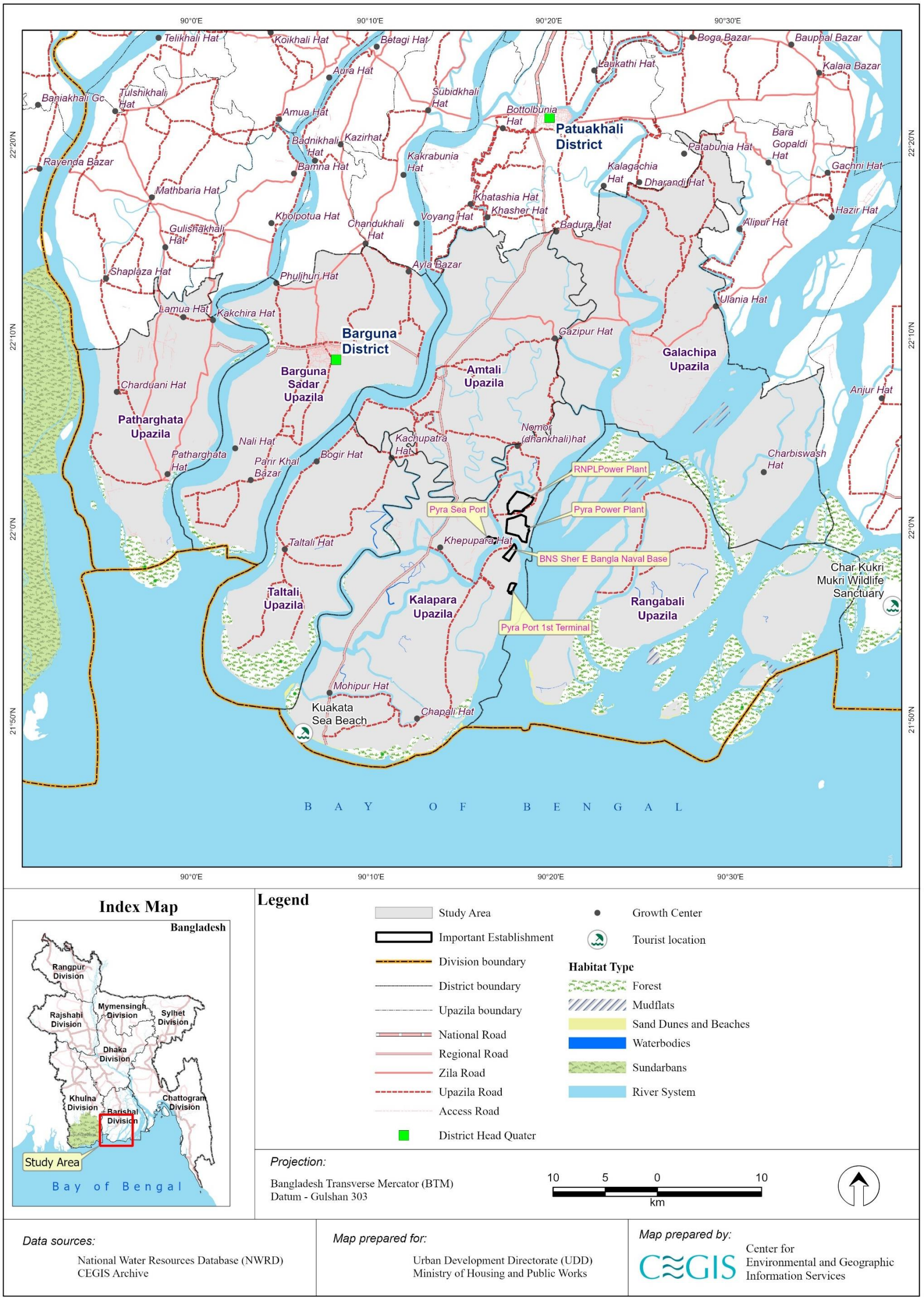
In last 5 years in Patuakhali and Barguna districts under Coastal Forest Division, Patuakhali total 1164.5 seedling kilometer plantation had been raised under social forestry program which are presented range wise in the following Table 3.2.

[1] http://www.bforest.gov.bd/site/page/eca2a291-b487-4c7a-8ce0-dbe5069524ac/-; last accessed on 15th Jan, 2019.

2http://www.bforest.gov.bd/site/page/837e6966-0fce-4274-a0d0-bcdfa49ce492/- ; last accessed on 15th Jan, 2019.

Table 3.2: Information on Last 5-Year Plantation Under Social Forestry

Sl. No	Name of district	Name of Upazilla	Name of Range	Plantation area(km)
1	Patuakhali	Kalapara	Mahipur	482.5
2		Galachipa	Galachipa	174.0
3		Rangabali	Rangabali	60.0
4	Barguna	Barguna sadar	SFNTC, Barguna	140.0
5		Taltali	Amtali (Taltali)	10.0
6		Patharghata	Patarghata	200.0
7		Amtali	SFPC, Amati	98.0
			Total	**1,164.5**



Index Map

Legend

- Study Area
- Important Establishment
- Division boundary
- District boundary
- Upazila boundary
- National Road
- Regional Road
- Zila Road
- Upazila Road
- Access Road
- District Head Quater
- Growth Center
- Tourist location

Habitat Type

- Forest
- Mudflats
- Sand Dunes and Beaches
- Waterbodies
- Sundarbans
- River System

Projection:

Bangladesh Transverse Mercator (BTM)
Datum - Gulshan 303

10 5 0 10
km

Data sources:

National Water Resources Database (NWRD)
CEGIS Archive

Map prepared for:

Urban Development Directorate (UDD)
Ministry of Housing and Public Works

Map prepared by:

CEGIS
Center for Environmental and Geographic Information Services

Figure 3.1: Habitat Map Including Forest Coverage of the Study Area

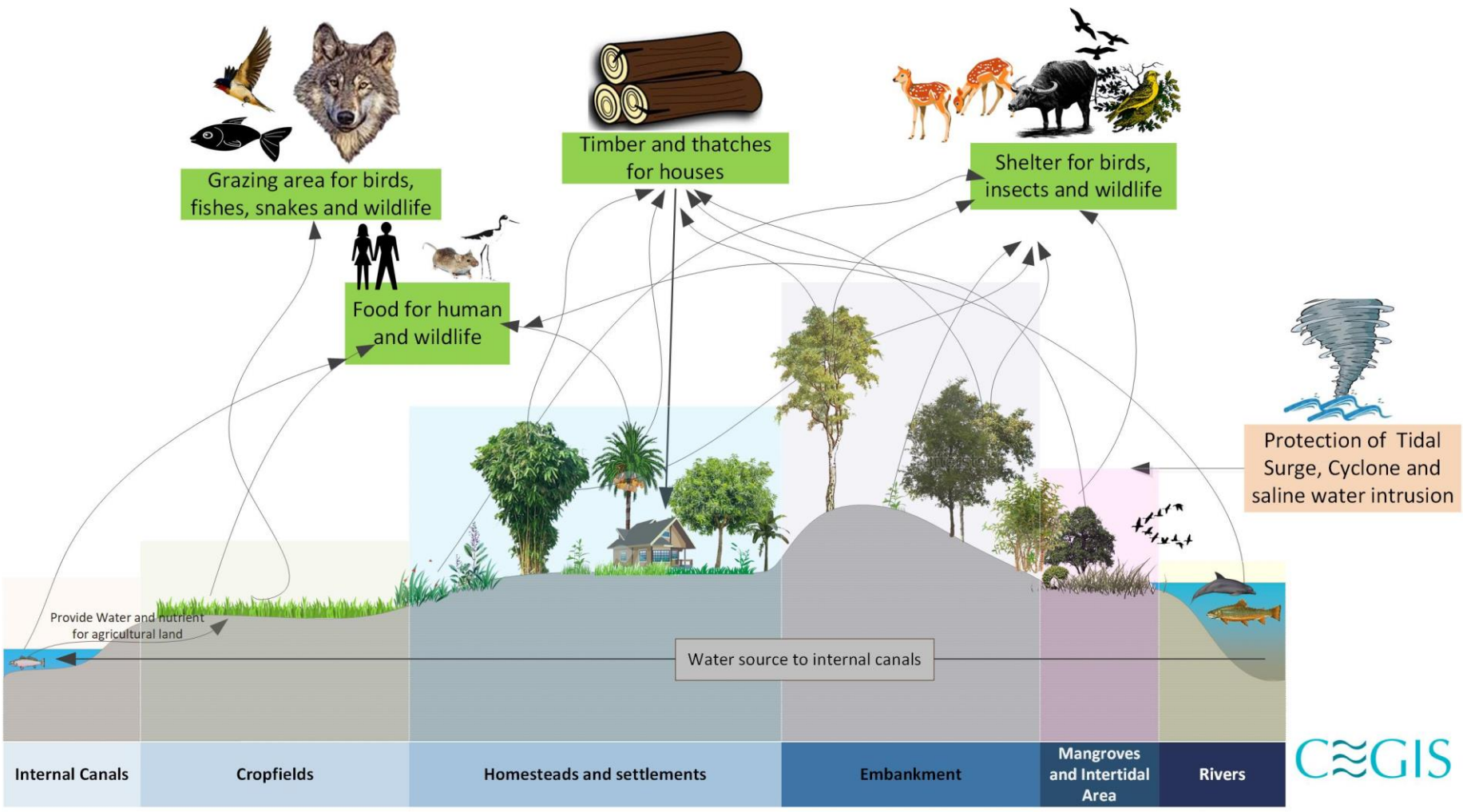


Figure 3.2: Major Ecosystem Services from Different Habitats of the Study Area

Figure 3.3: Biodiversity of Coastal Mangroves

3.2.2 Mudflats and Inter Tidal Area

Mudflats are the dominant features of the coastal ecosystem in Bangladesh which lies in association with mangrove or along the active accretion zone of coastal islands. The study area consists about 1,000 ha mudflats and intertidal area which have the major contributions to roam migratory birds, fostering fish grazing and feeding grounds of wader birds. Mudflats are also the primary succession ground of mangrove vegetation.

3.2.3 Sand Dunes and Sandy Beaches

Dunes are simply piling of sand are present on shorelines where fine sediment is transported landward by a combination of wind and waves, and stabilized with vegetation. Primary dunes (or fore dunes) are situated nearest to the ocean and are affected most significantly by waves and salt spray. Secondary dunes (or rear dunes) are located further inland and are not often directly exposed to marine influences.

The study area possesses more than 500ha of sand dunes (Landuse Analyzed by CEGIS, 2022) and beaches which are very scattered except the Kuakata Sea Beaches. Sand dunes and beaches area are ideal habitat for crabs and turtles.

Figure 3.4: Different types of habitats within the study area

3.2.4 Inland Waterbodies

Hundreds of canals and numerous homestead ponds are the major inland waterbodies within the area. The canals are crisscrossed within the land area act as arteries of the aquatic ecosystem. Each of the canals are connected with its nearer river, carries tidal nutrients into the inland and ensure flashing facilities of the area. Ponds are the water reservoir to the local people to meetup their domestic needs. Inland waterbodies expand over 800ha within the study area.

3.2.5 Homesteads and Other Natural Habitats

Homestead is the major feature of the area that support to abode human and mainly consist the vegetation influence by human. Homestead vegetation is the single most important plant community. It includes two types of plants: those cultivated for their economic value and those that are self-propagating. The settlement area in the study boundary is ABOUT 2,800 ha. Settlement vegetation also support most of the resident birds and rodents.

3.2.6 Embankments

Being located within the coastal region, embankment is a common feature that constructed during the polderization in 60's decade. Embankment save the resources within the polder from the tidal inundation. The embankment has great contributions for rural communication and creates supporting habitats for various resident birds' rodents and reptiles.

3.2.7 Marine and Estuary

Estuary, the transitions zone between sea and river has important roles of ecosystem services and providence of habitat for various fishes, crustaceans and cetaceans. This aquatic ecosystem occupied 7,194 ha area along the southern site of the study area.

Figure 3.5: Irrawaddy dolphin (*Orcaella brevirostris*) is an iconic aquatic mammal in estuary region of the study area

3.3 Protected Areas

Bangladesh currently has 51 protected areas so far, of which 20 National Parks, 24 Wildlife Sanctuaries, 10 eco-parks, 2 Special Biodiversity Conservation Area, two Marine Protected Area (MPA), two Vulture Safe Zone, two botanical gardens and one aviary park which have been declared by the government to conserve wildlife and their habitats of those areas since January 2022 as publishes in the website of Bangladesh Forest Department (BFD, 2022)[3].

Following sections describe the protected areas within the study area.

3.3.1 Reserve Forests

The study area included 6 ranges and 4 centers of forest division under Bangladesh Forest Department (BFD) and that comprises of 7 upazillas of Patuakhali and Barguna districts. The reserve forests include the absolute mangrove vegetation coverage, intertidal area, canals, creeks mudflats and somewhere sandy beaches or sand dunes. The area of reserve forests and the forests under process of reservations for these upazillas and districts are as follows in Table 3.3.

Table 3.3: Reserve Forest within the Study Area

Sl. No	Name of district	Name of Upazilla	Area of reserve forest land (ha)	6, Dhara declared (ha)
1	Patuakhali	Kalapara	2,906	2,590
2		Galachipa	6,236	2,037
3		Rangabali	12,793	4,452
4	Barguna	Barguna sadar	666	-
5		Taltali	7,857	-

3 http://www.bforest.gov.bd/site/page/5430ce33-561e-44f6-9827-ea1ebaa2c00d/-, last accessed 7th June, 2022.

Sl. No	Name of district	Name of Upazilla	Area of reserve forest land (ha)	6, Dhara declared (ha)
6		Patharghata	3,834	83
7		Amtali	-	-
		Total	**34,292**	**9,161**

Source: BFD, 2022

Besides the above land areas, coastal char land under water more than one lac acres are in the process of reservation (4 dhara) though yet not ready for plantation.

3.3.2 Eco-parks

Eco-park has designated under the Wildlife (Conservation and Security) Act, 2012 that means an area of natural ecological habitat of flora and fauna with outstanding scenic beauties. It is managed for providing recreational facilities for visitors and which is declared as such through official gazette notification under section 19 of the Act. Here should be mentioned that, none of the eco-park falls within the study area.

3.3.3 Wildlife Sanctuaries

Wildlife Sanctuary is an area maintained as an undisturbed breeding ground for wild fauna and where the habitat is protected for the continued well-being of the resident or migratory fauna. At present, the study area possesses two wildlife sanctuaries such as Tengragiri Wildlife Sanctuary and the Sonarchar Wildlife Sanctuary those cover 4,048 ha mangroves in Barguna and 2,026 ha mangroves in Patuakhali respectively.

Tengragiri Wildlife Sanctuary is located at the north WAPDA embankment, at south the Bay of Bengal, at the east Andharmanik and at the west Ashar char, Nidrar char, estuary of the river Payra and the Bay of Bengal. Sonarchar wildlife Sanctuary is bounded by the Bura Gouranga river at north, Bay of Bengal at the south, east and west side. Both of the wildlife sanctuaries are enriched with numerous flora and faunal communities.

BFD has proposed another wildlife sanctuary namely Laldia Wildlife Sanctuary in Char Lathimara, Badurtala and Laldia mouzas at south point of Patharghata upazilla in Barguna district.

Figure 3.6: Part of Sonarchar Wildlife Sanctuary

3.3.4 National Parks

As per according to Wildlife (Conservation and Security) Act, 2012, National Park means comparatively large area of outstanding scenic and natural beauty with the primary object of providing public education, research and recreation and managed for preservation of natural state of flora and fauna and outstanding charming scenery, and which is an area declared as such through official gazette notification under section 17 of this Act.

The only Kuakata National Park within the study area was declared in 24 October 2010 under GO No. MoEF/ Forest-Sec-2/2/national park/10/2010/509 dated 24/10/2010. The National Park is located at Latachapli and Gangamari mouzas of Kalapara Upazila and bounded with the WAPDA embankment at north, at south and east the Bay of Bengal, and at the west Andharmanik and the Bay of Bengal. It is Coastal plain land filled with mangrove and non-mangrove forest. The national park is surrounded by many canals and creeks. All over the year these waterways flow with high and low tide.

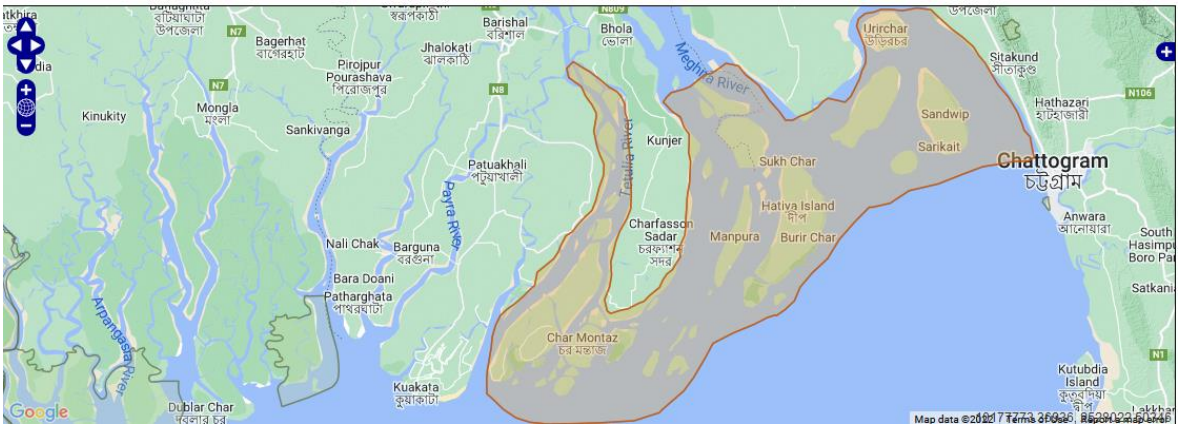
3.4 Other Designated Areas

3.4.1 Important Birds and Biodiversity Areas (IBAs)

A total of 20 IBAs are designated in Bangladesh with a total area of about 544,438 ha (Birdlife 2019)4. Of which 11 protected; 2 partially protected; 6 unprotected and 11 support globally threatened species, 10 have biome-restricted species and nine qualify as important bird areas because they hold

4http://datazone.birdlife.org/country/bangladesh/ibas, last accessed on 15 Sep, 2022.

large congregations of water birds5. West part of Ganges-Brahmaputra-Meghna Delta IBA falls within the study area covers the estuaries, intertidal areas and small islands like Char Montaz, Andar Char, Sonar Char, Char Kukri Mukri, Chal Luxmi, Char Hare etc. (See Figure 3.7)[6] .



Source: Birdlife International

Figure 3.7: Location of I Ganges-Brahmaputra-Meghna Delta IBA Within the Study Area

3.4.2 Key Biodiversity Areas (KBAs)

Key Biodiversity Areas (KBAs)7 are the most important places in the world for species and their habitats. Faced with a global environmental crisis, the respective habitat need to focus our collective efforts on conserving the places that matter most. The KBA Programme supports the identification, mapping, monitoring and conservation of KBAs to help safeguard the most critical sites for nature in earth from rainforests to reefs, mountains to marshes, deserts to grasslands and to the deepest parts of the oceans.

Bangladesh possesses 20 KBAs. The study area consists Ganges-Brahmaputra-Meghna Delta KBA that expand about 6,81,000 ha marine and terrestrial habitats of Meghna estuary (Figure 3.8).

3.4.3 Ecologically Critical Areas

The Ecologically Critical Area (ECA) is an environmentally protected zone where the ecosystem is considered to be endangered to reach a critical condition by the changes brought through various human activities. ECA is ecologically defined areas or ecosystems affected adversely by the changes brought through human activities. The Bangladesh Environment Conservation Act (BECA), 1995 has provision for Ecologically Critical Area (ECA) declarations by the Director General of the Department of Environment in certain cases where ecosystem is considered to be threatened to reach a critical state.

South-west part of Pathorghata Upazila falls within the Sundarban ECA (Figure 3.1)

5 Bangladesh, Key Habitats and Birds; Birdlife International.

6 BirdLife International (2022) Important Bird Areas factsheet: Ganges-Brahmaputra-Meghna delta. Downloaded from http://www.birdlife.org on 15/09/2022.

7 https://www.keybiodiversityareas.org/ Last accessed 14 June, 2022.

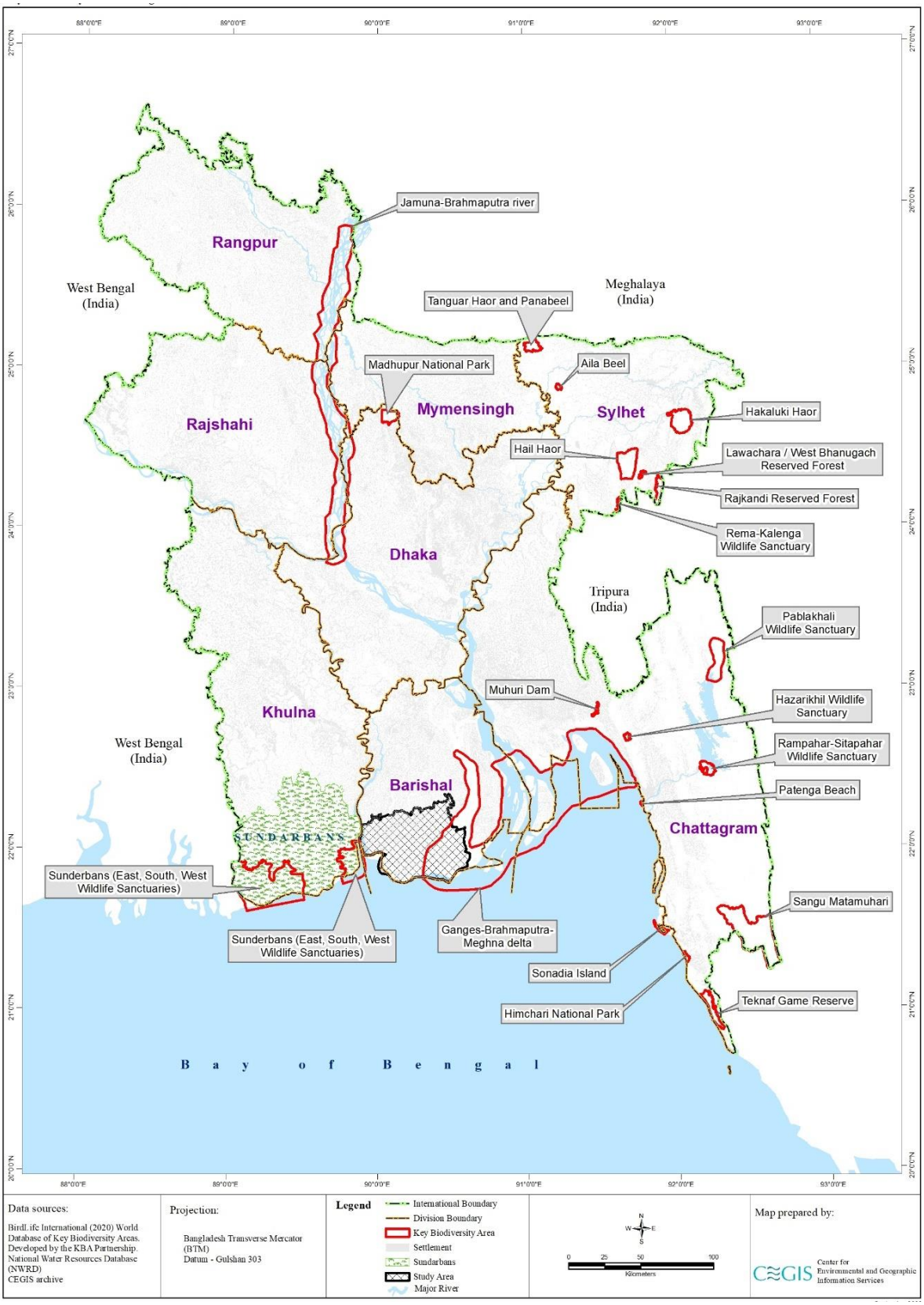


Figure 3.8: The study area within the KBAs in Bangladesh

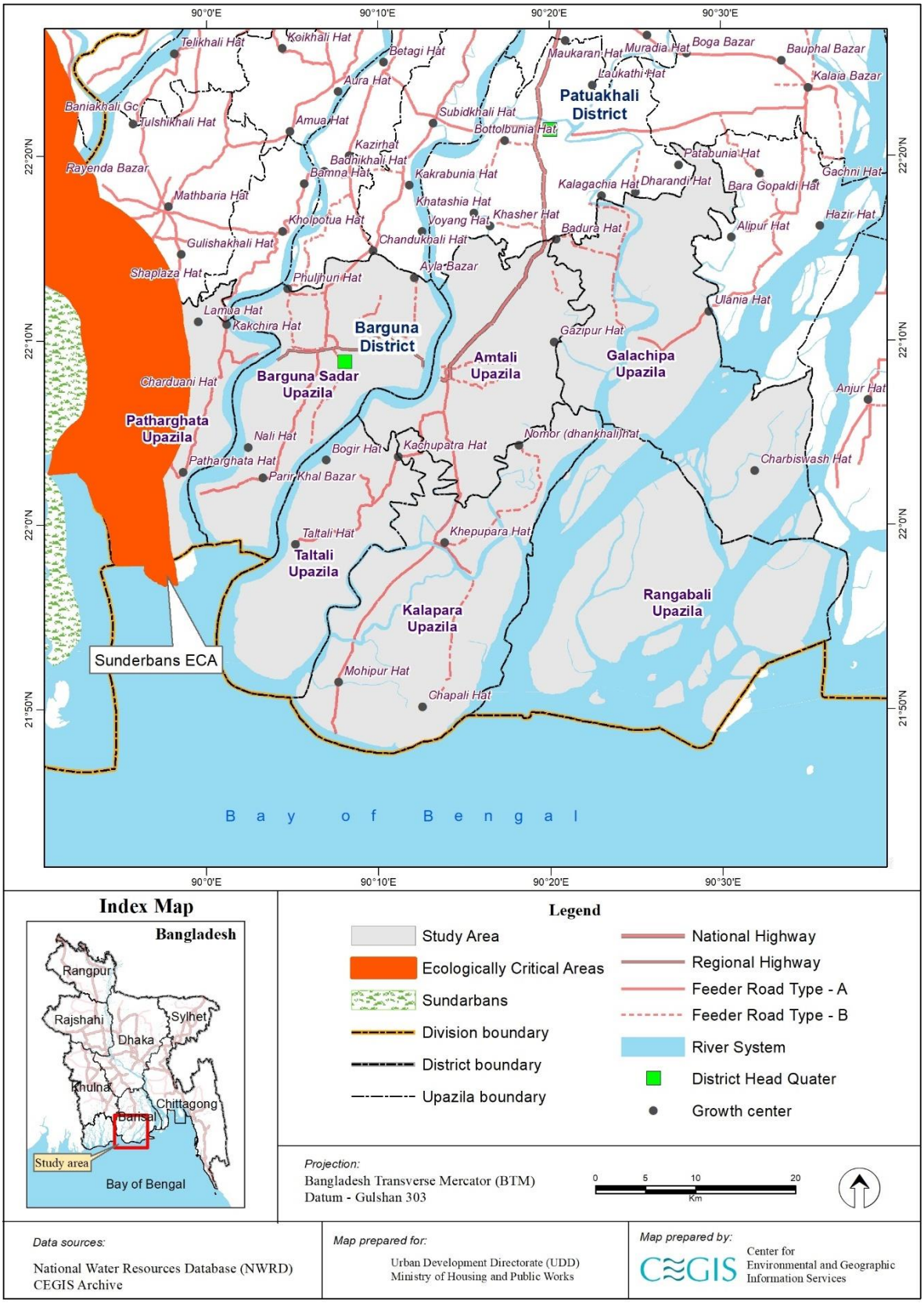


Figure 3.9: ECA within the Study Area

3.5 Distribution and Conservation of Biodiversity of the Study Area

Two districts namely Patuakhali and Barguna under Barishal Division is situated in the coastal region of Bangladesh having moderate diversity of biological resources. While conducting a baseline study on ecosystem nine (9) types of ecosystems in 14 (fourteen) locations have been identified and later during a field investigation team has visited all identified ecosystems for gathering information on flora and fauna including their current status. The CEGIS team has assessed ecological resources along with the status through Line Transect Walks (LTWs), Opportunistic Survey, Plot Count and random sampling methods for biodiversity dataset including species richness and diversity index (H′).

3.5.1 Floral Diversity

The findings from the conducted study on existing flora has been provided information basically on terrestrial and aquatic ecosystems, and mangrove ecosystem (an ecosystem of the inter-tidal zone) with an account of 190 species having different life-forms including herbs, shrubs, climbers and trees. The distribution of these flora species are noted as homestead, cropland, roadside, shorelines, canals, rivers and small water bodies like fish culture ponds. A brief account of flora of the proposed study area is given in Table 3.4 and details of the flora is shown in **Appendix A.**

Table 3.4: Brief account of flora of the study area

Area/Location	Ecosystem Type	GPS Coordinate	Usage	No. of Species
South Kathaltoli, Kathaltoli, Patharghata, Barguna	Terrestrial	22 7 48N 89 55 46.3E	Fruit, timber, vegetables, medicine, and fuelwood	52
4No Keorabunia, Patharghata, Barguna	Terrestrial	22 2 37N 89 58 11E	Fruit, timber, vegetables, medicine	31
Lotabaria, 9No Keorabunia, Barguna Sadar	Terrestrial	22 10 17.7N 90 10 25.7E	Fruit, vegetables, medicine, and fuelwood	36
College Branch Road 8No ward, Barguna Sadar	Terrestrial	22 10 17.7N 90 10 25.7E	Fruit, vegetables, medicine, and fuelwood	19
Boro Onkujanpaea 1No Ward, Nishanbari, Taltoli, Barguna	Terrestrial	21 57 24N 90 4 29E	Fruit, thatch, vegetables, medicine, and fuelwood	52
Kumir Mara Khal, East Sonatola, Nilganj, 3 No. ward	Aquatic	21 56 49N 90 10 42E	Food, forage, vegetable, fodder, medicine, basket, fencing	37
Mora Nodi, 6 No. ward, Nachnapara, Amtoli, Barguna	Aquatic	22 06 52N 90 14 17E	Fertilizer, fruit, vegetable, fodder, medicine, basket, fencing	21
6 No. Ward, Ulania, Mativanga, Golachipa, Patuakhali	Aquatic	22 09 13N 90 26 46E	Fertilizer, fruit, vegetable, fodder, medicine,	28
Haringhata Ecopark Cholhati, Hariyantana, Patharghata, Patuakhali	Mangrove Forest	21 58 32N 89 57 50E	Medicine, fuelwood, aromatic, thatch	30
Tengragiri Wildlife Sanctuary, Cholhati, Hariyantana, Patharghata, Barguna	Mangrove Forest	21 58 32N 89 57 50E	Food, medicine, fuel, aromatic, thatch	55
Lebur Char, Trimohoni, Jhaubon, Leburchar, Kuakata, Patuakhali	Mangrove Forest	21 51 56N 90 5 21.32E	Medicine, Duel, food, vegetable, thatch	33

Area/Location	Ecosystem Type	GPS Coordinate	Usage	No. of Species
Gora Padma Beach Mangrove, Cholabunia, Joyalbhanga, Barguna Sadar	Mangrove Forest	21 58 50.92N 90 3 19.24E	Food, duel, medicine, vegetable, thatch, aromatic	04
Taltali Char Mangrove, Barisal Tap biddut, Taltoli, Barguna	Mangrove Forest	21 58 24N 90 4 21E	Food, fuel, medicine, vegetable, aromatic	06
Kuakata Mangrove, Kuakata beach	Mangrove Forest	21 48 36.90N 90 8 9.56E	Food, fuel, fodder, medicine, thatch, vegetable, aromatic	58

Source: CEGIS Field Survey, 2022

3.5.2 Threatened Floral Species

Bangladesh is one of the most climatic vulnerable countries due its geographical location especially in the coastal region. The current study area is one of the vulnerable compared to other coastal districts. Coastal flooding takes a great loss frequently in this coastal vulnerable area. Recent research found that frequent inundation through coastal flooding takes place which leads a less diversification of plant community. A 20-years research indicates that intrusion of saline water has imposed great threat to plants growth, and survival including the mangrove species richness, too. Moreover, tidal surge or natural calamities are gradually taking the toll on the coastal mixed and mangrove vegetation. The recent field study provides information that a good number of species are in rare condition due to natural and human induced impacts including urbanization in the forestland, conversion of natural forestland into agricultural land, and tree felling practices. A list of threatened flora is presented in Table 3.5.

Table 3.5: Threatened flora of the study area

Sl. No.	Location	Ecosystem Type	Threatened species
1	South kathaltoli, Kathaltoli, Patharghata, Barguna	Terrestrial	*Bombax ceiba, Pongamia pinnata*
2	4No Keorabunia, Patharghata, Barguna	Terrestrial	*Bombax ceiba, Pongamia pinnata*
3	Lotabaria, 9No Keorabunia, Barguna Sadar	Terrestrial	*Tamarindus indica*
4	College Branch Road. 8No ward, Barguna Sadar	Terrestrial	*Streblus asper*
5	Boro Onkujanpaea, 1No ward, Nishanbari, Taltoli, Barguna	Terrestrial	*Bombax ceiba*
6	Kumir Mara khal, East Sonatola, Nilganj,3no ward	Aquatic	*Typha elephantiana*
7	Mora Nodi 6 no ward, Nachnapara, Amtoli, Barguna	Aquatic	*Lindernia anagallis*
8	6 no ward, Ulania, Mativanga, olachipa, Patuakhali	Aquatic	*Tamarindus indica*
9	Haringhata Ecopark, Cholhati, Hariyantana, Patharghata, Patuakhali	Mangrove Forest	*Tamarindus indica*
10	Tengra giri wildlife Sanctuary, Cholhati, Hariyantana, Patharghat, Barguna	Mangrove Forest	*Heritiera fomes*
11	Lebur Char, Trimohoni, Jhaubon, Leburchar, Kuakata, Patuakhali	Mangrove Forest	*Cuscuta Sp.*

Sl. No.	Location	Ecosystem Type	Threatened species
12	Ghora Padma beach Mangrove, Cholabunia, Joyalbhanga, Barguna Sadar	Mangrove Forest	*NA*
13	Taltali Char Mangrove, Barisal Tap biddut, Taltoli, Barguna	Mangrove Forest	*Lindernia anagallis*
14	Kuakata Mangrove Kuakata Beach	Mangrove Forest	*Heritiera fomes*

Source: CEGIS Field Survey, 2022

3.5.3 Faunal Diversity

Species diversity of fauna is low comparative to the other tropical area. The diversity of wild fauna basically varies on the basis of composition of flora and structure of the forest and canopy size on the whole. Naturally, mangrove does not support a variety of wild fauna on its mangrove ecosystem. Moreover, coastal flooding is a common scenario that destroys the core habitats of the wild fauna. Therefore, habitat disturbance is a question that does not offer suitable habitat to allow betterment of their survival or success of living. While conducting this field work the study team has explored that there are 14 different habitats or ecosystem exist and have been supporting a good number of fauna to provide ecosystem services and or retain integrity of the ecosystem functions. During the recent field visit 201 species of fauna were recorded in this study area. A brief account of key species that indicates suitability of habitats are presented in **Table 3.6 and 3.7** and detailed of the fauna found in this entire study area is also given in **Appendix B**.

Table 3.6: List of key wild fauna of the study area

Class	Order	Family	Scientific Name	English Name
Amphibia	Anura	Dicroglossidae	*Hoplobatrachus tigerinus*	Indian Bullfrog
Amphibia	Anura	Bufonidae	*Duttaphrynus melanostictus*	Asian Common Toad
Amphibia	Anura	Dicroglossidae	*Euphlyctis cyanophlyctis*	Skipper Frog
Amphibia	Anura	Dicroglossidae	*Polypedates leucomystax*	Common Tree Frog
Amphibia	Anura	Dicroglossidae	*Fejervarya asmati*	Asmat's Cricket Frog
Amphibia	Anura	Dicroglossidae	*Polypedates leucomystax*	Common Tree Frog
Amphibia	Anura	Dicroglossidae	*Hoplobatrachus crassus*	Jerdon's Bullfrog
Amphibia	Anura	Bufonidae	*Duttaphrynus melanostictus*	Asian Common Toad
Amphibia	Anura	Microhylidae	*Microhyla*	Microhylid Frog
Reptiles	Testudines	Geoemydidae	*Pangshura tecta*	Roofed Turtle
Reptilia	Squamata	Natricidae	*Xenochrophis piscator*	Checkered Keelback
Reptilia	Testudines	Geoemydidae	*Pangshura tecta*	Roofed Turtle
Aves	Passeriformes	Picnonotidae	*Pycnonotus jocosus*	Red-whiskered Bulbul
Aves	Accipitriformes	Accipitridae	*Haliastur indus*	Brahminy Kite
Aves	Passeriformes	Timalidae	*Turdoides earlei*	Striated Babbler
Aves	Charadriformes	Scolopacidae	*Actitis hypoleucos*	Common Sandpiper
Aves	Coraciformes	Alcedinidae	*Alcedo meninting*	Blue-eared Kingfisher
Aves	Passeriformes	Corvidae	*Dendrocitta vagabunda*	Rufous Treepie
Aves	Passeriformes	Nectarinidae	*Nectarinia zeylonica*	Purple-rumped Sunbird

Class	Order	Family	Scientific Name	English Name
Aves	Passeriformes	Estrilidae	*Lonchura punctulata*	Scaly-breasted Munia
Aves	Passeriformes	Zestropodidae	*Zosterops palpebrosus*	Oriental White-eye
Aves	Passeriformes	Aegithinidae	*Aegithina tiphia*	Common Iora
Aves	Columbiformes	Columbidae	*Streptopelia decaocto*	Eurasian Collared Dove
Aves	Passeriformes	Oriolidae	*Oriolus xanthornus*	Black-hooded Oriole
Aves	Passeriformes	Rhipiduridae	*Rhipidura albicollis*	White-throated Fantail
Aves	Passeriformes	Nectarinidae	*Arachnothera longirostra*	Little Spiderhunter
Aves	Passeriformes	Ploceidae	*Ploceus philippinus*	Baya Weaver
Aves	Passeriformes	Sturnidae	*Acridotheres ginginianus*	Bank Myna
Aves	Passeriformes	Campephagidae	*Pericrocotus cinnamomeus*	Small Minivet
Aves	Passeriformes	Paridae	*Parus major*	Great Tit
Aves	Coraciformes	Alcedinidae	*Pelargopsis capensis*	Stork-billed Kingfisher
Aves	Passeriformes	Zestropodidae	*Zosterops palpebrosus*	Oriental White-eye
Aves	Passeriformes	Cicticolidae	*Prinia inornata*	Plain Prinia
Aves	Passeriformes	Corvidae	*Dendrocitta vagabunda*	Rufous Treepie
Aves	Piciformes	Picidae	*Dinopium benghalense*	Black-rumped Flameback
Aves	Piciformes	Picidae	*Dinopium benghalense*	Black-rumped Flameback
Aves	Passeriformes	Estrilidae	*Lonchura malabarica*	White-throated Munia
Aves	Cuculiformes	Cuculidae	*Cacomantis merulinus*	Plaintive Cuckoo
Aves	Passeriformes	Rhipiduridae	*Rhipidura albicollis*	White-throated Fantail
Aves	Piciformes	Picidae	*Dendrocopos macei*	Fulvous-breasted Woodpecker
Aves	Passeriformes	Monarchidae	*Hypothymis azurea*	Black-naped Monarch
Aves	Coraciformes	Alcedinidae	*Pelargopsis capensis*	Stork-billed Kingfisher
Aves	Passeriformes	Nectarinidae	*Nectarinia asiatica*	Purple Sunbird
Aves	Columbiformes	Columbidae	*Treron phoenicopterus*	Yellow Footed Green Pigeon
Aves	Columbiformes	Columbidae	*Treron bicinctus*	Orange-breasted Green Pigeon
Aves	Psittaciformes	Psittacidae	*Psittacula krameri*	Rose-ringed Parakeet
Aves	Passeriformes	Ploceidae	*Ploceus philippinus*	Baya Weaver
Aves	Pelecaniformes	Ardidae	*Ardea purpurea*	Purple Heron
Aves	Passeriformes	Campephagidae	*Pericrocotus cinnamomeus*	Small Minivet
Aves	Passeriformes	Cicticolidae	*Cisticola juncidis*	Zitting Cisticola
Aves	Anseriformes	Anatidae	*Dendrocygna javanica*	Lesser Whistling Duck
Aves	Cuculiformes	Cuculidae	*Hierococcyx varius*	Common HawkCuckoo
Aves	Accipitriformes	Accipitridae	*Nisaetus cirrhatus*	Changeable HawkEagle
Aves	Accipitriformes	Accipitridae	*Spilornis cheela*	Crested Serpent Eagle
Aves	Passeriformes	Estrilidae	*Lonchura punctulata*	Scaly-breasted Munia

Class	Order	Family	Scientific Name	English Name
Aves	Passeriformes	Aegithinidae	*Aegithina tiphia*	Common Iora
Aves	Columbiformes	Columbidae	*Streptopelia tranquebarica*	Red Turtle Dove
Aves	Passeriformes	Oriolidae	*Oriolus xanthornus*	Black-hooded Oriole
Aves	Passeriformes	Nectarinidae	*Arachnothera longirostra*	Little Spiderhunter
Mammalia	Carnivora	Indian Grey Mongoose	*Herpestes edwardsii*	Herpestes edwardsii
Mammalia	Cetartiodactyla	Suidae	*Sus scrofa*	Wild Boar
Mammalia	Cetartiodactyla	Delphinidae	*Orcaella brevirostris*	Irrawaddy Dolphin
Mammalia	Carnivora	Felidae	*Prionailurus viverrinus*	Fishing Cat
Mammalia	Carnivora	Mustelidae	*Lutrogale perspicillata*	Smooth-coated Otter
Mammalia	Carnivora	Canidae	*Canis aureus*	Golden Jackal
Mammalia	Carnivora	Cervidae	*Axis axis*	Spotted Deer

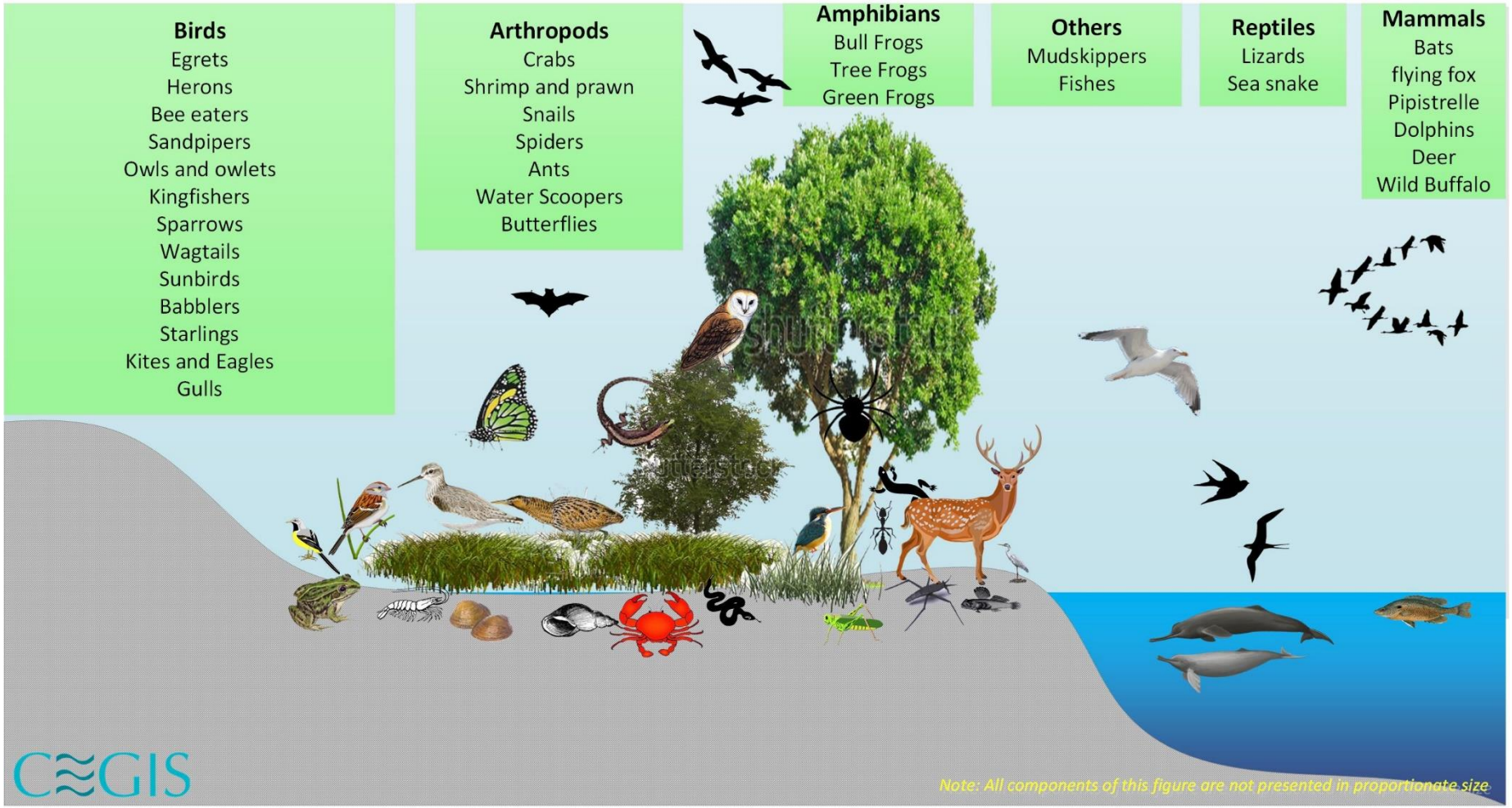


Figure 3.10: Major wildlife communities of the study area

Table 3.7: Key species of the wildlife hotspots of the study area

Sl. No.	Spot/Habitat	GPS Coordinates		Key Species (Wildlife/Fauna)
		Lat	Long	
1	Bihanga Char	22.02093	89.90658	Migratory Birds in winter
2	Harina Ghata	21.9641	89.975462	Otter, Fishing Cat, Wild Cat
3	Harina Ghata	21.98406	89.940986	Wild Boar
4	Majher Char	22.17988	90.03424	Migratory Birds in winter
5	Mangrove Forest In Bainchotki Ferry Ghat	22.15183	90.046505	Snake, Deer
6	Ammtoli Ferry Ghat	22.13265	90.218293	Irrawardy Dolphin
7	Near Powerplant of Payra	21.95369	90.035613	Irrawardy Dolphin, Indo-pacific Humpback Dolphin
8	Char Bijoy	21.7243	90.20504	Migratory Birds in Winter, Crab
9	Lebur Ban	21.83313	90.094439	Resident Bird Species, Fishing Cat, Wild Boar
10	Pakhi Mara	21.9481	90.178599	Residant Bird, Fishing Cat
11	Ammtoli	22.13658	90.2302	Colony of Heron Egret
12	Harina Ghata Forest Office	21.97576	89.96402	Northern Plains Grey Langur
13	Harina Ghata	21.9716	89.936662	Migratory Birds in Winter
14	Kuakata	21.80291	90.161237	Fox

3.5.4 Threatened Faunal Species

During the major field investigation, the CEGIS team has identified that there are several threats to the wildlife/fauna in their natural habitats e.g. urbanization on the natural habitat, extension of agricultural practices to forestland including the mangrove ecosystem, pollution on air and waterways, increasing of grazing/pasture land to forest peripheries, hunting pressures, and degradation of forestland through felling trees. In addition, recent natural disaster also took place on fauna habitat degradation. Oil spills and plastic pollution also responsible to creates threats to fauna both in the terrestrial and aquatic even in the intertidal zone of this coastal area. Unplanned tourism practices also slightly responsible for threatening the wildlife. The marine mammals e.g. dolphins sometimes find entangled in a fishing net of open water fishing. Therefore, various threats have been in this coastal districts for decades. The human induced threats to fauna are showing in the following Figure 3.11 and 3.12.

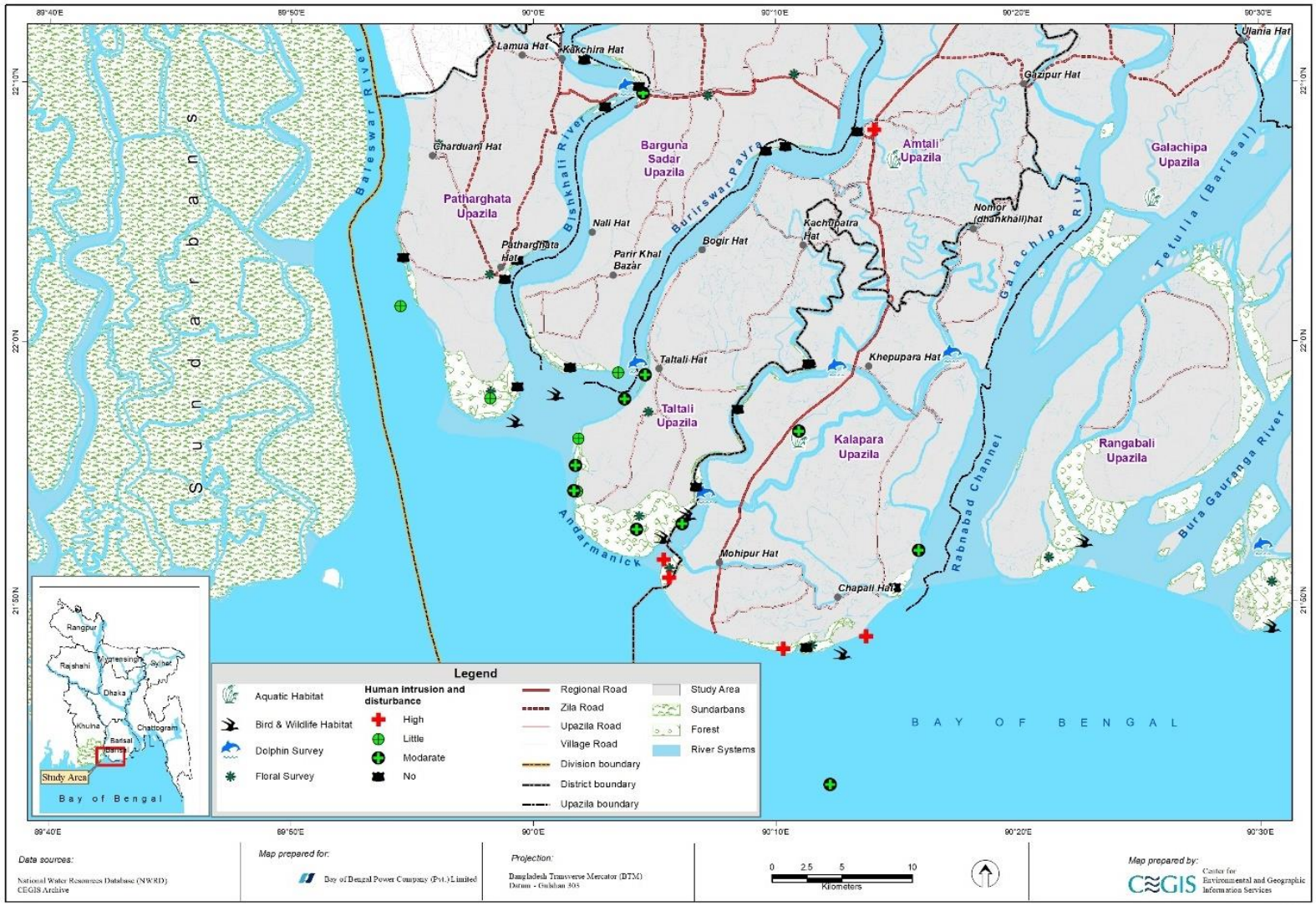


Figure 3.11: Habitat map with indication of human intrusion and disturbance in the study area

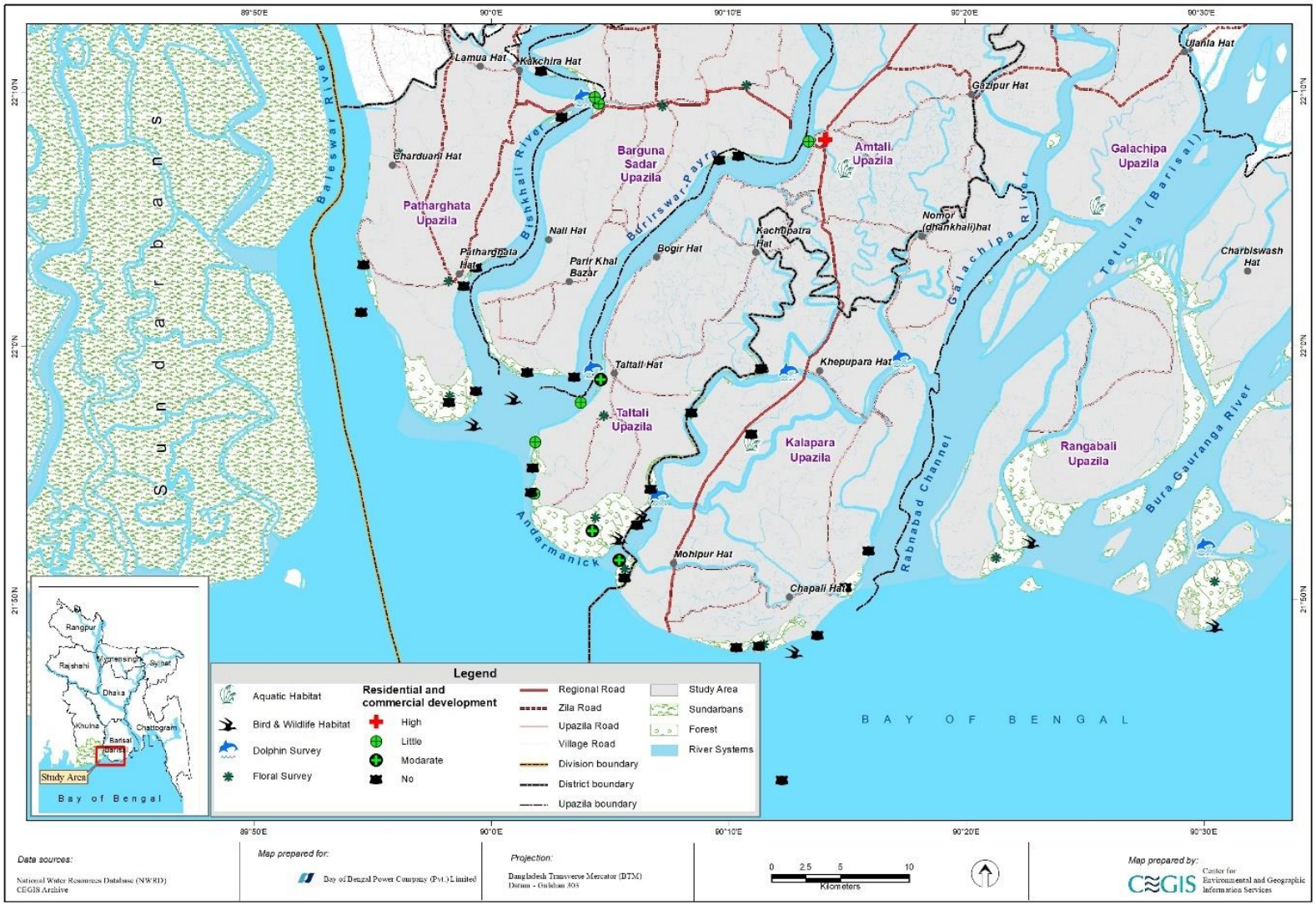


Figure 3.12: Habitat map with indication of residential and commercial development in the study area

Based on current field study, some faunas have been categorized as threatened species following IUCN-Bangladesh Red Data Book (2015).

Table 3.8: Threatened fauna of the study area

Class	Order	Family	Scientific Name	English Name	Conservation Status	
					IUCN Bangladesh Red List (2015)	IUCN Global
Aves	Piciformes	Picidae	*Chrysocolaptes guttacristatus*	Greater Flameback	NT	VU
Aves	Accipitriformes	Accipitridae	*Ichthyophaga ichthyaetus*	Grey-headed Fisheagle	NT	NT
Aves	Accipitriformes	Accipitridae	*Ichthyophaga ichthyaetus*	Grey-headed Fisheagle	NT	NT
Mammalia	Carnivora	Felidae	*Prionailurus viverrinus*	Fishing Cat	EN	EN
Mammalia	Carnivora	Mustelidae	*Lutrogale perspicillata*	Smooth-coated Otter	CR	VU
Mammalia	Cetartiodactyla	Delphinidae	*Orcaella brevirostris*	Irrawaddy Dolphin	NT	VU

Note: NT-Near Threatened, EN-Endangered, VU-Vulnerable, CR-Critically Endangered

3.6 Challenges and Issues

Various types of challenges and issues can be observed in context of environmental conservation of any given area. These can be divided into two broad categories namely, natural and anthropogenic. The study area is no exception. Being located in the coastal region of Bangladesh, the area is different from rest of the country because of its unique geo-physical characteristics and different socio-political consequences that often limit people's access to endowed resources and perpetuate risk and vulnerabilities. Bangladesh's coast is the biggest victim to natural disasters and highly affected by climate change with problems including salinity and water logging, soil erosion, flooding and cyclones etc. And anthropogenic pressure on the ecosystem is extremely high considering other parts of the country. The main challenges include land-use change, habitat destruction, over-exploitation, introduction of HYVs in agriculture, use of agrochemicals, invasive alien species (IAS), human-wildlife conflicts, pollution, urbanization, industrialization, unplanned plantation etc. These direct threats are related to the indirect threats such as socio-economic condition like population pressure, level of awareness and lack of substantial information about the management and law enforcement. The major challenges and issues that has been observed in and around the study area briefly described below.

3.6.1 Natural Calamities/Climatic Impact's

Storms/Cyclone: Inundation from the Bay during the passage of cyclones is not infrequent in the southern part of the district and does great damage. They usually occur in June before the breaking of the monsoon or in October or November after the monsoon is over. Inundations affect the coast for several miles inland and deposit a layer of sand, which not only destroy the crops of that season but reduce the fertility of the soil for some seasons afterwards. Incidental effects felt in that portion where the wave is at its height are the destruction of lives and the impregnation of all ponds which destroy the supply drinking water with saline water. At infrequent intervals storms and waves of great magnitude occur which are liable to cover the entire district or the greater portion of it with salt water and therefore affect the fertility and throw temporarily a great deal of the paddy land out of cultivation.

Coastal flood: Bangladesh is one of the most flood-prone countries in the world due to its unique geographical location, topography and exposure to tropical cyclones. With 50% of the land less than 8 meters above sea level, and a coastline of some 600 km, coastal flooding is a common problem.

Coastal erosion and sediment deposition

Bangladesh, at the confluence of the sediment laden Ganges and Brahmaputra Rivers, supports an enormous and rapidly gowing population (>140 million in 2011), across lowlying alluvial and delta plains that have accumulated over the past few thousand years. It has been identified as one of the most vulnerable places in the world to the impacts of climate change and sealevel rise. Although abundant sediment supply has resulted in accretion on some parts of the coast of Bangladesh, others are experiencing rapid erosion.

Salinity intrusions

Bangladesh belongs to one of the seaside countries, the adverse impact of saltwater intrusion is significant here. Salinity mainly affects land and water in the coastal areas. With the consequence of climate change, it gradually extends towards inland water and soil. This scenario of gradual increase of salinity intrusion in the coastal area is very threatening to the primary production system, coastal biodiversity and human health.

3.6.2 Anthropogenic Challenges

Agriculture in Char Land

There is pressure from the local people on Patuakhali Forest Division Chair land areas which are already planted demands to leave for agricultural crop.

Cattle Grazing and Trespass

Cattle trespass is a serious problem in Patuakhali forest division char land areas as young plantations are damaged and soil compactness occurs.

Poison Fishing

The fishermen who get the permits to fishing on the rivers inside forests use poison to kill the fish to quick fishing. This practice destroys the mother fish, yearlings and other aquatic species which seriously impacts on the aquatic biodiversity.

Illegal Fishing Net Use

The fishermen illegally carry the illegal fishing net which kill untargeted aquatic species

Seedling damage: Due to erosion and cattle trespass seedling damage is serious problem.

Lack of Administrative Support

Forest resource management is a very sensitive issue. Sometime very urgent assistance from district administration is required. Very often it is observed that sharp response is not provided.

Gender Equity

Lacking of efforts in reducing local and regional disparity through people participation and empowering of woman.

Illicit Felling of Trees

Illicit felling of trees in coastal forest is challenge for perpetuity of the ecosystem of the region.

Urbanization and Industrialization

The construction of sea port and other infrastructure are the indications for future Urbanization and Industrialization in this region. It is revealed that coastal ecosystem is vulnerable, dynamic and also very significant. Any wrong decision may collapse the total ecosystem which might be the great threat for the existing of the landscape

Political Support at the Root Level

Though all decisions and plans come as the top-down approach with unanimously acceptance of the political leaders, it is very often seen that at field level that support is not adequate rather some people become the hindrance to implement the government project activity.

Media news

For the greater interest of protecting forest and other natural resources it is anticipated that media would proclaim the message in favor of Government or government agency. But sometimes, it is observed that news published which may create negative impact in conservation of forest resources.

Inadequate Manpower and Capacity of BFD

For proper management of the forest and conservation activities, required number of active staff is most important. At present there is a crisis of staff due to complexity in recruitment which hampers in forest management. Forest management has entered in modern and technology-based era. The past management system is nearly invalid. The digitized system needs more technical staff which still is lacking. If it continues it would be difficult to proceed balancing with other agencies/institutions.

Unplanned Tourism

Out of various positive aspects of tourism, there are also negative aspects if the tourism happens in an unplanned way. The unsustainable practices led by tourism can also result in deforestation, habitat loss or put negative impacts on the water bodies and their creatures that leads the pressure on natural resources like minerals, soils, forests and wildlife. Transportation due to tourism or related factors has increased adversely which has led to increased air pollution. Improper development of infrastructures or the creation of enormous resorts, hotels must be done or approved through proper planning and process. Due to lack of planning, most of the development projects affect the scenery and nature of the habitats living there, thereby destroying the natural quality that makes those places a tourist attraction in the first place.

Water Quality

Nonetheless the water quality is not a major issue within the study area, but in future I will obvious to be an important concern. Details of the different water quality parameters is described in section Waste and Pollution Baseline in this report.

Following table represents the threats on different habitats and its wildlife within the study area.

Table 3.9: Identified threats on habitats and biodiversity at different places of the study area

Location	Habitat Type	Type of threats*						
		Residential and commercial development	Agriculture/ silviculture	Natural system modifications	Biological resource use	Pollution	Human intrusion and disturbance	Natural Digester
Bihango Dwip Mangrove	Forest	-	-	-	-	-	1	-
	Coast Line	-	-	-	-	-	1	-
Kholifar Hat Mangrove	Forest	-	-	-	-	-	-	-
Haringhata Mangrove Forest	Forest	-	-	-	1	-	1	-
Nilimar Char Mangrove	Forest	-	-	-	-	-	-	-
	Coast Line	-	-	-	-	-	-	-
9 No Ward Sluice Gate	Forest	-	-	-	-	-	-	-
	Coast Line	-	-	-	-	-	-	-
Bainchotki Char Mangrove	Forest	-	-	-	-	-	-	-
Khajura Mangrove	Forest	1	1	1	1	-	2	-
Kakchira Mangrove	Forest	1	1	1	1	-	-	-
Choto Labongola Mangrove	Forest	-	-	-	-	-	-	-
Choto Labongola Mangrove 2	Forest	-	-	-	-	-	-	-
Gora Padma Mangrove	Forest	-	1	-	2	-	-	1
	Coast Line	-	-	-	-	-	1	1
Nolbunia Char Mangrove	Forest	2	2	3	2	2	2	-
	Aquatic	1	-	2	3	2	2	-
Nishanbaria Mangrove	Forest	1	1	1	1	1	1	1
	Coast Line	-	-	-	-	1	2	3
Bara Nishanbaria Mangrove	Forest	1	1	1	1	1	1	1
	Coast Line	-	-	-	-	1	2	3

Location	Habitat Type	Type of threats*						
		Residential and commercial development	Agriculture/ silviculture	Natural system modifications	Biological resource use	Pollution	Human intrusion and disturbance	Natural Digester
Fatrar Char Mangrove	Forest	2	-	2	1	-	2	1
Fatrar Char Mangrove	Coast Line	-	-	-	2	-	2	2
Binoybari-Hazipur Char Mangrove	Forest	-	-	-	2	-	-	-
South Fatepur Char Forest	Forest	-	2	-	2	-	-	-
Sharikkhali Char Mangrove	Forest	-	1	-	1	-	-	-
Lebur Bon Mangrove	Forest	-	-	-	2	1	3	3
Kuakata Sandy Beach	Coast Line	2	-	1	3	1	3	3
Kuakata Eco-park and National Forest	Forest	-	2	1	1	1	3	3
Kuakata Eco-park and National Park 2	Forest	-	-	-	-	-	-	-
Lal Kankrar Char Mangrove 2	Forest	-	-	-	2	1	3	2
Dhulasor Mangove forest	Forest	-	1	2	1	1	-	-
Gangamati Sandy Beach	Coast Line	-	-	-	-	-	2	-
Nilganj Kumirmara Khal		-	-	-	2	-	2	-
Majher Char	Mudflat	-	2	-	1	-	-	-
Ammtoli Ferry Ghat	Aquatic	1	-	1	2	-	-	-
Ammtoli	Forest	3	1	2	1	2	3	-
Char Bijoy	Mudflat	-	-	-	2	1	2	-
Sonar Char Wildlife Sanctuary	Mangrove	-	-	-	2	-	1	2

**Note: Type of Threats; -=No threat, 1=Minor Threats, 2=Moderate Threats, 3=High Threats*

3.7 Management of Existing Ecosystem

3.7.1 Agencies with Responsibilities for the Governance and the Management

Key Agencies

Bangladesh Forest Department (BFD)

BFD is the key government agency responsible for the protection and maintenance of forests and wildlife. The major responsibilities of Forest Department include-

- Multi-dimensional resource management viz., forest resource development and management, protection, conservation and management of biodiversity.
- Protection and management of forests and wildlife wealth with enforcement of various Acts, Ordinances, Rules and Regulations pertaining to forest management. Take urgent action to end poaching and trafficking of protected species of flora and fauna and address both and supply of illegal wildlife products.
- Sustainable management of forests for maintain eco-system services as well as to facilitate meeting basic needs of present and future generations;
- Poverty reduction through creation of forest-based employment, livelihood opportunities and maintain ecological role of the zone for the forest dependent people;
- Maintenance of natural habitat for biodiversity conservation; enrichment and rehabilitation of degraded forest land;
- Participatory Forest management, horizontal expansion of tree cover with fast growing and high yielding variety of species through people-oriented forestry programme in state-owned fringe, marginal, sub-marginal and newly accreted land and khas land.
- Realization of Revenue, preparation of budget, auditing, accounting, etc;
- Encouragement and assistance in afforestation activities in public and private sectors;
- Provide technical advice and support to plant trees and practice agroforestry;
- Fulfillment of national obligations towards the international efforts to control climate change impacts, global warming, desertification, wildlife, biodiversity and other forestry related international treaties, protocols and conventions endorsed by the government;
- Rehabilitation of degraded forest land through people's participation issuance.
- Sustainably manage and protect marine and coastal ecosystems to avoid significant adverse impacts, including by strengthening their resilience, and take action for their restoration in order to achieve healthy and productive ecosystem.
- Support positive economic, social and environmental links between urban, peri-urban and coastal, rural areas by strengthening national and regional development planning.

Figure 3.13 represents the Administrative hierarchy of Coastal Forest Division, Patuakhali.

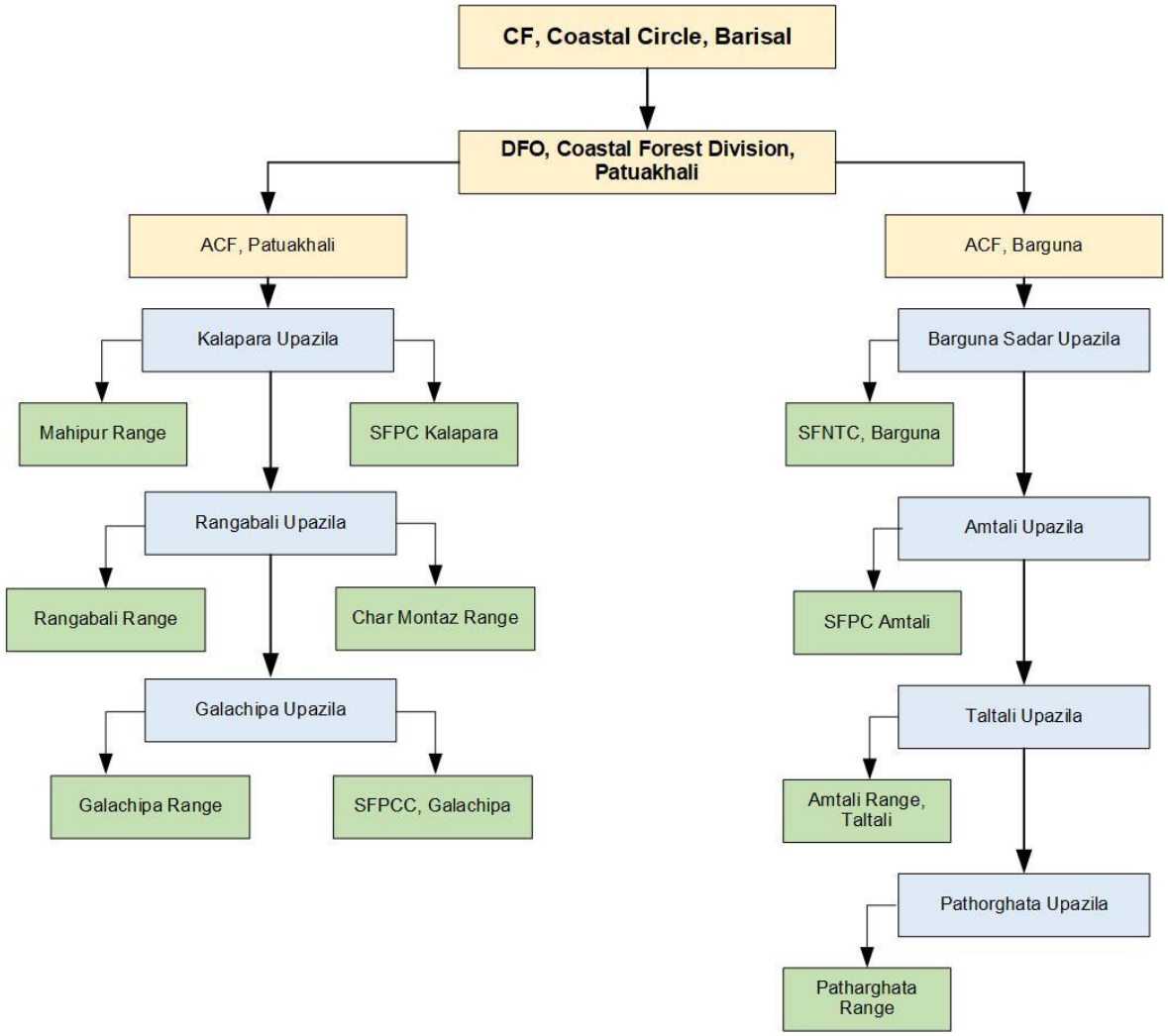


Figure 3.13: Administrative hierarchy of Coastal Forest Division, Patuakhali

Within study area under 7 Upazillas mentioned above, there are Kuakata National Park under Kalapara upazilla and Sonarchar Wildlife Sanctuary under Rangabali upazilla of Patuakhali district and Tengragiri Wildlife Sanctuary in Taltali upazilla and Laldia Wildlife Sanctuary in Patharghata upazilla of Barguna district.

District Administration

The Deputy Commissioner of the district is the Forest Settlement Officer of the concerned district. Forest Settlement Officer is empowered for reservation of the forest land. Forest Settlement Officer may exercise the following powers, like-

Power to enter, by himself or any officer authorized by him for the purpose, upon any land, and to survey, demarcate and make a map of the same; and (b) the powers of a civil court in the trial of suit.

The Deputy Commissioner, on his own motion or on the complaint of or upon information received from forest Department, can evict the unauthorized occupied forest land, building or part in the prescribed manner. In such situation the Deputy Commissioner can enter upon such land, building or part thereof and recover the same by evicting such person by demolishing and removing structures.

The deputy commissioner is the chair of District Environment and Forest Coordination Committee which is responsible for National Tree fair, saw mill licensing, and any other activities that need support from the committee.

The district authority is engaged with the timber auction and procurement activities the forest division.

Police Department

When any conflict occurs during protection of forest resources between local community or people and forest department staffs, Police is primarily responsible for the preservation of peace and order, protection of life and property of the victim people and prevention and detection of crime as quick as possible. Forest staff also inform the local police after the incident takes place for FIR or GD. Police response to crime incidents. They investigate into the matter and provide report to the judicial authority.

To protect forest resources police do patrolling with forest staff. Police also assist forest staff in recovering encroached forest land and seized forest produced.

Judiciary Department

After filing the case against the miscreants to the judicial court by forest department, the court by interpreting law and arguments from accused and the victim settle legal disputes, enforce rights of the citizens and impose penalties on the offenders. The judicial court plays a vital role in protecting the forest resources.

Supporting Agencies

Rapid Action Battalion (RAB)

When any big incident like recovery of unauthorized arms, ammunition, explosives or other matter like kidnapping cases happens with forest staffs the RAB come forward to handle the issues. They do proper investigation of any such offence and provide report to the court.

Coast Guard

Coast guard perform vital role for the protection of Coastal Forest and other resources like fish, wildlife and tourists inside the forests. They also Control piracy, illegal trafficking, and environmental pollution in Bangladesh waters and coastal areas, ensure overall security and law and order through security assistance to seaports, conduct relief and rescue operation in the coastal areas during natural calamity.

Bangladesh Navy

The Bangladesh navy act as front-line disaster management force in coastal belt. They also work for Controlling piracy, illegal trafficking, and environmental pollution in Bangladesh waters and coastal areas, ensure overall security and law and order.

Payra Port Authority

Payra Port is the 3rd sea port of Bangladesh located on the bank of Rabnabad Channel under Kalapara, a sub-district of Patuakhali. The port goes operation on 13th August 2016, with minimum essential logistics supports. Since September 2019 the coal and other cargo carrying ships have been calling the port regularly. The government of the People's Republic of Bangladesh has formulated short-, medium- and long-term plans to develop Payra Port as a modern sea port. By 2023, Payra is expected

to be a fully operational sea port through completion of capital dredging project as part of mid-term plan.

Payra Port land was handed over to the Port Authority from Patuakhali Forest Division through acquisition process. The port is connected with BFD in various ways. At Ramnabad area the port authority is developing a channel for vessel transportation. On the both side of the channel, patches of char land have been raising. Forest department in near future will bring these areas under plantation. The Port vessel goes into the deep sea where Forest department staff cannot go with their light vessels. In such situation for marine mega fauna conservation, forest department in collaboration with the port authority can patrol with their sea going vessel.

Bangladesh Tourism Board (BTB)

BTB has established with the aim of promoting the tourism industry of Bangladesh globally and introduce the tourism property of Bangladesh in the world court. The major responsibilities of BTB are to improve the image of the country in the outside world. Having the high tourism values of the study area within the country, BTB is an essential agency to contribute their roles in coordinate with other departments.

Department of Fisheries (DoF)

DoF is responsible to formulate and implement development projects /programs towards sustainable utilization of fisheries resources to ensure food security of the country. The department provide the list of the fishermen and Forest Department issues permit for entering inside the forest in Patuakhali Forest Division. Regarding the fishing activities DoF is needed to coordinate with BFD and other agencies for sustainable harvest of fish resources.

Department of Environment (DoE)

DoE is mandated to ensure sustainable environmental governance for achieving high quality of life for the benefit or present and future generations. DoE's roles will be most important to resist pollution in forest and maritime zone.

Department of Livestock (DLS)

DLS aims to meeting the demand of animal meat through providing animal health services, increasing animal production and productivity and value addition. This Department works for the livelihood development of the forest dependent people by providing loan on livestock. Regarding the issues on cattle grazing inside the forest close to the human habitation DLS and BFD needs to cooperation to minimize disturbance of forest resources.

Zilla Parisad, Patuakhali and Barguna:

Zilla parisad provides support for forest dependent communities by offering tube well for drinking water, improving sanitation facilities, repairing roads etc.

3.7.2 Conservation Initiatives and Challenges

Conservation initiatives for wildlife and forests

Habitat improvement initiatives

Patuakhali Forest Division has managed four Protected Areas (PAs) to conserve wildlife within there. These four PAs are Kuakata National Park, Tengragiri Wildlife Sanctuary, Sonarchar Wildlife

Sanctuary and proposed Laldia Wildlife Sanctuary. Some of the wildlife are Monkey, Wildboar, porcupine, Fox and Jackal, bat, dog, Mongoose, rat, Monitor lizard, Cobra, squirrel, Python, Haldi pakhi, Babui, owl, Bou kotha kao, kyte, shalik, shyama, tuntuni, dove, kingfisher, white stroke, Dahuk, Magpai, robin, nightingale and many others. According to the IUCN list, some species mentioned above are identified as rare and endangered species. During winter many migratory birds make their temporary residence in the sanctuary which attracts the tourists. To enrich these habitats, Patuakhali forest division has taken initiatives of habitat improvement plantation under SUFAL project. Till last financial year, 40.0 ha. of mangrove fodder plantation have been raised in Patuakhali Forest Division.

Awareness build-up

Forest Officers and staffs have been offered training for knowledge and skill development on PA management. Large scale outreach program and day observation like wildlife Olympiad are going to organized for motivation and awareness building. Training have been offered to the forest officials and staffs on Wildlife management and wildlife crime control matters. Smart patrolling has been introduced in PA area. Shark and Ray including other species conservation strategy and non-detrimental findings are prepared.

Afforestation and reforestation at degraded land and Newly accreted char land

More than 4,000ha accreted coastal areas have been covered by afforestation to create coastal green belt of trees as a barrier against sea borne storms. Moreover, 1,000ha of reforestation at degraded forest land have been done as restoration program in Patuakhali Forest Division.

Livelihood development of Forest dependent people

Institutionalizing collaborative Forest Management (CFM): The aim of the collaborative forest management is to give forest dependent communities a stake in the management and preservation of the quality of the forests over the long term and to foster local stewardship forests. The BFD's approach to community involvement in the degraded and denuded forest land through social forestry has been in implementation for over two decades. A more comprehensive systematic approach has been found essential for BFD to work closely with communities to protect the remaining standing forests.

Relevant key activities for this component are to identifying policy and regulatory measures to strengthening collaboration with communities in different ecosystems; ii) identifying the most forest dependent communities where the project forms collaborative forest management communities (CFMCs); iii) awareness rising, capacity development and training on the CFM approach for the committees and BFD staff. IV) Strengthening CFMC with own bank account, an operating fund and v) developing and institutional framework and rules for CFMC during implementation.

The formation of CFMCs: The formation of CFMCs has been facilitated by the NGO partners in consultation with the BFD Range and beat staff. The NGOs have been providing the capacity building support and CFMCs will be the main platform for activities of CFM. Village level collaborative forest management committee (CFMCs) are going to be formed with membership being open to all households in the nearby village. Community Mobilization and Organization: This sub-component will comprise of the following activities: i) Mobilization of communities with CFM committees in the forest depended villages and socializing the SUFAL project and the AIGA program. ii) Establishing and/or strengthening CFMC bank account and starting community savings. iii) Initiating village development activities through village development fund. iv) Training on livelihood diversification, preparation of livelihood proposals, accounts and book keeping. An important aspect will be organizing and training women and adolescent girls and offering them training and choice of income generation options.

Alternative income generation activities (AIGAs): A community operation Manual (COM) will be prepared prior to start of the project implementation in consultation with communities, taking into account experiences of CRPAR project and similar on-going operations in the country. The COM will elaborate the protocols for the implementation of the AIGAs.

Criteria for selection of AIGAs funds recipients: The livelihood funds will be maintained as a revolving fund at the community level and will be available to community members as micro credit. Priority for access to AIGA funds planned to be given to members of CFMCs who are a) among the poorest in the village, b) women-headed households c) landless and lack year-round employment, or d) belong to ethnic minority communities.

Following the above criteria till last financial year total 2225 numbers of beneficiaries including 1000 beneficiaries from PA have been selected in Patuakhali Forest Division. Out of which 200 beneficiaries have been given the loan to be self-dependent on 8 categories of trades like fisheries, nursery raising, small cottage industries, cattle feeding, poultry farming, small scale business etc. The target for providing loan for this year is 330 beneficiaries.

3.7.3 Policies, Legislations and Rules related to Biodiversity and Conservation

Introduction

This section of the report summarizes the policies, laws, regulations, guidelines of Bangladesh and international environmental agreements to which Bangladesh is a party that are relevant to environmental management and conservation of ecosystem, biodiversity distribution and their habitats around the country with particular emphasis on the South-Central Region of Bangladesh.

The two key non-sectoral regulations which govern the environmental management in Bangladesh are the Environment Conservation Act (ECA) 1995 (amended 2000, 2002, 2007 and 2010) and Environment Conservation Rules (ECR) 1997 (including amendments). ECA 1995 provides the requirements on environmental protection, improvement of environmental standards, and control and abatement of environmental pollution. Through the ECA 1995, the Department of Environment (DoE) is mandated to undertake any activity needed to conserve and enhance the quality of environment and to control, prevent and mitigate pollution. DOE is also responsible for the environmental approval process for all kinds of development activities.

The ECR, 1997, provide the parameters for: (a) the declaration of ecologically-critical areas and restrictions on operations and process which can or cannot be carried out/initiated in such areas, (b) securing an environmental clearance certificate, (c) environmental quality standards, (d) acceptable limits for discharges of waste, and (e) guidelines on pollution prevention. Overall, the ECA, (1995) and ECR, (1997) outline the regulatory mechanism to protect the environment in Bangladesh.

In Bangladesh, there are large number of sectoral regulations and policies which are not directly focusing on the environment and natural resources management but they can be summoned with regard to sectoral relevant environmental and natural resource management issues and related public services (Farooque and Hasan, 1996). Accordingly, Laws and regulations that are relevant to natural resource management directly or indirectly in Bangladesh are described below.

National Regulations

Table 3.10 summarizes the national environmental and biodiversity management regulations and other relevant laws that are related to environment and biodiversity management.

Table 3.10: National regulations relevant to sectoral development activities

Issue	Legislation or Regulation	Brief description of the legislation
Constitution of Bangladesh	Article 18A of Bangladesh Constitution	The Constitution of Bangladesh explicitly mandates 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 (Article 18A). In line with the spirit of the Constitution, the Government of Bangladesh enacted a comprehensive law titled as the Bangladesh Biodiversity Act 2017 which is listed below.
Protection of Environment including protected areas and pollution management for biodiversity management	Environment Conservation Act-1995 (all amendments including amendments in 2010)	The ECA 1995 amended in 2010 to broaden its horizon to protect wetlands, covered environment conservation, standards development, pollution control and abatement, declaration of ecologically critical areas (ECAs) and imposing of restriction for operations within the jurisdiction of such areas, defining and conserving wetlands, hill cutting, ship breaking, and hazardous waste disposal. The 2010 amendment empowered the government to enforce more penalties than before. Moreover, affected persons were given provision for make objections or take legal actions against polluters or any entity creating a nuisance.
	Environment Conservation Rules-1997 (including all amendments)	These rules, promulgated under the ECA 95, categorise industries and projects and identify the types of environmental assessments needed for the categories, and established national environmental quality standards.
	Environment Court Act (2010)	Aimed to resolve disputes and establish justice regarding environmental and social damage due to any development activities. This act allows government to take necessary legal action against any parties who create environmental hazards/ damage to environmentally sensitive areas as well as human society. According to this act, government can take legal actions if any environmental problem occurs due to interventions of the River Management Improvement Programme.
	The Forest Act, 1927 (amended in 1982, 1989, and Amendment Act in 2000)	This Act aims to protect forest resources and provides for reserving forests over which the Government has an acquired property right. It enables the restriction of many activities within forest areas and the imposition of punishment for violation. The Forest Act 1927 makes the forest department responsible to conserve forest as well as forest biodiversity including wildlife. The law has introduced social forestry along with co-management system to popularize and promote afforestation and conservation through community participation.
	The Protected Area Rule 2017	• Provides for the formation of Co-Management Committees for the management of Protected Areas. • Committees involve stakeholders including the resources users and especially ethnic people. • Empowers the Committee to act as official actor for the protection of forests and collect revenue • Provides for sharing of revenue to cover the recurrent costs of co-management. • Recently introduced in Sundarbans.

Issue	Legislation or Regulation	Brief description of the legislation
	Private Forest Act (PFA), 1959	The act allows the Government to take over management of improperly managed private forest lands, any private lands that can be afforested, and any land lying fallow for more than three years. Deals with the conservation of private forests and afforestation of wastelands.
	Wildlife (Protection and Safety) Act- 2012	Provides for the conservation and safety of biodiversity, forest and wildlife of the country by repealing the existing law relating to conservation and management of wildlife of Bangladesh. Under this Act, hunting, trapping, killing of wildlife are strictly prohibited.
	Bangladesh Biodiversity Act 2017	As a dualist country, Bangladesh requires implementing domestic legislation to give legal effect to the provisions of international treaties. The act was introduced 25 years after Bangladesh signed the Convention on Biodiversity in order to fulfil the State's international obligations. The law introduces an access and benefit-sharing (ABS) mechanism and also promotes research related to biotechnological and also documentation of traditional knowledge.
	Ecologically Critical Area Management Rules 2016	• Prohibit any change of land type within an ECA without permission of DoE. • Prohibit activities that could destroy or change the natural characteristics of soil and water. • Provide for penalties.
	Biosafety Rules, 2012	• Provide regulations on the approval process for biotech products developed domestically or by a third country. • Requires all GE products to be approved before they can be imported or sold domestically within Bangladesh.
	Noise Pollution Control Rules- 2006	This Rules give a right to the respective authority to mark off the areas under their jurisdiction as silent, residential, mixed, commercial or industrial. Also describes the approved standard limit of sound for each area. This rule protects the wildlife at their habitats.
	Bangladesh Water Act- 2013	Makes provisions for integrated development, management, abstraction, distribution, use, protection and conservation of water resources and aquatic species.
	The Play-ground, Open space, Park and Natural Wetland Conservation Act 2000 (Natural Water Bodies Protection Act 200).	According to this Act, the character of water bodies, i.e. rivers, canals, tanks, or floodplains identified as water bodies in the master plans or in the master plans formulated under the laws establishing the municipalities in division and district towns, shall not be changed without approval of concerned ministry. The law imposes conditions to take approval from the concerned authority while altering the nature of the abovementioned places which may cause ecological imbalance.
	The Water Supply and Sanitation Act (1996)	Regulates the management and control of water supply and sanitation in urban areas. Untreated sewage discharge will damage aquatic species and therefore, this law related to protection of aquatic species.
	Bangladesh Climate Change Trust Act 2010	An Act to establish a trust to be called the Climate Change Trust to redress the adverse impact of climate change on Bangladesh and to take measures on other matters relating thereto.

Issue	Legislation or Regulation	Brief description of the legislation
	The Ship Breaking and Recycling Rules-2011	The Rules promulgated under the ECA of 1995 (amended) defines and classifies hazardous materials (hazmats) (including hazardous wastes) and provides for safe and environmentally sound ship recycling in Bangladesh.
Fisheries	The Protection and Conservation of Fish Act 1950 (amended 1973, 1982, 1995, 2002)	The act sets requirements to protect and conserve fish. Defines fish as "all cartilaginous, bony fishes, prawn, shrimp, amphibians, tortoise, turtles, crustacean animals, mollusks, echinoderms and frogs at all stages in their life history."
	The Protection and Conservation of Fish Rules- 1985	The Rules focus on the protection of fisheries/fishes and aim to prevent the destruction of fish in the natural waters and killing of fish by poisoning.
	Private Fisheries Protection Act 1889	Provides for the protection of private fishing rights.
	Marine Fisheries ordinance 1983 and Marine Fisheries Rules-1983	Covers fisheries conservation and management.
	Pesticide Act-2018 and Pesticide Rules, 1985 (Amendment) in 2010	Bans harmful toxic substance which were earlier imported and used for pest control.
Water Transportation, handling and storage, pollution and coastal resources management,	Territorial Water and Marine Zone Act 1974 & Maritime Rules-1977	Provide guidelines for transportation through marine and inland water ways and control of pollution in the surrounding waterways, and for the conservation, management and development of marine fisheries.
	Hazardous Wastes and Ship Breaking Waste Management Rules, 2011 (22 December, 2011; MoEF)	The legislation is premised on the Basel Convention. It bars the import of wastes if ships are not certified by authorized agents of exporting countries as not containing hazardous wastes; provides regulations for safe disposal of hazardous waste. Implementation through an emergency response plan Implementation is the responsibility of a National Technical Committee under MoEF.
Non-Agricultural Tenancy Act 1949-for land use State Acquisition and Tenancy Act 1950-land use	Makes provisions relating to the certain non-agricultural tenancies in Bangladesh.	Introduced to eradicate flaws and gaps in the provisions for collection and receiving of rents for land. It also declares forests and waterbodies as non-retainable properties.
Health and Safety and labor management	The Penal Code 1860	The Code contains still valid provisions relating to pollution management, environment protection, and protection of health and safety.
	Dangerous Cargoes Act 1953	The Act provides for guidelines for cargos to avoid any discharges of hazardous materials in the surrounding water ways and adjacent land.
	Pressure Vessel Rules 1995 (amended 2004)	The Rules provide the safety requirements for units handling divergent types of hazardous materials.

National policy framework

The major sectoral policies relevant to environment and biodiversity management are: Environment Policy (1992) and National Environment Policy (Amended) 2013; Forest Policy (1994); Fisheries Policy (1998); Water Policy (1999); Wetland Policy (1998) etc.

In addition, various strategies and plans address environmental and sustainability concerns such as National Conservation Strategy (NCS) 1992; National Environment Management Action Plan (NEMAP) 1995; and Bangladesh Climate Change Strategy and Action Plan (BCCSAP) 2009. In addition, Perspective Plan (a three-year rolling development plan) as well as Vision 2021 and Vision2041 which also address the Sustainable Development Goals (SDGS) have been described below.

Relevant environmental and biodiversity related national policies, strategies and plans

Key relevant sectoral policies, strategies and plans are listed in Table 3.11.

Table 3.11: Relevant National policies, strategies and plans related to sectoral development activities

Issue	National Policies	Brief description of the policies
Environmental management	The National Environment Policy 1992 (updated 2013)	The National Environment Policy (NEP), 1992 was Bangladesh's first environmental legislation, revised in 2013 to address climate change. The NEP 2013 also address the increased extent and magnitude of environmental degradation. It identifies the major impediments to environmental conservation: population growth, poverty, illiteracy, lack of awareness and healthcare services, limitation of arable land, unplanned development and urbanization, and industrialization.
	National Environment Policy, 2018	This update focuses on fulfilling the constitutional policy to conserve the environment and biodiversity as a priority in association with national economic development activities. Considers environmental disasters, natural calamities, and climate change-induced impacts on natural resources with the target of sustainable development.
	National Biodiversity Strategy and Action Plan for Bangladesh (NBSAP,B), 2016-2021	A comprehensive strategy to address climate change challenges in Bangladesh. Bangladesh Climate Change Strategy and Action Plan built on six themes: • Food security, social protection and health • Comprehensive disaster management • Infrastructure • Research and knowledge management • Mitigation and low carbon development • Capacity-building and institutional strengthening.
	Country Investment Plan (CIP) for Environment Forestry and Climate Change, 2016-2021	• Provides a national roadmap to increase the contribution of environment, forest and climate change sectors to sustainable development of the country through the enhanced provision of ecosystem services- thereby helping to reduce poverty, improve environmental and human health benefits and increase resilience to climate change. The plan: • Identifies programmatic and sub-programmatic areas for Environment, Forest and Climate Change (EFCC) sectors; • Identifies the investment priority areas under each sub-programme;

Issue	National Policies	Brief description of the policies
		• Identifies responsible agencies for implementing the different programmes and sub-programmes of EFCC sectors; • Organizes projects to facilitate coherence and synergies among them and minimize duplication; • Estimates the financing needs over the next five years (2016-2021) and, by comparing them with current investments, quantifies the financing gap and identifies neglected areas
	Bangladesh Wildlife Master Plan, 2015-35	• Protection of important endangered/threatened species, • Management of natural habitat for wildlife • Planning of ecological network and land-uses, • Scientific management of protected areas, • Building institutional capacity • Policy and legal framework development, • Combating wildlife trafficking, • Supporting communities in wildlife zone, • International and regional cooperation, • Developing nature based eco-tourism • Communications awareness and education, • Wildlife Research
	National Environmental Management Action Plan 1995	The plan covers the conservation of habitats and biodiversity including environmental management and quality of life. It identifies the main national environmental issues, including those related to the water sector such as flood damage, riverbank erosion, environmental degradation of water bodies, increased water pollution, shortage of irrigation water and drainage congestion; and identifies various specific regional concerns.
	National Conservation Strategy 1992	The strategy focuses on the conservation of environment and life.
	National Water Management Plan, 2001 (approved by the National Water Resources Council in 2004)	The plan aims to achieve integrated development, management and use of water resources in Bangladesh over a period of 25 years. The Water Resources Planning Organization (WARPO) has been assigned to monitor the plan. The Plan's major programmes have been organized under eight sub-sectoral clusters: i) Institutional Development, ii) Enabling Environment, iii) Main River, iv) Towns and Rural Areas, v) Major Cities; vi) Disaster Management; vii) Agriculture and Water Management, and viii) Environment and Aquatic Resources.
	National Forest Policy 1994	The policy was the first step to recognize of the importance of people's participation in forestry. It commits to sustainable development, poverty alleviation, local people's participation in forest protection, and government support for forestry development.
	National Forest Policy, 2016 (Draft)	The main focus of the policy is to arrest deforestation, and degradation of forest resources, enrich and extend areas under tree cover, through appropriate programmes and projects, to ensure that at least 20% of the country comes under tree cover by 2035, with at least a canopy density of 50%.
	National Water Policy 1999	Provides guidance to ensure optimal development and management of water. All agencies and departments entrusted

Issue	National Policies	Brief description of the policies
		with water resource management responsibilities (regulation, planning, construction, operation, and maintenance) are required to enhance environmental amenities and ensure that environmental resources are protected and restored in executing their tasks.
	National Policy for Safe Water Supply and Sanitation 1998	Aims to ensure accessibility to all of water and sanitation services within the shortest possible time at a price that is affordable to all.
	Coastal Zone Policy 2005	Provides for management and support to the coastal region in a manner so that the people of the region can lead their life and livelihoods within a secure and conducive environment.
	Coastal Development Strategy 2006	The strategy is the instrument to implement the Coastal Zone Policy, identifying strategic priorities to guide interventions and investment in the coastal region for betterment of life and livelihood of the people of the region.
	Wetland Policy 1998	Provides guidelines for the protection of wetlands and related species.
	Bangladesh Climate Change Strategy and Action Plan (BCCSAP) 2009	A comprehensive strategy to address climate change challenges in Bangladesh. Bangladesh Climate Change Strategy and Action Plan built on six themes: • Food security, social protection and health • Comprehensive disaster management • Infrastructure • Research and knowledge management • Mitigation and low carbon development • Capacity-building and institutional strengthening.
	Bangladesh Delta Plan 2100	Aims to ensure an optimum level of water safety and food security, as well as economic growth and a framework for its implementation based on effective governance.
	National Adaptation Plan of Action (NAPA) - for Climate Change 2005 (updated 2009)	Identifies many adaptation measures to be taken by different ministries and departments - in line with decisions of UNFCCC.
	Bangladesh Standards and Guidelines for Sludge Management 2015	The guidelines support the mandatory requirements under the Environment Conservation Act, 1995 (amended 2010) for proper management of sludge and installation of effluent treatment plants (ETP). They provide extensive information and methods for all aspects of sludge management and operating effluent treatment plants, and disposal.
Land use	National Land Use Policy 2001	Identifies components for ensuring land use activities are aligned with environmental conservation and sustainability. Sets out mechanisms for land zoning in rural and urban areas for better management of biodiversity and natural resources management.
Fisheries	National Fisheries policy 1998 and National Fisheries Strategy 2006	The objectives of the policy are to: enhance fisheries production; maintain ecological balance and conserve biodiversity; fulfil the demand for animal protein; achieve economic growth through exporting fish and fisheries products; and alleviate poverty of the fishers. The strategy proposes ways in which the policy can be implemented and what support can be offered to guide the sector.

Issue	National Policies	Brief description of the policies
Bangladesh Forestry Master Plan 2017-2036 (FMP 2017-2036)	FMP 2017-2036 has prepared to be able to deal with the emerging environmental and socioeconomic challenges, and capitalize the opportunities thrown up by the emerging global consensus in dealing with environmental issues.	• Enhance area and quality of forest • ensure strict conservation, growth, increased ecosystem services and sustainable management of state forests • Extend protected area coverage upto 30% of all notified forest land • Address climate issues in forestry sector • Maximize production of timber and fuel wood through social forestry and agroforestry outside forests.
Tourism	National Tourism Policy, 2010	This policy has been prepared to facilitate tourism activities and represent the country's tourist attractions in national and international area. The main objectives of the policies are: • to establish the tourism industry as a developing and sustainable • sector, contributing to the national economy, generating • employment; promoting socio-economic development (by involving • local people with local government organizations), and maintain • Ecological balance and protect biodiversity. • to ensure tourism generates employment and contributes to • poverty alleviation; • to enable tourism to earn foreign currency; • to develop and maintain eco-tourism

Recommendations for improvement of existing policies of Bangladesh

The updated laws, rules and policies are implemented in many sectors of Bangladesh. However, the improvement of these instruments will be required to improve from time to time based on the need. Therefore, few recommendations are suggested for better management of biodiversity and listed in Table-3.12.

Table 3.12: Recommendations for improvements in few legal instruments

PPPs and Legal Instruments	Main Elements	Recommended Changes
National Biodiversity Strategy and Action Plan for Bangladesh (NBSAP,B), 2016-2021	A comprehensive strategy to address climate change challenges in Bangladesh. NBSAP built on six themes.	• Need to stop the conversion of forest to other lands. • Restriction on the introduction of the exotic species in plantation programmes as climate change mitigation measures • There shall be a mechanism for assessing value of ecosystem service that is provided to the society • Develop mechanism for protection of Bio-piracy/bio-theft

PPPs and Legal Instruments	Main Elements	Recommended Changes
National Forest policy-2016	1. To arrest deforestation, and degradation of forest resources, enrich and extend areas under tree cover, through appropriate programmes and projects, to ensure that at least 20% of the country comes under tree cover by 2035, with at least a canopy density of 50%. 2 To ensure strict conservation, growth, increased ecosystem services and sustainable management of state forests. Introduce Forest Certification as a tool to improve forest management through market influence.	• Ecosystem services, as a concept, is mentioned only and particularly focusing carbon sequestration only • The policy needs to focus on the broader benefits of forest and tree-based ecosystems including provisioning and cultural services that are limited in the existing policy. • The ecosystem services concept need to be focused as a guiding framework for ecosystem-based decision-making and also for monitoring sustainable forest use.

3.8 Institutional Framework

3.8.1 National Institutional Arrangements

The main institutions which have sectoral regulations, policies and development plans that are directly or indirectly relevant to environmental and biodiversity management are:

Planning Commission

Ministry of Environment, Forest and Climate Change (MoEFCC):

- Department of Forest;
- Department of Environment;
- Bangladesh National Herbarium;

Ministry of Agriculture:

- Department of Agriculture Extension;

Ministry of Fisheries and Livestock (Department of Livestock);

Ministry of Water Resources:

- Bangladesh Water Development Board (BWDB),

Ministry of Local Government, Rural Development and Cooperatives:

- Local Government Engineering Department (LGED);
- Department of public health Engineering (DPHE);
- Water Supply and Sewerage Authorities (WASA),

Bangladesh Inland Water Transport Authority

The Ministry of Environment, Forest and Climate Change (MoEFCC) has overall responsibility for environmental matters. But, the National Environment Council (NEC) (chaired by the Prime Minister), and the Executive Committee of the NEC (chaired by the Minister for MoEFCC provides guidance to the sectoral ministries/agencies on matters of national environmental concern. At the Divisional level,

the Divisional Environment Committee (chaired by the Commissioner with representation from government agencies) is responsible for dealing with environmental issues at the local level. However, these lower-level institutional arrangements are in need of strengthening.

Sector Ministries have their own policy and programme frameworks for addressing environmental management in Bangladesh, but they lack adequate institutional capacity to effectively implement required actions and measures. The MoEFCC has responsibility for working with other ministries to ensure that environmental concerns are given due recognition when implementing their development program, and provides policy advice and coordination for action plans across all sectors. The MoEFCC is also responsible for reviewing and monitoring the impact of development initiatives on the environment across all sectors and nationally.

3.8.2 Divisional and Local Arrangements

Bangladesh is divided into eight divisions, Each division is further split into several districts (*jela*) which are then further sub-divided into Upazilas. This SEA study area (South Central Region) falls within Barisal Division. Each Division is headed by a Divisional Commissioner who acts as the supervisory head of all the government Offices (except the central government offices) situated in the division.

Local government institutions include Union Parishad, Upazila Parishad and Zila Parishad and have been vested with a wide range of development functions including planning for the provision of general physical infrastructure at the local level. Local Government Ordinances mandate Union Parishads and Upazila Parishads to coordinate development activity implemented by the government and NGOs within their territorial and functional jurisdiction.

3.9 Relevant International Convention, Treaty and Protocol

Bangladesh has already had ratified or signed a number of important multilateral environmental agreements (MEAs) related to environment protection and conservation of natural resources which have been already accommodated in the national policies of the country. The Environment Policy, National Conservation Strategy, National Biodiversity Strategy and Action Plan are examples of instruments that were influenced by obligations under international conventions, treaties and protocols.

This International convention, treaty and protocols act as international guidelines that Bangladesh is obligated to comply with when implementing sectoral development activities and projects. The international treaties relevant to environment and biodiversity management that are signed and ratified by Bangladesh are described Table 3.13.

Table 3.13: International conventions, treaties and protocols ratified by Bangladesh

Sector	International convention, treaty or protocol	Descriptions	Date ratified	Date Entered into Force
Environment and biodiversity, environmental pollution	Convention on Biological Diversity (1992)	1992 Convention on Biological Diversity (CBD) that deal with the sustainable management of biological resources including fauna and flora. The convention requires signatories to develop national strategies	03-05-1994	29-12-1993

Sector	International convention, treaty or protocol	Descriptions	Date ratified	Date Entered into Force
		(National Biodiversity Strategy and Action Plan) for the conservation and sustainable use of biological diversity.		
	Convention on International Trade in Endangered Species of Wild Fauna and Flora (Washington 1973) – also known as CITES	The 1973 Convention on the International Trade in Endangered Species (CITES) that deal with the sustainable management of biological resources including fauna and flora. Addresses the exploitation patterns and overharvesting that threaten species of flora and fauna. Under this Convention, the governments agree to restrict or regulate trade in species that are threatened by unsustainable patterns and to protect certain endangered species from overexploitation by means of a system of import/export permits.	20-11-1981	01-07-1975
	The International Plant Protection Convention (IPPC), 1951	Aims to secure coordinated, effective action to prevent and to control the introduction and spread of pests of plants and plant products.	01-09-1978	
	United Nations Framework Convention on Climate Change (UNFCCC), 1992	Aims to achieve stabilization of greenhouse gas (GHG) concentrations in the atmosphere at a level low enough to prevent dangerous anthropogenic interference with the climate system.	Adopted in 1992 and enforced from 15-04-1994	15-04-1994
	Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (1989)	Aims to reduce the amount of waste produced by signatories and regulate the international traffic in hazardous wastes.	01-04-1993	05-05-1992
	Convention on Wetlands of International	Provides a framework for national action and international cooperation	21-9-1992 (ratified)	1971

Sector	International convention, treaty or protocol	Descriptions	Date ratified	Date Entered into Force
	Importance ("Ramsar 1971").	for the conservation and wise use of wetlands and their resources.		
	Convention on the Conservation of Migratory species of wild Animals (Bonn 1979)	1979 the convention Aims to conserve migratory species within their migratory ranges. Also elaborated on the Conservation of Migratory Species of Wild Animals with aims to protect the species of wild animals that migrate across or outside of national boundaries.	01-12-2005 (ratified)-	1979 and enforced in 1983
	International Convention on Oil Pollution Preparedness, Response and Cooperation (London, 1990.)	Parties are required to establish measures for dealing with pollution incidents, either nationally or in co-operation with other countries.		Signed 30-11-1990 and enforced from 13-05-1995
Nuclear Pollution	The Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency is a 1986 treaty of the International Atomic Energy Agency (IAEA)	Parties agreed to provide notification to the IAEA of any assistance that they can provide in the case of a nuclear accident that occurs in another state that has ratified the treaty.	1988	1986
Land degradation	UN Convention to Combat Desertification (UNCCD) 1994	A legally binding international agreement linked to sustainable development. It addresses most vulnerable ecosystems and peoples living in the dryland area.	1995	1994
Cultural and natural Heritage	Convention Concerning the Protection of the World Cultural and Natural Heritage (Paris 1972)	Defines and provides for the conservation of world`s heritage by listing the natural and cultural sites whose value should be preserved.	03-11-1983	23-11-1972
Sea, maritime safety and marine pollution	International Convention for the Safety of Life at Sea (SOLAS), 1974 (amended)	Specifies minimum standards for the construction, equipment and operation of ships, compatible with their safety.	04-11-2002	25-05-980
	United Nations Convention on the Law of the Sea (Montego Bay, 1982.)	Provides guidance on ship-based pollution control and management	1982	1982

Sector	International convention, treaty or protocol	Descriptions	Date ratified	Date Entered into Force
	The International Convention for the Prevention of Pollution from Ships, 1973 as modified by the Protocol of 1978 (MARPOL 73/78, The current convention is a combination of 1973 Convention and the 1978 Protocol, which entered into force on 2 October 1983.	Includes regulations aimed at preventing and minimizing pollution from ships - both accidental pollution and that from routine operations	4-11-2002	02-10-1983
	International Convention for the Prevention of Pollution of the Sea by Oil (London, 1954 (as amended on I I April 1962 and 21 October 1969.)	Applies to all ships, except tankers of under 150 tons gross tonnage and other ships of under 500 tons gross tonnage, registered in the territory of, or having the nationality of, a Party. Naval ships and ships engaged in whaling are excepted (art. 2). Discharges are prohibited, except when a ship is proceeding en route or when the instantaneous rate of discharge does not exceed 60 litres per mile.	28-12-1981	Entered in 1954 and amended in 1962 and in 1969

3.10 Key Aspect in the Theme Relating to Ecosystem and Wildlife Conservation Including Forests

Key aspect in the theme	Primary competent authority (CA)– and their mandates	Key support organisations (Govt., NGO, donor, CBO, etc.)	Performance of CA and support organisations
Coastal afforestation	BFD Mandates are, • Plantation in newly accreted char lands • Management of mangrove forests • Reforestation within the existing forested land • Surveillance against forest destruction • Conservation and protection of wildlife within the afforested areas	Govt. Agencies • DC, UNO and local administration • Bangladesh Police, Bangladesh Coast Guard and RAB • DoE, DoF, DLS NGO's • Local, national and international NGO's. Donor Agencies • WB, ADB, GIZ, GCF	CA performance BFD is managing the reserve forests and other coastal and mangrove plantations over the time with limitations of required manpower, monetary and logistic resources. Existing problems are: • Illicit cutting of forest trees • Wildlife poaching and trafficking • Grazing of cow/buffalos within the coastal forest areas

Key aspect in the theme	Primary competent authority (CA)– and their mandates	Key support organisations (Govt., NGO, donor, CBO, etc.)	Performance of CA and support organisations
			• Disturbances of wildlife by the tourists Govt. Agencies • DC allocate temporarily the land of newly accreted chars to BFD for plantations for short time unless declaration of Reserve Forest. In some cases, BFD cannot start plantation in proper time due to the delay of the land handover process • Allocating of forest land other than forestry purposes. Support organizations Poor communication and transportation facilities hinder the implementation of law and order enforcement.
Social forestry on settlements and marginal lands	BFD Mandates are: • Plantation within the prospective areas of human settlements, road/ embankments sides, and marginal lands • Ensure sapling supply through nursery raising • Caring of social plantation through collaboration with local people or respective departments like LGED, BWDB or RHD • Benefit sharing of social plantation	Govt. Agencies • LGED, BWDB, RHD • UNO and local administration • Pyra Port Authority Donor Agencies WB, ADB	CA performance Facing problems in selection of tree species considering the economic outputs from the plantations. Sometimes BFD bound to decide exotic tree plantation for its quick economic returns to the local beneficiaries. Govt. Agencies Having some lack of coordination among the agencies regarding the project implementations. Donor Agencies None.
Biodiversity conservation	BFD Mandates are: • In-situ and ex-situ conservation of forest flora and wildlife species • Ensure habitat quality for wildlife within the forest • Surveillance against wildlife disturbance/poaching/trafficking	Govt. Agencies DoE Donor Agencies, ADB	CA performance Not perform in full pledges due to manpower and resource shortage. Govt. Agencies DoE has no administrative setup or manpower in upazila level to take actions against biodiversity destruction Donor Agencies

Key aspect in the theme	Primary competent authority (CA)– and their mandates	Key support organisations (Govt., NGO, donor, CBO, etc.)	Performance of CA and support organisations
	• Protect overharvesting of fishes and aquatic resources within the reserve forest area		Facing problems in project implementation by the respective Govt. Department who have manpower shortage.
Habitat conservation	<u>BFD</u> Mandates are: • Conserve forest area as habitats for wildlife <u>DoE</u> Mandates are: • Designate and conserve wildlife habitats except forest area • Declaration and management of ECA • Ensure environmental quality • Enforce law and order against environmental degradations <u>MoEFCC</u> • Declaration of Marine Protected Area	<u>Govt. Agencies</u> Bangladesh Coast Guard <u>Research Organization</u> WCS	<u>CA performance</u> BFD and DoE not perform in full pledges due to manpower and resource shortage. DoE has no administrative setup or manpower in upazila level to take actions against habitat destruction <u>Govt. Agencies</u> Bangladesh Coast Guard mainly roles to protect illegal harvest of marine economic resources (i.e. fishes) by the foreign boats, but does not take actions against water degradation or non-fisheries resource harvesting <u>Donor Agencies</u> Not confirm.
PA management	<u>BFD</u> • Declaration and management of protected area	<u>Govt. Agencies</u> DC of respective districts <u>Donor Agencies</u> USAID, GIZ, WWF, World Bank	<u>CA performance</u> • Not perform in full pledges due to manpower and logistics shortage. • Corridor connectivity of PA's. • Inadequate communication and transportation facilities in PA's <u>Govt. Agencies</u> NA <u>Donor Agencies</u> Presently no project is running within this area under mentioned donor agencies

3.11 Relevant Legislation and Regulation

Key aspect in the theme	Primary legislation	Accompanying or enabling regulations	Comments on adequacy or not re. legislation and regulations
Coastal afforestation	National Forest Policy, 1994 National Forest Policy, 2016 (Draft)	• Arrest deforestation, and degradation of forest resources; • Enrich and extend areas under tree cover, through appropriate programmes and projects, to ensure that at least 20% of the country comes under tree cover by 2035, with at least a canopy density of 50%.	• There is no restriction in converting forestland to agricultural land before declaration of plantation area as "Reserve Forest". Thus many of the forest lands all over the country have got converted to agricultural fields.
	Coastal Zone Policy, 2005	• Management and support to the coastal region in a manner so that the people of the region can lead their life and livelihoods within a secure and conducive environment.	• Mainly focuses on human livelihood and needs to highlight environmental and nature conservation issues.
	Bangladesh Forestry Master Plan 2017-2036 (draft)	• Enhance area and quality of forest; • Ensure strict conservation, growth, increased ecosystem services and sustainable management of state forests • Extend protected area coverage upto 30% of all notified forest land; • Address climate issues in forestry sector; • Maximise forest production through social forestry and agroforestry outside forests.	• Adequately address the related issues; • But, might increase competition among land users – due to plantations developed in agricultural, horticultural and grazing areas that might reduce crop productivity – due to shading by plantations alongside narrow rural roads; • Might evict poor and asset-less forest users due to encroachment control measure - causing social conflict.
	Non-Agricultural Tenancy Act 1949-for land use State Acquisition and Tenancy Act 1950-land use	• Makes provisions relating to the certain non-agricultural tenancies in Bangladesh. • Declares forests and water bodies as non-retainable properties.	• Need to highlight the roles of BFD regarding forested and plantation areas
Social forestry on settlements and marginal lands	National Forest Policy 1994	• The main aim of this policy is- • Ensure people's participation in forestry sector • Increase social forestry system for plantation on encroached, unutilized forests and vacant areas	• Not resolve the following issues: • Extensive use of fast-growing monoculture species plantation mainly to accrue financial benefit early might cause loss of biodiversity and native environment • Shade besides road/rail side plantations might impede

Key aspect in the theme	Primary legislation	Accompanying or enabling regulations	Comments on adequacy or not re. legislation and regulations
		• Promote extensive plantation of fast-growing native species within and outside state forests • Tree planting programme by govt. semi-government, and private sectors; • Encourage wood-based industries to adopt contract farming - to improve supply of raw materials	agricultural production and create social conflicts
Biodiversity conservation and Habitat conservation	Bangladesh Wildlife Master Plan, 2015-35	• Protection of important endangered/threatened species, • Management of natural habitat for wildlife • Planning of ecological network and land-uses, • Scientific management of protected areas, • Building institutional capacity • Policy and legal framework development, • Combating wildlife trafficking, • Supporting communities in wildlife zone, • International and regional cooperation, • Developing nature based eco-tourism • Communications awareness and education, • Wildlife Research	• Pending the issue of the activities like relocating encroachers to outside PAs, demarcation and fencing of PAs are yet to be implemented and are likely to cause conflict in the society. • • Speedy resolve the compensation issues regarding human wildlife conflict.
PA management	Wildlife (Conservation and Security) Act, 2012 Protected Area Conservation Act,2017	• Declaration of sanctuaries, National Parks, community conservation area, safari park, Eco Park, botanical garden and wild animal breeding centre; • Declaration of landscape zone or corridor, buffer zone and core zone, special biodiversity conservation area; • Declaration of National heritage, memorial tree, sacred tree and kunjaban	• Need more transparency in land ownership related issues within the PAs • Sharing of income from the PA's with the CMC not yet fully done.

3.12 Relevant PPPs

Key PPPs relating to the theme	Main projects emanating from the PPPs	Main negative environmental impacts emanating from the projects	Main negative socio-economic impacts emanating from the projects
Coastal Zone Policy, 2005 and Coastal Development Strategy, 2006	• Mitigation of natural disasters and ensuring safety and protection by constructing/rehabilitating embankments, sea walls, cyclone shelters, etc., and by greenbelt development; • Water resources management to combat water related disasters, increase freshwater availability, improve navigation and economic activity; • Improving condition of rural livelihoods and sustainable economic opportunities for coastal communities; • Promoting productive economic activities and focused development of tourism and fisheries sector; • Promoting sustainable environmental and social responsive shrimp farming • Infrastructure development and industrial development; • Social development by building facilities and awareness for health and nutrition, education, and water and sanitation; • Economic development activities to reduce poverty and increase livelihood opportunities; • Participatory management of resources, public-partnership, gender equity, women empowerment;	• Degraded coastal environment due to industrial pollution as a result of increased non-farm industrial activities; • Local environment pollution will be increased due to infrastructural development. • Increased water pollution due to improved river navigability and increased shipping (inland and sea); • Loss of wildlife habitat due to infrastructural development; • Damage to homestead vegetation and gardens; • Increased siltation in rivers and inland water bodies • Natural coastal process has been altered as a result of structural measures to mitigate natural disaster.	• Increase population density and thereby vulnerability to natural disaster; • Coastal embankment acts as a false sense of security: • Increase social problem due degradation of environment by coastal polder; • Loss of grazing field for livestock; • Rise of social tension due to large farmers/outsiders forcing the leasing of small land parcels (next to large farms) for shrimp aquaculture.
Bangladesh Delta Plan-2100	• Construction/rehabilitation of embankments • Dredging of rivers, khals and channels • Management of submerged estuarine char lands	• Mangrove forest degradation might occur due to improper storage and disposal of dredged material • Sedimentation on forest floor caused vegetation damage changes in the natural flow direction	Lower agricultural production due to plantation on marginal lands

Key PPPs relating to the theme	Main projects emanating from the PPPs	Main negative environmental impacts emanating from the projects	Main negative socio-economic impacts emanating from the projects
	• Development of a long-term plan for land reclamation in the estuarine region • Construction of cross-dams for effective land reclamation • Plantation and coastal afforestation for land stabilization • Development of coastal greenbelt • Improving the coastal ship fleet & capability including port facilities • Development of ecotourism & marine cruises	• More pressure on mangrove forest might occur due to increased shipping and coastal navigation.	
National Land use Policy, 2001	• Preparing plots to develop a digital land zoning map; • Formulating land zoning laws and rules; • Enacting laws and policies on land use based on zoning map; • Identifying khas land (government-owned fallow land); • Stopping the use of agricultural land for house building and other infrastructural development; • Constructing multi-storied buildings for the landless people; • Establishing an inter-ministerial taskforce to oversee the bringing of new lands - formed by deposition of river sediments (char lands) - • Stopping indiscriminate use of land.	Low-level local environmental pollution due to the construction of multi-storeyed buildings	-
National Livestock Extension Policy, 2013	Priorities the coastal region under location specific planning to realize the potential to rear dairy cattle and buffalo	Might destruction of newly planted seedlings and undergrowth of forest floor due to grazing of livestock in charlands	-
National Agricultural Extension Policy, 2015	• Promoting adoption of new agricultural technology to suit a changing climate; • Increase public private participation in agricultural	• Having risks to expansion of agriculture within the forested land.	Increased conflicts in the coastal region between fishing and farming communities

Key PPPs relating to the theme	Main projects emanating from the PPPs	Main negative environmental impacts emanating from the projects	Main negative socio-economic impacts emanating from the projects
	extension, with provision of incentives to follow existing rules and regulations • Strengthen forecasting system for natural disasters (e.g. floods, cyclones) in disaster prone areas.	• Increased pollution by fertilizer and pesticide residues.	due to agricultural growth.
National Agriculture Policy, 2018	• Promoting a selection of region-specific crops • Improving water management-related infrastructure. • Increasing vegetable and fruit cultivation at homestead level. • Increasing cultivation of cash crops.	• Increased agricultural activity will lead to increased pollution by fertilizer and pesticide residues; • Increased agricultural activity will create pressure on grazing land thus pressure on forested land. • Increased irrigated rice area and farm mechanization will enhance greenhouse gas emissions; • Possible increase in soil salinity due to increased dry season irrigation (in case of long time stagnation of water that rarely happens).	Increase conflict with BFD and local farmers regarding crop production and forest plantation.
Bangladesh Wildlife Master Plan, 2015-35	• Specific program to protect important species (tiger, elephant, cetaceans, etc.); • Demarcation, fencing and expansion of PAs, • Empowering relevant agencies to enforce wildlife laws; • Strengthening Community stakes in conservation; • Generation of Conservation based jobs and business;	-	• Activities like relocating encroachers to outside PAs, demarcation and fencing of PAs are yet to be implemented and are likely to cause conflict in the society. • Increase of PA's area may cause social conflict and decrease in livelihood options.
National Adaptation Programme of Action (NAPA), 2005	• Expansion of coastal greenbelt and Afforestation and reforestation programme;	• Widening and re-enforcement activities may pose forest area.	• Conflict may arise between government and local people where there is no

Key PPPs relating to the theme	Main projects emanating from the PPPs	Main negative environmental impacts emanating from the projects	Main negative socio-economic impacts emanating from the projects
(updated 2009)	• Widening and re-enforcement of embankments, construction of higher and wider roads etc.		char lands or intertidal area for establishing greenbelt;
National Tourism Policy, 2010	• Construction of tourists' facilities (e.g. eco-lodges, watchtowers, rope-ways, walk-ways) and development of activities (e.g. night-hiking); • Development of quick and easy communication to beach destinations by air, rail and road; • Promote tourism in SW region based on historical, archaeological and religious sites. • Development of nature, culture, adventure and archaeological based tourism.	• Increased waste generation and thus pollute forest soil and sea/river water; • Expansion of tourist infrastructures within the plantation and forest areas; • Disturbance to wildlife due to excess tourist movement within the wildlife habitats. • Increase of tourist activity will degrade forests and its habitat • Due to increase of tourists, creates more noise and that will decrease wildlife population.	• Conflicts may arise regarding forest management by the respective authorities (i.e. BFD) due to allow tourism activities within the forests. • More infrastructure development will cause forest and biodiversity degradation and that will cause decrease in livelihood opportunities as well as food production.

3.13 Drivers of Change

Key change	Main external drivers	Main internal drivers	Main actions to "fuel" or "brake" the drivers, depending on whether the change is good or bad
Coastal greenbelt formation	Availability of the suitable land for plantation	• Logistics and manpower of BFD; • Availability of suitable projects	Enhance logistic and financial support of BFD
Char land stabilization	Cyclone, coastal inundation, Storms	Use of forestland other than forestry practice	Restrict illegal use of char land through providing logistic support to respective departments
Creation of new alternate livelihood opportunities	Soil and water quality degradation, threats to wildlife by the insecticides	• Lack of awareness; • Lack of manpower of enforcement authority such as DoE, BFD	• Enhance awareness among the local people and recruit more manpower to the DoE and BFD
More crop production aligns with national targets	Change landuse of inland area and forest land for shrimp culture	• Inter departmental coordination gap; • Local political influence by the land grabber;	Demarcation of land area according to its uses

Key change	Main external drivers	Main internal drivers	Main actions to "fuel" or "brake" the drivers, depending on whether the change is good or bad
More fish production	Encroachment of intertidal area and forest land for shrimp culture	• Lack of law enforcement; • Local political influence by the land grabber;	Enhance awareness among the local people and recruit more manpower to the DoE and BFD
Coastal biodiversity and ecosystem services enhancement	Implementation of different programmes by respective departments	Location specific planning, allocation of required resources	Implement location specific regional planning considering its landcover and natural features
Enhance tourism facilities	Development of tourist Infrastructures and increase tourists' movement	• Lack of integration of plans among different departments; • Insufficient manpower of BFD and DoE	• Demarcation of tourist allow areas • Enhance surveillance system through providing sufficient logistic support to BFD

3.14 Conclusion

Bangladesh is comparatively rich in species within South Asia due to its soil quality and climatic condition which has been further enhanced due to overlapping of the two major biotic sub-regions such as Indo-Himalayas and Indo-China in Bangladesh.

The proposed SEA administrative boundary covers "The South Central Region" of Bangladesh. The landscapes of the study area comprise different features like forests including mangrove forest, rivers, mudflats, beaches and sand dunes. Most of the forests lies within the intertidal area and south facing along the coastal part. Water bodies and channels, rivers and tributaries support good habitat for flora and fauna. Mangrove ecosystem is directly linked with the enhanced productivity of the nursery ground for marine fish and shellfish fauna (Hussain & Hoq 2010) and protection from the tidal surges and cyclones. Homestead, aquatic vegetation and reed-land supports the wild birds as their feeding and roosting place. Key near-shore ecosystems such as sea grass meadows, marshes, and mangroves are particularly valued for their extremely high productivity, which supports a great abundance and diversity of fish as well as shrimp, oysters, crabs, and other invertebrates. All the features create ecosystems to survive the natural biota and provide different kinds of ecosystem services to the human beings. The nursery role of coastal estuaries and marine ecosystems also extend supports for protection and conservation of these areas.

The study area possesses reserve forest, two wildlife sanctuaries with numerous flora and faunal communities, one national park at Kuakata, West part of Ganges-Brahmaputra-Meghna Delta IBA and part of Ganges-Brahmaputra-Meghna Delta KBA. In addition, part of the Sundarbans ECA at South-west part of Pathorghata Upazila located within the proposed study area.

The prominent biodiversity hot spots include: the terrestrial vegetation, mangrove forest, the estuaries and brackish ecosystems that have important species which include crab eating frogs, sea snakes, cobras, sea turtles, raptors storks, wader, wild-duck, deer, dolphins with conservation values.

At the current stage, biodiversity of the region and as a whole of Bangladesh is burdened by poverty, food insecurity, and intensifying climate change. However, these underlying drivers of biodiversity loss are a result of unsustainable human activity and behavior. And still the fabulous wildlife of the south-central region and Bangladesh as a whole is in continuous threat from different direction and their numbers are decreasing at an alarming rate. To protect biodiversity and the prosperity of

communities around this region and the country, it is essential to adopt and shoot demand for more responsible and sustainable practices that safeguard soil, water, forests, and wildlife. Government should properly implement all of the existing laws and legislations and have to build up trained manpower for the protection of biodiversity.

The integrated approach used in coastal zone management is an adequate method in dealing with the matter of biodiversity. In addition, concept of behavioral approaches to align biodiversity preservation with agricultural production and also campaigning for Conservation trainings in communities around the country to empower local practitioners with tools and skills to promote local biodiversity protection would be worthwhile.

The present Payra-Kuakata Comprehensive Master Plan focusing on Eco-Tourism is an integrated and comprehensive development plan. The current SEA study will guide holistic and environmentally-sustainable planning for the implementation of the PKCP, whilst bearing in mind other relevant socio-economic and infrastructural development within the PKCP area of influence. There are risks – for both the region (including endangered species and their habitats/hot spots) and the Sundarbans as well as adjoining forest areas - can be minimized and managed through the findings of current SEA study and an appropriate SEMP implementation.

This may be mentioned that the management of biodiversity is a complex matter that needs the involvement of many different partners ranging from governmental organizations to private companies, NGO's and volunteers. This aside, national commitment, improved legislation and enforcement will offer an essential framework for promoting and maintaining biodiversity of the country with particular emphasis on the South-Central Region.

4. Delta Morphology, River Dynamics, and Water Resources Management

4.1 Background

The coastal zone of Bangladesh is located in the tropical region and can be broadly divided into three regions: the deltaic eastern region, the deltaic central region, and the stable deltaic western region. The coastal zone of Bangladesh, consisting of a vast network of rivers, a large number of islands between channels, a submarine canyon (Swatch of No Ground), the funnel shaped part of northern Bay of Bengal, is highly vulnerable to climatic hazards, especially tidal inundation induced from occasional horrendous cyclones and storm surges that is followed by consequent intrusion of saline water. Land subsidence is also quite prominent in the coastal area, yet this zone has great potential for agriculture. Moreover, being enclosed by man-made polders, the region is often subjected to water logging resulting from inadequate in-polder water management. The water takes longer to drain out for the reason of the area being low-lying. However, the coastal zone of Bangladesh is rich in natural resources and provide various benefits towards the nation. The mangrove, fisheries, tourism, sea culture activities, shipping and inland navigations, etc. are some examples of these benefits. As strong interaction between the water resources with other components (e.g., ecosystem) exists and also water resources of coastal region play a key role in the livelihood and economic stability of the local people, it needs to be kept pristine in any kind of development plan. Having said that, lacking is evident in implementing/ maintaining integration among all available resources. Moreover, some development plans overlook environmental considerations in planning which encourages exploitation of the natural resources. On this point, water resources can be highlighted as it is widely discriminated in the process of implementing any project.

National Water Policy (1999) in Bangladesh gives due importance on water resources management and encourages development in capacity building. Though it is a guideline for the nation's framework of sustainable water resources management, it needs updating in case of coastal zone. As the water resources at the coastal zone depends majorly on the available freshwater from upstream, some potential issues can be incorporated in the existing policy.

Urban Development Directorate considers the south-central coastal region, consisting seven districts (Faridpur, Madaripur, Shariatpur, Barisal, Patuakhali, Barguna and Bhola), to be potential for the purpose of expanding regional infrastructure and thus uplifting the overall socio-economic status. They have developed a regional plan focusing on the seven Upazilas of Barguna and Patuakhali Districts. On this backdrop, a Strategic Environmental Assessment (SEA) is in progress and this report can be used as a baseline for the water resources management of area of interest under this project.

4.2 Scope of this Report

The main objective of this report is to assess and present the baseline condition of the water resources of SC region. Specific scopes include:

- The study focuses on the overall hydrological setting of the SC region and the potential impacts of the hydrological parameters on development plans.
- The flow analysis within the region will be limited to the intrusion of freshwater from upstream into the SC region, residual flow paths, tidal asymmetry features, natural drainage pattern etc.
- The study analyses the trend of groundwater level and flood level of some specific return periods within the SC region.

- The study provides an analysis on the historical development of the rivers within the study area along with the change in the morphology of the coastline.
- The study also describes the tentative natural hazards of the region that are likely to affect the infrastructure development and identification of key stakeholders
- The present and future risks that may arise will be covered within the scope of the study
- The relevant policies, plans and programs will be reviewed within this study which will later aid in the forming of an environmental strategy.
- The study includes a section covering prediction of some driving factors that may hinder the implementation process of any regional plan of the SC region.

4.3 Meteorological Analysis

Data on meteorological parameters such as rainfall, temperature and relative humidity of the BMD stations in the South-Central region were collected from CEGIS archive. The average total rainfall data for three stations located at the SC region is taken for analysis to represent the yearly and seasonal trend of the entire region. For analyzing temperature and relative humidity, average value of six stations located within the SC region are considered as representative for the entire scenario of region. For the study purpose, data from three BMD stations have been used namely, [Patuakhali Station, Baruguna Sadar and Galachipa Sadar by setting mini weather station] to synthesize a representative station for the entire south-central region.

4.3.1 Rainfall

The rainfall data for the year–span 1983-2013 is analyzed to gather an overview of the rainfall pattern (yearly) at the study area (Figure 4.1). The overall trend of rainfall shows a decreasing pattern, which can be a precursor to less generated run-off and subsequent reduced flow in the rivers within the vicinity.

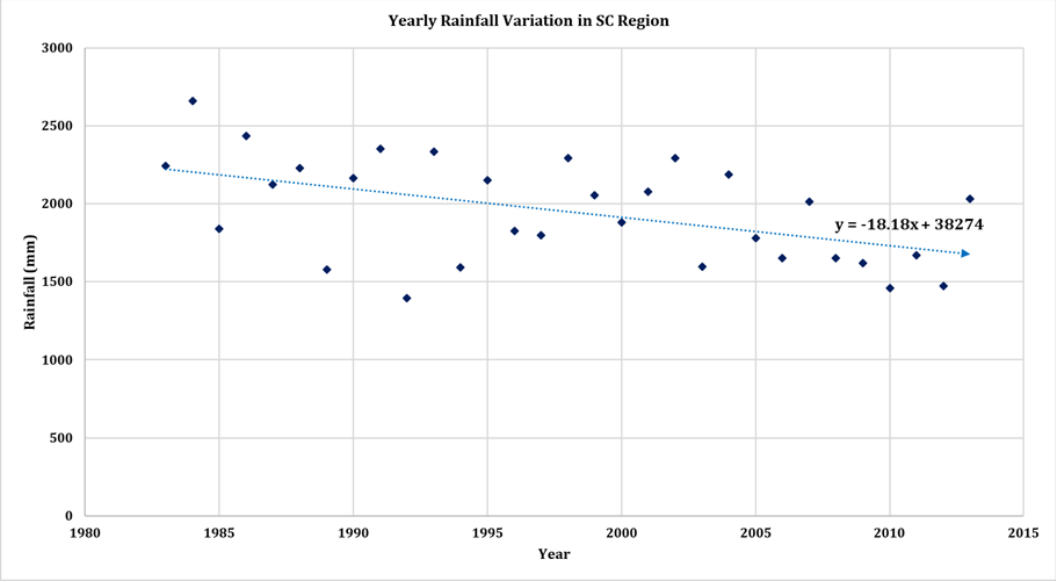


Figure 4.1:Trend of Yearly Rainfall in SC Region

The summary of the monthly rainfall variation is represented in Figure 2.2 by box plot; which provides the information of the variability or dispersion of the data. The median rainfall value for each month is represented by the separating line of each box. The interquartile distance represents that range

within which 50% data are present. The upper whisker and lower whisker represent the maximum and minimum values.

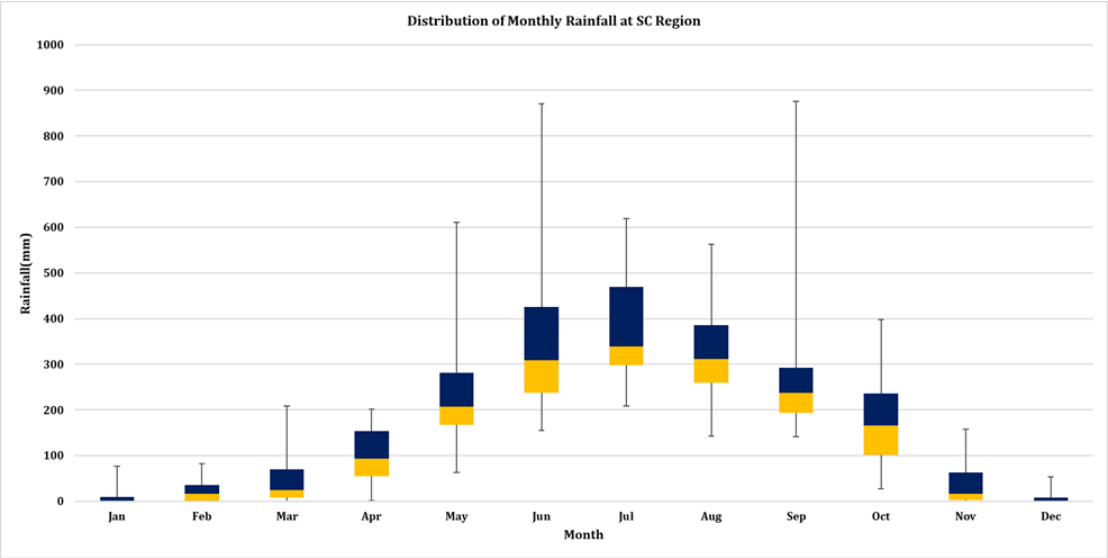


Figure 4.2: Monthly Distribution of Rainfall in SC Region

The monthly variation of the rainfall is represented in the hyetograph in Figure 4.3 below. The rainfall increases significantly in monsoon period (June-September) and again begins to decrease in the post-monsoon period and reaches to the least amount in December. From the analysis, it has been observed that only 4% of the total rainfall occurs in the dry period (December-February), whereas 62% precipitation occurs in monsoon (June-September) (Figure 4.3). The remaining 34% rainfall occurs during pre-monsoon (March-May) and post-monsoon (October-November) period.

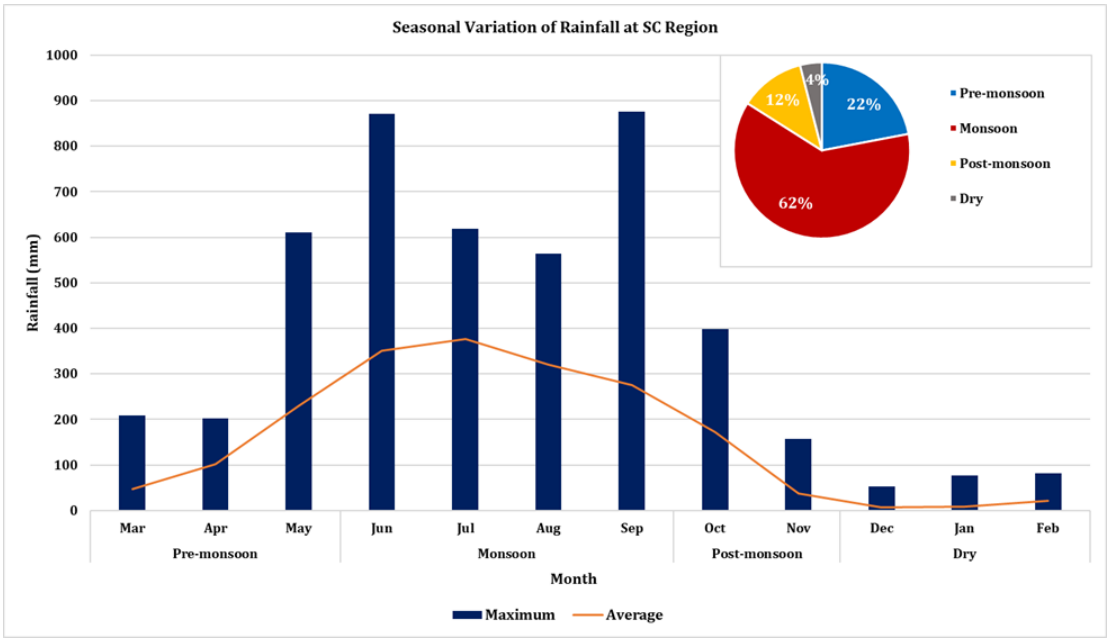
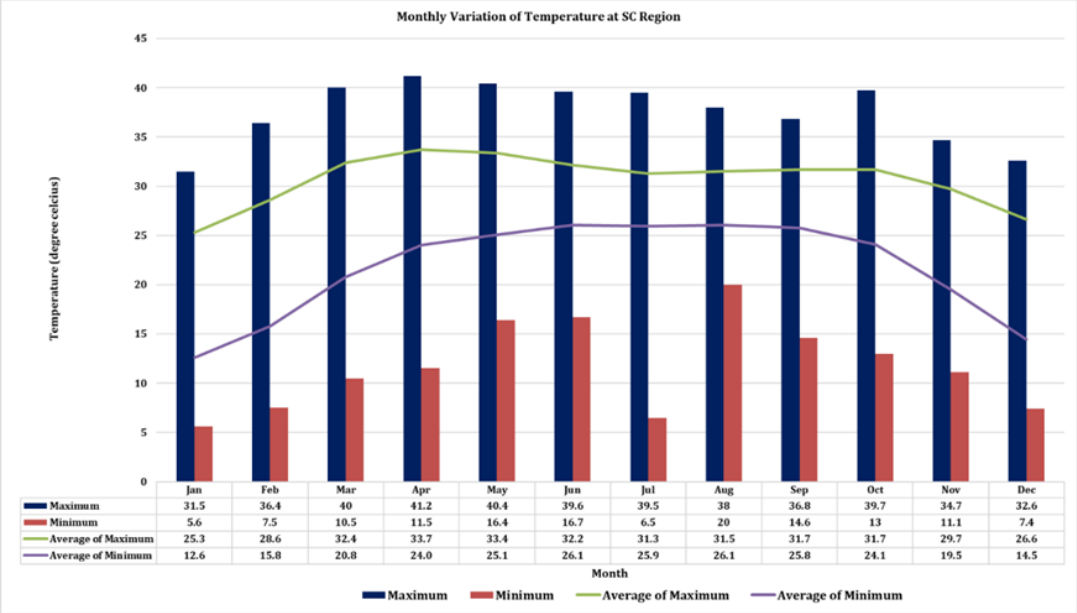


Figure 4.3: Seasonal Rainfall Variation at SC Region

4.3.2 Temperature

Temperature data has been analyzed for the period 1983-2013. Decreasing pattern in both maximum and minimum temperature indicate that the overall temperature at SC region is reducing (Figure 4.5). The highest temperature has been observed to rise up to 40.5°C in the month of May and lowest temperature is observed to occur in January (Figure 4.4).



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Maximum	31.5	36.4	40	41.2	40.4	39.6	39.5	38	36.8	39.7	34.7	32.6
Minimum	5.6	7.5	10.5	11.5	16.4	16.7	6.5	20	14.6	13	11.1	7.4
Average of Maximum	25.3	28.6	32.4	33.7	33.4	32.2	31.3	31.5	31.7	31.7	29.7	26.6
Average of Minimum	12.6	15.8	20.8	24.0	25.1	26.1	25.9	26.1	25.8	24.1	19.5	14.5

Figure 4.4: Monthly Variation of Temperature at SC Region

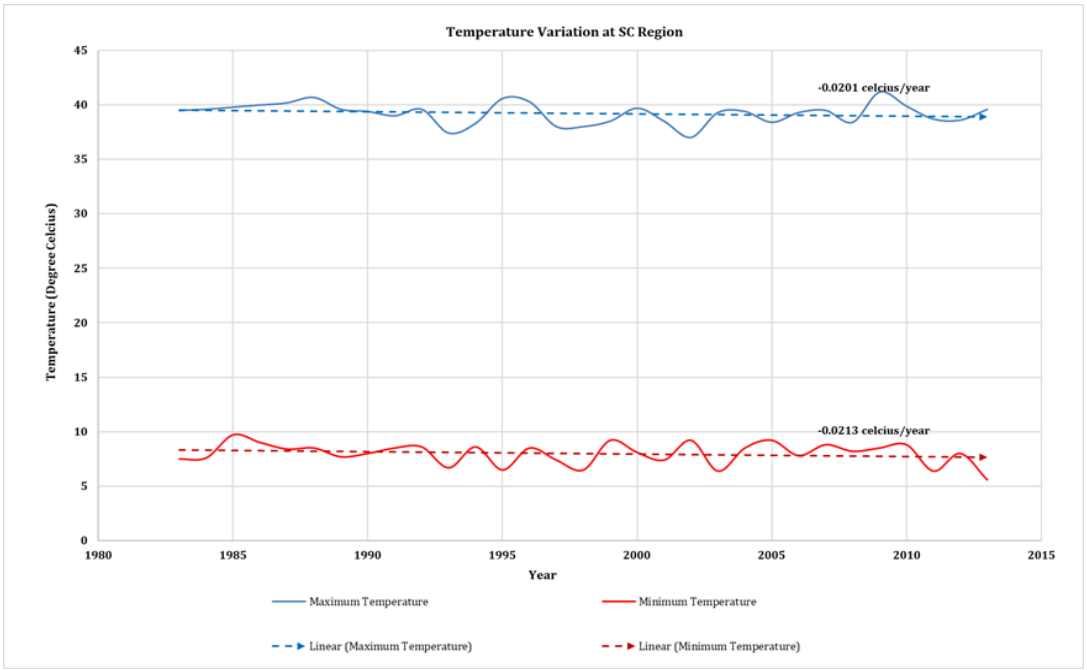


Figure 4.5: Trend of Yearly Temperature at SC Region

4.4 Main Rivers System

The river system in the South-Central (SC) region in Bangladesh receives the majority of freshwater from the Arial Khan River system and Meghna-Tentulia River System. The Gorai River system also

contributes to the freshwater inflow through Baleswar System. The bulk of the central coastal zone is subjected to tidal effect. The river system is presented in Figure 4.6.

4.4.1 Gorai-Madhumati River System

The Gorai is the main right bank distributary of the Ganges and a major freshwater source for the entire southwest region of Bangladesh during the dry season. It receives water from the Ganges and discharges to the Madhumati River. Portion of the Gorai flow is also diverted towards the southcentral region through the Madhumati and Kaliganga near Pirojpur. The river is perennial but following the commissioning of the Farakka Barrage in India in 1975, the flows started declining during the lean season from the mid-seventies. The volume has also declined due to silting up of its bed. Siltation at the river mouth has further deteriorated inflow from the Ganges in the dry season, on the other hand reducing normal flood-carrying capacity resulting from overtopping of its banks. The Danger Level recorded at Gorai Railway Bridge station of Bangladesh Water Development Board (BWDB) is 12.75 mPWD. It is a Class-IV Route of Bangladesh Inland Water Transport Authority (BIWTA). (BWDB, 2011)

4.4.2 Shandhya-Baleswar River System

The Shandhya River branches off the Arial Khan in the Rohmotpur union of the Babuganj Thana under Barishal district. Later, it joins the Kocha River at the Shoriktola Dhumritola union of the Sadar upazila, Pirojpur. The river is tidal and it overflows its banks during the monsoon. It is a perennial flowing river and categorized as Class-III Route of the BIWTA. It will be covered under this study.

This extremely tapering river issues from the Kaligonga (Pirojpur) in the Deergho union of the Nazirpur upazila under Pirojpur district and outfalls into the Bay of Bengal through the Pathorghata upazila under the Borguna district. It is a perennial flow river. It is more than 60 times wide at downstream compared with its starting width. The length and width of the river are 146 km and 1.6 km respectively. During the monsoon, the flow increases, and rising waters overflow its banks into the floodplains. This is a tidal river and boats ply through the year-round.

4.4.3 Buriswar-Payra River System

The highly tapering river Burishwar-Payra off-takes from the Pandob River at the Koloskati union of the Bakerganj upazila under Barishal district. Afterwards it flows through Angariya, Lebukhali, Pangasiya, Itabarhiya, Chhoto Bighai, Borho Bighai, Aila Patkata, Amtoli Pourashova, Burhir Char, Arpangasiya and Ponchokoraliya unions. It debouches into the Bay of Bengal through the Borhobagi union of the Amtoli upazila under Borguna district. Water flows perennially in this strongly tidal river and boats of all sizes move up and down all the year round. Monsoon waters overflow into the adjoining floodplains. The length and width (avg) of the river is 90km and 1200m accordingly. Gulisakhali is the branch of this system. This is a Class-II Route of the BIWTA.

4.4.4 Meghna-Tentulia River System

The combined flow of the Upper Meghna and the Padma is known as the Lower Meghna at downstream. Once upon a time in the past, the river would flow past Lakshmipur and Noakhali towns to its left and outfall into the Bay of Bengal near Sandwip. Arriving near Bhola perimeter, it had split into three odd branch channels. The eastern mainstream was named as the very Lower Meghna. The midstream flowing past Bhola to the west was named as Shahbajpur Channel. The western stream passing along the western perimeter of Bhola was called Tetulia Channel. About 60 years ago, the eastern channel started drying up from Lakshmipur downstream. At present, the Meghna (Lower) continues as Shahbajpur Channel from the north of Bhola until its outfall into the bay. The river ranks

3rd in the world, in terms of water flow volumes. The confluence of the Upper Meghna and the Padma is one of the widest (11km) and largest of its kind in the world. There are many midstream alluvial chars (islands) dotting the river, which divide it into two major channels. Of the two, the larger, eastern channel is 5-6.5 km wide and the western channel is 2km wide. Further downstream to the south, the lower Meghna bifurcates into three channels before debouching into the Bay: Tetulia (Isha) River, Shahbajpur and Bamani. The 5- 6.5km wide Tetulia separates Bhola Island from Barishal. The monsoon flow is nearly 5 million cusecs which also carries 1500 m tons of silt per year. This is a Class-I Route of BIWTA.

The Tetulia originates from the Meghna River at the Ilisha union of the Sadar upazila under Bhola. Proceeding through the Char Kajol, Panpot-ti unions, it falls into the Bay of Bengal through the Chalitabuniya union of the Golachipa Upazila under Patuakhali district. Water flows perennially through the channel. Width upstream is greater than that downstream. The river overflows its banks during the monsoon. It is strongly tidal. Small and big boats ply throughout the year in this Class-I Route of BIWTA.

4.4.5 Kirtonkhola-Sugandhya-Bishkhali River System

The Kirtonkhola River, which is tidal, issues from the Arial Khan River at the Shayestabad union of the Sadar Upazilla, Barishal. Flowing through Char Monai, Char Koua, and Chorbarhiya unions, the Kirtonkhola ends its journey into the Sugandhya River at the Dapdapiya union of Nalchhiti Upazila under Jhalakati district. It is a perennial flow river that bursts its banks during the monsoon. Small and big boats ply through this perennial river round the year. This is classified as Class-I route by BIWTA.

This short but comparatively wide river branches off the Kirtonkhola River at the Dapdapiya Union of the Nalchhiti Upazila under Jhalakati district. It proceeds through Ward # 21, Mogrha, Nalchhiti Paurashabha, Kulkati, Panabaliya Unions before out-falling into the Bishkhali River at the Gabkhan Dhanshiri Union of the Sadar Upazila under the same district. It has perennial water flows and overflows its banks during the monsoon. Boats ply all the times of the year in this tidal river. It is a Class-I Route of the BIWTA.

The Bishkhali River debouches from the Shugandhya River at the Gabkhan Dhanshiri Union of the Sadar Upazila, Jhalakati, and flows through Rajapur, Kathliya, Betagi Upazilas. It falls into the Bay of Bengal through the Sadar union of the Patharghata Upazila under Barguna. Water flows down the channel all year round. The river is more than seven times wider downstream. Water flows overtopping its banks during the monsoon and boats of different sizes move up and down the dwarf channel. This river is the Class-III Route of BIWTA.

4.4.6 Arial Khan River System

Taking off the Padma at the Dheokhali Union of the Sodorpur UZ, Faridpur, the Arhial Khan drains into the Tentuliya (Barishal) River through the Chor Gopalpur Union of the Mehendiganj UZ under Barishla District. It is a large distributary of the Padma River. Nearly a couple of century ago, the Padma would exhaust its waters into the Bay of Bengal through this channel. Later, the combined flow of the Jamuna and the Padma passed through the Kirtinasha channel due southeast to the Meghna near Chandpur. Its offtake mouth changes position conforming to the morphology of the Padma. The river flows through Faridpur, Madaripur and Barishal districts in its course. Water is available throughout the year in this tidal river. Water overflows its banks during the monsoon. The Shandhya, the Kumar (Upper), Nehalganj-Rongmatiya and the Kirtonkhola are the major distributaries of this distributary river. Erosion is observed along either of its banks. Navigation continues throughout the year. This is a Class-III (downstream) and Class-4 (upstream) Route of BIWTA.

4.4.7 Andarmanik River

The Andarmanik originates from the Tiyakhali River in the Mithakhali union of the Kolaparha upazila under Patuakhali district. Flowing through the Neelganj and the Khaprhabhanga unions, it drains into the Bay of Bengal through the Borhobogi union of the Amtoli upazila under Barguna district. There is flow taking place throughout the year which boosts during the monsoon overtopping its banks into the floodplain. Small and big boats ply throughout the seasons. The length and width of the river is 29km and 0.5 km accordingly. It has strong tidal effects and there are bank protection works along the right and the left banks.

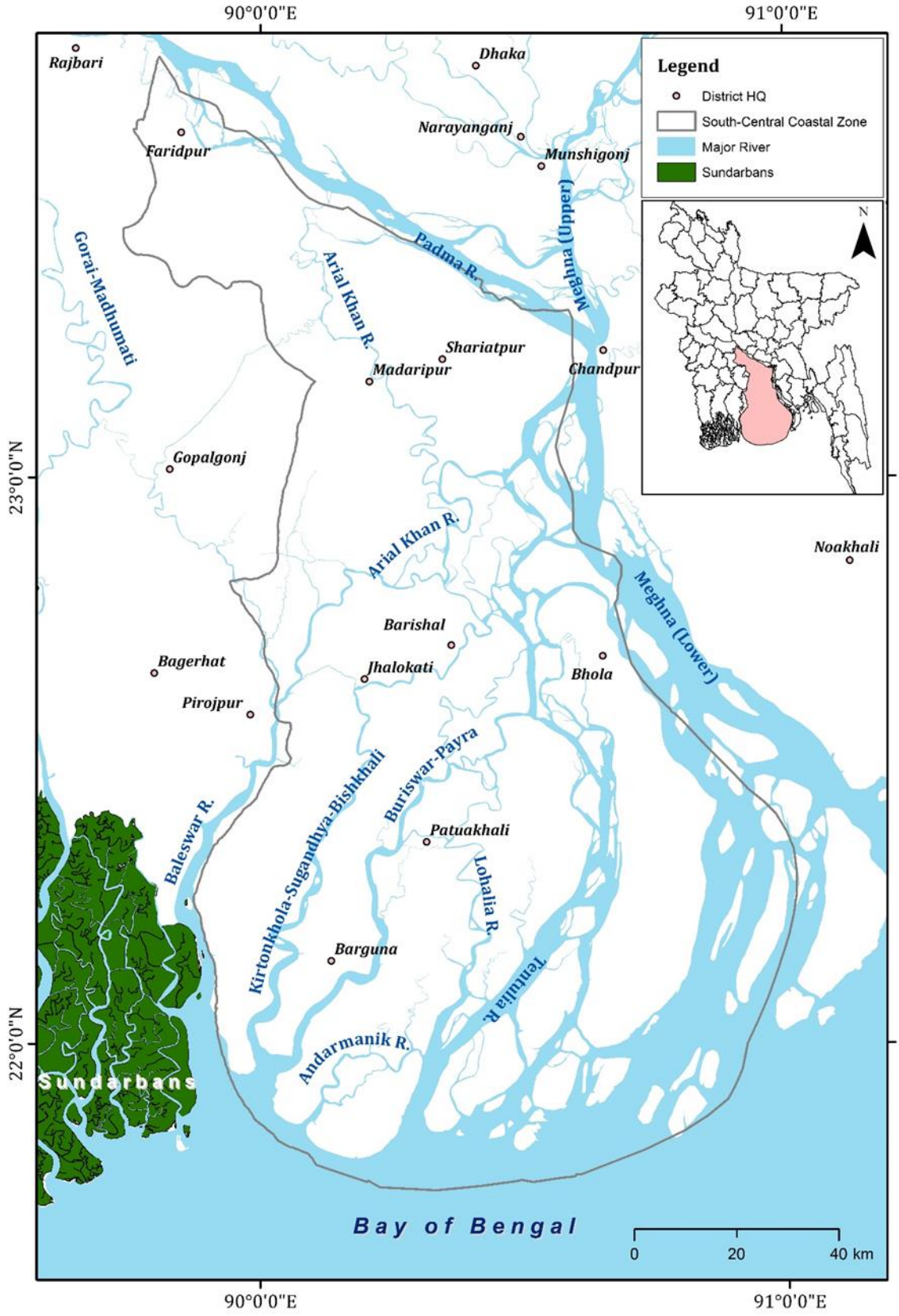


Figure 4.6: Major River Systems in the SC Region

4.5 Availability of Freshwater

Freshwater enters the project location primarily from three ends; from Gorai through the Madhumati-Kaliganga onto Baleswar, from Arial Khan and from Meghna. To analyze the freshwater inflow at SC region, data from three discharge stations are being selected. They are- Gorai Railway Bridge (99) in Gorai River, Chowdhury Char (4A) in Arial khan and Mawa (93.5L) in Padma River. The period of data for each station has been analyzed in based on their availability on NWRD.

The discharge data at the Gorai Railway Bridge station for the period from 1989 to 2019 has been collected and analyzed. As the daily discharge data is not observed, rating curve has been prepared and daily discharge has been generated consequently. The generated discharge data has been plotted and presented in Figure 4.7. The general pattern of the discharge shows a reducing trend.

The discharge data of Arial Khan River has been collected and analyzed for the year span 1990 to 2019. The trend is observed to be decreasing. Similarly, the discharge data at the Mawa points shows a reducing trend as well. In case of Mawa, discharge data from the year 1990 to 2019 has been used in the analysis. Both Mawa point and Chowdhury char accumulates flow from Gorai River. Therefore, the reduction in the flow of the lastly mentioned two stations may have been induced by the decrease in flow of Gorai River. The negative slopes of the trend line at the selected three locations translate to reduction in freshwater inflow in the SC region. The probable cause for such decreasing flow may be due to lack of flow augmentation from upstream. Moreover, SC region also receives flow from the Ganges basin. Hydraulic structures constructed by the neighboring country for their own benefit may be posing a negative impact in ours. Furthermore, sedimentation at river beds of this delta results in reduction of conveyance capacity of the natural alluvial rivers.

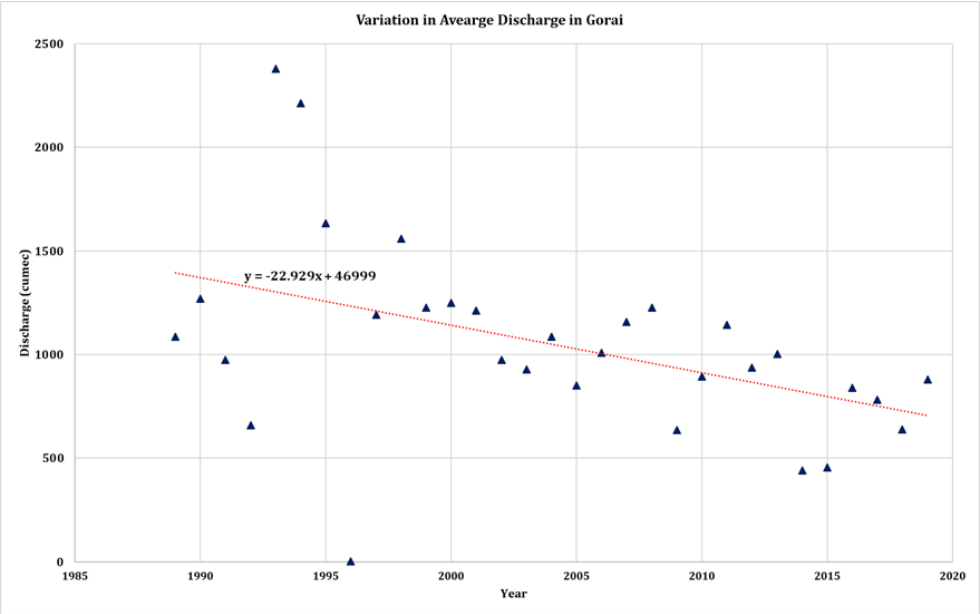


Figure 4.7: Trend in Discharge at Gorai Railway Bridge from 1989 to 2019

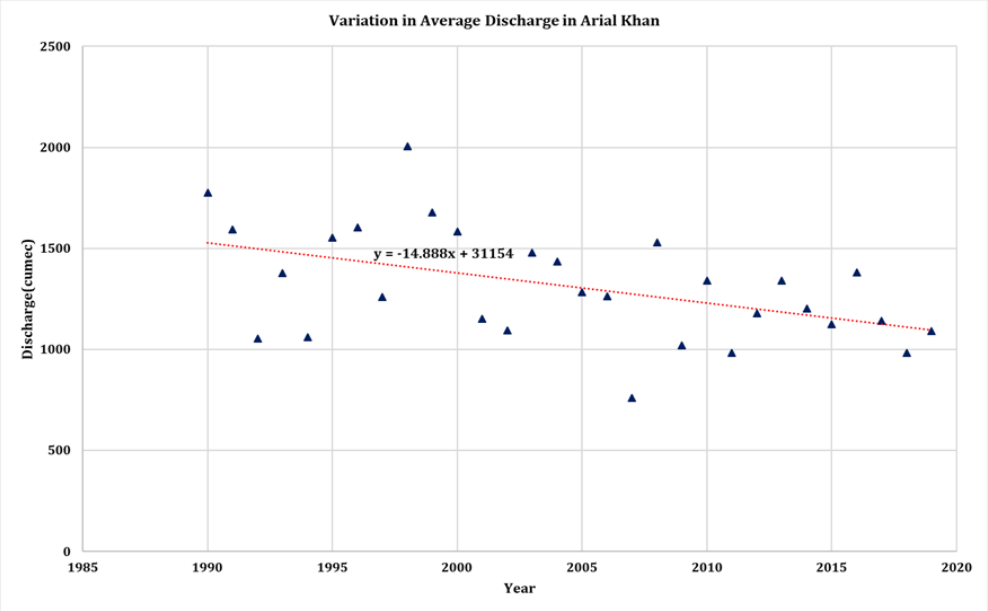


Figure 4.8: Variation in Discharge at Chowdhury Char from 1964 to 2019

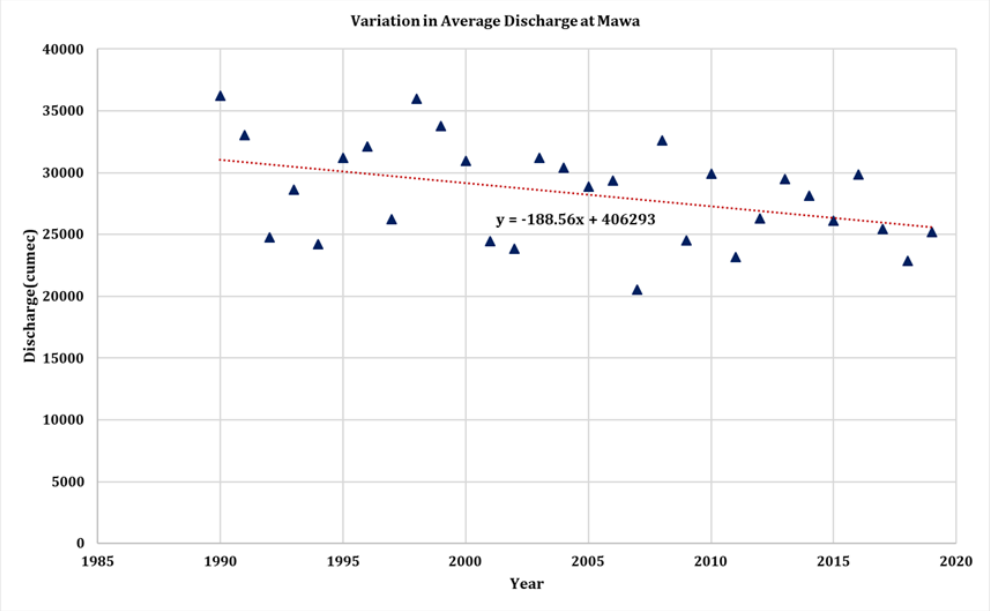


Figure 4.9: Discharge at Mawa from 1990 to 2019

Flow duration curve is the graphical representation to illustrate the relation between the exceedance probability of streamflow and its magnitude. For three stations mentioned above, flow duration curves have been plotted and interpreted (Figure 4.10, Figure 4.11 and Figure 4.12). The FDC for Mawa point (Figure 4.12) shows that the discharge at this location exceeds 10,000 cumec in 70% of the time as the combined flow of Jamuna and Ganges reaches here, whereas at Gorai River and Arial Khan River, this huge discharge almost never occurs. Gorai River and Arial Khan River have low flow, and thus 2000 cumec flow is exceeded at these station in only about 25% and 27% of the time respectively (Figure 4.10 and Figure 4.11).

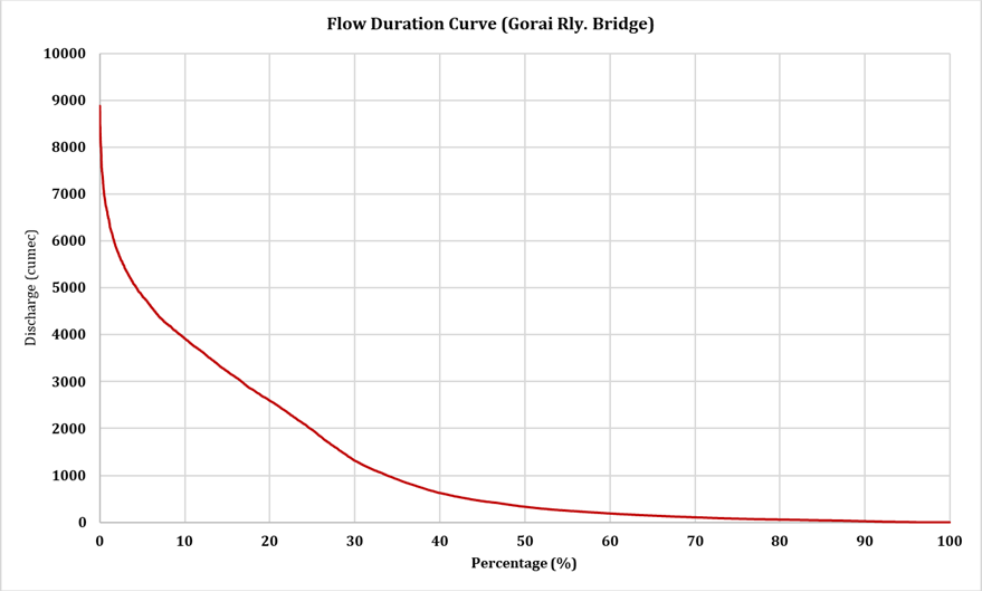


Figure 4.10: FDC Analysis at Gorai Railway Bridge

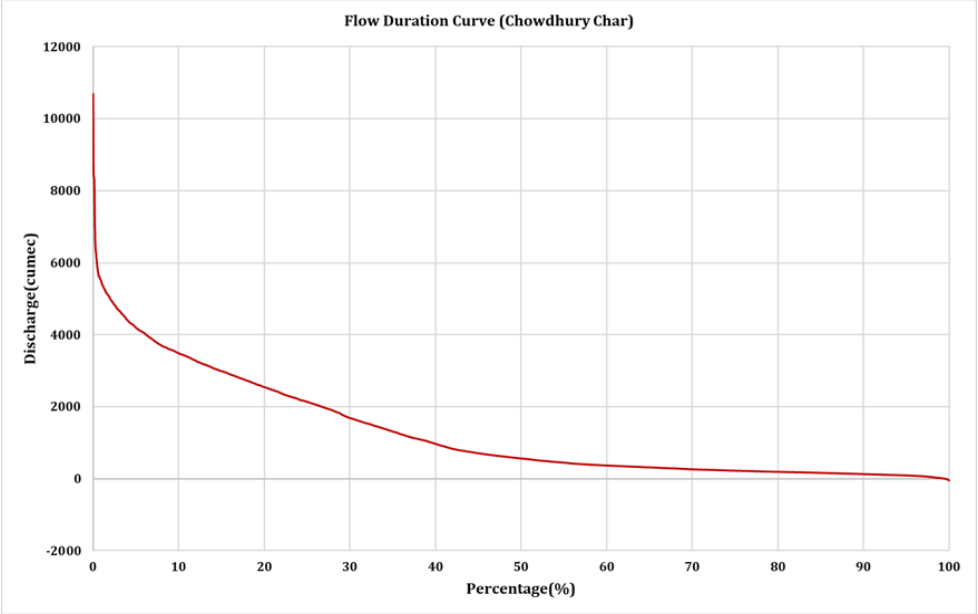


Figure 4.11: FDC Analysis at Chowdhury Char

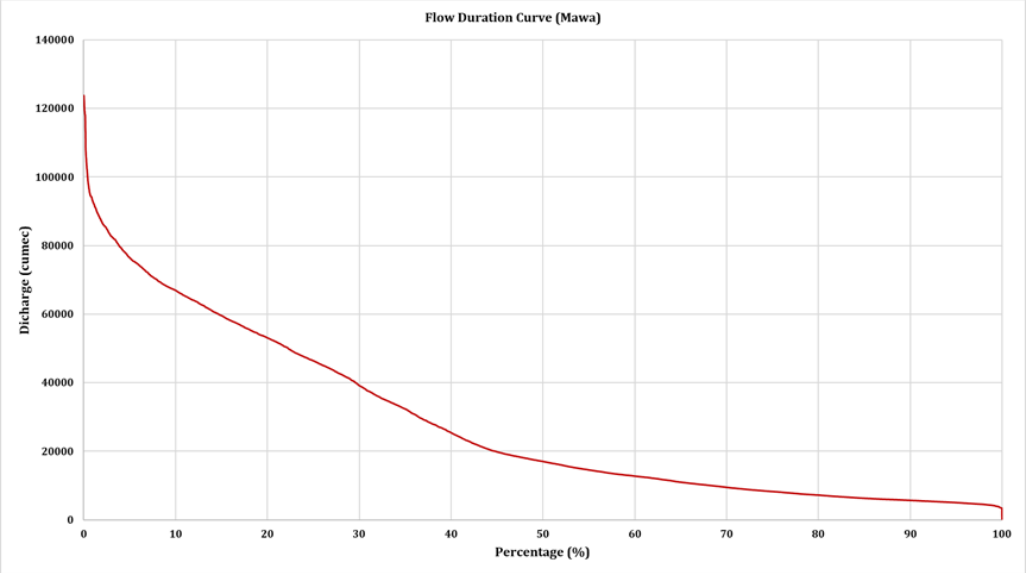


Figure 4.12: FDC Analysis at Mawa

4.6 Groundwater Level Analysis

Groundwater level at the SC region has been analyzed using the available data collected from NWRD. Five representative stations have been selected for conducting the analysis on trend of groundwater level over the years. Among them three stations are situated at Patharghata (BAG005), Barguna Sadar (BAG004) and Galachipa (PAT001) Upazilas and two stations (BAG001 and BAG002) are located at Amtali Upazila.

The trend is observed to be decreasing at Amtali and Patharghata. On the other hand, the trend at Galachipa and Barguna Sadar show increasing pattern. The trend illustrates that the use of groundwater is more in Amtali and Patharghata compared to that of Galachipa and Barguna Sadar. The highest groundwater level depletion is observed at Patharghata (0.01 m/year). Groundwater use is interpreted to be less at Galachipa Upazila analyzed from increasing trend represented in Figure 4.13.

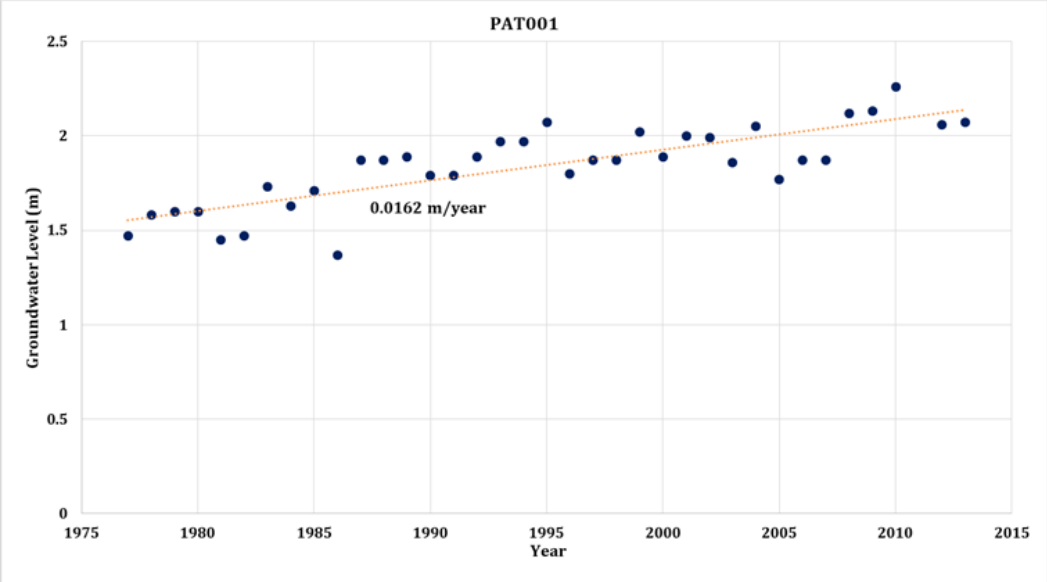


Figure 4.13: Trend of Groundwater level at Galachipa

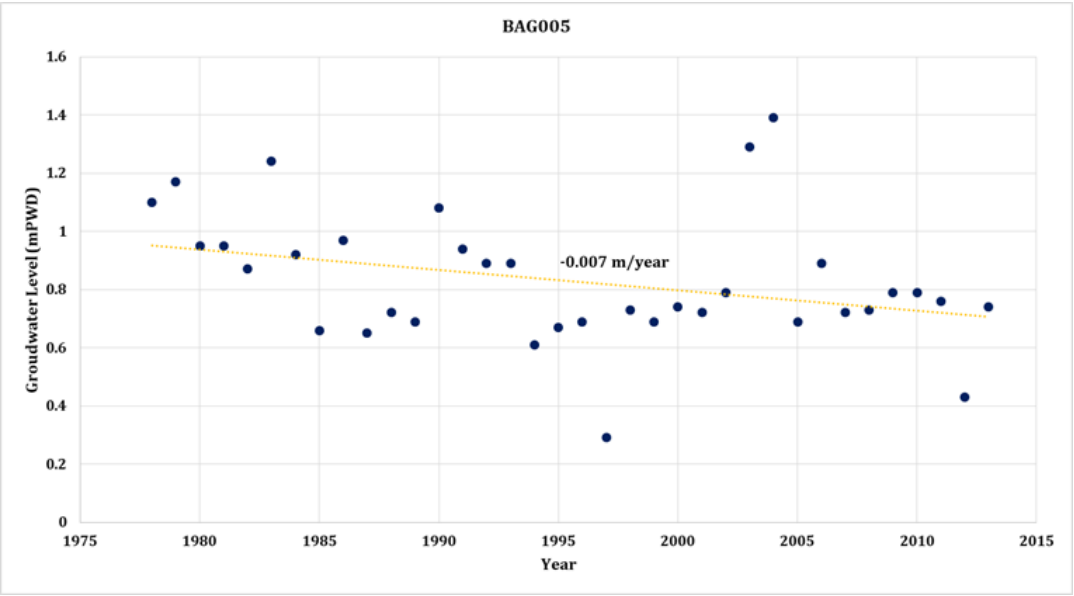


Figure 4.14: Trend of Groundwater level at Patharghata

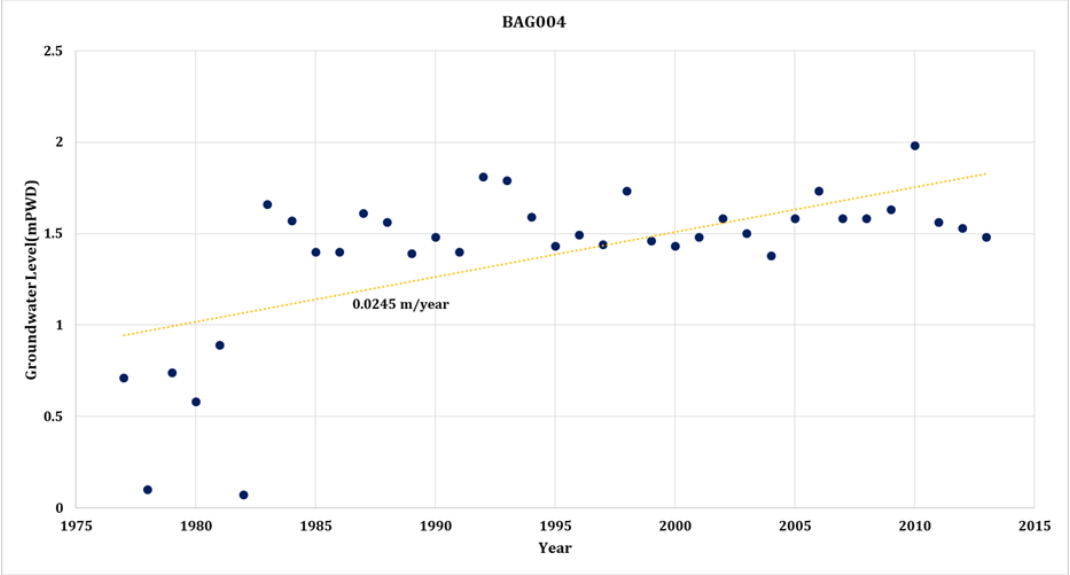


Figure 4.15: Trend of Groundwater level at Barguna Sadar

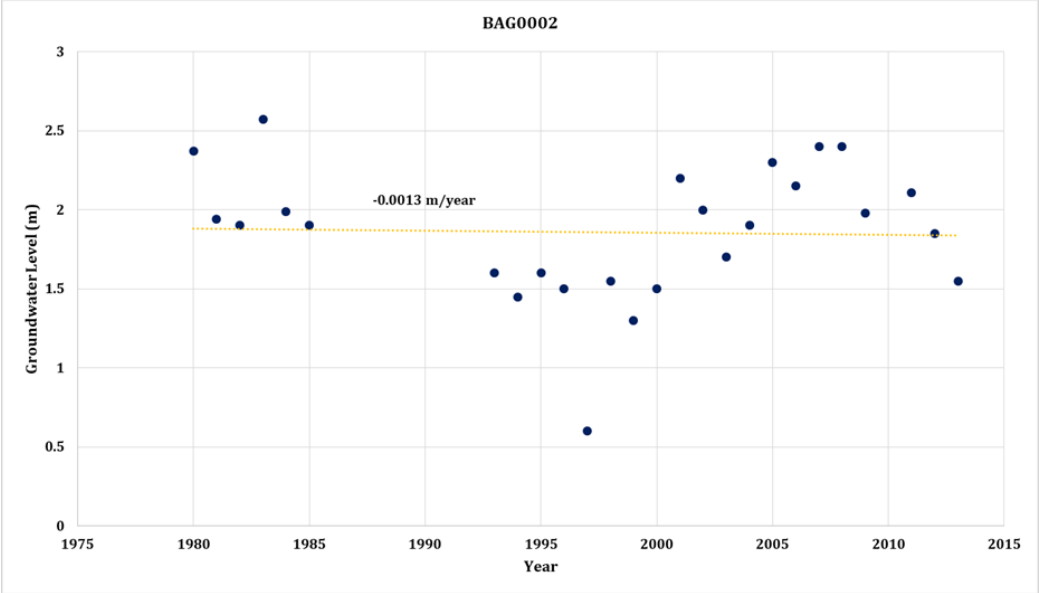


Figure 4.16: Trend of Groundwater level at Amtali (a)

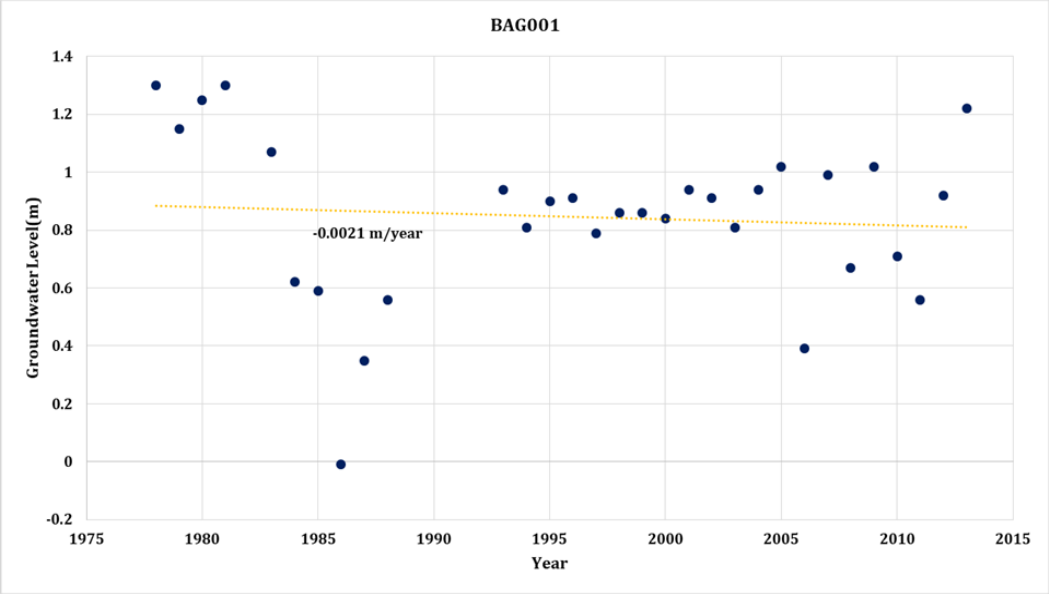


Figure 4.17: Trend of Groundwater level at Amtali (b)

4.7 Water Level and Flood Frequency Analysis

The water level is analyzed for four representative stations to gather the overview of the entire SC region. One station has been selected for each of four river systems. They are- Bhola Kheyaghat station representing the water level at Tentulia, Rayanda station at Gorai-Madhumati River system, Mirjaganj station at Buriswar syetem and Patharghata station at Bishkhali River.

For Patharghata station, monthly variation is represented in Figure 4.18. It is observed that the water level reaches its peak, about 1.14 mPWD in the month of August and lean months are observed to be extending from November to March (Figure 4.18). The trend of the maximum and minimum water level is represented in the Figure 4.19. Both the trends show increasing pattern indicating that the water level at these stations have been increased from the past.

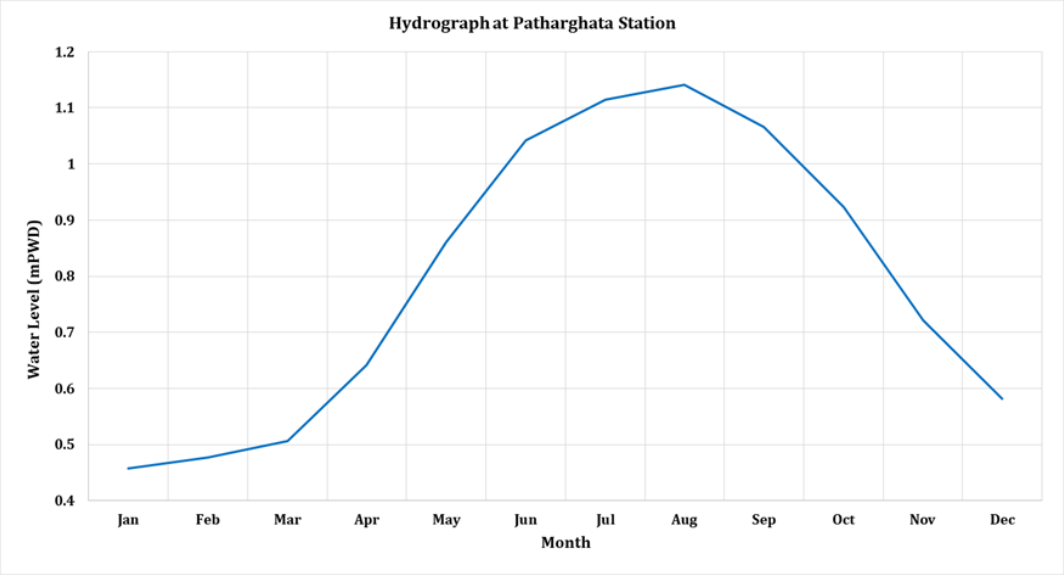


Figure 4.18: Trend of Water Level at Patharghata

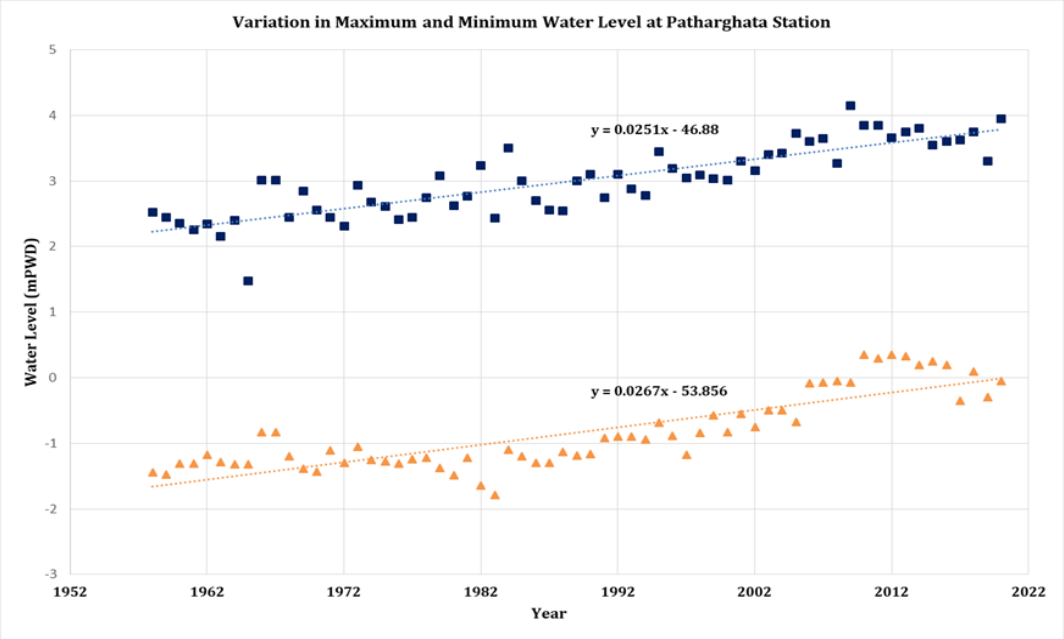


Figure 4.19: Trend of Maximum and Minimum Water Level at Patharghata

At Bhola Kheyaghat the peak water level is attained in August and the recession starts from November (Figure 4.20). The peak water level is about 1.8 mPWD, which is higher than that of Patharghata. The trend of maximum and minimum water level at Bhola Kheyaghat is represented in Figure 4.21. The trend shows increasing pattern which indicates the rise in water level at this station over the years. However, the trend line has milder slope that Patharghata indicating that the water level is increasing at a faster rate over the years.

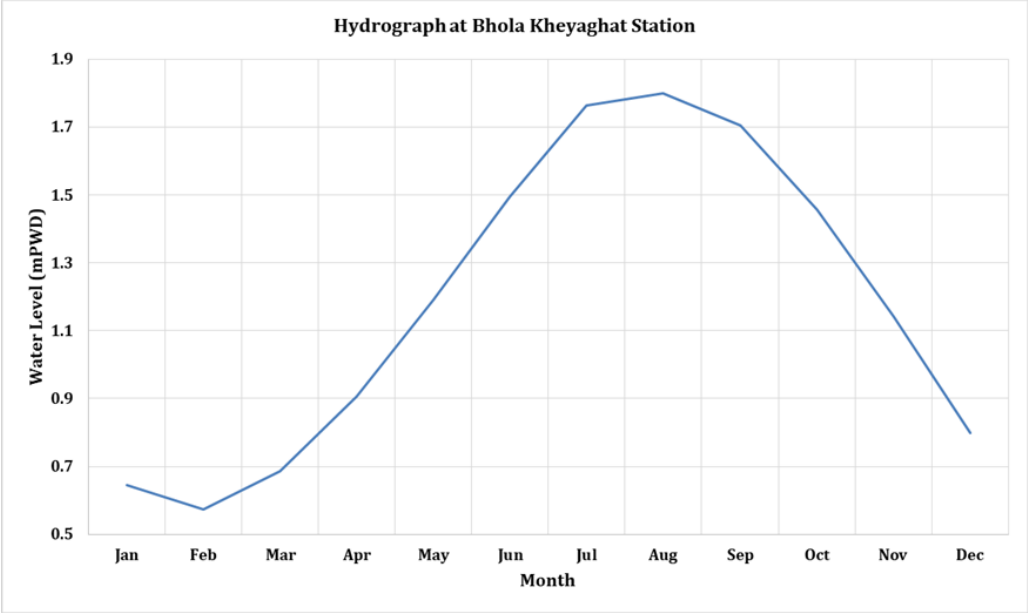


Figure 4.20: Trend of Water Level at Bhola Kheyaghat

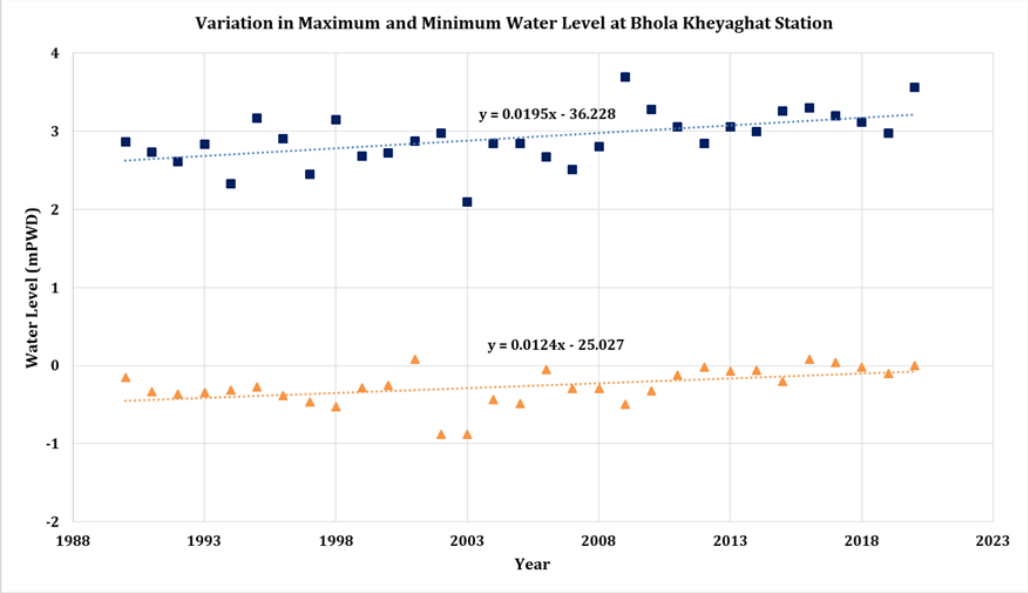


Figure 4.21: Trend of Maximum and Minimum of Water Level at Bhola Kheyaghat

The peak water level at Mirjaganj station is about 1.75 mPWD and reaches to its peak in August. The hydrograph is represented in Figure 4.22. The trend of maximum and minimum water level shows increasing pattern Figure 4.23).

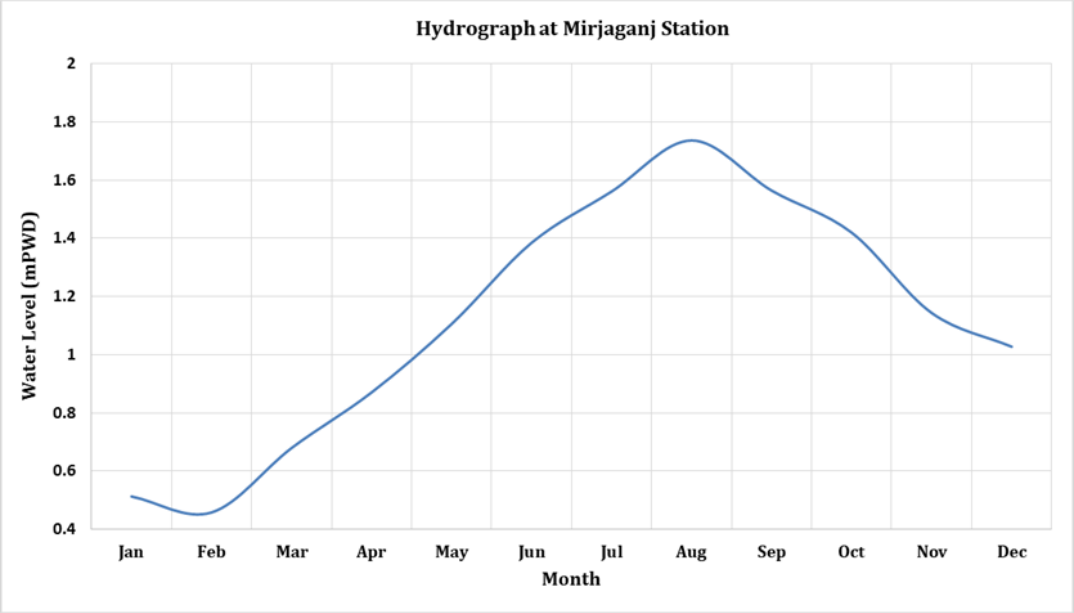


Figure 4.22: Trend of Water Level at Mirjaganj

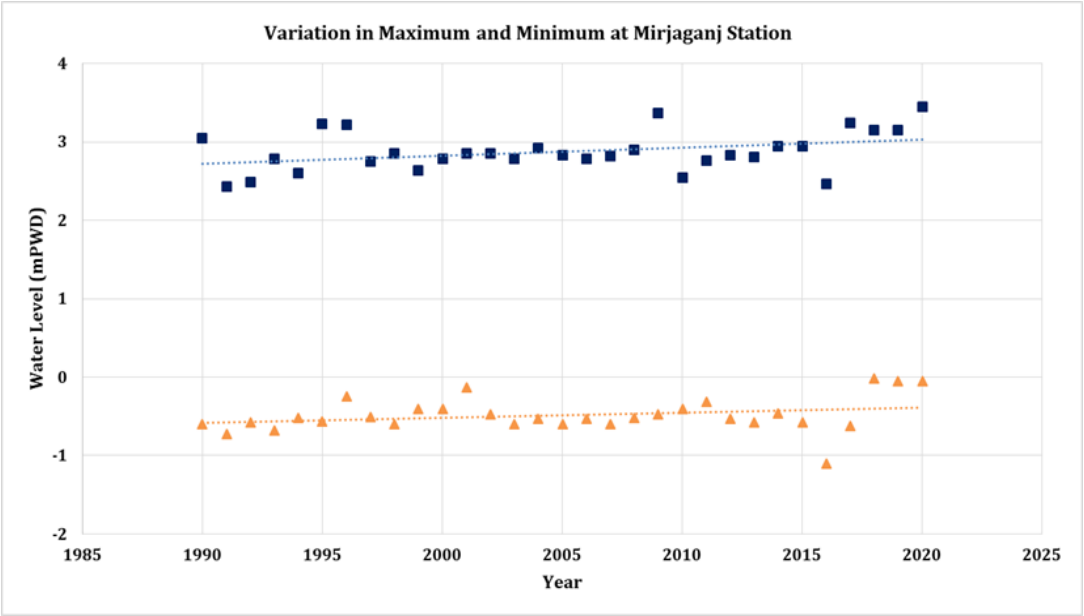


Figure 4.23: Trend of Maximum and Minimum Water Level at Mirjaganj

The highest water level at Rayanda station reaches upto 1.71 mPWD in the month of August as per shown in Figure 4.24. The trend is represented in Figure 4.26. The trend depicts that the water level at this station has increased from past (Figure 4.25).

Though the water level is highest at Bhola Kheyaghat (observed from the historical data analysis), the increasing trend is faster at Patharghata (Bishkhali River). This indicates that the water level is rising faster near the coast as Patharghata is way downstream of Bhola Kheyaghat. This rise in water level indicates the increased probability of tidal flood.

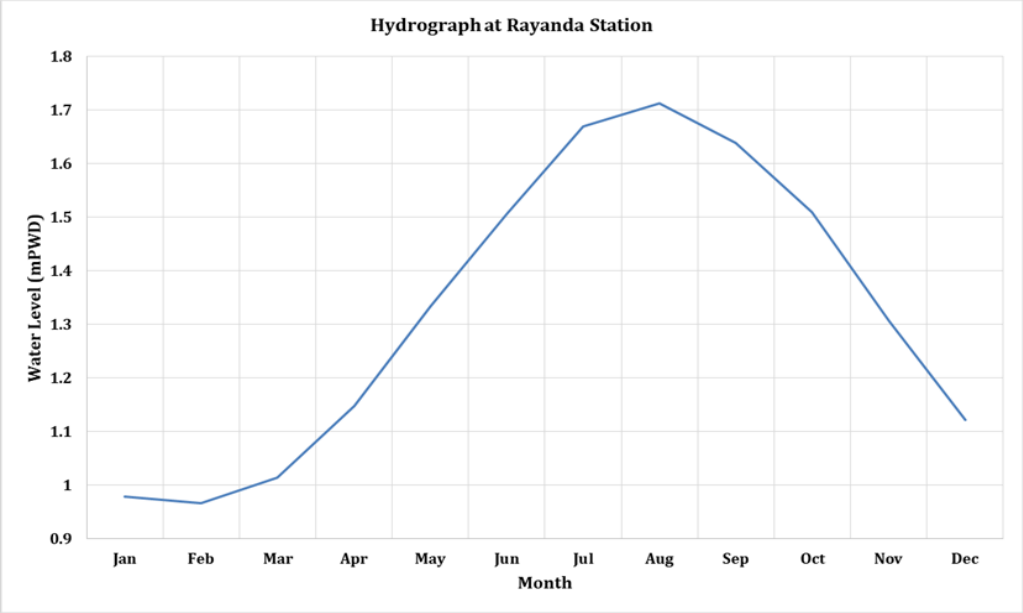


Figure 4.24: Trend of Water Level at Rayanda

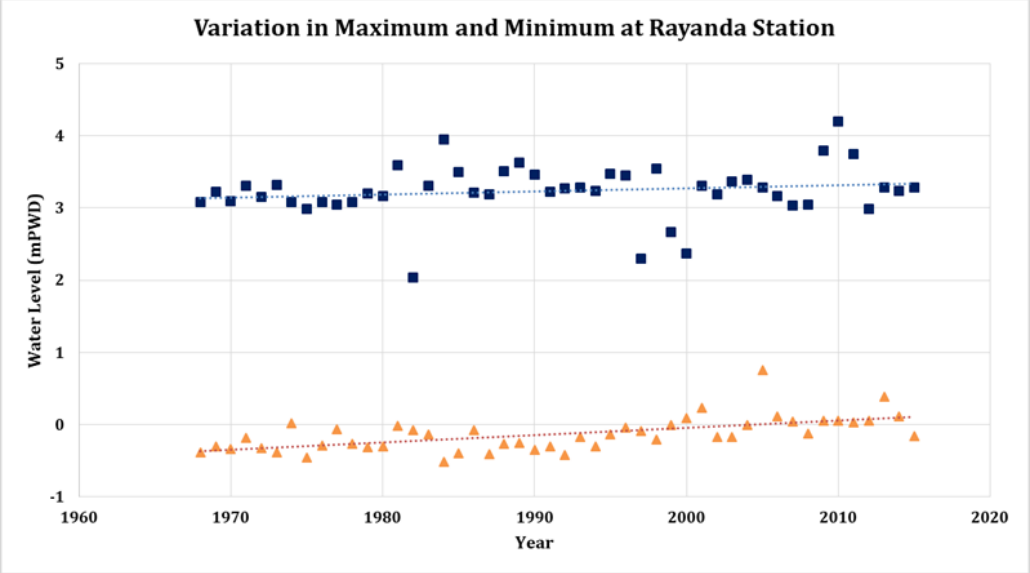


Figure 4.25: Trend of Maximum and Minimum Water Level at Rayanda

Frequency analysis has been done for the four water level stations mentioned above. The flood levels for various return periods are represented in Figure 4.26. From the graphs, it can be observed that for 50-year return period, the water level at Patharghata is highest (4.14 mPWD). It is indicative of tidal flood occurring at SC region.

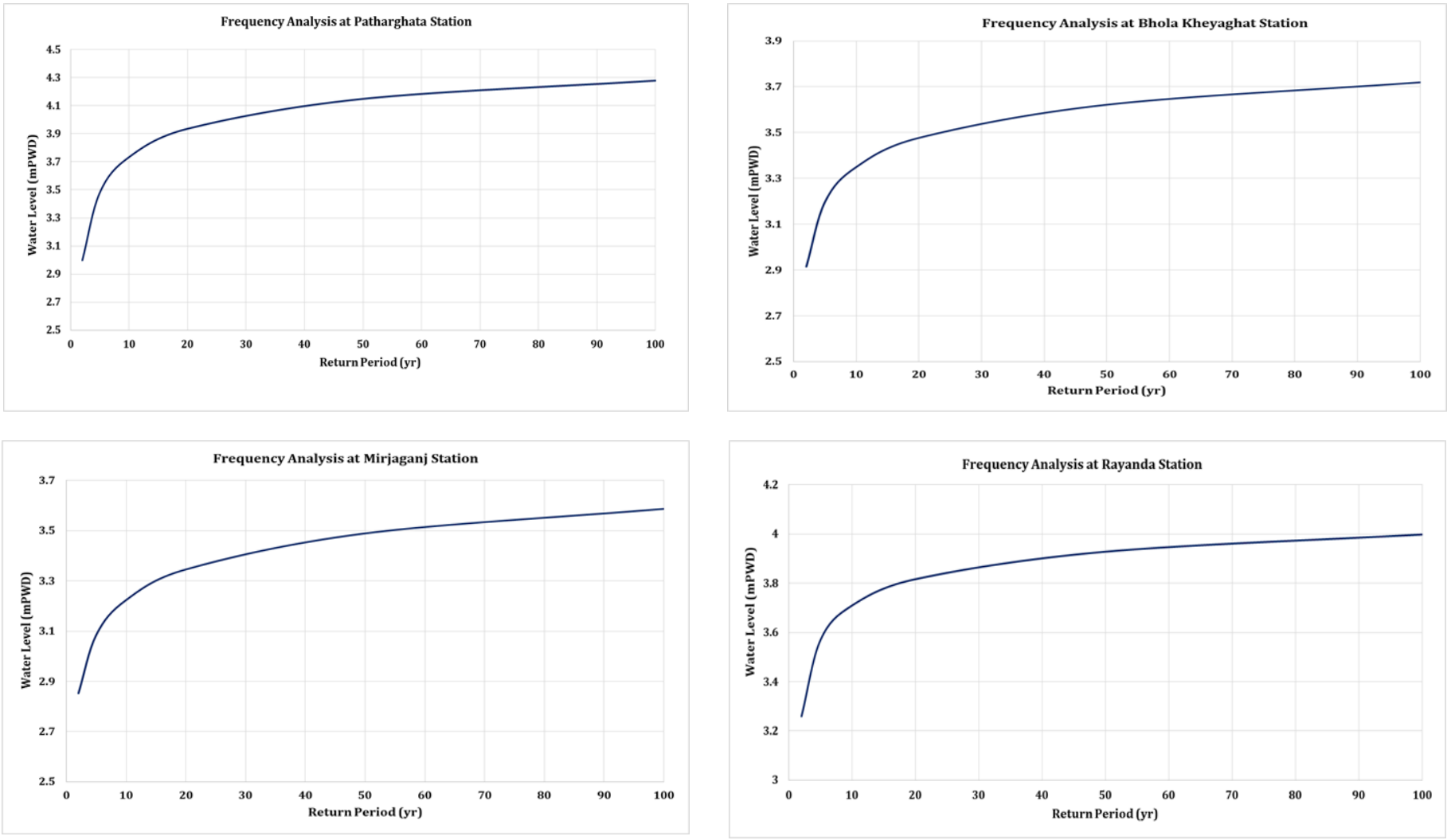


Figure 4.26: Water Level Corresponding to Various Return Periods at Four Tidal Stations

4.8 Tidal Inundation

The average elevation of coastal lands in Bangladesh is below 1.5 m MSL. It is predicted in several studies that the sea-level in the Bay of Bengal may rise in the range of 0.3 to 1.5 by the year 2050 (DOE, 1993). In the coastal front there will be stronger-than-usual backwater effect due to sea level rise induced high oceanic stage, resulting into retardation of discharge flow, particularly around the confluence points of the major rivers. Consequently, the risk of floods of high intensity and duration, similar to that occurred in 1998, will be exacerbated. Under climate change scenario about 18 percent of current lowly flooded areas will be susceptible to higher levels of flooding while about 12 to 16 per cent new areas will be at risk of varied degrees of inundation. As per NAPA recommendations, SLRs in the coast of Bangladesh are 14 cm, 32 cm and 88 cm for the year 2030, 2050 and 2100. In a recent study, IWM (2006) predicted that flooding of coastal lands may increase by 21% by the year 2001 while it is 10.3% for the year 2050 with respect to ordinary flooding condition when approximately 50% lands go under flood.

4.9 Natural Drainage Characteristics

The drainage pattern at SC region is mostly parallel (Figure 2.27). The main drainage occurs in this region by means of the rivers which are tidal in nature. Tidal rivers generally bring coastal sediments inward the land and consequently gets deposited in riverbed, coast and floodplain. The deposited sediment gets washed away eventually when upstream flow dominates into the rivers. However, with the increase tidal inundation at SC region, the sedimentation process has accelerated over the time. Moreover, decease in the upstream flow into the rivers have worsen the situation even more. Furthermore, implementation of development plans with unplanned land reclamation has caused river encroachment. With the narrowing of the rivers and elevation of their beds due to sedimentation process, it has been challenging for them to drain out the incoming flow. When any storm events, the water in this region takes days to finally drain out.

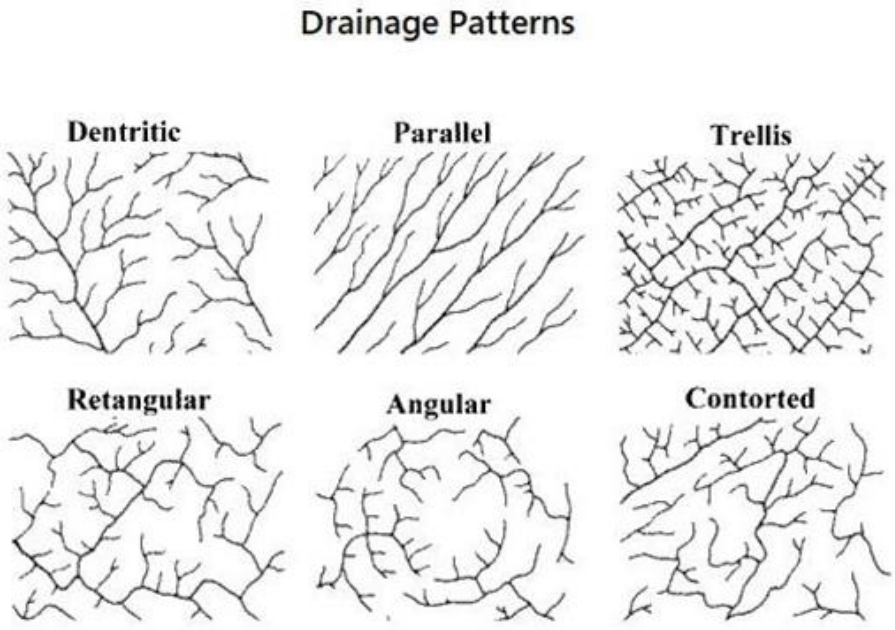


Figure 4.27: Different types of drainage patterns

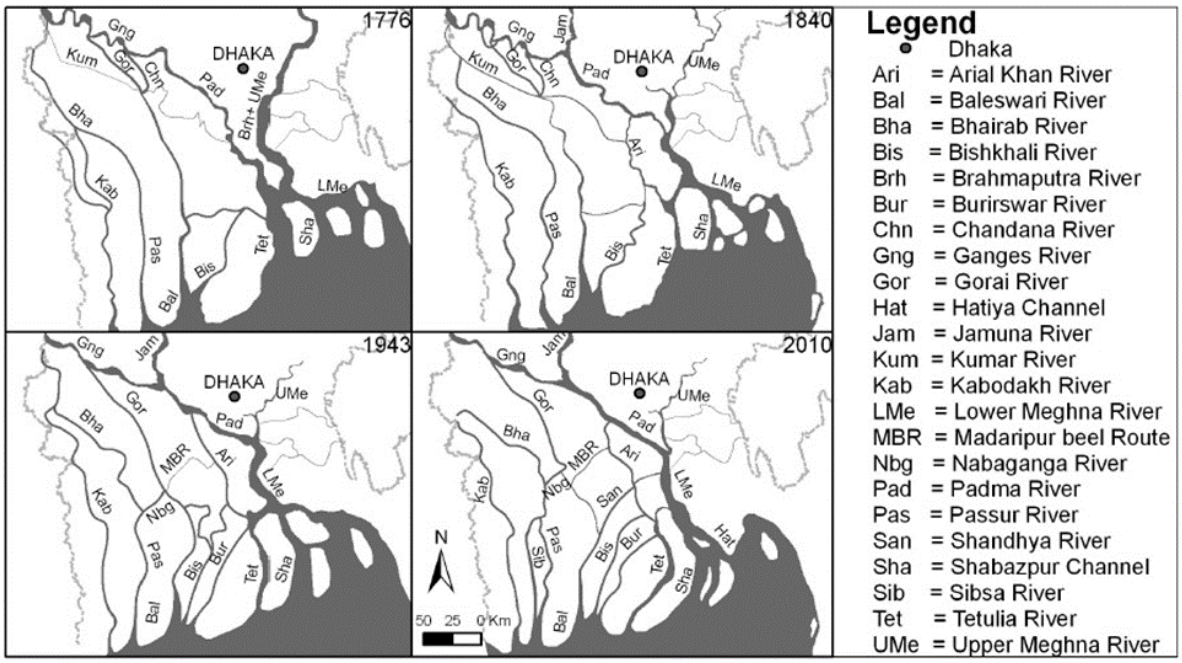
4.10 Morphological Settings

4.10.1 Historical Development

Rivers are very dynamic in the delta of Bangladesh especially in the south-central region. It was observed that Brahmaputra River joined the Ganges River after it's avulsion in the nineteenth century. This has significantly changed the river system of this area. Historical development of these rivers is shown in Figure 4.28.

Baleshwar, Bishkhali, Burishwar-Payra, Andharmank, Lohalia, Rabnabad and Tentulia are the major rivers in the study area (Figure 4.29). Rivers in the south region of Bangladesh are very dynamic. It was observed that Brahmaputra River joined with the Ganges River after it's avulsion in the nineteenth century. This has resulted significant changes in river system of this area.

At present all the water flow and sediment of Ganges and Brahmaputra merge with Meghna River at Chandpur and fall in Bay of Bengal through Meghna Estuary. All the major rivers of the study area are connected with the Meghna River and receive non-saline fresh water from the combined GBM (Ganges-Brahmaputra-Meghna) flow. Baleshwar is the last western river which receive fresh water from Meghna. Baleshwar shows the boundary of saline zone (Sundarbans) and less saline zone of Meghna estuary system. Hence, the rivers from Shahbazpur channel at East to Baleshwar River at West are fluvial-tidal dominated as there are both upstream flow and tidal flow.



Source: Sarker et. Al. 2013

Figure 4.28: Development of River in South-West zone

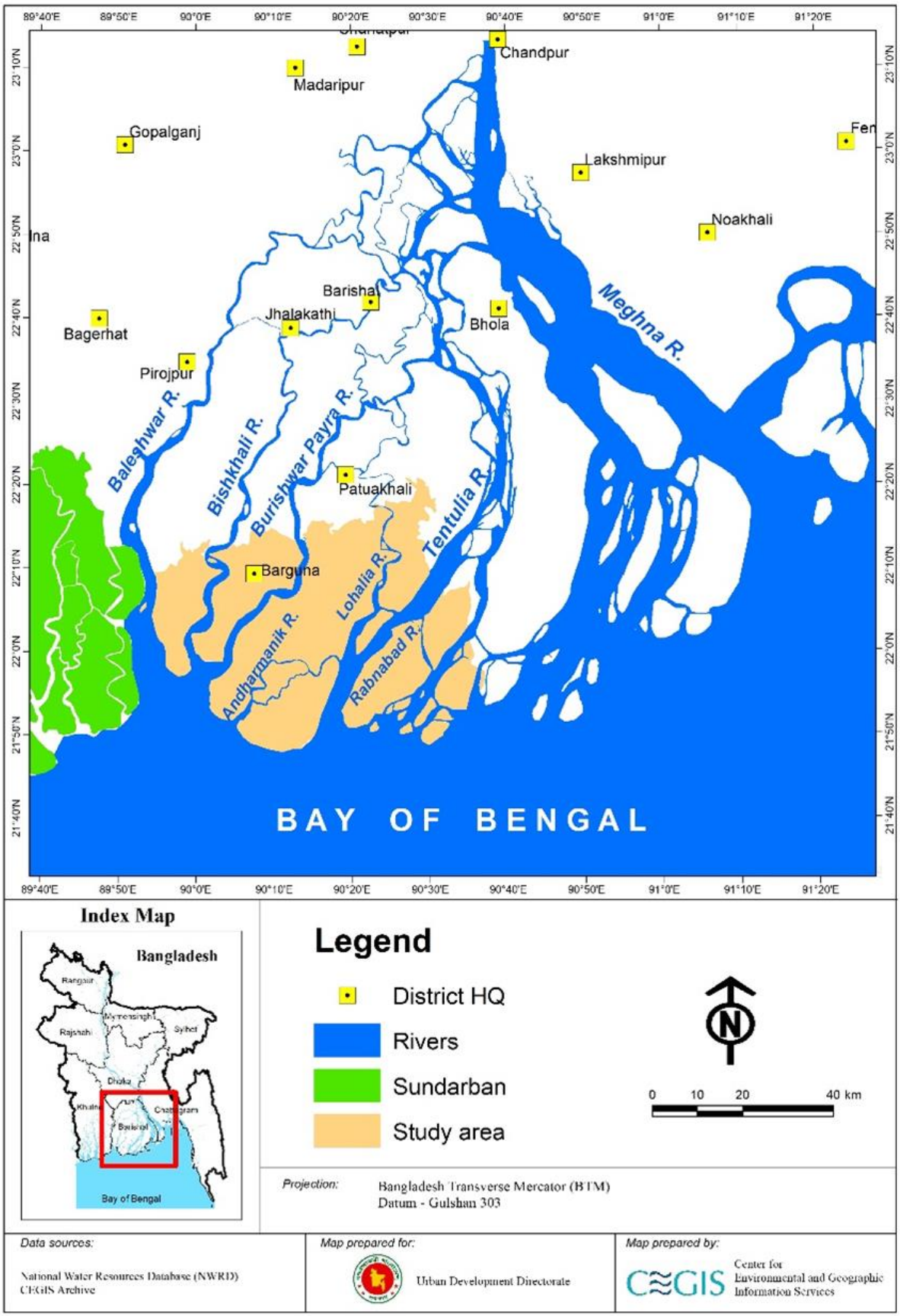


Figure 4.29: Map of study area and Meghna estuary

4.10.2 River Planform Analysis

The study area is located at the coastal region of Bay of Bengal and all the adjacent river estuaries are included here. Satellite images and historical maps have been analyzed to assess the change in river planform for last three centuries. Figure 4.30 shows the changes in planform of the study area in different times.

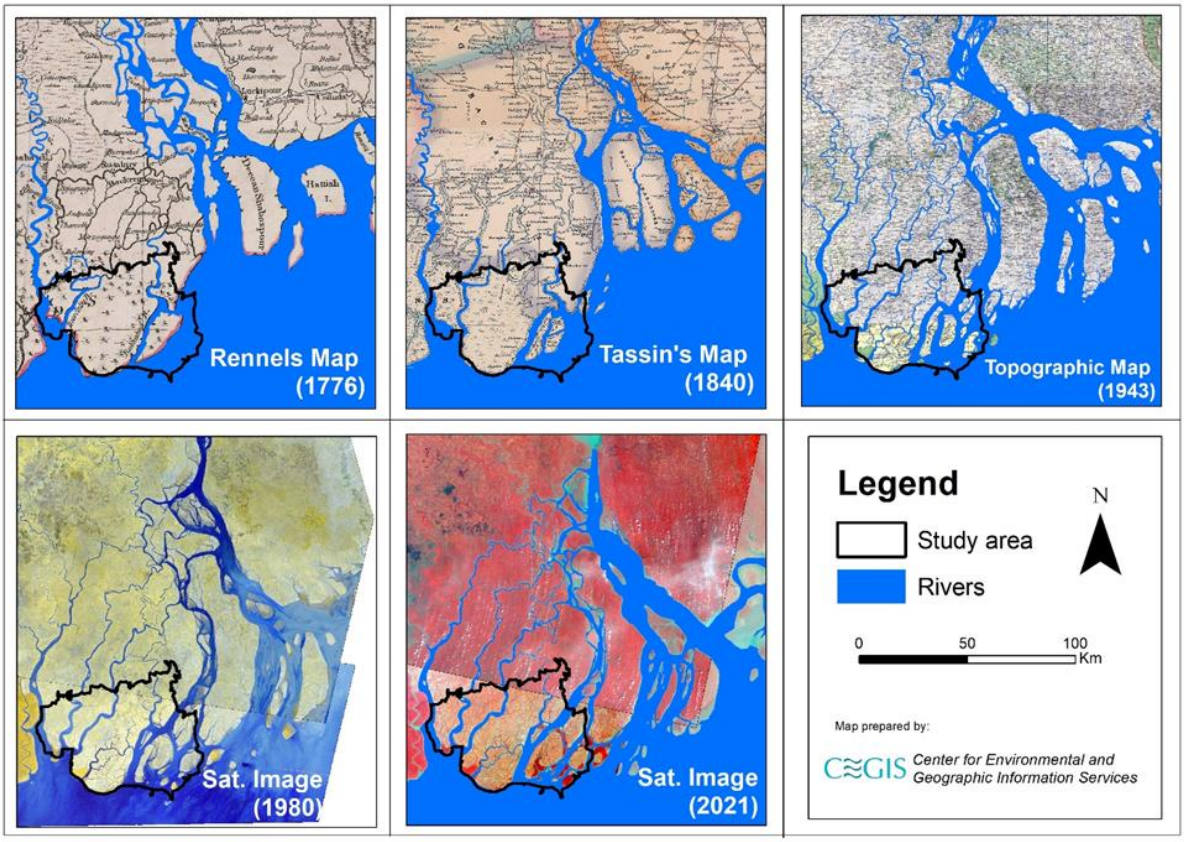


Figure 4.30: Change of river planform inside study area

Rennels Map of 1776 shows that Ganges/Padma and Meghna were totally separated from each other and they reached to the Bay of Bengal individually. The study area was bounded by Baleshwar in the west and Ganges estuary in the east.

After the avulsion of Brahmaputra towards Jamuna, the flow joined with Ganges and the combined flow (named as Padma) met Meghna at Chandpur as it can be seen in Tassin's map (1840). The combined flow of Ganges, Brahmaputra-Jamuna and Meghna (GBM) fall in the Bay through three major channel. The western channel, named as Tentulia channel can be seen on the east of study area.

The three major distributaries of Meghna estuary are also clearly visible in Topographic Map of 1943. The estuary of Tentulia channel shows some newly developed islands inside the study area.

Satellite image of 1980 shows declination of the eastern channel of Meghna estuary system and the GBM flow is flowing through two major channel named Tentulia (West channel) and Shahbazpur (East channel). The islands of Tentulia channel shows added area in their shapes.

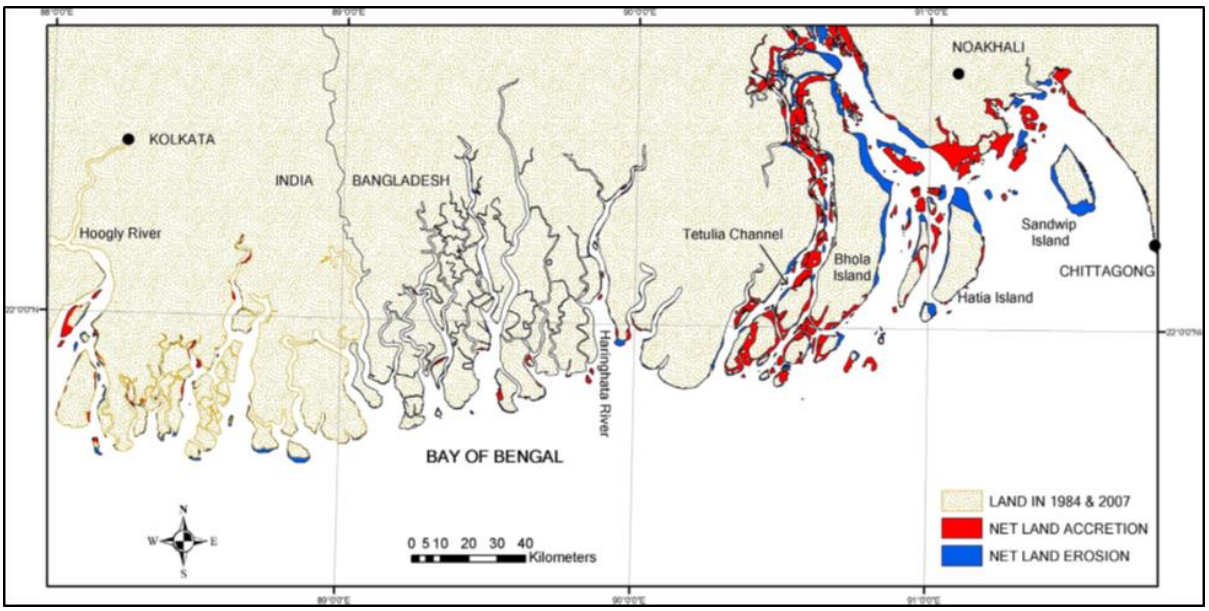
Recent satellite image of 2021 shows lots of changes in the Meghna estuary but relatively same planform for the other rivers. Many of the distributaries generated from the Lower Meghna and/or Arial Khan River are getting enlarged as Shandhya during last four decades (Sarker et al. ICWFM 2013).

For our study area, the eastern side shows more dynamic planform compared to the western side. It is mainly due to the Tentulia estuary, which is experiencing pro-gradation process. Considering the administrative boundary, river planform showed significant changes in Rangabali and Galachipa upazila of Patuakhali District.

4.10.3 Coastline Changes

The coastline of study area is situated in the Ganges Delta or Ganges-Brahmaputra–Meghna (GBM) delta. The total extent of GBM Delta coast area (From Hoogly River in west to Meghna in the east) are covered with lots of active or declined distributaries. Hence, the coastline is not smooth, rather intersected by lots of tidal rivers, canals and creeks.

Comparison of Landsat images taken in 1984 and 2007 showed a net land gain of 451 km^2 in the total GBM estuary within that period, representing an average annual growth rate of 19.6 km^2 (Brammer, 2013). The total gained and lost lands are shown in Figure 4.31. It shows some land gaining in the mouth of Tentulia River inside the study area. Earlier, calculated annual net gains was found 14.8 km^2 between 1792 and 1840 and 4.4 km^2 between 1840 and 1984 (Allison 1998).



Source: (Brammer, 2013)

Figure 4.31: Gains and losses of land on the Brahmaputra–Ganges–Meghna delta front from 1984 to 2007

Figure 4.32 shows the changes in coastline of the study area from 1984 to 2020. It can be seen that the west part of the study area has eroded slightly and on the other hand, the estuary of Tentulia has experienced deposition of sediment as well as formation of new islands.

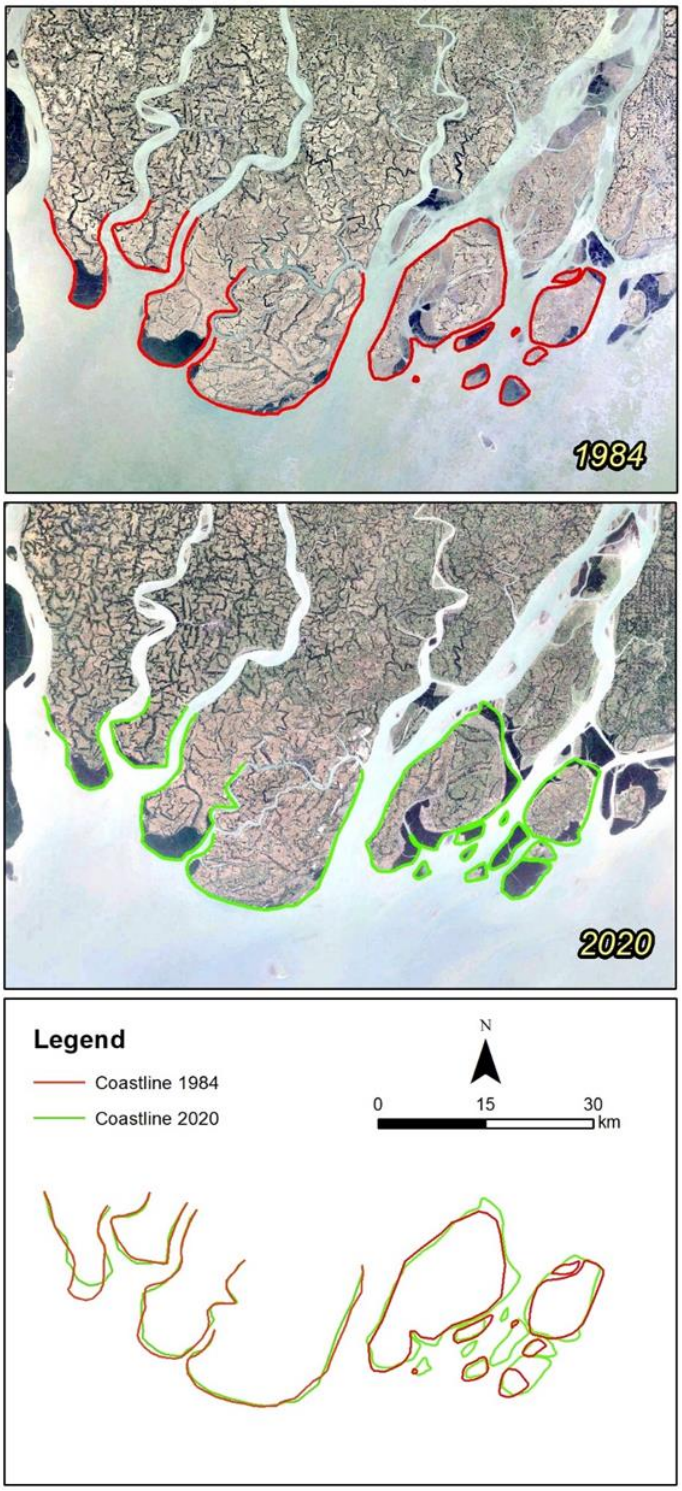


Figure 4.32: Comparison of coastline for study area between 1984 and 2020

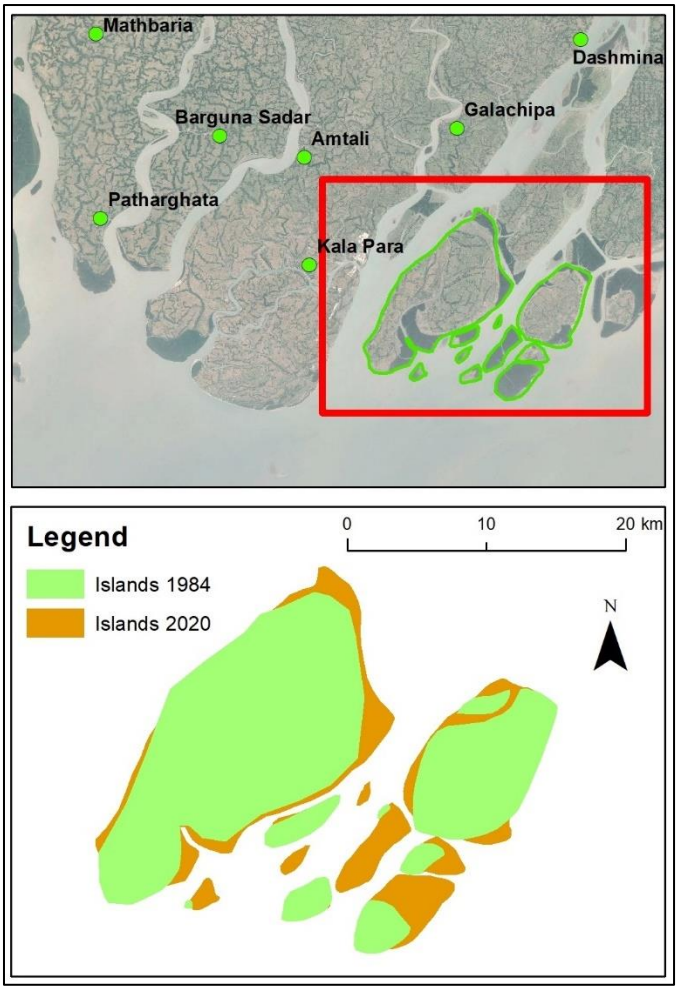


Figure 4.33: Changes of island area at Tentulia-Rabnabad estuary from 1984 to 2020

Figure 4.33 shows the change of islands at the Tentulia-Rabnabad estuary for the mentioned time period. Area of the marked islands was 30,855 Ha in 1984. In 2020, the area became 36,275 Ha by increasing 17.6% of land. Artificial mangrove at this zone has accelerate the land pro-gradation process here.

4.10.4 Sedimentation

Estuaries of the Baleswar, the Payra-Biskhali and the Meghna rivers are dominated by fresh water processes. As a result, riverbed sedimentation by tide is less compared to the western estuaries like Sibsa or Passur systems.

Coastline analysis shows more sedimentation in the mouth of Tentulia channel comparing to estuary of Baleshwar or Bishkhali-Burishwar Payra system. This sedimentation occurs mainly due to the upstream combined flow of Ganges-Brahmaputra-Meghna System.

During land formation process, sediment becomes visible when a bar (composed of fine sand, silt and clay) emerges during low tide. Initially the elevation of the bar is very close and slightly higher to the average low tide level. Over time, the elevation increases. Gradually Uri grass, small mangroves grow and finally mangroves (sometimes artificial plantation) appear at the final stage of land formation. For Tetulia Channel, time required for land formation was found to be as much as 25 years (Sarker et. al. 2009).

Sometimes individual event causes lots of sedimentation beyond normal hydro-morphological process. For example, the sediment generated by 1950 Assam earthquake is considered to have immense effect on this delta building process, especially on the topography of the estuary (Brammer, 2004). Moreover, erosion of the Himalayas, highland boundaries, avulsion of Brahmaputra has influenced the process. This active delta building process has impact on accelerating the dynamics of rivers and Meghna estuary of this region (Sarker M.A., 2013). Huge landslides in the Himalayas caused by the Assam earthquake of 1950 is responsible for the net accretion of about 1100 km2 (46 km2/yr) from 1943 to 1973. After the effect of the Assam earthquake diminished, the prevailing rate of net accretion in the estuary reached about 10 km2/yr (BDP 2100).

4.10.5 Erosion/Accretion

Figure 4.33 shows erosion and accretion of the rivers for 32 years (1989-2021). The total amount of eroded land and accreted lands are 3500 Ha and 2700 Ha respectively. Hence the erosion is about 30% higher than the accretion. Table 4.1 shows river wise erosion and accretion for the mentioned time period.

Table 4.1: River wise erosion and accretion for 1989-2021

River	Erosion of 1989-2021 (ha)	Accretion of 1989-2021 (ha)
Tentulia	797	197
Lohalia-Rabndabad	855	601
Burishwar Payra	625	396
Bishkhali	483	727
Baleshwar	439	227
Andharmanik	200	363
Others (Tiakhali, Hauder Bharani, etc.)	101	189
Total	**3500**	**2700**

For the individual rivers, erosion is higher than accretion except Bishkhali and Andharmanik. These two rivers shows some mangrove development in their bank line, especially at the downstream part (Figure 4.34). Though erosion is higher than the accretion for Tentulia, there are lots of River Island inside the river which are increasing in area. The calculation of erosion-accretion of the above table only considered the changes of bank line and development of char/islands is excluded from the figures.

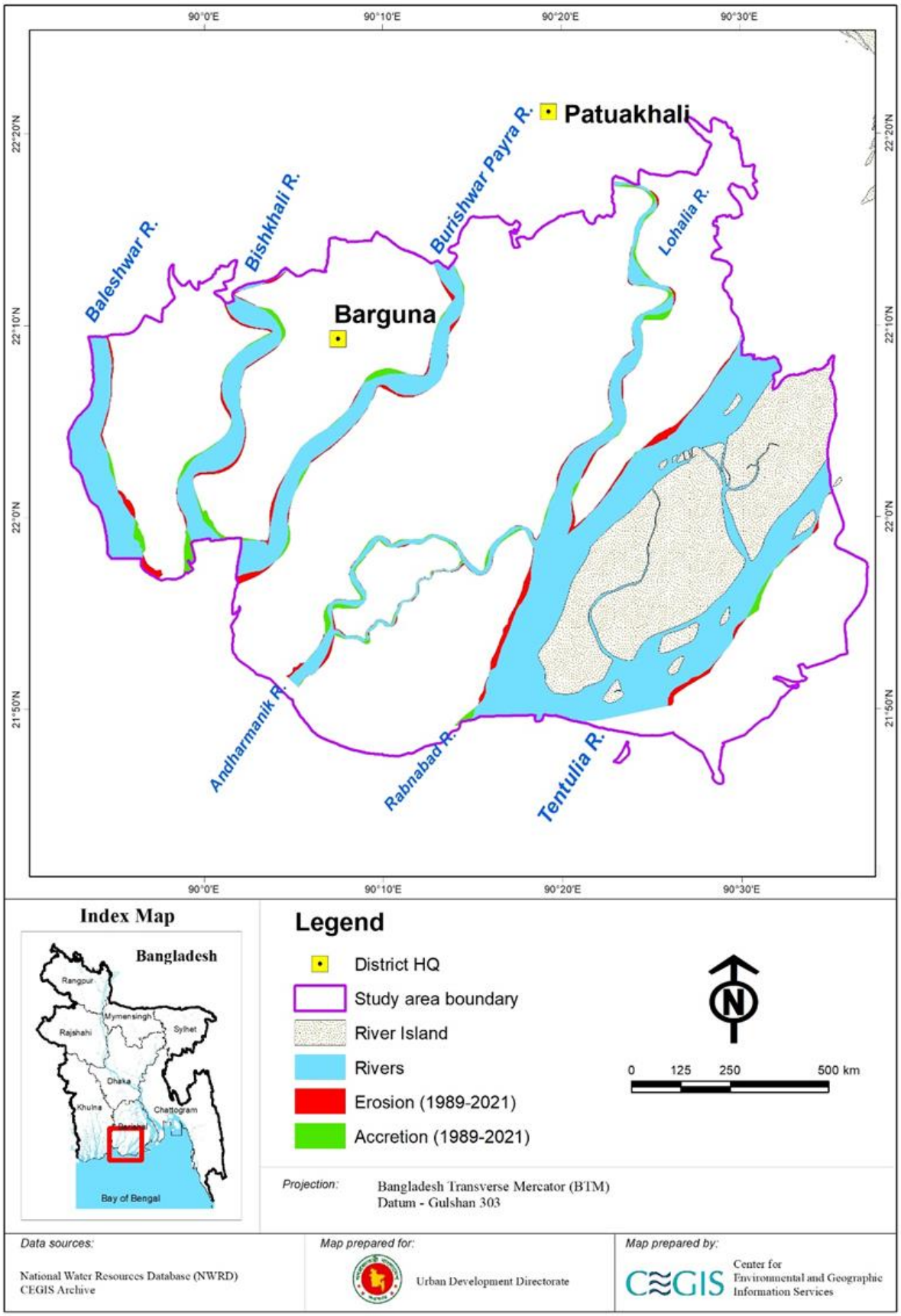


Figure 4.34: Erosion and accretion of the rivers from 1989 to 2021

Andharmanik River (1985)

Andharmanik River (2021)

Estuary of Bishkhali (1985)

Estuary of Bishkhali (2021)

Figure 4.35: Mangrove at the accreted lands of Andharmanik and Bishkhali

4.11 Natural Disasters

4.11.1 Floods

Bangladesh is situated downstream of the largest delta in the world. Thousands of rivers crisscross the whole country. Bangladesh faces flood problems almost every year. In an average flood, 18% of the country becomes flooded. In 1998, 75% of the country became flooded. Flood in Bangladesh can be described as a blessing and at the same time a curse. During a normal flooding event, the soil becomes fertile due to the deposition of silt with biomass whereas, in case of a catastrophic flood, it destroys lives and properties. Besides, the erosion destroys households and other properties. The most disastrous flood can occur in the coastal region when the high tides coincide with storm surge from tropical cyclone. In the coastal region, generally, three types of floods occur. Those are the rain-fed flood, river flood and tidal flood.

Floods and water logging is a very common problem in the South-Central Region. Both natural and man-made reasons are responsible for this. Though several rivers flow through the area with a well-established natural drainage system; siltation, excessive precipitation, increase of sea level, adverse effects of infrastructures etc. may cause an exceptional flood or water-logging in this area.

In July 2020, Bangladesh suffered the longest monsoon flood in 22 years. By 30th July, it had engulfed more than 35% of the country (mainly in the northern, north-eastern and south-eastern parts) with the possibility of it extending further[8]. Despite the damage and distress caused, this 2020 flood (by

the end of July) was less extensive than floods in 1988 (61%), 1998 (38% and 2007 (42%). The flood-prone areas of Bangladesh are presented in Figure 4.36.

The rain-fed flood is due to the heavy rainfall. If it coincides with the river flood from upstream, it can become disastrous. In the downstream of the SC region, the flood becomes more disastrous /catastrophic, if it coincides with the tidal flood. Every high tide can create a tidal flood. During high tide, the lowlands become flooded. If the tidal flood merges with the cyclone, it becomes catastrophic. Within the last one year since May 2019, Bangladesh was hit by three big cyclones and the flooding situation during this time was worse. There was a huge loss of properties and economy as well as some lives.

Man-made structures like embankments, shrimp culture, polder, sluice-gate etc. have been constructed and poor management of these structures has resulted in siltation at a number of rivers. Badly planned or executed infrastructure projects (such as roads or embankment with no or limited opening) often block the natural drainage system. A good plan and good operating of the structures may reduce this siltation as well as exceptional flooding.

4.11.2 Rain-fed Flood

This type of flood is caused by high-intensity rainfall. This flood is generally beneficial due to the deposition of silt. Though this flood creates less damage, it can be aggravated due to insufficient drainage.

4.11.3 River Flood

River flood can occur by overtopping the banks. This generally happens due to heavy rainfall in the upper catchment. This flood may become disastrous if the flood in all the main rivers coincides and may take a catastrophic turn if it encounters high tide in the sea.

4.11.4 Tidal Flood

A tidal flood can occur during high tide. During this time, the low lands become flooded. This flood may become disastrous when it coincides with the river flood.

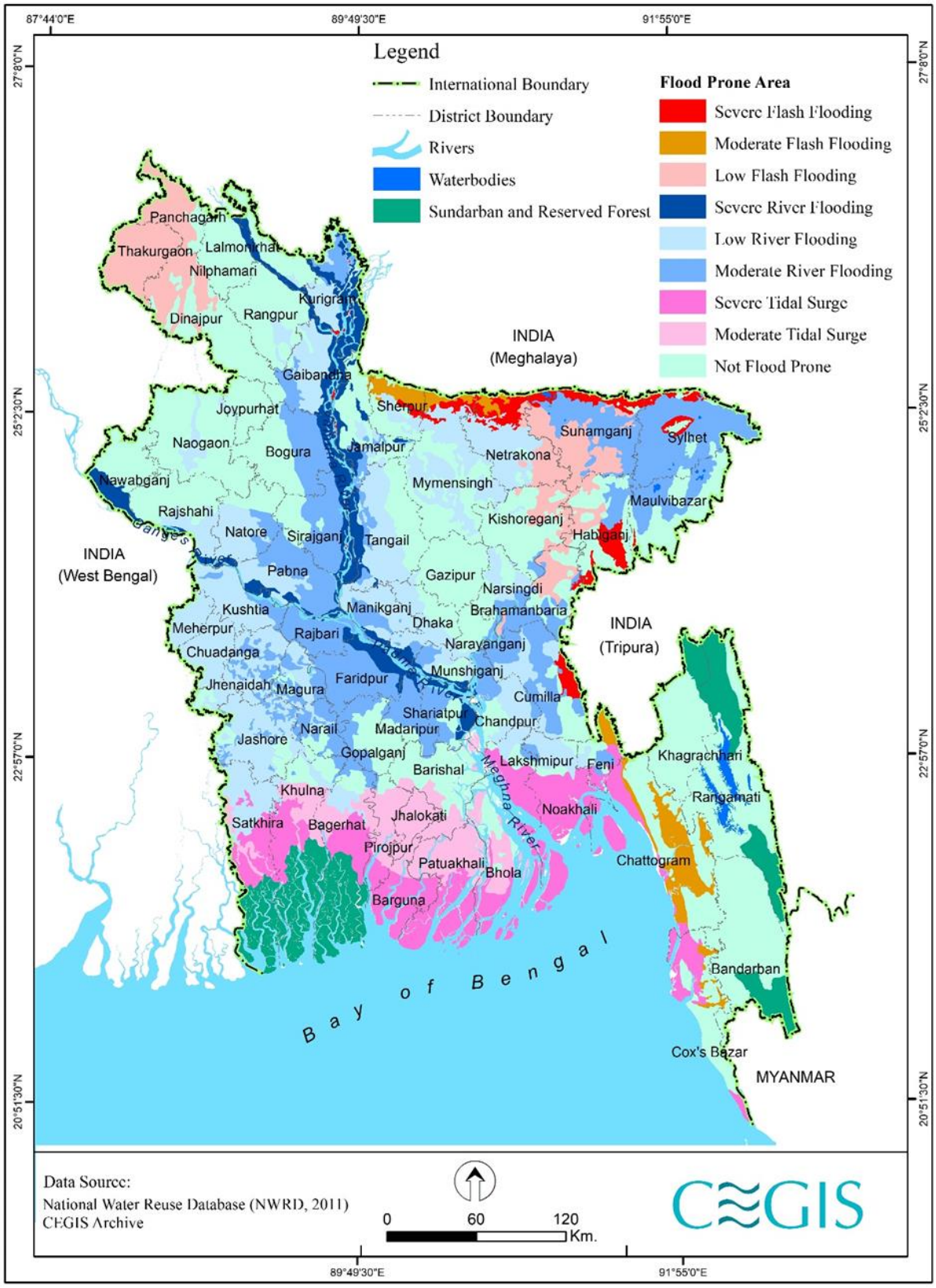


Figure 4.36: Flood Prone Areas in Bangladesh

4.12 Cyclones and Storm-surge

The coastal areas of Bangladesh and the Bay of Bengal are located at the tip of northern Indian Ocean, which has the shape of an inverted funnel, and the Bay itself is quite shallow. The area is frequently hit by severe cyclonic storms, generating long wave tidal surges. These surges are amplified when they traverse shallow waters, and have a disastrous effect on the coastal areas of Bangladesh. Usually cyclones are generated in the deep sea when sea surface temperature reaches the threshold value of about 27^0C. With increasing temperature, barometric pressure drops and the additional energy is dissipated in the form of high-speed winds. In Bangladesh, cyclones are observed twice a year: during late April and early May (early summer), and between late October and early November (late autumn/fall). A storm surge during a cyclone inundates coastal areas and offshore islands, which causes most of the loss of life and property. Information on storm surge height is very scarce in Bangladesh. Available literature provides a range of 1.5 to 9.0-meter-high storm surges during various severe cyclones (Haider et al., 1991). However, a SMRC report shows the surge height for 1876 cyclone was 13.6 m at Bakerganj and the surge height for 1970 cyclone was 10m. Locations of these surge heights are not known. Therefore, it is difficult to compare maximum wind speed and corresponding surge heights. Displacement of water surface during a cyclonic storm surge also depends on the height of tide, which is a function of lunar attraction and wind-factor. There is considerable difference in tide-height depending on the season and position of the moon relative to the sun. Another important factor is the path of cyclones. Due to its geographic location, cyclones hitting the Khulna region in the south west, have comparatively lower storm surges than those hitting the Meghna estuary. The paths of a few recent cyclones that hit Bangladesh are shown in Figure 4.37. These include the recent 1997 cyclone. From time immemorial, cyclones have visited the delta and caused extensive damages to the lives and properties of millions of people in the coastal districts of Bangladesh. In 1584, about 200,000 people were reportedly killed in Barisal by a cyclone storm surge. Another cyclone that hit in 1822 killed more than 70,000 people in Barisal and 95 percent population of the Hatiya Island. Considering the much smaller populations during those times, the numbers of deaths give an indication to the severity of the cyclones. A cyclone in November 1970 hit the southern districts of Bangladesh (the then East Pakistan) forcing a 9 m high storm surge and killing approximately 300,000 people (Haider et al., 1991). The cyclone of 1991 caused 138,000 lives. In more recent Ali (1999) is very clear regarding the use of the misnomer "tidal surge" when referring to storm surges. Tides are created by gravitational forces where as the "surge" we describe here are caused by cyclones, or weather related activities. However, number of deaths caused by the cyclones with severe intensity have declined due to the growing successful institutional arrangements for disaster management and the fact that there are now over 2000 cyclone shelters spread along the coast (which are being utilized during the cyclones). In terms of climate change, warmer sea surface temperatures are correlated with tropical cyclone activity. Some studies have concluded that a 1°C increase in sea surface temperatures could increase tropical cyclone intensity by 10 percent (e.g., Henderson-Sellers and Zhang, 1997). It has been found that higher temperatures may not increase tropical cyclone activity. However, even with similar intensity, the destructive effects of cyclones would be intensified by sea level rise induced increased water depths in the shallow continental shelf of the Bay of Bengal. Assuming there is a positive correlation between sea surface temperature and tropical cyclone intensity, Ali (1996) calculated the effect of a repeat of the 1991 cyclone with a 10 percent increase in intensity and sea level rise. He concluded that this could result in storm surge 2 m higher and inundating 13 percent more land than the 1991 cyclone. Ali (1999) in a more recent Bangla publication mentions that during the years 1877-1995, 365 cyclones were recorded in the Bay of Bengal which died before hitting the coast. He suggests that: in a warmer world, some of such cyclones could actually hit the land. Therefore, even if the total number of cyclones do not increase, the number of cyclones hitting the

land, with resulting damages, may increase. He reiterates the point on increased intensity of cyclones under climate change.

Tropical cyclone hits Bangladesh in early summer (April-May) and late monsoon (October-November) periodically. The cyclones strengthen as they initially move northward in the Bay of Bengal towards the coast of Bangladesh, although some weaken before they reach the coast. Such cyclones often pass inland. Two categories of storms are recognized: tropical cyclones with wind speeds of >117 km/hr near their center (tropical cyclones); and severe cyclonic storms with wind speeds of 87−117 km/hr. Both categories can cause substantial damage to property and crops by a strong wind, heavy rainfall and storm surges– the latter causing most of the human and livestock casualties, depending on whether they make landfall near high tide or low tide.

Tropical cyclones can adversely impact the environment and livelihoods. About one-tenth of the global cyclones occur in the Bay of Bengal. According to the Bangladesh Bureau of Statistics Yearbook (2014), 21 cyclones and severe cyclonic storms hit the Bangladesh coast in the period of 1960-2010. Two-thirds of these occurred in the post-monsoon season (MoEFCC, 2018). In the coastal area, it may become disastrous, if it coincides with the high tide. During this time the water level can increase up to 10 m than normal.

CEGIS has analyzed records held by the Bangladesh Meteorological Department on cyclonic storm events for the 1960-2020 period. According to CEGIS, the data indicate that the number of different cyclones types hitting Bangladesh has decreased over this period – from 24 in the 1960s to 13 in 2020s. However, the formation of deep depressions and the occurrence of super cyclones (> 222 km/hr) increased in the period 1990-2020 by 6% compared to the previous 30 years. Figure 4.2 shows the distribution of high-intensity cyclone along the Bangladesh coastline since 1963.

The cyclone of 1970 was the most disastrous which produced a surge height of 10m. In 1991, the surge height was 6 m. From 2000 to 2010, Sidr (2007) and Aila (2009) were destructive cyclones. Since May 2019, Bangladesh has been hit by three surges. They are Cyclone Fani on May 04, 2019, Cyclone Bulbul on November 09, 2019 and Cyclone Amphan on May 20, 2020.

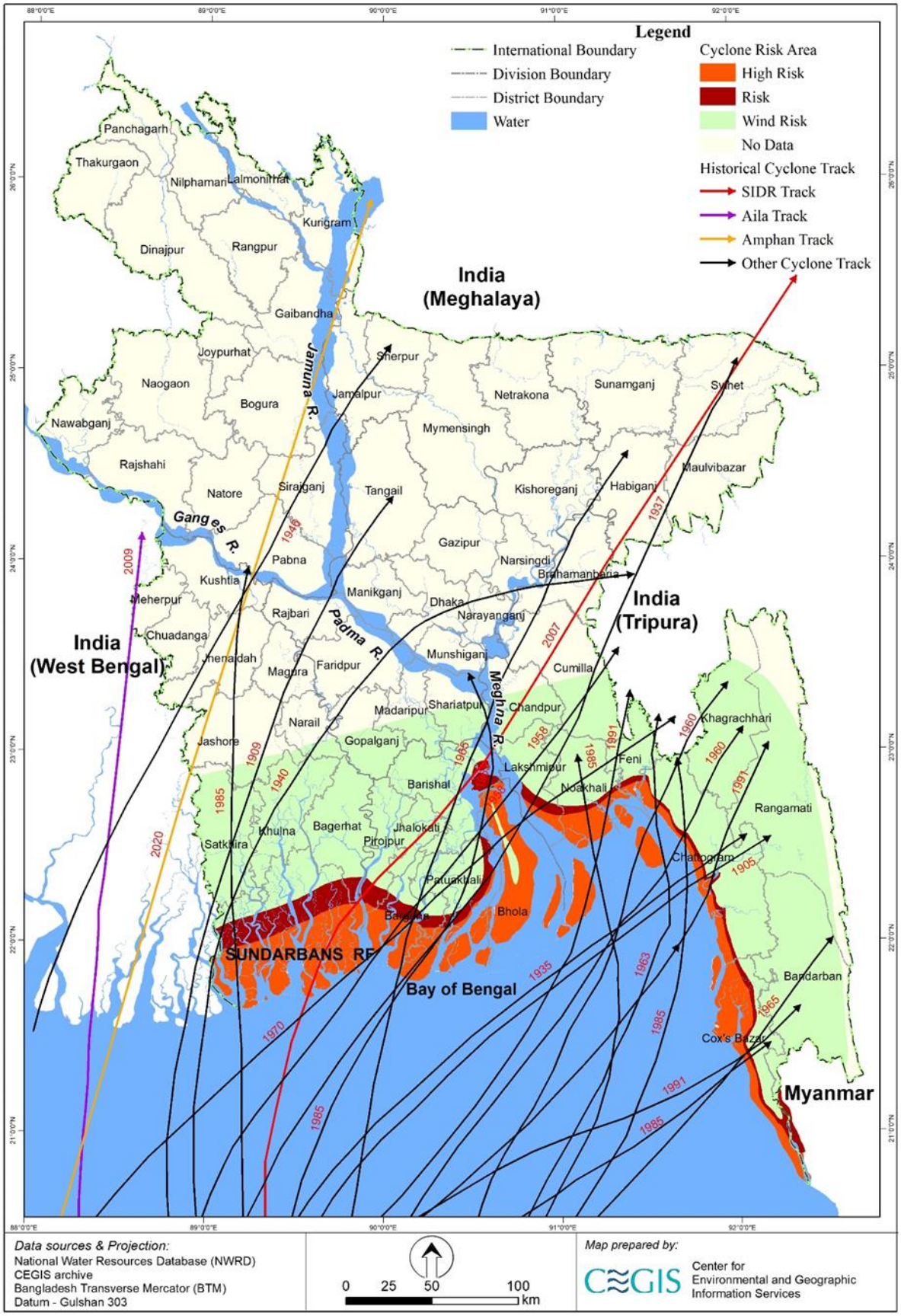


Figure 4.37: Historical Cyclone Tracks over Bangladesh

4.13 Development of Navigation and Drainage

4.13.1 Navigation Routes and Polder Areas

The Ganges is a dynamic and erosion-prone river. Riverbank erosion adds a lot of sediment that is deposited downstream along its course and distributaries or carried into the Bay of Bengal. Before 1960s, the river water also flows through the land during tides. This led to unproductive lands. To increase agricultural production and other economic activities, embankments were constructed in the coastal area during the 1950s and 1960s (improving embankments along tidal rivers that had been built by landowners since the 17th century), creating polders between the tidal rivers and extending 150 km inland in the west, and constraining flood dynamics (van Staveren et al., 2017). The embankments were built around continuous river banks, but they cut off the minor creeks which let water into and out of the enclosed areas under natural conditions. Under natural conditions, the rivers had levees on their banks surrounding lower basins behind them.

The purpose was to prevent salt-water flooding of the floodplain areas inland and provide increased security for monsoon-season rice production. Sluices in the embankments prevented the inflow of salt-water at high tide and allowed ponded rainwater to drain away at low tide. There have been problems in the allocating of government funds for regular and adequate embankment and sluice maintenance. Landowners have also deliberately breached embankments to allow brackish water to flood polders for shrimp farming (which provides higher economic returns per ha than rice cultivation). However, this also displaced many small tenant farmers and reduced labor demand. Storm surges in 2007 and 2009 associated with cyclones breached some embankments (subsequently repaired) causing salt-water flooding. Cyclone Amphan in May 2020 gain breached many embankments causing salt-water flooding within polders.

Improper management of the polders led to the water-logging problem. According to Khadim et al., 2013, Khulna and Jessore districts were facing regular drainage congestion and water-logging. However, the polders delinked the floodplain from the rivers which aggravated the drainage congestion and water-logging situation in this region. As a part of the Khulna-Jessore Drainage Rehabilitation Project (KJDRP), embankments, rubber dams and dykes, regulators and flushing inlets has been constructed with the introduction of Tidal River Management (TRM). The major objective of TRM is to receive the suspended sediment from the rivers into the project area of KJDRP. The TRM has reduced the water-logging problem to some extent in the Khulna and Jessore area. Nevertheless, it is still a problem for the SW and SC region.

Bangladesh Inland Water Transport Authority (BIWTA) under the Ministry of Shipping maintains the navigation in the inland waterways of Bangladesh including river ports, ferry ghats and other berthing stations for water vehicle. BIWTA has classified the inland waterways into four categories according the draft condition of the river for navigation. These are – Class I (Depth ≥ 12 ft), Class-II (6ft ≤ Depth ≤12 ft), Class-III (3ft ≤ Depth ≤6 ft) and Class-IV (Depth < 3ft). The routes are shown in Figure 4.38.

Primarily rivers in Bangladesh can be classified into two groups, namely tidal and non-tidal. In the tidal rivers, there are tide dominated (high sediment) and fluvio-tidal rivers (less sediment). On the other hand, in the non-tidal part, there are active, misfit, under-fit and rivers in the subsiding basin. Moreover, major rivers have also different characteristics. Tidal rivers are in the southern part of Bangladesh. Tidal rivers can be further classified into tide dominated where sediment is high and fluvio-tidal where sediment is less compared to tide dominated rivers. Tide normally governs the navigation in the tidal rivers. Sediment enters to the tidal system during flooding and comes out during ebbing. But due to tidal asymmetry, sediment deposit to the river system and makes river silted up. Moreover, it is important to spread the tidal volume to the internal canals or creeks otherwise sediment enters to the main channel which is hindrance to navigation. As a result, it is often difficult to dredge the channel and it requires huge amount of dredging every year which is more expensive.

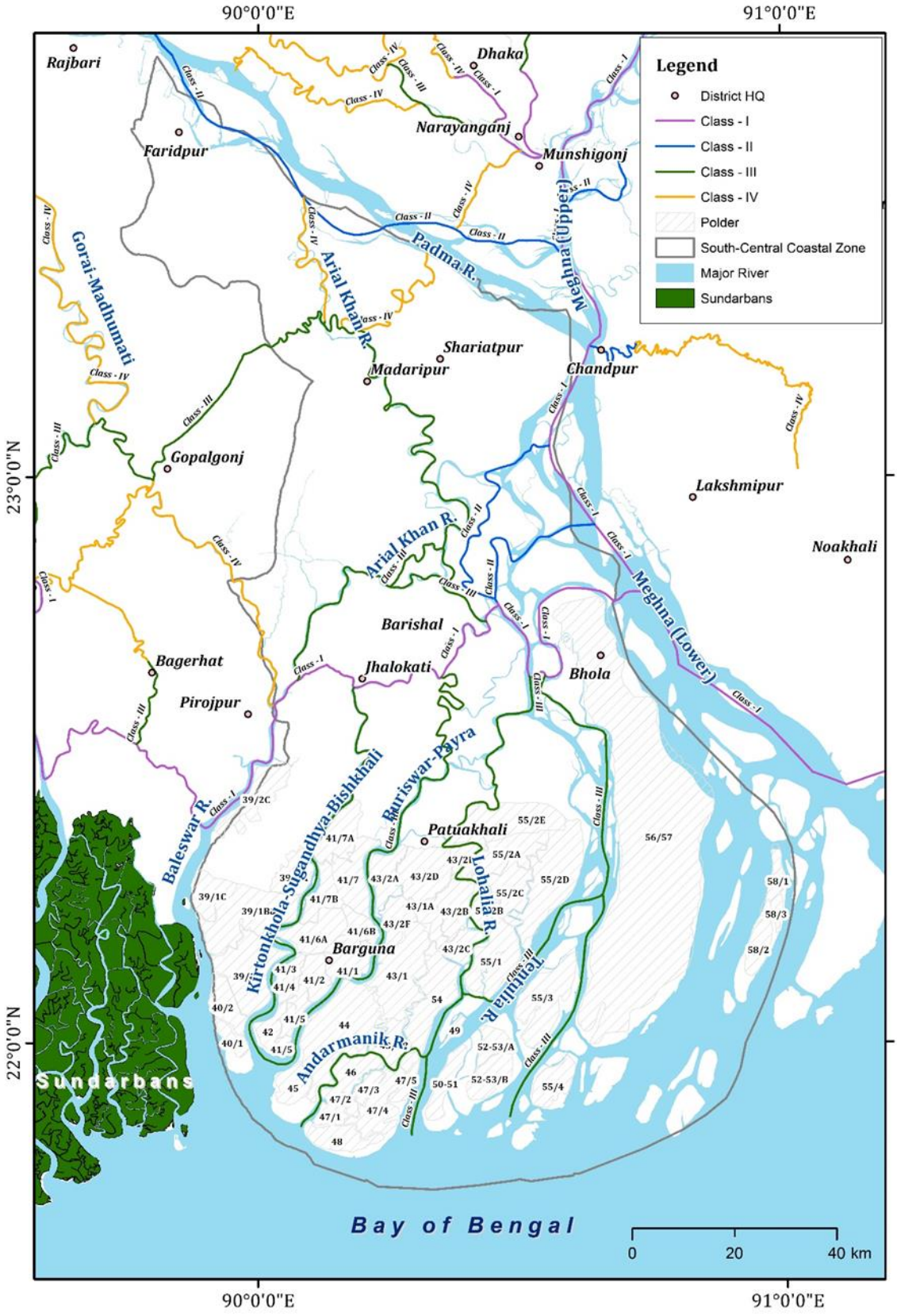


Figure 4.38: Polder Area and Navigation Routes in South-Central Region

4.13.2 Responsible Institutions

For the water resources development in this area, several organizations are working. These are:

- **Bangladesh Water Development Board (BWDB)**- mainly responsible for polder management like construction and rehabilitation of embankment, rehabilitation of sluice gates; capital dredging as a part of river training works; flood forecasting etc.
- **Water Resources Planning Organization (WARPO)**- mainly responsible for planning for water resources development.
- **River Research Institute (RRI)**- mainly responsible for modeling related to rivers
- **Joint River Commission, Bangladesh (JRC)**- maintains liaison between the participating countries, formulate flood control works and recommend implementation of joint projects etc.
- **Bangladesh Agricultural Development Corporation (BADC)**- mainly responsible for minor irrigation by groundwater and low lift pump (LLP), construction of rubber dams.
- **Local Government and Engineering Department (LGED)**-mainly responsible for small-scale irrigation (below 1000 ha).
- **Bangladesh Inland Water Transport Authority (BIWTA)**- responsible for dredging to maintain navigability.
- **Payra Port Authority (PPA)**- responsible for maintenance of port area.

4.14 Present and Future Risks

4.14.1 Present Challenges of the SC Region

Water Logging

Any rise of the sea level will propagate upstream into the river system. In Bangladesh, this backwater effect will be more pronounced because of the morphologically dynamic rivers, which will adapt their bed levels in a relatively short time period. This whole process will lead to decreased river gradients, increased flood risks and increased drainage congestion. Since most of coastal plains are within 3 to 5 meters from the mean sea level, it was previously thought that a significant part of the coastal areas (as high as 18 percent of the country) would be completely inundated by rising sea waters (Huq et al., 1995; Houghton et al., 1996). Such a speculation was made based on two major approximations: (a) the coastal plains are not protected and (b) the seawater front with follow the contour line. In reality, however, it is found that most of the coastal plains in the central regions are protected. Due to the backwater effect, embankments further land inwards may be topped and areas flooded. This could still turn most of the seaward polders into islands. Drainage congestion may become an even more serious threat than higher flood risks. Due to the siltation and the poor maintenance of the drainage channel network in many parts of the coastal zone, drainage congestion is already a grave problem (EGIS, 1998), and the problem is expected to increase considerably. Proper emphasis should be given to the fact that: protection measures against inundation by embankments interrupt the natural processes of land sedimentation and delta formation. This implies that subsidence and sea level rise will not be compensated by sedimentation, and the risks of inundation and drainage congestion will be even greater in the future. These amplifying effects are particularly alarming, and indicate that quite a different approach may be required to face the problems in especially the seaward parts of Bangladesh. Unlike the densely populated seafront areas, the Sundarbans is not protected and is heavily influenced by tidal effects. A rise in sea level will tend to inundate the mudflats of the forest and reduce the land area of the forest. The forest floor, however, may be experiencing a natural uplift

at a rate similar to the anticipated rate of sea level change. Whether natural uplift is strong enough to counterbalance sea level rise is very uncertain, and present research continues to emphasize the vulnerability aspects of the Sundarbans.

Storm Surge

Tropical cyclone hits Bangladesh in early summer (April-May) and late monsoon (October-November). Cyclone is usually followed by storm surge. The level of disastrous nature, that a cyclone already possess, gets geared up when time of cyclone coincides with the time of high tide. After storm surge hits the coast, the coastal area gets inundated which is a great risk for the people and property.

Salinity Water Intrusion

The effect of saline water intrusion is highly seasonal in Bangladesh. Saline intrusion is at its minimum during the monsoon (June-October) when the GBM rivers discharge about 80 percent of the annual fresh water flow. In winter months the saline front begins to penetrate inland and the affected areas rise sharply from 10 percent in the monsoon to over 40 percent. Climate change would increase saline intrusion through several means: directly pushing the saline/ fresh waterfront in the rivers through higher sea levels; lower river flows from upstream, increasing the pushing effect from the sea; upward pressure on the saline/ fresh water interface in the groundwater aquifers (every cm of sea level rise will result in a thirty-fold rise of the interface because of the hydrostatic pressure balance); percolation from the increased saline surface waters into the ground water systems and increasing evaporation rate in winter, leading to enhanced capillary action and subsequent salinization of coastal soils. All these effects would have significant adverse impacts in the coastal areas. Climate change induced extreme weather events, especially low flow conditions in winter will accentuate the saline intrusion in the coastal areas.

The river water salinity depends on the freshwater flow from upstream, salinity in the coast and coastal water circulation pattern. The salinity intrusion is taking place further inside the country due to the reduction of upstream freshwater flow. The soil salinity is also increasing due to increased waterlogging mostly inside the coastal polders. Salinity at the estuary depends on the season. Monsoon flow Mawa point into Tentulia, Buriswar-Payra, Kirtonkhola and Lohalia systems plays active role in reducing the salinity of SC region. However, the salinity intrusion is still prominent in this region and it is evident from the map in Figure 4.39 that the salinity front is moving inwards the coastal zone.

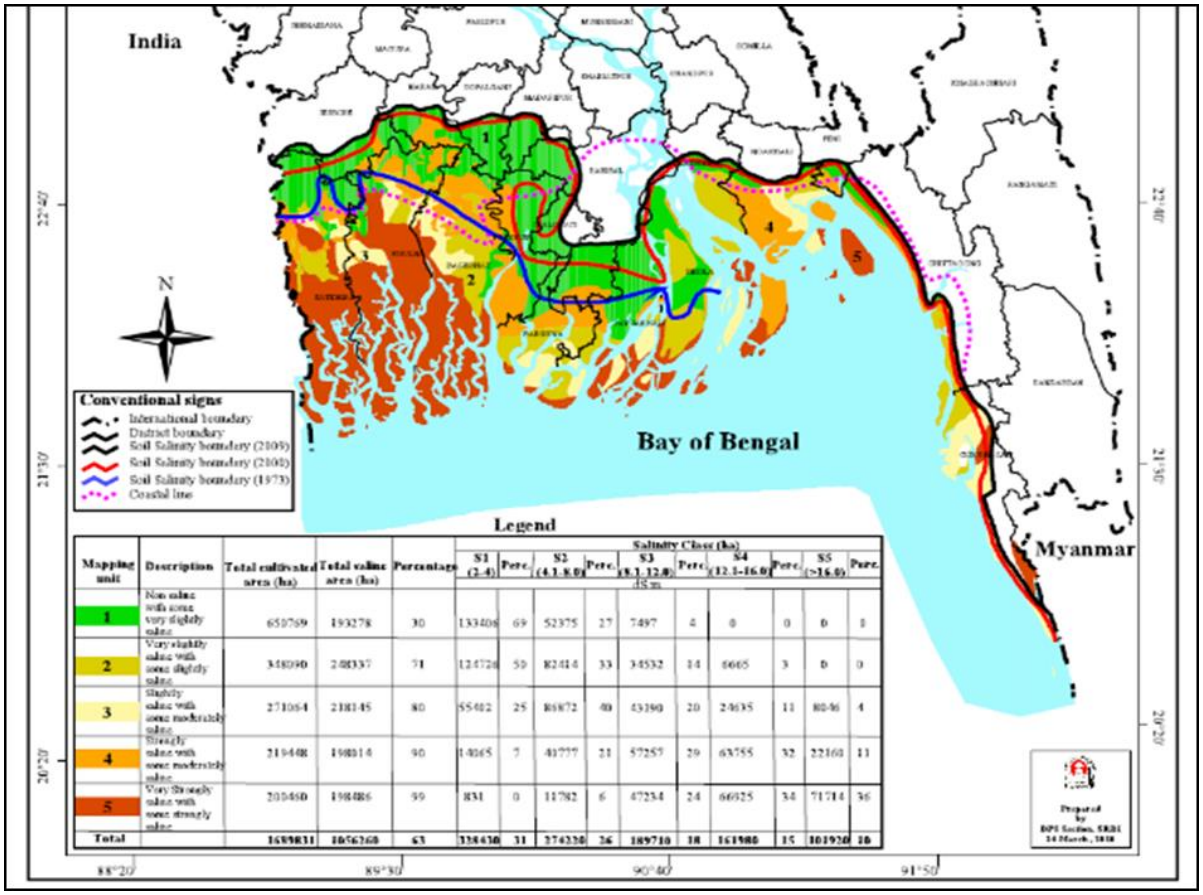


Figure 4.39: Movement of Salinity Front

Water Supply

Coastal area uses both surface water and groundwater for various purposes. Rural water supply almost completely depends on the surface water and winter agriculture is dependent on groundwater. This area is endowed with both fresh and brackish water resources. Freshwater is abundant during monsoon whereas, water becomes scarce during dry season. The reduction in freshwater inflow increases the salinity content of the surface water by means of accelerated backwater flow. Moreover, sea level rise and tide induced floods contribute to the intrusion as well making the existing water unsuitable for agricultural, industrial, domestic and other uses. Consequently, the groundwater aquifers in the coastal districts are encountering growing stress of salinization resulting from over-extraction. Low river flow substantially contributes to the stress.

Coastal Morphology

The morphological dynamism is manifested in the coastal zone as well. The coastal zone has experienced natural erosion and accretion in the past, as well as anthropogenic accretion and subsequent erosion in recent years. Although some literature suggests the morphological processes in coastal region is very slow, expected changes in the inflow of riverine sediments has presented the coastal morphology to be highly uncertain. Furthermore, new embankments for reclaiming additional land would affect the morphological dynamics of the coast

4.14.2 Present Challenges of the SC Region

Decrease in Freshwater Flow

Figure 4.40 represents the daily discharge at in Gorai River. Gorai-Madhumati River system contributes to the freshwater inflow into the SC coastal. The graph clearly represents decline in the amount of discharge. Declining discharge into the region will aggravate salinity intrusion which will eventually add to the misery of the inhabitants.

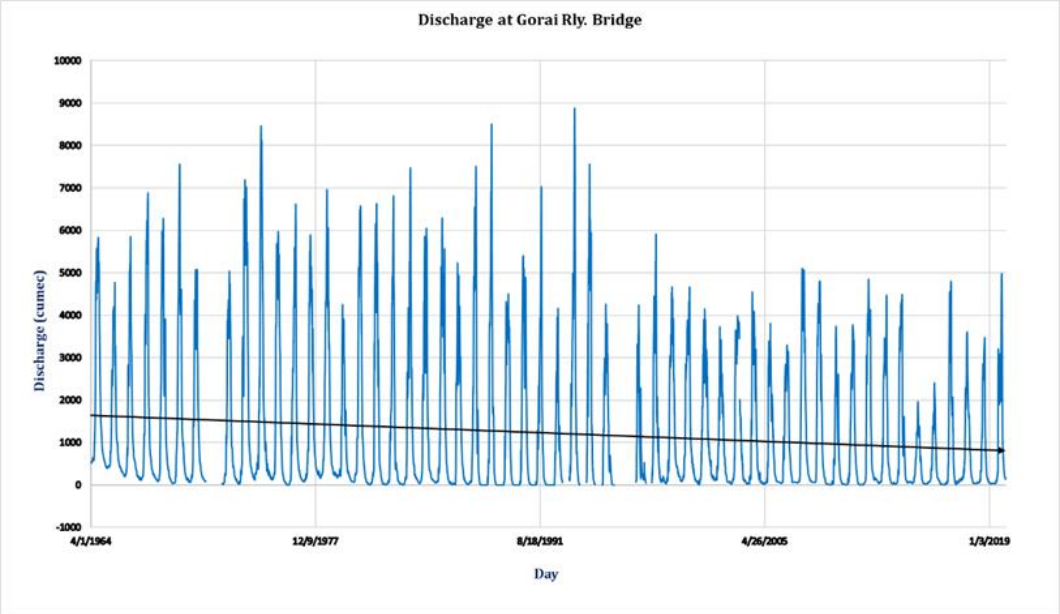


Figure 4.40: Trend of Daily Discharge in Gorai

Sea-level Rise

Sea level rise is an evident threat to the coastal zone of Bangladesh, a low-lying delta that is often subjected to land subsidence. UNEP predicted a 1.5 m sea level rise by 2030 which will inundate 16% of total land mass and effect 15 million people. (Baten et al., 2015) World Bank in its report on Climate Change & Sustainable Development (edition of 2000) predicted a rise of 10 cm, 25 cm and 1 m by the year 2020, 2050 and 2100 repectively which will likely to inundate 2%, 4% and 17.5% of total land mass respectively. Based on 22-year historical data, SMRC has developed a trend of sea level rise in three tidal stations in the coast of Bangladesh and the trend depicts a worrying picture where coastal area would experience 5.9 mm sea level rise every year. Saline water intrusion inward of the coastal zone is an aftermath of sea level rise. Moreover, during dry season freshwater inflow remains less and thus worsens the overall situation. In Figure 4.41, the average water level at Patharghata demonstrates increase in sea level.

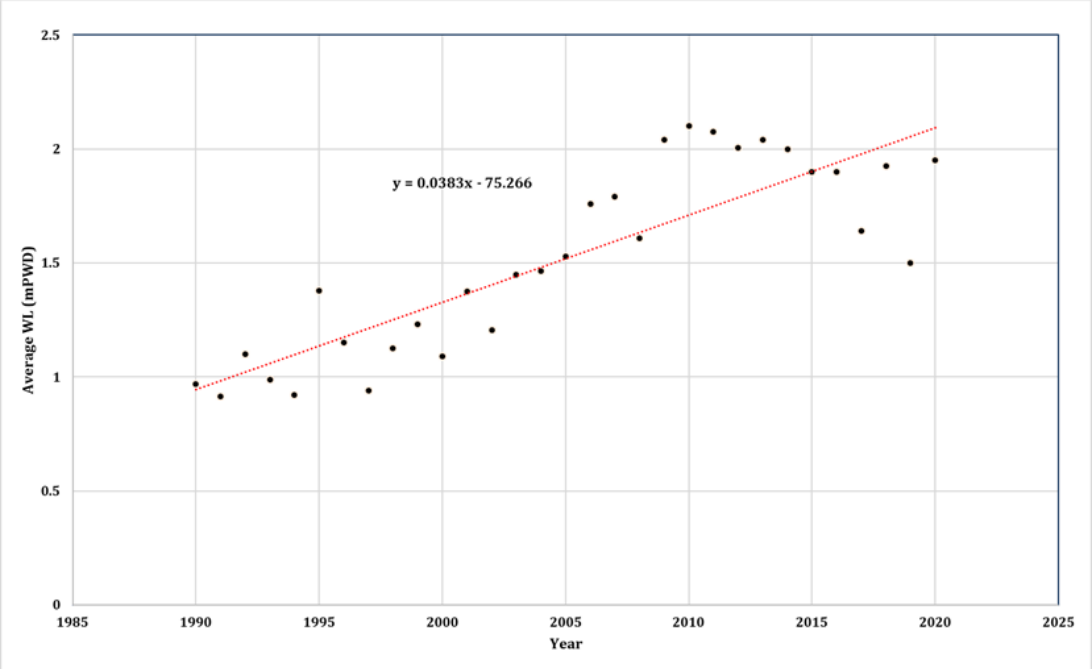


Figure 4.41: Sea Level Rise at Patharghata

4.15 Policies PLand and Programs

4.15.1 Administration/Competent Authorities

Table 4.2: Competent Authorities in Key Aspects

Key aspect in the theme	Primary competent authority (CA)	Mandates	Key support organisations (govt, NGO, donor, CBO, etc.)	Performance of CT and support organisations
Water Resources Management and River morphology	Ministry of Water Resources	- Regulation and development of rivers and river valleys. - General policy and technical assistance in the field of irrigation, flood control, anti-water-logging, drainage and anti-erosions. - All matters relating to irrigation, flood forecasting and warring, flood control, flood control works, causes off floods and damage caused by floods to irrigation projects, embankments, etc. - Basic, fundamental and applied research on river valley projects and flood control works. - International cooperation in the field of flood control and development of water resources. - International commissions and conferences relating to irrigation, flood control and water resourse management. - Construction and maintenance of canals under W. D. B. Project; construction and maintenance of water control structures for the canals executed under the Canal Digging programme. - Soil conservation drainage and water-logging. - Storage of water and construction of reservoirs, embankment and barrages. - Land reclamation, estuary control. - Anti-salinity measures and anti-desertification. - Hydrological survey and data collection. - Matters relating to Joint Rivers Commission; Joint Committee, Standing Committee, etc. and Common Border Rivers.	- Bangladesh Water Development Board (BWDB) - Water Resources Planning Organization (WARPO) - Joint River Commission (JRC)	All the competent authority is carrying out the activities as per their mandates with the assistance of their supporting agencies/organizations. They are trying to formulate plans, strategies and implementing the projects as per policy, plan, act, program with special focus to Bangladesh Delta Plan 2100.

Key aspect in the theme	Primary competent authority (CA)	Mandates	Key support organisations (govt, NGO, donor, CBO, etc.)	Performance of CT and support organisations
		- Secretariat administration including financial matters. - Administration and control of Subordinate office organization under this Ministry. - Liaison with International Organization and matters relating to treaties and agreements with other countries and world bodies relating to subjects allotted to this Ministry. - All laws on subject to this Ministry. - Inquiries and statistics on any of the subject allotted to this Ministry. - Fees in respect of any of the subjects allotted to this Ministry except fees taken in courts.		
	Ministry of Shipping	To ensure World class management of ports, maritime and water transportation. The ministry serves the mission- Modernization of sea ports, river ports and land ports, conservation of navigability of waterways, creation of efficient workforce in the maritime sector, safe and affordable transportation of passengers & goods and facilitation of international trade.	- Bangladesh Inland Water Transport Authority (BIWTA) - Payra Port Authority	
	Ministry of Local Government, Rural Development and Co-operatives	- Formulation of rural development policy and laws, rules and policy relating to cooperatives; - Formulation and implementation of programmes/and projects to alleviate rural poverty; - Assist entrepreneurs through micro-credit, agricultural credit, co-operative based small and cottage industries, co-operative bank, co-operative insurance, co-operative based farming and marketing, milk and other cooperative enterprises; - Initiate human resource development programmes for members of the cooperatives, provide education, training and conduct research programmes on rural development and cooperatives; - Innovate new model/strategy on rural development through action research;	- Local Government Engineering Department (LGED) - City Corporation - Local Government Authorities	

Key aspect in the theme	Primary competent authority (CA)	Mandates	Key support organisations (govt, NGO, donor, CBO, etc.)	Performance of CT and support organisations
		- Assist in the socio-economic development and empowerment of rural women through formation of formal and informal groups under cooperative programmes.		
	Ministry of Road Transport and Bridges	To build sustainable, safe and quality highway network and integrated modern mass transport system in order to improve socio-economic condition of the people through development and expansion, repair, rehabilitation and maintenance of highways.	- Road and Highways Department (RHD) - Bangladesh Bridge Authority (BBA)	
	Ministry of Disaster Relief and Rehabilitation	To drive national risk reduction reform programmes. Its mission relative to this agenda is: "To achieve a paradigm shift in disaster management from conventional response and relief to a more comprehensive risk reduction culture, and to promote food security as an important factor in ensuring the resilience of communities to hazards"	- Bangladesh Climate Change Trust (BCCT)	
	Public Private Partnership	Development of sustainable public service infrastructure. Creating an enabling environment for government institutions through public private partnerships in the delivery of sustainable public service infrastructure.	- NGOs	

4.15.2 Relevant Legislation and Regulations

Table 4.3: Primary Legislations Associated with the Key Aspects of the Theme

Key aspect in the theme	Primary legislation	Accompanying or enabling regulations	Comments on adequacy or not re. legislation and regs
River Management	The Embankment and Drainage Act (1952): An Act to consolidate the laws relating to embankment and drainage and to make better provision for the construction, maintenance, management, removal and control of embankments and water courses for the better drainage of lands and for their protection from floods, erosion or other damage by water.	Implementing Agency: East Pakistan Water and Power Development Authority. Presently Bangladesh Water Development Board is taking care of it.	Proper implementation of the law is necessary
Integrated Water Resources Management	National Water Act, 2013: To make provisions for integrated development, management, abstraction, distribution, use, protection and conservation of water resources	BWDB implement all major surface water development projects and other Flood Management, Drainage and Irrigation (FMDI) projects with command area above 1,000 hectares while LGED would take care the less area BIWTA will be main authority for river transport including river dredging to maintain river navigation	Proper implementation of the law is necessary

4.15.3 Relevant PPPs and Consequent Environmental, Socio-economic Impacts

National Water Policy (1999)

The main objective of this policy was to provide direction to all agencies working with the water sector, and institutions that relate to the water sector in one form or another

These objectives are broadly:

- To address issues related to the harnessing and development of all forms of surface water and ground water and management of these resources in an efficient and equitable manner
- To ensure the availability of water to all elements of the society including the poor and the underprivileged, and to take into account the particular needs of women and children.
- To accelerate the development of sustainable public and private water delivery systems with appropriate legal and financial measures and incentives, including delineation of water rights and water pricing.
- To bring institutional changes that will help decentralize the management of water resources and enhance the role of women in water management.

- To develop a legal and regulatory environment that will help the process of decentralization, sound environmental management, and improve the investment climate for the private sector in water development and management.
- To develop a state of knowledge and capability that will enable the country to design future water resources management plans by itself with economic efficiency, gender equity, social justice and environmental awareness to facilitate achievement of the water management objectives through broad public participation.

The National Water Management Plan (NWMP) (2001)

A plan to guide the management of the country's water resources and to include new priorities and challenges in the water sector. The overall objectives of the NWMP are to contribute in a balanced fashion to the overall national goals of economic development, poverty alleviation, food security, public health and safety, decent standard of living for the people and protection of the natural environment.

National Strategy for Water Supply and Sanitation, 2014

The National Strategy for Water Supply and Sanitation has been developed by the Ministry of Local Government, Rural Development and Cooperatives (LGRD) and Local Government Engineering Department (LGED). The strategy has been prepared by reviewing sectoral documents of water supply and sanitation. This strategy is synchronized incorporating outstanding issues in those existing sectoral documents and emerging issues. The objectives and main activities are presented below.

Key Objectives

- To ensure – as a basic human right - safe and sustainable water supply, sanitation and hygiene services for all, leading to better health and well-being;
- To protect and preserve human health, water supply and sanitation facilities from the adverse impact of natural and man-made disasters and climate change.

Main Activities

- Establish a water quality monitoring system and protocol, delineating the roles and responsibilities of the consumers, service providers, local and central government institutions;
- Carry out screening and monitoring of all potentially contaminated tube wells to identify contaminant levels and the population at risk.

WASH (water, sanitation and hygiene) interventions:

- Adopt a transparent, accountable, participatory, demand-driven and inclusive approach in all stages of WASH service delivery programs;
- Ensure safe drinking water security through integrated water resource management;
- Give priority to arsenic mitigation in affected areas;
- Undertake specific approaches for hard to reach areas and vulnerable people;
- Establish faecal sludge management;
- Manage solid waste judiciously; harnessing useful resources from solid and liquid wastes, e.g. biogas through anaerobic digestion and residual material for conversion to fertilizer/compost;
- Improve hygiene promotion;
- Facilitate private sector participation.

Emerging challenges

- Adopt integrated water resource management;
- Address the growing pace of urbanization through the preparation of master plans, exploration of alternate water sources, renovation/ reclamation of natural canals. etc.;
- Cope with disaster, adapt to climate change and safeguard the environment, e.g. through developing common frameworks, strengthening disaster preparedness and monitoring, and capacity development of relevant institutions;
- Institutionalize research and development

Sector governance

- Undertake integrated and accountable development approach;
- Recover the cost of services while keeping a safety net for the poor;
- Strengthen and reposition institutions;
- Promote enhanced private sector participation;
- Enhance coordination and monitoring

Coastal Zone Policy (2005)

A policy so that the coastal people can pursue their livelihoods under secured conditions in a sustainable manner without impairing the integrity of the natural environment. It is guidance to concerned authority for the management and development of the coastal zone in a manner that provides a secure and conducive environment for coastal communities. It also helps to coordinate planning and support implementation and monitoring of development activities in the coastal zone.

Meghna Estuary Study (1998)

The study was conducted to retain and increase the operational knowledge of hydraulic and morphological processes in the Meghna Estuary and to develop appropriate approaches and techniques for efficient land reclamation as well as effective river bank protection measures.

Perspective Plan of Bangladesh (2012)

The Perspective Plan provides the road map for accelerated growth and lays down broad approaches for eradication of poverty, inequality, and human deprivation.

Water Resources Management Strategies

- Follow the IWRM framework for best allocation of water to various uses
- Encourage research and development in designing appropriate adaptive activities to manage climate change impacts on and through the water sector
- Focus on surface water irrigation and stabilize a reduced use of groundwater;
- Encourage greater use of rainwater and its local storage for use in the dry season;
- Examine large-scale O&M activities in embankments and polders to prevent salinity intrusion along the coast, and identify and implement the best option for the purpose;
- Rehabilitate coastal embankments to help adapt to climate change;
- Protect rivers from erosion of water courses and enhancement of land reclamation;
- Undertake planned and phased dredging and river training activities;

- Examine the government's water sector agencies and institutions and, if necessary, redesign, reorient and further equip them for more effective implementation of policies and strategies;
- Resume negotiations with India and other upper riparian states for equitable water sharing arrangements for all trans-boundary rivers, particularly major rivers.

7th Five Year Plan (FY2016-2020)

Water Resources Strategies

- River Dredging for non-destructive, easy and smooth passage of flood flow of the river system
- Basin-wide Water Resources Development Initiative
- Water sharing with neighboring countries to reduce stress on surface water during dry season period
- The Ganges Barrage Project with ancillary infrastructure
- Participatory Water Management
- To hold water of wetlands including jalmohals and rivers in dry season
- To introduce climate proofing of structures for the areas of climate risk
- O&M of Completed Projects
- Coastal Zone Management
- Small Scale Water Resources Development
- Public Private Partnership

Bangladesh Delta Plan 2100 (being updated)

Delta Plan Specific Goals

- Ensure Safety from Floods and Climate Change related Disasters
- Enhance Water Security and Efficiency of Water Usages
- Ensure Sustainable and Integrated River Systems and Estuaries Management
- Conserve and Preserve Wetlands and Ecosystems and Promote their Wise Use
- Develop Effective Institutions and Equitable Governance for In-Country and Trans-Boundary Water Resources Management
- Achieve Optimal and Integrated Use of Land and Water Resources

Water Resources Strategies:

- Flood risk management strategies
- Fresh water strategy
- Coastal zone strategy
- River system and Estuarine strategy

Table 4.4: Impacts of the Project on Existing PPPs

Key PPPs relating to the theme	Main projects emanating from the PPPs	Main negative environmental impacts emanating from the projects	Main negative socio-economic impacts emanating from the projects
• National Water Policy (1999) • Coastal Zone Policy (2005) • The National Water Management Plan (NWMP) (2001) • Perspective Plan of Bangladesh (2012) • 7th Five Year Plan (FY2016-2020) • Bangladesh Delta Plan 2100 (being updated) • Meghna Estuary Study (1998)	FAP 4: Southwest Area Water Resources Management Project (1993)	• This project includes planning, design and construction/rehabilitation of FCD infrastructures, institutionalization of the process of identifying, planning, implementing, and managing water resources from an integrated and cross-sectoral perspective with the establishment of viable water management organizations (WMOs). • Due to flood control and drainage structures, natural water flow disturbed. In addition to that connectivity between river and floodplain has hampered.	Conflict of interest between different stakeholders.
	Integrated Coastal Zone Management Plan Project (2005)	• It is an outline of priority areas in addressing present and future water resources management issues (safeguarding the availability of fresh water, water supply and sanitation program, integrated and decentralized approach to regional water resources management) • Human interventions for the water resources management might alter the ecosystem of the area.	Conflict of interest between different stakeholders.
	Coastal Embankment Improvement Project Phase 1 (CEIP-1)	Natural development of the tidal plain has been disturbed. Poldering effects interrupts the connectivity between rivers and internal channels	Conflicts between stakeholders (agriculture vs fisheries), water-logging and drainage congestion

4.16 Divers of Future Changes

Water is the most important sector for the development of one country. This sector is also rapidly impacted by the development of technology, climate change etc. The important driver for future change in the water sector is presented below.

Table 4.5: Tentative Drivers of Future Change

Key change	Main external drivers	Main internal drivers	Main actions to "fuel" or "brake" the drivers, depending on whether the change is good or bad
River erosion	Climate change	Flow and Sediment, migration of meandering bends, bank materials	Environment-friendly bank protective measures
Sedimentation in rivers	Upstream intervention/flow diversion, poldering, extreme event like landslide at the source of the rivers (hilly areas)	Sediment discharge, tidal asymmetry	Sediment management and modification of tide regulating structures, tidal river management
Delta pro-gradation	Human structures, Mangrove plantation	Tidal pumping process, Geo-morphological event like earthquake	Proper utilization of newly developed lands
Subsidence	Poldering	Natural subsidence process	Allowing sediment in floodplain, effective management of polders
Sea level rise	Climate change	Change in wave characteristics	Raising coastal embankment to required height
Salinity Intrusion	Tidal Inundation	Reduction in freshwater flow into the rivers	Increasing natural flow into the river by flow augmentation
Water-logging	High tide	Geomorphological characteristics of the region hinders its natural draining capacity	Removing the accumulated silts in rivers and raising the elevation of low-lying areas

5. Fisheries and Aquaculture

5.1 Fish Habitat Status, Production, Development Effects and Challenge

5.1.1 Introduction

Bangladesh has vast inland water areas which cover 4.7 million hectares (ha) of land comprising of capture fishery 3.86 million ha and culture fishery 0.84 million ha (DoF, 2021). The country has 166,000 sq.km of marine area including its Exclusive Economic Zone (EEZ) which is under the economic jurisdiction of the country for exploration, exploitation, conservation and management of its resources. Bangladesh has a 710 km long coast line which is composed of the interface of various ecological and economic systems, including mangroves, tidal flat, estuaries, sea grass, about 70 islands, accreted land, beaches, a peninsula, rural settlements, urban and industrial areas, and ports (Ahmad H., 2019). The coastal area is highly productive and rich in biological diversity. One of the unique features of the area is mangrove forests, which support diverse fish species and other commercially important aquatic organisms (Hoq, M.E., et al, 2013). The fisheries sector contributes 3.57% to the national GDP and 26.50% to the agricultural GDP. More than 12 percent of population are directly or indirectly dependent on the fisheries sector for their livelihoods (DoF, 2021).

The study area is situated on the coastal area of Bangladesh spatially dispersed over Patuakhali and Barguna Districts. This section focuses on fisheries and aquaculture in the study area.

5.1.2 Habitat Assessment

The estimated total fish habitat area is about 172,792 ha, which is an assemblage of open water fishery and aquaculture by about 98% and 2% respectively. The open water fisheries are dominated by floodplain habitat followed by river and canal, and mud flat/inter tidal area. The aquaculture includes various culture technology adopted fish ponds i.e. extensive pond, semi-intensive pond and intensive pond. The extent of fish habitats is shown in the **Table 5.1.**

Table 5.1: Extent of fish habitats in the study area

Habitat category	Habitats	Habitat area (ha)	Percent (%) of area
Open water fishery	River and canal	71,466	41.4
	Floodplain	94,932	54.9
	Mud flat/Inter tidal area	2,703	1.6
Sub-Total		**169,101**	**97.9**
Aquaculture	Extensive fish pond	664	0.4
	Semi-intensive fish pond	2953	1.7
	Intensive fish pond	74	0.04
Sub-Total		**3691**	**2.1**
Total		**172,792**	**100**

Source: CEGIS estimation based on land use data, 2019

Open water fishery

River, floodplain and mud flat or intertidal area are the major habitats in the capture fishery. Extent of the habitats by the administrative Upazila are as follows;

Rivers

Rivers are major hydrological feature in the Barguna and Patuakhali District. It is a repository of riverine fishes and shrimp/prawn. In the study area, riverine habitat is the highest in Rangabali Upazila (**Figure 5.1**).

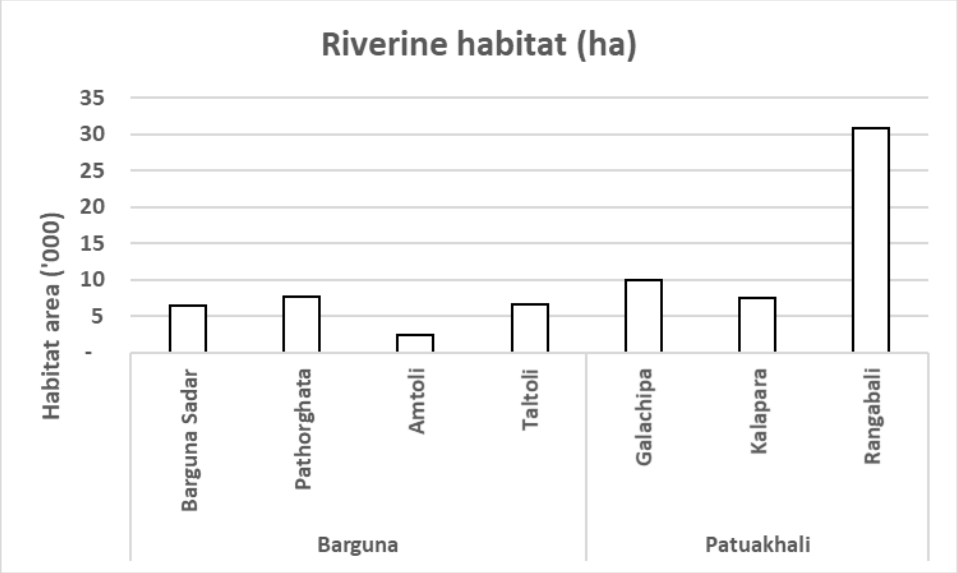


Figure 5.1: Extent of riverine fish habitat by Upazila

Floodplain

Floodplain functions as important role in fisheries in respect breeding, grazing and nursing ground of fishes. The floodplain becomes inundated during periods of high river flow during the rainy season and remains under water for three (03) to four (04) months, offering fish habitat. In the study area, the highest extent of floodplain area is found in Kalapara Upazila (Figure 5.2).

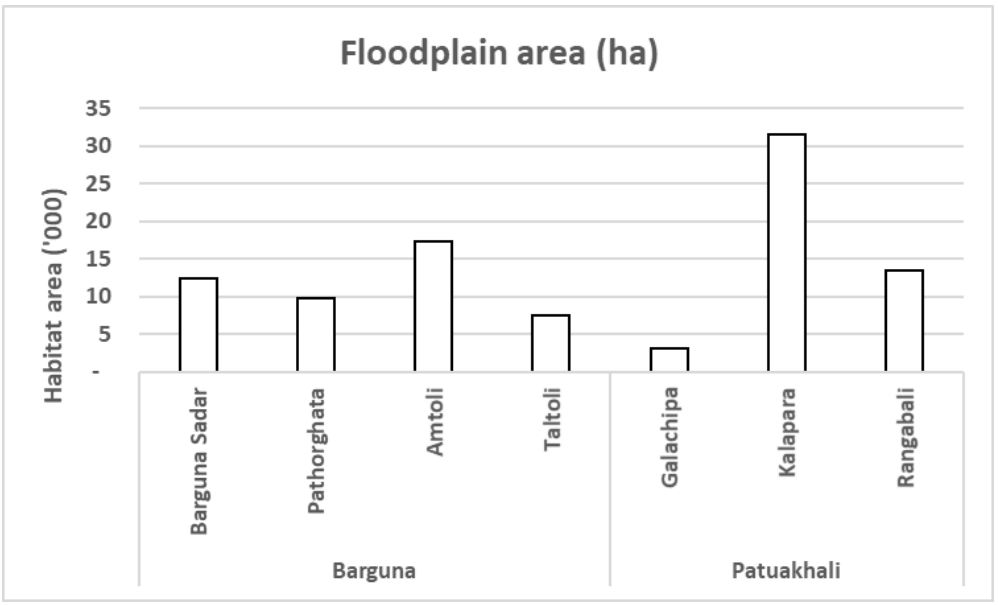


Figure 5.2: Extent of floodplain fisheries by Upazila

Mud flat/Inter tidal area

Inter tidal area functions as important role in fisheries in respect grazing and nursing ground of fishes. The inter tidal area becomes inundated during high tide and remain under water about 06 hours for twice a day. In the study area, maximum inter tidal area is found in Rangabali Upazila of Patuakhali District as shown in **Figure 5.3.**

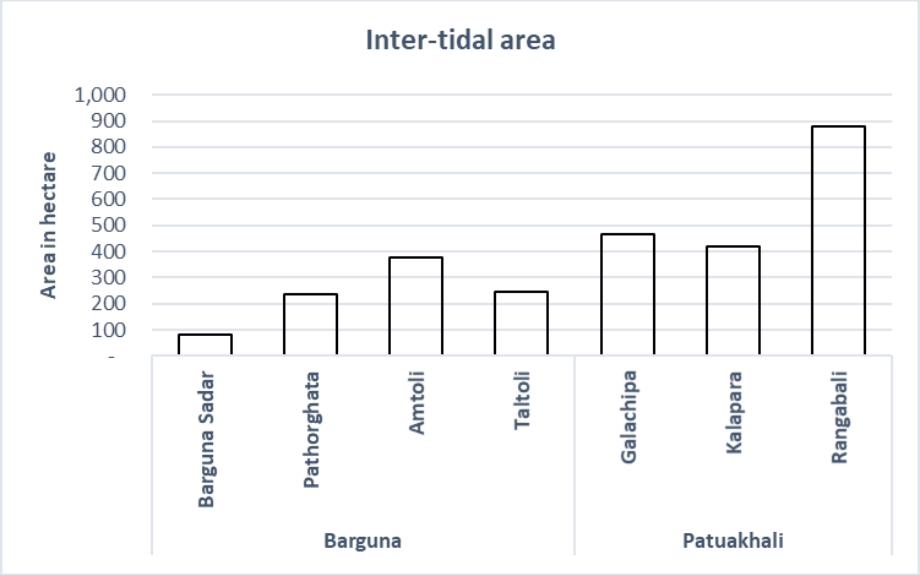


Figure 5.3: Extent of mud flat/inter tidal habitat by Upazila

Aquaculture

Ponds

According to culture method, ponds in the study area are categorized into three types i.e., extensive pond, semi-intensive pond and intensive pond. Different types of aquaculture production technologies predominate in the study area. Semi-intensive fish ponds are the most widespread and are found in a number of Upazilas. The highest number of semi-intensive fish ponds are in Kalapara Upazila of Patuakhali District (**Figure 5.4**).

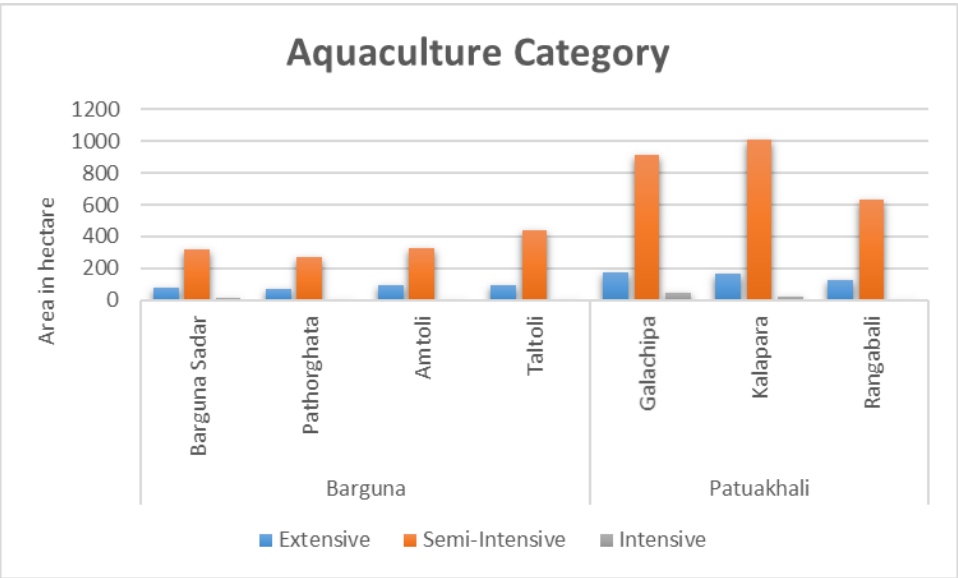


Figure 5.4: Category of fish ponds by Upazila

5.1.3 Coastal Habitat Condition and Water Pollution

The coastal waters (rivers and channels) and sediments are polluted by sewage from settlements and urban areas, agricultural pesticides and fertilizers, toxic chemicals in industrial effluents. This pollution has serious impacts on biodiversity. Oil exploration in the coastal areas has emerged as a new threat, causing habitat destruction.

Oil pollution

Oil spills include any spill of crude oil or oil distilled products (e.g., gasoline, diesel fuels, jet fuels, kerosene, Stoddard solvent, hydraulic oils, lubricating oils) that can pollute the surface of the land, air, and water environments. Oil spills range from a few gallons to millions or even hundreds of millions of gallons.

Annually, approximately 400,000 tons of crude oil is spilt into the Bay of Bengal of which about 6,000 tons is contributed by Bangladesh (PMA, 2005). Bangladesh imports around 1.2 million tons of crude oil and 0.5 million tons of refined oil every year (PMA, 2005). A certain portion of the oil leaks into the sea. There are numerous incidents of pollution, including major accidents. Some spills are extensive and their effects are clearly visible.

Consequences of oil pollution

Oil in water affects water quality:

- reduces visibility (increased turbidity) and plant photosynthesis;
- reduces dissolved oxygen (causing an imbalance in respiration and production);
- Increases demands on nutrients (causing imbalance in nutrient budget);
- Increases the organic carbon content.

Table 5.2: Effects of oil pollution on marine biota

Organisms	Effects
Phytoplankton	✓ Reduced carbon fixation, cell photosynthesis and finally death
Zooplankton	✓ Clogged by the oil and sink to bottom
Mangrove Vegetation	✓ Mangrove swamps are highly vulnerable to oiling and oil residue
Marine Mammals	✓ Hampered on breeding ✓ May die from ingestion oil causing liver damage
Algae and Sea Weeds	✓ Cell division is inhabited at oil concentration of 0.01 ppm ✓ Sea weeds are clogged and smothered by oil
Eggs and Larvae	✓ At concentration of 0.01 ppm crude oil hatching of fish eggs is irregular, late and deformed ✓ At 1ppm of oil creates abnormal development of young lobsters
Fish and Shelfish	✓ Locking of gills of fishes ✓ Retardation of growth ✓ Reduction by defence
Benthos	✓ Oil residues as tar balls creates acute toxic condition at the bottom ✓ Aromatic hydrocarbons cause pronounced mortality to the burrowing organisms

Source: BOBLME, 2011

Heavy metal pollution

Heavy metals are serious pollutants because they are stable compounds, not readily removed by oxidation, precipitation or by any other natural process. The most common heavy metal pollutants include cadmium, chromium, copper, nickel, lead, mercury and arsenic. Mercury and cadmium are of greatest concern for living organisms, including mangrove wetland species which concentrate heavy metals in their tissues.

Consequences of heavy metal pollution

Excessive levels of heavy metal contamination alter the biogeochemistry of mangrove sediments and physiology of mangrove species. It can cause mangrove plants to initiate a variety of sub-cellular responses (i.e. metabolic reactions) which can cause damage at the cellular level or lead to wider phytotoxic responses (Vangronsveld and Clijsters, 1994). Heavy metals may decrease the growth and respiration rates of mangroves and may eventually kill them and place future mangrove generations at risk. It can also negatively impact associated animals (through bioaccumulation in the food chain).

Agrochemical pollution

In recent years, farmers have been using large amounts of pesticides, herbicides, fungicides and fertilizers in agriculture and aquaculture without any awareness of their impacts. However, excessive and improper use of pesticides and fertilizers in the cropped area may pose a significant risk to coastal waters following surface soil erosion and wash-out of the agricultural field by floods and rainfall. Pesticides such as aldrin, dieldrin, endrin and heptachlor are extensively used in Bangladesh. Dieldrin is about 40–50 times more toxic than DDT (ESCAP/UN, 1987). Over 4,520 tons of pesticides are used annually in the agricultural areas of the coastal districts. Of this, 1,130 tons (25%) may reach the surface water system as residue during the rainy season (ESCAP/UN, 1987; FRI, 1994). Since the Green Revolution of the late 1970s, the use of inorganic fertilizers and pesticides has increased by 400%. It has been estimated that rivers currently add about 2000 tons per year of pesticide residues to coastal waters of Bangladesh (Shahadat et al., 2002). More than 900 industries discharge untreated liquid and solid wastes, directly or indirectly, into brackish water bodies (PMA, 2005). Increasing indiscriminate and excessive use of pesticides now poses a considerable threat to surface water in the Ganges-Brahmaputra delta plain.

Consequences of agro-chemical pollution

Rising pesticide contamination is a serious concern. Pesticides are highly toxic and tend to accumulate in coastal and marine biota. Pesticides in the mangrove wetland environment may affect living organisms through bio-accumulation in trophic levels and, through contamination of seafood, may become a public health problem. It has been estimated that 90% of the pesticides to crops that are applied do not reach the targeted species (PAB, 2004). Pesticides accumulation can also lead to decreased in fisheries production and can kill fish in areas of poor water circulation. Ground water and drinking water supplies may become contaminated (PMA, 2005).

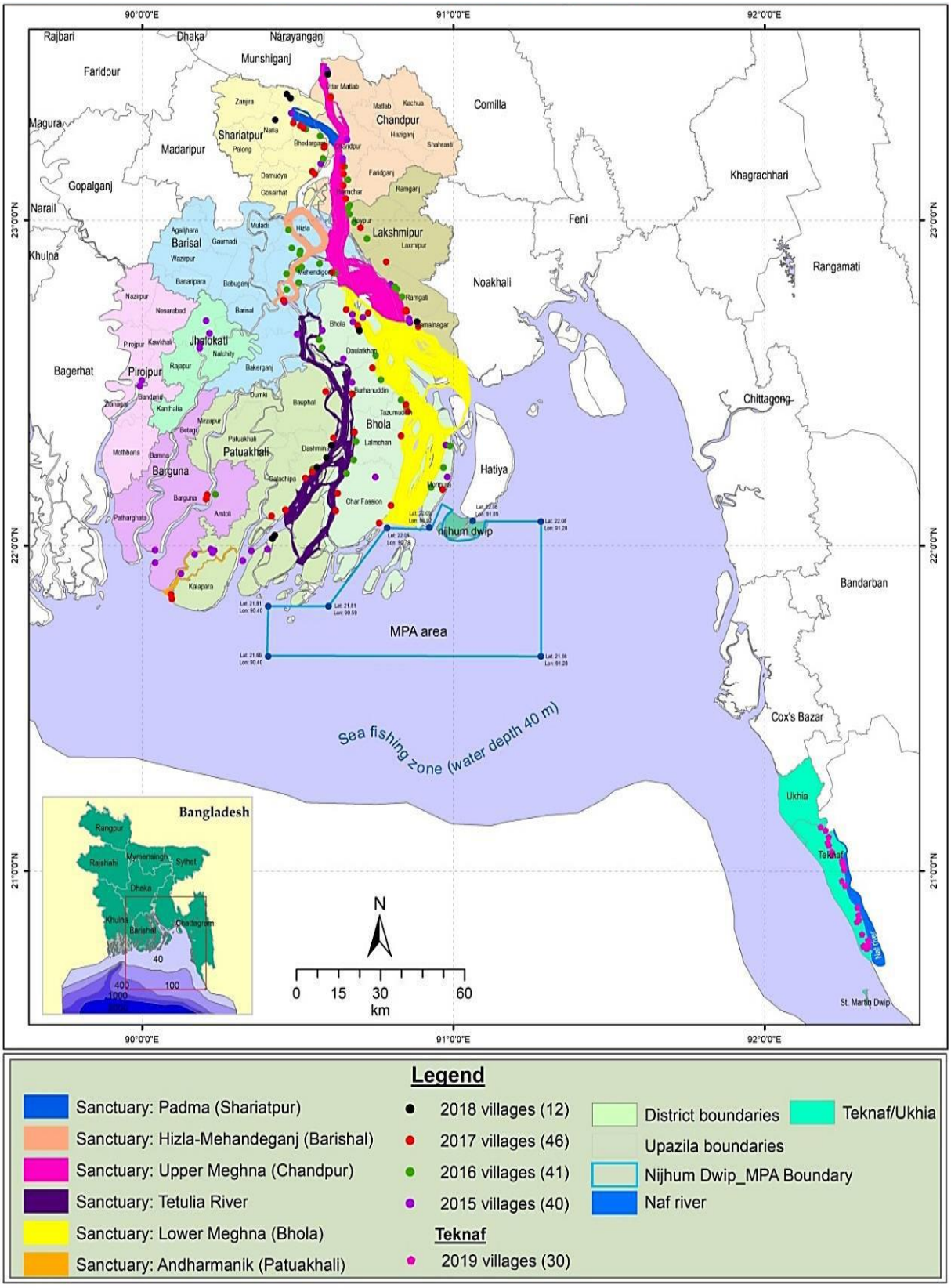
5.1.4 Fish Migration

The estuary and river systems in the study act as the major migration route for both anadromous and catadromous fishes. The Meghna River System supports all of the basic requirements of biology of various fish species. These requirements include feeding, grazing, nursing, breeding and even spawning. Major migratory species are Hilsa (*Tenualosa ilisha*), Daitna (*Acanthopagrus latus*), Bele (*Glossogobius giuris*), Gagra (*Nemapteryx nenga*), Koral (*Lates calcarifer*), Loittya (*Harpodon*

nehereus), Paissa (*Liza parsia*), Pangas (*Pangasius pangasius*), Poma (*Poma poma*), Tairel (*Eleutheronema tetradactylum*), Topse (*Polynemus paradiseus*), Tular Dandi (*Sillaginopsis panijus*), etc.

5.1.5 Hilsa Sanctuary and Spawning Ground

There are six (06) hilsa sanctuaries that have been declared in Bangladesh. Among them, two (02) hilsa sanctuaries were established in the Andharmanik and Tentulia River which are fall in the study area. Moreover, there are four important hilsa spawning grounds in the country which are- i) Dhalerchar of Charfashion in Bhola (about 125Km 2); ii) Monpura in Bhola (about 80Km 2); iii) Moulavichar of Hatia in Noakhali (about 120Km 2); and iv) Kalirchar of Sandwip (about 194Km 2) (M.M. Islam, 2016). Among the spawning grounds, two are situated in the study area as shown in **Figure 5.5.**



Source: World Fish, 2020

Figure 5.5: Hilsa sanctuary in Bangladesh

5.1.6 Fish Diversity

The Meghna River estuary is the largest estuarine ecosystem in Bangladesh which support diverse fisheries. The most important fin fish from an economic perspective are hilsa (*Tenualosa ilisha*) and the most important crustaceans are tiger shrimp (*Panaeus monodon*), giant freshwater prawn (*Macrobrachium rosenbergii*) and mud crab (*Scylla olivacea*) (Hoq 2008). Other economically important species include silver jew fish (*Johnius argenteus*), white grunter (*Pomadasys hasta*), Asian sea bass (*Lates calcarife*), fatty catfish (*Pangasius pangasius*), tilapia (*Oreochromis niloticus*), green back mullet (*Chelon subviridis*), grey mullet (*Mugil cephalus*), long whiskered catfish (*Mystus gulio*), rui (*Labeo rohita*), catla (*Catla catla*), common carp (*Cyprinus carpio*) and silber barb (*Barbonymus gonionotus*).

5.1.7 Habitat Linkage to Fish Susceptibility

The mangroves serve various functions for animals and plants. Mangrove habitats act as reservoirs, refuges, feeding grounds and nursery grounds for many terrestrial and aquatic wildlife species. Decomposed mangrove detritus acts as a feed source for many aquatic organisms, including commercial species (e.g. shellfish, shrimps, lagoon fish) (Sukardjo et al. 2013).

Fish breeding patterns

Inland water fish species are mostly resident (except for major carps, pangas and ilish which are migratory), and breed in almost any water bodies. They can be grouped according to their spawning pattern:

- Floodplain breeders include Golsha (*Mystus gulio*), Tengra (*Mystus cavasius*), Paissa (*Liza persia*), Chewa (*Apocrypte bato*), Punti (*Puntius spp.*), Chanda (*Chanda nama*), Mola (*Amblypharyngodon mola*), etc.
- River breeders include Rui (*Labeo rohita*), Catla (*Catla catla*), Kalibaus (*Labeo calbasu*), Mrigel (*Cirrhinus cirrhosus*), Ghagot (*Arius gagora*), Ayre (*Sperata aor*), Pangas (*Pangasius pangasius*), Bhangan (*Mugil cephalus*), Tapse (*Polynemous paradiseus*), Tairel (*Eleutheronema tetradactylum*), Koral (*Lates calcarifer*), etc.

Breeding pattern in floodplains

Breeding starts at the onset of monsoon flooding, when water in the rivers and channels flows into the low-lying area. Piscivorous (carnivorous) species-Boal (*Wallago attu*), Shol (*Channa striata*) and Gazar (*Channa marulius*) breed earlier than the non-piscivorous species. Most of the catfish, live fish and other small fish move to inundated shallow waters and start breeding at the end of March and early April. Torrential rainfall with thunder stimulates breeding of Boal (*wallago attu)*, Pabda (*Ompok pabda*), Koi (*anabas testudineus*), Paissa (*Liza Persia*), Punti (*Puntius spp*), etc. Species such as Boal (*wallago attu)*, Foli (*Notopterus notopterus*), Pabda (*Ompok pabda*), Shol (*Channa striata*), Gazar (*Channa marulius*), Lati (*Channa puntata*) and Koi (*Anabas testudineus*) prefer a newly inundated weedy area with shallow water and slow current.

Breeding pattern in rivers

Reproductive patterns are more diverse among the river breeders. Ayre (*Sperata aor*), Rita (*Rita rita*), Ghagot (*Arius gagora*) and Guizza (*Sperata seenghala*) dig breeding pits in shallow places in April and May and are also known to breed around 'Katha' (artificial fish aggregation devices often involving tree or roots, or tree branches). Chital and Foli breed during May to June in shallow areas over hard substances such as stones, bamboo or submerged tree branches. Small fish including Chela (*Chela*

cachius), Kachki (*Corica soborna*), Baila (*Glossogobius giuris*) and Baim (*Mastacembalus armatus*) breed in shallow areas of rivers in April and rani prefer to breed in calm and quiet places.

5.1.8 Fisheries Technology

Fishing crafts and gear

Both mechanized and non-mechanized fishing trawlers as well as many types of fishing country boats are used in the study region, depending on water body type and fishing gear employed (Table 5.3).

Table 5.3: Main types of fishing country boats used in the southern region

Sl. No.	Boat/vessel types		Length (m)	Used nets/gears
1	Donga, dugout	An artisanal small boat, made of Palmyra Palm and used in low-lying areas. These boats can last for more than a decade.	<6.5	Light gear
2	Bachari nauka	A wooden small boat	<17	Seine netting
3	Dinghi nauka	Small boat with round bottom. The fore and the hind part of the boat are high above the water level. The stem and the bow are long and pointed. In smaller boats there is no deck but the bigger ones usually possess one. The hood is usually lacking, but when present, is located in the posterior part of the boat. The oars are long and paddle-like. The sail is not carried by most dingis	<10	Various types of nets
4	Kosha nauka	Anterior and posterior ends are blunt, 7-10 m in length and with a flat bottom. Its oars are made of bamboo poles; the deck is made of whole or split bamboo pieces. A hood is never provided. A triangular sail, when present, is situated in the anterior half of the boat. The boat is used for fishing in shallow waters.	4-10	Various types of nets
5	Chandi nauka	A traditional fishing boat. The bottom of the boat is either flat or round. The stem is between 40 and 150 cm. A steering paddle similar to that of an ordinary oar is fixed at the rear of the boat. The hood is situated in the central part of the boat. The sail is often absent but when present is rectangular or square-shaped and placed at the front.	5-17	Drift netting for ilish

Source: K. A. Kabir, 2019

Fishing varies according to habitat, location, season, and the type of gear employed (**Table 5.4**) and traps used (**Table 5.5**). The use of push nets and collection of post-larvae shrimp and prawn are often blamed for the deterioration in the diversity of the coastal fisheries, but indiscriminate fishing is equally responsible. Often this leaves no opportunity for fish that enter the canals on retreating tides to escape and return to the estuaries. However, the practice of using gear and traps is gradually reducing because of reduced siltation in the rivers and canals.

Table 5.4: Fishing gear (nets), operation, expenditure and targeted catch

Gear type	Local name	Mesh size	Shape	Fishers need	Target species
Gill net	Poma jal	3.0–6.0	RS	4–5	Hilsa, Poma, Bata, Ramchos
	Shahin jal	4.0–7.0	RS	–	Hilsa, Koral, Boal, Ayr, Loitta
	Current jal	0.2–0.4	RS	1–2	Pangus, Hilsa, Chapila, Indian major carps
	Fash jal	4.5–15.0	RS	1–2	Pangas, Poma, Hilsa, Bata, Aire
	Chandi jal	4.0–4.5	RS	10–15	Hilsa, Poma
	Koral jal	10.2–15.2	RS	–	Koral, Pangus, Ayr
	Koi jal	1.2–5.1	RS	–	Koi, Magur, Shing, Shol
	Punti jal	2.2–3.5	RS	1–2	Punti, Bele, Gulsa, Bata, Koi, Pangas, Poma
	Bata jal	2.5–5.0	RS	2–3	Bata, Chewa, Poma
Seine net	Jagatberjal/Shattingjal	0.5–2.0	RS	4–15	Juvenile Pangas, Poma, Juvenile Hilsa
	Gosijal/Khotijal	0.2–1.0	RS	1–10	Small fishes, Hilsa
Fixed purse net	Behundijal	0.5–2.0	CS	2	Bata, Kuchia, Koral, Koi, Bashpata, Poma, Chewa, Chiring,
	Badhajal	1	RS	1	Small fish
	Goriajal	0.2–2.5	RS	1	Small fish
	Chorjal	0.5	FS	1 – 5	Various litoral fish species
Cast net	Jhakijal	0.5–1.0	CS	1	Bata, Chela, Taposhi, Prawn, Baim, Koi, Koral, Kuchia
Lift net	Dharma jal	0.5–1.5	SS	1	Bele, Taki, Shoal, Punti, Koi, Gulsha, Baim
Push net	Moiajal	0.5–1.0	RS	2	Fry, Larvae and Fingerling of various species
	Thelajal	0.5–1.0	TS	1	Shrimp larvae, Gulsha, Punti, Tengra, Mola, Chela
Dip net	Kharajal	0.5–2.0	FS	1	Ketchki, Bele, Shol, Taki, Punti, Koi, Pangus, Poma, Tengra

Source: Rahman et al. 2016a; Siddique et al. 2013; Rahman et al. 2016b

Table 5.5: Commonly used traps, hooks and wounding gear used to catch fish

Gear type	Local name	Size	Shape	Common catch
Fishing Traps	Vair	1.0x0.5x0.8 cubic meter	Long box like trap with a door extending from its base to its apex which is made of split bamboo	*Cyprinus carpio, Labeo rohita, Catlac atla, Wallagonia attu, Channa punctatus, Channa striatus, Channa marulius and Mastacembelus armetus*
	Pangus chai	3x2x2 cubic Meter	Rectangular with 2–3 doors and made by bamboo splits. Bait is used in this trap	*Pangasius Pangasius*

Gear type	Local name	Size	Shape	Common catch
	Kholsun	0.7x1.0x0.3 cubic meter	Rectangular box shaped fish trap made of split bamboo, tied with jute rope or cane and consisted of two doors from its apex for fish opening	*Mastacembelus armetus, Anabas testudineus, Puntius spp., Mystus vittatus, Corica soborna, Amblypharyngodon mola, Chanda nama, Colisa fasciatus* and small prawn
	Bitte		A basket shaped fishing trap, made of split bamboo with two or three entrances and an opening on the trap for collecting fish	*Mastacembelus armetus, Anabas testudineus*, Punti (*Puntius* spp.), Tengra (*Mystus vittatus*), small prawn etc.
	BanarGhop		Used as a barricade or trap for fish, made of split bamboo.	*Labeo rohita, Catla catla, Mystus vittatus* and prawn
	Icha chai		Triangular or cylindrical shaped trap made of bamboo splits and threads	*Mastacembelus armetus* and prawn
Hooks and Lines	Barshi		It is a very simple barbed hook tied with one end of a line and the other end with a bamboo stick	*Labeo calbasu, Anabas testudineus, Puntius spp., Rita rita, Mystus vittatus* and some carp species
	Borsha		A narrow small portion of dried bamboo is used as float from which a half meter long line is hanged with barbed baited hook	*Anabas testudineus, Channa punctatus, Puntius spp., Mystus vittatus* and some other small fish
	Daun		A long line measuring from 46 to 450 m, which is set into shallow water with bamboo pools 4–6 cm above water. A small line of 0.45–1 m with barbed hooks is lowered into water with bait.	*Rita rita, Mastacembelus armetus,Polynemus paradiseus, Channa striatus, Channa punctatus, Channa marulius*
	MaittaDaun		A baited long line which may contain even up to 4–5 thousand hooks with 10 cm interval in flowing water with heavy current. A boat is needed to operate this lines	*Wallago attu, Sperata aor, Anabas testudineus, Channa punctatus, Puntius spp., Labeo calbasu, Heteropneustes fossilis, Rita rita*
Wounding Gears	Juti	5–10 bamboo splits attached to the shaft by cords measuring 2–3 m in length	Spear shape	*Wallago attu, Channa striatus, Channa punctatus*
	Konch		Spear shape 10 pieces of bamboo splits are firmly fixed in a bunch. The pointed ends of the	*Labeo rohita, Catla catla, Channa striatus, Channa marulius*

Gear type	Local name	Size	Shape	Common catch
			bamboo splits are covered with sharp and pointed iron caps to increase the efficiency	
Teta	Long bamboo handle with several iron hooks and iron rod at the base		Spear shape	*Wallago attu, Channa striatus, Channa punctatus, Glossogobius giuris*

Source: Siddique et al. 2013

5.1.9 Backward and Forward Linkage

Stock and hatchlings of different fish and shrimp/prawn species are collected from wild source (particularly rivers) and from government and private hatcheries and nurseries.

Hatcheries and nurseries

In the study area, the most common cultivated species of fish include: Rui (*Labeo rohita*), Catla (*Catla catla*), Marigal (*Cirrhinus mrigala*), Silver carp (*Hypothalmichthys molitrix*), Grass carp (*Ctenopharyngodon idella*) and Common carp (*Cyprinus carpio*). Other fish species also cultivated in ponds include: mono sex tilapia (*Oreochromis nilotica*), Thai pangus (*Pangasius sutchi*), Thai sharpunti (*Puntius gonionotus*), mirror carp (*Cyprinus carpio specularis*), bighead carp (*Hypophthalmicthys nobilis*) and bata (*Cirrhinous reba*).

Throughout the study region, there are 10 government hatcheries and 12 private hatcheries of which Barguna District has 04 nos and Patuakhali District has 08 nos (Table 5.6).

Table 5.6: Hatchling production from Govt. and Private Hatcheries

Hatchling Production (kg) of Govt. Hatchery, 2020											
Name/ Location of Hatchery	No. of Hatchery	Major Carp	Exotic Carp	Pangas	Thai Punti	Bata	Koi	Shingi/ Magur	Other	Total	Tilapia Juvenile (Lakh)
Barishal Division	10	336	34	20	5	0	0	15	15	425	1.10
Hatchling Production (kg) of Private Hatchery, 2021											
Barguna	4	0	0	0	0	0	25	0	1850	1875	127
Patuakhali	8	3660	1685	236	1588	0	110	215	0	7494	50

Source: DoF, 2021

Fish market and post-harvest facilities

There are 08 fish landing centers and 169 local fish markets in the study area as shown in **Table 5.7**. Fish landing centers are the places where different sources of harvested fish and fisheries commodities are accumulated and these harvested fishes are transferred from the landing centers to the consumer markets via different distributional channels (Ali et al., 2004). Fish landing centers play a vital role in quick and smooth disposal of fresh fish as well the quality of fishery products. The landed

fish in the study area are transferred to different parts of the country and also to the other countries through landing centers.

Table 5.7: fish market and landing center in the study area

District	Upazila	No. of Fish Market	No Fish Landing Center
Barguna	Barguna Sadar	17	1
	Pathorghata	29	1
	Amtoli	35	1
	Taltoli	13	1
Patuakhali	Golachipa	43	1
	Kalapara	20	3
	Ranhabali	12	-
Total		169	8

Source: Zila Tattho Batayon, 2022

5.1.10 Fish Production

The estuarine systems and braided rivers in the area, as well as the vast area of the tidal floodplain are rich endowed with a diversity of aquatic fauna. These areas offer plentiful opportunities to grow fish, shrimps and crabs. Hilsa is the largest fishery in this region and shrimp brings the highest cash and export earnings. While aquaculture is the major contributor to national fish production, agricultural GDP and export earnings. The future growth and sustainability of both aquaculture and fisheries in the region face many challenges including change in the flow of rivers due to siltation and reduced upstream flow, climate change, sea level rise, and outbreaks of disease in fish and crustaceans.

The estimated total fish production in the study area is 54,531 MT, which is contributed mostly by the capture fishery at 80% and the culture fishery shares the rest. The capture fish production is dominated by the riverine habitat (about 43%) followed by floodplain habitat (about 37%) and inter tidal area. Similarly, the culture fish production is dominated by the semi-intensive fish pond at about 18% followed by extensive fish pond and intensive fish pond as presented in **Table 5.8.**

Table 5.8: Fish production estimation in the study area

Habitat category	Habitats	Production (MT)	Percent (%) of Production
Capture	River and Khal	23,226	42.6
	Floodplain	19,936	36.6
	Mud flat/Inter tidal area	203	0.4
	Sub-Total	**43,365**	**80**
Culture	Extensive fish pond	930	1.7
	Semi-intensive fish pond	9,745	17.9
	Intensive fish pond	492	0.9
	Sub-Total	**11,167**	**20**
	Total	**54,531**	**100**

Source: CEGIS estimation based on DoF 2021 (FRSS 2020-21)

5.2 Fisheries Management

5.2.1 Management Activities

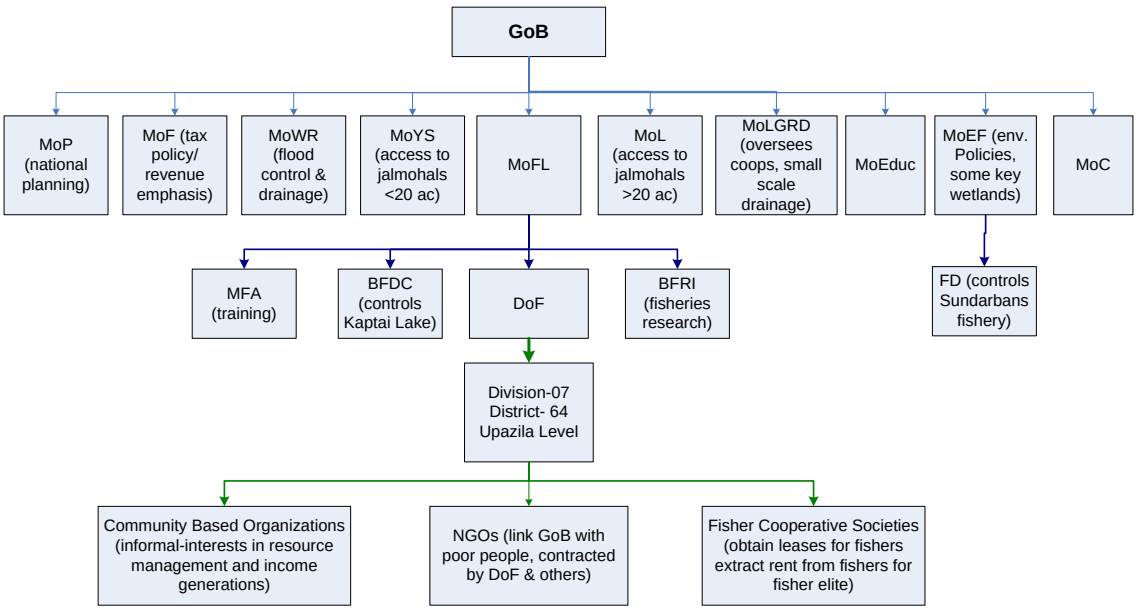
Fisheries management in the study region is mainly concentrated on the riverine and marine fisheries, with more limited management in open water bodies such as fish sanctuaries and beel fisheries.

To maintain stock and production in open water fisheries, the following management practices are implemented in the region:

- Establishment of fish sanctuaries to conserve diversity;
- Prohibited or restricted fishing in some areas of the rivers to ensure safe breeding and conservation of fish biodiversity;
- Enhancement of stock by releasing fish fingerlings in open waterbodies;
- Community-based fisheries management in open waterbodies;
- Leasing and licensing for fishing of 'Jalmohal' (government-owned water bodies) by the Ministry of Land (MoL);
- Restricting gear and fishing of fecund fishes in the breeding season;
- Habitat restoration programmes, including re-excavation of rivers and connectivity (refers to canal/Khals that connect rivers and floodplain at the onset of monsoon).

5.2.2 Fisheries Organizations and Institutions

Several organizations and institutions (Shown in **Table 5.9**) are involved in fisheries development and management in Bangladesh (Organogram in **Figure 5.6**) (BDP-2100, 2016). Ministry of Fisheries and Livestock (MOFL), Government of Bangladesh is the main and lead administrative agency responsible for formulating fisheries policy and development strategies. Under MOFL there are four agencies namely (i) Department of Fisheries (DoF), (ii) Bangladesh Fisheries Research Institute (BFRI), (iii) Bangladesh Fisheries Development Corporation (BFDC) and (iv) Marine Fisheries Academy, each with specific functions and responsibilities for development and management of the fisheries sector.



Source: BDP-2100, 2016

Figure 5.6: Government and non-Government agency roles in fisheries in Bangladesh

Table 5.9: Government agencies involved in fisheries management and conservation

Ministries	Institutions	Activities
Ministry of Fisheries and Livestock (MoFL)	Department of Fisheries (DoF)	Extension, management, project implementation, training and human resource development, enforcement of laws and regulations, conservation, quality control, registration & certification, fishing licenses, fisheries awareness building and motivation, support to policy formulation, administration, etc.
	Bangladesh Fisheries Development Corporation (BFDC)	Marketing, production, training, etc.
	Bangladesh Fisheries Research Institute (BFRI)	Fisheries and other aquatic animal related research and training
	Fisheries and Livestock Information Department (FLID)	Fisheries and livestock related information dissemination
Local Government, Rural Development and Co-operatives	Upazila Administration	Management of water bodies less than 20 ha, field level supervision and management of fisheries resources, etc.
	Rural Development Board	Fisheries components of integrated rural development
	Directorate of Co-operatives	Registration and Supervision of fishermen co-operatives
	Bangladesh Jatiya Matshyajibi Samabay Samiti (BJMSS)	Development of fishermen co-operatives and facilitate of procuring ice plants and import of gears
	Bangladesh Samabay Bank Ltd.	Financing fishermen's co-operatives
Ministry of Land (MoL)	Land Administration and Land Reform Division	Leasing of public water bodies
Ministry of Water Resources	Bangladesh Water Development Board (BWDB)	Leasing of reservoirs and irrigation canals and implement fisheries projects
Ministry of Commerce	Department of Commerce	Promotion of fish and fishery products, registration and regulation of fish processing plants
Ministry of Shipping	Mercantile Marine Department	Registration of fishing vessels/boats/crafts
Ministry of Education	Universities, colleges and training institutes	Higher fisheries education and diploma
Ministry of Sports and Youth Development	Youth Development and Training Center	Training, motivation and credit support to fish culture practice to youths
Ministry of Finance	External Resource Division	Administration of external aid on fisheries
	Commercial Banks	Credits or loan for fish culture
		Budget for the fisheries sector and projects
Ministry of Planning	Fisheries Section	Planning and approval of fisheries sector projects and monitoring and evaluation of different projects
Ministry of Foreign Affairs	-	Fish export related functions and expansion of fish and fishery products export. All fisheries related international policies and issues.

Source: BDP-2100, 2016

Organizational Setup of the DoF

For rendering above services to achieve the mission and vision of the DoF, it has following wings: (i) Inland Fisheries, (ii) Marine Fisheries, (iii) Fisheries Resources Survey System (FRSS), (iv) Fish Inspection and Quality Control (FIQC), and (v) Training. A total of 5,786 man-powers from different tiers are involved in DoF for providing its mandated services. Among the posted manpower 4,314 are under revenue budget and 1,472 are under development projects.

Institutional Issues and Challenges

BDP-2100 (2016), Project Development Objectives of SCMFP (2016) and ECOFISH project (2014) of DoF identified some institutional issues and challenges of fisheries sectors in Bangladesh. Some are given in the following table (**Table 5.10**).

Table 5.10: Institutional issues and challenges

Issues	Challenges
Human Resources	
• Insufficient international training for developing field-oriented knowledge and skills • Inadequate capacity for integrated fisheries management • Insufficient DoF staffs and professionals • Ineffective collaboration of public-private partnership in fisheries management	• Traditional management systems are being challenged by powerful interests • Changing spectacle on fisheries employment
Economical Resources	
• Insufficient investment in fisheries research & study • Proper technology extension to reduce the post-harvest losses	• Indiscriminate marketing system • Less interest in abiding by the code of conduct in preparation and using of fish feed
Social Resources	
• Deficit in trust between local fishermen/farmers and staffs of DoF and other NGOs • Inefficient signaling system in weather forecast in marine condition • Inadequate awareness program in coping mechanism against the adversity in marine condition	• Anthropogenic security issues like robbery, killing of fishers in marine fishing • Natural calamity • Mortgage/Dadan • Equity issue i.e. social conflict for sharing benefits • Biasness in selecting proper fishermen in leasing 'Jalmohal' • Enmity predominantly in aquaculture sector
Technological Resources	
• Lack of developed ICT system in local level of fisheries management and fish farming system • Lack of digitalized financial mechanism at local and regional fisheries management • Lack of digital information-help activities • Inadequate tools and trawls for industrial fishing in respect of new maritime boundary	• Improper use of ICT • Local adoption of ICT systems • ICT mobilizations
Research	
• Lack of integrated fisheries research like Flood Action Plan-17, -20, etc.	• Funding

Issues	Challenges
• Lack of knowledge sharing of the findings of conducted research • Lack of research in finding out fishing grounds in new maritime boundary	• Mainstreaming the research findings to national fisheries policy
Strategic Direction	
• Maximum ordinance, rules and acts are old • Poor enforcement of rules and regulations	• Influence of musclemen in the rightful implementation of these acts is the major hindrance • Political willingness
Management Organizations and Their Roles and Practices	
• Insufficient implementation of management activities • Insufficient monitoring and evaluation • Inadequacy in accountability • Inadequacy in transparency	• Taxation • Funding • Influence of musclemen in the rightful implementation of the programs is the major hindrance

Source: BDP-2100 (2018), Project Development Objectives of SCMFP (2016) and ECOFISH project (2014)

Fisheries Department

The Department of Fisheries (DoF) has undertaken a number of projects to promote fish conservation, production and diversity, and to support dependent livelihoods, shown in **Table 5.11.**

Table 5.11: Different existing projects of DoF to promote fish conservation, production and diversity, and to support dependent livelihoods

Sl.	Project Name	Project Information	Objectives	Reference
1	Sustainable Coastal and Marine Fisheries Project	• Starting from: July, 2018 • Ending: June, 2023	• To build the capacity of the GoB and research agencies to conduct evidence based stock management and implement MCS for the artisanal and industrial Fisheries; • To improve quality to ensure food safety and higher value capture from export-oriented fishery and mariculture; • To stabilize fish stocks and improve coastal communities and poor fishers' livelihoods.	DoF Official Website: https://fisheries.portal.gov.bd/site/page/2466f08f-4fb2-42e6-9431-cdf36544b0dc
2	National Agricultural Technology Program, Phase-II	• Starting from: October, 2015 • Ending: September, 2021	• To increase the productivity of fish farmers at the marginal level; • To improve access of fish farmers to marketing systems in specific districts	DoF Official Website: https://fisheries.portal.gov.bd/site/page/d9918a53-fb84-4553-ad66-94fd1ff6319e
3	Expansion of Aquaculture Technology Service up to union Level	• Starting from: March, 2015 • Ending: June, 2020	• To ensure participation of local fish farmers in selected unions and increase fish production through	DoF Official Website: https://fisheries.portal.gov.bd/site/page

Sl.	Project Name	Project Information	Objectives	Reference
			application of advanced fish farming technology. • To create employment opportunities for the rural population through fish farming and various fisheries related activities • To enhance the institutional knowledge, skills and capacity of the concerned stakeholders through adequate training in fisheries • To involve the Union Parishad in all fisheries development activities as a functioning body for balanced use of local aquatic resources. • To establish the Union Based Fisheries Extension System to conduct sustainable expansion activities in the field with the participation of Department of Fisheries, Union Parishads, Leafs and local fishermen.	/056caa90-b571-4261-acd0-aebdd1d444bd

5.2.3 Impact of Water Management Projects - Flood Control, Drainage and Irrigation (FCD/I)

After abolishing the Jamindari system to manage small scale water resources management (flood management) in 1960, different public sector management projects, like USAID funded CEP, the ADB-funded CEP-2 (CEP-2) and the Coastal Embankment Rehabilitation Project had been implemented in line with the 'green revolution' paradigms to 'grow more food' (S. Nowreen, et al., 2014). Some key projects related to water management are given in the following table (Table 5.12).

Table 5.12: Key completed projects in the southern region

Sl.	Project Name	Project Information	Implementing Agencies	Major Activities	Reference
1	Coastal Embankment Improvement Project, Phase-1 (CEIP-1)	Sep, 2013 - Sep-2020	BWDB	• Embankment Construction • Construction of Regulator and Water Control Structure	The World Bank, 2013
2	Bangladesh Coastal Embankment Rehabilitation Project (CERP)	1995 - 2003	BWDB	Embankment Rehabilitation	The World Bank, 2005
3	BIWTA Flood Rehabilitation Project, 1998	July, 1999-Dec, 2000	BIWTA	River Dredging	BIWTA Official Website:

Sl.	Project Name	Project Information	Implementing Agencies	Major Activities	Reference
4	Construction of ferry terminal and ferry ghats including other allied facilities of Harinaghat and Alubazar for introducing Ferry services between Chandpur-Shariatpur waterways	July, 1999 – June, 2004	BIWTA	Construction of ferry terminal and ferry ghats	http://biwta.portal.gov.bd/sites/default/files/files/biwta.portal.gov.bd/page/860b0ae5_6e04_4aa1_a4c0_90e09105e7f8/2020-08-18-14-53-3d922a833f129d5f43171acd963eda49.pdf
5	Widening and development of navigability by dredging of Gabkhan canal connecting Dhaka- Mongla and Chittagong-Mongla river route	July, 2004-Dec, 2007	BIWTA	River Dredging	
6	Development of navigability of 4 nos. important inland water ways by dredging	Jan, 2005-June, 2008	BIWTA	River Dredging	
7	Dredging of Madaripur-harmuguria-TakerhatGopalganj River Route (2nd Revised)	Jan, 2011 – June, 2016	BIWTA	River Dredging	
8	South-west Area Integrated Water Resources Management Project	Apr, 2005 - Dec, 2015	BWDB	Irrigation	BWDB Official Website: https://www.bwdb.gov.bd/completed-project#page-2
9	Several Projects under Climate Smart Agricultural Water Management Project (CSAWMP)	Jan, 2017 - Jun, 2018	BWDB	Climate Change Resilience	
10	Re-Excavation Of Kobatak River	Jul, 2000 - Jun, 2006	BWDB	Improvement of Drainage Congestion	

Embankment induced impacts on fishery

Bangladesh Delta Plan-2100 has identified the following issues to be impacted due to water centric infrastructures:

Loss of catch through loss of habitat: Whenever flood control projects reduce the area of flooded land, in turn, the habitat for fish production shrinks. In unregulated floodplains, beels and canals not managed by flood control projects, the annual fish yield or catch per unit area varied geographically between regions like SW region and other regions, and between land heights within the flood phase series F2-F4[9], ranging between 68 and 202 kg/ha to 202 kg/ha (arithmetic mean value 119 kg/ha).

[9] F1: medium lowland, seasonally flooded, flooding depth 91-180cm; F3: lowland, seasonally flooded, flooding depth>180cm; F4: lowland to very lowland, seasonally and perennially flooded, flooding depth >180cm.

Reduction in migratory fish in catches: The contribution to catches by migratory species was substantially reduced by full flood control or controlled flooding, but relatively unaffected by partial flood control - except in Manu Irrigation Project (MIP) where there was a reduction of 19% on regulated floodplains despite cuts in embankments.

Reduced fish migrations: Full flood control and controlled flooding reduced lateral fish migrations between rivers and floodplains in two ways:

a) by reducing the number of entry points on to floodplains - thereby concentrating fish into fewer channels where they were more susceptible to capture, and

b) by closing regulator gates for extended periods during the pre-monsoon and monsoon.

However, under controlled flooding, there is greater opportunity for fish to enter floodplains than under full flood control since gates are opened intermittently.

Dam induced impacts on fishery: Dams, built to change natural flow regimes reduce the natural productivity of rivers and khals. Dams also act as barriers preventing diadromous fish[10] migrating and so causing decline in their numbers.

Reduced fish density/abundance: Full flood control projects can result in a significant reduction in biological productivity by decreasing fish abundance, even when sluice gates provide restricted access to floodplains.

Reduced biodiversity: Full flood control and controlled flooding had an adverse impact on fish diversity. The effect of full flood control was more severe and resulted in a reduction of 33% in the total number of species reported annually. Under controlled flooding, the reduction was much less (4%) in the South West Region due to the low abundance of migratory species. The reduction in diversity was greater for migratory species than floodplain residents: 95% and 29% to 45% for migratory species under full flood control and controlled flooding.

Disruption of fish community structure: Fish community structure in flood controlled areas was disrupted not only by a loss of riverine and migratory species, but also by major changes in the composition of the remaining floodplain resident species. As the degree of flood control increased, there was a corresponding loss in community heterogeneity and catches were increasingly dependent on a relatively small number of abundant floodplain resident species.

Reduction in catch per unit area (CPUA): FCD/I development reduced fish catches through loss of habitat and reduced catch per unit area from the remaining regulated floodplains. There is a complex relationship between catch, degree of flood control, fish densities and the amount of fishing effort. Under full flood control, annual CPUA was reduced by 81%; under controlled flooding for deep water rice it was reduced by 37%, but increased in two sites probably due to higher fishing effort. Under partial flood control, CPUA values were found similar inside and outside the projects while in some cases there was a 20% reduction of CPUA.

Increased fishing effort: Under full flood control, lower flooding substantially reduced the opportunity for fishing and the amount of fishing effort per unit area of floodplain compared to unregulated floodplains. In contrast, controlled river flooding provided more stable and predictable hydrological conditions which stimulated increased fishing effort using small scale subsistence gear along village shorelines.

[10] Fish that vspend portions of their life cycles partially in fresh water and partially in salt water.

Increased capture at regulators: Flood control structures on rivers and channels/khals were found to be deliberately used to prevent or hinder the passage of fish and facilitate their capture.

Reduced potential for stock enhancement: Whenever flood control results in a reduction in the extent and magnitude of flooding, the area of floodplain available for potential restocking is reduced. The severity of this impact is related directly to the degree of flood control exerted by the project and the topography of regulated floodplains. Under full flood control, there would be little opportunity for extensive stocking of open-water floodplains.

Changed ecological integrity of riverine systems: Human intervention along the river bank changes river shape and flow pattern. This can alter the ecological integrity or affect the riverine ecosystems resulting in loss of native fish species and products. Excessive changes to natural flow regimes due to different water regulatory structures under the water management projects of FCD/I alter and degrade the ecosystem, affecting fisheries resources and society.

Impacts on fisheries induced by erosion protection

In heavily trained rivers in the South West Region (e.g. Kapadak River, Madhumati River), river morphology has changed extensively. Morphological changes include the formation of new char land (sand bars), river bank erosion, rapid movement of the river bed, formation of deep scour holes, sedimentation and channel shifting. Such changes alter the suitability of the river environment for fish reproduction and the reproductive potential of the fish community.

FCD/I projects alter the pattern of sediment deposition on the floodplain, and especially severely affect prime fish refuge habitat through infilling of river duars (deep pools) - reducing primary productivity of the floodplain.

Where spurs (groynes) are constructed, sedimentation occurs on their upstream side which disconnects can block small channels entering the river from the adjacent floodplain.

When river training is undertaken to alter the course and flow of a river, it can change the migration paths of fish species. When river training causes high velocity, small fish, juveniles and fry of fishes cannot swim against the current – affecting the structure of the fish community.

Impact of infrastructural development

Impact of unplanned roads

The Food for Work Programme (BDP-2100) has led to the construction of many unplanned rural roads traversing open floodplains and blocking canals and drainage channels - leading to serious impacts on fisheries:

The roads have hindered fish movements on floodplains by blocking their entry from rivers to the floodplains, and their exit as floodplains recede.

Studies (BDP-2100) show that fisheries outside formal flood control areas are less abundant and diverse than in areas under partial flood control. To reduce the adverse impacts of rural road construction, there is a need for institutional changes in the inter-sectoral planning process, and a practical change to ensure greater provision of fish-friendly culverts through roads wherever they cross existing canals and also traverse extensive areas of open floodplains

Impact of autonomous development

Business as usual condition is considered as the autonomous development, which has been creating the following impacts:

Increased water pollution

- **Increased water pollution from household and urban waste**: Population increase is leading to an increase in the production of domestic sewage. During the dry season when there is low flow, rivers and natural water bodies lose most of their capacity to self-purify of the biodegradable wastes such as sewage. Dissolved oxygen levels can become depleted with a corresponding increase of Biological Oxygen Demand (BOD) which impedes fish productivity and can result in deaths.
- **Use of pesticides and fertilizers**: Agriculture intensification invariably leads to increasing use of fertilisers and pesticides, and their residues (nutrients and toxic chemicals) are flushed into rivers and water bodies causing eutrophication, reducing fish productivity and sometimes causing deaths.

Industrial development

The South West Region is identified to become a major economic hub in Bangladesh. Industrial development is expanding rapidly, promoted by the establishment and expansion of Mongla Port. Many industries discharge inadequately treated effluent into the environment, containing many chemicals that are toxic to fish and sometimes lethal.

Habitat encroachment

Population expansion has led to increased urbanization, encroaching in riverine, beel and floodplain habitats, reducing migratory routes of both anadromous [11] and diadromous [12] fishes through encroaching the migratory canals. M N. Hasan (2013) reported that agricultural land is declined about 0.26% annually from 1976-77 to 2010-11 (34 years' average), 0.42% annually from 1976-77 to 2000-01 (25 years' average), 0.75% annually from 1983-84 to 1993-94 (10 years' average) and 0.40% annually from 1993-1994 to 2003-2004 (10 years' average).

Encroachment for shrimp farm extension

Unplanned expansion of shrimp farms has also encroached into many rivers, and many beels and floodplain rice fields have been converted to shrimp farm. These changes have also blocked migratory routes of white and black fishes.

Urbanization

Population increase and economic development is driving urbanization in the South West Region, encroaching into fish habitats and increasing water pollution due to inadequate waste management. Many low-lying areas which functioned as fish breeding areas, nurseries and grazing ground have been filled up. These changes have also contributed to the decline of fish diversity and production.

[11] Freshwater fish which spend most of their lives in saltwater and return to freshwater to spawn.

[12] Fish that spend portions of their life cycles partially in fresh water and partially in salt water.

5.3 Fisheries Releated Administration/Competent Authorities

Key aspect in the theme	Primary competent authority (CA)– and their mandates	Key support organisations (govt, NGO, donor, CBO, etc.)	Performance of CA and support organisations
Fish habitat	Ministry of Fisheries and Livestock (MoFL); Ministry of Land (MoL); Ministry of Environment, Forest and Climate Change (MoEFCC), Ministry of Water Resources (MoWR)	Department of Fisheries (DoF); Department of Environment (DoE); Forest Department (DF); Department of Bangladesh Haor and Wetland Development; Bangladesh Water Development Board (BWDB); Local Administration; International Union Conservation of Nature (IUCN); WorldFish Bangladesh; World Bank; Local NGOs	Upazila Fisheries Office (UFO) of DoF manages the open water bodies in cooperation with local administration. The UFO has limitation for supervising and monitoring the water bodies due to limited manpower.
Fish species diversity	Ministry of Fisheries and Livestock; Ministry of Environment, Forest and Climate Change (MoEFCC); Ministry of Water Resources (MoWR)	Department of Fisheries (DoF); Department of Bangladesh Haor and Wetland Development; International Union Conservation of Nature (IUCN); WorldFish Bangladesh	The UFO manages the open water bodies in cooperation with local administration. The UFO has limitation for proper monitoring the water bodies due to have limited manpower.
Fish production	Ministry of Fisheries and Livestock;	Department of Fisheries (DoF); International Union Conservation of Nature (IUCN); WorldFish Bangladesh	The UFO give various training and advice on modern aquaculture technology. In addition to some international and local NGOs work at the local level for boost up fish production but very limited scale.
Hilsa sanctuary and spawning ground	Ministry of Fisheries and Livestock;	Department of Fisheries (DoF); International Union Conservation of Nature (IUCN); WorldFish Bangladesh	DoF has identified and declared six hilsa sanctuary and four major spawning ground in the coastal area with assistance of IUCN, and WorldFish. It need research more to identify other suitable areas for hilsa sanctuary to conserve this important species.

5.4 Fisheries Releated Legislation and Regulations

Key aspect in the theme	Primary legislation	Accompanying or enabling regulations	Comments on adequacy or not legislation and regs
Fish habitat	• National Fisheries Policy of Bangladesh (NFP), 1998; • Public Water Body (Jalmahal) Management Policy (PWBMP)-2009;	• National Fisheries Strategy-2006 • 8th Five Year Plan (2020-2025)	NFP-1998 stated about conservation of open water bodies and fish breeding ground but with the gap in habitat restoration and connectivity improvement for degraded water bodies

Key aspect in the theme	Primary legislation	Accompanying or enabling regulations	Comments on adequacy or not legislation and regs
Fish species diversity	• National Fisheries Policy of Bangladesh (NFP), 1998; • Public Water Body (Jalmohal) Management Policy (PWBMP), 2009	• The Protection and Conservation of Fish (Amendment) Act, 2018 • 8th Five Year Plan (2020-2025)	NFP-1998 stated about conservation of fish species diversity through establishing fish sanctuary, follow fisheries act, fishing ban for hilsa and other species but has adequacy about reviving the endangered species.
Fish production	National Fisheries Policy of Bangladesh (NFP), 1998	• National Fisheries Strategy-2006 • 8th Five Year Plan (2020-2025)	NFP-1998 stated about fish culture and management in closed freshwater bodies but has inadequacy for increasing fish production in the open water bodies
Hilsa sanctuary and spawning ground	National Fisheries Policy of Bangladesh (NFP), 1998	8th Five Year Plan (2020-2025)	Stated about establishment of sanctuary and improvement of hilsa fish but has limitation for execution and monitoring the effectiveness of the sanctuary

5.5 Relevant Policy, Plans and Programs

Key PPPs relating to the theme	Main projects emanating from the PPPs	Main negative environmental impacts emanating from the projects	Main negative socio-economic impacts emanating from the projects
National Fisheries Policy of Bangladesh (NFP), 1998	• Implementation of the Fisheries Act, fishing ban for Hilsa and other species • Development of fish sanctuary area to protect fish biodiversity	Not have negative environmental impact	The law enforcers seized and destroy unauthorized gears during fishing thus the poor fishermen face huge economic loss
Public Water Body (Jalmohal) Management Policy (PWBMP), 2009	• Leasing public water bodies to local fishermen and strengthening their financial capacity; • Biodiversity conservation by enforcing the rules and regulations of leasing of public water bodies.	Ecological imbalance is noticed in the water bodies as the lease holders harvest fish by dewatering of beel.	Influential people take lease the public water bodies so actual poor fishermen deprive from their right
Seventh Five Year Plan (2016-2020)	• Management of open water bodies and restoring the connectivity; • Taking development projects following environmental rules and regulation	• Dredging or re-excavation work may cause ecological imbalance in the water bodies; • Development work such as construction of road/embankment in low lying areas may cause hamper fish migration	Social conflict may arise between the contractor and affected community
8th Five Year Plan (2020-2025)	Biodiversity conservation through establishing fish sanctuary.		

5.6 Drivers of Change

Key change	Main external drivers	Main internal drivers	Main actions to "fuel" or "brake" the drivers, depending on whether the change is good or bad
Fish habitat	Climatic hazards; River flow and sedimentation	• Construction of road and embankment; • Industrial development and releasing untreated effluent • Depletion of forest	• Should have sufficient bridge/culvert/sluice gate in the road and embankment; • Ensure treatment of all industrial effluents; • Conserve existing forest and initiate afforestation program
Fish species diversity	• Introduce invasive species; • Water pollution; • Climatic hazards; Sedimentation	• Fishing by destructive gear; • Indiscriminate fishing; • Disobey fishing rules and regulation; • Inadequate conservation initiatives;	• Stop illegal net making factory; • Motivational workshop for the fishermen community for not use prohibited fishing gear and poising fishing; • Declare more fish sanctuary and proper monitoring system
Fish production	• Climatic hazards; • Improved technology;	• Poor financial capacity of the fish farmers; • Inadequacy of fish feed and quality seed,	• Training on modern aquaculture technology to the fish farmers; • Provision of financial support to the poor farmers; • Financial support facility with minimum interest for fish feed industry

5.7 Issues Relevant to Fisheries Resources

- Silt deposition and industrial untreated effluents are degrading aquatic habitat quality in the area due to climatic;
- Climatic hazards such as cyclone, storm surge may influx pollutant water into the aquaculture ponds;
- Saline intrusion due to dry season is posing minor threats on freshwater species only and its habitats;
- Degradation of open water bodies is causing decline the abundance of indigenous fish species in the area;
- Fish production is getting hampered due to climatic hazards, inadequacy of fish feed and quality fish seed;

6. Agriculture Resources

6.1 Introduction

The southern region of Bangladesh, home to more than 35 million people, accounts for about a third of the country's landmass. About half of the southern zone is open to the sea. It also has a distinctly different water management system and cropping patterns from the rest of Bangladesh. Being coastal, farming systems of southern agriculture are different from other parts of the country due to land type, soil type, etc. Climate change poses an especially serious challenge to southern agricultural production. Agriculture in these regions is at high risk due to cyclones, tidal waves, the salinity of soil and water, and submergence. Mechanization of agriculture, cropping pattern change as well as varietal change, seasonal change of crop production, etc. should help sustain crop production in this region. This baseline gives an overview of the farming status of the PKCP area.

6.2 Agro Ecological Zone (AEZ)

The PKCP area comprises two Agro-Ecological Zones named Ganges Tidal Floodplain (78%) and Young Meghna Estuarine Floodplain (22%) of the area. Details of the AEZ are presented below in Table 6.1.

Table 6.1: Agro-Ecological Zone (AEZ) of the PKCP area

AEZ No.	Region Name	Rangabali	Galachipa	Kalapara	Amtoli	Taltoli	Barguna Sadar	Patharghata	Total Area (ha)
13	Ganges Tidal Floodplain	2198.03	30375.38	43623.51	29259.82	22494.56	31653.74	22247.66	181852.70
18	Young Meghna Estuarine Floodplain	37877.39	13257.80	0	0	0	0	0	51135.19
Total									232987.90

Source: National Water Resource Database (NWRD), 2015

6.3 Land Use

Land use of the PKCP area is shown in below Tables 6.2 and 6.3. Kolapara and Amtoli Upazila have the most (62% of the total) land used by agriculture (crop agriculture). Rangabali Upazila uses 33% of the total land.

Table 6.2: Land use of PKCP area

Sl No	Landuse	Area ha)						
		Golachipa	Kolapara	Rangabali	Barguna Sadar	Amtoli	Taltoli	Patharghata
1	Agricultural Land	28511	30333	22164	18418	19181	13380	12681
2	Water Bodies	10363	7978	32056	6703	2439	6874	7970
3	Mangrove Plantation	1611	694	8645	439	3	2904	958
4	Orchards and Other Vegetation	4	1	219	82	32	48	107
5	Settlement	12167	9510	4670	11580	9082	4730	7932
6	Others	106	511	235	504	228	138	223
	Total	**52762**	**49027**	**67988**	**37726**	**30966**	**28073**	**29871**

Source: National Water Resource Database (NWRD), 2015

Table 6.3: Land use percentage (%) of PKCP area

Sl No	Landuse	Area (%)						
		Golachipa	Kolapara	Rangabali	Barguna Sadar	Amtoli	Taltoli	Patharghata
1	Agricultural Land	54	62	33	49	62	48	42
2	Water Bodies	20	16	47	18	8	24	27
3	Mangrove Plantation	3	1	13	1	0	10	3
4	Orchards and Other Vegetation	0	0	0	0	0	0	0
5	Settlement	23	19	7	31	29	17	27
6	Others	0	1	0	1	1	0	1
	Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Source: National Water Resource Database (NWRD), 2015

6.4 Land Type

Medium highland is the dominant land type in all seven Upazilas of the PKCP area. Details land type of the seven Upazilas is presented below in Table 6.4.

Table 6.4: Land type of PKCP area

SL No.	Land type	Golachipa	Kolapara	Rangabali	Barguna Sadar	Amtoli	Taltoli	Patharghata
1	Medium Highland	34,701	38,955	17,500	25,236	25,623	18,080	18,734
2	Medium Lowland	1,923	20	3,271	-	37	2,415	-
3	Lowland	1,189	7	5,103	-	4	-	-
4	Others	14,953	9,803	41,913	12,414	5,302	5,527	11,148
	Total	52,765	48,785	67,787	37,649	30,966	26,022	29,882

Source: National Water Resource Database (NWRD), 2015

6.5 Soil Texture

Clay loam type soil is the dominant soil type in Kolapara, Barguna Sadar, and Amtoli Upazila of the PKCP area. In the case of Taltoli and Patharghata percentage of clay is higher among the soil classes. Both clay and clay loam type are dominant in Golachipa Upazila. Details of soil texture of the PKCP area is presented below in Table 6.5.

Table 6.5: Soil texture of PKCP area

SL No.	Drainage	Golachipa	Kolapara	Rangabali	Barguna Sadar	Amtoli	Taltoli	Patharghata
1	Clay	14,868	78	-	11,023	11,266	10,001	12,289
2	Clay Loam	15,025	38,601	7,125	14,125	14,357	8,079	4,388
3	Loam	7,919	303	18,749	87	41	2,415	2,057
4	Others	14,953	9,803	41,913	12,414	5,302	5,527	11,148
	Total	**52,765**	**48,785**	**67,787**	**37,649**	**30,966**	**26,022**	**29,882**

Source: SOLARIS

6.6 Drainage

Drainage plays a vital role in the management of soil. Poorly drained class is dominant in all Upazilas except Barguna Sadar Upazila. Very poorly drained soil is the dominant soil class in Barguna Sadar Upazila. Details of soil drainage classification of PKCP area are presented below in Table 6.6.

Table 6.6: Drainage classification of PKCP area

SL No.	Drainage	Area (ha)						
		Golachipa	Kolapara	Rangabali	Barguna Sadar	Amtoli	Taltoli	Patharghata
1	Very Poorly Drained	1,189	27	5,103	5,988	41	2,415	0
2	Poorly Drained	36,509	38,955	20,771	587	25,623	18,080	18,734
3	Imperfectly Drained	114	0	0	0	0	0	0
4	Others	14,953	9,803	41,913	31,074	5,302	5,527	11,148
	Total	**52,765**	**48,785**	**67,787**	**37,649**	**30,966**	**26,022**	**29,882**

Source: SOLARIS

6.7 Farming Practices of the Area

Agriculture is the main livelihood of the PKCP area. Local farmers of the area cultivate crops mainly twice in a crop calendar which are Kharif-II and Rabi. Due to drainage constraints, the maximum amount of land cannot use for cultivation. Salinity and irrigation water constraints also hamper desirable crop production in the Boro season.

6.8 Cropping Pattern and Cropping Intensity

Transplanted Aman rice followed by pulses is the main cropping pattern of this region. Nowadays, the Department of Agricultural Extension (DAE) emphasizes oil crops (sunflower, soybean, etc.) production to meet up-country demand. The cropping intensity of the area is around 200% which is almost similar to the national cropping intensity. Fallow – T. Aman – Fallow and Fallow – T. Aman –

Mungbean cover most of the project areas of PKCP. Table 6.7 represents the Upazila-wise cropping pattern of the PKCP area.

Table 6.7: Dominant Cropping Pattern of the PKCP area

Kharif -1	Kharif -2	Rabi	Area (ha)	% of NCA
Amtoli Upazila				
Fallow	T. Aman	Fallow	2040	9.1
Fallow	T. Aman	Mung bean	4980	22.0
Aus	T. Aman	Mung bean	4230	19.0
Aus	T. Aman	Khesari	2820	12.6
Fallow	T. Aman	Khesari	2180	9.8
Aus	T. Aman	Watermelon	1000	4.5
Cropping Intensity = 222%				
Fallow	T. Aman	Watermelon	990	4.4
Barguna Sadar				
T. Aus	T. Aman	Khesari	10200	38.7
Fallow	Fallow	T. Aman	4400	16.7
Fallow	T. Aman	Khesari	3800	14.4
T. Aus	T. Aman	Mung bean	4000	15.2
T. Aus	T. Aman	Vegetables	3000	11.4
Cropping Intensity = 253%				
Galachipa Upazila				
Fallow	T. Aman	Mung bean	13500	47.7
Fallow	T. Aman	Watermelon	8500	30.0
Fallow	T. Aman	Groundnut	1550	5.5
Fallow	T. Aman	HYV Boro	1850	6.5
Fallow	T. Aman	Chilli	1200	4.2
Fallow	T. Aman	Khesari	500	1.8
Fallow	T. Aman	Felon	850	3.0
Fallow	T. Aman	Vegetables	350	1.2
Cropping Intensity = 190%				
Kalapara Upazila				
Fallow	T. Aman	Fallow	13758	39.6
Fallow	T. Aman	Pulse/Oil seed crops	10420	31.0
T. Aus	T. Aman	Pulse/Oil seed crops	2940	8.5
Fallow	T. Aman	HYV Boro	2875	8.3
Fallow	T. Aman	Vegetables	1048	3.0
Fallow	T. Aman	Watermelon/Melon	708	2.0
Cropping Intensity = 172%				
Rangabali Upazila				
Fallow	T. Aman	Mung bean	13180	53.2
Fallow	T. Aman	Watermelon	7630	30.8
Fallow	T. Aman	Groundnut	1390	5.6
Fallow	T. Aman	Felon	1385	5.6
Fallow	T. Aman	Chilli	1195	4.8
Cropping Intensity = 194%				
Taltoli Upazila				
Fallow	T. Aman	Fallow	6100	37.0
Fallow	T. Aman	Mung bean	2230	13.0
Fallow	T. Aman	HYV Boro	2000	12.0

Kharif -1	Kharif -2	Rabi	Area (ha)	% of NCA
T. Aus	T. Aman	Fallow	1140	7.0
Fallow	T. Aman	Khesari	1000	6.0
T. Aus	T. Aman	Mung bean	770	5.0
Fallow	T. Aman	Vegetables	496	3.0
Fallow	T. Aman	Watermelon	400	2.4
Cropping Intensity = 172%				
Patharghata Upazila				
Fallow	T. Aman	Mungbean	8414	44.1
Fallow	T. Aman	Fallow	3471	18.2
T. Aus	T. Aman	Mungbean	2300	12.1
Fallow	T. Aman	Khesari	1500	7.9
S. Vegetable	S. Vegetable	W. Vegetable	915	4.8
T. Aus	T. Aman	Khesari	700	3.7
Fallow	T. Aman	Sunflower	450	2.4
T. Aus	T. Aman	Potato	350	1.8
Cropping Intensity = 194%				

Source: Upazila Agriculture Office, Department of Agricultural Extension (DAE)

6.9 Crop Damage and Production Constraints

Due to their coastal locality, all seven (7) Upazilas of the PKCP area are vulnerable to natural disasters such as floods, cyclones, tidal surges, etc. Recently, climate change triggered these natural disasters both in terms of occurrence and intensity. Salinity is increasing and spreading day by day. These are the major challenge of crop production in this area. Another constraint is the communication system which hampers the transportation of agricultural inputs and products.

- Natural disasters, e.g. cyclones (Sidr, Ayla), tidal surges, etc.
- Drought (due to no rainfall), Flood, erratic rainfall
- Salinity intrusion
- Drainage congestion
- Increasing trend of natural disasters due to climate change
- Transport/communication for agricultural input and products

6.10 Crop Production Plan

To maintain the environmental balance, the DAE emphasizes bio-fertilizer, bio-pesticide, and ICM/IPM instead of chemical fertilizers and pesticides in crop farming systems. Upazila Agriculture Office has taken different types of intervention to make the environment sustainable. With these interventions, total crop production will be sustainable as well as maintain environmental balance. Some of the interventions are listed below.

- Crop zoning, if possible land zoning
- Climate-smart (salt tolerant) rice and non-rice cultivation
- Increase the area of pulse and oil seed crops to meet the country's demand as well as save the foreign currency
- Use of bio-fertilizer and bio-pesticides to maintain environmental balance
- Ensure quality and improved agricultural input (seed, fertilizer, pesticide, irrigation water, etc.)

- Construction of sluice gate, culvert and embankment for the improvement of drainage condition and availability of irrigation water;
- Dredging/Re-excavation of the river, Khal and canal
- Farmer training on modern agricultural farming practices
- Use fallow (temporary) land under crop cultivation
- Mechanization of agriculture

6.11 Administration/Competent Authorities

Key aspect in the theme	Primary competent authority (CA)– and their mandates	Key support organisations (govt, NGO, donor, CBO, etc.)	Performance of CT and support organisations
Land use change	Ministry of Agriculture (MoA); Ministry of Fisheries and Livestock; Ministry of Land (MoL); Ministry of Forest, Environment and Climate Change (MoEFCC)	Department of Agricultural Extension (DAE); Department of Fisheries (DoF); National Agricultural Research System (NARS) organizations (BARI, BRRI, BJRI, BINA, BSRI, BLRI, SRDI, BFRI, BTRI, CDB); Bangladesh Agricultural Research Council (BARC)	Lead farmers, farmers associations, local NGOs, Donor organizations, agricultural intervention implementation organizations
Crop production	Ministry of Agriculture (MoA);	Department of Agricultural Extension (DAE); (NARS) organizations (BARI, BRRI, BJRI, BINA, BSRI, BLRI, SRDI, BFRI, BTRI, CDB); Bangladesh Agricultural Research Council (BARC)	Lead farmers, farmers association
Change of livelihood	Ministry of Agriculture (MoA); Ministry of Fisheries and Livestock; Ministry of Land (MoL);		Crop farmers, Fish farmers, farmers association
Salinity intrusion	Ministry of Agriculture (MoA);	SRDI, BINA	Crop farmers, Fish farmers, farmers association
Farming system change	Ministry of Agriculture (MoA); Ministry of Fisheries and Livestock; Ministry of Agriculture (MoA); Ministry of Fisheries and Livestock;	BARC, BARI	Lead farmers, farmers association

6.12 Relevant Legislation and Regulations

Key aspect in the theme	Primary legislation	Accompanying or enabling regulations	Comments on adequacy or not re. legislation and regs
Land use change	1. National Land use policy 2001; 2. Agricultural (Appropriate use and Conservation) Land Bill 2022		Agricultural Land Bill placed in JS (March 31, 2022)

Key aspect in the theme	Primary legislation	Accompanying or enabling regulations	Comments on adequacy or not re. legislation and regs
Crop production	National Agriculture Policy, 2018	National Agriculture Extension Policy 2020	
Change of livelihood			
Salinity intrusion	Groundwater Management Rules for Agricultural Purposes 2019		
Change of cropping pattern	GAP 2020 National Agri Marketing Policy (2000) draft	8th Five-year Plan	

6.13 Relevant PPPs

Key PPPs relating to the theme	Main projects emanating from the PPPs	Main negative environmental impacts emanating from the projects	Main negative socio-economic impacts emanating from the projects
Timely weather information	Agrometeorological Information System Development	Environmental pollution due to increasing the use of fertilizer and pesticides	N/A
Farm mechanization	Enhancement of Crop Production through Farm Mechanization Project	Will enhance GHG emissions; Environmental pollution due to the use of increasing fertilizers and pesticides; Surface Water contamination	Agricultural laborers will lose their work.
Crop production	Farmers Training at Upazila level for Transfer of Technology (2nd Phase) Project	Environmental pollution due to increasing fertilizers and pesticides;	Agricultural laborers will lose their work.
Crop diversification	Production, Storage & Distribution of Quality Seeds of Pulses, Oil & Onion at Farmer's Level Project – 2nd Phase	Environmental pollution due to increasing fertilizers and pesticides; Air/water/sound pollution due to Storage and processing industries	Cropland will decrease
Crop production and food safety	Production, Storage & Distribution of Quality Seeds of Rice, Wheat & Jute at Farmer's Level Project – 2nd Phase	Environmental pollution due to increasing fertilizers and pesticides;	Cropland will decrease
Crop production	Smallholder Agricultural Competitiveness Project (SACP)	Environmental pollution due to increasing fertilizers and pesticides;	
Agricultural development	Barisal, Patuakhali, Bhola, Jhalokati, Barguna, Madaripur and Shariatpur Agricultural Development Project	Environmental pollution due to increasing fertilizers and pesticides;	

6.14 Drivers of Change

(please arrange the above in a table as indicated – in all columns, please provide only a few bullets that captures the essence of the answer – keep it short and simple!)

Key change	Main external drivers	Main internal drivers	Main actions to "fuel" or "brake" the drivers, depending on whether the change is good or bad
Land use change	Climate Change; Urbanization; industrialization;	Salinity intrusion; drainage congestion; shortage of agricultural labor	Improvement of the embankment and hydraulic structure; re-excavation; agricultural mechanization
Loss of crop production	Less rainfall/erratic rainfall	Salinity intrusion; absence of crop rotation	Improvement of the embankment and hydraulic structure; Supply of quality agricultural inputs;
Change of cropping pattern	Climate change; erratic rainfall;	Late Aman due to drainage congestion or low land type	Introducing short duration variety;

6.15 Main Issues Concerned with the Theme

- Conversion of agricultural land to non-agricultural use;
- Loss of crop production due to natural hazards (cyclone, tidal surge, etc.);
- Farming system (cropping pattern and crop type) change;
- Development of agro-processing industries;
- Increasing the use of chemical fertilizers and pesticides;
- Agricultural mechanization
- Crop area increase

7. Marine Resources and Blue Economy

7.1 Introduction

7.1.1 Background

At the final settlement of maritime border disputes with neighboring countries, Myanmar and India, in 2012 and 2014 respectively, Bangladesh has received entitlement of 118,813 km2 in the Bay of Bengal comprising her territorial sea, Exclusive Economic Zone (EEZ) and Continental shelf (MoFA, 2014). The shallow shelf sea constitutes about 20% and 35% respectively, and the rest (45%) is lying in deeper waters. In Bangladesh itself, around 18.2 percent of the population is dependent on the country's ocean economy (World Bank Group, 2018).

For long, the developing countries are maintaining a higher economic growth (annual GDP growth rate) than that of the developed countries. In accelerating the higher growth rate, the developed countries have exhausted most of their natural resources, whereas major portion of the resources remained untapped in the developing countries. Economists' consider this phenomenon as the low growth trap. Likewise, blue economy is one of the unutilized resources in the developing countries, which can play vital role in the economic growth and development. It is perceived that global economy can maintain 7% average growth rate by the proper utilization of the ocean economy. Like most of the developing countries, potentials of blue economy remained unutilized in Bangladesh. However, the government of Bangladesh started exploring the sectors of ocean and blue economy for economic development. In connection to this government has adopted the ocean and blue economy in the 8th Five Year Fiscal plan and Bangladesh Delta Plan 2100. The similar objectives of the government were observed in the recent national budget speech that emphasizes the importance of the blue economy and government plans respectively.

"85. The historic sea conquest under the leadership of our government has paved the way for developing the country's blue economy. In 2014, we prepared short-term, medium-term and long-term plan of action to develop the blue economy and harness the potentials of marine resources. Recently, we have updated the action plans (2018 to 2030) in line with SDGs declared by the United Nations and have started implementing them. Through the joint efforts with the Food and Agriculture Organization of the United Nations (FAO, UN), we have prepared a 'National Plan of Action' to prevent, deter and eliminate illegal and unregulated fishing. As of February 2022, the fish research and survey vessel 'RV Meen Sandhani' has so far conducted 35 survey cruises. The government has also taken up a project called ''Pilot Project on Tuna and Similar Pelagic Fishing in the Deep Sea". I am confident that this will open a new horizon in the ocean economy."

Since Bangladesh is grappling with its growing population, maintaining an uprising economic growth and food security alongside is a challenge to her. Thus, utilization of ocean economy has immense potentials to Bangladesh. Moreover, the ocean economy of Bangladesh has only low-labor intensive sectors that causes much negative externalities. Therefore, this study aims analyzing the existing legal provisions, policies, plans and projects and the baseline of the blue economy of Bangladesh. In this connection, the present study examines how the policies, plans and projects can influence this economy and how the ocean economy be managed in a sustainable way to ensure the sustainable economic growth.

7.1.2 Scope of Work

There will be a brief description on the terminologies- **ocean economy and blue economy**, brief discussion on plans and policies regarding the blue economy and a baseline description of different sub-sectors of blue economy in Bangladesh.

7.2 Methodology and Explanation of the Terminologies

This report is prepared based on the data and facts collected from secondary sources. In analyzing the data facts, both of the qualitative and the quantitative approaches were adopted simultaneously. The terminologies of the ocean economy and blue economy are explained as follows:

The concept of blue economy is a very recent one, relevant to costal states and countries with an interest in developing sustainable ocean economy. This concept got higher attention during the Rio+20 UN Sustainable Development Conference in 2012. In nonprofessional's term, it comprises all the activities of the economy, which takes place directly or indirectly at seas and the oceans, as well as the coastal waters, even not excluding the distant value chain of the ocean products. The National Maritime Foundation, an active Indian think tank, has adopted the following definition of blue economy:

"Marine-based economic development that leads to improved human wellbeing and social equity, while significantly reducing environmental risks and ecological scarcities".

However, a universal definition devised by the Economist Intelligence Unit echoes as:

"A sustainable ocean economy emerges when economic activity is in balance with the long-term capacity of ocean ecosystems and remain resilient and healthy".

In contrast, China's idea of a blue economy focuses three different areas;

1. sustainable development and conservation;
2. coastal and ocean resources into a broader integrated plan for national economic development; and,
3. encouraging the marine industry to play a greater role in the economy.

Apparently, both the blue economy and the ocean economy are used alternatively but, there is a difference between them. The difference between the "ocean economy" and the "blue economy" is that the former provides no measure or indication of **sustainability,** but the concept of the blue economy promotes sustainable development of the ocean economy. It is a pathway over time, where ocean economy transforms via policy reforms towards a blue economy which have been depicted in the thematic Figure 7.1 below.

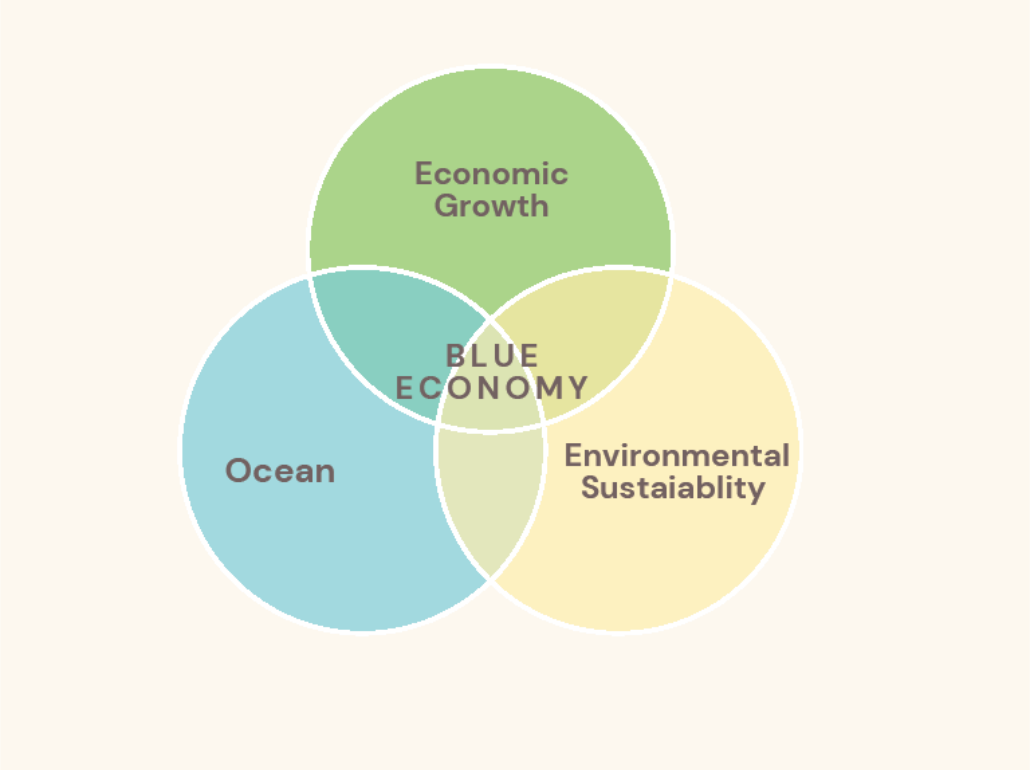


Figure 7.1: Thematic Concept of the Blue Economy

7.3 Blue Economy in the Context of Bangladesh

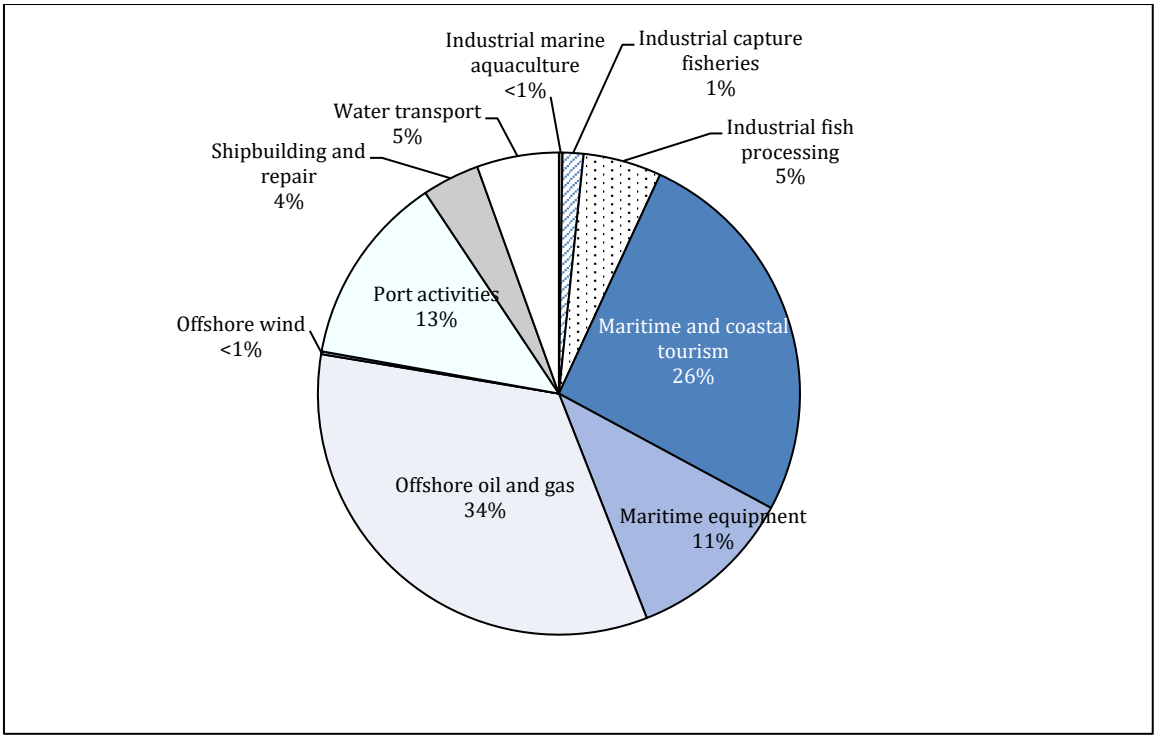
7.3.1 Sectors of Blue Economy

Blue Economy has the prospect to contribute Bangladesh economy on a much higher level. Twenty-six potential Blue Economy sectors has been identified by the MoFA (Blue economy of Bangladesh: Prospects and challenges, Bangladesh Bank, The Financial Express 27 January 2021) which includes the fishery, maritime trade and shipping, energy, tourism, coastal protection, maritime safety and surveillance for development of blue economy in Bangladesh.

The **Blue Economy Development Work Plan** by the Ministry of Foreign Affairs has categorized the blue economy within nine sub-sectors:

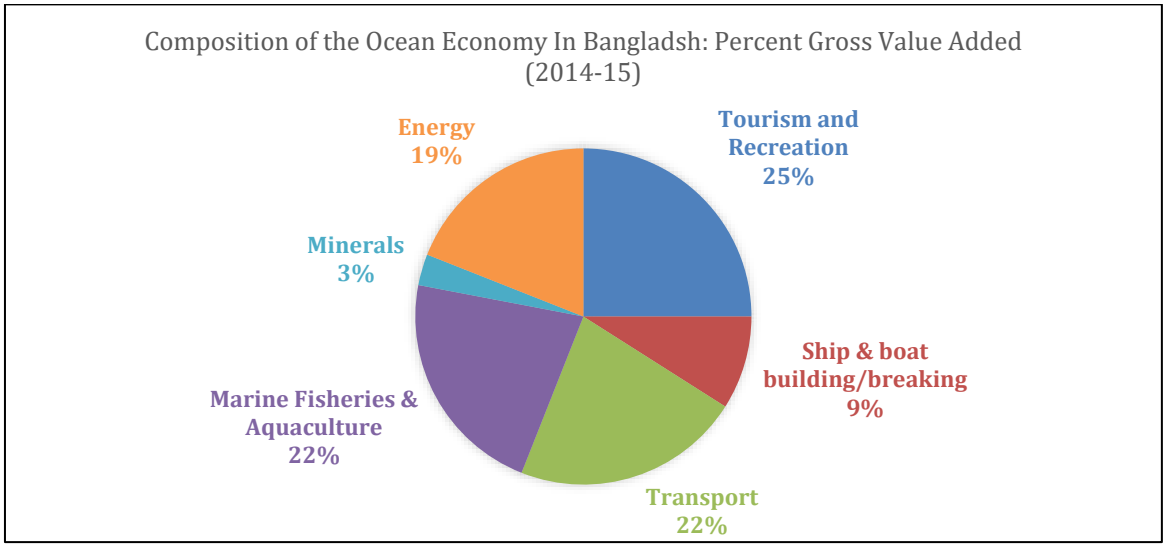
1. Marine Fisheries
2. Mari culture
3. Commercial Shipping
4. Marine Tourism
5. Offshore Energy, Renewable Energy and Blue Biotechnologies
6. Ecosystem services of Mangroves
7. Ship building and Recycling Industry
8. Marine Pollution
9. Marine Spatial Planning

Figure 2 below depicts the comparison of the value added from different marine sectors in the rest of the world 7.2(a) and Bangladesh 7.2(b). Also, figure 7.2(c) shows the composition of the marine catch, and percentage of marine catch (Figure 2 (d)) in 2012 in Bangladesh.



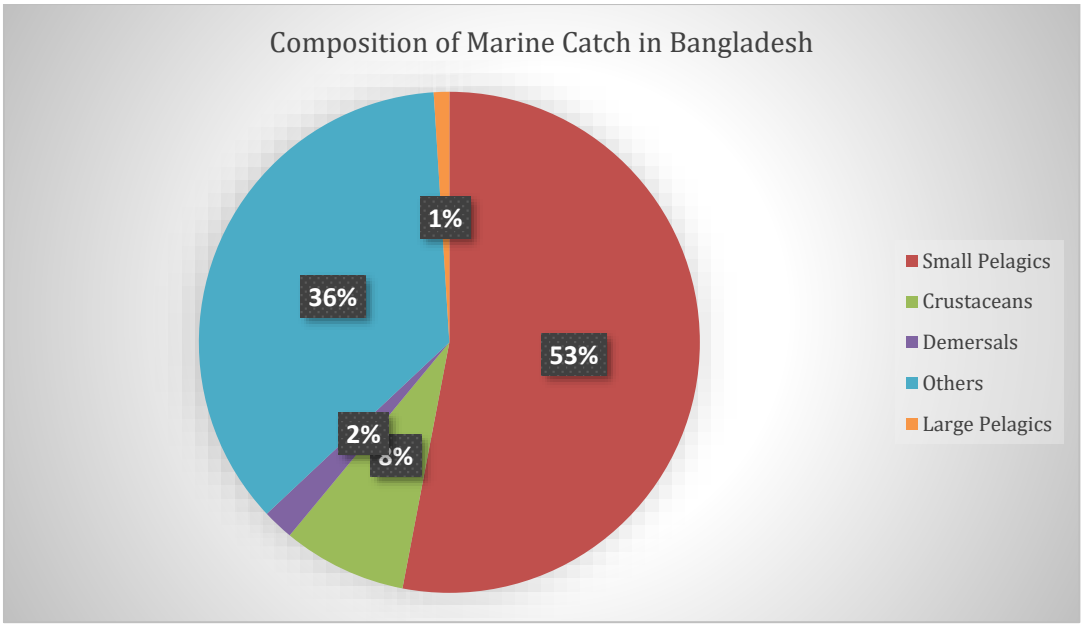
Source: The Ocean Economy in 2030 - © OECD 01-01-2016

Figure 7.2(a): Value added by Ocean-based Industries by 2010



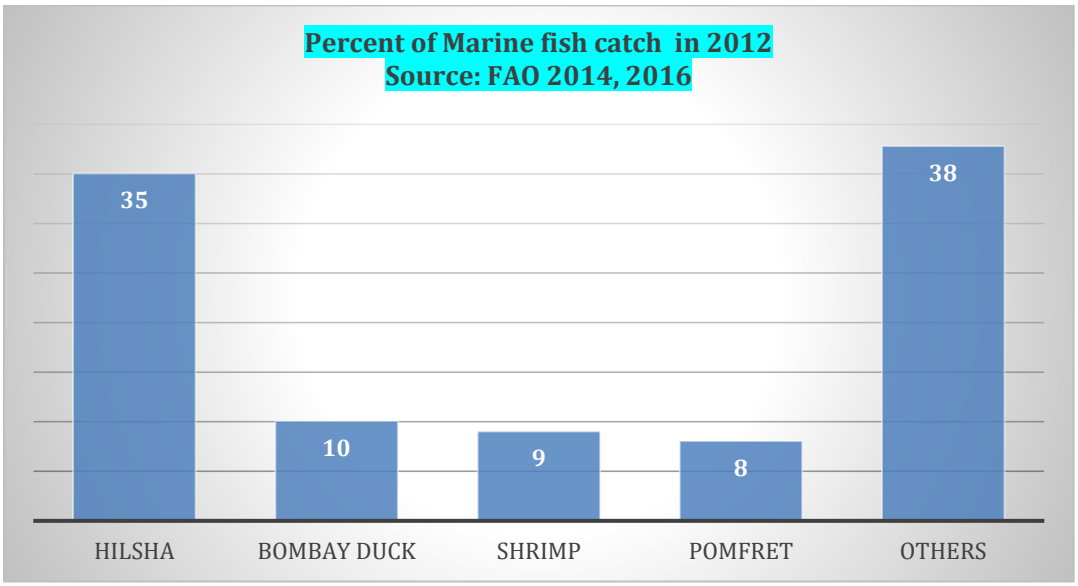
Source: BBS report (Unpublished), World Bank report

Figure 7.2(b): Comparison of Ocean Economy in Bangladesh



Source: Patil, et al., 2018

Figure 7.2(c): Composition of Marine Catch in Bangladesh



Source: FAO 2014, 2016

Figure 7.2(d): Percent of Marine fish catch in 2012

Marine fisheries and Meri-culture

Bangladesh ocean waters cover the widest continental shelf area in the Bay of Bengal. The coastline includes a number of estuaries, and further inland some 230 rivers running 24,000 kilometers long support large freshwater fisheries, along with small lakes (beels), permanent bodies of floodplain water, and temporary lakes created by rains or floods (FAO, 2014). About 475 species of fish are found in the Exclusive Economic Zone (EEZ) of Bangladesh compared to 250 in-land sweet water species (Iqbal, K.M, The Daily Star).

Some 5.5 million hectares of fertile floodplains support a large volume of aquaculture production, as part of the global "blue revolution" of the last 35 years (Economist, 2003). Annual production levels

increased from 91,000 tons in 1980 to 1.7 million in 2012, making Bangladesh the world's fifth-largest aquaculture producer (FAO, 2014; 2016). Although many countries do not consider fishing and aquaculture that are categorized as "freshwater" or "inland" to be part of the ocean economy, the geography of Bangladesh makes it logical to include.

These production systems have followed different trends, with explosive growth in aquaculture over the last 35 years and steady growth in marine capture fisheries, peaking in 2010 at roughly 700,000 tons and then averaging 600,000 tons per year (FAO, 2017).

It is estimated that Bangladesh catches only 0.70 million tons of fish every year out of the total 8.0 million tons of fish available in the Bay of Bengal. (Bangladesh Bank) where marine fisheries contribute 19.40 per cent of the total fish production of the country (Bangladesh Bank). Integrated multi-tropic offshore aquaculture is the fastest growing global food sector providing 47 percent of the fish for human consumption (Blue economy and marine spatial planning, M Khaled Iqbal, Daily Star, date).

Figure 2 (d) above shows that the bulk of production from marine capture fisheries in Bangladesh (as in many other tropical nations) consists of small pelagic species (e.g., hilsa shad, 53 percent), with high-value crustaceans (e.g. crabs and shrimp), large pelagic (e.g. tuna and sharks), and demersal (e.g. croaker) making up a total of roughly 11 percent (FAO, 2017)

Together with rice, fish is the major contributor of the Bangladeshi diet, providing 60 percent of the animal protein intake in the country, as well as other essential vitamins and nutrients (DoF, 2017). For poorer groups in Bangladesh, fish is most often the only source of protein. An estimated 70 percent of the rural population occasionally fishes for subsistence (FAO, 2014).

Commercial Shipping and maritime trade

80 percent of global trade by volume, and over 70 per cent by value is carried through the ocean. World seaborne trade grew by 4% in 2011 to 10.7 billion tonnes by 2017 (UNCTAD, Review of Maritime Transport, (2018) and container traffic is projected to triple by 2030 (Ibid)). Bangladesh's external freight trade is mostly seaborne which is on yearly average 90 percent of the total freight trade of the country (Blue economy of Bangladesh: Prospects and challenges, Bangladesh Bank, Financial Express 2021)

Bangladesh shipping industry and maritime trade industry consists mostly passenger Shipping and Maritime trade. About 231.5 million passengers has been transported through inland and coastal networks in 2012 (Alam, 2015). The maritime trade and other transports have contributed a gross value of US$67 billion by 2,500 foreign ships to and from Bangladesh in a one-year period in 2013-2014 (Alam, 2014). Over a ten-year period, importers, exporters, and buyers paid a cumulative amount of about US$95 billion in freight and related charges to shipping companies, airlines, and freight operators (Alam, 2016). The top import and export partners of Bangladesh in 2011 were China, India, Europe, Indonesia, Singapore, and Thailand (World Bank 2017).

Marine Tourism

Marine tourism in Bangladesh is flourishing in recent years. Marine and coastal tourism represent an estimated 16 percent of the country's total sector, in terms of leisure and recreation visitor days (Emerton, 2014). A part from domestic tourists, foreign tourists are highly attracted to marine tourism in Bangladesh. The record shows that on an average, 81.0 per cent of the international tourists in Bangladesh visit Cox's Bazaar; the largest sea-beach in the world (Bangladesh Bank, year). This tourism includes:

- beach-based recreation and tourism;
- tourist activities in proximity to the sea; and
- nautical boating including yachting and marinas, recreational fish catch.

In 2016, tourism and recreation contributed just over US$10 billion to national GDP and created more than 2 million direct and indirect jobs (WTTC, 2017). In 2013, the estimated gross value of the ocean economy of the country was US$1.6 billion. Although the marine tourism is expanding Bangladesh, no recreational fishing occurs in the country's marine waters (Humayun et al., 2016). Data from the United Nations reinforce this picture of low levels of recreational fishing in Bangladesh, with imports of fishing rods, reels, hooks, and other tackle adding up to a total trade value of just US$ 0.127 Million in 2013 (United Nations Comtrade Database, 2017).

Minerals, Offshore Energy, Renewable Energy and Blue Biotechnologies

Salt production is the prime and primary mineral that blue economy in Bangladesh is enriched with. The coastal district; Cox's Bazar alone produces 95 percent of the country's salt where 15 percent of all rural households are involved (Al Mamun et al. 2014). The salt production chain includes a network of mobile mills that refine crude salt mined from saltpans on the beaches of Cox's Bazar. In total more than five million people directly and indirectly employed in this sector. Another estimates claim that livelihood of 25 million people depends directly and indirectly on this sector. The value of the sea salt is reported USD 197.88 million in the 2014-15 fiscal year (Patil et. al., 2018).

The marine coast of the Bangladesh is enriched with the other valuable minerals. Several studies have found that the sands containing valuable heavy minerals intermittently over the 250 kilometers of coast from Patenga to Teknaf, including zircon, rutile, ilmenite, leucoxene, kyanite, garnet, magnetite, and monazite (Hossain et al., 2014)

Relatively little oil and gas production has occurred to date in Bangladeshi waters, despite significant potentials. Before 2014, twenty exploratory wells were drilled in the marine coast of the Bangladesh of which two led to discoveries of relatively small reserves of gas, the Sangu and Kutubdia fields (Hossain et al. 2014). The production began in the Sangu, but in 2013 it was closed, by shutting-down this sector of the country's ocean economy (Kabir, 2016). The resolutions of maritime boundary dispute in 2012 and 2014 have generated new interest in offshore exploration, as the newly established boundaries provide one of the largest estimated oil and gas reserves in the Bangladesh region (Pakistan Defense 2017 and Petrobangla 2016). Shallow offshore blocks throughout the EEZ have attracted attention, in particular those adjacent to Myanmar, given their likely similar geological features to gas fields discovered in that country (Hossain et al., 2014). Recently, Bangladesh has discovered a new natural gas field in the southern island district of Bhola with a hope of 700 billion estimated cubic feet of gas reserves (BAPEX, 2017).

Ecosystem services of the Mangroves

Carbon sequestration as an underestimated and underpriced ecosystem service, though a recent study estimated that global mangrove destruction has resulted in up to US$42 billion in annual economic damage due to increased greenhouse gas emissions (UNEP, 2014). Intact mangrove forests store carbon at the rates that surpass those of tropical forests.

Mangrove forests in Bangladesh make up more than 3 percent of the global total (Giri et al., 2011 and Giri et al., 2015), ranking the country 12th in the world by mangrove area (Hamilton and Casey, 2016). Almost all of these mangroves are located within the Sundarbans forests, providing a range of ecosystem services (such as carbon sequestration) with benefits beyond the country (Das and Vincent, 2009 and Miteva et al., 2015). Current research suggests a carbon density in the Sundarbans (including carbon stored above ground, below ground, and in the top meter of soil in mangrove ecosystems) of 239.91 Mg/ ha for the 435,861 hectares of mangroves (Lee et al., 2015, 2016, and unpublished data). To illustrate the scale of carbon emissions reduced by conservation of the Sundarbans mangroves, a global average loss rate of 0.7 percent per year was applied (Pendleton et al., 2012) using a price of US$5/Mg CO2eq. These calculations, while hypothetical, suggest a total value of US$122.8 million for carbon sequestration over 20 years.

Ship Building and recycling Industry

Due to long coastline, Bangladesh has huge potentials in shipbuilding and shipbreaking. However, Bangladesh started the shipbuilding but it has potential to expand its output by 10 to 15 percent over the next decade (Dausendschoen, 2016). The contribution of shipbuilding was more than double in 2014-15, with construction and export of two large ships. Some 300 ship- and boat-building yards and workshops lie scattered throughout the country, supplying domestic needs for water transport (Alam, 2014). Two major shipyards have delivered more than 20 vessels to European customers since 2005 (Dausendschoen 2016).

As an alternative to shipbuilding, Bangladesh is serving as one of the major shipbreaking industry since the 1980s (largely in Chittagong), grew by an average of 14 percent annually (Rahman, 2017). Since 1980, the industry grew by an average of 14 percent annually, measured by the weight and number of ships recycled (Ahammad and Sujauddin, 2017). The roughly 125 breaking yards in Bangladesh provide raw materials for a number of other economic activities in the country. There are 200,000 workers are employed in the Shipbreaking industry in Chittagong and it provides about 1 million direct and indirect jobs to the country (Alam, 2015 and Hossain, 2015).

Marine pollution protection and marine spatial planning

The government of Bangladesh in its “Blue Economy Development Work plan” have considered two more sectors to develop the blue economy of Bangladesh. One of it is termed as marine pollution protection and the other is marine spatial planning. Due to the single-use plastic-wastage, oil spillage and chemical pollutants the health of marine economy is at a stake. Though the government is taking initiatives to mitigate this phenomenon, it is mostly at a planning stage so far. These plans extend to, reducing fisheries sector wastage and plastic pollution, reducing micro plastic from consumer goods, assessing micro plastic and heavy metal in ocean etc.

For implementing "Blue Economy" in the marine area, a proper ocean management tool is required that is also related to the 14th goal of SDG 2030; whereas Bangladesh is in the early stage of managing its maritime resources. However, Marine Spatial Planning (MSP) is a very popular multidimensional tool for ocean management. Its integrated approach helps to resolve issues between the ocean users and it can secure ecological, economic and social advantages. Current legal framework, stakeholder engagement and coordination is not sufficient and integrated (Shuva, S. H., & Uddin, M. M., 2021). Sub

projects related to the spatial management under the work plan of the foreign ministry of Bangladesh has emphasis on chalking and implementing Marine spatial planning, including ocean ecology in the national education curriculum, planned expansion of land by forming new ice lands using modern technologies.

Mega projects

There are various mega projects are in progress in the coastal areas in Bangladesh. The Port of Payra is a seaport located at Kalapara in Patuakhali and established under an Act of the Parliament in 2013. The government has inaugurated port officially in 2016. It is located on the Ramnabad Channel near the Bay of Bengal. The Payra Port was constructed by the financial support of the public-private partnership (PPP). The primary plan was to make the port as a deep-seaport, but the decision was changed later to make it a standard seaport rather than a deep-sea port.

There is an ongoing deep-seaport at Matarbari, under a mega project, which will be the first deep-seaport in the country located in the Maheshkhali Upazila of the Cox's Bazar District. Matarbari seaport was supposed to be built for Matarbari coal-fired power plant but the government has decided to turn it into a deep sea port. The goal of this deep-seaport is to reduce the pressure on the Chittagong Sea-Port.

BIMRAD- the first maritime research organization in the country that was established on 03 July 2018 is runned by Bangladesh Navy. The initiative of the BIMRAD has been undergone to meet the necessary technical, technological, and strategically knowledge need for capacity building in this thriving sector. In broader sense to augment maritime awareness of policy-makers and civil society. Bangladesh Navy frigate program and BNS Sheikh Hasina (full-fledged submarine base of Bangladesh Navy) have initiated to develop and implement a sustainable spatial management plan and uphold the security in the ocean for Bangladesh.

Another mega project of the government titled Fish Research and Survey Vessel 'RV Meen Sandhani' has so far conducted 35 survey cruises, which will be much important for an exact valuation of annual value added from the marine fisheries sector. There are other significant projects, such as, Bangladesh Ocean Research Institute (BORI), Bangabandhu Sheikh MujiburRahman Maritime University (BSMRMU), and Blue Delta Governance Project. Potentially, these mega projects will accelerate the sustainable uses of the marine economy of the Bangladesh.

7.4 Assessment of Negative Externalities and Mitigtation Measures

7.4.1 Marine Pollution

Marine or ocean pollution occurs by contamination of ocean environment by discharge of industrial wastage in the ocean or to the coastline from petroleum processing and urbanization and industrialization on the coastal areas, untreated sewage, oil spillage, plastic and chemical waste disposal in the water from ship breaking. Human activities like deforestation and irrational expansion of coastal shrimp farming, etc. are resulting in ecological degradation. Sound pollution from the ship and other marine vehicles are also causing navigation problem for various kinds of marine organisms and animals. These pollution sources can be categorized into two groups; the ship source pollution and the Land-based pollution.

7.4.2 Pollution from Fishing Vessel

There are 205-registered fishing trawlers are running through the Karnaphuli River. These trawlers are continuously dumping wastes, garbage, sewage, bilge water, materials washout from deck and engine room. They also dump processing wastage, solid materials such as plastic bottles and other

plastic equipment's, discarded food waste, galley wastage, rotten fish, etc. Other items such as discarded fishing nets cause harm to the marine environment or create a navigational hazard. As well as fishing hampers the marine Biodiversity in coastal areas by overfishing, ghost fishing, bottom trawling, etc. There are no sewage treatment plants in fishing vessels, so all vessels discharge sewage directly into the river and sea water (Shill, E. et al, 2021)

7.4.3 Oily-water Discharge from Ship

Due to ship operation spills of lubricating oil, fuel oil, and grease spread in the bilge area. When oily-water separator does not fit properly, it causes oil pollution. In addition, the cleaning process of crude oil tanks contribute to marine pollution because cleaning process contains certain chemicals that discharged overboard. An undetermined amount of oil spill occurred in Chittagong port area due hose rupturing in 2016. Table 7.1 below comprises the oil spills in Chittagong coastal area in the last decade, which contributed in marine pollution.

Table 7.1: Oil spills record in Chittagong coastal (Compiled by the researchers)

Year	Source of oil spills	Causes of incident	Place of incident	Amount (in tons)
2019	Oil tanker	Collision	Karnaphuli channel (Padma jetty)	10
2019	Freight train	Derailed	Halda canal	25
2016	Oil tanker	Collision	Karnaphuli channel (dangarchar)	5-6
2015	Freight train	Derailed	Kithabchar canal	undetermined
2014	Freight train	Derailed	Sitakunda (canal)	66
2013	Freight train	Derailed	Karnaphuli channel (near the kalurghat)	33
2011	Oil tanker	Sunk	Karnaphuli channel (Dolphin jetty)	180

Source: Shill, et al., 2021

7.4.4 Anti-fouling Paints

Some antifouling chemical such as, Tributyltin (TBT), which was one of the active components used in anti-fouling and leading to indirect impacts on marine wildlife. Human also face health hazard after eating contaminated food. It also can cause of severe damage to reproduction or immune systems.

7.4.5 Ship Breaking Industry

The most dangerous pollution source in Chittagong coast is the ship breaking and recycling industry. At present, there are 125 ship-breaking yards in this area and space extends from over 14 km along from Fauzdarhat to Kumira Coast (Hossain et al., 2005). Generally, tankers, cargo ships, and container ships are cut, and scrapped in the Chittagong shipbreaking yards. The wastes from scrapped ships, including oils and persistent organic pollutants (POPs), Asbestos, heavy metals, Polyvinyl Chloride (PVC), PCBs (mainly cables), ODS (mainly polyurethane foam), Paints (metals, tributyltin (TBT), Waste liquid organic (acid), Miscellaneous (mainly sewage), and reusable liquids organics are creating huge pollution in the shipbreaking area (Shill, E. et al., 2021)

7.4.6 Industrial, Fertilizer, Textile and Domestic Pollution

The south and north side of Karnaphuli, Kalurghat, Patenga, Bhatiary, Sitakunda, Nasirabad, Anwara, and Kaptai are considered industrial hotspots. Chittagong port, fertilizer factory such as KAFCO; situated in the bank of the Karnaphuli River which cause pollution to the river water. In addition, these

areas are dense urban surrounding the coast, and thus all these sources pollute the water of the Bay of Bengal and hampers the marine ecosystem.

7.4.7 Loss of the Aesthetic Value of the Sea-beach

In recent years, the domestic tourism has expanded a lot. To the tourists, sea-beaches are the most attractive sites. Therefore, unregulated domestic tourism is creating huge pollution into the sea-beaches every day. Various polluting agents' likes plastic litter and oil, etc. pollute all of the sea-beaches continuously. Because of this pollution, the sea-beaches are losing their aesthetic values along with the quality of the water.

7.4.8 Impact of Pollution

Most of the time effects of oil spills are visible among larger species of wildlife, like marine mammals, seabirds, crabs, mollusks, and other water organisms. Aquatic and coastal wildlife is exposed directly by the oil spills and suffer from immediate health problems such as skin irritation, altering of the immune system, reproductive or developmental damage, liver disease, neurological effects (headache, dizziness), etc. through ingestion, absorption, and inhalation. People who had worked in cleaning up the spill had twice as much mercury in their urine than normal levels. There are 21 species of marine fish in the Bay of Bengal that have been depleted from Bangladesh water body due to the oil spills. Chemical pollutants from agricultural and industrial activities and due to excessive carbon footprints (because of thrive in tourism sector) also contribute to global warming by human activities. Micro plastic is found in the wide variety of marine species that causes risk of chemicals adhered to plastics transferring through the food chain from marine organisms to humans. Wide range of pollution in the coastal environment of Chittagong threats to the livelihoods of coastal communities and associated industries pose a serious health risk to humans through contaminated seafood and affects marine ecosystems such as, Extinction of the dolphins.

7.5 Existing Policy and Plans

Managing marine resources refer the aim of maximizing utility keeping in consideration of the environment and ecological constraints. For managing the blue economy to achieve the sustainable growth, there needs an integrated policy. However, there are lot of policies related and relevant to the blue economy of which some are discussed below.

The Territory Waters and Maritime Zones Act of 1974 was the first instrument to declare Bangladeshi territorial waters and maritime zones in the BoB (Alam and Faruque, 2010). Bangladesh contrived the Coastal Zone Policy (2005) to develop a management framework for coastal and maritime areas. In 1983, the Marine Fisheries Ordinance was enacted as the first comprehensive legal instrument for exploiting, conserving, and managing national marine fisheries resources (The Marine Fisheries Ordinance, 1983). Later, this ordinance was replaced by the Marine Fisheries Act, 2020.

The Bangladesh Petroleum Act, 1974 highlights the execution of petroleum operations without hampering ecology, the environment, or other maritime and sea-bed resources (The Bangladesh Petroleum Act, 1974).

The Chittagong Port Authority Act of 1995 and The Mongla Port Authority Act of 1995 separately regulate the operation of national ports. The Bangladesh Shipping Corporation Order of 1972 provides for better operation and development of shipping and ocean transport services. The Bangladesh Shipping Corporation Act of 2017 was formulated to repeal and to re-enact the Bangladesh Shipping Corporation Order of 1972 to provide safe and proficient maritime trade services through international waterways and to enhance regional cooperation and business transactions (Ministry of Shipping, 2018). The Bangladesh Merchant Shipping Ordinance of 1983 is a comprehensive law for

the maritime shipping sector that places the Department of Shipping under the Ministry of shipping (The Bangladesh Merchant Shipping Ordinance, 1983). The Bangladesh Environment Conservation Act of 1995 (Amendment 2000, 2002) and The Environment Conservation Rules of 1997 were critical foundations for environmental protection and for the establishment of the Department of the Environment under the Ministry of Environment and Forests. These acts and rules are the central government branches dedicated to environmental conservation and protection and to the control and mitigation of environmental pollution (Alam et al., 2018; Mohammad, 2012; Department of Environment, Ministry of Environment and Forest, 2010; Ministry of Environment and Forest, 1997). The naval wing of the Armed Forces Division is entrusted with maintaining the sovereignty and territorial integrity of the oceanic realm, as empowered by the Navy Ordinance of 1961 (Amendment 1977). The Coast Guard Act of 1994 charges the Bangladesh coast guard with protecting the marine environment and maritime safety (Alam et al., 2018). In 2018, the Bangladesh government published a draft of the Maritime Act, which needs further revision to implement marine environmental protection and maritime safety. Considering the shortcomings of the present legal provisions and the lack of cross-sectorial coordination and integration, a comprehensive approach to ocean governance structure is highly required to project national economic growth and sustainable development.

In 2018, the Government of Bangladesh completed the formulation of Bangladesh Delta Plan 2100 (BDP2100). Since Bangladesh neither developed blue economy nor substantially invest in it, the BDP2100 outlines blue economy strategies and measures in a separate chapter named water resource management (Volume 1).

7.5.1 Bangladesh Delta Plan

The blue economy is now considered as a new 'development space' in Bangladesh. Shipping, seaports, ship building and recycling, marine fisheries, sea salt, coastal tourism, ocean energy, land reclamation, maritime surveillance, human resources development and governance have been identified as key priority issues for the development of blue economy.

In addition to the port facilities that could serve the needs of the growing internal trade and commerce needs of Bangladesh, with proper investments, Bangladesh can become a regional hub for the sea transportation. The Government has rightly decided that sole reliance on imported fossil fuel cannot be the answer for growing primary energy shortage due to expansion of manufacturing sector. Imported coal, LNG and LPG require port facilities to handle bulky cargoes.

Marine fishing is already emerging as one of the major sources of domestic food, exports, income and employment. The 7th FYP (2016-2020) emphasizes on the prospect of 'blue economy' (GoB 2015) as:

"Blue economy concept has ushered in a new horizon for economic development. The norms of Blue economy lend significant contribution towards eradication of poverty, contributing to food and nutrition security, and generation of sustainable and inclusive livelihoods. Marine fisheries are an important component of the blue economy. As mentioned before, share of marine fisheries in the fisheries sector has increased from 11% in FY1973 to 17% in FY2014. Potentials are immense. There are 475 species of fish found in the EEZ compared to 250 species on land. Fish provides the much needed protein needs of the population. Hilsa (Tenualosa ilisha) is the largest and single most valuable species with annual catch of 340,000 MT, and generates employment and income for 2.5 million people valued at US$ 1.3 billion per year (BoBLME 2012, Hossain et al. 2014). A national programme needs to be taken to popularise marine fish as part of the normal diet. This will also contribute to nutrition security"

There is also an emerging demand for coastal tourism and therefore, unregulated coastal resorts are emerging as an alternative to the Cox's Bazar sea beach like Kuakata of Patuakhali. Except the tourism, other types of potential areas are exploration of petroleum and other marine resources, beach mineral sand, renewable energy by wave, land reclamation by sediment management, etc. The government

has decided to signal its top priority to adaptive delta management including issues and challenges related to climate change, coastal zone and river management, water supply and sanitation, environment, biodiversity, agriculture, fisheries, blue economy, navigation and land management is to assign GED the responsibility of coordination, facilitation as well as M&E of BDP 2100 implementation. As such, a well-structured set up of the policies is needed in GED, i.e. Delta wing that will take the responsibility for rendering those tasks in an integrated and holistic manner. The Seventh-Five Year Plan (7FYP) of Bangladesh has mentioned twelve actions for maintaining a prosperous and sustainable blue economy, which include fisheries, renewable energy, human resources, transshipment, tourism and climate change among others (excerpt from Bangladesh Delta Plan 2100, Volume 1).

7.5.2 The 8th 5-year Plan & SDG

The 14th goal of SDG specially focused on the conservation and sustainability of sea and marine resources. The prime hazards of the marine and blue economies that are considered are the marine pollution, over fishing, acidification, ocean warming and eutrophication. The SDGs emphasize to prevent and significantly reduce the marine pollution by 2025 to manage and protect sustainable coastal ecosystem, regulating harvesting and overfishing of ocean fishes, to implement science based monitoring and management plans along with extensive research and development for more efficiency. It emphasis on small artisanal fisheries. The SDGs have specified to conserve at least 10 percent of the coastal and marine areas. The overall vision resonates the aim to increase the economic benefits to Small Island developing States and least developed countries from the sustainable use of marine resources, including through sustainable management of fisheries, aquaculture and tourism by 2030.

7.5.3 Specific Activities to Improve Green Growth under the 8th Five Years Plan

The Government will explore the potential of the blue economy through a sustainable mechanism and identify adequate policies which will help formulate an optimal investment plan which can contribute to sustainable and inclusive economic growth, employment, and well-being while preserving the health of the ocean. BCCT has developed its long-term, mid-term and short-term plan under blue economy. From CCTF, a few projects have been already undertaken, which addressed the theme of the blue economy. The CCTF also have undertaken two projects for the capacity building, awareness raising and socioeconomic development under the blue economy.

Under the 8FYP period, the government aims to prioritize implementing the targets as noted in the "Coast Guard Goal 2030". It will also ensure that the strategic objectives of the "Blue Economy" are protected by ensuring the safety of our marine resources. Exploring blue economy (in the fisheries sector) through community participation and collaborative leading to equitable distribution of the benefits for optimal economic and social growth, and reducing post-harvest loss. Harness the potential of blue economy, stock assessment of marine fisheries and promote sustainable exploitation of marine fishes, especially tuna and tuna like other pelagic fishing.

Currently, total marine fish production is 697.10 thousand metric tons. Whereas the strategic objectives in the 8th FYP plan for the marine fisheries sector aim to achieve by increasing fish production targets of 713.16 thousand metric tons. This plan targets to increase the participation of women in aquaculture production, and fisheries. The fishers in Bangladesh hardly have capabilities of catching demersal fishes below 50 metres depth of the water. The long line fishing is totally absent in the deep water. The capacity development of the fishers in the deep sea will be a major focus of the 8th FYP. A parallel national programme may require to popularizing the marine fish as part of the normal diet.

The strategies for marine fisheries in the 8th FYP plan is aligned with the perspective plan of 2041 and the Bangladesh Delta Plan 2100. It aims to undertake the following strategies:

- Restrict and control pouching of resources and illegal entry of foreign travelers.
- Introduce Vessel Tracking and Monitoring System (VTMS).

7.5.4 Use of the Space Technology in Planning and Implementation

Satellite ecosystem revolves around the connectivity "beyond" the fiber and other common means of communication. It can support all the sectors of the 'Blue Economy' i.e. aquaculture, fisheries, coastal tourism, maritime transport, research etc. Satellite based 'Vessel Tracking & Monitoring System (VTMS)' will facilitate to detect fleet patterns and aids monitoring, control, and surveillance efforts whenever needed, especially in case of natural disasters. The specific uses of the satellite technology are as follows:

- Identify conservation needs and methods that can be effectively administered and regularly Monitored.
- Cooperate with the Coast Guard and Navy on the control of encroachment and breach of regulations, also by the local vessels.
- Institutional capacity building of the concerned agencies, strengthening of monitoring, control and surveillance system (MCS) in the Bay of Bengal.
- Assessing the stock and maximum sustainable yield of the marine fisheries
- Collaborative effort for distant water fishing (beyond 200m of EEZ and ABNJ) to explore and exploit tuna and large pelagic fishes.
- Establish MPAs (marine protected areas) as breeding grounds.

7.5.5 Other Strategies

The other important strategies specific to fisheries sub-sector are as follows:

- Private sector investment will be promoted for the value chain of fish and fisheries products.
- Motivational activities for farmers/ entrepreneurs will be taken to adopt advanced farming technologies. Application of Information and Communication Technology (ICT) will be promoted to disseminate fisheries information and modern technology in the remote areas of the country for facilitating fisheries activities particularly for the aquaculture.
- Promulgation of new acts, laws, rules, regulations, aligned with attainments of SDG targets.
- New development projects and programmes will be undertaken aiming the specific SDG targets.
- Developed skilled/trained work force to operate modern laboratory as well as processing plants.
- Regular and long-term study/research on change of the biodiversity, impact of sanctuary, habitat restoration; physical, chemical & biological changes of Haor basin, fish production, fish migration and socio-economic condition of fishers' folk will be implemented

- Strengthening the collaboration and coordination among ministries, departments and agencies.

In March 2020, as the pandemic was about to unsettle the world, the Government of Bangladesh published the 'Making Vision 2041 a Reality: Perspective Plan of Bangladesh 2021 −2041' (PP2041). The final chapter of the PP2041 talks about sustainable environment, climate resilience, and blue economy. To explore and unlock the potentials of blue economy in Bangladesh-owned 118,813 square km of the Bay of Bengal, the Plan envisages appropriate policies and investments in a number of areas (excerpt from 8th FYP). The Perspective Plan 2041 resonates that collaborative efforts need to be taken for exploring the blue economy-related activities concerning the fisheries sector, focusing on the blue economy (marine fisheries) for the diversification of the life and livelihood.

7.6 Administration/Competent Authorities for Blue Economy

Key aspect in the theme	Primary competent authority (CA)– and their mandates	Key support organisations (govt, NGO, donor, CBO, etc.)	Performance of CT and support organisations
Coastal Protection	Ministry of Environment and Forest	Disaster management information centre (DMIC) of Ministry of Food and Disaster Management	Performance is up to the mark
Existence of Biodiversity	Ministry of Environment and Forests	• Bangladesh National Herbarium, • Department of Environment, • NGOs	Performance is good with respect to the capacity. But, there is a lack of proper valuation technique of ecosystem services for baseline study; moreover, proper monitoring of projects after implementation is also absent in many cases.
Waste Disposal	Ministry of Water Resources	Private Public Partnership (PPP)	Insufficient and ineffective effort at many cases whereas there is a huge pressure in urban population and safe disposal of waste has become a burning concern.
Energy	Ministry of Power, Energy and Mineral Resources (MoPEMR)	• Sustainable and Renewable Energy Development Authority (SREDA); • Bangladesh Power Development Board (BPDB)- Blue Economy Cell • Private companies	Less visible effort
Living Resources	Ministry of Fisheries and Livestock (MoFL)	• Department of Fisheries • Bangladesh Fisheries Development Corporations (BFDC) • NGOs and PPP	Performance is up to the mark
Tourism	Ministry of Civil Aviation and Tourism	• Bangladesh Parjatan Corporation • Chambers of Commerce	Monitoring and implementation of the regulations, and plans are not up to the mark. Therefore,

Key aspect in the theme	Primary competent authority (CA)– and their mandates	Key support organisations (govt, NGO, donor, CBO, etc.)	Performance of CT and support organisations
		• Private companies	the coastal and marine tourism is not considered as 'budget and tourist friendly'.
Shipping and Transport	Ministry of Power, Energy and Mineral Resources (MoPEMR);	• Infrastructure Financing Facility (BIFF); • Inland Water Transport Authority • Bangladesh Coast Guard • Private and public-private partnership	Mobilization of new funding sources and Private public partnership is not sufficient
Ocean Based Industry	Ministry of Industries (MoI);	• Bangladesh Standards and Testing Institution (BSTI); • Bangladesh Small and Cottage Industries Corporation (BSCIC); • Bangladesh Chemical Industries Corporation (BCIC); • Bangladesh Bank • Private companies, NGOs and public private partnership	Mobilization of new funding sources and Private public partnership is not sufficient

7.7 Relevant Legislation and Regulations of Blue Economy

Key aspect in the theme	Primary legislation	Accompanying or enabling regulations	Comments
Coastal Protection	Climate Change Trust Act 2010		Sufficient but need integration and post implementation monitoring
Existence of Biodiversity	• Wetland Protection Act, 2000; • Environment Conservation Act, 1995, 2000, 2002; 2010 (Amendment) • The Environment Court Act 2010 • Environmental Conservation Rules, 1997, 2000, 2001; • The Marine Environment Conservation Act, 2004 • National Environment Policy 2018 • Bangladesh Biodiversity Act, 2017 • National Conservation Strategy, 2005; • National River Protection Commission Act, 2013; • Forest Act 1927; • Wildlife Protection and Security Act, 2012	• Environment Conservation Act 2000, 2002; 2010 (Amendment) • Environmental Conservation Rules 2000, 2001 • National Conservation Strategy, 2005;	Sufficient but need integration and post implementation monitoring and coordination, and integration with other government and non-profit organizations and institutions.

Key aspect in the theme	Primary legislation	Accompanying or enabling regulations	Comments
	• Protected Area Management Rules, 2017 • Ecologically Critical Areas Management Rules, 2016		
Waste Disposal	• Integrated Water Resources Management (IWRM), 2005 • Participatory Water Management Regulations, 2014 • Ship-breaking and Hazardous Waste Management Rules, 2010	• Participatory Water Management Regulations, 2014 • Ship-breaking and Hazardous Waste Management Rules, 2010	Sufficient but need integration and post implementation monitoring and coordination and integration with other government and non-profit organisations and institutions.
Tourism	• Tourism Board Act, 2010; • Bangladesh Tourism Protected Areas and Special Tourism Zone Act, 2010; • Bangladesh Tourism Protected Areas and Special Tourism Zone Rules, 2011 • Bangladesh Parjatan Board Act, 2010 • The Bangladesh Parjatan Corporation Order, 1972 • Bangladesh Tourist Reservation Area and Special Tourism Zone Act, 2010 • Bangladesh Tour Operators and Tour Guides (Registration and Operation) Act, 2021 (Draft)	• Bangladesh Tour Operators and Tour Guides (Registration and Operation) Act, 2021(Draft) • Bangladesh Tourism Protected Areas and Special Tourism Zone Rules, 2011	Sufficient but need integration and post implementation monitoring and coordination and integration with other government and non-profit organizations and institutions.
Shipping and Transport and maritime spatial management	• Clean Air Act; • Import Policy Orders, 2012-2015; • The Port Authority Act, 1976 • Payra Port Authority Act, 2013; • Chittagong Port Authority Act, 1995; • Mongla Port Authority Act, 1995 • Navy Ordinance, 1961 • Coast Guard Act, 1994 • Bangladesh Merchant Shipping Ordinance, 1983 • Territorial Waters and Maritime Zones Act of 1974 • Maritime Act, 2018 (Draft) • Navy Ordinance of 1961 • Bangladesh Maritime Zones Act, 2019 • Territorial Waters and Maritime Zones (Amendment) Act, 2021 • National Coastal Zone Policy 2005	• Navy Ordinance, 1961 • Coast Guard Act, 1994 • Bangladesh Merchant Shipping Ordinance, 1983	Sufficient but need integration and post implementation monitoring and coordination and integration with other government and non-profit organizations and institutions.
Ocean Based Industries	• Inclusive Digital Financial Systems, 2015	Bangladesh Economic Zones Act, 2010	Sufficient, but need integration and post implementation

Key aspect in the theme	Primary legislation	Accompanying or enabling regulations	Comments
	• Bangladesh Economic Zones Act, 2010		monitoring and coordination and integration with other government and non-profit organizations and institutions.
Energy	The Bangladesh Petroleum Act, 1974		Sufficient but need coordination with other institutions and organizations
Living Resources	• Fish Hatchery Act 2010 • Fish Hatchery Rules 2011 • Fish Feed and Animal Feed Act 2010 • Fish Feed Rules 2011 • Fisheries Research Institute Ordinance 1984 • The Marine Fishery Ordinance, 1983 • Marine Fisheries Act of 2020 • Fish and Fish Products (Inspection and Quality Control) Ordinance, 1983 • Fish and Fish Products (Inspection and Quality Control) Bill, 2020	• Fish Hatchery Rules 2011 • Marine Fisheries Act of 2020 • Fish and Fish Products (Inspection and Quality Control) Bill, 2020 • Fish Feed Rules 2011	Sufficient but need integration and post implementation monitoring and coordination and integration with other government and non-profit organisations and institutions.

7.8 Brief Description of MaFin Relevant PPPs

Key PPPs relating to the theme	Main projects emanating from the PPPs	Main negative environmental impacts emanating from the projects	Main negative socio-economic impacts emanating from the projects
Payra Port Authority Act, 2013	Payra Deep Sea Port	• Higher carbon footprint • Larger amount of disposed wastage • Hamper in marine and costal biodiversity	Relocation of local people and excessive labor influx
Bangladesh Maritime Zones Act	• Bangladesh Institute of Maritime Research and Development • Oceanographic Research Institute of Bangladesh (Act No. 7 of 2015)	None	None
• Perspective plan • 8th five-year plan • 7th five-year plan	• EU-BGD Joint collaboration on Blue Economy • Blue Delta Governance Project	None	None

Key PPPs relating to the theme	**Main projects emanating from the PPPs**	**Main negative environmental impacts emanating from the projects**	**Main negative socio-economic impacts emanating from the projects**
• Bangladesh Delta Plan • Bangladesh Climate Change Strategy and Action Plan (BCCSAP) • National Action Plan for Adaptation (NAPA)	• Bangladesh Navy frigate program • BNS Sheikh Hasina - full-fledged submarine base of Bangladesh Navy		
Bangabandhu Sheikh Mujibur Rahman Maritime University, Bangladesh Act 2013 (Act No. 47)	Bangabandhu Sheikh Mujibur Rahman Maritime University (BSMRMU)	None	None
Renewable Energy Policy, 2008	• 60MW wind power generation plant in Cox's Bazar • Ocean wave energy based power plant for Sandwip • A dozen other wind powered energy generation plants to be implemented (underway)	None	None
• National Marine Fisheries Policy; • National Aquaculture Development Strategy and Action Plan (2013-2020) • National Shrimp Policy 2014	• Fish Research and Survey Vessel 'RV Meen Sandhani' has so far conducted 35 survey cruises • Pilot Project on Tuna and Similar Pelagic Fishing in the Deep Sea	Excess catch of fisheries due to lack of proper maintenance and monitoring	None
• National Tourism Policy, 2009 • National Tourism Policy 2010 • Tourism Master Plan (2021–2041) • Tourism Vision 2020	• Parky Beach development Project • Kuakata Tourism Project • St. martins Tourism Project • Feasibility study to construct the global standard tourist establishment in Sundarbans. • Development of Tourism resort and entertainment village at Parjatan Holiday complex in Cox's Bazar • International standard Tourism Complex in the existing Motel Upal Compound of BPC in Cox's Bazar. • Poshur Hotel Compound Development at Mongla • Sheikh Hasina Tower at Khurushkul in Cox's Bazar, establishment of an exclusive tourist zone	• Higher carbon and water footprint • Larger amount of wastage and pollution • Hamper the marine and coastal biodiversity.	

7.9 Drivers of Change

In the following table four major forces are summarized as external drivers of future growth in the output from Bangladesh's ocean economy: (i) demographic change, (ii) markets and the economy (market size, profitability, micro- and macro-economic trends, and investment), (iii) science and technology (technology methods and innovations, intellectual property),) and (iv) climate change.

Key change	Main external drivers	Main internal drivers	Main actions to "fuel" or "brake" the drivers, depending on whether the change is good or bad
Explosive increase in Aquaculture	• Rapid Increase in global technologies for aquaculture • Increase in global population and global market demand for marine foods	• Technological and knowledge development • Government initiatives	• Larger investment • Capacity build-up • Public-private partnership
Steady growth in fishing	Increase in global population and global market demand for marine foods	• Technological and knowledge development along with more equipped vassals to catch fish in the deep sea • Government initiatives • Lack of marine product diversification	• Larger investment • Capacity build-up • Public-private partnership • Expansion of the commercial fishing area (beyond the 80 m depth) • Value addition and reducing post-harvest losses • Real time/dynamic assessment of fisheries stocks
Stagnant commercial shipping and trade	Nearby sea-ports have much more facilities, swift and hassle-free, easier transit connectivity	• Lack of Deep sea port facilities • Inadequate port facilities and less capacity	• Deep sea port • Swift and smooth administrative procedures • Capacity build-up
Moderate increase in tourism	Increased global demand	Government initiatives	• Introducing new tourism products • Improve the existing tourist sites • Develop new tourist spots • Issuance of on arrival visa and one stop service to the foreign tourists.
• Oil spills and other forms of marine pollution in the Bay of Bengal • Ocean acidification, mangroves	Free rider's problem Increased traffic in the sea	• Mass industrialization without maintaining necessary environmental regulations • Adopting low-end and	• Proper integrated co-ordination among government agencies • Public Private partnership • Proper environmental impact assessment guideline for the ocean economy.

Key change	Main external drivers	Main internal drivers	Main actions to "fuel" or "brake" the drivers, depending on whether the change is good or bad
and sea grass meadows reduction • Environmental and social costs of ship breaking industry		environmentally unsustainable technologies	• Following international regulations for dumping leftover ship materials • Capacity building for monitoring and evaluation. • Implementing polluters' pay/tax/compensation to reduce the pollution. • Implementing ecosystem services valuation and payment schemes to reduce free riders problem.
Declining Mangrove revenue	Climate change and natural disasters	Increased livelihood dependency	Restoration of mangrove forests through afforestation and reforestation
Constant/average salt production	• Technological improvement in salt production at Europe and North America • Risk from losses due to rainfall (Al Mamun et al. 2014)	• Comparative disadvantage • High cost of capital from largely informal institutions (Al Mamun et al. 2014)	• Improvements in production processes • Easing the loan facilities in the formal sector • Enforcing law and order to curb the influence of the informal sector
Lowest ship building productivity in the world Declining market demand of ship building	• Lack of technological invention, and innovation • Countries like China and Vietnam are leading the ship building industry in this region which is suppressing the demand of ship building in Bangladesh	• Lack of capital-intensive mode of production • Lack of global reputation	• Conducting training program • Incorporating process enhancement • Modernizing yard facilities • Employing more integrated production technology
Declining growth of ship breaking industry	Uncertain future demand of ship breaking induced items and materials	Lack proper investment and infrastructure support	• Government support, capacity building, investment and need assessment with future demand projection • Upgrade the infrastructure for waste management, and occupational health and safety of the workers

7.10 Concluding Remarks

The potential of the blue economy towards the growth of the GDP of Bangladesh is very much apparent. It is evident that, how marine resources can directly add to a sustainable blue growth. For an example, every 10% development of a port throughput may generate a 6 - 20% increase in the GDP of that region. In the near future, there will be at least four ports running in full swing (Chittagong, Mongla, Payra and Matarbari) in Bangladesh (Mannan et al., 2021) which signals the future growth of the economy of Bangladesh.

There are some large fast-track mega projects to develop the infrastructure, roads and connectivity of Bangladesh. The government is planning to build the EPZs and SEZs in almost every division. To get the fruit ripe and sweet infrastructural growth, network and connectivity needs to be aligned with the ocean economy maintaining the marine ecosystem.

Therefore, there needs a strong co-ordination among the government bodies, donor agencies, private organizations, NGOs and public private partnership to strengthen optimal uses of the marine and blue economy with respect to the regulations, policies and programs.

8. Infrastructure and Navigation

8.1 Background

Infrastructure is essential to the growth of a nation. As Bangladesh aspires to become a developed country in order to achieve Vision 2041, this sector will play an essential role in ensuring socioeconomic development of Bangladesh. Road, rail, air, and waterways are the connecting connectors between villages, districts, regions, and countries. Inter- or intra-regional connectivity through transportation and communication development paves the way for accelerated growth by providing access to laggard regions. There are many challenges in infrastructural development such as lack of maintenance and insufficient funding, slow implementation, encroachments on major highways and land resettlement, traffic growth and road safety, climate change and hazards, lack of access to facilities in rural areas, and institutional issues ((BDP2100, 2018)).

In the last decade, many infrastructural developments have taken place and a range of mega projects are in the pipeline in the Payra-Kuakata area such as the Payra sea port and the Padma Bridge. Apart from the improved communication, development of infrastructure can lead to both positive and negative environmental and societal impacts which will be addressed by the Strategic Environmental Assessment (SEA) of Payra-Kuakata area.

8.2 Objectives

The overall objectives of the Strategic Environmental Assessment are to achieve

- Identifying the main environmental concern and indicators of the Payra Kuakata Coastal Region
- Spatially resolving the main effects
- Assessing the effects using suitable environmental indicators.

This report will provide an overview of the historical background and information on the baseline standing of infrastructure of the Payra-Kuakata area, and predicts for the growth of traffic (passengers and freight) and other infrastructure. It also describes projects, the main legislation and relevant government policies, plans and programmers (PPPs) and their possible influences, and outlines the competent agencies and their roles.

8.3 Administration/Agencies/Institutions under the Ministers and Other Organizations

8.3.1 Ministry of Housing and Public Works

The Ministry of Housing and Public Works is a ministry of the government of the People's Republic of Bangladesh which provides housing and regulates the state construction activities in the country. The Ministry of Housing and Public Works provides housing and regulates the state construction activities in the country. This ministry was formed on 12 January 1972. Its head office is situated in in the Secretariat, Dhaka. The directories under this ministry are Khulna Development Authority, Public Works Department, Chittagong Development Authority, National Housing Authority, Urban Development Directorate, Capital Development Authority (RAJUK), Rajshahi Development Authority, Department of Architecture, Housing and Building Research Institute and; Directorate of Government Accommodation.

Vision

Safe, affordable, habitable housing and facilitative working environment.

Mission

To provide housing facilities for standard living of the people in urban areas and better working environment for public offices through planning, research and proper use of land.

Functions

- Formulation and amendment of housing policies, Laws, codes and rules.
- Research and technological innovation on housing, building construction, urban development.
- Preparation of architectural and structural design of public buildings and other infrastructure.
- Collection of revenues.
- Allotment of government offices and residents.
- Management of abandoned property and acquired land.
- Preparation of master plan

Roles & responsibilities

The Ministry of Housing and Public Works (MoHPW) is responsible for carrying out public sector construction and looking after urban and city development housing settlements across the country. The State-owned House Building Finance Corporation is designed to ensure adequate and accessible credit flow to this sector.

The Ministry of Housing and Public Works has developed a number of different polices, including the Bangladesh Housing Policy (BHP) and Land Acquisition Policy (LAP) designed to ensure better housing to the landless and helpless people across Bangladesh.

8.3.2 Ministry of Railways

Railway is the largest state transport sector of the government of Bangladesh among the public transport modes of the country. The first railway in this country was started on 15 November 1862 with the construction of Darshana-Jagati railway line. At present Bangladesh Railway's 2877 km railway line network is connected to 44 districts of the country. After 2011, GoB has established Ministry of Railways. Now, the activities of Bangladesh Railway were conducted under the Ministry of railways

Vision

To provide safe, reliable, cost effective and time efficient rail transport service in the country through modernizing, expanding & maintaining rail system in a manner which supports government strategies for economic, social & environmental development.

Mission

To build a safe, affordable, efficient and environmentally friendly railway network across the country through expansion and modernization of railway transport system.

Major Activities

- To develop & maintain railway tracks & station infrastructures throughout the country.
- To maintain & upgrade locomotives, coaches & other rolling stocks.

- To maintain & modernize signaling & interlocking system & Telecon system of Bangladesh Railway.
- To ensure safe, speedy & efficient train operation.
- To implement Government transport policy in rail sector.
- To Procure modern technology related rolling stocks, track materials & signaling systems suitable for Bangladesh Railway.
- To manage land asset of Bangladesh Railway.
- To ensure optimum utilization of Development Budget & Revenue Budget of Bangladesh Railway.

Bangladesh Railway

Bangladesh Railway also known as Bangla Rail is the state-owned rail transport agency of Bangladesh. It operates and maintains all railways in the country, and is overseen by the Directorate General of Bangladesh Railway. The Bangladesh Railway is governed by the Ministry of Railways and the Bangladesh Railway Authority.

Vision

Safe, affordable, modern and environmentally friendly railway transport system.

Mission

To build a safe, affordable, efficient and environmentally friendly railway network across the country through expansion and modernization of railway transport system.

Major Activities

- Formulation of policies and strategies for railways and rail transport and safety;
- Development, expansion and maintenance of railways including Bangladesh Railways;
- Coordination of railway system at national and international level;
- Survey and monitoring of rail transport;
- Formulation and implementation of safety policies for rail transport;
- Establishment of international railway system and execution of transport agreements;
- Determination and rescheduling of fares and tolls of Bangladesh Railway;
- Conduction of development and investment programs and budgetary activities of Bangladesh Railway;
- Conduction and control the administrative activities of all offices and agencies under the Ministry.

8.3.3 Ministry of Road Transport and Bridges

The Ministry of Communication is now Ministry of Road Transport and Bridges. The government has changed the name of the Ministry of Communication on February 10, 2014 to avoid confusion and complications, particularly in the international arena. The mission of this ministry to build sustainable, safe and quality highway network and integrated modern mass transport system in order to improve socio-economic condition of the people through development and expansion, repair, rehabilitation

and maintenance of highways. The vision of this ministry is to ensure the sustainable highways and safe road transport.

Vision

Sustainable Highways and safe Road Transport.

Mission

To build sustainable, safe and quality highway network and integrated modern mass transport system in order to improve socio-economic condition of the people through development and expansion, repair, rehabilitation and maintenance of highways.

Major Functions

- Repair, rehabilitate and maintain the highway network
- Improve and expand the national, regional highways and zilla roads
- Adopt and accomplish economically important highway projects
- Introduce and operate digital motor vehicle management system
- Ensure road safety
- Introduce and operate integrated mass rapid transit system
- Provide passenger and cargo services on domestic and international routes
- Encourage Public Private Partnership (PPP) in road transport sector

Roads and Highways Department

Roads and Highways, the apex body of GoB responsible for the construction and maintenance of major road and bridge network of Bangladesh was created in 1962. Vision of RHD is to develop an efficient highway network. RHD is committed to the mission – to develop sustainable, safe and quality road infrastructure for socio-economic development of the people by repair, reform, maintenance, development and extension of highways.

Bangladesh Road Transport Corporation

Bangladesh road transport Corporation (BRTC) is state owned organization which mandate is to build a safe and modernized transport system all over the Bangladesh. BRTC was established in 1961 and it is responsible for issuing bus and maintaining public transport. BRTC have set some mission-

- Increasing passenger's facilities
- Building skill manpower in transport sector
- Increase number of Vehicle

8.3.4 Ministry of Disaster Management and Reliefs

Vision

To reduce the risk of people, particularly the poor and vulnerable, from the effects of natural, environmental, human-caused hazard.

Mission

Ministry of disaster management and reliefs has been set mandate to carry out disaster risk reduction reform programs such as disaster resilient infrastructure, integrated capacity building program.

Major functions

- Building disaster resilient infrastructure Such as MuJib Killa, Roads
- Manage the national, local level disaster awareness building training
- Supplies relief to disadvantages people during disaster
- Run some project such as work for food
- Allocating relief in disaster prone area

Department of Disaster management

Department of Disaster management (DDM) was established in 2012 under Disaster management act,2012. DDM has been set its mandate is to reduce overall vulnerability to disaster impacts through undertaking risk reduction activities; efficiently carrying out humanitarian assistance programs to strengthen the capacity of the poor and disadvantaged; and strengthening and coordinating disaster risk reduction and emergency response programs carried out by various government and non-government organizations. DDM would function as a thriving center of excellence for Disaster Risk Reduction (DRR) integration into the Disaster Management Program.

8.3.5 Ministry of Civil Aviation and Tourism

Mission

Provide safe, secure and efficient civil aviation facilities and attract tourist by diversification of tourist products and improved service delivery.

Vision

Prime aviation hub and attractive tourist destination.

Major Functions

- Formulation, updating and implementation of laws and policies relating to civil aviation and tourism;
- Modernization of airports and coordination of air routes and air services;
- Supervision of activities relating to air space control, safe take-off and landing of aircraft, aeronautical inspection, and the issuance of licenses for aircrafts and pilots;
- Increase competitiveness and services of Biman Bangladesh Airlines as national flag carrier;
- Signing of contracts relating to civil aviation and tourism with local and international organizations and their coordination;
- Providing license and registration of travel agencies, hotels and restaurants and renewing and controlling of those;
- Development and marketing of tourism products and undertaking research for development of tourism industry, its modern management and creation of efficient manpower; and

- Establishment, operation and control of allied services-based organizations relating to the overall development of tourism industries.

8.3.6 Ministry of Information

The Ministry of Information is the branch of the Government of Bangladesh responsible for formulation and implementation of the rules and regulations and laws relating to information, broadcasting, the press and films in Bangladesh. After the Independence War of 1971, the 'Ministry of Information and Radio' was formulated. Later, the ministry was renamed 'Ministry of Information' without altering any of the responsibilities. At present, Dr. Hasan Mahmud, MP is the Honorable Minister of Ministry of Information.

Vision of the Ministry of Information is management of dynamic, participatory and transparent flow of information. The mission of Ministry of Information is to involve, inform, aware and motivate people in the free and participatory flow of information and ensure peoples' right to information by strengthening public and private media outlets.

Ministry of Information is allocated to carry out following business, according to Rules of Business, 1996 (Revised up to April 2017):

- Publicity policy- internal and external
- Audio-visual, pictorial and press coverage of all activities of the President, Prime Minister and Ministers both home and abroad.
- Co-ordination of publicity activities of the different Ministries/ Divisions and Bangladesh Missions abroad.
- Films including production of news reels and documentaries.
- Press relations including journalists' delegation and other media delegation.
- Policy regarding Government advertisement.
- Maintenance of rural publicity organizations.
- Preparation and release of communiques, press notes, handouts *etc.*
- Press arrangement in connection with tours of the President, Prime Minister and Ministers.
- Community listening schemes.
- Bengali translation of Acts, Rules *etc.*
- Preparation of media lists.
- Preservation and interpretation of the policies and activities of the Government of Bangladesh through the medium of the press.
- Advising Government of information problems relating to the press, keeping Government informed of the main trends of public opinion as reflected in the press and liaison between Government and the press.
- Administration of press and publication law.
- Publicity for the armed forces
- Administration of the press and regulation of Books Act and the Newspaper Act.
- Publicity of the Five-Year Plans.

- Financial assistance to distinguished musicians, both vocal and instrumental, dancers and dramatists who have contributed substantially to the success of Radio and other units of this Ministry or the survivors in indigent circumstances.
- Administration of Radio and Television and all other matters relating to broadcasting and Television: Bangladesh Betar and Bangladesh Television.
- Analysis and interpretation of public opinion as reflected in the national press.
- Arrangement for the President's press briefings/conference/moots
- Monitoring the performance of national press and broadcasting media and submission of regular reports to the President.
- Preservation as "National Records" of all speeches of the President.
- Administration of BCS (information).
- Matters relating to trust for press. Dainik Bangla and Dainik Barta Ltd.
- Compulsory screening of films.
- Sanctioning of Cinematograph films for exhibition.
- Administration of Cinematograph Act; Cinematograph and Censorship.
- Grant of State awards for films produced in Bangladesh.
- Matters relating to Bangladesh Film Development Corporation.
- Bangladesh Film Archives.
- Secretariat administration including financial matters.
- Administration and control of subordinate offices and organizations under this Ministry.
- Liaison with International Organizations and mattes relating to treaties and agreements with other countries and world bodies relating to this Ministry
- All laws on subjects allotted to this Ministry.
- Inquiries and statistics on any of the subjects allotted to this Ministry.
- Fees in respect of any of the subjects allotted to this Ministry except fees taken in courts.

Ministry of Information transacts through 12 agencies-

1. Press Information Department (PID):
2. Bangladesh Betar:
3. Bangladesh Television (BTV):
4. Department of Mass Communication (DMC):
5. Department of Films & Publications (DFP):
6. Bangladesh Film Archive (BFA)
7. Press Institute of Bangladesh (PIB)
8. National Institute of Mass Communication (NIMC)
9. Bangladesh Sangbad Sangstha (BSS)
10. Bangladesh Film Development Corporation (BFDC)
11. Bangladesh Film Censor Board (BFCB)
12. Bangladesh Press Council (BPC)

8.3.7 Ministry of Local Government, Rural Development and Co-operatives

The Ministry of Local Government, Rural Development and Co-operatives is a ministry in the cabinet of the government of the People's Republic of Bangladesh. It is responsible for the housing and building, regional and rural policy, municipal and cities administration and finances, and the conduct of elections. Mr. MD. Tazul Islam, MP is the honorable minister and Mr. Swapan Bhattacharjee, MP is the honorable state minister of this ministry at present.

The Ministry of Local Government, Rural Development and Co-operatives contains two divisions:

- Local Government Division
- Rural Development and Co-operatives Division

Local Government Division

Local Government Division is implementing various development and service-oriented activities for poverty alleviation and to make the rural people's life more comfortable, sound and meaningful. The activities of the LGD is extended up to the grass- root level of the country. The Union Parishad, Upazila Parishad, Zila Parishad, Municipalities and City Corporations are the Local Government Institutions under this division. In addition, the Local Government Engineering Department (LGED), Department of Public Health Engineering (DPHE), Dhaka WASA, Chittagong WASA, Khulna WASA and National Institute of Local Government (NILG) are the different Department /Directorate/Institutions of this Division.

Mission of LGD is – "Improving the standard of living of the people by strengthening local government systems and institutions and implement activities for social, economic and infrastructure development".

LGD performs the following Major Functions:

- Manage all matters relating to local government and local government institutions
- Finance, control and inspect local government institutions established for the running of local government and local administration
- Manage all matters relating to drinking water
- Develop water supply, sanitation and sewerage facilities in rural and urban areas
- Construct, maintain and manage Upazila, union and village roads including the roads of towns and municipal areas and bridges/ culverts
- Manage matters relating to village police
- Develop, maintain and manage growth centers and hats-bazaars connected via Upazila, union and village roads
- Develop, maintain and manage small scale water resource infrastructures within the limit determined by the government

Local Government Engineering Department

Local Government Engineering Department (LGED) is one the largest engineering agencies of the country. It began its journey in 60s as Rural Works Programme and with the passage of time its activities expanded from remotest corner of the country up to the cities.

Vision

LGED would continue to remain professionally competent, efficient and effective public sector agency for performing the interrelated and complementary functions of:

Developing, maintaining and managing transport, trading and small scale water resources infrastructure at the local level by ensuring LGI and community participation and taking care of environmental and social issues.

Providing technical and institutional support to strengthen the local government institutions and serving local communities and other stakeholders.

Mission

- Development and management of local infrastructure for increasing farm/non-farm production,
- Generating employment, improving socio-economic condition, promoting local governance,
- Reducing poverty and
- Acting as agent of change at the local level.

Major Activities

- Rural Infrastructure:
  - Construction/ Rehabilitation / Maintenance of Rural Road Bridge/ Culvert
  - Development and Maintenance of Growth Centre/ Hat Bazar
  - Construction of Landing Station (Ghat)/ Jetty
  - Construction of Union Parishad Complex
  - Construction of Upazila Parishad Complex and Upazila Parishad Extension Administration Building with hall room
  - Construction of Multi-Purpose Cyclone Shelter
  - Tree Plantation
  - Implementing labor Intensive activities through Labor Contracting Society (LCS)
- Urban Infrastructure:
  - Construction/ Rehabilitation / Maintenance of Rural Road Bridge/ Culvert
  - Development and Maintenance of Growth Centre/ Hat Bazar
  - Construction of Landing Station (Ghat)/ Jetty
  - Construction of Union Parishad Complex
  - Construction of Upazila Parishad Complex and Upazila Parishad Extension Administration Building with hall room
  - Construction of Multi-Purpose Cyclone Shelter
  - Tree Plantation
  - Implementing labor Intensive activities through Labor Contracting Society (LCS)
- Small Scale Water Resource Development:
  - Construction of Sluicegate
  - Construction Rubber Dam

- Excavation and Re-excavation of Canals
- Construction and Re-Construction Embankment
- Formation of Water Management Cooperative Society (WMCA)
- Excavation of Pond
- Micro Credit Program
- Income Generation related Training Program

Rural Development and Co-operatives Division

Mission Statement of RDCD is "To reduce poverty and improve the socio-economic conditions of the poor people living in rural areas through rural development, cooperative based activities and conducting continuous research on rural development."

Mandates of RDCD are presented below:

- Formulation of rural development policy and laws, rules and policy relating to cooperatives;
- Formulation and implementation of programmes/and projects to alleviate rural poverty;
- Assist entrepreneurs through micro-credit, agricultural credit, co-operative based small and cottage industries, co-operative bank, co-operative insurance, co-operative based farming and marketing, milk and other cooperative enterprises;
- Initiate human resource development programmes for members of the cooperatives, provide education, training and conduct research programmes on rural development and cooperatives;
- Innovate new model/strategy on rural development through action research;
- Assist in the socio-economic development and empowerment of rural women through formation of formal and informal groups under cooperative programmes.

Rural Development and CO-operatives Division transacts through following departments-

1. Department of Cooperatives
2. Bangladesh Rural Development Board (BRDB)
3. Bangladesh Academy for Rural Development (BARD)
4. Rural Development Academy (RDA)
5. Bangabandhu Academy for Poverty Alleviation and Rural Development (BAPARD)
6. Bangladesh Milk Producers' Cooperative Union Limited (Milk vita)
7. Palli Daridro Bimochon Foundation (PDBF)
8. Small Farmer Development Foundation (SFDF)
9. Bangladesh Samabaya Bank Ltd.
10. Bangladesh National Cooperative Federation for Rural Development (BNCFRD)

8.3.8 Ministry of Shipping

Ministry of Shipping is the apex body of Government of Bangladesh responsible for formulating policies and plans on subjects such as national waterways, inland water transport, ports, ocean shipping, safety, environmental regulatory aspects of maritime shipping and maritime education and facilitating implementation of various projects. This ministry also oversees the maintenance and expansion of water transportation and communication systems.

Vision of Ministry of Shipping is to ensure World class management of ports, maritime and water transportation. The ministry serves the mission- Modernization of sea ports, river ports and land ports, conservation of navigability of waterways, creation of efficient workforce in the maritime sector, safe and affordable transportation of passengers & goods and facilitation of international trade.

- Ministry of Shipping has following departments-
- Bangladesh Inland Water Transport Authority (BIWTA)
- Bangladesh Inland Water Transport Corporation (BIWTC)
- Chittagong Port Authority
- Mongla Port Authority
- Bangladesh Land Port Authority
- Bangladesh Shipping Corporation (BSC)
- Department of Shipping
- Marine Academy
- National Maritime Institution
- National River Protection Commission
- Paira Port Authority
- Directorate of Seamen & Emigration Welfare

Bangladesh Inland Water Transport Authority (BIWTA)

BIWTA is the authority for development, maintenance and control of inland water transport in Bangladesh. It is the successor of EPIWTA, which was formulated in accordance with the Inland Transport Authority Ordinance in 1958.

Statement of vision of BIWTA is to mobilize economic growth of Bangladesh by creating a safe and efficient inland water transport network. BIWTA serves the following missions-

- Development and maintenance of navigation routes
- Facilitating safe and efficient loading/ unloading of passenger and freight
- Developing an intermodal transport system through co-ordination with other modes of transport
- Human resources development in inland water transport sector

Major functions of BIWTA are of 2 categories-

- Development and Maintenance Functions
    - Carry out river conservancy works including river training works for navigational purposes and for provision of aids to navigation including marks, buoys, lights and semaphore signals
    - Disseminate navigational and meteorological information including publication of river charts
    - Provided pilotage and hydrographic survey services
    - Draw up programmers of dredging requirements and priorities for efficient maintenance of existing navigable waterways and for resuscitation of dead or dying rivers, channels, or canals, including development of new channels and canals for navigation

- Develop, maintain and operate inland river ports, landing/ferry ghats and terminal facilities in such ports or ghats
- Carry out removal of wrecks and obstruction in inland navigable waterways
- Conduct traffic surveys to establish passenger and cargo requirements on the main rivers, feeders and creek routes
- Develop rural water transport by progressing of schemes for modernizing and mechanizing country craft
- Ensure co-ordination of Inland Water Transport with other forms of transport, with major sea ports, and with trade and agricultural interests for the optimum utilisation of the available transport capacity
- Conduct research in matters relating to Inland Water Transport including development of-
  - Craft design
  - Technique of towage
  - Landing and terminal facilities
  - Port installations
- Arrange programmes of technical training for Inland Water Transport personnel
- Maintain liaison with the shipyard and ship repair industry to meet the requirements of the Inland
- Water Transport fleet repairs and new constructions
- Maintain liaison with the Government and facilitate import of repair materials for the Inland Water Transport Industry
- Prepare plans or schemes for carrying out any of the above-mentioned functions.

- Regulatory Functions
  - Fixation of maximum and minimum fares and freight rates for Inland Water Transport on behalf of the Government
  - Approve time tables for passenger launch services
  - Inspection shies, cargo and inland vessel to ensure compliance with the provision of ISO -1976
  - Act as the Competent Authority of Bangladesh for the protocol on Inland Water Transit and Trade, looking after the use of waterways of Bangladesh on behalf of the Govt. of Bangladesh for the purpose of trade and transit between Bangladesh and India as provided in the Protocol

Payra Port Authority

Payra Port is the 3rd sea port of Bangladesh located in general area in East on the bank of Rabnabad Channel under Kalapara in Patuakhali. Vision of Payra Port Authority is stated as (PPA, 2013)

Objective of Payra port authority is to provide necessary services and facilities to the port users efficiently and effectively at competitive price. Though it started its limited scale port operations by offloading bulk cargoes at inner/outer anchorage, with the passage of time it is going to handle maximum volume of container and bulk cargoes of Bangladesh using the geographical advantages and good hinterland connectivity.

8.3.9 Ministry of Power and Mineral Resources

Vision

Secure and clean energy for everyone

Mission

- Access to affordable reliable sustainable modern energy for everyone
- Promote green energy to protect climate change

Function

- Building Robust infrastructure for energy supply and distribution
- Efficient use of domestic energy resource
- Development of green energy resource
- Human capital development
- Generation energy policy and act

Bangladesh Rural Electrification Board

Bangladesh Rural Electrification Board (BREB) is a government owned organization which was established in1977. BRED have set up their mandate to provide sustainable, reliable, affordable electricity to all within 2030. It provides services in rural areas of Bangladesh.

West Zone Power distribution company limited

West Zone Power distribution company Limited (WZPDCL) was established in 2002. WZPDCL have been mandated to provide electricity to 21 districts of Southern and south-western area of Bangladesh. Mission of WZPDCL is to provide quality electricity at reasonable, affordable prices through excellence of professional services.

8.3.10 Bangladesh Economic Zones Authority

Bangladesh Economic Zones Authority (BEZA) has been founded in 2010 under the Bangladesh Economic Zones Rule, 2010. BEZA has been operated under the Prime Minister's Office and it is responsible to build and manage all special economic zones. BEZA has fixed its goal to build 100 economic zones on 30.000 hectares of land, creating 10,000,000 jobs within the next 15 years.

8.3.11 Summary of Key Aspects, Competent Authority and Its Performances

The primary competent authority (ministries/agencies) responsible for managing resources/issues, and their roles, mandates and performance are briefly summarized in the following table:

Key aspect	**Primary competent authority (CA)– and their mandates**	**Key support organisations (govt, NGO, donor, CBO, etc.)**	**Performance of CA and support organisations**
Sustainable Housing	• MoHPW • MoLGRDC	• GoB, • UNICEF • BHBFC	☐Exceeds Expectations ☐Meet Expectations ☒ Need Improvement ☐ Unacceptable

Key aspect	Primary competent authority (CA)– and their mandates	Key support organisations (govt, NGO, donor, CBO, etc.)	Performance of CA and support organisations
Mass transport system	• Bangladesh Railways • BRTC • BIWTA	• GoB, • WB, • JICA • ADB	☐Exceeds Expectations ☐Meet Expectations ☒ Need Improvement ☐ Unacceptable
Disaster risk Mitigation	• DDM, • MoDMR	• GoB • World Bank • USAID • JICA • ADB	☐Exceeds Expectations ☒Meet Expectations ☐ Need Improvement ☐ Unacceptable
Blue economy-based Development	• Ministry of shipping • BEZA • Payra Port Authority • BIWTA	• GoB • World Bank • JICA •	☐Exceeds Expectations ☐Meet Expectations ☒ Need Improvement ☐ Unacceptable
Availability of power and energy	• WZPDCL • BREB	• GoB, • MoPEMR	☐Exceeds Expectations ☒Meet Expectations ☐ Need Improvement ☐ Unacceptable

8.4 Relevant Plan, Policy and Programs

The following PPPs have been specifically reviewed for the infrastructure sector:

- Integrated Multi-Modal Transport Policy 2013
- National Land Transport Policy 2004
- Road Master Plan 2009
- Railway Master Plan (2010-2030)
- National Shipping Policy 2000
- Coastal Development Strategy, 2006

There are also national level multi sectoral plans such as Bangladesh Delta Plan 2100, National Water Management Plan 2004, Perspective Plan 2010-2021, Second Perspective Plan 2021-2041 which covers infrastructure.

8.4.1 Policies

Integrated Multi-Modal Transport Policy, 2013

This policy was developed by the Ministry of Communication (currently known as Ministry of Road Transport and Bridges) and Gazetted 26 September 2013, Published on 29 September 2013. The objectives are:

- To reduce cost of transporting goods and thus costs to public;
- To aid export competitiveness, through lower transport costs;
- To improve safety and reduce accident rate;

- To take advantages of Bangladesh's geographical position to trade through an efficient transport sector;
- To reduce the worst environmental effects of transport;
- To ensure that transport meets social needs in terms of cost accessibility to all sectors of society.

National Land Transport Policy, 2004

Road Transport and Highways Division, Ministry of Road Transport and Bridges prepared this policy in 2004. The objectives are:

- To provide a safe and dependable transport service;
- To remove unnecessary control and formulation of laws and regulations conducive to providing service;
- To control fares;
- To determine the roles of the government private sectors;
- To maintain an economic and environmental balance;
- To ensure maximum good utilization of government funds;
- To expand the role of transport in the ever-increasing economic activities;
- To reduce the transport cost of goods for export;
- To ensure growth of traffic commensurate with economic development;
- To introduction an integrated transport system;
- To provide alternate transport systems;
- To create awareness regarding better standard of life and safety;
- To alleviate poverty.

National Shipping Policy 2000

Ministry of Shipping developed these programmes comprising a set of projects for development of Shipping and maritime.

Objectives

- To develop a balanced and integrated transport network through adoption of strategies/programs;
- Integrating inland water transport sub-sector with the existing road transport system

Coastal Development Strategy, 2006

The Coastal Development Strategy (CDS) is based on the approved Coastal Zone Policy (CZPo) 2005. By identifying organizational goals and setting targets, CDS plans for organized priority activities and preparations for their execution. Strategies include ensuring fresh and safe water availability; safety from man-made and natural hazards; optimizing use of coastal lands; promoting economic growth emphasizing non-farm rural employment; sustainable management of natural resources: exploiting untapped and less explored opportunities; improving livelihood conditions of people-especially women; environmental conservation; empowerment through knowledge management; creating an enabling institutional environment.

Coastal Zone Policy 2005

The Coastal Zone Policy aims to provide a general guidance to all agencies and institutions concerned for the management and development of the coastal zone in a manner that provides a secure and conducive environment for coastal communities to pursue their life and livelihoods. Sustainable use of coastal resources is one of the recommended measures, limiting harvesting, extraction or utilization to the corresponding regeneration cycles. Efforts will be given to make sustainable use of natural resources.

8.4.2 Plans

Road Master Plan, 2009

This policy was developed by the Ministry of Road Transport and Bridges and approved on 2nd June 2009. The objectives are:

- To protect the value of RHD's road and bridge assets;
- To improve the connectivity of the road network;
- To enhance and develop the strategic road network to meet economic and traffic growth targets;
- To improve the Zila (District) Road network to enhance connectivity to the country's growth centers;
- To improve road safety and reduce road accidents;
- To provide environmental and social protection

Railway Master Plan (2016-2045)

This plan was prepared by Bangladesh Railway, which was approved 30th January 2018. The plan sets out measures to rehabilitate, modernize, improve and expand railway infrastructure, improve efficiency and operational capacity. The objectives are as follows:

- To allow the railways to play a greater role in the overall transport sector with a view to contributing to economic and social development;
- To prepare the railways for playing a transport role in regional and international context;
- To integrate railway network though a multi-modal approach;
- To increase railway efficiency with interventions to make best use of assets;
- To obtain a greater share of the freight market, with more efficient management of railway assets and improved financial efficiency (all NLTP goals).

Second Perspective Plan for the year: 2021-2041

This plan prepared by the Planning Commission of GED, Provides the road map for accelerated growth and lays down broad approaches for eradication of poverty, inequality, and human deprivation.

Key objectives relevant to infrastructure are:

- Achieve Upper Middle-Income Country (UMIC) status by 2031 and High-Income Country (HIC) status by 2041;
- Industrialization with export-oriented manufacturing and structural transformation into the future;

- A service sector of the future providing the bridge for the transformation of the rural agrarian economy to a primarily industrial and digital economy;
- Efficient energy and infrastructure as essential components of the enabling environment that facilitates rapid, efficient and sustainable growth;
- Building a country resilient to climate change and other environmental challenges;

Bangladesh Delta Plan 2100 (BDP2100)

BDP2100 was prepared to achieve safe, climate resilient and prosperous delta through ensuring long-term water and food security, economic growth and environmental sustainability. This plan was also the output of Planning Commission, GED approved in 2018.

Specific Objectives

- To ensure safety from floods and climate change-related disasters;
- To enhance water security and efficiency of water usages;
- To ensure sustainable and integrated river systems and estuaries management;
- To conserve and preserve wetlands and ecosystems and promote their wise use;
- To develop effective institutions and equitable governance for in-country and trans-boundary Water Resources Management;
- To achieve optimal and integrated use of land and water resources;

Eighth Five Year Plan 2021-25

Overall goal is to attain SDG targets and also eliminate extreme poverty by FY2031 and achieve High-Income Country (HIC) status by FY2041. Specific objectives are:

- To achieve GDP growth acceleration, employment generation and rapid poverty reduction;
- To restore human health, confidence, employment, income and economic activities;
- To empower every citizen to participate fully in, and benefit from, the development process;
- To provide a sustainable development pathway that is resilient to disaster and climate change, entails sustainable use of natural resources and successfully manages the inevitable urbanization transition.

Perspective Plan 2010-2021

The government has developed a Perspective Plan covering the period from 2010 to 2021. The aim of this plan is to implement Vision 2021.

Ensuring food security and environment-friendly Development have been particularly given emphasized in the Perspective Plan. This would be Translated through successive five-year plans. Priority attention has also been given on coastal Agriculture.

National Adaptation Programme of Action (NAPA) 2009

NAPA has recognized the necessity of addressing the environmental issue and natural resource management with the participation of stakeholders in bargaining over resource use, allocation and distribution. This action plan identified 15 priority activities including general awareness raising, capacity building, and project implementation in vulnerable regions with special focus on agriculture

and water resources and identified 45 adaptation measures with 18 immediate and medium-term adaptation measures

8.4.3 Summary of Key PPPs, Main Projects, and Its Environmental, Socio economic Impacts

Main relevant PPPs and their consequent environmental, social or economic impacts and why they arise, are briefly discussed in the Table shown below:

Key PPPs relating to the theme	Main projects emanating from the PPPs	Main negative environmental impacts emanating from the projects	Main negative socio-economic impacts emanating from the projects
Integrated Multi-Modal Transport Policy, 2013	• Padma multi-purpose bridge project • Bhanga-Payra Rail Link project	• Increased noise and air pollution due to traffic movement; • Increased risk of health hazards (e g from pollution); • Reduced run-off of polluted due to paved roads; • Habitat fragmentation may cause biodiversity loss; • Increased marine pollution due to inadequate waste management; • Increase in accidents due to night-time trips, especially during severe weather;	• Increased migration from rural to urban area due to better facilities; • Increased conflict over ownership of land/property in roadside areas. • Reduced value of properties located in the vicinity of railway stations; • Displacement of dwellers due to expansion of railways network; • Increased slum-dwelling due to migration of displaced people to urban areas; • Loss of agricultural land; • Displacement of people
National Land Transport Policy 2004	• Padma multi-purpose bridge project • Bhanga-Payra Rail Link project • Road Construction Project	• Conversion of roadside agricultural land to commercial land/ industrial land – due to improving road accessibility; • Increased noise and air pollution (with consequent health issues) due to increased traffic and congestion.	• Change or loss of livelihoods for boatmen due to construction of new bridges in the rural areas; • The use of natural gas in domestic purpose has been cut down by Government due to increasing CNG use in vehicles which are creating • Increased urban fire accident due to increased illegal connection of gas.
Road Master Plan 2009	• Padma multi-purpose bridge project • Bhanga-Payra Rail Link project		Increased accidents due to increase in roads use e.g. travelling to educational institutes, shopping malls etc.

Key PPPs relating to the theme	Main projects emanating from the PPPs	Main negative environmental impacts emanating from the projects	Main negative socio-economic impacts emanating from the projects
Railway Master Plan (2010-2030)	Bhanga-Payra Rail Link project	• Noise pollution near the residential areas • Increased occupational health and safety risks • Conversion of agricultural land and loss of wetlands due to construction of new railway corridors	• Involuntary resettlement, migration, and urbanization • Possible removal of important infrastructure/service facilities next to railway lines (e.g. clinics, health clubs, schools) could create local conflict and problems • Destruction/removal of cultural heritage sites (e.g. tombs, historical mosques and temples) when railways are improved/extended could create local conflicts and problems
National Shipping Policy 2000	• Ship construction and improvement project • Navy Land Acquisition • Payra Port Land Acquisition	• Increased navigation may disturb aquatic habitats • Change in land use required under this policy might cause land degradation	Establishment of new facilities and improvement/ modernization of existing infrastructure will harm the river and coastal ecosystem
National Energy Policy 1996	• Sena Kollan Organization Power Plant Land Acquisition • 132/33kv Grid Power Plant • 1320 Mega Watt Super Thermal Power Plant based on Coal at Patuakhali • 1320-Megawatt Thermal Power Plant • Ashugonj 1320-Megawatt Super Thermal Power Plant	• Increased temperature due to burn fossil fuel to produce energy • Increased noise and air pollution, and health risks	
The building construction act, 1952	• Treasury building construction at Barguna • Taltoli Fire Service Office	• Decreased wetland • Loss of agriculture and forest land • Destruction of natural habitant of wildlife.	Loss of livelihood of farmer

Key PPPs relating to the theme	Main projects emanating from the PPPs	Main negative environmental impacts emanating from the projects	Main negative socio-economic impacts emanating from the projects
	• Textile Vocational at Barguna • Taltoli Upazila Land Office • altoli Sub Registry Office • 4 Amtali Farmer Tanning Institute Construction • Bangabandhu Upashahar Cum Residential Area Development Project • Amtali Police Station • Barguna circuit house • Coastal Town Development Project • Fire service and civil defense station construction project at galachipa upazila • Payra Port Authority, Truck Terminal and Borjo Nirman		

8.5 Regulations

8.5.1 The Environmental Court Act 2000

The Environmental Court Act 2000 recommends the establishment of environmental courts for the trial of offenses relating to environmental pollution. It includes protocols for the establishment of the court, and defines the court's jurisdiction, appropriate penalties, powers of search and entry, and procedures for investigation, trial and appeal.

8.5.2 Environmental Conservation Act, 1995

The Bangladesh Environmental Conservation Act and the accompanying Rules are arguably the most important legislative documents for addressing industrial water pollution. The Act is dedicated to the "conservation, improvement of quality standards, and control through mitigation of pollution of the environment". The Environmental Conservation Act (1995) deals mainly with processes and activities that result in pollution. This Act also makes provision for the protection of ecosystems. Under the Act, the government can declare "ecologically critical areas" in any area likely to reach environmentally critical conditions and can specify operations and processes that cannot be initiated or continued in

those areas. The Act also confers power to the DoE to order corrective measures to be taken by any person believed to be responsible directly or indirectly for causing damage to the ecosystem.

8.5.3 Summary of Key Aspect, Primary Legislation and Its Accompanying Regulations, and Its Adequacy

Key aspect in the theme	Primary legislation	Accompanying or enabling regulations	Comments on adequacy or not re. legislation and regs
Environmental pollution	ECA, 1995; ECA 2000	ECR,1997	Adequate
Sustainable housing	TIA,1953	BNBC,1952,2004	Adequate
Protection of natural water flows and Navigable River Network	The Canal Act,1864	The Bangladesh maritime zones Act,2018, Payra Sea Port Act 2013	Adequate
Safe, Secure and Transport system	Road transport Corporation ordinance , 1961	Road Transport Act, 2018	Adequate
Affordable reliable and green energy for everyone	The Bangladesh Energy Regulatory Commission (BERC) Act , 2003	The Bangladesh Energy Regulatory Commission Act, 2003	Inadequate , did not cover the aspect of green energy
Disaster risk mitigation	Disaster Management Act, 2012	Standing order of Disaster, 2019	Adequate
Adaptable climate change measures	NA	NA	Required legislative rules and regulation , need control mechanism to excessive carbon emission
Delta management	Delta Act, Under preparation	NA	After the act will be passed then its adequacy can be measured.

8.6 Drivers of Change

8.6.1 Introduction

Infrastructure framework of the Payra-Kuakata region pays is a vital role in economic and social operations in this region. Due to demographic and economic needs, infrastructural development has been occurred very quickly. Consequently, properly planned and utilized infrastructural development fosters and facilitates socio-economic progress.

The main key drivers were identified by analyzing of the infrastructure development status,

- Expansion and upgrading of road network, railways, waterways and airways
- Mega project
- Blue-Economy based development
- Development of communication facilities

A brief account of how these driving factors influence the PKCP project area are presented here:

8.6.2 Expansion and Upgrading of Road Network, Railways, Waterways and Airways

The Government of Bangladesh is taking measures to increase the length, extent and level of service provided by these widely-used transportation modes. Each of these transportation modes has their merits. For example, Roadways offer door-to-door transportation (ease of user), Railways can carry the most passengers in a single enclosure (efficiency of space and time), cargo movement through the waterways is most energy efficient (cost-effectivity). A coordinated approach to utilize the merits of these modes will lead to better transport of passengers and freight.

8.6.3 Some Remarkable Mega Projects

Recently Padma bridge have been opened. This bridge connects the South and South-West region with the rest of the country in terms of roadways and railways. The commuting time have been shortened, which will make mobility of commuters and transportation of freight a lot faster. Faster mobility enhances development in this region.

Payra sea port is an environmental friendly port which is being created in southern region. This project is under construction. In the full operational phase, this project will be generating a new job in the EPZ, SEZ and ship building and repairing industries which will foster the economic growth of this region.

8.6.4 Blue Economy based Development

Bangladesh is blessed with a vast coastline. The prospect of utilizing the marine resources has been realized and steps are being taken with Blue Economy concept as the core directive. The Payra-Kuakata project area, having Bay of Bengal, waterways to other country, is a key player in utilizing the potential of Blue Economy in the coastal region.

8.6.5 Development of Communication Facilities

In this age of information transfer and connectivity, communication is more virtual rather than physical. Mobile phones and internet facilities reduce the need for physical mobility in most cases. If the improvement of communication facilities is not improved at the same rate as infrastructural facilities, the utility of infrastructures will get compromised.

Key change	Main external drivers	Main internal drivers	Main actions to "fuel" or "brake" the drivers, depending on whether the change is good or bad
Frequent Flooding	Intervention of river flow by Bridge, culvert and dam, Climate change	Unplanned Infrastructure development	Flood Protection, adaptation and mitigation measures Planned development
Vibrant economic growth	construction of regional road connectivity	Local Investment	Controlled development
Agricultural and forest land use change	High population growth	unplanned infrastructure development	Roadside tree plantation
Rapid Urbanization	development of regional transport system	Local demand of housing	Controlled development
Decrease of Aquaculture	Urbanization, Industrialization	Land use change	Wetland Conservation

8.6.6 Summary of Key Changes and Its External-Internal Drivers

The following table lists the key changes and main external and internal drivers behind the changes occurring due to infrastructural development:

Key change	Main external drivers	Main internal drivers	Main actions to "fuel" or "brake" the drivers, depending on whether the change is good or bad
Frequent Flooding	Intervention of river flow by Bridge, culvert and dam, Climate change	Unplanned Infrastructure development	Flood Protection, adaptation and mitigation measures Planned development
Vibrant economic growth	construction of regional road connectivity	Local Investment	Controlled development
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Rapid Urbanization	development of regional transport system	Local demand of housing	Controlled development
Decrease of Aquaculture	Urbanization, Industrialization	Land use change	Wetland Conservation

8.7 Baseline Conditions

8.7.1 Land and Air Transportation

Roads and Highways

After the partition of British India in 1947, only 480 km of metaled roads existed in the then East Pakistan while the total length of unmetalled roads was 3,600 km. Development of the road network was accelerated in the early 1960s with the enactment of The Road Transport Corporation Ordinance in 1961. The policy direction was towards connecting Dhaka with district headquarters.

The liberation war in 1971 left the road transport sector of Bangladesh disrupted. As the national began to rebuild, there was a renewed focus on road transport. Frequent disasters have also caused a lot of damage requiring rebuilding of infrastructure. These challenges, combined with the low-lying landscape and riverine characteristic of the country, have inhibited development of the road network in Bangladesh until recently.

Several government institutions are involved in the operation and maintenance of the road transport sector. The Ministry of Road Transport and Bridges (MRTB) is the highest regulatory and policy making body. The Roads and Highways Department (RHD) and Local Government Engineering Department (LGED) are the two main agencies responsible for development of roads. National highways, regional highways, and districts roads are built and maintained by the RHD. LGED is responsible for constructing upazila roads, union and village roads.

Other government agencies under the MRTB are the Bangladesh Road Transport Authority (BRTA), Bangladesh Road Transport Corporation (BRTC) and Dhaka Transport Coordination Authority (DTCA). Government development authorities such as City Corporations and Municipalities are also engaged in the maintenance and development of the road network at the regional level.

Railways

Rail transport in Bangladesh began on 15 November 1862, when 53.11 km of 5 ft 6 in (1,676 mm) (broad gauge) line was opened between Darshana in Chuadanga District and Jogotee in Kushtia District. On 4 January 1885, a further 14.98 km 1,000 mm (3 ft 3 3/8 in) (metre gauge) line was opened.

Bangladesh Railway, also known as Bangla Rail, is the state-owned rail transport agency. It operates and maintains all railways in the country and is governed by the Ministry of Railways and the Bangladesh Railway Authority.

In 2005, the total length of the Bangladesh Railway was 2,855 km. There was 660 km of broad-gauge track (mostly in the western region), 1,830 km of metre gauge track (mostly in the central and eastern regions) and 365 km of dual gauge track. In 1998, the Jamuna Bridge was built to connect the previously divided east and west rail networks in dual gauge.

Barishal division is the only division without having railway connectivity. But GoB have taken a project to establish a direct rail line of 214 kilometers from Bhanga to Payra sea port. This rail line will connect the whole southern part with the capitals through Bhanga, Tekerhat, Madaripur, Gournadi, Dehergoti (airport), Barisal Sadar (Kashipur), Bakerganj, Patuakhali, Amtoli, Payra Port, Payra Airport and Kuakata with a total 11 station.

Airways

Bangladesh Biman (now Biman Bangladesh Airlines) was formed in 1972. This is the only government airline operating in the country. The Civil Aviation Authority of Bangladesh is in charge of the civil aviation sector. Currently, there is one airport in Barishal division which is 150km far from Kuakata.

Inland waterways

The history of using mechanized vessels on inland waterways in Bangladesh dates back to the 19th century. Mechanised steam-powered vessels were introduced by two companies: Indian General Navigation (IGN) and River Steam Navigation (RSN).

The Inland Waterways Bill was passed by the Bengal Legislature in 1934. But the Bill was not enacted and a Waterways Board could not be created. Following the partition of India in 1947, several agencies, committees and experts proposed the creation of a statutory organization to look after the inland waterways transport (IWT) sector (BIWTA, 2017).

In 1958, the East Pakistan Inland Water Transport Authority Ordinance was passed and the East Pakistan Inland Water Transport Authority (EPIWTA) came into existence – succeeded by BIWTA (BIWTA, 2017).

Payra-Kuakata comprehenshive plan area is a riverine region having a navigable network (river and canal combined) varying from 2432 km round the year to 2676 km during the monsoon. Its inland water transport (IWT) continues to be an important mode of transport for the movement of freight and passengers. Water transport is such a mode of transport that has been characterized as the least-cost, environment friendly, less prone to accident and low maintenance cost. Moreover, the development of waterways does not even require any cultivable land. Rather, it is very much helpful for development of other sectors of economy including maintaining ecological balance.

Ports

In the southern area, the Bay of Bengal is fringed by the coastal belt. Here, sea ports are vital for the country's exports and imports. Land ports and 24 river ports also play a significant role in transport of freight and passengers both internationally and domestically.

Payra port is the only sea port within the southern region.

Shipping

Bangladesh is recognized as a maritime nation and the shipping sector is important to the economy. A major portion of freight transport is conducted by sea going vessels and smaller ships operating in the inland waterways.

There is a long history of shipbuilding. It is estimated that the shipbuilding output of Bengal during the sixteenth and seventeenth centuries was 223,250 tons annually, while 23,061 tons was produced in nineteen colonies in North America from 1769 to 1771 (Ray, 2011). During the first half of the 19th century, the shipyards at Chittagong built ships up to 1000 DWT. During the East Pakistan period, public sector enterprises dominated the shipbuilding Industry.

Dockyard and Engineering Works Limited, the first modern shipyard of Bangladesh, was established in 1922. After the liberation war in 1971, the dockyard was nationalized under the Ministry of Industries. It came under the control of Bangladesh Navy in 2006.

Sundarban Navigation company Limited is locally ship building company of Barishal division. Export Promotion Bureau has recommended giving priority to the shipbuilding industry of this region in the upcoming three-year import policy.

Expansion of Payra sea port activities, international shipping routes in the Payra, Mother vessels movement, Unloading/loading activities in the Payra river at Kolapara is important issue.

Communications

In 1971, after the independence of Bangladesh, the Bangladesh Telegraph and Telephone Department was set up under the Ministry of Posts and Telecommunications. It was converted the Telegraph and Telephone Board' under the Telegraph and Telephone Board Ordinance, 1975, and in 1979 became the Bangladesh Telegraph and Telephone Board (BTTB). From 1st July, 2008, as per the Telecommunication Policy, 1998, the BTTB was converted under a further ordinance into a public limited company – the Bangladesh Telecommunication Company Limited.

8.7.2 Other Infrastructure

Bridges

The Roads and Highways Department (RHD) is responsible for the construction and the maintenance of the major roads and bridges network of Bangladesh. The RHD was created in 1962 when the old 'Construction & Building (C&B) organization was split into two separate bodies (the other being Public Works Department). Since its creation, the RHD has constructed 3,548 bridges, 856 baily bridges and 14,814 culverts across the country. It also plans to replace ferry routes with bridges.

A proposal to construct the Hardinge Bridge in western Bangladesh was put forward in 1889. The 1.8-kilometer-long bridge crosses the Padma River, and runs between the railway stations Bheramara and Paksey. The bridge was officially inaugurated in 1915. It benefited the local population, providing jobs for twenty-four thousand people. It was once used as a railway to enable more convenient communication between Assam, what was Eastern Bengal and Calcutta.

8.8 Infrastructure State and Trends

8.8.1 Land and Air Transportation

The study area, located within ecological region with panoramic beauty, is in Barisal division. The entire study area is comprised with seven Upazilas of Barguna and Patuakhali Districts. Tourism development is a crucial finding. Also, Sonar char of Rangabali upazila is a place of panoramic beauty. There is ample opportunity for tourism development in the study area. Moreover, Payra Bandar, the third sea port is going to be established at Ravnabad Channel in Kalapara Upazila, which would act as a catalyst for radical change in the overall urbanization in the area.

Better transportation accessibility to study area is extremely needed to improve its connectivity within the area and with the remaining parts of the country. Better accessibility within the tourist spots can enhance the tourism sector of the country which will have greater impact on tourism and economic sector in Bangladesh. In addition, improvement of walkability and other facilities like housing, tourist entertainment activities, restaurants etc. within the tourist spots is necessary to provide safety and comfort to the local and international tourists.

Road and Highways

In Bangladesh, the road sector has been playing an increasingly significant role in transporting both passengers and freight. As mentioned earlier, RHD is responsible for the construction and the maintenance of the National highways, Regional highways and Zilla (District) roads along with bridge network of Bangladesh while LGED is entrusted with the construction of smaller feeder roads namely Upazila roads, Union roads and Rural roads connecting growth centers, villages and thana headquarters of the country.

Payra-Kuakata region of Bangladesh is laced with numerous rivers and streams, which results in all the roads having the most bridges and culverts rather than any roadway system in other region of the country. It is limited to two lanes of traffic for the most of its length. The traffic of this area is characterized with heavy, medium and low motorized vehicles and also non-motorized vehicles. In addition, vehicle movement are seen in the roads linked to the Payra sea port.

The length and RHD and LGED roads in the study area of the project are shown below:

Table 8.1: Length of different types of Roads in Payra-Kuakata region

Road Types	Amtoli	Barguna sadar	Patarghata	Taltoli	Golachipa	Kalapara	Rangabali	Total Length (Km)	Concerned Department
Regional road	80.97							80.97	RHD
Zilla road	81.52							81.52	RHD
Upazilla road	73.3	150.26	47.98	97.62	84.25	120.14		573.55	RHD & LGED
Union road	166.86	117.99	101.65	45.65	90.78	229.97	101.3	854.2	LGED
Village road-A	279.55	403.2	265.73	198.94	1103.08	242.82	357.23	2850.55	LGED
Village road-B	511.22	861.96	309.45	330.76		1345.79	288.89	3648.07	LGED

Source: RHD- Road Maintenance & Management System Database; LGED road database.

The present transport network is shown in the figures below. **Figure 8.1** and **Figure 8.2** present the road map of Payra-Kuakata Comprehensive Plan Area. **Figure 8.3** shows the routes used by heavy vehicles while **Figure 8.**4 shows the routes used mainly by light vehicles. It is important to note that light vehicles are also found in the routes used by heavy vehicles like trucks and buses. Roads are of average standard. Most of the road conditions are so bad that it becomes risky for the motorized vehicles to move on the roads. There are cracks on the pavement at many points with a lot of holes. Most of the roads are Katcha and Brick pavement roads which are not in good condition. During flood road goes under water and becomes muddy, hence local people are fully dependent on waterways for movement. Moreover, roads are also narrow and condition of culvert is miserable. Condition of launch ghat is also not good. Moreover, it is observed that the chaotic and provisional stand for local buses, electric auto rickshaws and motorbikes create traffic congestion around the Kalapara bazar, Khepupara Bridge and its access road. **Figure 8.3** shows the river routes and river/ferry ghats of the study area.

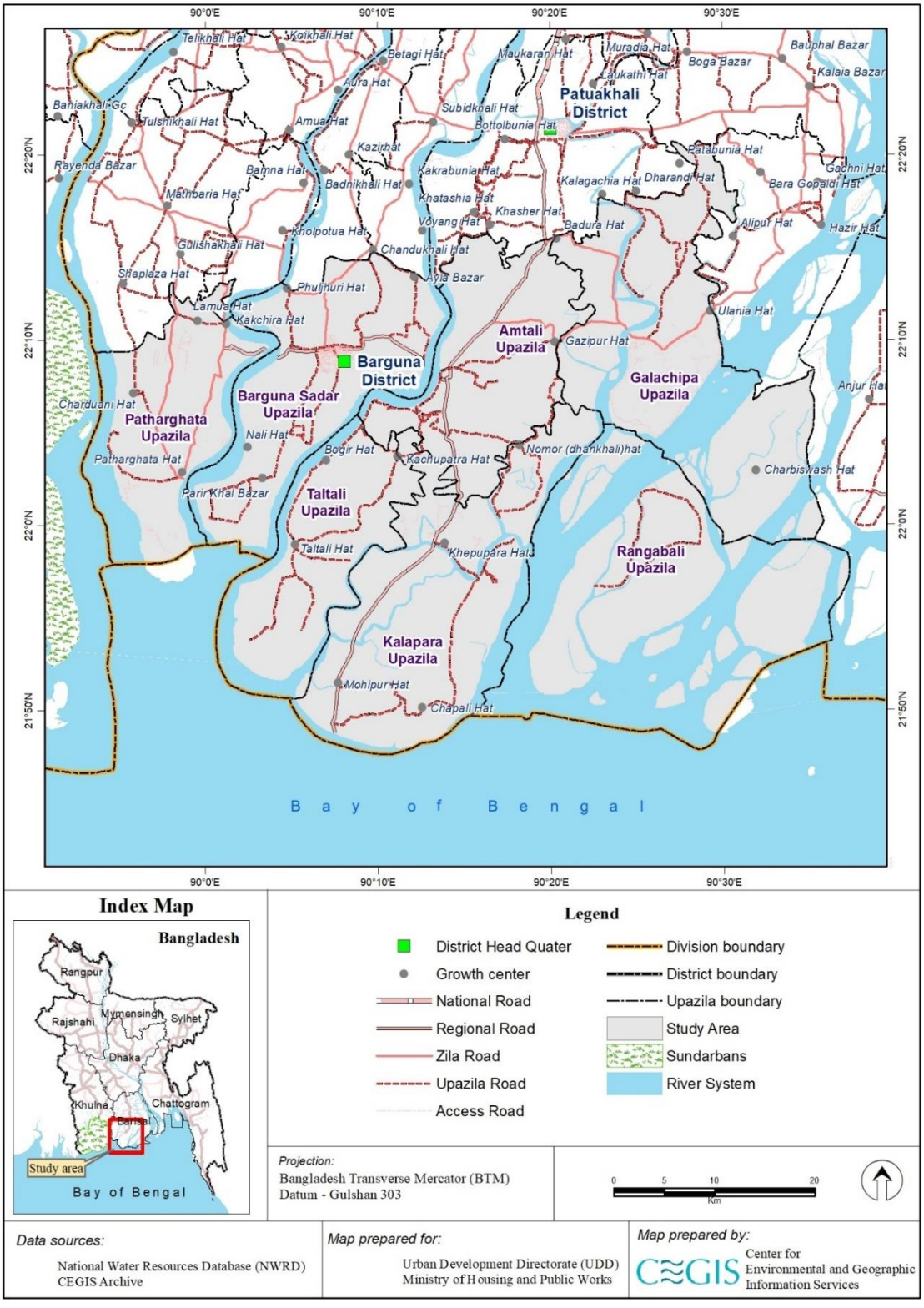
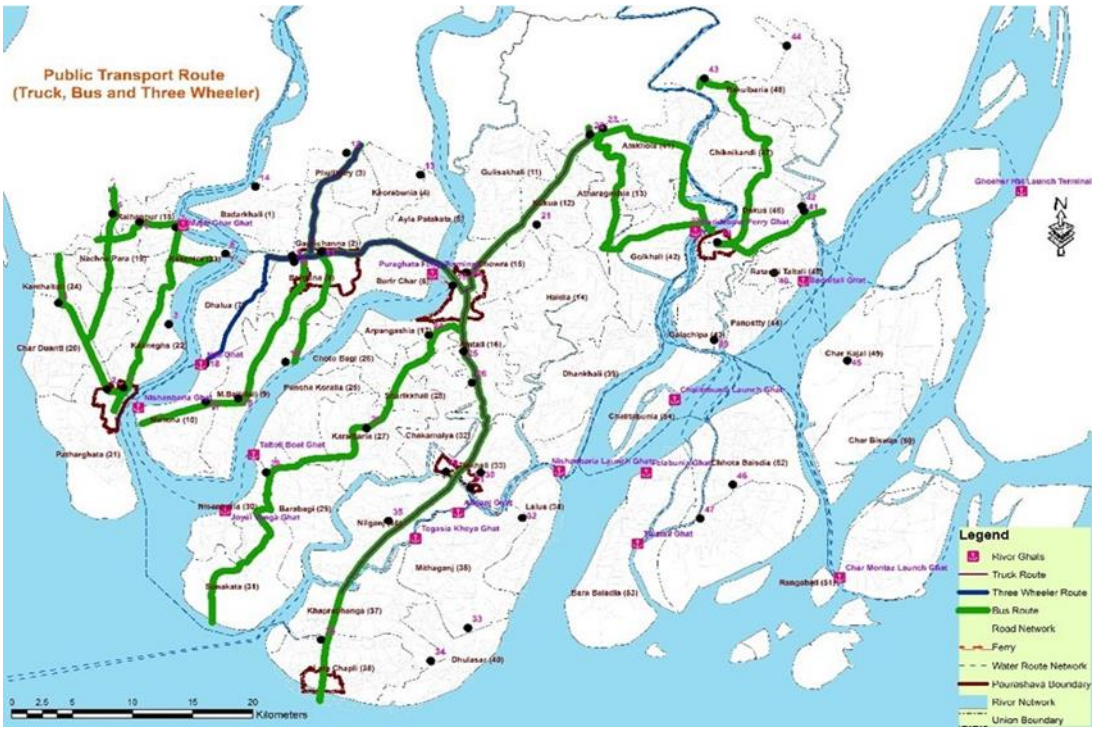


Figure 8.1: Road Map of Payra-Kuakata Comprehensive Plan Area

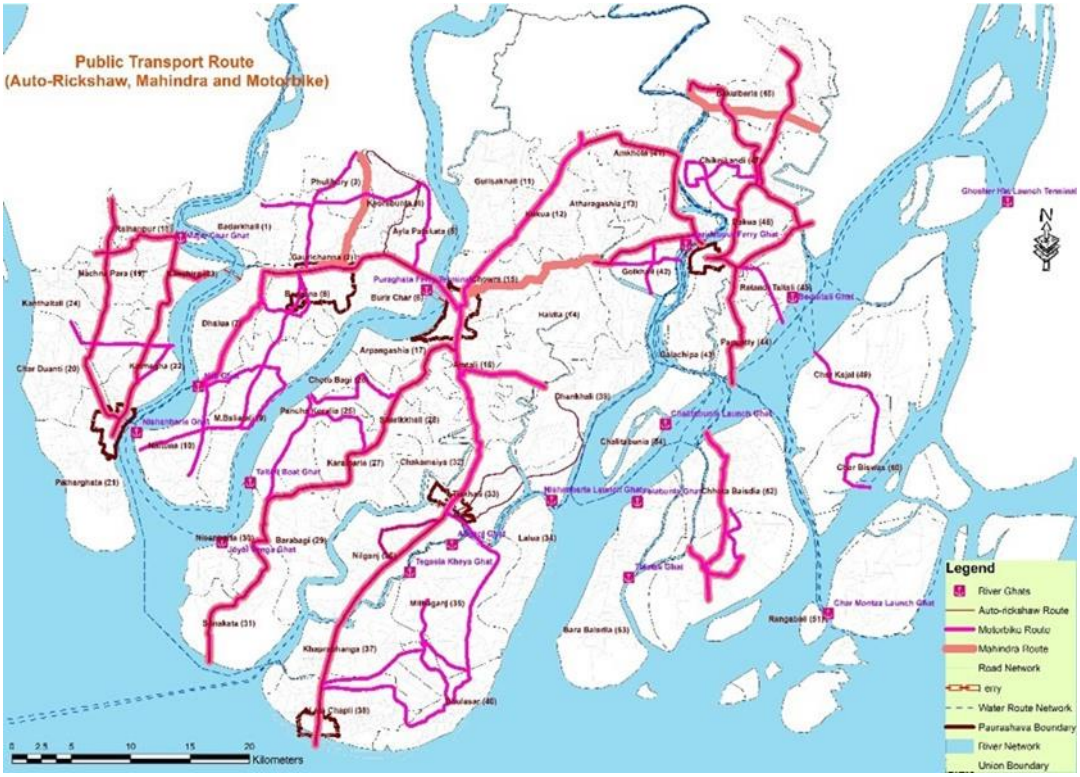
Source: (UDD, 2021)

Figure 8.2: Type of Road in Payra-Kuakata Comprehensive Plan Area



Source: (UDD, 2021)

Figure 8.3: Public Transport Routes (Heavy Vehicles)

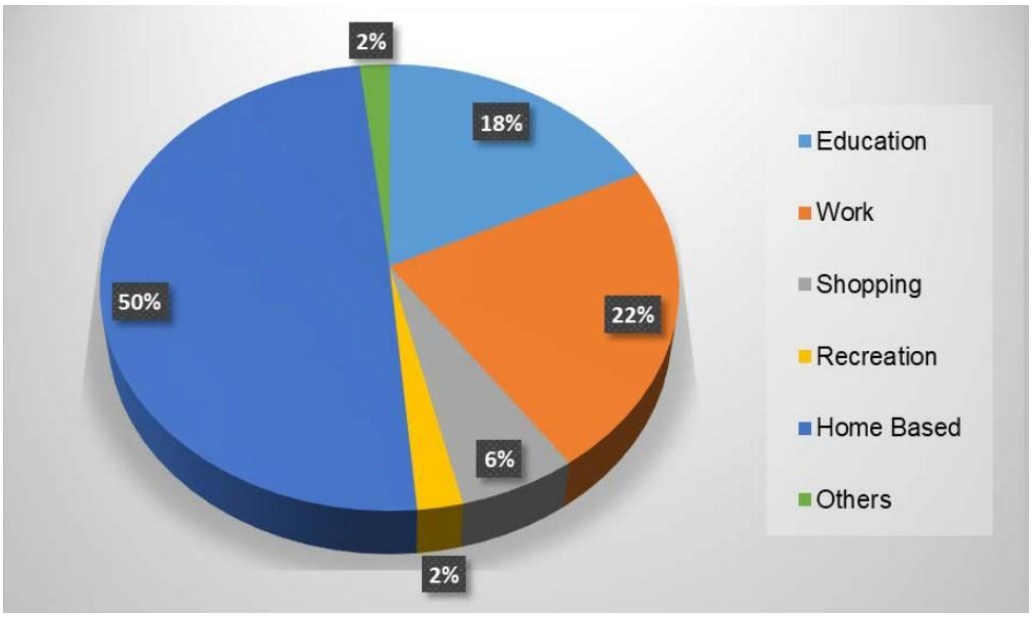


Source: (UDD, 2021)

Figure 8.4: Public Transport Routes (Light Vehicles)

Trip Purpose

For the ease of analysis all trip purposes have been grouped five categories: Educational, Shopping (trips to bazar are also included), Work, Recreational and others (personal, treatment etc.). Other than these categories there is another category called Home Based Trip which includes all trips that destined to a household. Combining the results for each zone, the share of trips by different purposes as obtained from the household survey, can be represented by the following pie chart (**Figure 8.5**). It is seen that 18% of the trips are made for educational purpose, 22% trips are made for work purposes and shopping trips account for about 6% of trips.

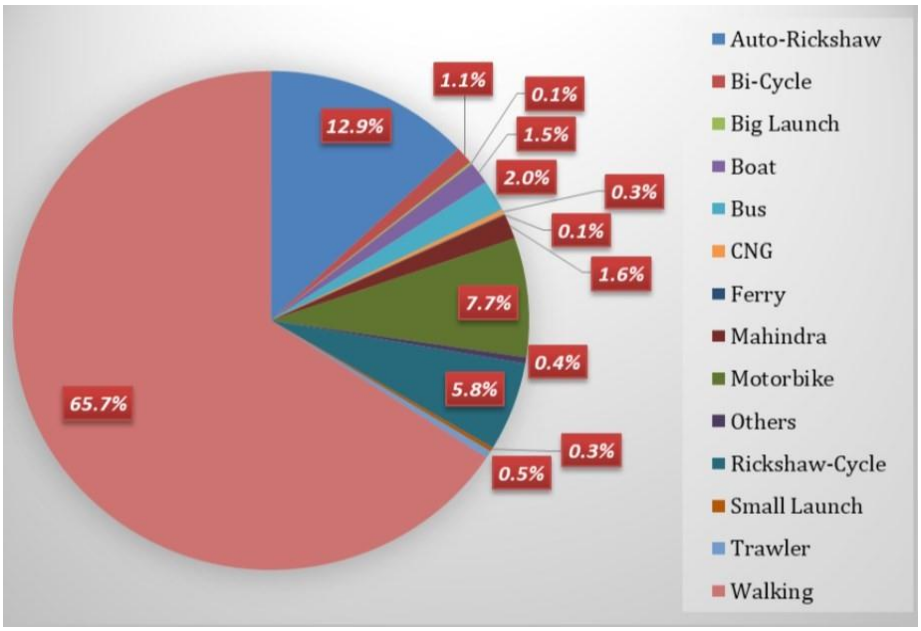


Source: (UDD, 2021)

Figure 8.5: Trip Purpose

Mode Choice

In the overall scenario for whole Study area (**Figure 8.6**), people make most of the trips by walking which is 65.7% of total trips. These trips are mainly short distance trips. Again, 12.9% are made by Auto-Rickshaw, 7.7% by Motorbike and 5.8% Rickshaw-Cycle. Among the other modes except walking water modes account for a total of 2.4% (where big launch 0.1%, boat 1.5%, ferry 0.1%, small launch 0.3% and trawler 0.5%). People do not use water transport in case of medium or short distance because of more time consumption. In short and medium distance trips, road-based mode is more suitable. People use more boat service mainly for crossing river or canal from one side to another. In case of long-distance travel people use big and small launches because of comfort compared to bus service. Each upazila is locally well connected by road network.



Source: (UDD, 2021)

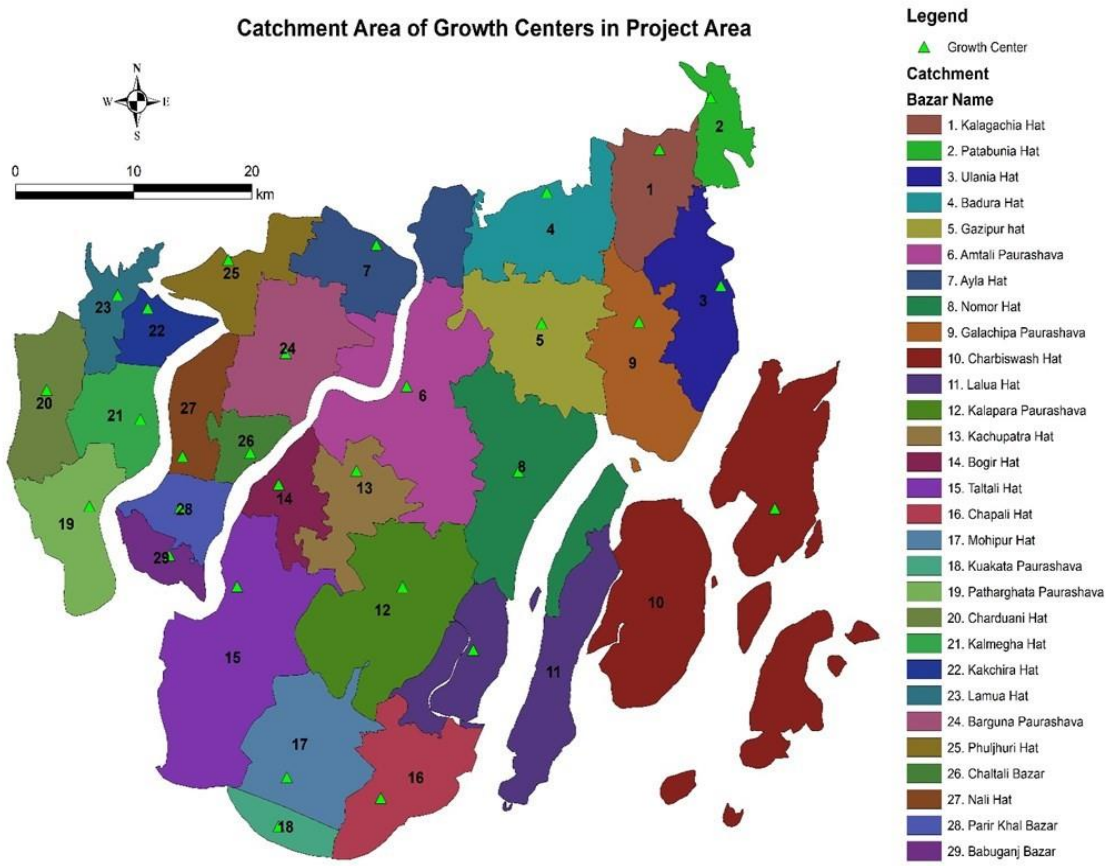
Figure 8.6: Mode of Travel

Transport Study of Growth Centers

Growth Centers (GC) are those areas where maximum economic growth in a certain region is expected. For study area, it is assumed that most economic activities in present scenario take place in the major growth centers. In addition, it can be considered that the other markets will also develop to be of the same attributes as those of the existing GCs with overall development of the study area. So some issues are needed to find out like *existing road network, road condition, traffic congestion, mode of travel, parking facility and catchment area* of the growth centers. For this study, Twenty-nine (29) growth centers were studied out of which 23 were Hats/Bazars and six (6) were Pouarashavas as shown below.

Patharghata Upazila • Lamua Hat • Kakchira Hat • Charduani Hat • Kalmegha Hat • Patharghata Paurashava	Barguna Sadar Upazila • Phuljhuri Hat • Ayla Hat • Chalitatali Bazar • Nali Hat • Baliatali • Babuganj Bazar • Barguna Paurashava	Amtali Upazila • Gazipur Hat • Amtali Paurashava	Kalapara Upazila • Nomor Hat • Kalapara • Paurashava • Lalua Hat • Chapali Hat • Mohipur Hat • Kuakata Paurashava	Galachipa Upazila • Patabunia Hat • Kalagachia Hat • Badura Hat • Ulania Hat • Galachipa Hat • Char Biswas Hat	Taltali Upazila • Taltali Hat • Bogir Hat • Kochupatra • Hat

Figure 4.7 presents the Growth Centers and their catchment areas while **Table 4.1** shows the current and projected population of Growth Centers and their catchment areas.



Source: (UDD, 2021)

Figure 8.7: Growth Centers and their Catchment Areas

Table 8.2: Growth Centers and Catchment Area Population (2011 – 2041)

FID	Growth Center/Bazar Name	Catchment Population 2011	Projected Catchment population 2021	Projected catchment population 2031	Projected catchment population 2041
1	Kalagachia Hat	22867	25643	28139	30636
2	Patabunia Hat	21745	24384	26758	29133
3	Ulania Hat	49890	55946	61392	66839
4	Badura Hat	50863	57889	63462	69036
5	Gazipur hat	56366	64390	70572	76754
6	Amtali Paurashava	100288	114949	125657	136364
7	Ayla Hat	52739	58733	63781	68829
8	Nomor Hat	52325	59332	65901	72471
9	Galachipa Paurashava	68851	77208	84725	92242
10	Charbiswash Hat	114556	125788	137761	149734
11	Lalua Hat	51898	57532	63731	69931
12	Kalapara Paurashava	76447	86884	97467	108049
13	Kachupatra Hat	22850	26109	28800	31490
14	Bogir Hat	16989	19462	21296	23130
15	Taltali Hat	55497	63574	69565	75557
16	Chapali Hat	30074	34180	38343	42506

FID	Growth Center/Bazar Name	Catchment Population 2011	Projected Catchment population 2021	Projected catchment population 2031	Projected catchment population 2041
17	Mohipur Hat	49398	56142	62980	69819
18	Kuakata Paurashava	18250	20742	23268	25794
19	Patharghata Paurashava	58393	66748	72940	79132
20	Charduani Hat	36917	42199	46114	50029
21	Kalmegha Hat	26271	30030	32816	35602
22	Kakchira Hat	21371	24429	26695	28961
23	Lamua Hat	20975	23976	26200	28425
24	Barguna Paurashava	101603	110589	119444	128299
25	Phuljhuri Hat	39080	42537	45942	49348
26	Chaltali Bazar	12924	14067	15193	16320
27	Nali Hat	29815	32452	35050	37649
28	Parir Khal Bazar	16180	17611	19021	20431
29	Babuganj Bazar	14602	15894	17166	18439

Source: (UDD, 2021)

Road Network

Every growth center is connected with mainly upazila or union roads (**Figure 9-8**). Some GCs are accessible via waterway. Some other village roads are connected with the prominent access road. These connected roads ease the accessibility towards other areas.

Road Condition

Most of the road conditions are so bad that it becomes risky for the motorized vehicles to move on the roads. Pavement depleted at many points with a lot of holes and shattered. Most of the roads are Katcha and Brick soling roads which are not in good condition. During flood road goes under and becomes muddy. Roads are also so narrow. Condition of culvert is also miserable. Condition of launch ghat is not also good.

Traffic Congestion

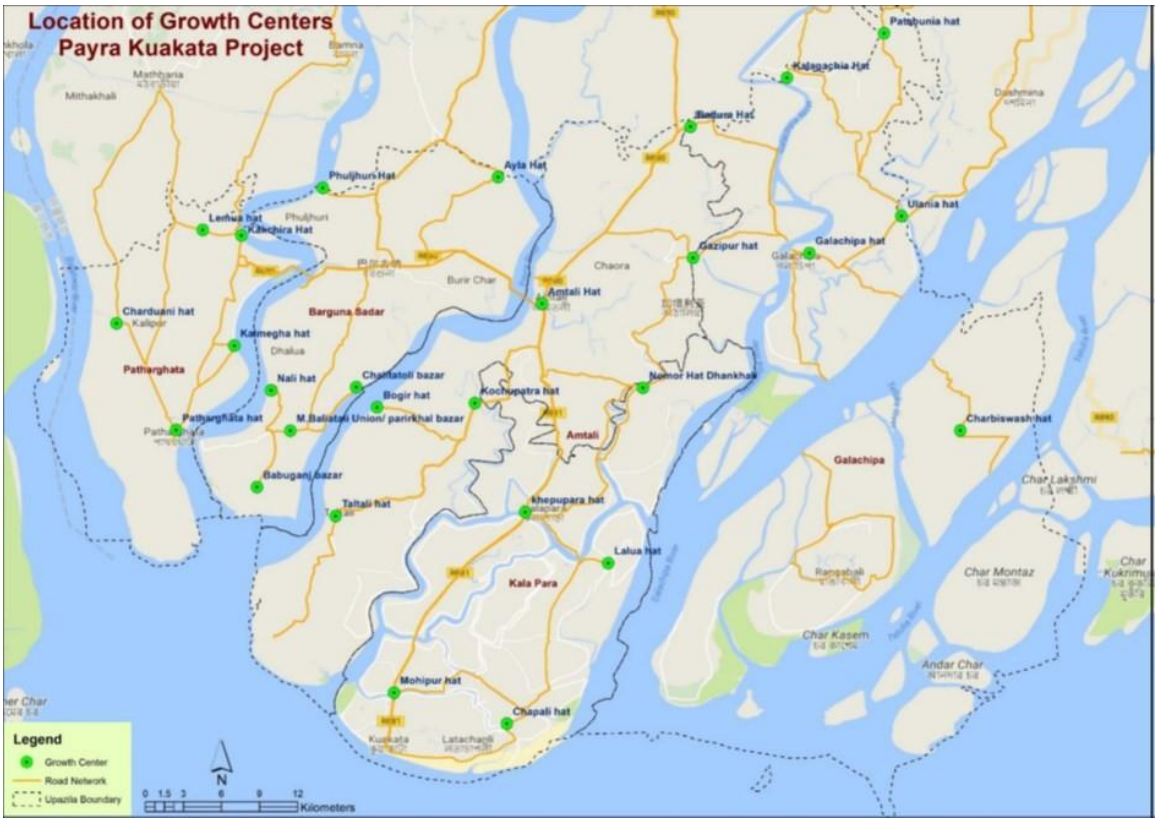
Traffic congestion is noticeable mainly in typical hat days. Most business activities are done in hat day/ days. Goods loading and unloading occur in that day; many people come for different purposes in the hat day so growth center becomes crowded in that day. The volume of vehicle also becomes high. So traffic congestion occurs in typical hat days rather than other days of the week. On street parking encroaches the road which leads to the traffic jam.

Parking Facility

There is no parking facility in the growth centers. Vehicles are parked on the street. There are some bus depots where people can access the growth center by bus. There are also some ghats for goods loading and unloading especially fish products.

Mode of Travel

The major modes of travel are motorbike, tomtom, easybike, auto rickshaw, three-wheeler, mahindra, cycle rickshaw, bicycle, borak, passenger pickup, tempo, bus etc. In the waterway trawler, boat and launch area available to travel.

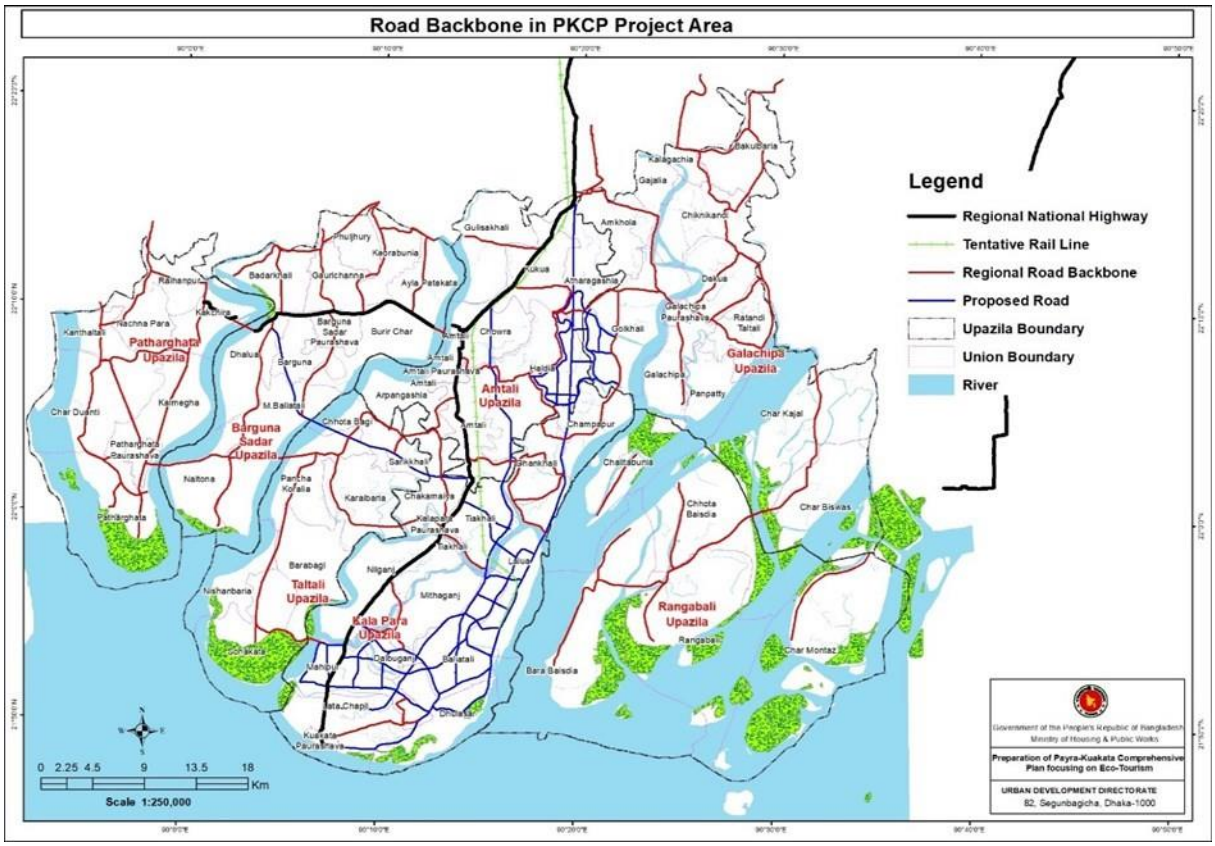


Source: (UDD, 2021)

Figure 8.8: Location and Accessibility of the Growth Centers

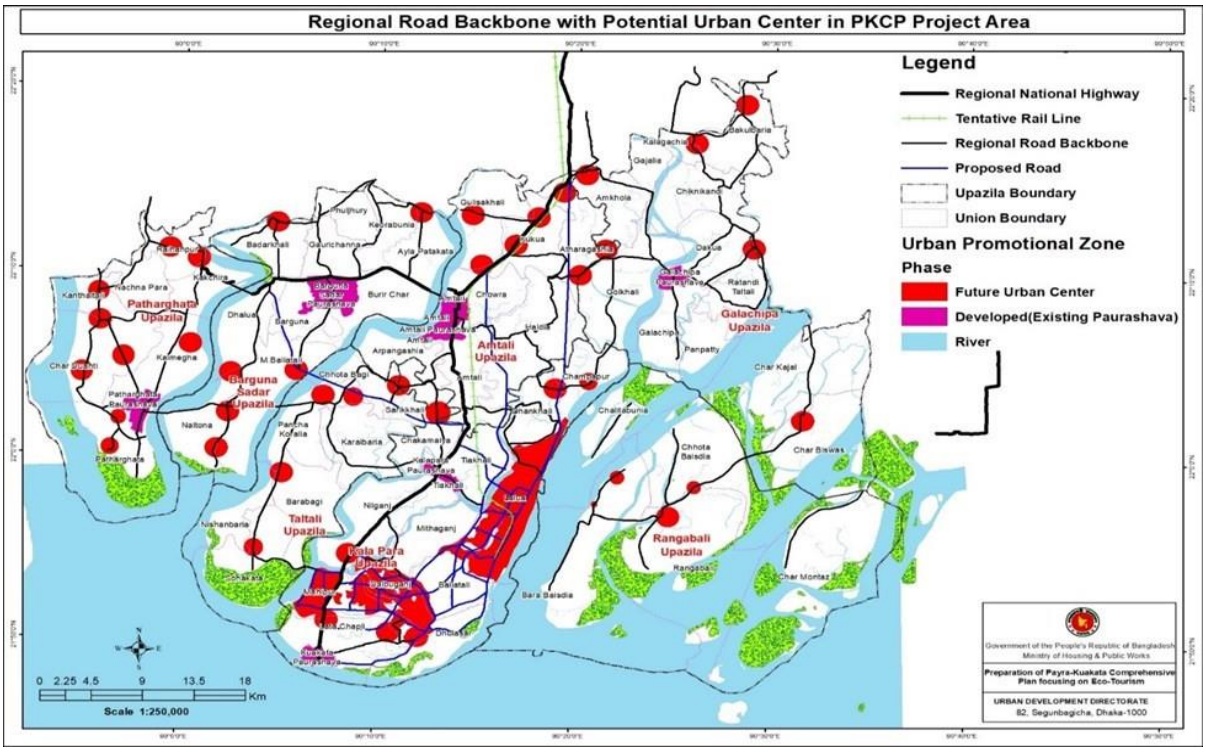
8.8.2 Proposed Road Network and Its Validation by Transport Demand Modeling

The main purpose of this project is to develop a comprehensive plan to promote tourism as well as enhance socio-economic and infrastructural development of the seven upazilas of the Barguna and Patuakhali Districts. The transportation model developed under this project will optimize the overall transportation system and business activities associated with the major transportation hubs like Payra Port and Kuakata Sea Beach as well as other small to medium growth centres in the project area. The proposed transportation network is shown in **Figure 9-9** while **Figure 9-10** shows the prospective future urban centers along the proposed transportation network. **Figure 9-11** shows the phasing of development of the prospective urban centers as shown in **Figure 9-10**.



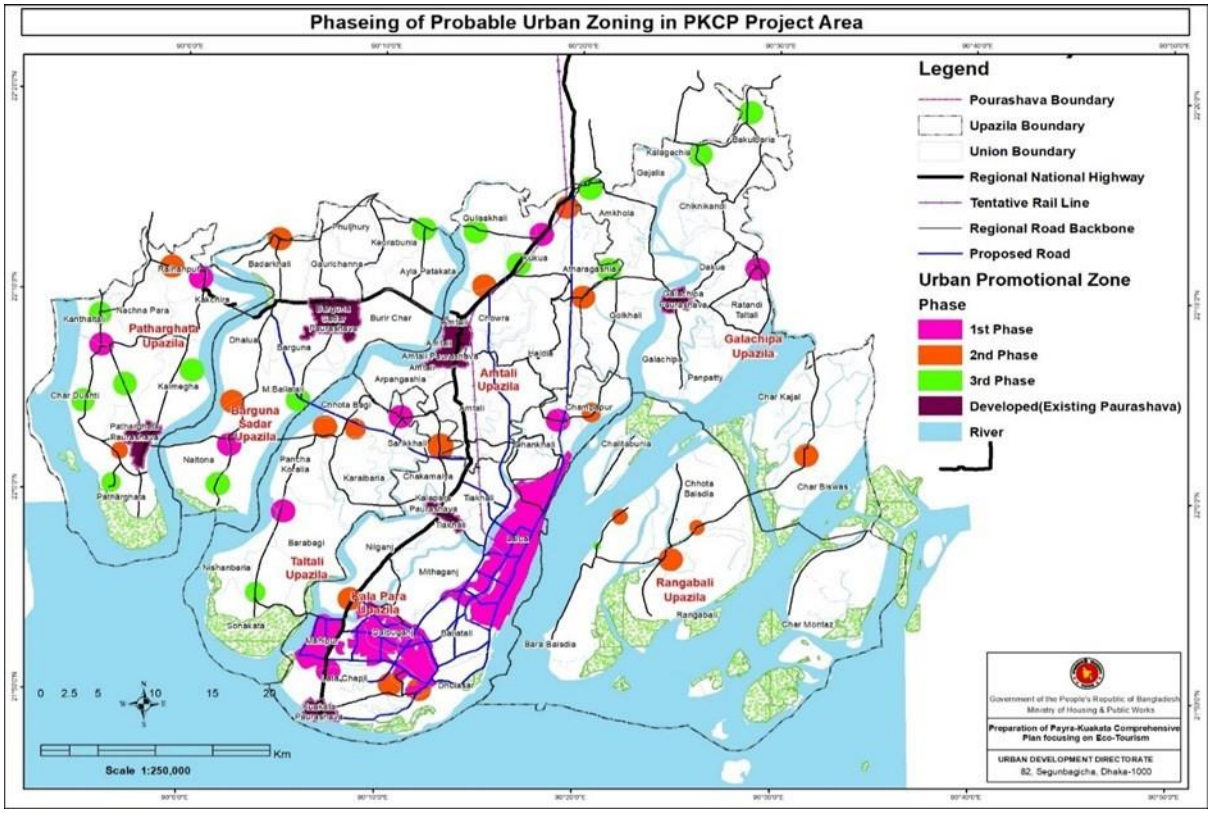
Source: (UDD, 2021)

Figure 8.9: Proposed Transportation Network



Source: (UDD, 2021)

Figure 8.10: Proposed Transportation Network and Future Urban Centers



Source: (UDD, 2021)

Figure 8.11: Phasing of Development of Future Urban Centers

In order to construct a 20-year prediction model for transportation of the project area and to estimate the future traffic demand on the future road network of Payra-Kuakata the following surveys have been conducted: 1) Reconnaissance Survey, 2) Household Interview Survey, 3) Passenger Interview Survey, 4) Survey on Growth Centre, 5) Traffic Count Survey including Motorized Vessel Count, 6) Pedestrian and Vehicle Count at Kuakata Sea Beach, 7) Survey at Fishing Boat Terminal, 8) Origin-Destination Survey of both motorized vehicle and vessel, 9) Public Transport Interview Survey, 10) Stakeholder Interview Survey and 11) Travel Time Survey. In addition, population and employment patterns of Growth Centers (Hats/Bazars and Paurashavas) and their catchment areas have been projected up to 2041 for use in future transport demand forecasting.

Using all the collected survey data and the projected population and employment patterns a four-step travel demand forecasting model has been developed for Payra-Kuakata region incorporating the dynamics of a cluster of prospective cities or townships in riverine region having huge economic and tourism opportunities. In this model, two different major scenarios have been considered (including the base scenario). Under these major scenarios, several child scenarios can be considered, e.g., different alignments, approach roads, railroads, etc. The major scenarios are as follows:

Scenario 1 (Base Scenario – 2019): This scenario represents the existing transportation condition in the seven selected upazilas in Payra-Kuakata and the regional roads within the vicinity. The model is constructed with the existing road and public transportation network, traffic count data and socioeconomic data.

Scenario 2 (Future Scenario – 2040): This scenario projects the traffic demand and calculates corresponding traffic loading on the network for the year 2040 considering projected population and employment, calculated based on the newly proposed land use plan for PayraKuakata keeping ecotourism in focus.

The outcome from the model suggests that the travel within the study area in the base year is limited within specific OD zones. The road network comprising of road category of zila road and regional roads exhibit high operating speed and the local road networks are operating at lower speed. Also, bottle necks in the study area can only be seen at points where there is a ferry, i.e., construction of bridges will alleviate that congestion. All these issues have been successfully addressed in the future scenario with proposed road network. The scenarios also yield the total network cost during the peak hours as well as the off-peak hours as follows:

Base Year (in time unit, hr):

- Total AM Network Costs: 10,628,972
- Total OP Network Costs: 17,138,541
- Total PM Network Costs: 9,695,002

Future Scenario (in time unit, hr):

- Total AM Network Costs: 28,017,165
- Total OP Network Costs: 57,241,740
- Total PM Network Costs: 27,557,087

The results suggest that as both the future road network is larger and the traffic volume on the network is higher, the total network cost during the peak hours as well as the off-peak hour, represented in terms of time unit, i.e., amount of time vehicles ply on the roads, are substantially higher in the future scenario. It suggests the proposed land use change in the study area will significantly increase vehicular movement in the network for the future scenario, i.e., an indication that the proposed expansion of road network can be justified to handle the future traffic demand. At the same time, the network is not going to remain overly congested, i.e., decent amount of operating speed can be achieved. This further justifies that the proposed road network is sufficient.

Barishal division is not surrounded by any international boundary. Therefore, there is no available global highway network. But Some National and Regional Highways of Bangladesh is indirectly influenced this PKCP area. Regional highways (R881) and national highways (N8) are connected with Asian highways (AH1 & AH41).

Table 8.3: International Highway Network in the PKCP project area

Highway Network	Route No.	Area covered in the PKCP project area
Asian Highway	AH1	Amtoli, Galachipa
	AH41	Barguna, Patharghata
Bangladesh- China - India - Myanmar (BCIM) Economic Corridor		Amtoli, Galachipa, Rangabali
SAARC Highway Corridor (SHC)	SHC4	Taltoli, Barguna, Patharghata
	SHC8	Kalapara, Taltoli, Barguna, Patharghata

Data Source: (UNESCAP, 2016), (Road Transport and Highways Division, 2016)

Brief description of the highway networks is presented below-

The Asian Highway

The Asian Highway (AH) project was initiated by the UN-ECAFE (United Nations Economic Commission for Asia and the Far East) in 1959, with the aim of creating a regional cooperation amongst main land countries in Asia based on road transport linkages. UN-ECAFE is now the United Nations Economic and Social Commission for Asia and the Pacific (UN-ESCAP). The Asian Highway falls under the Asian Land Transport Infrastructure Development (ALTID) project, which also includes the Trans-Asian Railway.

The Asian Highway network currently comprises about 144,630 kilometers of roads, including 15,400 kilometers of potential AH routes in China, passing through 32 Asian member States with linkages to Europe (UNESCAP, 2014)

In Bangladesh, there are three AH Routes extending a total 1771 kilometer namely, Asian Highway-1 (AH1), Asian Highway-2 (AH2) and Asian Highway-41 (AH41). AH1 and AH2 are 2 routes which substantially cross more than one sub-region. AH41 is within the South Asia sub-region. (UNESCAP, 2016).

Source: (Road Transport and Highways Division, 2016)

Figure 8.12: The Asian Highway Routes in Bangladesh

Bangladesh- China - India - Myanmar (BCIM) Economic Corridor

The Bangladesh–China–India–Myanmar Forum for Regional Cooperation (BICM) is a sub-regional organization of Asian nations consisting of these four countries. This multi-modal corridor passing through Bangladesh and Myanmar is going to be the first expressway between India and China. The proposed corridor will cover 1.65 million square kms, encompassing an estimated 440 million people in China's Yunnan Province, Bangladesh, Myanmar and Bihar in Northern India through the combination of road, rail, water, and air linkages in the region.

As of December 2013, the four nations drew up a long-discussed plan, emphasizing the need to quickly improve physical connectivity in the region, this marked the formal endorsement on the BCIM-EC by the four nations. A2,800-km economic corridor connecting 20 major cities and towns of the BCIM countries is the aim of this proposed project. This corridor is planned to start from Kolkata, the capital of West Bengal and will end in Kunming, capital of China's Yunnan Province via Bangladesh's Jessore, Dhaka, and Sylhet; Imphal of Manipur and Silchar of Assam in North Eastern part of India, and Myanmar's Ka Lay, Monywa, Mandalay, Lashio and Muse.

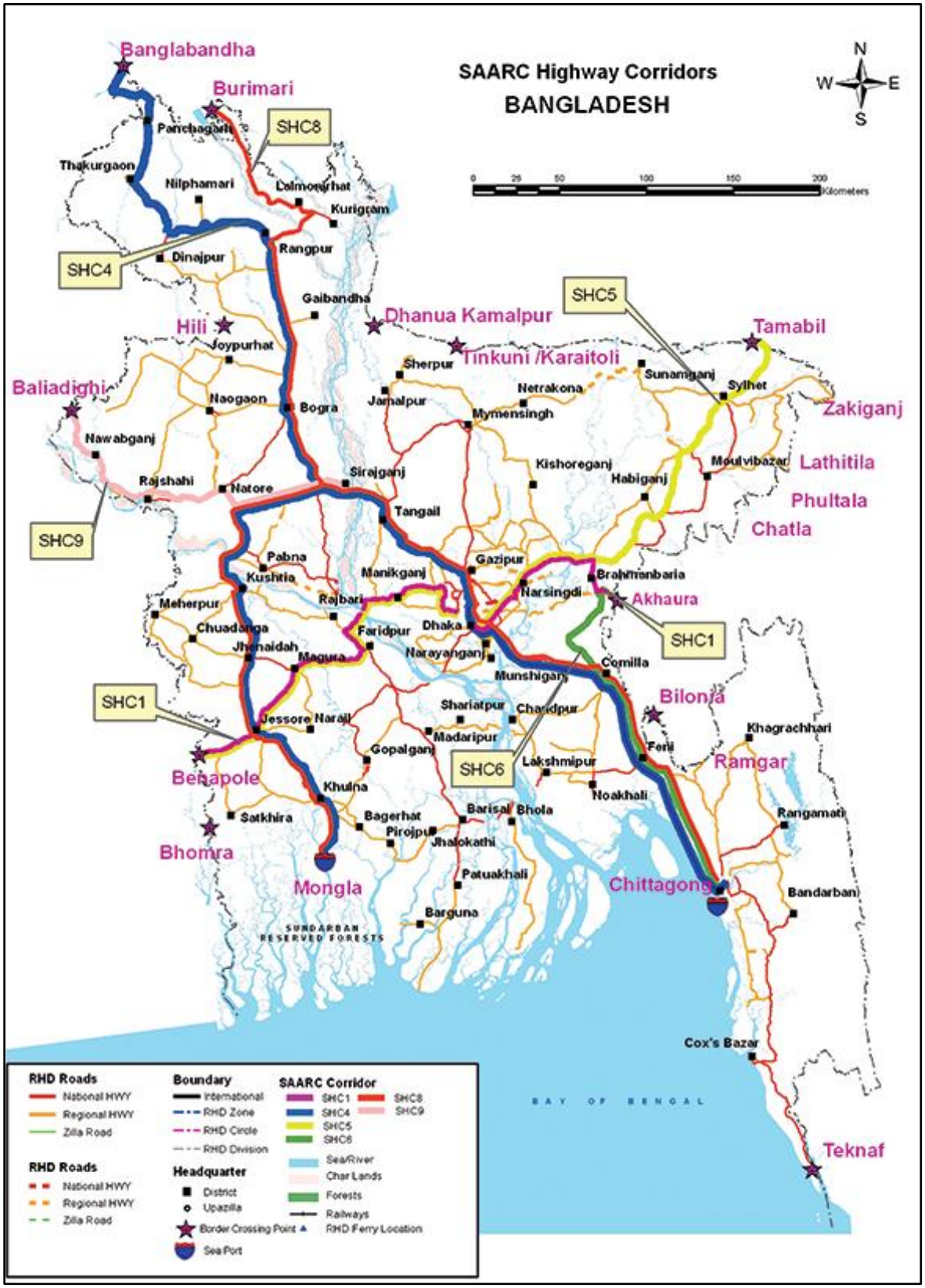
Figure 8.13: The Route of the BCIM Economic Corridor

SAARC Highway Corridor

The South Asian Association for Regional Cooperation (SAARC) is a political and economic union in South Asia consisting of **Bangladesh, India, Pakistan, Nepal, Bhutan, Sri Lanka, Maldives and Afghanistan.** SAARC was founded with a view to promoting the welfare and improving the quality of life of the people of the region by enhancing regional cooperation among the countries. Realizing the growing importance of regional connectivity through road transport in allied economic prosperity in 12th SAARC Summit, Islamabad in 2004, decision to strengthen transport, transit and communication links across the region was taken. SAARC Regional Multimodal Transport Study (SRMTS), with financial and technical aid from ADB was initiated as cornerstone for pursuing this decision.

SRMTS recommended 10 road corridors for future development. Out of the 10 SAARC Highway Corridors (SHC), six corridors (e.g. SHC1, SHC4, SHC5, SHC6, SHC8, SHC9) cross Bangladesh. Four

corridors out of these six corridors are partially in the southwest region of Bangladesh, which are (e.g. SHC1, SHC4, SHC5 and SHC8).



Source: (Road Transport and Highways Division, 2016)

Figure 8.14: SAARC Highway Corridors involved in Bangladesh

Railways

Barishal division is the only division without having railway connectivity. But GoB have taken a project to establish a direct rail line of 214 kilometers from Bhanga to Payra sea port. This rail line will connect the whole southern part with the capitals through Bhanga, Tekerhat, Madaripur, Gournadi, Dehergoti (airport), Barisal Sadar (Kashipur), Bakerganj, Patuakhali, Amtoli, Payra Port, Payra Airport and Kuakata with a total 11 station.

Airways

Barishal domestic airport is located at 13 km north of Barishal city (Figure 8.15), lying 4 m above mean sea level. The airport has single asphalt runway , serving the whole Barishal division (**Error! Reference source not found.**).

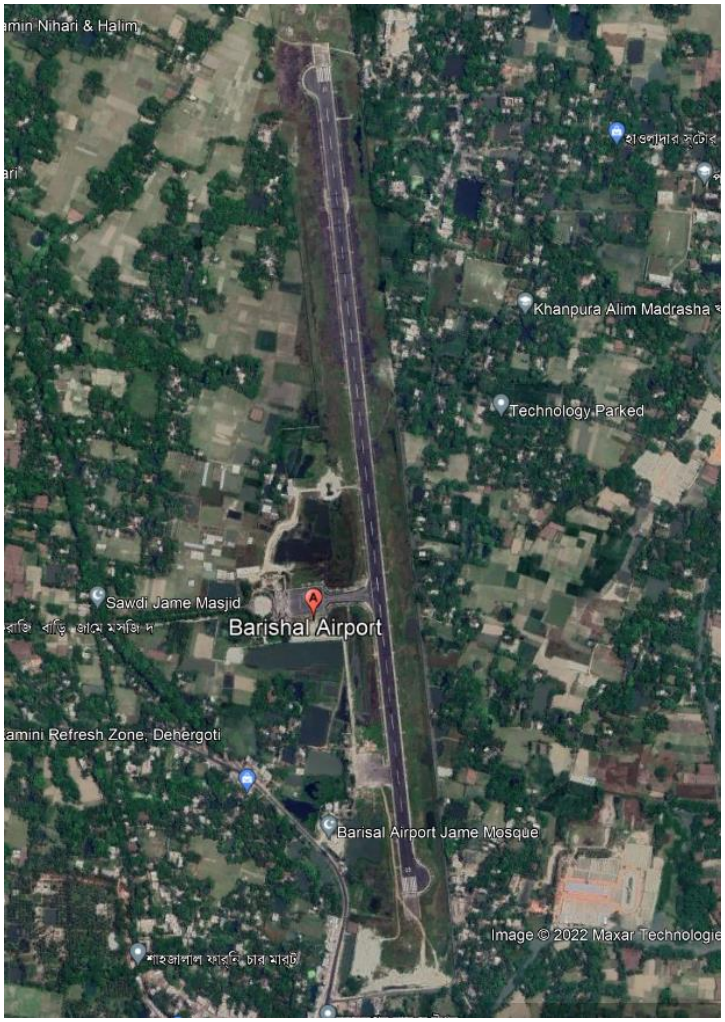


Figure 8.15: Arial View of Barishal Airport

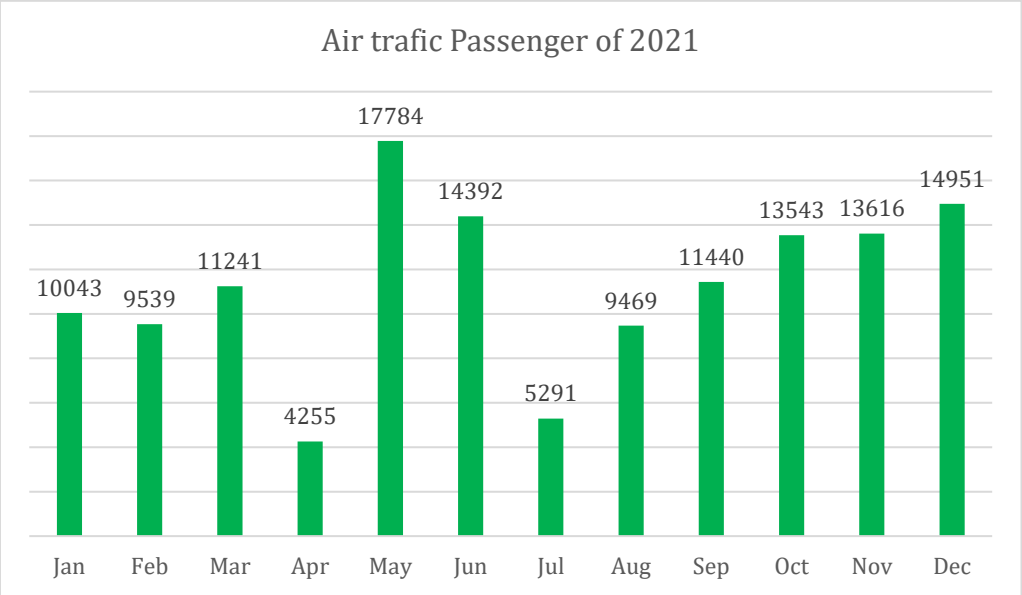
Before it was re-constructed, there was a huge demand for an airport in the region, for quicker travel to capital Dhaka. Local organizations held many strikes and demonstrations for its construction. About BDT 4 million cost have been estimated to build this airport. It was officially inaugurated by the then president Abdur Rahman Biswas on 3 December 1995. Aero Bengal Airlines, a private airline, was the first airline to launch flights to the airport. National carrier, Biman started their services in November 1995. In 2007, the airport played a significant role during the relief operation in the aftermath of Cyclone Sidr in November 2007, thus virtually saving thousands of lives of the cyclone affected people.

International relief materials like drinking water, rice, blankets and other lifesaving materials were possible to send to the devastated victims of the cyclone with the help of the airport

Present Operating Airlines

Three airlines currently operate passenger flights between Barishal and Dhaka: Biman Bangladesh Airlines; Novoair and US-Bangla Airlines. Domestic cargo flights also use Barishal airport. At present, 49 aircraft (of 25 aircraft categories) operate in Bangladesh, of which 10 (all jets) are operated by the government-owned Biman Bangladesh, the national flag carrier.

According to BBS 2021, passenger of Barisal airport data was reported at 14,951.000 Person in Dec 2021. This records an increase from the previous number of 13,616.000 Person for Nov 2021. This passenger data is updated monthly, averaging 1,524.500 Person from Jan 1998 to Dec 2021, with 218 observations. The data reached an all-time high of 17,784.000 Person in May 2021 and a record low of 0.000 Person in Jun 2020. Air movement and traffic of Barisal data remains active status in CEIC and is reported by Bangladesh Bureau of Statistics. The data is categorized under Global Database's Bangladesh.



Source: BBS 2021

Figure 8.16: Change of passenger's number of Barishal Airport

a) Biman Bangladesh Airlines

Bimaan is the largest carrier, but is still a relatively small company. It flies to 19 international and three domestic destinations. It currently operates one daily return flight per day from Dhaka to Barishal

b) NOVOAIR

NOVOAIR is the premium brand private airline in Bangladesh and started domestic flight operations in January 2013. The company has a fleet of three EMB-145 jets which can carry 49 passengers each and can travel up to a distance of 2,500 KM, and ATR 72-500 aircraft (Novoair, 2014). It operated flights between Dhaka and Barishal in 2016.

c) US-Bangla Airlines

The US-Bangla Airlines (USBA) Ltd began operations in 2014 and currently carries 50% of total domestic air traffic. In 2015, US-Bangla started flights between Dhaka and Barishal.

8.8.3 Inland Waterways, Navigation, Shipping

Inland Waterways

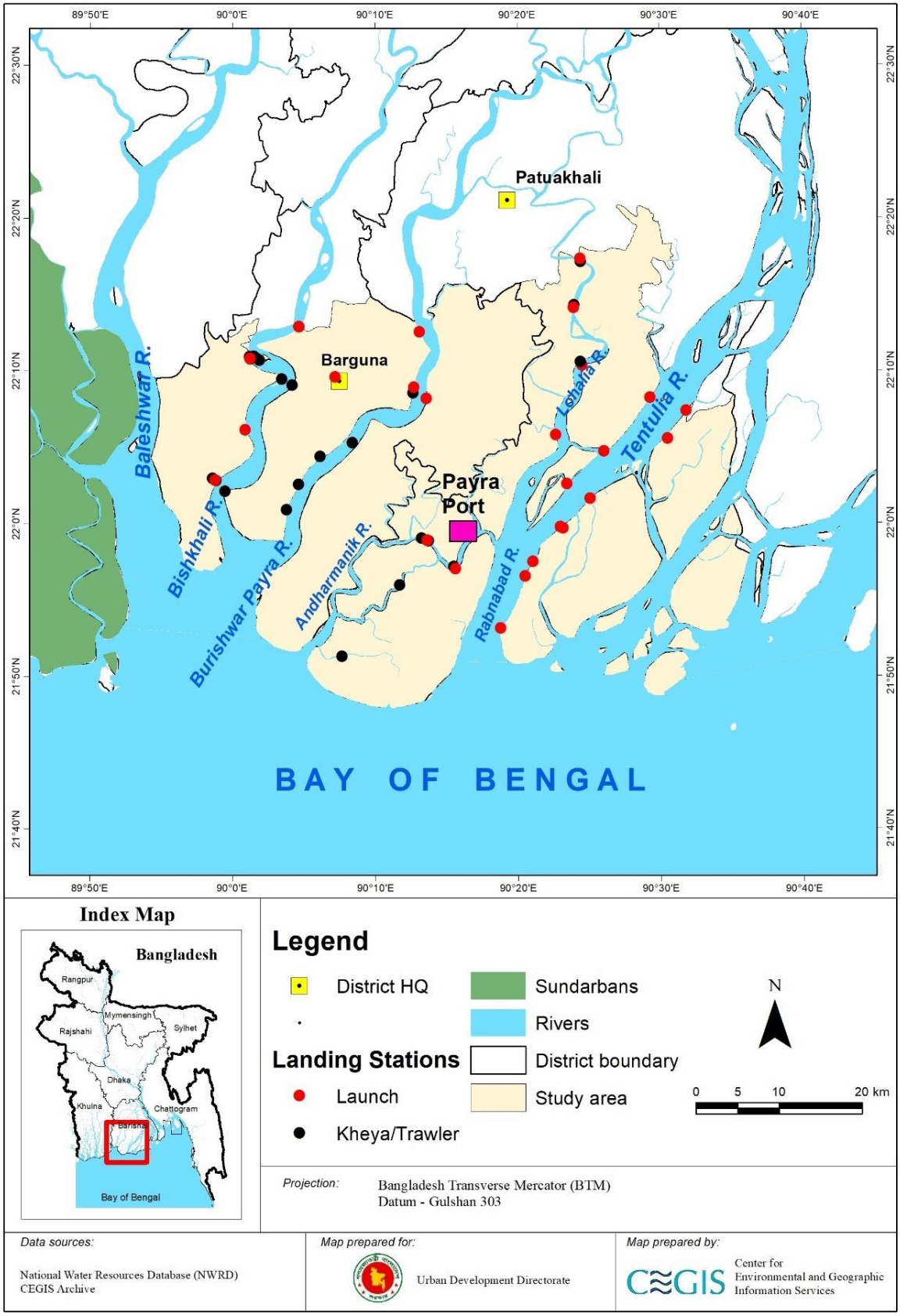
PKCPA is a riverine region having a navigable network (river and canal combined) varying from 2432 km round the year to 2676 km during the monsoon. Its inland water transport (IWT) continues to be an important mode of transport for the movement of freight and passengers. Water transport is such a mode of transport that has been characterized as the least-cost, environment friendly, less prone to accident and low maintenance cost. Moreover, the development of waterways does not even require any cultivable land. Rather, it is very much helpful for development of other sectors of economy including maintaining ecological balance.

Table 8.4 presents the lengths (Kms.) of waterways while **Figure 4.10** shows locations of landing stations of the region.

Table 8.4: Waterways in the Region (km)

Upazila	Waterway during monsoon (River + Canal)	Waterway round the year (River+Canal)
Amtali and Taltali	120	140
Barguna Sadar	112	88
Patharghata	130	82
Galachipa and Rangabali	2083	1900
Kalapara	231	222
	2676	2432

Source: BBS (2013): District Statistics 2011 (Barguna and Patuakhali)



Source: (UDD, 2021)

Figure 8.17: Location of landing stations in the study area

Table 8.5: Name of the landing stations and average number of passenger per day

Name of Ghat	District	Upzila	Average number of passengers per day	Type
Bodorpur Kheya ghat	Patuakhali	Golachipa	10000	Kheya/Trawler
Purakata Trawller Ghat(Ferryghat)	Barguna	Barguna Sadar	8000	Kheya/Trawler
Baliatoli kheya ghat	Patuakhali	Kolapara	4000	Kheya/Trawler
Chalitatoli kheya ghat	Barguna	Barguna Sadar	4000	Kheya/Trawler
Barguna Launch Ghat	Barguna	Barguna Sadar	4000	Launch
Gulbunia Kheya Ghat	Barguna	Barguna Sadar	4000	Kheya/Trawler
Tegasia Kheya ghat	Patuakhali	Kolapara	1600	Kheya/Trawler
Chorkajol Launch Ghat	Patuakhali	Golachipa	1400	Launch
Kolapotti kheya ghat	Patuakhali	Kolapara	1200	Kheya/Trawler
Kolapara Trawller ghat	Patuakhali	Kolapara	1108	Kheya/Trawler
Bainchoki Kheya ghat	Barguna	Patharghata	1092	Kheya/Trawler
Boroytala kheya ghat	Barguna	Barguna	1063	Kheya/Trawler
Amkhola Kheya gaht	Patuakhali	Golachipa	1000	Kheya/Trawler
Amtoli Launch Ghat	Barguna	Amtoli	1000	Launch
Panpotti Launch ghat	Patuakhali	Golachipa	1000	Launch
Kakchira Launch Ghat	Barguna	Patharghata	954	Launch
Fuljhuri Kheya Ghat	Barguna	Barguna	854	Kheya/Trawler
Mohipur Kheya ghat	Patuakhali	Kolapara	800	Kheya/Trawler
Golachipa Launch ghat	Patuakhali	Golachipa	800	Launch
Kalmegha Kheya Ghat	Barguna	Patharghata	718	Launch
Fuljhuri Launch Ghat	Barguna	Barguna	654	Launch
Ayla Launch Ghat	Barguna	Barguna Sadar	617	Launch
Khepupara Launch Ghat	Patuakhali	Kolapara	563	Launch
Nichanbari Ghat	Barguna	Barguna	519	Kheya/Trawler
Kuralia Launch Ghat	Patuakhali	Rangabali	500	Launch
Chor Shiba Launch Ghat	Patuakhali	Golachipa	500	Launch
Bodnatoli Launch Ghat	Patuakhali	Golachipa	500	Launch
Patharghata Kheya Ghat	Barguna	Patharghata	491	Kheya/Trawler
Majher Char	Barguna	Barguna	453	Kheya/Trawler
Patharghat Launch Ghat	Barguna	Patharghata	446	Launch
Golsakhali	Barguna	Barguna	422	Kheya/Trawler
Lotakat Kheya ghat	Barguna	Barguna Sadar	400	Kheya/Trawler
Purakata Launch Ghat	Barguna	Barguna Sadar	400	Launch
Kakchira Kheya ghat	Barguna	Patharghata	354	Kheya/Trawler
Kolagasiya kheya ghat	Patuakhali	Golachipa	300	Kheya/Trawler
Patua Launch ghat	Patuakhali	Kolapara	300	Launch

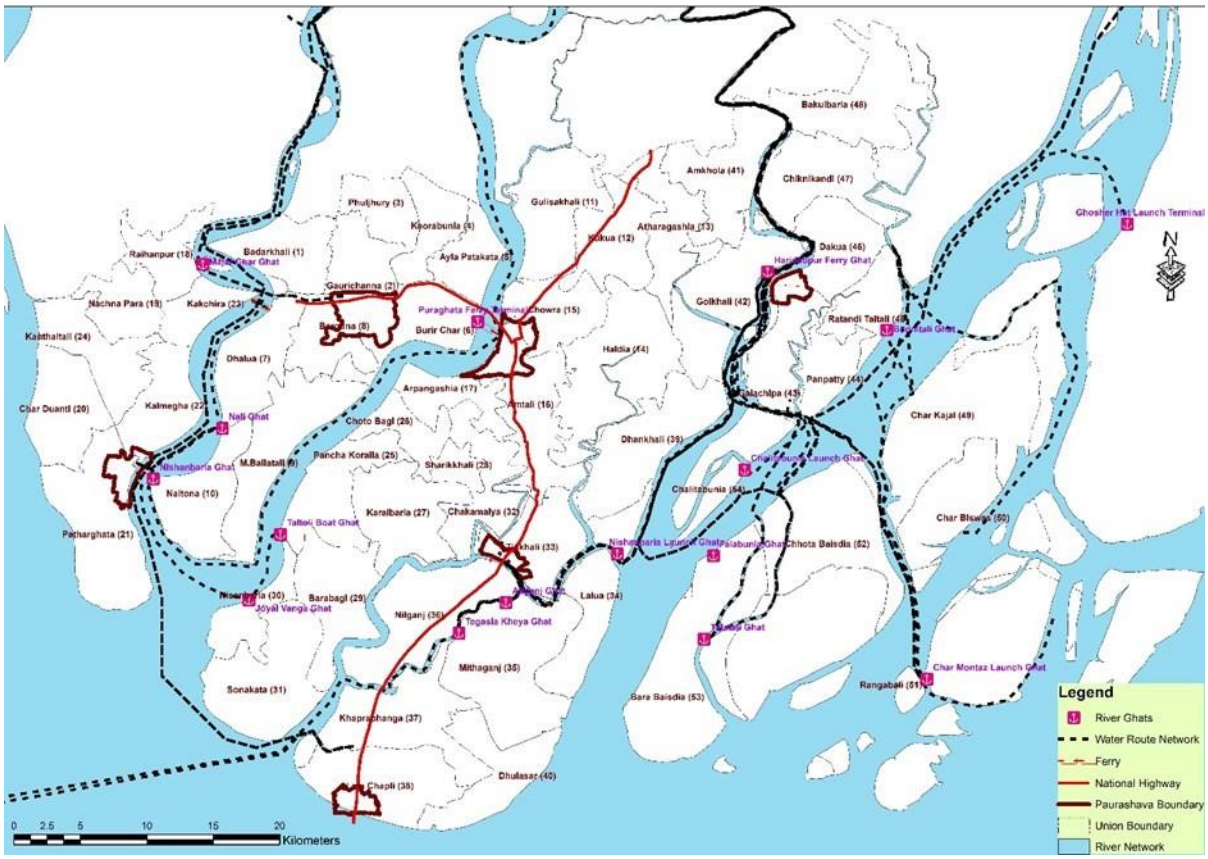
Name of Ghat	District	Upzila	Average number of passengers per day	Type
Baliatoli Launch ghat	Patuakhali	Kolapara	200	Launch
Kolagasia Launch ghat	Patuakhali	Golachipa	160	Launch
Baliatoli kheya kheya ghat	Barguna	Barguna Sadar	120	Kheya/Trawler
Amkhola Launch Ghat	Patuakhali	Golachipa	120	Launch
Chaltabunia Launch Ghat	Patuakhali	Rangabali	50	Launch
12 No. Launch Ghat	Patuakhali	Rangabali	50	Launch
Felabunia Launch Ghat	Patuakhali	Rangabali	50	Launch
Tungibaa Launch ghat	Patuakhali	Rangabali	50	Launch
Gaiyapara Launch ghat	Patuakhali	Rangabali	50	Launch
Nijkata Launch Ghat	Patuakhali	Rangabali	50	Launch

Table 8.5 provides the name of stations (Launch and Kheya/trawler) and average number of passengers per day. High volume of passenger movement is observed at Bodorpur Kheya ghat, Purakata Trawller Ghat(Ferryghat), Baliatoli kheya ghat, Chalitatoli kheya ghat, Barguna Launch Ghat, Gulbunia Kheya Ghat etc. stations.

Ferries link sections of roads separated by large channels in the absence of bridges. Functionally these are an entirely separate category since they are part of the road transport system rather than the IWT system. However, operationally it is sensible to integrate aspects of the ferry services (such as vessel maintenance and repair and river dredging) with those of IWT. Overall ferry service in Patuakhali and Barguna is in awful condition over the years. 10 ferries are already shutdown a long time ago. Most of the ferries are now at risky situation due to cracks that let water get inside and it often requires removal of the water with pumping machines.

Three of the ferries are active now: (i) Lebukhali point on Paira River along with Patuakhali-Barisal road, (ii) Amtali on the Paira River along Patuakhali-Barguna road and (iii) at Bainchutki along Barguna-Kakchira road in Barguna district. The ferries at Lebukhali, Kalapara, Hazipur, Mohipur and Amtali run round the clock while the rest run only during the day only. Vehicles cross the gangway at Mohipur on Patuakhali-Kuakata road amid risk as steel-made plates at the north side cracked. Workers have to regularly pump out water from the ferry there. The pontoon at Galachipa ferry terminal partly sinks during the high tide as cracks developed at its bottom.

Rangabali Upazila is an isolated island and does not have any ferry service. All five unions Rangabali, Char Montaj, Borobaishdia, Chotobaishdia and Chalitabunia under Rangabali upazila are separated from the main land and about 80,000 people of these unions have to use small trawlers to communicate with Patuakhali district headquarters and other Upazilas. Steps should be taken to start a ferry service immediately between Rangabali and Galachipa. Eventually steps should be taken to develop ferry operations on secondary routes terminals.



Source: (UDD, 2021)

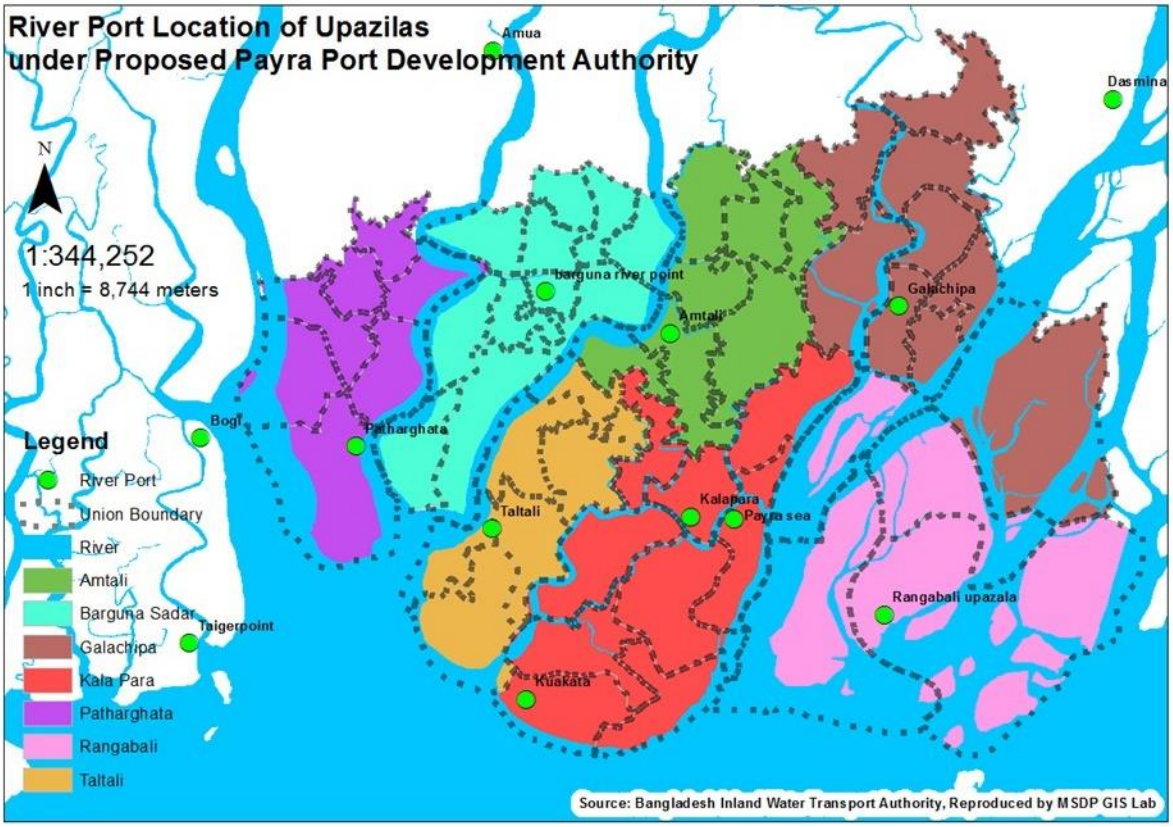
Figure 8.18: River Routes and River/Ferry Ghats

Figure 8.18 shows the river port locations in the region. BIWTA classifies navigable rivers in Bangladesh into 4 categories as shown in **Table 8.6**. The navigable rivers and canals in the PKCP region should be classified and special attention should be given to the problems suffered by the waterways of the region from (i) siltation, (ii) day & night navigational problems, (iii) shortage of passenger & cargo handling facilities including transit shed at river ports, (iv) Presence of manual loading/unloading of cargo at river ports, (v) underdeveloped rural launch landing stations, inadequate number of water crafts etc.

Table 8.6: Categories of Navigable River Networks in Bangladesh

Class	Minimum Draft	Minimum Vertical Clearance	Minimum Horizontal Clearance	
Class- I	3.66 m	18.30 m	76.22 m	Least Available Draft (LAD) of 3.6 m required to be maintained round the year.
Class- II	2.13 m	12.20 m	76.22 m	Links major inland ports or place of economic importance to class I routes
Class–III	1.52 m	7.62 m	30.48 m	Being seasonal in nature, it is not feasible to maintain higher LAD throughout the year
Class–IV	Less than 1.52 m	5.00 m	20.00 m	These are seasonal routes where maintenance of LAD of 1.5m or more in dry season not feasible

Source: IWT Master Plan Study 2009



Source: (UDD, 2021)

Figure 8.19: River Port Locations in Different Upazilas of the Region

PKCP Area is one of the poorest and least developed areas of Bangladesh. It is also prone to cyclones and storm surges. Major roads in the area are in poor condition, and sometimes impassable in the wet season. Certain parts of the network are closed to vehicle traffic due to inadequate structure of ferry connections. Cargo and passengers transport heavily rely on IWT. A substantial portion of the rural population here has no access to road transport and is directly affected by availability of IWT services. While the rural road network has considerably developed during the past ten years, many rural areas in the region remain isolated, especially during the high water season where road density is lower than in the rest of the country.

The water transport system, however, cannot be used to its full potential unless it has connectivity with road transportation systems. Water transport, therefore, should be a part of multimodal network comprising water bodies (rivers and canals) and roadways, including culverts, bridges etc., to be developed. This involves investment in a large number of activities to be carried out for infrastructure development including construction of roads and bridges, Channeling of the existing waterways through massive dredging and procurement of dredgers, improvement of day and night navigation for water crafts by providing navigational aids, construction of inland river ports etc. Some of the ports/terminals should be planned as multimodal hubs which will connect rail, road and waterways. Thus, integrated development of the rail, road and waterways will contribute towards sustainable development of the region.

Ports

Sea Ports

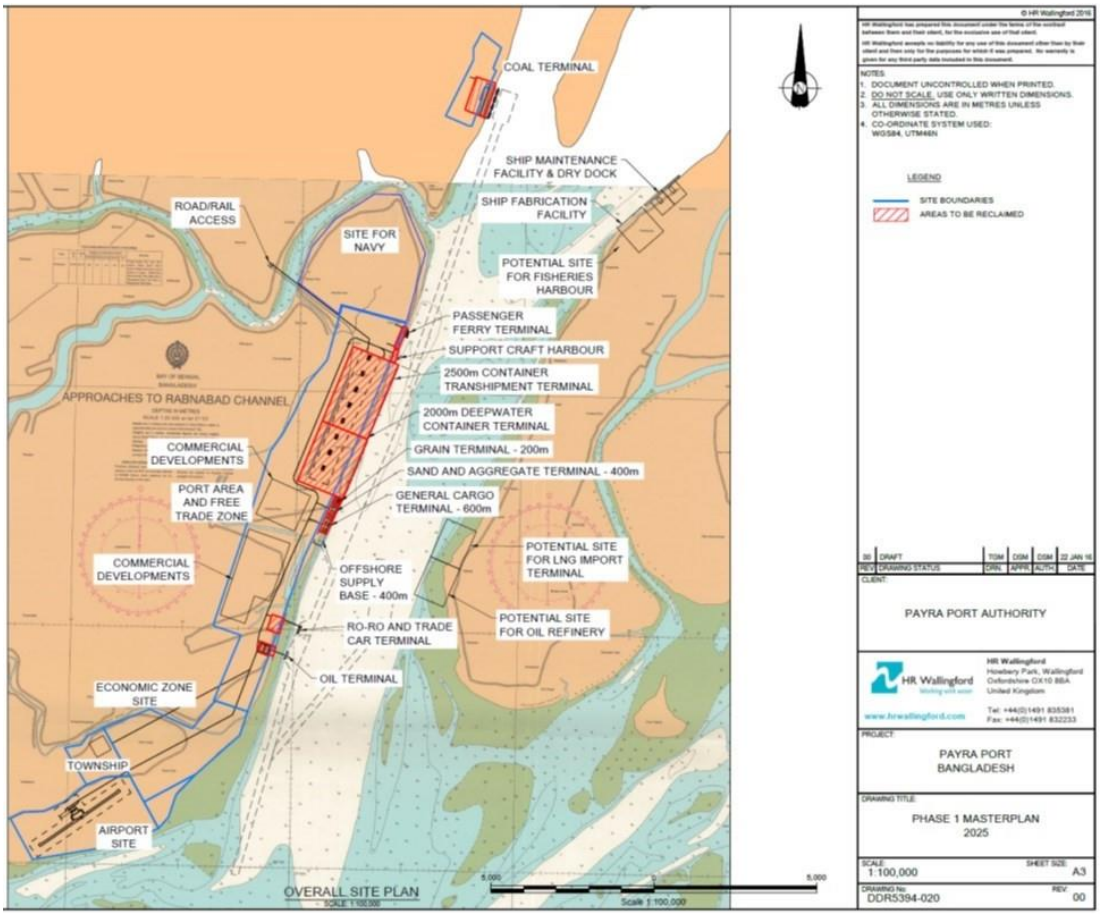
The Payra Port Authority and the port were established on 19 November 2013 through the Payra Sea Port Act 2013. The port started commercial operations from August 2016 under the port authority. Payra deep sea port is still under construction that is planned to be completed in three phases and the first phase is completed already in 2016 which was started in 2013. It is situated in the Southern part of Bangladesh, in Patuakhali District's Kalapara Upazilla. The port was planned to be upgraded to a deep sea port with the assistance of China. According to a techno-feasibility study prepared by British firm HR Wallingford & Consortium, Payra Port will require around 7,000 acres of land. Of the land, 6,000 acres will be used for port development, 500 acres for coal terminal and the rest for resettlement of the people affected by the construction of the port. Payra Port Authority (PPA) has already completed the construction of:

- A warehouse that has the capacity to hold 100,000 tons of goods.
- A six-stories administrative building is mostly done. It has already been opened for official activity as a site office for the port.
- Construction of a water purification plant to provide the port and adjacent area with safe drinking water is also complete.
- An 80-meter-long and 21meter wide temporary jetty for service yard has also been set up and construction is going on in full swing.
- Housing for the officials and staff of PPA on 32 acres of land is mostly complete
- Construction of a four-lane port connecting concrete roads with the national highway is currently in progress.
- Rehabilitation of the homeless people due to land acquisition for port construction is also underway. According to PPA, there are six rehabilitation clusters ongoing on 484.11 acres of acquired land, and it will accommodate at least 3,500 affected families. The authorities are expecting the rehabilitation will be complete next year.

Works that remain to be completed are the following:

- Airport
- Rail Link to Dhaka
- Exclusive Economic Zone
- 200MW Power Plant
- Two container Terminals
- Multipurpose Terminals
- LNG Terminal
- Internal Ferry Terminals
- Ship-yard and Ship Repair Facilities

Figure 8.20 presents the site plan of the Payra Port and shows the locations of various Port facilities while **Figure 8.19** presents the draft zoning of the port area, adjacent township, airport and surrounding areas prepared by the Urban Development Directorate (UDD).



Source: Detailed Techno-Economic Feasibility Study and Conceptual Port Master Planning - Payra Port Final Report – January 2016

Figure 8.20: Payra Port Site Plan

River Ports

There are two river ports in the Southern region at Barishal and Patuakhali.

The Barishal river port is the second largest river port in Bangladesh which was declared in 1869. In 2003, Bangladesh government undertook a project for the construction of a modern river terminal and jetties in Barisal river port. In 2011, the Barisal river port development and modernization project has been completed and opened for use.

8.8.4 Communication

Overview

The goverment agency responsible for operations in the telecommunications sector is the Bangladesh Telecommunications Company Limited (BTCL) under the Ministry of Post and Telecommunications. After many institutional reforms since 1971, the Bangladesh Telegraph and Telephone Board (BTTB) was formed with the right to issue licenses for telecom and wireless services. BTTB was converted in 2008 to the Bangladesh Telecommunications Company Limited (BTCL), a public company with 100 shares held by the government (BTCL, 2014) .

Telephone Services

At present, BTCL provides telephone service to about 1 million subscribers down to the level of upzilas (thana) and growth centres. It also provides dial-up internet services at the grass-root level using telephone lines.

Mobile Services

There are 4 mobile network operators under private ownership in Bangladesh: Grameenphone, Robi, Banglalink and Airtel. The number of registered mobile subscribers has been continuously rising – from 45.21 million in February 2009, to 124.705 million in April 2015, to 165.337 in March, 2020 (BTRC, 2020).

Radio

Bangladesh Betar is the national radio, broadcasting in AM, FM and shortwave bands. Several other private radio channels operate using the FM band. These private channels have grown popularity in the last decade. In the Southern Region, there is only one radio station located in Barishal.

Television

Bangladesh entered the era of cable television in 1964 with the first television signal broadcast by then then Pakistan Television Corporation (PTV). After 1971, Bangladesh Television (BTV) was formed in 1972 and was the only Bangladeshi television channel up to the 1990s. Since then a number of stations have been established. There are several state-owned channels: BTV, BTV Chittagong, BTV World and Sangsad Bangladesh. These channels also broadcast news in the Southern Region. There are also a number of privately-owned entertainments, news, music, children and movie channels which broadcasted in the Barishal Division.

Internet services

The Bangladesh Telecommunications Company Limited (BTCL) provides dial-up Internet access in all 64 districts of the country. As of January 2009, there were 32,433 subscribers. The '.bd' domain for web-hosting is also handled by BTCL

BTCL provides consumer-level broadband Internet services under the branding of BCUBE. The service is provided through ADSL2+ technology. BTCL currently has about 15,000 customers.

In cooperation with Korean Economic Development Cooperation Fund (EDCF), BTCL plans to establish a broadband wireless access network across the whole country.

Satellites

In 2018, Bangladesh launched the Bangabandhu Satellite-1 (Bangabandhu-1), the first Bangladeshi geostationary communications and broadcasting satellite. The Bangladesh Communication Satellite Company Limited (BCSCL) was established to perform post launch activities using the satellite.

8.8.5 Other Infrastructure

Padma Multipurpose Road-Rail Bridge

The Padma Multipurpose Road-Rail Bridge (simply Padma Bridge) is the largest project in the country's communication sector in terms of size and expenditure. It is being constructed over the Padma River from Mawa (Munshiganj) to Janjira (Shariatpur) point (Figure 3.1). The Bangladesh

Bridge Authority (BBA) is implementing this historical mega project. It is a two level steel truss bridge that will carry a four lane highway on the upper level and a single track railway on the lower level. This is a long-awaited project, especially for the people of Barishal Division.

The Padma Bridge is 6.15 km long and 18.10 wide. The main components include: the main bridge, river training works, bridge end facilities for approach roads, resettlement, and environment and land acquisition.

The main bridge construction is being executing by the China's Major Bridge Engineering Co. Ltd., whilst the government-owned China Railway Group Limited is undertaking the rail network works.

The current (fourth) completion date for the project is now June 2021, with costs having risen to Tk 30,193 crore following several revisions. Further delays may result due to the Covid-19 pandemic (The Daily Star, 2020).

Due to riverine nature of the South West and South Central region of the country, connectivity of road network in these regions with the rest of the country is poor. When completed, the Padma Bridge run a vital link between the national and Southern regional highway networks.

A number of neighboring districts will be primarily influenced by the Padma Bridge: Dhaka, Munshiganj, Manikganj districts of the North Central region; and Rajbari, Faridpur, Madaripur and Shariatpur districts of the South West and South Central regions. Road connectivity of the other 21 districts in the Southern region will be improved through national and regional highway network.

This reduction in travel time and improved accessibility to the Payra Kuakata project area will have economic benefits. It is expected that the GDP growth of the country is expected to be increased by 1.2 % after the operation of this bridge (The Daily Star, 2020). But the bridge will also lead to increased volumes of traffic. Considering impact of improved accessibility on regional economic output and impact of a change in regional economic output on truck travel, elasticity of 0.55 was derived[13]. Traffic at the Mawa ferry crossing (in the vicinity of the Padma Bridge project site) (ADB, 2005) will be diverted to the bridge. In addition, it is estimated that approximately 80% of the traffic currently using the Paturia ferry across the Padma river (60 km upstream of the Padma bridge site) will be diverted to the new Padma Bridge.

[13] This means a 10% decrease in travel time to/from Dhaka will lead to a 5.5% increase in district economic output. An elasticity value of around 1.0 was estimated for truck travel across the Padma River with respect to nominal gross domestic product (GDP), from historic data on GDP growth and truck traffic growth. The elasticity of induced truck traffic with respect to travel cost is 0.55 (= 0.55 x 1.0), using travel time to/from Dhaka as an indicator of the generalized costs of truck traffic (ADB, 2005).

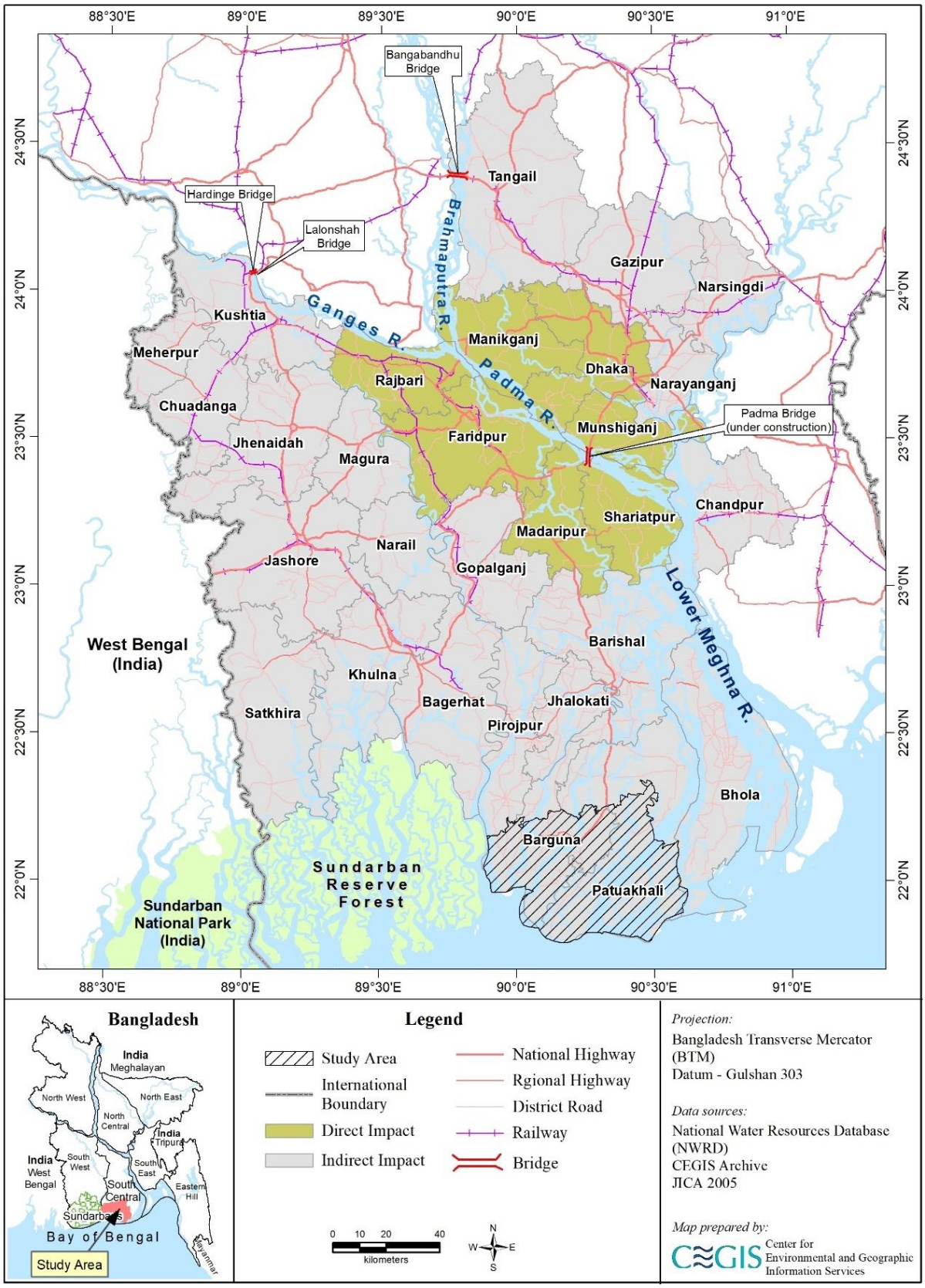


Figure 8.21: Districts to be impacted by Padma Multipurpose Bridge

The nearest gas producing area is located at Bhola, an Island district of Bangladesh. Bhola has two gas producing fields: Shabazpur East-1 and is Bhola North-1. But it is too expensive to construct a gas supply network from these gas fields to the Barishal divisionunder water.

Educational facilities

The highest number of education institutes is in Barguna Sadar (**Table 8.7**), the reason of this upazila being ahead in education facilities. Galachipa comes second and Kalapara third. When the population per educational institutes is examined, it is apparent that colleges in the planning area are not adequate to serve the population. Especially Rangabali and Taltali upazilas are the most neglected having no colleges.

Table 8.7: Number of Educational Institutions and Per Institution Population

Upazila	Primary	Secondary	College	Popⁿ per primary school	Popⁿ per secondary school	Popⁿ per college
Galachipa	175	40	10	1476	6456	25852
Kalapara	161	33	6	1477	7207	39639
Rangabali	70	16	0	1476	6456	N/A
Patharghata	138	29	5	1188	5653	32785
Taltali	67	19	0	1321	4751	N/A
Barguna Sadar	205	59	6	1275	4430	43557
Amtali	138	38	7	1321	4751	26114

Source: (UDD, 2021)

Technical and Vocational Institutions

The number of technical and vocational institutions is negligible in the planning area (**Table 8.8**). There are only four in Barguna Sadar upazila, three in Kalapara and one in Galachipa.

Table 8.8: Number of Technical and Vocational Institutions

Upazila	Technical and Vocational
Galachipa	1
Kalapara	3
Rangabali	0
Patharghata	0
Taltali	0
Barguna Sadar	4
Amtali	0

Health care facilities

Barguna Sadar upazila has the largest government health complex with 100 beds and the greatest number of staffs (**Table 8.9**).

Table 8.9: Number of Government Health Complex and Health Personnel 2011

Upazila	Number of beds	Number of doctors	Number of nurses	Number of technicians	Number of other staffs
Amtali	80	4	15	12	11
Barguna Sadar	100	9	23	8	20
Patharghata	50	7	7	2	9
Galachipa	50	7	24	1	5
Kalapara	72	13	18	6	135

Source: (UDD, 2021)

There are not many private health facilities in the planning area (**Table 8.10**). Barguna Sadar upazila has seven private hospitals and clinics and Patharghata has only three. Other upazilas do not have any private health facilities.

Table 8.10: Number of Private Hospitals/ Clinics

Upazila	Number of centers	Number of beds	Number of doctors	Number of nurses	Number of technicians	Number of other staffs
Amtali	0	0	0	0	0	0
Taltali	0	0	0	0	0	0
Barguna Sadar	7	30	6	11	12	37
Patharghata	3	30	0	3	3	9
Galachipa	0	0	0	0	0	0
Rangabali	0	0	0	0	0	0
Kalapara	0	0	0	0	0	0

Source: (UDD, 2021)

Tourist Locations in Payra-Kuakata Region

Payra-Kuakata region offers ample opportunities for creating facilities for tourists. The region is home to unique flora and fauna and possesses many panoramic beauties. Forests, beaches, lakes and rivers make the region ideal place for ecotourism development. A Brief Description of potential tourism sites in the Payra-Kuakata Project Area is present in the following.

Sonakata Ecopark

The Sonakata ecopark located in the forest of Fatra of the newly founded Taltoli Upazilla of Barguna District has recently been bustling with crowds, both from inside and outside of the district. The 19-acre ecotourism center is shrouded with exquisite flora and fauna, with numerous canals spread throughout the ecopark like spider-webs (**Figure 8.22**). The greeneries of both sides of the canals quickly captivate the visiting outdoorsmen. The tourists can also quench the thirst for more by visiting the sea beach located at south-west side of the ecopark. The ecopark is located about 40 kilometers from Amtali. The newly built roads without any need for ferries enables the tourists easily visit the park. Many tourists are visiting the park from Kuakata by launch, trawlers etc. The park gets crowded during the winter. Many visitors come to the park from various regions of the country for camping, picnic and other outdoors activity.

Source: (UDD, 2021)

Figure 8.22: Sonakata Ecopark

Rakhaine Village

13 Rakhaine Villages are located throughout the Kabirajpara, Agathakurpara, Tatipara, Monukhapara, Momeshepara, Tongpara, Laupara, Chhatonpara, Talukdarpara, Boro Ankupara, Chhoto Ankupara and Sawdagorpara of Taltoli Upazilla. A total of One Thousand and Five Hundered Fifty-Eight rakhaines are living in these villages. The Rakhaines are indigenous people of Taltoli Upazilla with origins rooted back in Myanmar. About Seventeen thousand Rakhaines are spread throughout Barguna, Patuakhali, Coxs' Bazar, Chattogram, Rangamati, Bandarban and Khagrachari. Their village is seen illuminated at night, with them wide awake looming clothes. Many tourists visit these villages to experience the indigenous lifestyle and acquire the knowledge about the Rakhaines. A sacred and historic Rakhaine temple is situated here aside from the village. Tourist spots like Ashar Char, Sonar Char are located near these Rakhaine villages.

Shuvo Shondha Beach

The Shuvo Shondha Beach is located in Nalbunia in Nishanbaria Union of Taltoli Upazila (**Figure 8.23**). The main three rivers: Payra, Bishkhali and Bawleshwer of Barguna district has been all connected near the beach. The shoreline covers Four kilometer area and the sea beach itself is about 15 kilometers away from Taltoli Upazilla Sadar adjacent to the south western side Sonakata Ecopark. In the past due to its distance from Jila Sadar the sea beach was somewhat deserted and devoid from any form of tourism except from local people and fishermen who came here for livelihood purposes. Thanks to social media, the sea beach has attracted the attention of many tourist and nature enthusiasts.

Source: (UDD, 2021)

Figure 8.23: Shuvo Shondha Beach

Misripara Buddhist Temple

A near thousand people come to visit the Buddhist Temple in Misripara of Kalapara Upazilla. The temple is about 8 kilometers from Kuakata has attracted the attention of many tourists throughout the nation. According to the temple authority, besides the local visitors many tourists of foreign nationality also come to see the temple. The 32 feet tall statue of the Buddha is considered one of the largest Buddha statues of Asia (**Figure 8.24**). The temple covers 2 acres of area. According to the local people the temple was damaged during the Sidr and Aila tropical storm. Thanks to the donation of German government, the temple has been able resurface as a whole new religious site in 2014. Many shops have been built surrounding the temple and the transportation facilities have also been improved.

Source: (UDD, 2021)

Figure 8.24: Misripara Buddhist Temple

Kuakata Sea Beach

Kuakata is one of the main sea beach situated at the southernmost area of Bangladesh. The sea beach is known as the "Sagar Kannya" (Sea Maiden). This is the only sea beach in Bangladesh where both sunset and sunrise can be seen (**Figure 8.25**).

Source: (UDD, 2021)

Figure 8.25: Kuakata Sea Beach

Several tourist spots are also located nearest Kuakata Sea Beach. Other places of interest near the sea beach include:

***Fatra Forest*:** A mangrove forest reserve at the western part of Kuakata sea beach which has been considered as the "second Sundarban" (**Figure 8.26**). Keye, Gauya, Goran, Golpata etc type of mangrove trees are seen there. There are also many birds and animals like monkeys pigs etc. Visitors can go there by trawler Fare is Tk. 1000-Tk. 3000 and required travel time is 30 min – 1.30 hr. Fatrar Char is also a part of Sundarban forest.

Source: (UDD, 2021)

Figure 8.26: Fatra Forest

***Well of Kuakata*:** An ancient well is built near the Rakhaine village of Keranipara (**Figure 8.27**). Legend has it the name Kuakata has been derived from the Well as the local people calls it The "Kua" (well) of Kuakata.

Source: (UDD, 2021)

Figure 8.27: Well of Kuakata

Sheema Buddhist Temple: The temple is standing right in front of the the Well of Kuakata. A buddhastatue weighing 37 mon made of osta metal is situated here. **Figure 8-7** shows the image of the temple.

Source: (UDD, 2021)

Figure 8.28: Sheema Buddhist Temple

***Coconut Foliage of the Sea Coast*:** The sea beach has numerous coconut foliages which enhanced the beauty of the beach to a much greater extent (**Figure 8.29**).

Source: (UDD, 2021)

Figure 8.29: Coconut Foliage of the Sea Coast

Alipur Port: The Alipur Port which has been considered one the largest of busiest fisheries port is about 4 kilometers away from the kuakata sea beach. **Figure 8.30** shows an image of the port.

Source: (UDD, 2021)

Figure 8.30: Alipur Port

***Gangamati Forest*:** Gangamati forest (or Gajmati Forest according to some local people) is situated at the east side of the sea beach. **Figure 8.31** shows an image of the forest.

Figure 8.31: Gangamati Forest

Shutki Palli

A numerous fishermen family lives in Ashar Char and a large shutki (dried fish) industry has been established here. During the drying season many fishermen come to these chars like a nomad. The processing of dried fish takes most of the 7/8 months of a year. Many men and women are engaged in processing dried fish in Kalapara Upazilla of Patuakhali. The fishermen families have been flocking here to earn livelihood. The number of fisherman huts is increasing as a result of the profitable business. Several trawlers can be seen in the sea engaged in harvesting. The traders buy fishes like poa, sonapata, modhufaissha, rupchanda, potka, shaplapata, chapila, faissha, loitta, chingri, chhuri, Hangor, bhol, med and other fishes of various species from the fishermen. Some people are seen busy clean and processing the harvested fishes. **Figure 8.32** shows an image of Shutki Palli.

Figure 8.32: Shutki Palli

Gurinda One Gambuz Mosque

Gurinda One Gambuz Mosque can be considered one of the most ancient artifacts of the Islamic architecture of Bangladesh (**Figure 8.33**). It is located in Ratnadi of Galachipa upazilla at the east side of Ulania Street. Due to the lack of much needed reparation and maintenance the mosque is almost turning to a ruin. It is believed that mosque has been built around the time of the rise of Muslim Empire in Chardadip Bakla. According to the legend, the mosque has been built before the catastrophic hurricane and cyclone of 1584. Moreover, according to some people, the mosque was built before the conquest of Chandradip in 1465 by Sultan Mobarak Shah. The main complex of the mosque is about 360 square feet of area and the height is about 16 feet. The mosque has only one floot and one Gambuz (Dome) thus gaining the name One Gambuz Mosque. The mosque has been built from 4 feet from the ground. It has one meeting house.

Figure 8.33: Gurinda One Gambuz Mosque

Sonar Char Reserve

The reserve is located around 50 kilometer south-east and 40 kilometers from the Kuakata tourist zone at the estuary of Buragauranga river. The area of Sonar Char is about 10 square kilometers. The char was devastated in the 70's catastrophic cyclone. The trees were uprooted making sonar char a barren land. The Patuakhali Forest Department took the responsibility of reforesting the char in 1975. The department planted kewra, sundari, khulsi, koroi plants covering up to 5.5 acre of land. Besides, many plants were grown on its own through the natural courses. These plants turned Sonar Char into an amazing forest land. Besides the flora, Sonar char has ample amounts of faunas as well as foxes, bulls, boars, monkeys etc. In 1995 a total of nine deer were released in sonar char in two bouts. There are no confirmed statistics about the total number of deer in the char at present day however many of them can be seen grazing throughout the forest. In the beach an abundant number of red crab can be sighted. Myriads of species of birds can also be observed especially in winter when migrant birds arrive here. Realizing the tourism potentiality of Sonar Char, Bangladesh Parjatan Corporation (BPC) proposed a tourist complex at Sonar Char that includes a youth inn, a restaurant, picnic sheds, outdoor party area and eco-cottaqes. The project, however, would not be feasible right now because of lack of communication network, inadequate accommodation facility and very poor utility services

(electricity, water supply, gas). According to the results of the cost-benefit analysis of the project prepared by the consultant, it is also seen that the project is neither economically nor financially viable. **Figure 8.34** shows an image of Sonar Char Reserve.

Figure 8.34: Sonar Char Reserve

Laldia Forest

The Laldia reserve and Haringhata tourism spot is situated 6 kilometers away from the Patharghata upazila town of Barguna in Sadar union of Haringhata Bishkhali River. Across the Bishkhali River in the Bay of Bengal lies the Laldia sea beach. The tourism spot covers as much as area from Bishkhali river bank to the coast of Bay of Bengal. It's located at the south side of Patharghata upazila. The forest can be found strolling through about two hours of distance in the Haringhata forest. Bishkhali river is at the east side of the and at west side is the Baleshwer river. The beach is clinging to the Laldia forest. Though the forest is quite small it has no lacking for entrancing the attention of nature loving visitors. The forest is teeming with wildlife and a tourist can become enthralled by the sound of sea water rushing on the coast. A flock of seagull and thousands of red crabs can be seen at the forest side beach. Four watchtowers, a total of ten benches and brick road has been built for the tourists. A fresh water pond has also been dug. Many mangrove plants like kewra and sundari has been planted as well as rain trees. Many species of wild animals can also be seen in the forest. **Figure 8.35** shows an image of the forest.

Figure 8.35: Laldia Forest

Haringhata Forest and Tourist Spot

Endless sea at the one side and natural forestry on other and in between stands the Haringhata Forest to fascinate the nature loving tourists. The forest is at the southern side of Patharghata upazilla. One can experience the sunset and sunrise as well as find many wildlife and myriads of plant species (**Figure 8.36**). The Haringhata name came from the fact that the forest use to be grazing ground for the spotted deer which can also be found at the sundarban. The beauty of the forest has been enhanced by the three adjacent beaches – laldia, padma and lathimara. It can be said that this spot is one of the best for observing both sunset and sunrise. The naturally made forest is teeming with thousands of species of plants and trees. The mail flora includes mangrove trees like kewra, goran, gewa, ora etc. Spotted Deers, Monkeys, Wild cats, Boars can be seen in the forest. Aside from these several species of birds and reptiles can also be seen here. One of the most attractive aspects of the forest is its serpent like myriads of canals. During the high tide river cruising through the forest can be mesmerizing.

Figure 8.36: Haringhata Forest and Tourist Spot

Bihongo Island

Bihongo Island is can be found at the estuary of the river Baleshwer of the Bay of Bengal. The island was named "Bihongo" recently. It is known as Dhansir Char to the local people. The island is much closer to the world heritage site Sundarbans. Patharghata and Sundarban is at the east side of the island. According to the elders of Ruhita village the island surfaced around 20 to 25 years ago. The naturally decorated island is filled with wildlife and trees (**Figure 8.37**). The island looks like an emerald hill from afar, the red crabs on the white sand looks like red carpet, the grey seagulls far away. The afternoon looks great at this place especially when the sun sets the sky ablaze golden with sunlight. The fishermen flock around the sea during the fishing season. One can easily buy fishes from there at a really low price.

Figure 8.37: Bihongo Island

The distribution of existing socio-economic facilities by upazilas is presented in **Table 6-1** while the **Table 6-2** presents the distribution of facilities per 10,000 people which gives a relative picture of the upazilas in terms of availability of facilities. For example, in Patharghata Upazila, there is only 0.67 or less than one high School per 10,000 people while in Galachipa Upazila, there are 2.24 High Schools per 10,000 people. This means that in Galachipa Upazila availability of High Schools is about 3.34 times (2.24/0.67) better than the availability of High Schools in Patharghata Upazila.

Galachipa performs best while Patharghata performs worst in terms of educational facilities if high school is considered. In case of primary school Patharghata performs better than other upazilas while Rangabali's performance is the worst in this case. Availability of madrasa is the highest in Amtali but the lowest in Kalapara.

A comparative analysis of health facilities indicates that Amtali has better facilities in all categories of health facilities such as health complex/hospital, family welfare centres and community clinics compared to other upazilas. Rangabali suffers most in terms of availability of health facilities although the condition in other upazilas is not at all satisfactory.

Significant variations are observed when availability of commercial facilities such as growth centres and rural markets are considered. Patharghata has highest number of growth centres per thousand populations while Amtali has the highest number of rural markets per thousand populations.

Rangabali and Barguna Sadar lag behind other upazilas in terms of availability of growth centres and rural markets respectively.

Cyclone Shelters are widely available in different upazilas. However, highest number of cyclone Shelters per unit of population is found in Taltali while lowest number is found in Amtali.

Social Facilities

Requirements of socio-economic facilities have been determined on the basis of threshold population for each facility as discussed above. Threshold population of each facility in the study area as calculated on the basis of Reed-Muench method is shown below:

Facility	Threshold Population
Primary school	450
Madrasa	8315
High school	7217
College	31783
Upazila health complex/ hospital	208403
Family welfare centre	22001
Community clinic	24975
Growth centre	38202
Rural market	2850
Cyclone shelter	2569

For calculating threshold population Mouza, Union and Upazila level population data are required. That is why population data of 2011 population Census have been used for this purpose.

Table 8.13 presents the projected requirements of socio-economic facilities in different upazilas in 2021 while **Table 8.14** and **Table 8.15** show the projected requirements of facilities in different upazilas in 2031 and 2041, respectively. **Table 8.16** indicates that if facilities are provided on the basis of threshold population then there would be very little disparity among the upazilas in terms of availability of facilities under study.

Table 8.11: Distribution of Existing Facilities by Upazilas

Facility	Total Number of Existing Facilities									
	HS[1]	PS[2]	MDSA[3]	UHC/H[4]	FWC[5]	CC[6]	GC[7]	RM[8]	CS[9]	COL[10]
Galachipa	58	265	24	0	15	22	8	43	39	10
Kalapara	46	219	22	2	14	24	10	34	35	6
Rangabali	16	78	13	0	3	2	1	21	17	0
Patharghata	11	196	22	2	8	20	10	39	49	5
Taltali	11	94	15	0	5	10	5	11	33	2
Barguna Sadar	34	239	30	2	8	27	5	31	47	6
Amtali	28	186	34	4	19	24	3	47	22	6

Source: (UDD, 2021)

1=High School 2= Primary School 3=Madrasa 4=Upazila Health Complex/Hospital 5=Family Welfare Centre 6=Community Clinic 7= Growth Centre 8=Rural Market 9= Cyclone Shelter 10=College

Table 8.12: Existing Facilities per 10,000 People in Different Upazilas

Facility	Number of Existing Facilities per 10,000 People									
	HS[1]	PS[2]	MDSA[3]	UHC/H[4]	FWC[5]	CC[6]	GC[7]	RM[8]	CS[9]	COL[10]
Galachipa	2.24	10.25	0.92	0.00	0.58	0.85	0.31	1.66	1.51	0.39
Kalapara	1.93	9.20	0.92	0.08	0.58	1.01	0.42	1.43	1.47	0.25
Rangabali	1.55	7.57	1.26	0.00	0.29	0.19	0.10	2.04	1.65	0.00
Patharghata	0.67	11.95	1.34	0.12	0.49	1.22	0.61	2.38	2.99	0.31
Taltali	1.25	10.68	1.70	0.00	0.56	1.13	0.56	1.25	3.75	0.23
Barguna Sadar	1.30	9.14	1.14	0.08	0.30	1.03	0.19	1.18	1.80	0.23
Amtali	1.53	10.17	1.86	0.21	1.04	1.31	0.16	2.57	1.20	0.33

Source: (UDD, 2021)

1=High School 2= Primary School 3=Madrasa 4=Upazila Health Complex/Hospital 5=Family Welfare Centre 6=Community Clinic 7= Growth Centre 8=Rural Market 9= Cyclone Shelter 10=College

Table 8.13: Projected Requirement of Facilities by Upazilas in 2021

Facility	Total Number of Facilities Required by 2021									
	HS[1]	PS[2]	MDSA[3]	UHC/H[4]	FWC[5]	CC[6]	GC[7]	RM[8]	CS[9]	COL[10]
Galachipa	40	644	35	1	13	12	8	102	113	9
Kalapara	37	600	33	1	12	11	7	95	105	9
Rangabali	15	247	13	1	5	4	3	39	43	4
Patharghata	26	416	23	1	9	8	5	66	73	6
Taltali	14	224	12	0	5	4	3	35	39	3
Barguna Sadar	39	632	34	1	13	11	7	100	111	9
Amtali	29	469	25	1	10	8	6	74	82	7

Source: (UDD, 2021)

1=High School 2= Primary School 3=Madrasa 4=Upazila Health Complex/Hospital 5=Family Welfare Centre 6=Community Clinic 7= Growth Centre 8=Rural Market 9= Cyclone Shelter 10=College

Table 8.14: Projected Requirement of Facilities by Upazilas in 2031

Facility	Total Number of Facilities Required by 2031									
	HS[1]	PS[2]	MDSA[3]	UHC/H[4]	FWC[5]	CC[6]	GC[7]	RM[8]	CS[9]	COL[10]
Galachipa	44	707	38	2	14	13	8	112	124	10
Kalapara	42	674	36	1	14	12	8	106	118	10
Rangabali	17	271	15	1	6	5	3	43	47	4
Patharghata	28	455	25	1	9	8	5	72	80	6
Taltali	15	245	13	1	5	4	3	39	43	3
Barguna Sadar	43	682	37	1	14	12	8	108	120	10
Amtali	32	514	28	1	11	9	6	81	90	7

1=High School 2= Primary School 3=Madrasa 4=Upazila Health Complex/Hospital 5=Family Welfare Centre 6=Community Clinic 7= Growth Centre 8=Rural Market 9= Cyclone Shelter 10=College

Table 8.15: Projected Requirement of Facilities by Upazilas in 2041

Facility	Total Number of Facilities Required by 2041									
	HS[1]	PS[2]	MDSA[3]	UHC/H[4]	FWC[5]	CC[6]	GC[7]	RM[8]	CS[9]	COL[10]
Galachipa	48	769	42	2	16	14	9	122	135	11
Kalapara	47	747	40	2	15	13	9	118	131	11
Rangabali	18	294	16	1	6	5	3	46	51	4
Patharghata	31	493	27	1	10	9	6	78	86	7
Taltali	17	266	14	1	5	5	3	42	47	4
Barguna Sadar	46	733	40	2	15	13	9	116	128	10
Amtali	35	559	30	1	11	10	7	88	98	8

1=High School 2= Primary School 3=Madrasa 4=Upazila Health Complex/Hospital 5=Family Welfare Centre 6=Community Clinic 7= Growth Centre 8=Rural Market 9= Cyclone Shelter 10=College

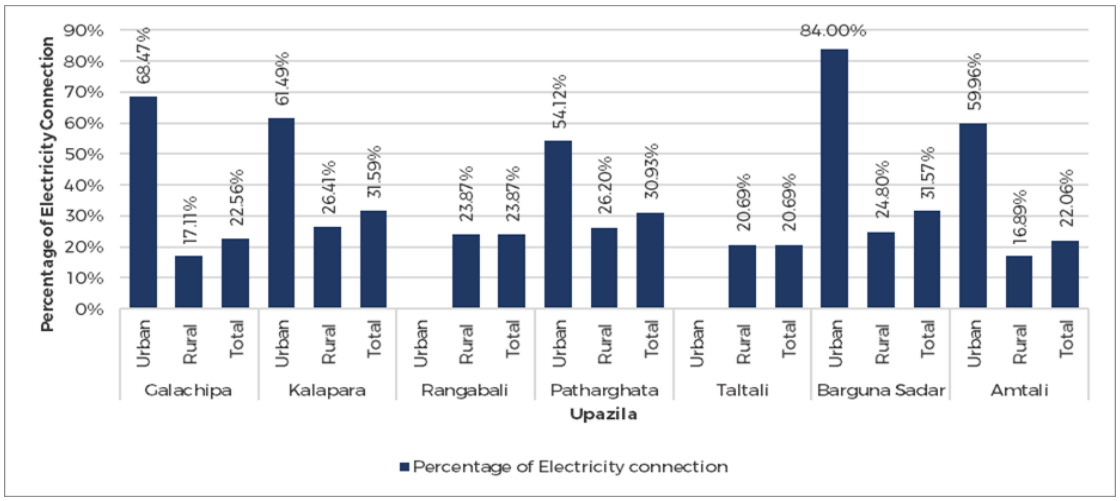
Table 8.16: Facilities per 10,000 People if Required Facilities are Provided

Facility	Number of Facilities per 10,000 People in 2041 if Required Facilities are Provided									
	HS[1]	PS[2]	MDSA[3]	UHC/H[4]	FWC[5]	CC[6]	GC[7]	RM[8]	CS[9]	COL[10]
Galachipa	1.39	22.20	1.21	0.06	0.46	0.40	0.26	3.52	1.39	0.35
Kalapara	1.40	22.22	1.19	0.06	0.45	0.39	0.27	3.51	1.40	0.38
Rangabali	1.36	22.23	1.21	0.08	0.45	0.38	0.23	3.48	1.36	0.39
Patharghata	1.40	22.19	1.22	0.05	0.45	0.41	0.27	3.51	1.40	0.37
Taltali	1.42	22.20	1.17	0.08	0.42	0.42	0.25	3.51	1.42	0.34
Barguna Sadar	1.39	22.21	1.21	0.06	0.45	0.39	0.27	3.52	1.39	0.34
Amtali	1.39	22.23	1.19	0.04	0.44	0.40	0.28	3.50	1.39	0.38

1=High School 2= Primary School 3=Madrasa 4=Upazila Health Complex/Hospital 5=Family Welfare Centre 6=Community Clinic 7= Growth Centre 8=Rural Market 9= Cyclone Shelter 10=College

Electricity Connection

The disparity between urban and rural areas of Patuakhali and Barguna district gets apparent when the percentage of households with electricity connection in urban and rural areas are compared with each other (**Figure 1-17**). 66% of the households in urban areas have electricity connection while only 22% of the households in rural areas have that facility. Barguna Sadar has the highest percentage of urban electricity connection (84%) while Patharghata upazila has the lowest (54%). In rural areas, Kalapara has the highest percentage of electricity connections (32%) while Galachipa and Amtali both have only 17% of the households with electricity connection.



Source: (UDD, 2021)

Figure 8.38: Distribution of Household by Electricity Connection and Area of Residence

8.9 Impacts of PPPs

8.9.1 Plan and Policies

Any type of programmes or projects are designed to ensure planned development to bring benefits in the short and long term for the country. Achieving the economic growth and improving quality of life are the major objectives of the Perspective Plan 2021-2041. While BDP2100 looks at more holistic and eco-friendly approach with adaptive and no regret solutions in view of the uncertainties of climate change induced hazards for developing a delta country like Bangladesh within the next 100 years. In fulfilling the planning objectives infrastructure plays a vital role. Connecting urban with rural areas, providing access to social services (e.g. education, health, etc.) and creating job opportunities through linkage to industries are the positive impacts that are accrued from development of infrastructure namely transportation and communication. Policy acts as guidelines and plans suggests strategies to minimize negative impacts. However, some projects on infrastructure development might cause some direct or indirect impacts (e.g. water, air and soil pollution etc.) on the surrounding environment during the pre-construction, construction and the post construction phase depending on its type. Beside the environmental pollution, there are other impacts such as land use change, habitat destruction, etc. Socio-economic impacts are also visible in the form of displacement, migration, squatters, health problems and occupational hazards, conflicts of interest etc.

These can be minimized through mitigation and management measures. Environmental management plans that are prepared as part of the feasibility study provides alternative options for managing the negative impacts arising from development works. Nowadays, the PPPs are prepared mostly considering multiple environmental consequences and hence encourage multi-sectoral and integrated approach for development e.g. Bangladesh Delta Plan2100 and the second Perspective Plan. Apart from the proper adoption and implementation of the PPPs, softer measures such as training and capacity building, awareness raising are needed to deal with the consequences.

Integrated Multi-Modal Transport Policy 2013

Positive impacts

Road Transport

- Increased regional cooperation through Asian Highway;
- Safe movement of both passenger and freight traffic;
- Increased revenue generation (tolls and duties from roads and bridges);
- Efficient use of road network;
- Reduced operating and traffic costs;
- Improved access to social facilities, e.g. growth centers, hospitals, educational institutes;
- Less air and noise pollution due to less traffic congestion;
- Increased economic productivity due to reduced commuting time;
- Increased employment opportunities in public transport sector;
- Increase value of land or property.
- Better environment through road side tree plantation

Rail Transport

- Increased trading of goods and services through multimodal corridors between major economic centers, e.g. Trans-Asian railway;
- Improved service quality of Bangladesh Railway (e.g. speed and comfort).

Air Transport

- Development of tourism sector;
- Increased staff skills for immigration and improved IT systems.

Inland Waterways, Ports and Navigation:

- More use of inland transport would reduce emission from vehicle usage;
- Reduced water pollution through efficient waste management;
- Better infrastructure and navigation facilities;
- Efficient operation of multimodal transport in waterways sector;
- Cheaper transportation cost using inland waterways;
- Proper flood control, regulated and steady water flow and navigation through regional water management;
- Increased capacity of existing land and sea ports (specially Payra port);
- Increased economic productivity and reduced operating costs;
- Updated information on waterways of all classes.

Negative impacts

Road Transport

- Increased risk of accidents near educational institutes, shopping malls, etc. due to land use change dynamics e.g. more land under commercial use;
- Increased noise and air pollution due to traffic movement;
- Increased risk of health hazards (e g from pollution);
- Reduced run-off of polluted due to paved roads;
- Increased migration from rural to urban area due to better facilities;
- Increased conflict over ownership of land/property in roadside areas.

Railways Transport

- Reduced value of properties located in the vicinity of railway stations;
- Displacement of dwellers due to expansion of railways network;
- Increased slum-dwelling due to migration of displaced people to urban areas;
- Habitat fragmentation may cause biodiversity loss;

Air Transport

- Increased noise level in the adjacent areas;
- Reduced availability of land for other purposes (e.g. no-flight zone).

Inland Waterways, Ports and Navigation:

- Increased marine pollution due to inadequate waste management;
- Increase in accidents due to night-time trips, especially during severe weather;
- Loss of agricultural land;
- Displacement of people.

National Land Transport Policy 2004

Positive impacts

- Improvement of rail and water way communication will decrease fuel consumption and reducing CO2 emissions;
- Improved women's' literacy and reduced dropout rate in the rural areas due to improvement of rural network system;
- Increased employment opportunities due to toll roads;
- Reduced accidents and road congestion due to road junction control;
- Reduced time for long-distance travel due to construction of new bridges;
- Reduced accidental events at level crossings due to rail improvements and reduced traffic congestion following development of flyovers
- Reduce burning of fuels;
- Increased private sector participation in railways;
- Improved operations of railways;

- Improved Rail infrastructure and connectivity/branch lines;
- Inter-regional rail links will increase passenger movements and reduce fuel consumption due decreasing bus movement.
- Reduced air pollution in rural areas due to promotion of non-motorized vehicles;
- Improved appropriate uses of unutilized roadside land - where appropriate, fish farms in roadside borrow pits will be encouraged;
- Reduced atmospheric pollution due to ban on heating bitumen for surfacing roads;
- Reduced road accidents due to incorporating non-motorized vehicle lanes;
- Reduced air pollution due to increasing CNG use and vehicles testing.

Negative impacts

- Loss of agricultural land due to improvement of regional and national highway and extension of rural roads;
- Change or loss of livelihoods for boatmen due to construction of new bridges in the rural areas;
- Increased noise and air pollution, and health risks, due to traffic congestion;
- The use of natural gas in domestic purpose has been cut down by Government due to increasing CNG use in vehicles which are creating
- Increased urban fire accident due to increased illegal connection of gas.

Road Master Plan 2009

Positive impacts:

- Improved traffic management (e.g. use of road lanes, control of vehicle speed, use of horns) by trained traffic police;
- Faster transportation of food, agricultural and industrial products due to improved road network and improved connections between rural economic growth centers; with reduced operating costs.
- Better accessibility to important destinations and social facilities such as Upazila offices,
- Markets, railway and water landing stations, schools, health centers.

Negative impacts:

- Increased pollution and accidents due to shift from public to private transport.
- Conversion of roadside agricultural land to commercial land/ industrial land – due to improving road accessibility;
- Increased accidents due to increase in roads use e.g. travelling to educational institutes, shopping malls etc.
- Increased noise and air pollution (with consequent health issues) due to increased traffic and congestion.

Railway Master Plan (2010-2030)

Positive impacts:

- Reduced loss of agriculturally productive land or expensive urban land – since rail has a smaller footprint than building new roads

- Reduced involuntary resettlement (same reason as above).
- Reduced environmental damage (including GHG) by shifting modal share from road to rail transport.

Negative impacts:

- Involuntary resettlement, migration, and urbanization;
- Unfair distribution of benefits, local conflicts of interest, and impacts on local economy;
- Noise pollution near the residential areas;
- Increase railway-related accidents;
- Increased occupational health and safety risks;
- Possible removal of important infrastructure/service facilities next to railway lines (e.g. clinics, health clubs, schools) could create local conflict and problems;
- Destruction/removal of cultural heritage sites (e.g. tombs, historical mosques and temples) when railways are improved/extended could create local conflicts and problems;
- Conversion of agricultural land and loss of wetlands due to construction of new railway corridors.

National Shipping Policy 2000

Positive impacts:

- Improved handling and management of containers will lead to reduced environmental pollution from both freight such as oil, lubricants, petroleum/ hazardous materials and food/agricultural products (by preventing rotting and decaying);
- Review and reform of organizational bodies, training, increased safety etc. will increase capacity, raise the standard of life of employees and labor;
- Attracting private sector in port management can create a lucrative job sector;
- The Environmental Protection Agency as proposed by the policy has not been formed. However, divisional and district level offices of the DoE are working to regulate and help limit pollution - following the standards as per the National Environment Policy 2018.

Negative impacts:

- Expansion of the shipbuilding, breaking and repairing industry is likely to result in increased pollution;
- Change in land use required under this policy might cause land degradation;
- Establishment of new facilities and improvement/ modernization of existing infrastructure will harm the river and coastal ecosystem. For example
- Riverbank erosion may occur without protection measures.
- Increased navigation may disturb aquatic habitats.

Second Perspective Plan for the year: 2021-2041

Positive impacts:

Transportation and communication

- Smooth flow of passenger and goods traffic;
- Provision of affordable and faster transport services;
- More convenient commodity transport system;
- Stronger inter-district and inter-regional connectivity;
- Reduced risks of accidents;
- Introduction of rapid mass movement of people, easy commuter services with less congestion; reduced noise and air pollution (e.g. CO2 emissions).
- Properly and well managed traffic movement.

ICT and science and technology

- ICT service brought to the people's doorsteps through digital technology;
- Improved productivity of indigenous products using innovative technology;
- Expanded economic areas through invention-innovation;
- Increased technologically skilled manpower;
- Improved knowledge on information technology.

Negative impacts:

Transportation and communication

- Increased air and noise pollution due to development of transportation and communication facilities, e.g. stations, ports, etc.
- Land degradation due to expansion of transportation network;
- Displacement of people due to land acquisition.

ICT and Digital Bangladesh

- Widening gap between different social classes and sections of the populace (between those with and without access to ICT);
- Increased e-waste due to expansion of digital technology.
- Increase in cyber-crimes.

Bangladesh Delta Plan 2100 (BDP2100)

BDP2100 is a massive plan covering 15 sectors. The impacts related to infrastructure are presented below:

Positive impacts:

- Improved protection from flood-storm-surge through resilient infrastructure;
- Improved navigation and connectivity and cheaper transportation of freight;
- Increased conveyance and storage capacities in rivers and wetlands, respectively through dredging;

Negative impacts:

- More pressure on already vulnerable ecosystem of the Payra-Kuakata region might occur due to increased shipping and coastal navigation.
- Environmental degradation, especially in the Payra sea port might occur due to improper storage and disposal of dredged material;

Eighth Five Year Plan 2021-25

Some major positive and negative impacts of Eighth Five Year Plan on infrastructure is mentioned below:

Positive impacts:

Urbanization

- Improved urban areas with better facilities - providing economic benefit;
- Enriched urban life;
- Increased employment opportunities;
- Reduced urban poverty.

Agriculture & livestock

- Increased crop production with enhanced food security;
- Reduced malnutrition;
- Marginal and small farmers will receive priority attention;
- Reduced crop damage due to strengthened early weather forecasting system;
- Reduced pressure on ground water;
- Increased production of dairy products by smallholders;
- Introduction of salinity- and stress-tolerant crop varieties;
- Increased production of horticulture crops.

Transportation

- Increase in overall capacity of highways;
- Climate-resilient road infrastructures developed;
- Reduced road damage from overloading and decreased road accidents;
- Modernized port facilities;
- Enhanced industrial development through expansion of railways;
- Improved navigability of inland waterways.

Power and energy

- Enhanced energy security;
- Industrial sector will be developed due to sufficient amount of electricity generation.
- Increased use of alternate primary fuel such as renewable solar energy for electricity generation.

Tourism

- Increased eco-tourism opportunities and increased related employment;
- Increase in supply and quality of workforce in the tourism industry;
- Increased numbers of tourists visiting archaeological sites;
- Improved access to funding, security and regulations, and service quality of front-line staff.

Environment and climate change

- Enhanced quality of surface water;
- Improved fresh air quality index;
- Control of air and water pollution;
- Improved management system (safe disposal) for solid waste, including though installing effluent treatment plants;
- Reduced blockage of drains and aesthetic discomfort;
- Reduced carbon emissions.

Disaster management

- Reduced food insecurity following disasters;
- Enhanced disaster resilience;
- Reduced vulnerability of at-risk communities;
- Improved recovery following disasters, including through the "building back better" approach.

Education

- Improved socio-economic conditions and lifestyles;
- Increased interest in education;
- Improved opportunities for attaining higher education and skills through establishment of equivalence between formal and non-formal education.

Cultural affairs

- Restoration of many of the intangible cultural heritage features that are on the verge of extinction;
- Increased number of cultural activities throughout the country.

Industry

- Streamlined regulatory processes and more efficient one-stop service, and improved compliance with regulatory requirements (e.g. labour, environment, building code, workplace safety);
- Removal of policy discrimination, if any, between domestic and foreign investments;
- Enhanced regional and sub-regional cooperation;
- Economic zones established in areas with vast economic potential.

Health

- Reduced impact of the COVID-19 pandemic;
- Improved service delivery and health network;
- Improved preventative and promotional health education services;
- Improved response to emerging, re-emerging and non-communicable diseases, health hazards due to climate change and emergency challenges due to catastrophes;
- Reduced levels of severe malnutrition, mortality and infertility;
- Improved and healthier lifestyles, through reducing environmental, economic, social and behavioral risks.

Nutrition

- Improved knowledge base and capacity (through training) of health personnel, family planning workers and agricultural extension workers regarding nutrition;
- Strengthened community awareness regarding health and nutrition - through disseminating messages;
- Community based arrangements will promote preparation of low-cost nutritious recipes, processing and preservation of micronutrient rich foods.

Social protection

- Reduction of hardcore/extreme poverty;
- Income security and greater opportunities to engage in the labour market provided for the most vulnerable women;
- Provision of social safety net and child grant.

Local and rural development

- Improved production of quality goods through cooperatives with fair producer prices;
- Expansion of markets, augmentation of regional balance and creation of investment opportunities, all of which are conducive to economic growth and poverty reduction;
- Increased income of targeted people; forming capital through savings and enhanced livelihoods.

Youth development

- Improved training, infrastructure and financial facilities will assist the youth to realize their potentials;
- Reduced income inequalities due to increased number of better-paid jobs.

Religious affairs

- Enhanced religious values, universal brotherhood and good citizenship;

Service sector

- Increased in average labour productivity of services;
- Increase in the share of modern services in total services GDP;

- Increased growth of non-labour export services focused specifically on ICT, international transport and tourism;
- Improved quality and safety of services.

Poverty and inequality

- Reduction of percentage of people under the poverty and extreme poverty line.

Information communications technology

- Increased opportunities for education for rural people through virtual university;
- Enhanced application of digital technologies;
- More widespread availability of online banking systems;
- Increased availability of e-services, e.g. telemedicine services, video-conferencing for the treatment of diseases, and video conferencing for administrative activities.

Land management

- Improved awareness of better land use;
- Increased resolution of land disputes.

Women and children

- Improved social security for women and children;
- Increased employment opportunities for women;
- Equal rights established for women.

Forestry

- Developed SEA report and EMP for protecting and conserving the Payra-Kuakata region, effective till 2041;
- Enhanced safe habitats for wildlife and biodiversity;
- Reduction of soil erosion.
- Decreased impacts of cyclone and storm surges on coastal settlements;
- Increased eco-tourism and related employment opportunities;
- Conservation of Gangamoti reserved mangrove forest, near the Kuakata sea bitch

Fisheries

- Increased fish production;
- Improved marketing and distribution system;
- Better prices available to fisherfolk;
- Increased fish production in ponds and closed water systems;
- Increased marine fish production;
- Reduced unemployment;
- Establishment of fish-friendly infrastructure – with fish habitats.

Negative impacts:

Urbanization

- Migration from rural to urban areas – with stress on basic urban facilities;
- Pollution as consequence of increased infrastructure development;
- Increased air pollution due to increased road transport density.

Transportation

- River-based container port building may hamper passenger traffic movement;
- Potential increase in pollution due to expansion of ship repairing industry;
- Changes in land use due to development of port and other facilities - might lead to land degradation.

Power and energy

- Increase in GHG emissions and potential increased pollution - due to increased use of coal and frequent transportation of coal by water;

Tourism

- Impairment of ecosystem due to increased tourism activities;

Industry

- Growth of industry might have cumulative negative impact on the environment (e.g. industrial effluent entering water courses; potential pollution due to improperly planned/designed industrial waste management facilities).

Education and health

- Increased pollution due to expansion of education and health care facilities;
- Health risks due to industrial development (power, chemical, cement factories, etc.).

Information communications technology

- Increase in e-waste.

Forestry

- Land transformed through afforestation can no longer be used for residential, agricultural and industrial development (Bangladesh is a land hungry country).

Fisheries

- Habitat destruction and salinization due to development of shrimp aquaculture;
- Increased conflict in coastal land use between fishing communities and farmers.

8.9.2 Projects

Impact of Padma Multipurpose Bridge Project

Padma Multipurpose Bridge is a long cherished mega project which is to connect the South and South West region of Bangladesh with the rest of the country using road network and rail network. Padma

bridge have been inaugurated and it is opened in 25th June, 2022. According to the EIA reports (BBA, 2010),The impact of Padma bridge is in a range of direct potential positive and negative impacts.. The positive and negative impacts are stated below-

Positive impacts

- The distance from Capital city Dhaka to nearly all major cities in Barishal division have been reduced by 100 km or more, bringing considerable savings in fuel consumption, and tumbling rate of air emission;
- Reduced deaths due to overloaded ferry vessels (launches and speed boats) that frequently sink in the Ganges;
- Strengthened links between the capital to Barishal division;
- Improved connectivity between the southern and the rest of country, providing increased access to markets, ports and growth centers and opportunities to develop businesses (including in agriculture and fisheries), expand industry, develop communications and tourism, etc., all driving economic growth, jobs and improved livelihoods.
- A multipurpose bridge will enhance freight, passenger travel, railway transportation, and utility crossings (high pressure gas transmission, high voltage power transmission, and optical fiber telecommunication cable) between Dhaka and major points in Barishal division and contribute substantially to the development of Payra-Kuakata as well as to the national and regional economic growth.
- Elimination of traffic congestion and long waiting times for ferries;
- New industrial zone has been created in Payra-Kuakata region (create new employment)
- Enhanced access to healthcare, educational and recreational facilities due to improved connectivity;

Negative impacts

- Unplanned urbanization, especially along road and railway corridors in the Barishal Region, triggering environmental and social issues at local and regional level - if not mitigated;
- Increased pollution and GHG emissions due to increased traffic;
- Loss of some livelihoods and incomes;

Impact of Payra Sea Port

The Payra Port Authority was founded on 19 November 2013 under the Payra Sea Port Act 2013. The port was initiated commercial operations from August 2016 under the port authority. Payra deep sea port is still under construction that is planned to be completed in three phases and the first phase is completed already in 2016 which was started in 2013. It is situated in the Southern part of Bangladesh, in Kalapara Upazila under Patuakhali District. The Payra Port Master Plan prepared in January, 2016 assumed that by 2025 when the port becomes fully operational it would handle nearly 2 million containers, 2.5 million tons of general cargo and nearly 43 million tons of other materials (oil products, grain, sand and aggregate, coal etc. About 13000 people are involved to the port and related facilities (free trade zone, airport, construction laborer of the port). Based on Assumption of the number of employments generated directly by the Payra port, envisages that after full development of the port total employment (direct and indirect) in the new township close to the port may be as high as 43,550 with a total population of about 1,26,000 (UDD, 2021).

9. Power and Energy

9.1 Introduction

This paper presents background information on the power and energy sector to support the Strategic Environmental Assessment for Payra-Kuakata of Bangladesh.

The Payra- Kuakata is the part of Barishal Division (the Patuakhali District). The area of the Patuakhali district is 3221.31 km2 and its population is 15,35,854[14].

This SEA is being undertaken because concerns have been raised, particularly by UNESCO, about the possible impacts on the environment, socio-economic from the Payra coal-fired power station and industrial development in the Payra-Kuakata area. Power generation is one of the major contributor to generate pollution (particularly airborne pollution). For this reason, the paper discusses power and energy facilities and development in the Barishal Division. Wherever possible, data for the Barishal Division is provided, but much is only available at national level. The paper covers three main sectors presented sequentially below.

9.2 Energy & Power Sector of Bangladesh

Energy consumption per capita is 0.28 toe, including around 489 kWh of electricity (2020). The country's overall energy consumption is increasing quickly (4.5%/year since 2010), driven by rapid economic growth (6.9%/year). Gas is the main energy source (57%), ahead of biomass (17%), coal (13%), and oil (12%) (2020)[15].

9.2.1 Sources of Energy

Natural Gas, liquefied gas, coal, biomass & biofuel, hydro energy, wind energy, solar energy are the main available energy resources in Bangladesh. Biomass accounts for about 27% of the primary energy and the rest 73% is being met by commercial energy. Natural gas accounts for about 62% of the commercial energy (with 8% imported LNG). Imported oil accounts for the lion's share of the rest.

Moreover, power is also generated by capitalizing Solar Home System (SHS) in on grid and off grid areas. The amount of power generation using solar system is currently about 401.26 MW. Estimated consumption of total energy is around 55.00 MTOE. Average increase of energy consumption is about 6% per annum. Per capita consumption of energy in Bangladesh is on an average 334 kgoe (Kilogram Oil Equivalent) and per capita generation of electricity is 512 kWh with an access to electricity 97 %, which is lower than those of South Asian neighbouring countries. The following table shows the energy consumption from 2018 to 2019 in Bangladesh[16].

[14] www.patuakhali.gov.bd

[15] https://www.enerdata.net/estore/energy-market/bangladesh/

[16] http://hcu.portal.gov.bd/sites/default/files/files/hcu.portal.gov.bd/publications/1eb522c0_8f5f_4f34_b133_d617b3d5c9ef/2020-01-15-11-06-d59870a995b81533dcc5d88fdf19318c.pdf#page=11&zoom=100,92,90

Table 9.1: Energy Consumption in 2018 – 2019

Sl. No.	Name	Unit in Mtoe
1	Oil (Crude +Refined)	8.65
2	LPG	0.70
3	Natural Gas	22.37
4	LNG	2.69
5	Coal (Imported)	3.64
6	Coal (Local)	0.51
7	Renewable Energy (Hydro)	0.17
8	Renewable Energy (Solar)	0.27
9	Electricity (Imported)	0.86
A	Total Commercial Energy	39.85
B	Biomass	14.75
	Total Primary Energy (A+B)	**54.60**

Natural Gas

The use of natural gas in Bangladesh began in the 1960s, at present it is the main source of the energy. Until now, 27 gas fields have been discovered. Natural gas covers about 75% of the total fuel consumption of the country being used in electricity production, fertilizer factories, domestic and commercial cooking, CNG vehicles, tea estates and other industries. As per the survey report of Energy and Mineral Division, Bangladesh has 3,449176.364 Million Cubic Feet Natural gas in six (06) gas fields[17]. The present scenario of the natural gas in Bangladesh is presented in the following Table 9.2. Scenario of sector wise gas consumption rate is presented in the following Figure 9.1.

Table 9.2: Scenario of sector wise gas consumption Status

Sl. No	Name of the Gas Field	Total in Stock (Million Cubic Feet)	Amount of extraction till 2021 (Million Cubic Feet)	Remaining Amount (Million Cubic Feet)
1.	Titas	7,582,000	5,043,235.503	2,538,764.497
2.	Habiganj	2,787,000	2,589,520.080	197,479.920
3.	Bakhrabad	1,387,000	848,504.155	538,495.845
4.	Narshingdi	345,000	223,854.526	121,145.474
5.	Meghna	101,000	76,608.372	24,391.628
6.	Kamta	50,000	21,101.000	28,899.00
	Total	12,252,000	8,802,823.636	3,449,176.364

[17] https://emrd.gov.bd/sites/default/files/files/emrd.portal.gov.bd/annual_reports/7a6e0a00_8576_4c89_81ee_81c5a9e72c68/Annual%20Report%202020-21-compressed_compressed_11zon.pdf

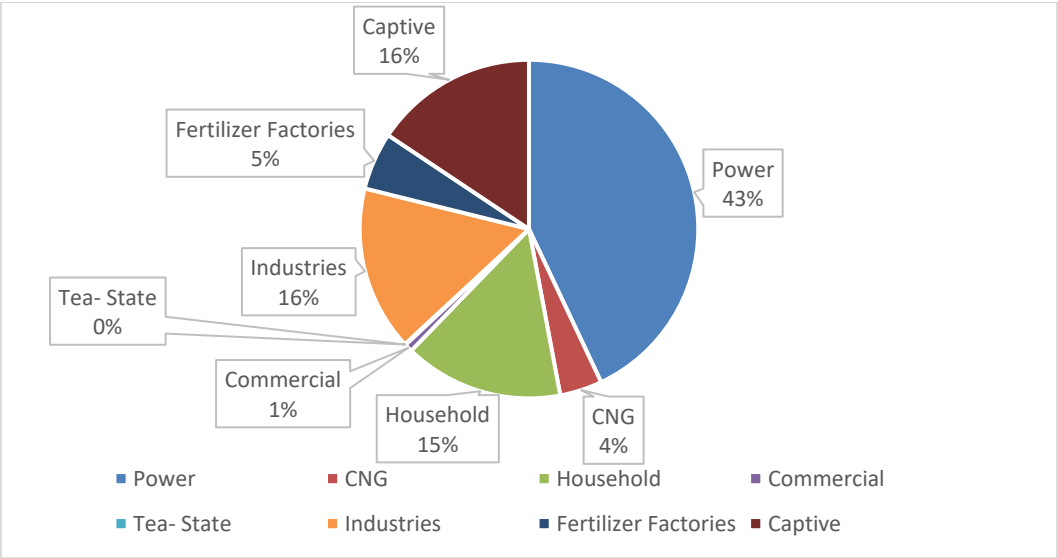


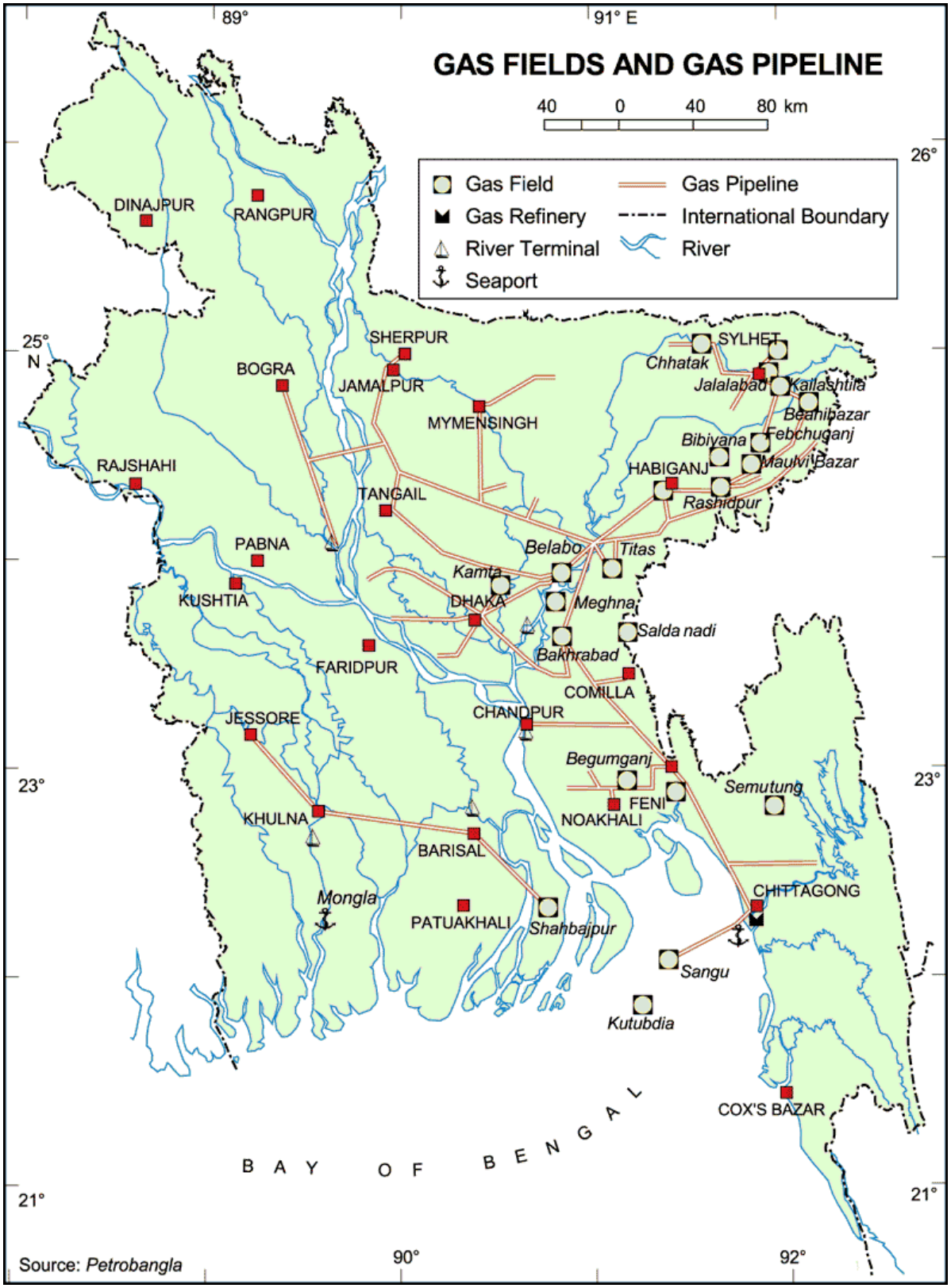
Figure 9.1: Sector wise Gas Consumption in Bangladesh

Natural gas production and consumption has increased drastically during last decades. The rate of Natural Gas Consumption was reported at 3.012 Cub ft/Day billion in Dec 2021. This is an increase from the previous 2.886 Cub ft/Day billion for Dec 2020. Bangladesh Natural Gas: Consumption data is updated yearly, averaging 0.688 Cub ft/Day bn from Dec 1971 to 2021[18].

Most people in the Barishal Regions of Bangladesh still rely on wood, electricity, LPG and kerosene for cooking. Sundarban Gas Company Ltd (SGCL) is the authority distributing the gas in Payra and Kuakata Region. At present SGCL has no existing gas pipeline in the Payra – Kuakata of Bangladesh. The gas network system over the country is shown in Figure 9.2.

At present, the government has stopped the pipeline gas supply for domestic uses, especially for cooking purposes. At the same time, it has started providing pre-paid meters for the existing gas distribution line connections which has significantly reduced gas bills.

18 https://www.ceicdata.com/en/indicator/bangladesh/natural-gas-consumption



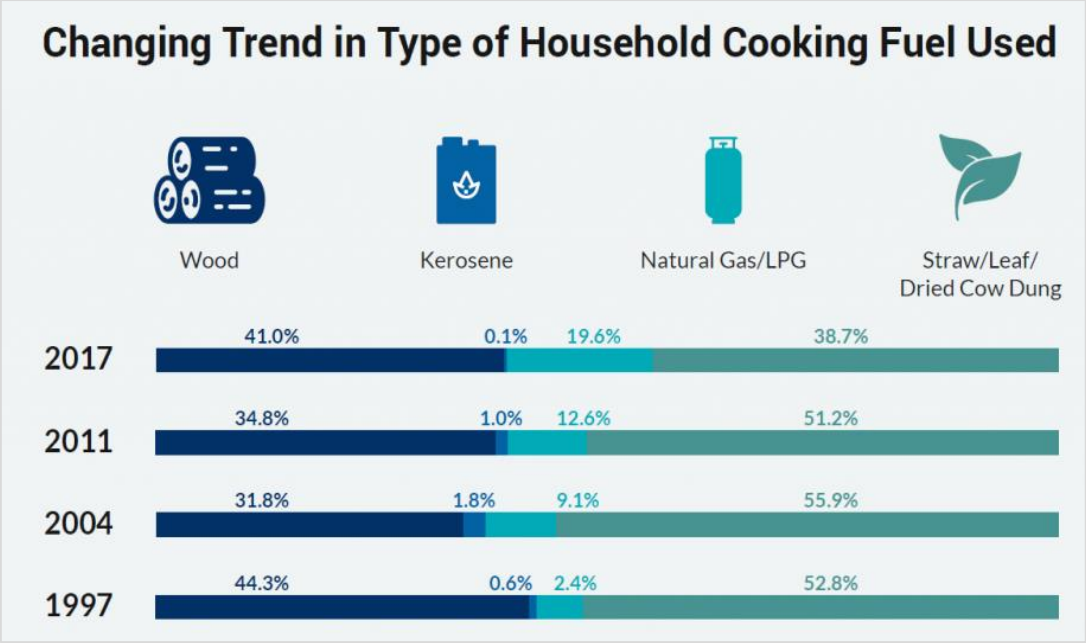
Source: Petrobangla

Figure 9.2: Location of the Gas Field and Gas Pipeline

Liquefied Petroleum Gas (LPG)

Until the end of the 1990s, the use of liquid petroleum gas (LPG) as fuel for cooking in Bangladesh was limited. Private sector interest in the LPG sector started to grow and accelerate from 2011 when restrictions were introduced, new connections to domestic consumers were suspended and gas supply to compressed natural gas (CNG) stations was rationed. The government also promoted the use of LPG for vehicles (auto gas). Additional fiscal and financial incentives were given to the private sector LPG importers, bottling plant owners and traders. According to the data of "Upending the Natural Gas Market in Bangladesh: Growth Prospects of LPG in Bangladesh", the local annual consumption of LPG grew to 0.95 million tons in 2019.

In Bangladesh, 25 companies are active in bottling LPG, including six satellite entities. In addition, the state-owned Bangladesh Petroleum Company (BPC) is also involved in the market to a limited capacity. The share of LPG used for cooking has shifted significantly over the last 20 years from 2.4% to 19.6% as presented in Figure 9.3.



Source: BBS, https://www.lightcastlebd.com/insights/2019/05/30/lpg-white-paper-may-2019

Figure 9.3: Type of Fuel used for cooking in Bangladesh with the range of 20 years

The maximum LPG production capacity from local sources is about 22,000-25,000 tons. Bangladesh total consumption was around 400,000 tons in 2016-2017, 650,000 tons in 2017-2018, 825,000 tons in 2018-2019, and increased to 950 000 tons in 2019[19].

Coal and Peat

Bangladesh has reserves of 3,100 million tons of coal with 13% in the proven category[20]. The reserves include five coalfields, all of which occur in the north western area that is sandwiched between the Jamuna River and the Padma River in north western Bangladesh. Currently, Barapukuria is the only mine supplying coal to the Barapukuria Coal Based Thermal Power Plant located at the coal mouth.

19 https://databd.co/wp-content/uploads/sites/5/edd/2019/05/LPG-White-Paper-May-2019.pdf
20 Proven coal reserves: coal located in active mines, and that can be extracted under current economic and technical conditions

These reserves are not sufficient to cover the expected demand of newly built thermal power plants and considerable amounts of coal will have to be imported.

Geological Survey of Pakistan (GSP) and geological survey of Bangladesh (GSB) discovered considerable quantities of peat deposits in various localities of Bangladesh. Peat deposits occur in the marshy areas of the north-eastern, central and south western parts with a total reserve of more than 170 million tons. Calorific value of peat ranges from 6,000 to 7000 BTU/lb (3334 to 3889 Kcal/Kg). Peat can be used as fuel for domestic purposes, brick manufacturing, boilers, etc. However, its exploitation has not yet started in Bangladesh.

GSP discovered the first peat field at Baghia-Chanda Beel of Madaripur district in 1953 which extend over an area of 500 km^2 with the thickness of 0.6m to 3.3m (average 2m) peat recorded nearly surface (up to 4m depth) and estimated reserve of the dry peat was calculated as 150 million tons.

Peat was found in 1961 at Terokhada, Mollarhat at Kola Mauza and Khulna Sadar area which thickness was 12 cm to 4m from subsurface 4 cm to 2.5 m depth within the area of 25 sq km. The deposit of dry peat in this area is 8 million tons. This peat can be mined for the production of electricity blending with high grade coal.

Liquefied Natural Gas (LNG)

Recently, Power Division suggested that coal based power plants, which made little progress or could not secure financing, be turned into LNG based plants[21] (see Figure 9.4). These ongoing projects have a total capacity of 13,000 megawatts – which is more than the country's current power consumption. As such, the ministry suggested keeping only the projects that are already under construction, and five ongoing coal power projects having 5,371MW of capacity fit the criteria (including the 1320 Pyra Thermal Power Plant).

The 13 other projects in question have acquired land, and they could be renegotiated into LNG based power projects. At present, a total of five LNG-based projects with a capacity of 8,750 megawatts of electricity are in the pipeline.

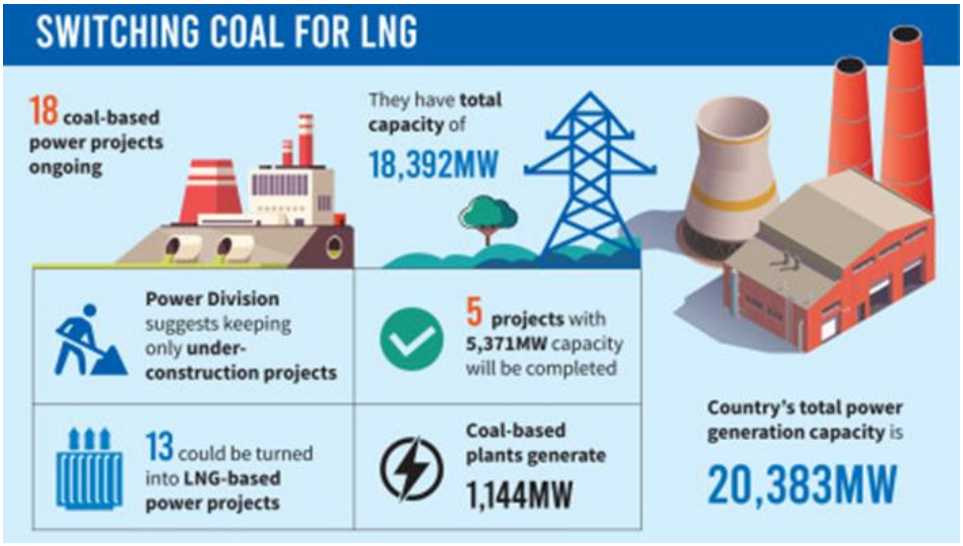


Figure 9.4: Scheme of potential switching from coal to LNG

21https://tbsnews.net/bangladesh/energy/bangladesh-plans-shift-coalpowerlng124261#.X0VDGxeqG2A.facebook

Biomass Fuels

There are three major types of biomass fuel resources are in use: wood fuels, agricultural residues and animal dung. Wood fuels are obtained from different types of forests and tree resources grown in rural areas. Agricultural residues and animal dung contribute a substantial portion of biomass fuel in Bangladesh. Availability of these resources (agricultural residues, animal dung) as fuel depends on local situation and socio-economic condition of the owners.

9.2.2 Use of Primary Fuel

Presently, primary commercial energy resources include natural gas, oil, condensates, coal, peat and renewable energy resources. Biomass still plays an important role in the country's energy consumption in the rural areas. Government is now actively considering use of nuclear energy for electricity generation.

9.2.3 Power Production

Net energy generation in total net energy generation in FY 2020-21 was 80,423 GWh where -60.19% derived from natural gas, 21.76% from furnace oil, 0.76% from diesel, 6.21% from coal, 0.81% from hydro and 0.20% from renewable sources and 10.08% of electricity was imported from India (BPDB, 2021[22]).

9.2.4 Energy Statistics

Energy statistics for Bangladesh up to 2021 are taken from the International Energy Agency[23] and the data on GDP and population from the World Bank[24].

Primary Energy Supply

In Bangladesh, about 57% of energy demand is met from natural gas[25]. Energy consumption per capita is 0.28 toe, including around 489 kWh of electricity (2020). The country's overall energy consumption is increasing quickly (4.5%/year since 2010), driven by rapid economic growth (6.9%/year). Gas is the main energy source (57%), ahead of biomass (17%), coal (13%), and oil (12%) (2020)[26]. Actual consumption of natural gas is fully covered by domestic sources.

Electricity Generation

From 2009 - 2020, over 17,000 MW capacity was added to the national grid. BPDB also prepared a plan for addition of 22,000 MW generation capacity within the year 2020 to 2025. At present 43 power generation projects of capacity 15,294 MW are under construction.

22 Bangladesh Power Development Board, Annual Report 2018-19 ; link: https://www.bpdb.gov.bd/bpdb_new/resourcefile/annualreports/annualreport_1574325376_Annual_Report_2018-19.pdf

23International Energy Agency (IEA):

https://www.iea.org/data-and-statistics/data-tables?country=BANGLADESH&energy=Balances&year=2017

24Population: World Bank: https://data.worldbank.org/indicator/SP.POP.TOTL?end=2018&locations=BD&start=1960&view=chart ; GDP: World Bank: https://data.worldbank.org/indicator/NY.GDP.MKTP.KD?locations=BD

25https://hcu.portal.gov.bd/sites/default/files/files/hcu.portal.gov.bd/publications/753d455d_3c37_43df_9ce6_6f80bdc0e982/2021-03-16-11-10-66fbccf16c104e594c24f303097aa65f.pdf

26 https://www.enerdata.net/estore/energy-market/bangladesh/

9.2.5 Status of Electricity Sector

Electricity is the major source of power for most of the country's economic activities. Bangladesh's total installed electricity generation capacity (including captive power) was 22,031 MW (BPDB Annual Report) in the year of 2020 -2021.

During fiscal year 2020-21, transmission grid substation capacity also increased due to completion of new Sub-stations and augmentation of existing grid substation. At the end of fiscal year 2020-21, grid capacity increased by 13% at different voltage level.

The utility electricity sector in Bangladesh has one national grid with an installed capacity of 22,562 MW as of October 2019 (including captive and renewable energy). Annual Report 2019 of BPDB confirm that around 95% of the population had access to electricity in 2019.

Electricity demand is growing day-by-day. In order to mitigate the demand-supply gap, an aggressive plan in the Seventh five-year plan 2015 has been prepared by the government for the addition of an envisaged 17,304 MW new generation capacity by 2023. The plan includes 50 power generation projects of capacity 15,151 MW which are now under construction. Distribution system losses are between 7 and 8 % (*2nd Perspective Plan: 2021-2041*).

Figure 9.5: Payra 1320 MW Coal Based Power Plant

9.2.6 Power Plants of Bangladesh

Power plants in the Barishal Division of Bangladesh

There are Seven (07) power stations operating in the Barishal of Bangladesh which are connected to the national grid. These power plants are fuelled by Gas, Coal, High Speed Diesel (HSD) and Heavy Fuel Oil (HFO). The present and future status of these power stations is presented in the following Tables.

Table 9.3: Status of existing power station in the Barishal Division

Sl. No.	Name of the Power Station	Fuel	Producer	Installed Capacity (MW)	
				Unit No. X Capacity	MW
1	Barisal 110 MW PP (Summit)	HFO	IPP	7*17.076	110
2	Bhola 33 MW PP (Venture)	Gas	NENP	1*34.50	40
3	Bhola 225 MW CCPP	Gas	PDB	2*63+1*68	194
4	Bhola 95 MW PP (Aggreko)	Gas	QRPP	96*1.10	0
5	Payra 1320 MW	Coal	BCPCL	2*622	1244
6	Bhola Nutan Biddut BD LTD	Gas	IPP	220	220
7	United Payra Power Ltd.	HFO	IPP	8*18.5+1*9.5	150
				Total	1958

Table 9.4: Future planned power plant projects in the Barishal of Bangladesh

Sl. No	Name of the Power Station	Fuel	Producer	Installed Capacity (MW)	Expected Commissioning Date
1	Borisal 307 MW Coal Fired Power Plant	Imported Coal	IPP	307	October, 2022
2	Patuakhali 1320 (2x660) MW USCPP (Phase-1)	Imported Coal	RNPL	1320	U#1: August, 2023 U#2: December, 2023
3	Payra 1200 MW LNG based CCPP (1st Phase)	RLNG	NWPGCL	1200	June, 2024

9.2.7 Renewable Energy

Currently, renewable energy sources have a very low share in the total generation (<2%). Besides traditional combustion of biomass (biogas), which plays the dominant role among renewable energy sources and has significant further potential, the most important form of renewable energy in Bangladesh is solar power: photovoltaics (PV), solar home systems (SHS), nano-grids and mini-grids. Such small-scale renewable energy solutions for energy generation are promising alternatives for the scattered communities. The generation capacity of renewable energy is shown in the following Table[27].

Table 9.5: Renewable energy generation in Bangladesh

Renewable Sources	Installed Capacity (MW)
Solar (PV-Cell)	129
Hydro (Hydro-electric Plant)	230
Biogas Power Plant	0.68
Bio-mass Power Plant	0.4

Source: SREDA (Retrieved on 9 March 2019)

27https://www.povertyactionlab.org/sites/default/files/researchpaper/298%20Cookstoves%20Bangladesh%20May2011.pdf

9.2.8 Cooking

99% of Bangladeshi households in rural areas, and over 60% in urban areas, use biomass/agricultural wastes as fuel for cooking[28]. It is used in traditional stoves which consist of a hole in the ground with a raised clay lip to rest the pot, with a separate fuel entry hole. Many households cook large volumes of food in large pots. Stoves are often fed with bigger pieces of wood or dung sticks. Most households are unaccustomed and/or unwilling to chop wood into small pieces. In addition, traditional stoves are constructed in a way that the fuel naturally slides further into the chamber as it burns. This allows multi-tasking during cooking.

Figure 9.6: Traditional Cooking stoves in Bangladesh

The traditional clay stoves are inefficient and generally poorly ventilated so that they produce fine particles, polycyclic aromatic hydrocarbons, carbon monoxide, dioxins and other carcinogens. Housewives, in particular, are exposed to high levels of these toxins between three and seven hours a day.

9.2.9 Network for Energy Transportation

Power Transmission Network

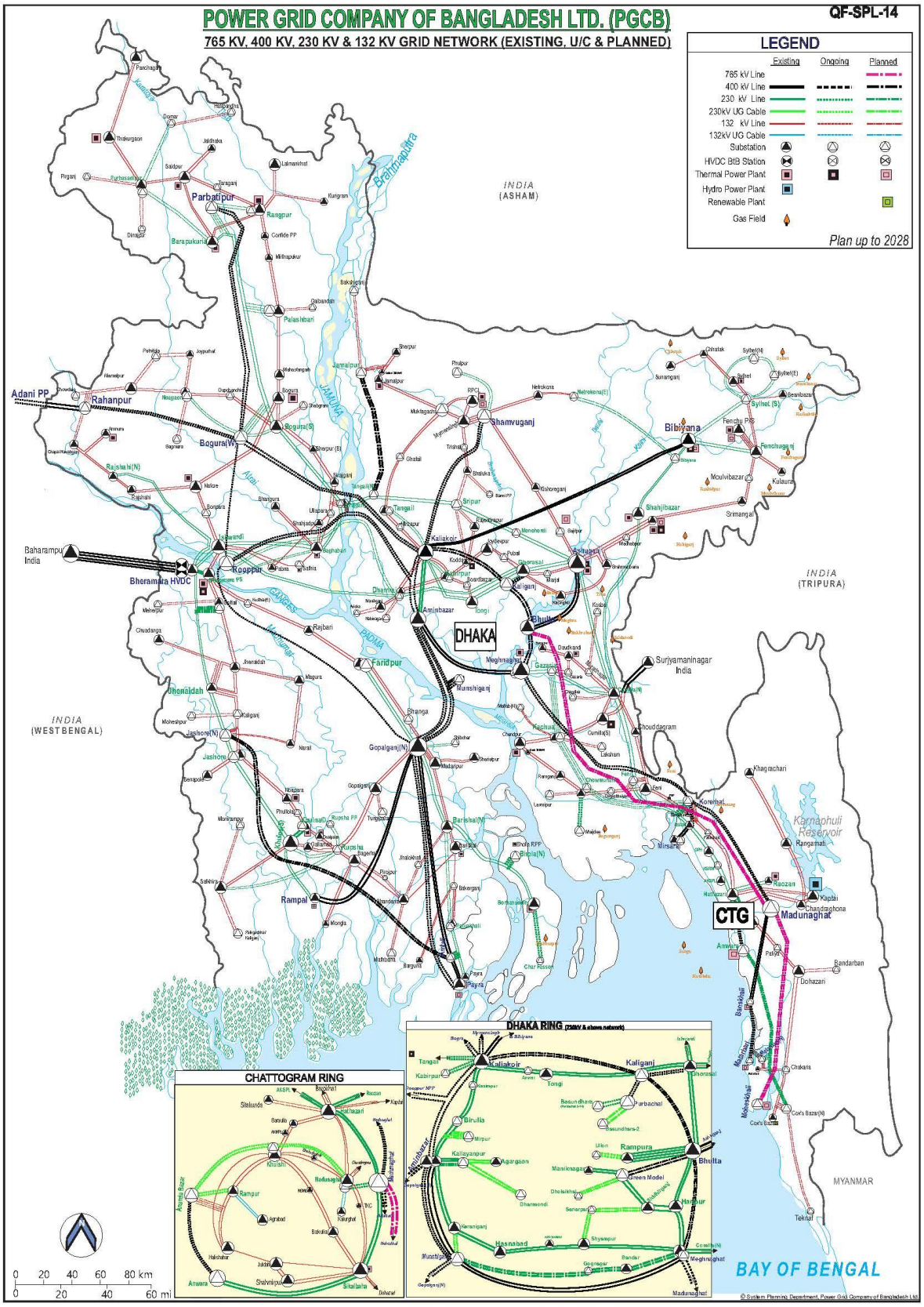
The national grid, operated by the state-owned Power Grid Company of Bangladesh (PGCB), covers the whole country and operates at 132 kV, 230 kV, and 400 kV. The country's transmission system is also connected to the national grid of India through 400 kV lines at Bheramara and Comilla. The first 400 kV transmission line runs from Meghnaghat to Aminbazark. Three other 400 kV transmission lines are under construction – one these is from Mongla to Aminbazar.

The utility electricity sector has one national grid with an installed capacity of 21,419 MW as of September 2019. The PGCB transferred 41,200 gigawatt-hours (GWh) in FY2015, 47,759 GWh in FY2016, and 50,846 GWh in FY2017 at the wheeling charge of Tk 0.27 per kilowatt-hour. There are many transmission system expansion and capacity improvement projects across the country - some underway, others planned. They aim to relieve existing system constraints and facilitate electricity transmission from power plants that are under construction and planned. The following table shows the status of on-going power transmission projects in the Barishal Division of Bangladesh. The grid network of Bangladesh[29] shown in Figure 9.7.

29 http://pgcb.gov.bd/site/download/b4b1a913-4d31-4a0b-89bb-f346a0ca98dd/-

Table 9.6: Status of on-going power transmission projects in the Barishal Division of Bangladesh

Name of the Project	Location: District	Time Line
Patuakhali-Payra-Gopalgonj 400 kV Transmission Line and Gopalgoj Substation	Goapalgoj, Madaripur, Borishal, Jhalkathi, Baguna and Patuakhali	January 2017 – Decemebr 2019
Extension of grid transmission in the SW Region	Faridpur, Gopalgoj, Madaripur, Barishal	July 2018 – June 2023
Development of Grid based electricity supply efficiency project	Rajbari, Jhinaidha, Satkhira, Bagerhat, Barishal and Pirojpur	January 2917- January 2021
National Power Transmission Network Development Project	Jessor, Barishal, Shariatpur	January 2013 – June 2019
Power Grid Network Strengthening Project	Barishal Khulna	October 2016 – June 2021
400kV Transmission Line Project Payra-Gopalgoj-Aminbajar	Dhaka, Manikgoj, Faridpur, Madaripur, Gopalgoj, Barishal, Jhalkathi, Barguna, Patukhali,	July 2019 – June 2022
Extension of grid transmission in the SW Region (Phase-2)	Patuakhali, Bagerhat, Gopalgoj, Barishal, Bhola, Madaripur, Kushtia, Meherpur, Pirojpur, Barguna, Jhinaidha, Chuadanga	July 2019 – June 2023



Source: Power Grid Company Ltd

Figure 9.7: Existing and Planned Grid Network of Bangladesh

Gas Transmission Network

There are six companies involved in gas distribution in Bangladesh: Titas Gas Transmission and Distribution Company Limited (TGTDCL), Bakhrabad Gas Distribution Company Limited (BGDCL), Jalalabad Gas Transmission & Distribution System Ltd. (JGTDSL), Pashchimanchal Gas Company Limited (PGCL), Karnaphuli Gas Distribution Company Limited (KGDCL), and Sundarban Gas Company Limited (SGCL) all of them are subsidiary companies of the Petrobangla (the government-owned national oil copmpany).

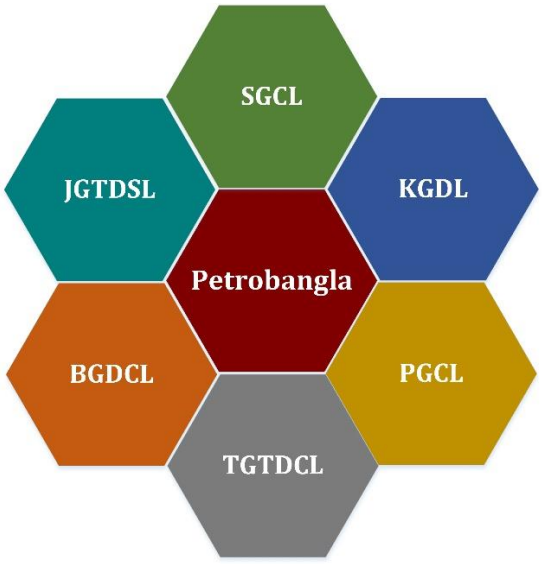


Figure 9.8: Gas transmission and Distribution Company in Bangladesh

The Sundarban Gas Company Limited (SGCL), established in 2009, supplies natural gas in the SW Region. Since 2011, under South West Region Gas Distribution Network Project, it has been implementing a gas distribution network in five districts: Kushtia, Jhenaidah, Jessore, Khulna and Bagerhat.

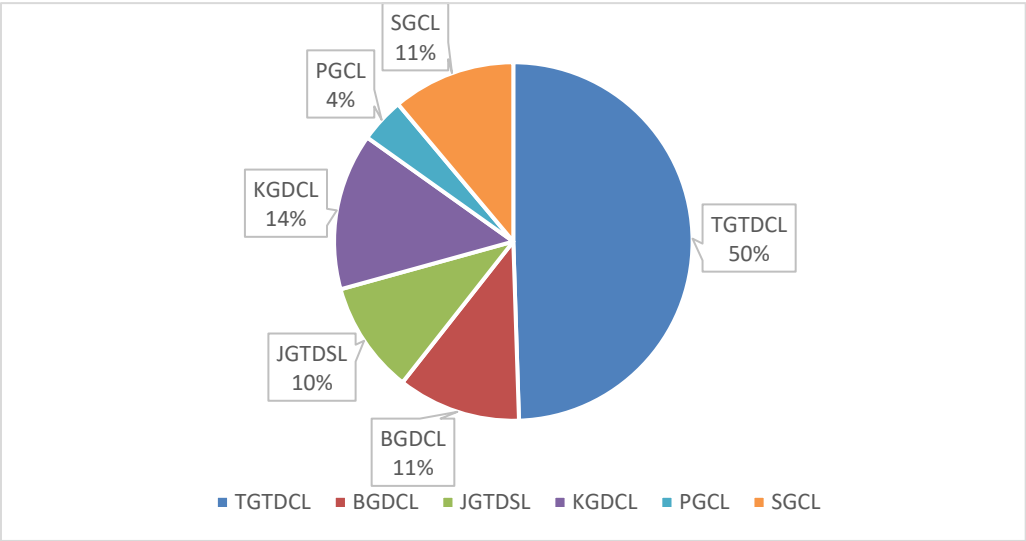
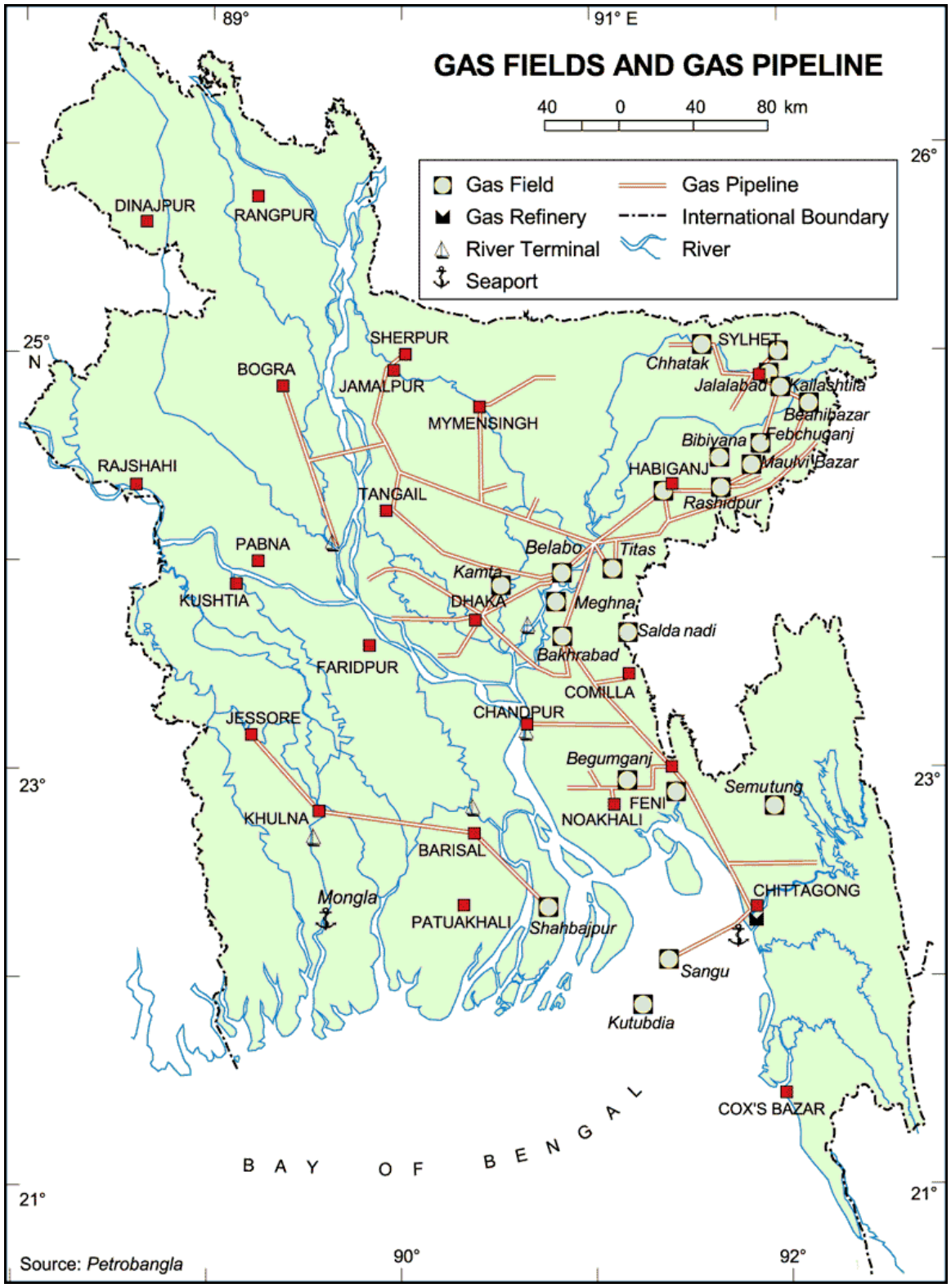


Figure 9.9: Market shares of gas supplying companies

The SGCL provided an estimated 11% of national gas distribution in 2016-2017 (Figure 9.9). Currently, the company supplies gas to the island district Bhola and to Bheramara in Kushtia district.

Currently SGCL has been supply gas to Bheramara 410 MW Power Plant, 6455 burners for household, 02 Commercial Institute, 05 Industrial Institute. The gas distribution network of Bangladesh has been shown in the following Figure.



Source: Petrobangla

Figure 9.10: Gas Distribution network pipeline

9.3 Institutional Arrangements of Energy Sector

In Bangladesh, the Ministry of Power, Energy and Mineral Resources (MoPEMR) Power Division manages the electricity business. Under its control, power is generated by the Bangladesh Power Development Board (BPDB). Some power plants are departments and subsidiaries of BPDB. There is also independent power producers (IPPs) and private power generation companies. A schematic diagram of current managing directives of the major relevant government line agencies of Power and Energy are displayed in the following figure.

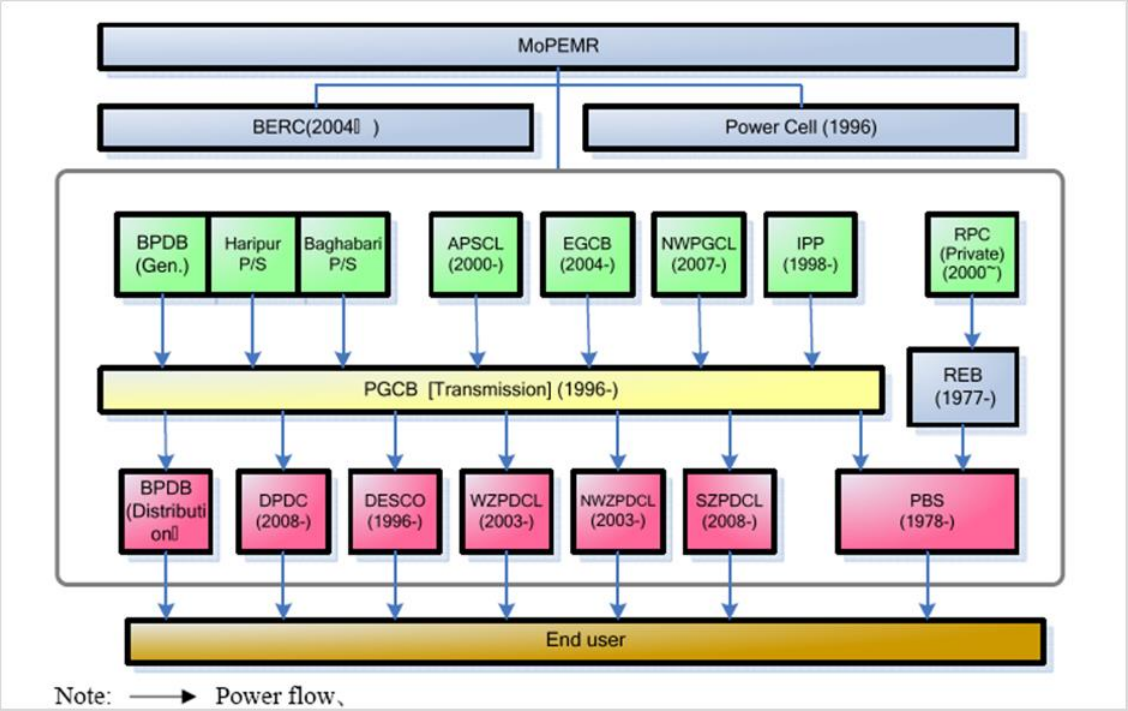


Figure 9.11: Structure of the electric power sector in Bangladesh

The authorized bodies in the power sector are listed in the following Table 9.7, including those operating in the SEA Study Area. The Figure 9.11 shows the structure of the electric power sector.

Table 9.7: Authorized bodies in power sectors

Abbreviation	Detail Name of the Authorities	Applicable for SEA Study Area
MoPEMR	Ministry of Power Energy and Mineral Resources, Power Division	X
	Regulator	
BERC	Bangladesh Energy Regulatory Commission	X
	Generation	
BPDB	Bangladesh Power Development Board	X
APSCL	Ashugonj Power Station Company Limited	
EGCB	Electricity Generation Company of Bangladesh	
NWPGCL	North-West Power Generation Company Limited	X
IPPs	Independent Power Producers	X
RPC	Rural Power Company Limited	
	Transmission	
PGCB	Power Grid Company Limited	X

Abbreviation	Detail Name of the Authorities	Applicable for SEA Study Area
	Distribution	
DPDC	Dhaka Power Distribution Company Limited	
DESCO	Dhaka Electricity Supply Company Limited	
WZPDCL	West Zone Power Distribution Company Limited	X
NWZPDCL	North-West Zone Power Distribution Company Limited	
SZPDCL	South Zone Power Distribution Company Limited	
REB	Rural Electrification Board	X
PBS	Palli Bidyut Samities	X

To understand the Power and Energy scenario at present, the mandates and function of the managerial bodies are needed to be reviewed. This will create a picture in mind to locate the further working scope in this regard. Therefore, a detail listing with organizations mandates and functions are shown in the following Table.

Organizations	Vision and Mission	Functions	Remarks
Government Authority			
MoPEMR	To ensure the uninterrupted power supply and proper use of national mineral resources	• Management of Power and Energy Sector. • Installation of new power plant • Identify the sources of mineral resources • Conservation of power and energy resources (government and private), power and resource inventory, grading and quality control of resources; • Planning cell preparation of schemes and coordination in respect of power and energy; • Research and training in Power, Energy and Mineral Resources Sector; • Mechanized related operations; • Matters relating to marketing of power, energy and mineral resources produce; • Liaison with international organizations and matters relating to treaties and agreements with other countries and world bodies relating to subjects allotted to this Ministry;	
Bangladesh Energy Regulation Commission (BERC)	To make provisions for the establishment of an independent and impartial regulatory commission for the energy sector	• Policy analysis; • Planning and evaluation; • Programme coordination; • Provide the guideline to adjust the pricing	
Bangladesh Power Development Board (BPDB)	• To deliver uninterrupted quality power to all. • To secure continuous growth of electricity for sustainable development and ensure customer satisfaction.	• To be engaged in implementing the development program of the government in the power sector; • To adopt modern technology and ensure optimum utilization of the primary and alternative source of fuel for sustainable development of power generation projects; • To purchase power as a Single Buyer from power producers;	

Organizations	Vision and Mission	Functions	Remarks
		• To provide reliable power supply to customers enabling socio economic development; • To promote a work culture, team spirit and inventiveness to overcome challenges; • To promote ideas, talent and value systems for employees.	
Power Grid Company of Bangladesh Ltd. (PGCB)	• Efficient and effective management of national power grid for reliable and quality transmission as well as economic dispatch of electricity throughout the country. • Economic up liftment of the country by reaching electricity to all through reliable transmission	• The main objective of the PGCB is to create facilities to evacuate power from the power plant. • To increase reliability and efficiency of the electrical power supply in Bangladesh through expanding and improving the 230 kV and 132 kV power transmission system of PGCBP rovide reliable power to all over the country. • Meet the growing load demand all over the country through existing substations. • To meet the growing demands of country	
Bangladesh Rural Electrification Board (BREB)	• Ensuring 100% Electrification within Mujib Year under the pledge "Sheikh Hasina's Initiatives-Electricity in Every House" • Providing quality consumer service through sustainable & uninterrupted power supply within fair and affordable cost • Upgrading the living standard of the rural people through reliable power supply in the countryside including the Off-Grid areas an integrated development in power distribution system.	• Works to achieve 100% electrification and use of electricity as a means of creating opportunities to improve agricultural production and enhance socio-economic development in rural areas. • To improve the standard of living and quality of life for rural people. • BREB covers the majority of rural areas in the Barishal through Rural electric cooperatives. • Electrification in local area (Upazila Complex) by using solar energy; • Solar powered irrigation pump and Solar Home System; • Introduction of solar powered irrigation pumps and power management and distribution system to mitigate energy crisis climate change; • 49 kWp BREB rooftop solar power plant.	
National NGOs/Consulting Firms			
EQMS Consulting	• To create sustainable solutions for the challenges of tomorrow to achieve SDGs.	• EQMS is a fundamental company value, ensuring freedom of action, choice and helping singling out of the best solutions concerning each project.	

Organizations	Vision and Mission	Functions	Remarks
Limited, established	• To be the best version of itself for a brighter future of the globe, treading carefully to achieve the best for all the clients.	• EQMS adopts a direct and systematic approach involving different specialized units with collaboration for different projects, allowing the management of multiple tasks simultaneously, offering clients the benefits of its skills and experiences. • To the development of sustainable projects by doing feasibility studies, environmental studies, social studies and monitoring and supervision studies.	
ERM	• Creating innovative solutions to sustainability challenges and unlocking commercial opportunities that meet the needs of today while preserving opportunity for future generations	• Supports clients across the breadth of their organizations to operationalize sustainability, underpinned technical expertise in addressing environmental, health, safety, risk and social issues • Capability of "boots to boardroom" approach for its comprehensive service model • ERM to develop strategic and technical solutions that advance objectives on the ground or at the executive level.	
Infrastructure Investment Finance Company (IIFC)	• To help intensify infrastructure development efforts in order to support the goals of sustainable economic growth of Bangladesh. • To be recognized globally as the Bangladesh Centre of Excellence in Infrastructure investment; and • To foster Bangladesh's economic development by promoting and facilitating private investment in infrastructure development.	• To introduce, promote, encourage, facilitate and assist all and any forms of Public-Private-Partnership (PPP) and the use of non-government finance and other resources in the development and improvement of infrastructure in Bangladesh. • To assist and advise ministries, agencies and other public sector bodies in Bangladesh with the identification, prioritization, preparation, evaluation, award, and implementation of infrastructure projects in which the private sector may participate. • To create interest of the private sector in investing in infrastructure projects in Bangladesh by disseminating information within Bangladesh and abroad about the opportunities. • To develop, organise and provide the Public Sector with training, technical advice and support for the purposes of enabling the Public Sector to involve it in infrastructure projects. • To investigate, research, advise on and advocate to the Public Sector the need for amendment, introduction or adoption of any laws, policies, orders or directives, whether by way of primary legislation, ministerial enactment or otherwise, which will procure, help or	

Organizations	Vision and Mission	Functions	Remarks
		otherwise facilitate the private sector's participation in infrastructure projects. • To become recognized nationally and internationally, amongst lenders and developers, as the country's Center of Excellence in infrastructure development. • To help conduct business to the highest professional standards in a cost-effective manner.	
Adroit Environment Consultants Ltd. (AECL)	• We aim to be the most competitive and the most productive service provider organization in Bangladesh. We want to ensure pollution free production and sustainable environment management for the industries and lead the industrial sector of Bangladesh from the darkness of environmental ignorance to the light of environmental compliance without affecting productivity. And finally, to help making a healthy and pollution free Bangladesh. • To provide, high quality services in Engineering & Environmental Sector to our customers by using state of the art technology and environmentally sound practices with high standard and accuracy. We provide our customers with confidence and innovative solutions to ensure their success in the global marketplace.	• AECL conducted hundreds of Initial Environment Examination, Environmental Impact Assessment, Environmental Management Plan, Resettlement Plan, etc., in various forms for the Power Sector, Textile (Dyeing, Printing and Weaving), Pharmaceutical, Oil, Gas & Energy, Fertilizer, Cement, Pulp & Paper, Iron & Steel, Ceramic, Infrastructure, Food Industry, Tannery & Leather, Chemical Industries, etc. • AECL has successfully introduced local technology based Wastewater Treatment plant in Bangladesh. This technology is very much cost effective compared to other plants in terms of chemical consumption and chemical efficiency.	
Center for Environmental and Geographic Information Services (CEGIS)	• To become a center of excellence for providing advisory services, research, databases and training in multifarious fields including environment, geographic information system, remote sensing of a wide group of national and international organizations for purposes of enhanced efficiency in planning, implementation and monitoring of projects and programs. • To support the management of natural resources for sustainable socio-economic development at home and abroad, using integrated environmental analysis, geographic information systems, remote sensing	• Consultancy and research on socio-economic development, environmental management, climate change vulnerabilities mitigation, adaptation and resilience, river morphology and erosion and remote sensing an GIS services to governmental, other national organizations and international bodies. • Assist government in developing sustainable management framework and strengthening line agencies by sharing knowledge and experiences. • Proactive services to line agencies for national emergency regarding environment, socio-economy, development and other natural resources management.	

Organizations	Vision and Mission	Functions	Remarks
	techniques, database, information technology and other modern technology outfits.		
International NGOs			
World Bank	• To reducing poverty, increasing shared prosperity, and promoting sustainable development; • To end extreme poverty: by reducing the share of the global population that lives in extreme poverty to 3 percent by 2030; • To promote shared prosperity: by increasing the income of the poorest 40 percent of people in every country;	• IBRD provides financial development and policy financing; • IDA provides zero-to low-interest loans and grants; • IFC mobilizes private sector investment and provides advice; • MIGA provides political risk insurance (guarantees); • ICSID settles investment disputes; • Results That Change Lives;	
Asian Development Bank (ADB)	The Asian Development Bank (ADB) is committed to achieving a prosperous, inclusive, resilient, and sustainable Asia and the Pacific, while sustaining its efforts to eradicate extreme poverty	• ADB assists its members, and partners, by providing loans, technical assistance, grants, and equity investments to promote social and economic development; • ADB maximizes the development impact of its assistance by facilitating policy dialogues, providing advisory services, and mobilizing financial resources through co-financing operations that tap official, commercial, and export credit sources;	
Waste Concern	To contribute towards waste recycling, environmental improvement, renewable energy, poverty reduction through job creation, and sustainable development. • Improve the environment by promoting waste recycling activities in the country; • Conduct research and experiments regarding solid waste management, recycling, clinical and hazardous waste management, waste water treatment, as well as organic farming; • Develop community--private sector--municipal partnerships towards the improvement of the urban environment;	• Solid Waste Management and Resource Recovery; • Clinical and Hazardous Waste Management; • Waste Water Treatment; • Community Based Environmental Improvement; • Urban Environmental Management; • Municipal Services Planning; • Environmental Impact Assessment; • Environmental Management System (ISO 14001); • Climate Change & Clean Development Mechanism; • Organic Farming; • Laboratory Testing Facility;	

Organizations	Vision and Mission	Functions	Remarks
	• Create job opportunities by promoting the recycling of waste;		

9.4 Relevant Policies, Acts and Legislations

Various policies, plans, strategies and guidelines have been developed for the power and energy sector. Moreover, important issues are discussed in the following Table.

Key Aspects in the Theme	Policy/Act/ Regulations	Compliance Requirements	Applicability
Energy Generation/ Evacuation	National Energy Policy 1995	The policy emphasizes to ensure environmentally sound sustainable energy development programs causing minimum damage to environment. This policy gave emphasis on environment friendly technology. Carrying out Environmental Impact Assessment (including a consideration of social impact) should be made mandatory and constitute an integral part of any new energy development project.	The proposed intervention needs to be carried out in such a manner that the activities during the construction phase do not cause significant damage to the environment.
	Electricity Act, 2018	This act repealed the Electricity Act 1910 and introduced a modification of provisions for developing and reforming the sectors of power generation, transmission, supply and distribution, for better service delivery to consumers and for meeting the increasing demand for electricity. Features of the new Act include: • Reintroduction of the principle of compensatory punishment giving unfettered discretion to the court without limiting the minimum period of imprisonment; • Chapter Two addresses development of electricity sector with a unitary operating system, replacing the previous Act's manifold structure; • Under Section 16, the consumer can now get a special service through a special line subject to a payment of special fees and might avoid the complications of making monthly payments through advance payment under section 22; • The principles of collective as well as individual accountability have been introduced under section 18(3), 37, 43;	This act is required for modification of provisions for developing and reforming the sectors of power generation, transmission, supply and distribution, for better service delivery to consumers and for meeting the increasing demand for electricity.

Key Aspects in the Theme	Policy/Act/ Regulations	Compliance Requirements	Applicability
		• Certain offences are now classified as cognizable, non-boilable, non-compoundable and some as cognizable, boilable and compoundable; • Under section 37, for illegal and defective power supply or supply beyond permitted area or discontinuance of supply to certain locality without justifiable ground, a licensee shall be punished with imprisonment for a term not exceeding one year or fine not exceeding one lac or both; • A person or groups of person can file a case against a company or licensee for unusual load shedding without justifiable cause under this section; • To prevent sabotaging of related structures, heavy punishment has been provided for (that too with alternative heavy fine).	
Natural Resources Allocation	Notification on the Natural Gas Allocation Policy 2019 (NGAP)	In 2019, the Ministry of Power Energy and Mineral Resources (MoPEMR) issued a Notification on the Natural Gas Allocation Policy (NGAP). It states that, for sustainable progress of the national economy, secure continuous gas supply is necessary. Therefore, the MoPEMR, has prioritised the future supply of gas to the productive sectors based on several factors. The Priority sectors are Industries (including small and cottage industries), Power sector, Fertilizer factories, Captive power, Tea gardens, Commercial areas, Compressed natural gas (CNG) production, Households.	This act is required for the SEA studies for sustainable progress of the national economy, secure continuous gas supply is necessary.
	Notification for LNG terminal construction, LNG import and Supply Policy for the Non-Government Sector, 2019	In 2019, the Ministry of Power Energy and Mineral Resources issued this notification which covers: • Capacity of the non-government entrepreneurship; • Construction of LNG infrastructure, import, regasification and storage procedure; • LNG importing process; • Procedure for gas suppling to the consumer; • Price of Re-gasified LNG determination; • Rules and Legislation to be followed.	This act is required for the SEA studies for sustainable progress of the national economy, secure continuous gas supply is necessary.

Key Aspects in the Theme	Policy/Act/ Regulations	Compliance Requirements	Applicability
	The National Oil Spillage Contingency Plan (NOSCOP)-Bangladesh, 2019	The Plan promulgated with the aim of ensuring a timely, efficient and effective response to prevent, control and combat oil/chemical spillage; developing an efficient mechanism for the detection and reporting of oil/chemical spills; ensure correct assessment of the nature of pollution incident at the water bodies; adopting a standard response techniques to control and combat oil/chemical spillage; strengthening the institutional capacity and to facilitate cooperation amongst them for effectively handle of oil/chemical spill and preventing and mitigating the pollution damages caused by the oil/chemical spill and where possible to restore the environment within available resources.	The Project authority will follow the NOSCOP-Bangladesh 2019 for responding timely to oil/ chemical spillage incident; minimizing capital loss and environmental degradation at the Project site and nearby river due to poor drainage.
Environmental Safeguard	The Environment Court Act, 2000	The Act provides the jurisdictions of environment court, penalty for violating court's order, trial procedure in special magistrate's court, power of entry and search, procedure for investigation, procedure and power of environment court, authority of environment court to inspect, appeal procedure and formation of environment appeal court.	The Act is triggered as the Project in some ways might be responsible for affecting the local environment. To generate, evacuation of the power pre-construction, construction and operation stages are required. Any unregulated event happened due to negligence of the Proponent is liable to penalize as per the Act.
	The Bangladesh Environmental Conservation Act of 1995 (ECA, 1995) and (Amendments 2000, 2002, 2007, 2010)	This Act is the key legislation in relation to environment protection in Bangladesh. It is promulgated for environment conservation, standards, development, pollution control, and abatement. It has repealed the Environment Pollution Control Ordinance of 1977. The Act has been amended in 2000, 2002, 2007 and 2010.	The Act is triggered as the Project may have the potential of violating the environmental quality standards and in contrast to this pollution control undertaking mitigation measures is the compelling job for the authority. Otherwise, punitive measures are provisioned for environmental, hazardous pollution as well as automobiles under this Act.
	National 3R Strategy for Waste	The 3R Strategy has been formulated in line with the National Goal of eliminating of waste disposal on open dumps, rivers and flood plain by 2015 and promoting recycling of waste through mandatory segregation of waste at source as well as creating a market for recycled products and	The Act is triggered with SEA. Power plant projects may have the potential to mismanagement of waste handling like solid and chemical waste. They might

Key Aspects in the Theme	Policy/Act/ Regulations	Compliance Requirements	Applicability
	Management, 2015	providing incentives for recycling of waste. The priority sectors for 3R are identified as municipal solid waste, industrial waste, biomedical waste, institutional and commercial waste and agricultural waste. The first core principle of the National 3R Strategies distinguishes waste as a resource. Realizing the importance of the source separation of waste, it is regarded as the second core principle of the strategies. Third and fourth principles state that technologies should be environment friendly, appropriate and affordable. Cleaner production is another core principle which is the continual effort to prevent pollution, reduce the use of energy, water and material resources and to minimize waste in the production process.	have impacts on environment as well as health hazard.
Socio-Economic	The Employment of Children Act, 1938	The Act provides prohibition of the employment of children below 12 years in any workshop where in any of the processes like explosives and firework, is carried on. The Act contains provision of punishment for employer permitting or employing children to work.	According to this Act, the construction authority should not employ any child during the construction of the Power Plant.
	The Fatal Accidents Act, 1855	This Act ensures that the respective authority with provide compensation to families for loss occasioned by the death of a person caused for wrongful Act.	The proposed project has possibilities of unplanned accidental event during project life cycle; hence this law is applicable and the proposed intervention needs to follow proper health and safety measures. Hence, the Act is triggered.

9.5 Relevant PPPs on Energy and Power Sector

9.5.1 Relevant PPPs

During the SEA screening procedure (see Screening Report, April 2020), nine strategic documents (policies, plans or programmes, PPP) were reviewed in detail and their potential environmental and socio-economic impacts provisionally assessed.

Table 9.8: Overall results of SEA screening process for the Power and energy sector

	Impact	Negative	Positive
013	Power & Energy System Master Plan 2016		
014	Draft National Energy policy 2006		
015	Renewable Energy Policy of Bangladesh, 2008		
016	Energy Efficiency and Conservation Master Plan up to 2030, (2015)		
017	Gas Sector Master Plan 2018		
018	Intended Nationally Determined Contributions (INDC), September, 2015		
019	Policy Guideline for Small Power Plant (SPP) in Private Sector, 2008		
020	Power and Energy Sector Strategy Paper (SSP), 2018		
021	National Action Plan for Clean Cooking, 2020		

Negative impacts Positive impacts

The above table indicates both potential negative and potential positive impacts which can be environmental and/or social and/or economic (details can be found in the appendix of the Screening Report (April 2020). Five of the policies, plans or programs (PPP) were judged to have high negative impacts (red flag) while four had medium negative potential impacts (amber flag). At the same time, seven PPPs had high positive potential impacts (dark blue flag) and two had medium positive impacts (light blue flag). Such co-existence of high negative and high positive impacts is typical for PPPs in the power and energy sector.

9.5.2 Screen of the PPPs

Environmental, social and economic impacts of particular PPPs are shown in detail in the following Table.

Key PPs Relating to the theme	Main Projects emanating from the PPPs	Negative environmental impacts emanating from the projects	Negative socio-economic impacts emanating from the projects
Power System Master Plan (PSMP) 2016	• Energy security for the nation • Installation of new Power Plants	• The co Pollution from newly built coal fired power plants (dust, sulphur dioxide and nitrogen oxides) and from combustion of natural gas (nitrogen oxides), • Increased GHG emission. • Range of Air Pollution has been increased • Contaminated of Surface Water • Waste (ash, fly ash, various types of hazardous waste), generated in the power and energy sector.	• Resettlement may occur due to land accusation, • Health issues related to air pollution and Sound pollution • Impact on ecosystems (acidification), habitat alteration and fragmentation etc. •
Draft National Energy Policy, 2006	• Improvement of power supply and of quality of life. • Industrial development and regional development.	Increase in national emissions of CO2 and air pollutants, increase in air pollution load, resettlement and habitat modification.	• Impacts of infrastructure development. • Risk related to storage and use of LPG/LNG
Renewable Energy Policy, 2008	• Improved power supply especially in rural areas; • Reduced power shortages • Effective use of waste to energy processes	• Micro-climate may be affected due to large scale solar power plant • Risk related to hazardous waste disposal	• Resettlement due to land take for renewable power plants; • Migration of species may be hindered • Habitat degradation • Relatively higher cost for power generation through renewable sources
Energy Efficiency and Conservation Master Plan up to 2030, 2015	Improved efficiency of energy consumption leading to reduction of consumption of fossil fuels (natural gas and coal), reduction of emissions of GHG and air pollutants, reduced health impacts of air pollution	Water and soil pollution may occur due to replacement or conversion of existing industries/buildings etc.	Local social disturbances may occur during replacement or conversion of existing industries. Increased initial investment costs

Key PPs Relating to the theme	Main Projects emanating from the PPPs	Negative environmental impacts emanating from the projects	Negative socio-economic impacts emanating from the projects
Gas Sector Master Plan 2018	• Increased energy security, • Industrialization of SW area and infrastructure development which will improve the quality of life and employment. • Reduce the use of biomass burning as cooking	• Increase industries will pollute the environment, • GHG emissions, • Habitat fragmentation,	Resettlement for pipeline installation etc.
Intended Nationally Determined Contributions, 2015	• Reduced GHG emissions (provided that GHG emission reduction by renewable sources will be really higher than GHG emissions from newly built thermal power plants), • Reduced pollution - through introduction of non-combustion renewable sources.	• Additional air pollution from new thermal power plants (emission limit values are stringent but not zero) which may have local negative impacts such as deposition of SO2, increased dust particles (SPM) in air • Water pollution though effluent, thermal plume and sewerage discharge	• Resettlement and habitat degradation for solar plant • Effects on bird migration due to wind power plant
Policy Guideline for Small Power Plant (SPP) in Private Sector, 2008	• Improved power supply, • Reduced power shortage for industries and residential areas	• Increased local air pollution depending on fuel (e.g. NOx and CO in the case of gas, dust, SO2, CO and NOx in the case of coal etc.) and increased GHG emissions. • Increased waste or hazardous waste.	Resettlement and habitat degradation for solar plant

9.6 Drivers of Future Changes

9.6.1 Future Energy Production and Consumption

The largest energy consumers in Bangladesh are industries and the residential sector, followed by the commercial and agricultural sectors. Bangladesh will need an estimated 34,000 MW of power by 2030 to sustain its economic growth of over 7%. Problems in the electric power sector include high system losses, delays in completion of new plants, low plant efficiency, erratic power supply, blackouts, and shortages of funds for power plant maintenance. The forecast of power demand and generation capacity is presented in Figure 9.12.

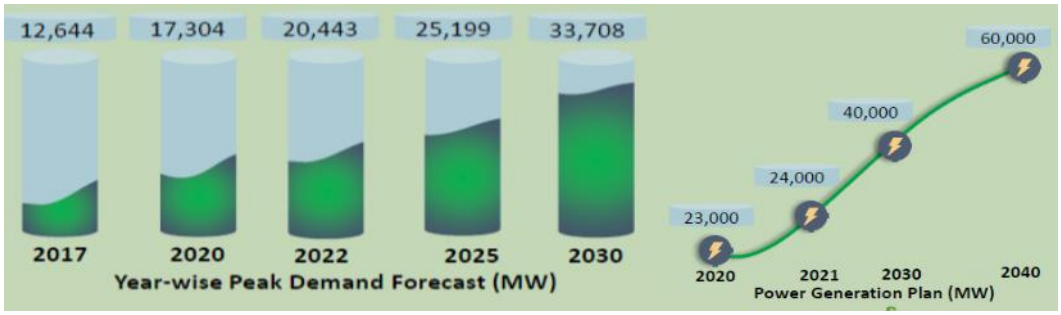


Figure 9.12: Forecast of energy demand and power generation

Power demand as well as power generation capacity are expected to increase by almost 100% between 2020 and 2030. A projection of final energy consumption in Bangladesh till 2041[30] is presented in Figure 9.13.

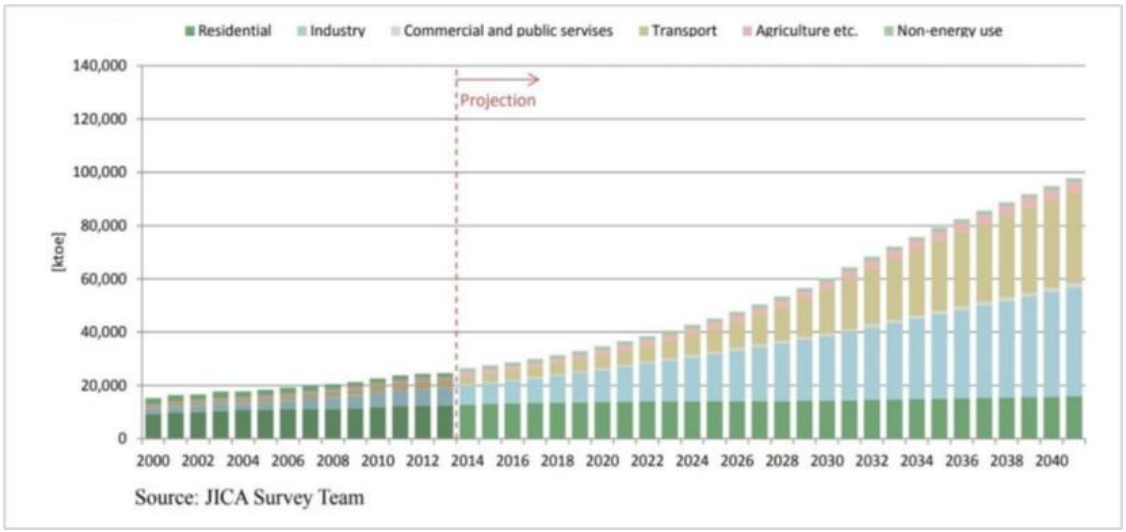


Figure 9.13: Projection of final energy consumption in Bangladesh till 2041

It can be seen that the sharp increase in energy consumption is attributed to industry and transport while the consumption in the residential sector is expected to remain more or less stable regardless of the expected increase in population.

30 The Power and Energy Sector of Bangladesh: Challenges of Moving beyond the Transition Stage [https://powerdivision.portal.gov.bd/sites/default/files/files/powerdivision.portal.gov.bd/page/c96429b5_a481_4ee3_8095_6746b376dcfd/TA%208839_Draft%20Final%20Report%20on%20Energy%20Security_Cover%20Note_Submitted_29th%20June.pdf Dated 4/6/2020]

9.6.2 Projection of Energy Sector

The GAINS Asia model (Scenario: WEO2016_NPS_CLE)[31] presents the following projection of TPES (Total primary energy supply) in Bangladesh till 2030.

Table 9.9: Energy Scenario for the GAINS Asia Model

Year	2005	2010	2015	2020	2025	2030
TPES (PJ)	1041.9	941.5	1213.3	1648.3	1919.0	2312.5
TPES (ktoe)	24950	22545	29054	34471	45953	55376
Population (million)	153.3	157.3	160.2	170.5	179.3	186.7
TPES/capita (toe)	0.163	0.143	0.181	0.202	0.256	0.297

*Note: *Population projection is derived from the report BBS & SID, 2015 (appendix)*

It can be seen that the TPES in both absolute value and per capita is expected to grow in Bangladesh by more than 90% between 2015 and 2030. We can assume that this rate will also apply to the SEA study Area.

9.6.3 Industries of the Study Area

The rate of energy consumption will increase along with the population increase. About 44.47% of total power generated in Bangladesh is consumed by the domestic sector, followed by large industry (38.95%), commercial (12.48%), agriculture (1.26%) and others (2.84%) sectors[32]. Power consumed by different sectors of Bangladesh is given by a chart in following Figure 9.14.

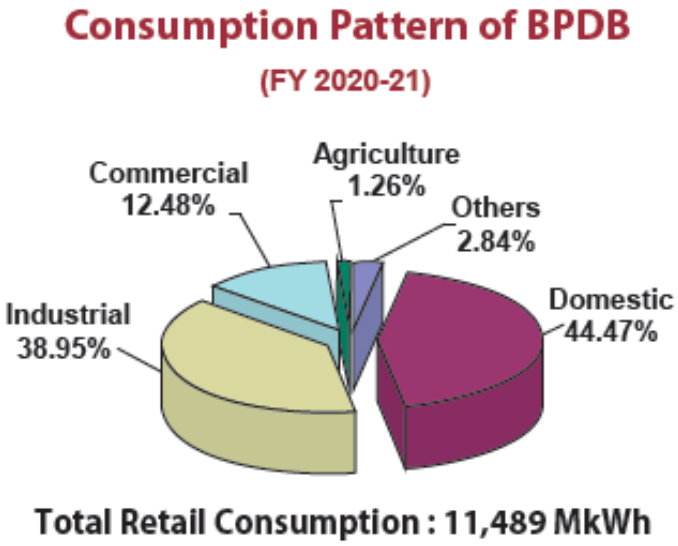


Figure 9.14: Power Consumption Pattern of BPDB

The demand for electricity continues to grow due to population growth, industrialization, additional connections and rise in the use of modern electrical appliances. Compared to other division of country, Barishal division is lagging behind in terms of industrializations. In the recent year the mega structructure of the country the Padma Bridge has been inaugurated which is connect the Barishal division with the capital. Besides well road communication, payra deep sea port, economic zones and

31 GAINS Asia https://gains.iiasa.ac.at/gains/ASN/index.login?accept_disclaimer=checked
32 http://bd.bpdb.gov.bd/bpdb/index.php/site/annual_reports/c4ff-123d-dae0-575b-7a77-a1c0-2f7e-a806-a836-2fdd

others infrastructures has been developed in the Patuakhali district study area of SEA. Government has plan to develop Railway Network and Export Processing Zone in the Barishal Division. As a result, there will be an industrial revolution in the Study Area. Present industrial scenario has been presented in the following Table 9.10.

Table 9.10: List of Industries in the SEA Study Area

Upazila Name	Rice Mill	Handloom	Weaving	Husking craft mill	Dry fish processing	Bamboo and cane industry	Wooden furniture	Sawmill	Semi-auto rice mill	Oil mill	Bakery	Pottery	Printing press	Tailoring shop	Cold storage	Flour mill	Plastic Industry	Garments Factory
Amtali & Taltali	0	150	124	190	200	560	52	37	8	0	15	0	3	337	0	8	0	0
Barguna Sadar	72	3	3	267	0	90	330	78	6	2	11	0	0	280	0	32	0	0
Patharghata	16	0	78	0	16	78	120	64	0	0	8	1	1	160	1	16	1	21
Galachipa & Rangabali	220	27	17	355	25	342	155	79	3	0	63	0	3	474	0	402	0	0
Kalapara	54	212	428	123	524	27	68	12	4	0	27	43	4	1260	0	46	0	0

Source: BBS, Census 2011

9.6.4 National Air Pollutants Emission Projections

Projections for national emissions of suspended particulate matter (TSP. PM_{10} and $PM_{2.5}$) have been developed for Bangladesh using the GAINS Asia model (Scenario: WEO2016_NPS_CLE) and are presented in the following Table 9.11.

Table 9.11: Emission projections for particulate matter ((TSP, PM10 and PM2.5) in Bangladesh (kt/year)

Air Polluting Sectors	2005	2010	2015	2020	2025	2030
TSP						
Power & heating plants	1.4	5.3	6.6	13.2	19.7	28.7
Residential combustion	250.7	214.3	251.3	282.4	269.1	263.2
Industrial combustion	14.7	21.4	26.7	31.9	36.7	40.7
Industrial processes	99.2	76.7	87.9	96.3	103.5	109.8
Light duty vehicles	3.3	3.5	4.7	5.1	4.7	4.4
Heavy duty vehicles-diesel	5.1	6.8	9.2	12.9	14.2	16.8
Non-road machinery	4.8	4.5	6.6	7.6	7.7	7.9
Agriculture	175.1	195.6	208.9	220.6	232.4	240.7
Waste	38.2	56.2	63.2	69.8	76.2	82.6
Sum	**592.3**	**584.3**	**665.3**	**739.9**	**764.3**	**795**
PM_{10}						
Power & heating plants	1.1	3.5	4.5	9.4	14.8	22.1
Residential combustion	242.9	206.8	242.1	271.8	258.8	252.9

Air Polluting Sectors	2005	2010	2015	2020	2025	2030
Industrial combustion	7.7	10.9	13.6	16.2	18.7	20.9
Industrial processes	55	38	45	49.3	52.7	55.6
Light duty vehicles	3.2	3.4	4.6	5	4.6	4.3
Heavy duty vehicles-diesel	3.4	3.8	4.9	6.6	7.1	8.1
Non-road machinery	4.6	4.3	6.3	7.2	7.3	7.5
Agriculture	119.8	131.7	141.2	149.1	157.4	162.4
Waste	36.4	52.7	59	65.2	71.1	77
Sum	**474**	**455.2**	**521.3**	**580**	**592.5**	**611.2**
$PM_{2.5}$						
Power & heating plants	0.9	2.5	3.3	6.2	10	15.2
Residential combustion	236.9	201.1	235.2	263.9	251	245.3
Industrial combustion	3.7	5	6.2	7.4	8.5	9.7
Industrial processes	33.4	21.3	25.8	28.4	30.3	32
Light duty vehicles	3	3.2	4.4	4.8	4.3	4.1
Heavy duty vehicles-diesel	3.2	3.3	4.3	5.7	5.9	6.8
Non-road machinery	4.3	4.1	5.9	6.8	6.9	7.2
Agriculture	88.2	95.1	102.1	107.9	113.8	116.9
Waste	35	50.1	56	61.7	67.2	72.7
Sum	**408.7**	**385.6**	**443.2**	**492.8**	**498.2**	**509.7**

Source: GAINS Asia https://gains.iiasa.ac.at/gains/ASN/index.login?accept_disclaimer=checked

The data in the above Table shows that:

- Total emissions of TSP, PM_{10} and $PM_{2.5}$ are expected to grow by 2030 by 35%, 29% and 25%, respectively;
- Residential combustion will remain the main source of emissions of particulate matter in 2030 (33% TSP, 41% of PM_{10} and 48% of $PM_{2.5}$), followed by agriculture (30% TSP, 27% of PM_{10} and 23% of $PM_{2.5}$) and industrial processes (14% TSP, 9% of PM_{10} and 6% of $PM_{2.5}$);
- An increasing trend in emissions of particulate matter can be seen, especially in the case of power and heating plants, agriculture, industrial combustion and heavy duty vehicles;
- A considerable increase in power and heating plants sector can be attributed to newly built coal fired power plants;

Emission projections for the main gaseous air pollutants (SO_2, NO_X, VOC, NH_3) developed for Bangladesh using the GAINS Asia model (Scenario: WEO2016_NPS_CLE) are presented in the following Table.

Table 9.12: Emission projections for main gaseous air pollutants in Bangladesh (kt/year)

Air Polluting Sectors	2005	2010	2015	2020	2025	2030
SO_2						
Power & heating plants	23.1	40.9	55.7	140.6	216.8	307.8
Fuel conversion	2.6	2	3.2	5.5	5.9	6
Residential combustion	40.1	32.1	38.2	43.5	42	41.5
Industrial combustion	42.4	60.8	98.6	117.7	130.9	144.3
Industrial processes	2.1	2.4	3.6	4.9	5.2	5.8

Air Polluting Sectors	2005	2010	2015	2020	2025	2030
Light duty vehicles	0.7	1.2	1.4	1.7	2	2.3
Heavy duty vehicles-diesel	2	1.4	1.1	1.5	1.7	2.2
Non-road machinery	10.6	6.2	8.6	9.9	9.9	10.4
Agriculture	2.9	3.1	3.4	3.6	3.8	3.9
Waste	0.4	0.8	0.9	1.1	1.2	1.3
Sum	**127**	**151.1**	**214.6**	**329.9**	**419.2**	**525.3**
NO_x						
Power & heating plants	28.5	13.3	19.3	40.7	64	96.6
Fuel conversion	0.3	0.3	0.5	0.9	1	1
Residential combustion	22.4	22.5	28	33.9	35	36.9
Industrial combustion	4.3	7.3	12.5	17.8	21.3	26.5
Industrial processes	2.8	3.1	4.4	6.4	7.6	9.3
Light duty vehicles	8.3	11.5	17.1	19.3	18.4	16.9
Heavy duty vehicles-diesel	38.5	62.5	83.8	111.1	115.9	134.8
Non-road machinery	38.9	37.2	55	62.8	63.6	66.1
Agriculture	62.1	66.4	71.3	75.3	79.4	81.5
Waste	10.2	19.8	23.5	26.3	29.3	32.3
Sum	**216.6**	**244**	**315.4**	**394.6**	**435.4**	**501.8**
VOC						
Power & heating plants	1.8	1.1	1.6	2.7	4.7	10.2
Residential combustion	277.3	266.9	323.2	371.7	362.1	358.1
Industrial combustion	1.9	2.8	3.5	4.3	5.1	5.7
Industrial processes	1.3	1.3	1.8	2	1.5	1.1
Solvent use	80	94.8	111.7	129.4	145.7	162.3
Fuel production & distribution	5	3.4	4.6	5.6	6	6.6
Light duty vehicles	31	27.4	38.4	45.3	45.6	41.7
Heavy duty vehicles-diesel	4.6	17	22.9	28.8	26.7	26.9
Non-road machinery	7.4	7.1	11.7	13.5	13.7	14.3
Agriculture	110.7	118.2	127	134.1	141.4	145.1
Waste	15.1	29.3	34.5	38.8	43.1	47.4
Sum	**536**	**569.1**	**681.1**	**776.2**	**795.8**	**819.8**
NH_3						
Power & heating plants	0	0.1	0.1	0.1	0.2	0.3
Residential combustion	3.8	3.2	3.8	4.4	4.2	4.1
Industrial processes	3.3	1.8	2.4	2.6	2.7	2.9
Light duty vehicles	0	0.1	0.3	0.5	1	1.4
Heavy duty vehicles-diesel	0	0	0.1	0.2	0.2	0.4
Agriculture	594	670.9	722	776.5	835.2	898.1
Waste	93.1	101.2	109.4	117.4	125.1	132.4
Sum	**694.1**	**777.3**	**838**	**901.7**	**968.6**	**1039.4**

Source: GAINS Asia https://gains.iiasa.ac.at/gains/ASN/index.login?accept_disclaimer=checked

The following parameters trends shown in above:

SO_2 emissions

- Total emissions of SO_2 are expected to grow by more than 12 times by 2030, driven by the power and heating plants sector;
- Sector power and heating plants will become the dominant source of SO_2 emissions (almost 59% in 2030) followed by industrial combustion (more than 27% in 2030);
- A considerable increase of SO_2 emissions in the power and heating plants sector can be attributed to newly built coal-fired power plants;
- An increasing trend in emissions of SO_2 can also be seen in industrial combustion.

NO_X emissions

- Total emissions of NO_X are expected to grow by almost 132% by 2030, driven by the heavy duty vehicles-diesel and the power and heating plants sectors;
- The heavy duty vehicles-diesel sector will become the most important source of NO_X emissions (almost 27% in 2030) followed by power and heating plants (more than 10% in 2030) and agriculture (more than 16%);
- A considerable increase of NO_X emissions in the power and heating plants sector will be attributed to newly built coal-fired power plants; and an increase in the heavy duty vehicles-diesel sector can be expected due to economic growth;
- An increasing trend in emissions of NO_X can be seen in all sectors.

VOC emissions

- Total emissions of VOC are expected to grow by 53% by 2030;
- Sector residential combustion will remain the most important source of VOC emissions (almost 44% in 2030) followed by the solvent use sector (almost 20% in 2030) and agriculture (almost 18%);
- An increasing trend in emissions of VOC can be seen in all sectors.

NH_3 emissions

- Total emissions of NH_3 are expected to grow by almost 50% by 2030;
- The agriculture sector will remain the dominant source of NH_3 emissions (more than 86% in 2030) followed by the waste sector (almost 13% in 2030);
- The contribution of other sectors is almost negligible;

9.6.5 GHG emission projections

Emission projections for GHG. CO_2. CH_4 and N_2O developed for Bangladesh using the GAINS Asia model (Scenario: WEO2016_NPS_CLE) are presented in Table[33].

33 All emissions are expressed in CO2 equivalents.

Table 9.13: Emission projections for GHG, CO2, CH4 and N2O in Bangladesh (Mt CO2 eq/year)

Items	2005	2010	2015	2020	2025	2030
Total GHG						
CO_2	39.3	33.5	45.4	70.0	88.4	113.6
CH_4	88.3	94.5	97.5	103.2	107.1	111.7
N_2O	25.6	28.2	29.7	31.5	33.3	35.9
Sum	**153.2**	**156.2**	**172.6**	**204.7**	**228.8**	**261.2**
Share of CO_2 (%)	25.6	21.4	26.3	34.2	38.6	43.5
Share pf CH_4 (%)	57.6	60.5	56.5	50.4	46.8	42.8
Indicators						
Population (million)	153.3	157.3	160.2	170.5	179.3	186.7
CO_2 per capita (t)	0.256	0.213	0.283	0.411	0.493	0.608
CO_2						
Power & heating plants	14.7	6	8.6	19.9	31.7	45.4
Fuel conversion	1.8	1.1	1	2	2.3	2.6
Residential combustion	8.6	7.5	9.3	11.8	12.9	14.7
Industrial combustion	4.4	6.3	9.6	14.4	17.6	22.6
Industrial processes	0.4	0.6	1	1.6	1.9	2.5
Light duty vehicles	1.2	2	3.1	3.7	4	4.5
Heavy duty vehicles-diesel	2.2	4.2	6	8.4	9.3	11.7
Non-road machinery	2.5	2.4	3.5	4	4	4.2
Non-energy use	3.7	3.3	3.2	4.1	4.6	5.3
Sum	**39.3**	**33.5**	**45.4**	**70.0**	**88.4**	**113.6**
CH_4						
Power & heating plants	0.27	0.053	0.078	0.09	0.173	0.385
Fuel conversion	0.03	0.015	0.01	0.028	0.03	0.038
Residential combustion	2.857	2.91	3.575	4.235	4.263	4.4
Industrial combustion	0.083	0.14	0.198	0.288	0.36	0.455
Industrial processes	0.003	0.003	0.003	0.003	0.003	0.003
Fuel production & distribution	1.575	2.665	3.193	3.24	3.288	3.435
Light duty vehicles	0.04	0.038	0.048	0.05	0.04	0.028
Heavy duty vehicles-diesel	0.073	0.39	0.535	0.54	0.443	0.338
Non-road machinery	0.005	0.005	0.01	0.01	0.01	0.013
Agriculture	74.12	77.83	79.45	81.04	82.63	84.16
Waste	9.153	10.40	10.31	13.62	15.78	18.35
Sum	**88.3**	**94.5**	**97.5**	**103.2**	**107.1**	**111.7**
N_2O						
Power & heating plants	0	0.026	0.026	0.079	0.132	0.212
Residential combustion	0.371	0.371	0.450	0.53	0.53	0.53
Industrial combustion	0.026	0.053	0.079	0.106	0.106	0.132
Solvent use	0.821	0.821	0.848	0.901	0.927	1.007
Light duty vehicles	0.026	0.026	0.053	0.053	0.079	0.132
Heavy duty vehicles-diesel	0	0.026	0.026	0.026	0.026	0.053
Non-road machinery	0.026	0.026	0.026	0.026	0.026	0.026

Items	2005	2010	2015	2020	2025	2030
Agriculture	20.11	22.60	23.85	25.15	26.55	28.04
Waste	4.160	4.24	4.319	4.611	4.849	5.035
Sum	**25.6**	**28.2**	**29.7**	**31.5**	**33.3**	**35.9**

Source: GAINS Asia https://gains.iiasa.ac.at/gains/ASN/index.login?accept_disclaimer=checked

Above table shows that between 2005 and 2030[34]:

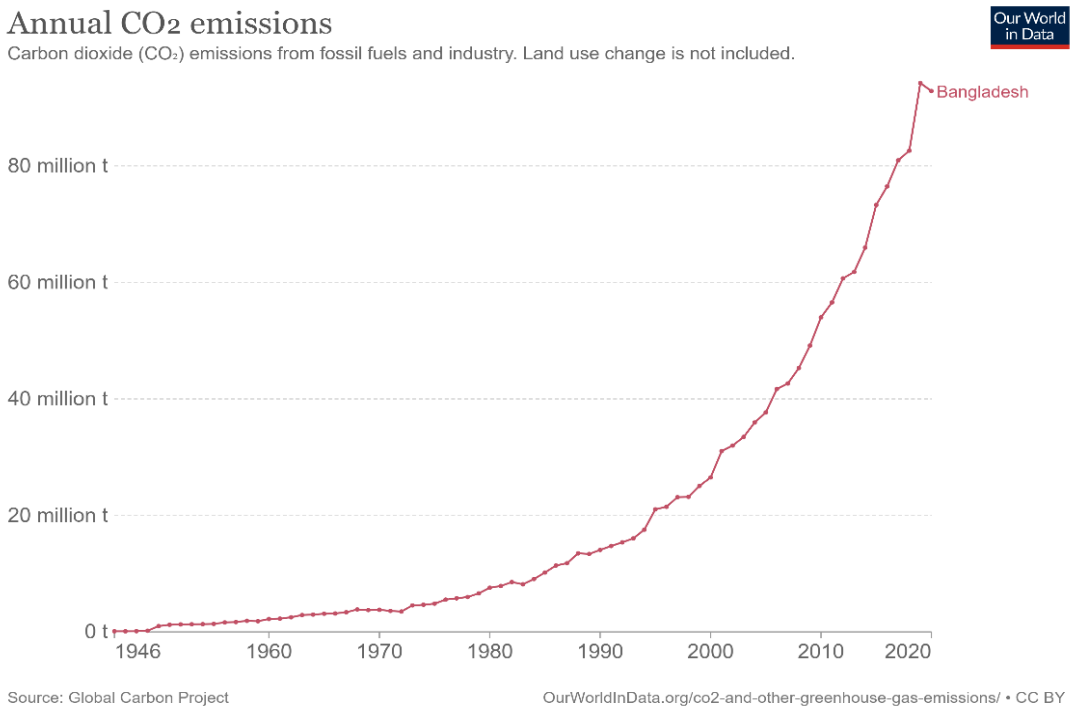
- Total national emissions of GHG, CO_2, CH_4 and N_2O could increase by 70%, 189%, 27% and 40%, respectively;
- A very sharp increase in CO_2 can be attributed to the introduction of newly built coal-fired power plants;
- The share of CO_2 in total GHG emissions could increase from almost 26% in 2005 to more than 43% in 2030, while the share of CH_4 could decrease from almost 58% to almost 43%;
- Fuel combustion in stationary installations are expected to be the dominant source of CO_2 emissions (66% in 2020, 73% in 2030);
- Emissions of CO_2 from fuel combustion are expected to be driven by electricity generation (40% in 2030) and industrial combustion (20% in 2030);
- Emissions of CO_2 per capita are expected to increase but still be very low (0.61 t in 2030), almost 10 times than the world average (5 t[35]);
- Agriculture should remain the dominant emitting sector of CH_4 (75% in 2030) and of N_2O (78% in 2030);

9.7 Issues Concerned with the Theme

9.7.1 National Emissions of GHG

In 2020, CO_2 emissions per capita for Bangladesh was 0.64 tons of CO_2 per capita. CO_2 emissions per capita of Bangladesh increased from 0.05 tons of CO_2 per capita in 1971 to 0.64 tons of CO_2 per capita in 2020 growing at an average annual rate of 5.48%.[36]Carbon dioxide emissions are those stemming from the burning of fossil fuels and the manufacture of cement. They include carbon dioxide produced during consumption of solid, liquid, and gas fuels and gas flaring.

34 All emissions are expressed in CO2 equivalents.
35 https://data.worldbank.org/indicator/en.atm.co2e.pc
36 https://knoema.com/atlas/Bangladesh/CO2-emissions-per-capita



Source: Global Carbon Project

Figure 9.15: GHG emission per capita in Bangladesh: 1971-2020

The following table shows total national emissions for various greenhouse gasses and carbon dioxide for the period 2006-2012 based on data reported under the UN Framework Convention on Climate Change (UNFCCC). It also includes carbon dioxide emissions for years after 2012 published by other sources.

Table 9.14: Emissions of GHG and CO_2 in Bangladesh 2006 – 2012

Items	Unit	2006	2007	2008	2009	2010	2011	2012
GHG emissions								
National emissions of GHG without LULUCF, of which	Mt CO_2 eq.	109.6	112.8	118.0	123.9	131.4	132.9	152.3
CO_2		46.9	49.9	53.7	58.8	65.7	66.9	80.0
Methane		47.4	47.3	48.4	49.4	49.8	50.7	53.4
N_2O		15.3	15.6	15.9	15.7	15.9	15.3	18.9
Share of CO_2	%	42.3	44.2	45.5	47.5	50.0	50.3	52.5
Share of CH_4	%	43.2	41.9	41.0	39.9	37.9	38.1	35.1
Indicators								
Population	mill	140.9	142.7	144.3	145.9	147.6	149.3	151.0
GDP[37]	USD billion	91.59	98.05	103.9	109.2	115.2	122.7	130.7
CO_2 /capita	t	0.333	0.350	0.372	0.403	0.445	0.448	0.530

37 GDP in constant prices 2010.

Items	Unit	2006	2007	2008	2009	2010	2011	2012
GHG/capita		0.778	0.790	0.818	0.849	0.890	0.890	1.01
CO_2 /GDP	t/ 1000 USD	0.512	0.509	0.517	0.538	0.570	0.545	0.612
GHG/GDP		1.197	1.150	1.136	1.135	1.141	1.083	1.165
CO_2 emissions								
Fuel combustion. of which	Mt	45.4	48.2	52.1	57.5	64.5	65.5	69.9
Electricity generation		17.8	20.6	20.5	23.1	25.1	26.0	29.1
Industries		13.7	13.7	16.2	17.1	18.1	19.1	20.0
Transport		6.2	5.3	5.6	7.1	10.4	10.3	8.4
Residential		4.2	4.6	5.3	5.4	6.1	6.4	6.4
Agriculture. forestry. fishing		2.5	2.8	3.1	3.4	2.9	2.1	3.8
Commercial/ institutional		1.0	1.2	1.3	1.4	1.8	1.5	2.0
CO_2 from fuels[38]		40.6	44.2	50.3	54.6	59.7	59.7	60.9
CO_2 from fuels[39]		43.5	44.4	49.5	53.7	59.9	63.4	67.5

Source: Third National Communication of Bangladesh to the United Nations Framework Convention on Climate Change (June 2018); https://unfccc.int/documents?f%5B0%5D=country%3A628&f%5B1%5D=document_type%3A626

Above table shows that between 2006 and 2012[40]:

- Total national emissions of GHG, CO_2, CH_4 and N_2O have increased by 39%, 71%, 13% and 24%, respectively;
- The share of CO_2 in total GHG emissions has increased from almost 26% in 2006 to more than 43% in 2012, while the share of CH_4 has decreased from 43% to 35%;
- Fuel combustion is the dominant source of CO_2 emissions (more than 87% in 2012);
- Emissions of CO_2 from fuel combustion are driven by electricity generation (almost 42% in 2012) and industrial combustion (almost 29% in 2012);
- Emissions of CO_2 per capita have increased but are still very low (0.53 t), almost 10 times than the world average (5 t[41]);
- Emissions of CO_2 per unit of GDP capita have increased to 0.61 t/1000 USD) and are higher than the world average (0.49 t/1000 USD[42]).

9.7.2 Status of Country Air Pollution

More than one-third of Bangladesh's population live in large urban areas. By 2050, at least half of the population is projected to be urbanized. There has been almost a three-fold increase in population since 1971. It now stands at around 170 million, making Bangladesh the eighth most populous country in the world with a population density of 1265 per km^2.[43] According to World Health Organization's guidelines, air quality is unsafe, presenting a serious environmental health hazard for the people. Indoor air pollution is mainly associated with the use of biomass fuels during cooking together with

38 https://www.worldometers.info/co2-emissions/bangladesh-co2-emissions/
39https://www.macrotrends.net/countries/BGD/bangladesh/carbon-co2-emissions
40 All emissions are expressed in CO2 equivalents.
41 https://data.worldbank.org/indicator/en.atm.co2e.pc
42https://data.worldbank.org/indicator/EN.ATM.CO2E.KD.GD
43 https://www.worldometers.info/world-population/bangladesh-population/

poor ventilation. Industrial emissions, construction works and traffic are the principal sources of outdoor air pollution.

According to the WHO[44], the annual mean concentration of fine particulate matter $PM_{2.5}$ in Bangladesh was 58.3μ g/m^3 in 2016 - one of the highest values worldwide (higher value can only be found for 8 countries [45]). By comparison, the WHO ambient air quality guideline value for annual mean concentration of fine particulate matter $PM_{2.5}$ is 10μ g/m^3. The EU air quality standard – limit value[46] is 20 μg/m^3, and the US national air quality primary standard[47] is 12 μg/m^3. The United Nations says $PM_{2.5}$ densities should not top 25 μg/m^3 of air in any given 24-hour period.

According to a recent World Bank study[48], Bangladesh is among the countries most affected by pollution and other environmental health risks. Diseases caused by pollution were responsible for 16% of all deaths worldwide in 2015, but in Bangladesh, this proportion was nearly 28%. Fine particulate matter ($PM_{2.5}$) air pollution, both ambient and indoor, is by far the most significant environmental risk, causing about 21% of all deaths in Bangladesh.[49] While air pollution is the leading environmental risk factor in all South Asian countries, the levels in Bangladesh are the highest in the region.

Indoor air pollution. Around 89% of households use solid fuel, mostly wood, agricultural wastes and cow dung (99% in rural areas, 60% in urban). There are some 49,000 deaths/year from indoor pollution (9,400 from outdoor air pollution), and 230 million cases of respiratory diseases/year. Indoor air pollution is regulated by the Bangladesh Labour Act 2006 covering mostly working conditions in premises. However, this Act does not stipulate any specific standard for pollutants.

Although Bangladesh has seen a small progress compared to the 2018 rankings, its air is still unhealthy.

9.7.3 Air Pollutants Emissions Inventories

Four key emission sources affect the SEA Study Area:

1. Point sources: power facilities, brick kilns, cement plants, other industries;
2. Line sources: roads and vehicles, water navigation routes and vessels, trains, etc;
3. Fugitive emissions: economic processing zones, residential areas, ash storage areas, sandy areas, etc;
4. Cross boundary sources: air pollutants transported from outside the SEA study area.

44 See https://apps.who.int/gho/data/node.main.152?lang=en
45 Bahrain, Cameroon, Egypt, India, Nepal, Niger, Quatar, Saudi Arabia)
46 Directive 2008/50/EC of the European Parliament and of the Council of 21 May 2008 on ambient air quality and cleaner air for Europe: https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A32008L0050
47 US EPA National Ambient Air Quality Standards: https://www.epa.gov/criteria-air-pollutants/naaqs-table
48 Enhancing Opportunities for Clean and Resilient Growth in Urban Bangladesh. Country Environmental Analysis 2018. http://documents.worldbank.org/curated/en/585301536851966118/pdf/129915-CEA-P161076-PUBLIC-Disclosed-9-16-2018.pdf
49 The concentration of particulate matter (PM) is a key air quality indicator since it is the most common air pollutant that affects short term and long term health. Two sizes of particulate matter are used to analyze air quality; fine particles with a diameter of less than 2.5 μm or PM2.5 and coarse particles with a diameter of less than 10 μm or PM10. PM2.5 particles are more concerning because their small size allows them to travel deeper into the cardiopulmonary system.

9.7.4 Technologies in Power Plants

Modern technologies with parameters associated with best available technologies/techniques (BAT) are expected to be used in newly built/planned power plants. State-of-the-art technologies and international standard guidelines are being applied in the newly constructed or planned power plants, such as:

- Use of high performance boiler (ultra-super critical);
- Electrostatic precipitator, flue gas desulphurization plant;
- Effluent treatment plant (ETP), sewage treatment plant (STP), cooling tower, advanced low-NOx burner;
- High concentration slurry disposal (HCSD) technology for ash management, protected ash impoundments;
- Combined cycle power plant rather than gas turbine of solar thermal;
- Importing relatively clean fuel like low sulphur-containing coal, high speed diesel and heavy fuel oil;
- Imposing greenbelt development;
- Maintaining national snatards (e.g. of the Department of Environment) and international standards (e.g of World Bank and Asian Development Bank).

9.7.5 Specific Issues

The first Power System Master Plan (1996) included the establishment of a baseload power station in the Barishal division to revive its industrial development. The 2010 Power System Master Plan proposed to establish a coal-based power plants near the load centre of the coastal part of the country which includes the Patuakhali District. Payra of Patuakhali District was subsequently selected as the site for 1320 MW coal-based thermal power plant operated by a joint venture company – North-West Power Generation Company Bangladesh Limited (NWPGCL) and China National Machinery Import and Export Corporation (CMC). The Power System Master Plan 2016[50], included rendered the following proposed energy infrastructure projects to be developed in the Barishal Division:

- Barisal 110 MW PP (Summit)
- Bhola 33 MW PP (Venture)
- Bhola 225 MW Combined Cycle Power Plant (CCPP)
- Bhola 95 MW PP (Aggreko)
- Payra 1320 MW thermal Power Plant
- Bhola Nutan Biddut BD LTD
- United Payra Power Ltd.

50 https://drive.google.com/file/d/0B5U58g3xLD-NOXRCZ01PRG1EZHc/view

10. Tourism

10.1 Introduction

Tourism industry is one of the fastest-growing and most dynamic sectors in the world which can significantly contribute to the sustainable development of emerging economies (Nekmahmud & Hassan, 2021). Due to its multidimensional features, the industry has created huge employment opportunities as well as economic development in different countries. Each and every country strives to gain a larger share of the global tourism market and Bangladesh is no exception. Travel and tourism contributed 6.1 percent of the world gross domestic product (GDP) in 2021 which is 5.81 trillion US dollars, 0.8 percent increase from 2020 but a decrease from the numbers that had been recorded before the corona virus (COVID-19) pandemic (Statista, 2022).

Bangladesh has significant tourism potential because of its natural beauty, ranging from mountains to rivers to beaches to biodiversity. It boasts the longest natural beach in the world in Cox's Bazar as well as the single largest mangrove forest in the world - the Sundarbans. Considering the growing impact of global tourism, Government established the Bangladesh Tourism Board in 2010. Bangladesh Parjatan Corporation and Bangladesh Tourism Board are two leading organisations under the Ministry of Civil Aviation and Tourism working to promote Bangladesh as a promising tourism destination in South Asia.

The tourism industry is far from thriving in Bangladesh. According to World Travel & Tourism Council (WTTC), tourism in Bangladesh accounted for an estimated 3% of the total economy, around US$ 9.11 billion in FY2019-20. Travel and tourism contributed 1.86 million jobs, which was 2.9% of total employment – while the international visitors had an impact of US$ 333 million, 0.7% of total exports (GED, 2020).

The FY 2020-2021 was under an acute crisis due to COVID-19 which disrupted the normal functioning of our traditional system. The tourism industry in Payra-Kuakata is still at the primal stage. Therefore, Government has taken policy and planning level strategies to promote tourism facilities to attract more national and international visitors.

10.2 Status of Tourism Industry

10.2.1 Existing Tourism Attractions

Kuakata is a picturesque tourist paradise in the southern tip of Bangladesh, popularly known as "*Sagar Kannya*" (Daughter of Sea). It is one of the most beautiful and captivating places in Bangladesh (Figure 10.1) for the tourists from home and abroad. Standing at the same place on the beach, anyone can enjoy the full view of the rising and setting of the '*crimson sun in the blue water*' of the Bay of Bengal (Figure 10.2 & 10.3) which makes the beach unique. With the Sundarbans in the corner and lush soft sands on the beach, Kuakata is yet unexplored by many tourists, hence is comparatively less crowded than the Cox's Bazar and other beaches.

The name of 'Kuakata' derived from the word *kua*, which means a "well" dug for drinking water (Figure 10.4). There is a popular belief that the early Rakhain settlers were facing difficulties to get fresh drinking water at the place. Then the settlers had to dig (*kata*) a lot of wells (*kuas*) to solve the problem. Kuakata is a virgin beach that offers a sanctuary for migratory winter birds, a series of coconut trees, sandy beach along blue Bay, and other eye pleasing features to the tourists.

Figure 10.1: Sites of Kuakata sea beach

Figure 10.2: The Old Well of Kuakata

Figure 10.3: Scene of Sunrise from Kuakata beach

Figure 10.4: Scene of Sunset from Kuakata beach

Natural

Kuakata National Park

This protected area is situated very close to the embankment constructed by the Bangladesh Water Development Board (BWDB) and at the brink of Kuakata Sea Beach. The existing beauty of this national park is excellent due to the presence of *jhau* forest (Figure 10.5).

Reserved Forests

Besides the Kuakata National Park, there are reserved forests situated side by side along the sea beach. The combination of sal-teak and jhau forests make the entire scenery very attractive (Figure 10.6).

Gongamati Reserved Forest

Gangamati Reserved Forest is an evergreen mangrove forest located on the eastern end of the beach of Kuakata. This forest is an extended part of the Sundarbans mangrove forest. This reserved forest protects the coast of Kuakata against the tidal surges. Moreover, it provides an opportunity for visitors to gather experiences of a small mangrove forest. Different types of plants like keora, gewa, baen, kankra, goran, hetal, golpata and a number of wild animals like wild boar, deer, monkey, and different types of birds are found in the forest.

Haringhata Forest

Haringhata forest is one of the parts of the Sundarbans located on the south of Patharghata upazila of Barguna district. The green forest is full of deer, monkeys and different birds. This forest area is located at the confluence of three rivers viz., Payra, Bishkhali and Baleshwar at the mouth of the Bay of Bengal. Fatrar Char (island) and Paddar Par (bank) are nearby.

Figure 10.5: Kuakata National Park

Figure 10.6: Haringhata Forest

Wetlands

The prospective wetland destinations are described below:

Sea

A part of the Bay of Bengal adjacent to Kuakata sea beach is a long-beached wetland which is also the habitat of different invertebrates, vertebrates and large animals (Figure 10.7). The coast supports many waders including migratory and local wildlife specifically, the dolphins and sea turtles.

Figure 10.7: Part of Bay of Bengal

Shuvo Sondha sea beach is a beautiful beach surrounded by deep sea waves and lush greenery located at Nalbunia under Nishanbaria union of Taltaliu of Barguna district. The beach is adjacent to Sonakata Ecopark which is a part of "Sona Dwip" which is named by the Honorable Prime Minister of Bangladesh. From this scenic beach, tourist can enjoy sunsets (Figure 10.7).

Rivers

The Payra is a tidal river system which is situated adjacent to Kuakata coastline area (Figure 10.8). The Payra river port is under construction which can be considered as an attractive tourist destination. Another destination is 'Ramnabad Channel'. This channel developed an island with mangrove vegetation. Tourists can visit this place from Kuakata.

Khal

The Porguza khal/canal flows just behind the Mumbi Para village where ecotourism has been proposed to be established. This is a tidal influence waterway (Figure 10.9). It could be an attractive tourist destination if proper initiatives are taken to develop the site through the best use of its natural resources.

Figure 10.8: The scenic beauty of Payra River system, Patuakhali

Figure 10.9: Scenic beauty of the Porguza Canal/Khal, Kuakata

Island/Char

Gangamotir Char

This is one of the largest islands in this area. This island is known as Island of sunrise and sunset. Its shorelines are vegetated with jhau, keora and gewa (Figure 10.10).

Kawar/Lal Kakrer Char

This Island is located adjacent to the Gangamotir Char, bestowed with same natural beauties and geographical characteristics. The red crabs draw attraction in their way of living throughout the beach (Figure 10.11).

Pakhir Char

This is a submersible island in the Bay of Bengal about 5 km from the beach of Kuakata. This is a long island and looks attractive in the presence of migratory birds. Birds move in flocks in different size and shapes. Some are in hovering as normal activities for fish hunting; some are in social activities, and so on.

Char Khaleque

It is situated parallel in the nearest area having similar characteristics both physical and biological. This island is home to many fishermen (temporary) where they take leisure during their daylong fishing. There are no permanent settlers here.

Fatrar Char

Fatrar Char is located at the west side and close to Kuakata beach. Travellers may visit the Fatrar Char from Kuakata. This beautiful island is also known as Fatrar bon being a part of the Sundarbans. The island has mangrove vegetation (like keora, gewa, goran, golpata, etc.) various wildlife including birds, monkeys, wild boars, and so on.

Lebur Char

Lebur Char (Figure 10.12) is located about five km east of Kuakata beach. There are several species of trees like keora, gewa, goran, koroi, golpata, etc. in the area of 1000 acres. Earlier, it was a part of the Sundarbans, but it is now totally isolated from the Sundarbans range.

Forest and Grassland

The beach is very near to the border of the Sundarbans mangrove forest from its western point and Gangamati reserved forest lies to the eastern point of the beach.

Some small patches of grassland grow within the tourist influenced area locally known as *Hogla forest* which could be a very impressive destination for tourists. The patches are located along the embankment.

Coconut grove and Jhaubon

The coconut grove was created on 200-acre of area around the sea beach area in 1960s. But for the continuous breaking of the beach, a part of the area has already been washed out by the sea. At the east side of the grove, there is a beautiful Jhaubon. During the dusk and under moonlight, it looks wonderful and the continuous whizzing sound of Jhaubon creates an echo of serenity to visitors at the daytime.

Figure 10.10: The forestland at Gangamotir Char

Figure 10.11: Red crabs at Kawar Char, Kuakata

Figure 10.12: Mangrove forest of Lebur Char

Figure 10.13: Shuvo Sondha Sea Beach, Taltali

10.2.2 Historical or Cultural

Ethnic culture is one of the main tourist attractions around the world. Their different religious and ritualistic festivals, arts and crafts are the key interest for the so-called main stream population. Kuakata is the place which was once renowned for its Rakhain population and their cultural heritage. Historians say that this Rakhain population migrated here from Burma (now Myanmar) around 1784, and became the major population of this area. The Rakhain population in Kuakata has diminished significantly, and at present, they are the minority population in Kuakata region. Though, presently only a few numbers of Rakhain population are living at the area, their cultural and religious heritages are still present which are one of the main tourist attractions of Kuakata.

Rakhain community has nearly 240 years old tradition in Kuakata. The largest Buddhist temple of Bangladesh is located 10 km away from the Rakhain Polli. The idol of Gautam Buddha is 36 feet high and weight is approximately 1500 kg. It is known that the beauty of the temple was followed by Chinese Architecture. The people of the Rakhain community, stranded in Arakan State, migrated to the sea under the leadership of their King Mong and then settled themselves in Chittagong and later in the forests of Patuakhali district and built their habitat following their traditional heritage and culture. The government gave them land for establishing their villages.

Rakhain community mostly follows "Buddhism" and "Buddha Purnima" is their most important spiritual festival. Each of their house has an own embodiment. Men are usually engaged in agriculture and the women are engaged in making handicrafts. They make lunge, scarf, shawl, dresses, etc. and sell in the women operated market named "Rakhain Mohila Market" (Figure 10.14).

Kuakata is the place of pilgrimage of the Hindus and Buddhist communities. The Buddhist devotees arrive here for the festival of ‘Rash Purnima’ and ‘Maghi Purnima’. The three-day celebrations began with devotees taking a dip in the Bay at dawn after the full moon, known as Rash Purnima. The devotees believe that the bath would wipe out all their sins. During the festival people of Hindu community participated in various activities like Kirton (religious song), religious discussions, puja of Lord Krishna and Radha and holly bathing in the Bay. A lot of tourists also gathered at the sea beach to enjoy the 150-year-old Mela (Figure 10.15).

Figure 10.14: Women-led Rakhain market at Mishripara, Kuakata

Figure 10.15: Rash Mela at Kuakata beach

10.2.3 Religious/Spiritual/Wellness

Gurinda One Gambuz Mosque

Gurinda One Gambuz Mosque can be considered as one of the most ancient artefacts of the Islamic architecture of Bangladesh (Figure 10.16) which is located in Ratnadi of Galachipa upazila of Patuakhali district. According to the local people, the mosque was built before the conquest of Chandradip in 1465 by Sultan Mobarak Shah. The main complex of the mosque is about 360 square feet of area and the height is about 16 feet. Due to lack of proper maintenance and care the mosque is turning to a ruin.

Misripara Buddhist Temple

This Buddhist Temple is regarded as the holiest and archaeologically important monastery of the Buddhist community of the region. The temple is 8 km away from Kuakata beach. Besides local tourists, many foreign tourists also used to visit the temple. The 32 feet tall statue (Figure 10.17) of the Buddha is considered one of the largest Buddha statues of Asia.

Figure 10.16: Gurinda One Gambuz Mosque, Ratnadi

Figure 10.17: Misripara Buddha Temple

10.2.4 Adventure Tourism

Adventure tourism is the fastest-growing sector and increasing its appeal to mainstream mass tourists (UNWTO, 2014). Adventure tourism is the most potential tourism industry in Bangladesh which could be developed in different places. Adventure tourism, such as boat cruises, wildlife safari, bird watching, horseback riding, nature walk, camp fire, swimming, cycling, biking, and exploring ethnic community's lifestyle are quite unique and popular in Kuakata among the tourists of all age groups.

Figure 10.18: Boat safari in Fatrar Char Mangrove Forest

Figure 10.19: Ride on Horses in Kuakata Sea Beach

10.2.5 Conference Tourism

To revive and strengthen Bangladesh's tourism sector, which was adversely hit by the Corona virus, several initiatives have been implemented to boost MICE (Meetings, Incentives, Conferences, and Exhibitions) tourism. In order to attract foreign institutions and organizations to organize various international conferences in Bangladesh, the Bangladesh Tourism Board has taken a wide publicity campaign globally by informing about various opportunities and facilities for organizing international conferences in Bangladesh, including the provision of discounts on hotel, motel, convention hall, plane etc.

10.3 Key Statistics of the Tourism Industry

10.3.1 Number of Local, Regional and Foreign Tourists and Their Places of Origin

We have done a review using online sources to have reliable and key statistics on tourism of the project area but no such data or information was available. We also conducted a short field visit from 13 September to 17 September 2022 to acquire relevant information. We had several meetings with different resource persons such as the Secretary of Kuakata Hotel Motel Association, the President of Tour Operators Association of Kuakata (TOAK), officials of Kalapara Upazila Parshad, and so on. They highlighted different aspects of Kuakata tourism. They mentioned that a very small number of foreign tourists (around 1 to 2 percent of total tourists) come to visit the beauty of Kuakata and the rest of the tourists are domestic.

10.3.2 Extent of Community Ownership of the Payra-Kuakata Region Tourism Industry

There is some local community engagement and ownership in the tourism industry of Kuakata though it is minimal. On the other hand, the tourism industry of Payra region is yet to engage the local community and ensuring their ownership. The tourism sector of Kuakata is gradually developing with the involvement of local businessmen. External investment is much higher than the local. Here, such

investments are mainly private sourced and focused toward the construction of commercial residential accommodations. The government is also investing there for improving various infrastructural developments particularly road communication, creating other tourism facilities including ensuring security of the tourists. Currently, there is no direct foreign investment in tourism sector at this region.

The local businesses are booming now particularly after inaugurating the Padma bridge. Very recently another bridge (8th Bangladesh-China Friendship bridge) in Bekutia, Pirojpur has been opened which made ferry-less uninterrupted travel to Kuakata-Payra region from Khulna and its surrounding districts. These two bridges are expected to increase both the private and public tourism investments in this region, and increase local community's participation and ownership. There are much more opportunities to increase the participation and ownership of local communities in tourism businesses to foster the development pace of this region. The concept of community-based tourism (CBT) is yet to be developed at this region which is very prospective here due to the presence of various components of CBT which can facilitate very active and direct involvement and ownership of the local communities particularly the disadvantaged local communities like the Rakhain tribal, women and other unprivileged section of the society.

10.3.3 Number of People Employed in the Tourism Sector in Payra-Kuakata Region

Tourism's contribution plays a vital role in Payra-Kuakata region. According to the secretary of Hotel Motel Owner Association of Kuakata, people employed in the tourism sector are fully regional. Senior and mid-level management are from different parts of the country. Around 1500 local people are engaged in tourism of Kuakata. Currently, there is no foreign employee here working solely in tourism sector. Most of the top and mid-level management employees are non-local, from different parts of the country. The local people are engaged mostly in lower-level of management as well as working as labourers in various types of activities.

10.3.4 Revenue Generated from Tourism in Payra-Kuakata Region

We have done online literature review but no relevant data or information was found in this context of revenues generated from the tourism sector of this area. Moreover, our recent field visit to this region (from 13 September to 17 September 2022) didn't get such required information.

10.3.5 Tourism Revenue Compared to Revenue Generated by Other Key Sectors

As mentioned above, there was no specific and systematic data on tourism revenues of this region. However, according to the data of Bangladesh Bureau of Statistics (BBS) 2020, revenue generated from key sectors are mentioned below.

- Agriculture: GDP from Agriculture in Bangladesh increased to BDT 11540.50 million in 2021 from BDT 11242.30 million in 2020.
- Manufacturing: GDP from Manufacturing in Bangladesh increased to BDT 27576.40 million in 2021 from BDT 26072.80 million in 2020.
- Services: GDP from Services in Bangladesh increased to BDT 164109 million in 2021 from BDT 154029 million in 2020.
- Transport: GDP from Transport in Bangladesh increased to BDT 12871.80 million in 2021 from BDT 12135.50 million in 2020.
- Construction: GDP from Construction in Bangladesh increased to BDT 9582.40 million in 2021 from BDT 8816.90 million in 2020.

- Mining: GDP from Mining in Bangladesh increased to BDT 1873.50 million in 2021 from BDT 1868.10 million in 2020.
- Utilities: GDP from Utilities in Bangladesh increased to BDT 1761.10 million in 2021 from BDT 1681.40 million in 2020.

10.4 Existing Tourism Facilities in Payra-Kuakata Region

10.4.1 Accommodation

Kuakata has two Dak Banglows and Sagar Kanya tourism Holiday homes. Moreover, LGED, roads and highways, district council, and Rakhain Culture Academy have several rest houses. However, in order to stay in these places, prior permission of the concerned department need to be taken. Moreover, there are a good number of private accommodations available here.

Beds available

At present, around 74 hotels and motels are available at Kuakata (Picture 2.20) which are under Kuakata Hotel and Motel Association. However, the total number of hotels are 150 according to the information of general secretary of Kuakata Hotel and Motel Association. According to them, on an average all the facilities have accommodation capacity of 15,000-20,000 per day. Among them, some are very high class and some are medium class. The rent of these accommodations varies depending on the quality of the hotel and room. Room rent also varies depending on the seasons. In the peak season, room rents are much higher than the off-season. A list of the present hotels and motels with its accommodation capacity and rent are presented below (Table 10.1).

Table 10.1: Existing accommodation facilities with their capacity and rent

Hotel Name	Capacity (No.)	Seat rent
Sikder Villa	100	Premier Villa with Pool – 32,000 BDT Premier Villa without Pool- 28,000 BDT Superior Villa – 24,000 BDT Premier Room – 12,000 BDT Superior Room – 10,000 BDT Deluxe Room with View – 8,000 BDT Deluxe Room – 6,000 BDT
Grand Hotel	100	Standard Deluxe- 16,000 BDT Deluxe Room - 19,920 BDT Premium Deluxe – 24,800 BDT Twin Deluxe – 28,800 BDT Executive Suite – 39,920 BDT Presidential Suite – 55,920 BDT
Hotel Banani Palace	100	A/C Deluxe Room - 3000 BDT A/C Twin Share Room - 2500 BDT Non-A/C Twin Share Room - 1500 BDT Ground Floor Twin Bed - 1000 BDT Dormitory Eight Bed - 4000 BDT
Hotel Kuakata Inn	100	Economy Double Room - 1200 BDT Economy Family Room - 1500 BDT A/C Deluxe Double Room - 1900 BDT A/C Deluxe Family Room - 2400 BDT

Hotel Name	Capacity (No.)	Seat rent
Hotel Neelanjana Ltd.	100	Family A/C Room - 3000 BDT Twin Share A/C Room - 2500 BDT A/C Deluxe Room - 2200 BDT Non-A/C Twin Share - 1600 BDT Non-A/C Deluxe - 1450 BDT Non-A/C Single - 850 BDT Non-A/C Conference Room (150 person) - 12000 BDT
Kuakata Guest House	60	A/C Double Bed Room - 2500 BDT Non-A/C Double Bed Room - 1600 BDT Double One Single One Non-A/C Room - 1500 BDT Non-A/C Twin Share - 1000 BDT Single Two Bed - 1000 BDT Single One Bed - 600 BDT 6 Bed Dormitory - 300 BDT
Hotel Sky Palace	100	Family Bed Non-A/C (Double) - 1200 BDT Twin Non-A/C (Double) - 1400 BDT Family Bed A/C (Double) - 2200 BDT Twin A/C (Double) - 2500 BDT Suit Room - 3000 BDT
Hotel Mohana International Ltd.	100	Economy Double Room - 1250 BDT Economy A/C Double Room - 1850 BDT A/C Family Room - 2050 BDT Economy 3 Bed Room - 1850 BDT Economy 3 Bed A/C Room - 2450 BDT VIP Suite A/C Room - 4500 BDT
Sagor Konna Resort Ltd.	50	VIP Suite - 2000 BDT Non-A/C Deluxe - 1500 BDT Economy Double Room - 1000 BDT
Beach Heaven	100	A/C Double Room - 3000 BDT A/C Twin Bed- 2000 BDT Non-A/C Deluxe - 1500 BDT Economy Double Room - 1000 BDT
Hotel Al Hera	30	A/C Twin Bed- 2000 BDT Non-A/C Deluxe - 1500 BDT Economy Double Room - 1000 BDT
Biswas Sea Palace	40	3 Bed A/C Room - 1800 BDT 3 Bed Non-A/C Room - 1500 BDT Double Bed - 1200 BDT Twin Share Bed - 1200 BDT
Kings Hotel	40	Economy Double - 600 BDT Non-A/C Deluxe - 800 BDT Deluxe Family Room - 1000 BDT
Bengal Guest House	40	Double Bed Room - 1000 BDT Twin Bed Room - 1200 BDT
Hotel Shagor	30	Single Bed Room - 200 BDT Economy Double Bed Room - 300 BDT Deluxe Double Bed Room - 400 BDT

Hotel Name	Capacity (No.)	Seat rent
Anandbari Guest House	60	Non-A/C Double Bed Room - 1200 BDT A/C Twin Bed Room - 1500 BDT A/C Family Room – 2000 BDT
Hotel Gosh International	100	Non-A/C Double Bed Room - 1200 BDT A/C Twin Bed Room - 1500 BDT A/C Family Room – 2000 BDT
Hotel Sea Palace	30	Single - 200 BDT Economy Double - 300 BDT Deluxe Double - 400 BDT
Hotel Sea Queen	100	Non-A/C Double Bed Room - 1200 BDT A/C Twin Bed Room - 1500 BDT A/C Family Room – 2000 BDT
Khepupara Family House	60	Single - 200 BDT Economy Double - 300 BDT Deluxe Double - 400 BDT
Hotel Shoibal	30	Single - 300 BDT Economy Double - 550 BDT Deluxe Double - 800 BDT
Hotel Sunflower	60	-
Hotel Graver Inn	100	Luxury – 5000 BDT Premium Twin – 4000 BDT Super Deluxe – 3500 BDT
Motel Parjatan	217	AC Deluxe - 5500 BDT AC Twin - 3500 BDT AC Couple Bed - 3500 BDT AC Four Bed - 4000 BDT Non-AC Twin - 2000 BDT Non-AC Couple - 2000 BDT Non-AC Four Bed – 2500 BDT
Zila Parishad Dakbanglow	20	GoB Rate
BWDB Dakbanglow	15	GoB Rate
LGED Dakbanglow	15	GoB Rate

Source: Kuakata Hotel Malik Shamiti, 2022.


Figure 10.20: Existing Hotel Facilities at Kuakata

Percentage bed-night occupancy (trends over past 5 years)

This type of data was not available either in the secondary or primary source. It needs further investigations or field works to explore such data.

10.4.2 Transportation

By road

Kuakata is located in Kalapara Upazila, Patuakhali District. The Padma Bridge has reduced the distance by road from Dhaka's Zero Point to Kuakata to almost 300 km. With no ferries required for the journey, the trip takes around 6 hours, which is less than half of the time it took before. It is 77 km and 22 km far from the district town Patuakhali and sub-district (Upazila) town Kalapara consecutively.

From Gabtali or Sayedabad bus stand different bus companies such as Green Line, Golden Line, Hanif, Sakura etc. added AC and Non-AC luxury multi-chair coaches and sleeping coaches in this route.

By launch

Dhaka to Kuakata via Patuakhali by launch

Since the distance from Patuakhali to Kuakata is relatively short, many people choose the Patuakhali water route to go to Kuakata. The launches of Patuakhali started their journey from Dhaka Sadarghat between 6 pm to 7 pm. From Patuakhali river port, one has to go to the bus stand by auto or rickshaw, and from there direct Kuakata by bus. It takes about 2 hours to reach Kuakata.

Dhaka to Kuakata via Barisal by launch

The country's largest and most luxurious launches operate on the Barishal waterway. Launches from Dhaka Sadarghat leave between 9 pm to 9.30 pm. From Barishal river port, one can choose Barishal "Rupatoli bus stand" or "Natullabad bus stand". There are available Patuakhali or Khepupara bus services. From Patuakhali one can go Kuakata by any local service.

Tourist vehicles available

There are different types of vehicles used by the tourists in the region. Usually they use motorbikes, auto rickshaws, tomtoms for local transport. In few tourist spots, tourists use boats to visit one place to another. According to local tour guides of Kuakata, approximately 400 bikes are available for tourists in this spot.

Tourist boats available

There are no dedicated tourist boats available for tourism in the Payra-Kuakata region.

10.5 Limitations of Tourism Sector Development

Bangladesh has a huge prospective to improve tourism due to its natural scenery and rich heritage. However, the industry underperforms because of its different challenges.

- Infrastructure for enhancement of the tourism in Kuakata is not well developed
- Inadequate of accommodation
- Poor image of Kuakata, as a tourist destination
- Inadequate air travel facilities
- Insufficient branding of Kuakata as an international tourist spot
- Problems related to safety security and hygiene
- Insufficient parking facilities
- Non-professional tour operators
- Inadequate entertainment facilities both physical and recreational
- Inadequate access to data and information in internet about Kuakata
- Inadequate Allocation in National Budget
- Inadequate initiative to preserve, conserve and maintain tourism products

10.6 Administration of the Tourism Sector

10.6.1 Existing Administrative Structures for Management of Tourism

Table 10.2: Key competent authorities and supporting institutes in the sector of tourism

Key aspect in the theme	Primary competent authority (CA)– and their mandates	Key support organisations (govt, NGO, donor, CBO, etc.)	Performance of CA and support organisations
Tourism policy, rules and regulations formulation	**Ministry of Civil Aviation and Tourism (MoCAT)** <u>Mandates</u> • Preparing Bangladesh as a prime aviation hub and attractive tourist destination. • Develop Bangladesh as an exotic tourist destination. • Develop well trained and efficient human resources for uplifting tourism sector in international arena. • Establish tourism as one of the major foreign currency earning sources. • Develop tourism sector through creating various tourism facilities and their promotion. • Formulation of various policy, rules and regulations to develop, promote and control tourism sector in Bangladesh.	• Bangladesh Tourism Board (BTB), MoCAT • Bangladesh Parjatan Corporation (BPC), MoCAT • Bangladesh Forest Department (BFD), MoEFCC • Tour Operators, travel agents, their associations like Tour Operators' Association of Bangladesh (TOAB), Tour Operators' Association of Kuakata (TOAK), Bangladesh Inbound Tour Operators Association (BD Inbound), Bangladesh Outbound Tour Operators Association (BOTOA) • Co-management organizations (CMOs) • Community-based Organizations (CBOs)	Bangladesh Parjatan Corporation (BPC) has been working since 1973 for the development and promotion of tourism sector of Bangladesh. They are trying to develop the country as a popular destination in this region. Additionally, they are significantly contributing to develop trained human resource in tourism sector. They have progressed much since its establishment. However, there are lot more scopes to achieve their vision and targets. Currently, they are more focused on doing tourism businesses particularly by providing tourism services like accommodation and restaurant services. They need to focus more on effective and functional marketing of tourism attractions of the country to attract more foreign tourists in Bangladesh. They need to have better collaboration with other concerned departments and ministries to develop tourism and make Bangladesh as a safe, secured and competitive tourism destination. They should more focus on private sectors to facilitate the development progress. Bangladesh Tourism Board (BTB) is comparatively new organization established in 2010 as the Nation Tourism Organization. Currently, they are preparing 'Bangladesh Tourism Master Plan (2021-2041)' to develop and promote tourism in a systematic way. However, still there are lack of coordination

Key aspect in the theme	Primary competent authority (CA)– and their mandates	Key support organisations (govt, NGO, donor, CBO, etc.)	Performance of CA and support organisations
	Bangladesh Forest Department, MoEFCC <u>Mandates</u> • Management and conservation of forest areas including the protected areas and its biodiversity. • Develop nature-based tourism (particularly ecotourism and community-based tourism) in these forest areas to promote conservation efforts. • Provide alternative income generation opportunities for the forest-dependent local communities to reduce their pressure on the natural resources.		between BTB and BPC and also with other ministries, departments as well private stakeholders. Moreover, the private sector is also trying hard to develop tourism in the country but they need more patronization as well as skilled manpower. There should have a good coordination among all the public-private-NGOs and local communities. BFD has an important role in developing and promoting tourism in Bangladesh. Massive and successful plantation (by BFD) working as green belt protecting the coastal areas.
Tourism management	• Bangladesh Tourism Board (BTB), MoCAT • Bangladesh Parjatan Corporation (BPC), MoCAT • Bangladesh Forest Department (BFD), MoEFCC	• BTB, BPC, BFD, Archaeological Department, Ministry of Cultural Affairs • Local city/municipality corporation, local government and local administration • Civil society • Tour operators and their associations • Co-management organizations (CMOs) and Community-based Organizations (CBOs) • Donors: Govt. and foreign (e.g., USAID, UNDP, European Union, World Bank)	Still tourism management is in infant stage in Bangladesh. The concerned CA and support organizations have lack of commitments and understandings on tourism destination management as well as tourist management. The private sector of tourism is not well-developed. They should come forward with good investment and efficient and technically sound manpower. The govt. still has insufficient coordination with the concerned stakeholders. If tourism management is done properly, it will reduce negative impacts of tourism significantly.

Key aspect in the theme	Primary competent authority (CA)– and their mandates	Key support organisations (govt, NGO, donor, CBO, etc.)	Performance of CA and support organisations
Marketing Bangladesh as an attractive tourist destination	BTB and BPC: to make Bangladesh as one of the tourist destination countries in South Asia	• BTB, BPC, BTB, BPC, BFD, Archaeological Department • Local city/municipality corporation, local government and local administration • Civil society • Tour operators and their associations	Still aggressive and systematic marketing for tourism sector is lacking in Bangladesh. The concerned authorities need coordinated efforts to promote tourism sector of Bangladesh. Private tourism sector should also come forward in this regard to attract Bangladesh to more tourists particularly international tourists.
Creating tourism facilities	BTB, BPC, BFD and private sector	• BTB, BPC, BTB, BPC, BFD, Archaeological Department • Local city/municipality corporation, local government and local administration • Private tourism enterprises and some NGOs • Sometimes Bangladesh Police, BGB, Army, Navy, etc. to develop tourism facilities for the tourists • Tour Operators' Association of Bangladesh (TOAB), Tour Operators' Association of Kuakata (TOAK), Bangladesh Inbound Tour Operators Association (BD Inbound), Bangladesh Outbound Tour Operators Association (BOTOA), Tour Guides Association of Bangladesh (TGAB), Tourism Developers Association of Bangladesh (TDAB), Tourism Resort Industries Association of Bangladesh (TRIAB) • Donors: Govt. and foreign	Still environment-friendly and sustainable tourism practice is to develop in Bangladesh. Most of these CA and supporting organizations are trying to do their businesses to make profits rather to emphasize more on the natural and cultural environment of the destinations. Domestic tourists are not environment friendly. These concerned authorities are to focus all these issues with due concerns.
Ensuring safety and security of destinations	Tourists Police: offer tourists a safe, secured and pleasant environment to enjoy the diversity of Bangladesh	Local administration, Bangladesh Police, BGB, Army, Coast Guard, BFD, private security agencies, etc.	Developing safety and security of the tourism destinations. Still much to do to ensure Bangladesh as a safe and secured tourism destination for both national and international tourists. Coordination among destination development authorities is required. Local administration can coordinate all the activities taken place at a destination.

10.6.2 Mandates of Authorities for Management of Tourism

National Tourism Policy 2010 guides all legislations and regulations of tourism sector. Moreover, there are some other policies which directly and indirectly influence tourism legislations and regulations such as National Environment Policy 2018, National Coastal Zone Policy 2005, National Forest Policy 1994, National Industrial Policy 2016, National Land Use Policy 2001.

Legislation

The tourism development activities of Bangladesh are mainly controlled through Parjatan Board Act 2010, Bangladesh Parjatan Corporation Order 1972, Bangladesh Tourist Reservation Area and Special Tourism Zone Act 2010, Bangladesh Tour Operators and Tour Guides (Registration and Operation) Act 2021.

Regulations

Table 10.3: Relevant legislation and regulations

Key aspect in the theme	Primary legislation	Accompanying or enabling regulations	Comments on adequacy or not re. legislation and regulations
National Tourism Organization	Bangladesh Tourism Board Act 2010	• Bangladesh Tourism Master Plan (2021-2042) • SOP for COVID-19 • Global Tourism Crisis Response Strategy • National Tourism Human Capital Strategy • Tourism Recovery Committee • Crisis Management Committee	This Board has been established for the overall development of tourism industry, regulation, co-ordination and administration of matters related to this industry of the country. They are responsible to formulate policies, rules and regulations, recommendations and assist in the implementation of the existing policies related to tourism. They are also responsible to identify, conserve, develop, grow the tourism attractions and create public awareness on tourism related issues. However, the implementation of these commitments is not up to the mark. The engagement of private sector is poor. The coordination among various stakeholders related to tourism is also slow. The Master Plan preparation is taking longer period of time.
Tourism development, service provider, marketing and human resource development	• Bangladesh Parjatan Corporation Order 1972 • Bangladesh Parjatan Corporation (Amendment) Act, 2022	BPC Service Rules 1990	BPC is responsible to promote and develop tourism, provide facilities, undertake measures and carry out all forms of activities connected with or ancillary to tourism industry. However, BPC is still lagging behind in achieving its objectives to satisfy the thrust of the national and international tourists.
Tourism destination declaration and management	Bangladesh Tourist Reservation Area and Special	• Bangladesh tourism protected areas and special tourism zone Rules, 2013	It is a good initiative. However, still the Act needs more coordination and collaboration with other line ministries and departments to protect

Key aspect in the theme	Primary legislation	Accompanying or enabling regulations	Comments on adequacy or not re. legislation and regulations
	Tourism Zone Act 2010	• Bangladesh tourism protected areas and special tourism zone Rules 2011 • Guidelines for Sundarbans Travel 2014	and manage tourism destination of Bangladesh. BPC needs more trained human resources to implement its mandates through their legislation and regulations.
Authorization of tour operators and tour guides	Bangladesh Tour Operators and Tour Guides (Registration and Operation) Act 2021	Various rules and regulations developed by various tour operators' associations and tour guides' associations	It is a new Act. Still waiting to implement on ground level. It needs acute cooperation of the associations of tour operators and tour guides to fulfil the objectives of this Act.
Conservation of forest-based tourism destinations and their management	Wildlife (Conservation and Security) Act, 2012	Protected Area Management Rules 2017	'Ecotourism or nature tourism' at the natural areas have been recognized. Conservation of these natural areas (including biodiversity), preservation of cultural heritage, and enhancement of the socio-economic well-being of local people have been stated. The implementation is still facing various challenges.
Controlling environmental pollution	The Bangladesh Environment Conservation (Amendment) Act, 2010		Regulations of industry establishment and other development activities for the conservation of the environment. Determined the standards of air, water, sound, soil, and other components of the environment. Defined the procedures for the protection of the environment and ecosystem along with measures against environmental degradation or pollution. Declaration of ecologically critical area and their regulations.

10.7 Drivers of Change Regarding Tourism in the Area

10.7.1 Main Internal Drivers

The National Tourism Policy, 2010 clearly admits that although there is huge potentiality in the tourism sector of Bangladesh but the country has not been able to achieve desirable progress. The policy stresses the need to identify new tourist spots, develop infrastructure and facilities over there, and promotion and marketing of the new spots. The main objective of the policy is to ensure sustainable tourism development of the country by developing the tourism sector, creating employment opportunities, ensuring socio-economic development involving local people and maintaining the environmental balance.

10.7.2 Main External Drivers

Table 10.4: Drivers of change

Key change	Main external drivers	Main internal drivers	Main actions to "fuel" or "brake" the drivers, depending on whether the change is good or bad
Increase in tourists' number	Construction of Padma Bridge	Better communication system	• Sustainable tourism development • Carrying capacity analysis
Accommodation problem	Over footfall of tourist	Less time to reach in the tourist's destination	• Well planned and international standard hotel construction • Climate smart infrastructure development
Beach erosion	Part of Kuakata beach disappeared due to strong tidal waves, the length of the beach has been shrunk	• Climate change; • sedimentation on sea-bed	• Sustainable measures must be taken to protect the sea beach from erosion • Advanced technology should implement to save the infrastructure as well as biodiversity
Inadequate transportation	Poor connectivity of road system	Lack of national budget	Well-planned spacious road needs to construct

10.8 Assessment of Impacts of Tourism

Table 10.5: Main impacts of current tourism

Types of impacts	Negative impacts	Avoidance or mitigation ideas	Positive impacts	Ideas for enhancing positive impacts
Biophysical	• Various types of environmental pollution • Affecting both guests and hosts population	• Proper enforcement of the concerned rules and regulations • Building environmental awareness • Educating school children about environment and its importance	• Conservation of biophysical environment through the entry fees and other fees and revenues • Building environment awareness through guided and systematic practice of tourism • Aesthetic beautification through planned and controlled tourism	• Following sustainable tourism practices with its guidelines • Regular monitoring and evaluation • Following rules and regulations properly • Proper signages, directions and information • Management plan for each of the destinations • Incentives for the compliance of sustainable tourism practice

Types of impacts	Negative impacts	Avoidance or mitigation ideas	Positive impacts	Ideas for enhancing positive impacts
Heritage or cultural	• Pollution of local heritage and culture • Loss of identity • Loss of language • Commodification of local heritage and culture	• Compliance of local rules and regulation of preserving local heritage and culture • Participation of local people (including senior citizens) in all decision-making processes • Practice of sustainable heritage and cultural tourism to empower the local community including tribal communities • Better education facilities for all the citizens particularly for the children • Focus more empowerment on the women and disadvantaged section of the society	• Preservation of local heritage and culture through practicing responsible tourism • Local heritage and culture-based tourism are known as important tourism attractions for both national and international tourists • A good way to ensure interactions between host and guest population • Exchange of knowledge, skills and technology	• Participation of local cultural groups in all tourism planning, implementations, monitoring, evaluation and management activities. • Following the standards/ guidelines of sustainable cultural and heritage (indigenous/tribal) tourism • Formulation of rules and regulations to follow the guidelines of cultural and heritage tourism
Economic	• High price of necessary and daily products and service for both hosts and guest population • Loss of local jobs • Increased land price • Increased cost for living standard	• Market regulation • Monitoring the tourism market regularly and take necessary actions • Priority to the local development keeping their local heritage, culture and environment intact	• New job opportunities for the local • New investment opportunities including foreign investment opportunities • New tourism product and services for the local and exotic people • Improvement of living standards	• Practice of sustainable and responsible tourism • Decision-making process including the local representatives • Involving the local government and administration • Follow the existing rules and regulation • Strict and regular monitoring and evaluation process

Types of impacts	Negative impacts	Avoidance or mitigation ideas	Positive impacts	Ideas for enhancing positive impacts
		• Following concerned rules and regulations • Empowerment of local people • Improvement of tourism supporting local infrastructure • Good facilities of education for all • Other measures for poverty alleviation	• More economic activities to improve local socio-economic status • More educational (both formal and informal) opportunities • More infrastructural development	• Having baseline study to compare the changes due to tourism sector • Destination Management Organization (DMO) to ensure good progress in tourism • Master plan to manage tourism developments
Human resources	• Loss of local human resource due to involvement of MNC/exotic people • Sex tourism and gender abuse • Excessive commercialization may occur loss of education for the local people	• More priority on local people in creating new jobs and employments • Empowering local community tourism enterprises • Empowering co-management organizations (CMOs) and community-based organizations (CBOs) • Following a good master plan for tourism	• Skilled local manpower • More training, education skills and human resource development opportunities • Confident and competent manpower to lead tourism sector • More training institutes and academic institutes	• Having human resource development master plan integrated to tourism master plan for a destination • DMO should address the issues of developing trained manpower in tourism sector • Policy support • Good incentives and motivation for tourism related jobs • Balance between training/academic degrees and new job creation

10.9 Potential for Expanding Various Types of Tourism Products

Conceptually, tourism products are offered to the tourists to visit a specific tourist destination. Tourism products are the prime reason for tourists to choose a destination which can satisfy the leisure, pleasure, religious, adventure, medical or business needs. The tourist products focus on facilities and services designed to attracts tourists and has some specific elements such as the tour, attraction, accessibility, transportation, accommodation, cousin and amenities.

Moreover, a tourism product can be considered as a package or bundle of both tangible and intangible elements of a destination. It can be analysed in terms of its attractions (cultural, natural and artificial resources), accessibility and accommodation (facilities, services, and activities) (Hasan, 2021).

While, the marketing of any product consists of 4Ps (product, price, promotion, and place). Therefore, to ensure ecotourism in Bangladesh, our tourism industry needs to improve, maintain and marketing

of sustainable tourism products for the long-term economic benefits with optimal use of natural resources. Sustainable tourism product means the use of scarce resources in an environmentally accountable, socially reasonable and economically feasible way, so that the users of a tourism product can meet their present needs without compromising forthcoming generations from being able to use the same resources (Hasan, 2021).

Bangladesh has a very bright prospect of tourism industry. As per the Economic Impact report by WTTC, the total contribution of travel and tourism of Bangladesh was USD 9,419.3 million in 2019 which comprised 2.7% of the total GDP. The WTTC forecastes that the contribution will rise to BDT 1753.1 billion by 2028. Thus, our government is planning to invest more to promote this sector as the tourism industry is given more emphasis on SDGs targets 8 and 9. Besides this, it is very important to develop and implement policies to promote sustainable tourism that will facilitate in creating employment and stimulates local culture and products (UN 2015). The Figure 10.21 shows the ecotourism potentialities in PKCP area which consideres the socio-economic development to biodiversity conservation through nature-based management system.

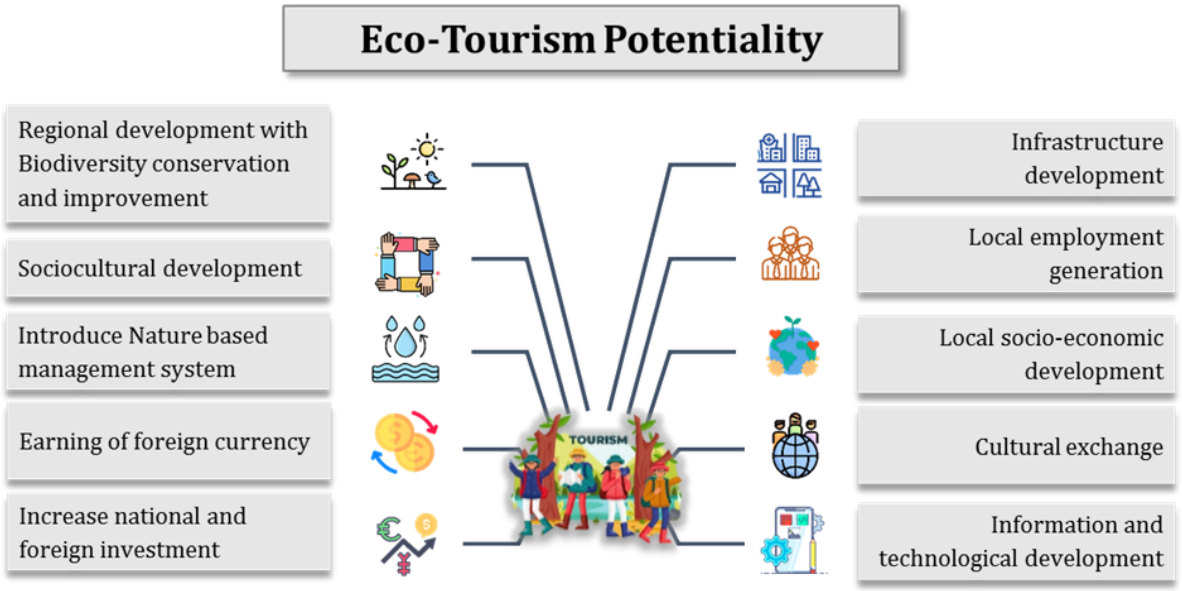


Figure 10.21: Eco-tourism potentialities in PKCP area

The inauguration of Padma Bridge on 25th June 2022 opens up a wide horizon of tourism potential in PKCP. According to field research, the number of tourists visiting Kuakata is 10 times more than before and this is due to improved communication system and short distance. Now it takes 5-6 hours to travel by road from Dhaka to Kuakata instead of 10-12 hours.

The Figure 10.22 shows the potential tourism products at PKCP area and following section will describe the potentiality for expanding various types of tourism products in PKCP area.

Figure 10.22: Shows the potential tourism products at PKCP area

10.9.1 Nature-based Tourism/Ecotourism

- The Fatrar Char mangrove forest would be a potential tourism spot for the tourists of home and abroad because of its rich biodiversity. The total area of the forest is about 997,508 acres. It is already known as the 'Second Sundarbans'. The forest has a great abundance with mangrove species of such as keora, gewa, sundari, fatra, garan, bain, golpata, etc. with numerous animals. The bird lovers can explore a wide range of birds in this forest. Construction of tree house and watch tower at different places of the mangrove forest could help tourists for smooth wildlife photography.
- The 12 canals and 7 ponds of the mangrove forest would be another tourist attraction. Forest Department has already taken a project to rehabilitate these canals. Soundless boat cruising may entertain the tourists who love to explore the mangrove forest. Besides, walkway on the bank of the canal can add additional value to the tourists.
- Local people are also demanding two watch towers at Tengragiri Ecopark and Guiakhali Ecopark, located in the two distinct parts of the Fatrar Char mangrove forest.
- The Kuakata sea beach which is locally known as Shagor Konnya (Daughter of Ocean) is potential for different tourism products such as: swimming, sightseeing (sunset-sunrise), picnic & barbecues party with seafood, beach volleyball, kite-flying, local handicrafts shopping, shellfish gathering, beach-combing, sun-bathing, driving along sea beach, riding speed boat, parasailing, construction of underwater sea aquarium, etc.
- Bangladesh Economic Zone Authority (BEZA) has taken some initiatives to build Exclusive Tourism Zone (ETZ) in different potential areas of Bangladesh for enhancing the tourism industry. After establishing of the ETZs, the authority would be able to allure many foreign as well as local tourists. BEZA should examine the possibility of setting up such zones in Kuakata.

10.9.2 Cultural Tourism

The lifestyle, culture and tradition of the tribal community (i.e., Rakhain) can appeal tourists from home and abroad. An ethnological museum may be established at Kuakata to preserve the traditional culture and heritage which can act as a treasure house of Rakhains.

Additionally, the promotion of traditional homemade rice flour cake (locally known as pitha) such as: chalon pitha, hetal patar pitha can attract the local and international tourists. Other special products made by them such as handicrafts including decorative clothes can also attract tourists.

Bangladesh can generate huge benefits by developing community-based ecotourism in the coastal regions if proper initiatives can take. As defined by Denman (2001), community-based ecotourism is a form of ecotourism where the local community plays a major role in its development and management, and a substantial portion of the benefits is received by the community. Since the community is proactively involved and the livelihoods of a host of the community's residents hinge on the intactness of the nature and the environment, the residents of the community have incentive to collectively conserve the tourist area (Nur, 2019).

10.9.3 Adventure Tourism

A charming island called Char Bijoy rises in the deep sea about 40 km from the Gangamati in the southeast corner of Kuakata beach. The area of the island is approximately 5 thousand acres. This virgin island is home for thousands of migratory birds and red crabs. The char became visible from five years ago which is also known as Hirer Char by the locals. It takes one and a half hours from Kuakata and two hours from Sonakata in Barguna to reach Char Bijoy. Boat based fishing and bird watching could be popular to the adventure centric tourists. With limited entrance and guideline this island could be an ideal spot for adventure tourism.

Besides, marine-based adventurous tourism activities such as yachting, wake-boarding, SCUBA diving, boat-based fishing, watching of sea cetaceans (whales, dolphins, and porpoises) in the Swatch of No Ground (SoNG), sea kayaking, kite-surfing, board-sailing (windsurfing). Proper safety support and policy guidelines are required from the authority to exploit the full potential of the adventurous marine tourism sector in Bangladesh.

10.9.4 Conference Tourism

- The Borguna and Patuakhli district has a great potentiality for organizing national level conference, meeting/seminar as the communication facilities is developed. Its multidimensional picturesque tourist spots and upgraded facility give positive message to local and foreigners to arrange national and international meetings, conferences or exhibitions.
- Beach conference tourism is an exciting form of tourist attraction. It opens a new frontier in tourism. Providing direct access to natural beauty and aquatic lives, it creates immense pleasure for professionals.
- It is necessary to develop regional specific videography/documentary and upload on the relevant (e.g., BPC) websites to attract more official tourist.
- Communicate with different agencies and offer them some package/combo discount for conference tourism could promote this sector.

10.9.5 Marine tourism

- Marine tourism is one of the expanding tourism segments around the world attracting tourists to marine activities which is a key component of the blue economy (Voyer et al. 2018). The Swatch of No Ground (SoNG), a trough-shaped submarine canyon is situated in the southern part of Dublar Char Island in the Bay of Bengal would be an exciting place to the tourists for observation of marine wildlife. It covers an area of around 1738 square kilometres with an average depth of 900 meters. This potential marine tourism hotspot is only 70 kilometres away from the Kuakata and Fakirhat, Taltali. Whales and Dolphins,

which are commonly appeared wildlife in SoNG, have gradually become ones among the most attractive touristic amenities. Through sea cruise, it is highly possible to arrange a safe and secure marine tourism package between November to March.

- Yachting, stand-up-paddle boarding, sea kayaking, surf ski paddling, kite-surfing, roaming around by cruising vessel for short destinations can also be introduced here.
- A seaside route from Chottogram to the Sundarbans (Khulna) and Kuakata (Potuakhali) can be envisaged. Cruising on these potential routes would likely to generate a substantial commercial value as well as a significant amenity value. Tourists would be able to explore and enjoy the natural beauty offered by coastal landscapes. It is important to mention that currently traveling from Chittagong to Khulna through land route requires travelling via Dhaka entailing a 12.30-hour journey of 445 km distance. If the proposed marine route is introduced, traveling from Chittagong to Khulna would significantly reduce time and cost. Additionally, it would help reduce ever-growing traffic jam on Dhaka-Chittagong highway (Nur, 2019).

10.10 Constraints for Expanding Different Types of Tourism Products

Kuakata is a second priority beach in the country. Though road communication has been improved than before, tourists do not tend to go there for a second time due to the lacking of standard facilities. The Figure 10.23 shows some major constrains in ecotourism development at PKCP area and the following section has discussed the detail constraints for expanding different types of tourism products there.

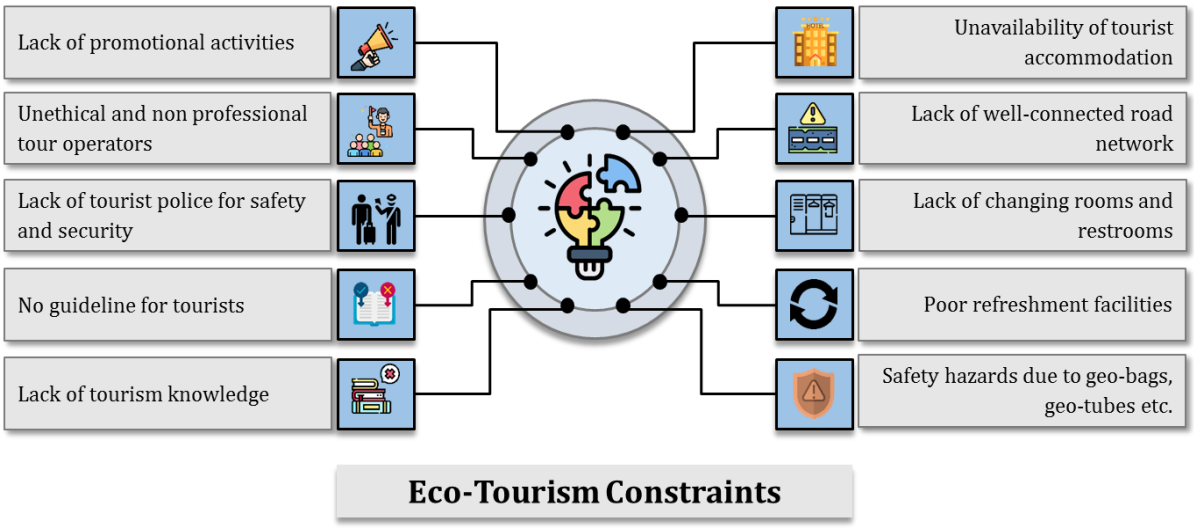


Figure 10.23: Some major constrains for expanding eco-tourism at PKCP area

10.10.1 Climate Change and Disaster Management Issues

- The PKCP project area is facing numerous environmental challenges induced by climate change that threaten tourism sector of the area. The challenges include coastal cyclone, increased salinity (surface and ground water, soil), erosion, flooding, sedimentation and changing pattern of streamflow due to upper-level watershed management.
- Most recently, tropical storms Sidr, Aila, Mohaseen, and Amphan have affected the Kuakata coastal belt. These natural disasters have had substantial negative impacts on natural resource management.

- Over time, as sand is regularly eroded by waves, uprooting and sweeping away trees, the forested regions inside the national park adjacent to the Kuakata beach are gradually disappearing.
- According to the statement of Mahipur Range Officer of the Forest Department, thousands of trees have been uprooted due to Cyclone Amphan and high tide in 2020. Each year, at least 50 hectares of forest land are being destroyed by sea waves and erosion and thus, in the last five years, about 250 hectares of forest land have been lost to the sea.
- From our field visit, it is witnessed that the continuous erosion has shrunk the width of the 18-kilometre-long sea beach and near Kuakata zero-point erosion occurred most. The erosion also threatened dry fish processing zone in Kuakata which is another tourist attraction. Though Bangladesh Water Development Board (BWDB) is trying to prevent sea beach from erosion but sustainable plan needs to be taken to protect this attractive beach.
- Besides, some man-made factors are influencing the disaster management issues of the study area, such as: pollution, waste disposal, spilling oil in the sea, disturbance of natural process, loss of green places, etc.
- Poor disaster management capacity and facilities, seasonality, natural disaster and improper planning for tourism carrying capacity are leading financial losses in tourism industry of the study area.

Figure 10.24: Destruction of Mangrove species due to Amphan at Lebur Char, Kuakata

Figure 10.25: Uprooted tree of Kuakata National Park due to erosion

10.10.2 Health Hazard and Safety Issue

- The beach is littered with building blocks and wooden logs, which are safety hazards for many tourists. Geo-bags and geo-tubes dumped by BWDB to control beach erosion is causing major injuries to tourist. In last three years, at least 3 people died and 25 people injured due to stuck in the geo bag while bathing in the sea beach near zero point.
- Freshwater scarcity and poor sanitation facilities in the coastal region will lead havoc the future tourism.
- There is no authorised tourist guide at Kuakata beach. Local untrained and unskilled people are playing the role of tourist guides which is creating some unexpected occurrences with tourist. Pickpocketing, mugging, teasing and physically assaulting of female tourists are becoming commonplace, local people noted during field investigation.

10.10.3 Lack of Tourism Infrastructure

- Surrounding the Kuakata beach there is no sufficient toilets and changing room. Existing few facilities are available there which are not maintaining standard hygienic and cleaning rules.
- Seriously dilapidated roads make it a pain to visit various nearby lucrative places including Rangamati Char, Red Crab Island, Jhouban, Shutki Polli and Buddhist temple. As a tourist place there is no footpath for the tourists to walk safely.
- Drainage system is also fragile in the Payra-Kuakata region. There is no developed waste management system in the tourism hub.
- Tourists from home and abroad suffer a lot as there is no official bus stand or parking lot in Kuakata. They have to park their cars here and there creating chaos on the tourist spots. Dhaka bound passenger busses park on the main road in front of Bangladesh Parjatan Corporation motel, Barisal bound buses via Patuakhali park on the Kuakata zero point (Chowrasta) and buses, microbuses, private cars brought by tourist park at different places including coconut garden, roads, Rakhain market's field and other places. Though six (6) acres of land is prepared for the bus stand in Kuakata, it is not enough to accommodate the huge traffic during peak season.
- There aren't sufficient accommodation facilities to stay in Kuakata because existing hotels and resorts can only accommodate a maximum of 15,000 guests at once, according to Ruman Imtiaz Tushar, president of the Tour Operators' Association of Kuakata. Those exiting hotels are not comparable with international standard.
- Lack of marine tourism-based activities in PKCP area has noticed.

10.10.4 Inadequate Waste Disposal and Beach Noise Pollution

- The Kuakata beach is under the threat of plastic and sound pollution due to uncontrolled tourism. Not only tourist but local beach tourism-based entrepreneurs are dumping waste at beach as there is no proper waste management system developed there.
- They are playing music on loud volume which is hampering the habitat through noise pollution. Although Tourist Police trying hard to ensure beach quality but increasing degradation is continuously deteriorating the beach ambience. For instance, hiring a motorcycle is a common phenomenon at the beach which cause sound pollution as well as destruction of the habitats of red crabs.
- Inadequate awareness of local people is one of the major impediments to sustainable development of tourism in PKCP area.

10.10.5 Insufficient Proper Planning and Budget

- Planning is instrumental in the process of any sort of development. Tourism industry is no exception. Although Bangladesh tourism authority has several entities that were established for the betterment of tourism industry, a proper planning is yet to be designed and implemented for the specific purpose of developing the country’s coastal and marine tourism.
- There is no well-established tourism master plan for the country. Tourism sector needs to integrate with other cross-cutting issues for developing a proper regional tourism plan.
- Traditionally every year Bangladesh government proposes an allocation for Civil Aviation and Tourism Ministry in the national budget. But the size of the allocation appears very scanty. For example, in the recent budget (2017-18) Tk. 687 crore was proposed which is

0.17% of the budget. It is quite impossible to develop a sustainable coastal and marine tourism with this scanty allocation (Siddique et al., 2021).

- Developing a sustainable coastal and marine tourism is a long-term phenomenon. Because government has incentive to focus on short-term objectives ignoring long-term ones, such development agendum is left mostly unattended. Short-term focus induces government to give priority to economic achievements over social and environmental concerns creating a strong barrier to sustainable development of tourism (Dudds and Butler, 2009).

10.10.6 Poor Information and Publicity

- Although some websites have been created on tourism attractions, accommodation and transportation facilities with rent but still there are lack of authentic information. Tourist are getting confused when they find mismatch information in reality with the website.
- Bangladesh lags far behind the nations in its peer group in taking proper marketing strategy to promote and publicize even its mature tourist destinations. Some of tourist spots of PKCP area are not mature yet. The immaturity of those spots can largely be attributed to the lack of necessary publicity.

10.10.7 Political Instability

- Sometimes social and political consequences affect the tourism sector of the country. PKCP project area is also not out of this.
- Local political conflicts hamper the regional development of tourism sector.

10.10.8 Insufficient Coordination Between Agencies

There must be coordination between different agencies involved in a process in order for the process to succeed. As far as development of coastal and marine tourism is concerned, several government agencies such as Civil Aviation and Tourism Ministry, Bangladesh Tourism Board and Bangladesh Parjatan Corporation are involved. Some degree of coordination among them must prevail (Siddique et al., 2021).

Besides, local administration, local community, NGOs working for the conservation of environment, potential private investors etc. are relevant entities. These non-government entities also must have coordination among themselves and with the government agencies. However, in countries like Bangladesh, it is the government bureaucracy that inherently stands in the way of necessary coordination (Siddique et al., 2021).

11. Economic and Industrial Development

11.1 Introduction

11.1.1 Employment

Employment Status of Working Population by Sex

In the Figure 11.1 shows that the majority of home work is done by women, with very little to no involvement from men. The majority of men's employment is outside the home. Female participation in outside employment is extremely low. 77% of the male population is occupied outside the house while only 5% of the females are employed outside their home. In stark contrast, women participate in household work at a rate of 74% while men only make up 4% of the workforce.

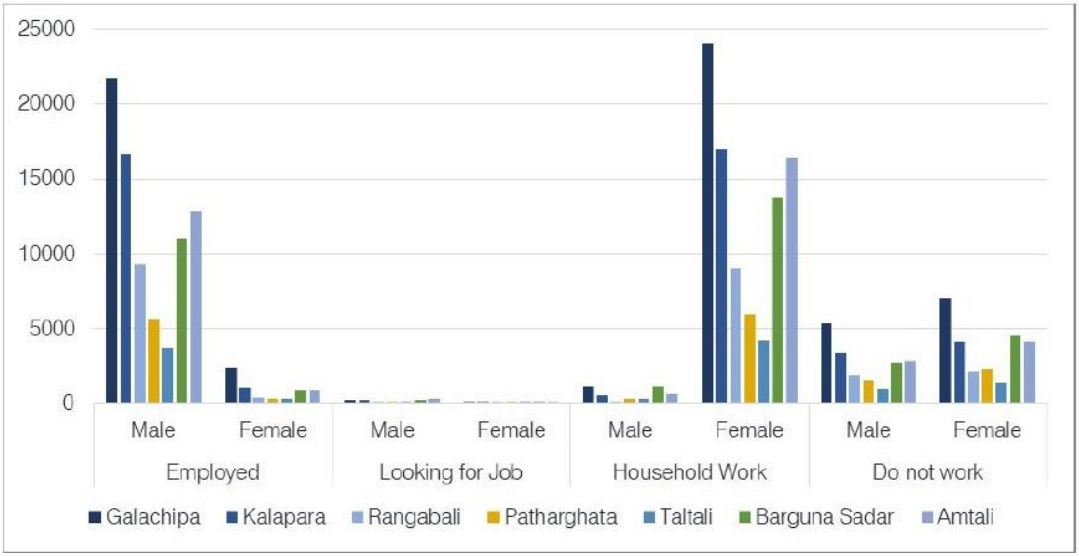


Figure 11.1: Employment Status of Working Population by Sex

Employment Status of Working Population

Comparing the upazilas overall employment rates (Figure 11.2), it can be seen that a large proportion of the population is employed. The upazilas of Patharghata, Barguna Sadar, and Taltali have the highest rates of unemployment. The upazilas with the highest employment rates are Kalapara and Rangabali. Household work as expected is high in all upazilas.

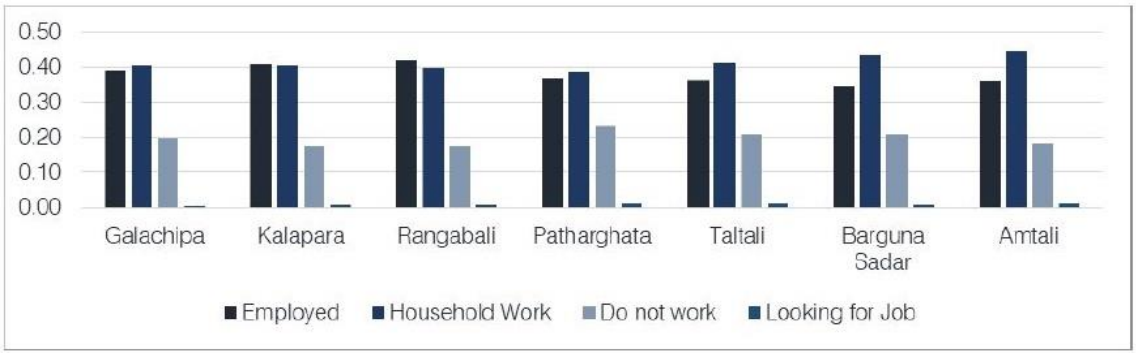


Figure 11.2: Employment Status of Working Population

Table 11.1: Employment Distribution

Upazila Name	Mining and Quarrying	Manufacturing	Electricity, Gas and Water Supply	Construction	Wholesale and Retail Trade	Hotel and Restaurant	Transportation, Storage, and Communication	Bank, Insurance and Financial Activities	Real Estate and renting	Public Administration and Defense	Education	Health and Social Work	Community, Social and Personal services
Galachipa	2	1705	0	9	10465	3390	765	705	0	531	2952	235	4320
Kalapara	13	2247	102	2	5180	1816	233	898	13	811	2823	229	1987
Rangabali	0	426	0	0	4362	1227	189	302	0	168	882	69	1123
Patharghata	0	1622	108	0	3894	1317	144	601	0	443	1734	219	1964
Taltali	0	292	0	0	2792	522	113	412	0	120	1002	81	1148
Barguna Sadar	0	2365	129	46	4850	2263	231	1693	46	1119	3542	490	2415
Amtali	0	1699	22	0	4168	1807	200	914	0	600	2348	329	2227

Source: Economic Census, 2013

Galachipa upazila contributes the most to national employment among the seven, according to an analysis of employment data for the upazilas and a comparison with overall employment. With 25,079 TPEs, it accounts for 0.1% of all employment across the country. Taltali upazila contributes the least (0.03%) (TPE – 6,482). The towns of Galachipa, Barguna Sadar, Kalapara, Amtali, Patharghata, Rangabali, and Taltali are listed in decreasing order of total employment.

11.2 Food Security

Bangladesh has made significant progress in food security in recent years compared to many of its Asian counterparts. With more than 58.5 million people facing mild chronic food insecurity (IPC Level 2), representing 36% of the total population, and 69.8 million people facing IPC Level 1, representing 43% of the total population. Nearly 35 million people, or 21% of Bangladesh's total population, face moderate and severe chronic food insecurity (IPC Levels 3 and 4), with 11.7 million of those individuals facing severe chronic food insecurity (IPC Level 4), and 23.1 million of those individuals facing moderate chronic food insecurity (IPC Level 3). (IPC Level 3).

Of the eight divisions in Bangladesh, the divisions of Chattogram and Dhaka have the lowest proportion of people in Moderate or Severe Chronic Food Insecurity (18% and 16% respectively). The largest percentage of people facing moderate or severe chronic food insecurity (31%) is found in Rangpur division, followed by **Barishal division** (24%) and Rajshahi division (23%).

Out of all 64 districts, 19 districts have been classified in IPC Level 2. Forty-three districts have been classified in IPC Level 3. The study area Barguna and Patuakhali districts have been classified in IPC Level 3.

Table 11.2: Districts Wise Food Security IPC Level

Region	District Population	Area Level	Total Rural	Level 1		Level 2		Level 3		Level 4	
				People	%	People	%	People	%	People	%
Barishal	Barguna	3	929817	325436	35	325436	35	185963	20	92982	10
	Patuakhali	3	1543380	694521	45	385845	25	308676	20	154338	10

Source: IPC, 2022

11.3 Export & Import (Goods & Service)

Export & Import Statistics

Bangladesh export earnings during FY 2020-21 was US$ 45367.19 million and import payment for the same year was US$ 61571.40 million which shows that export earning covered 73.68% of import bill. During 2019-20 and 2018-19 export earning covered 71.46% and 74.99% of import bill respectively. Export earnings during FY 2020-21 was US$ 38758.31 million and import payment for the same fiscal year was US$ 54344.40 million of goods sector. On the other hand, export earnings during FY 2020-21 was US$ 6608.88 million and import payment for the same year was US$ 7227.00 of service sector. Since inception Bangladesh is having trade deficit mainly due to heavy import of fuel, capital machinery, industrial raw material indications a rapid industrialization.

Source: EPB

Figure 11.3: Export & Import Statistics

Export Statistics of Principal Commodities

Table 11.3: Export Statistics of Principal Commodities

The principal commodities that registered growth/decline in the export earnings during the FY 2020-21					
Commodities	Export Earning	Growth (%)	Commodities	Export Earning	Growth (%)
Knitwear	16960.03	21.94%	Plastic Products	115.28	14.68%
Woven	14496.7	3.24%	Knit Fabrics	64.77	17.91%
Home Textile	1132.03	49.17%	Leather & Leather Products	252.56	14.55%

The principal commodities that registered growth/decline in the export earnings during the FY 2020-21					
Commodities	**Export Earning**	**Growth (%)**	**Commodities**	**Export Earning**	**Growth (%)**
Footwear (Leather)	569.88	19.03%	Leather	119.14	21.19%
Chemical Products	280.58	41.09%	Cap	226.38	18.42%
Engineering Equipment	96.31	44.89%	Raw Jute	138.15	6.36%
Electric Products	67.48	71.31%	Jute Yearn & Twine	799.04	41.61%
Carpet	33.54	58.73%	Jute Sacks & Bags	138.66	30.15%
Pharmaceuticals	169.02	24.47%	Ceramic Products	31.11	11.23%
Handicrafts	33.97	65.55%	Furniture	79.47	4.00%
Bi-Cycle	130.89	58.00%	Gold Shaft	14.3	2.73%
Spices	43.29	30.08%	Fruits	0.58	18.37%
Dry Food	283.38	46.29%	Shrimps	328.84	-1.15%
Rubber	34.24	30.59%	Vegetables	118.73	-27.60%
Copper Wiar	55.24	123.01%	Paper & Paper Products	71.44	-8.38%
Tea	3.56	14.10%	Petroleum bi Products	23.33	-0.64%
Tobacco	86.2	7.27%	Terry Towel	34.77	-5.34%
Special Textile	130.9	12.81%	Crabs	12.38	-50.18%
Footwear (Exc. Leather)	344.46	24.30%			

Source: EPB

The study area has a great opportunity to contribute national export by exporting local products such as spices, fruits, shrimps, vegetable, crabs, raw jute etc.

11.4 Incentives

To facilitate and encourage investment, the Government of Bangladesh provides various fiscal and non-fiscal incentives, privileges and facilities comprising of exemptions/reduction of corporate income taxes, reduced import taxes on capital machineries and raw materials, reduced VAT, provision of export subsidies and various other banking facilities and privileges. Companies located in EZs/EPZs are entitled for different sets of incentive package of tax exemption.

Incentive for newly established companies

Reduced corporate income tax is offered to newly established businesses based on sector and location. Government reduced corporate income tax of 5 to 10 years. The duration and percentage of tax reduction will depend on the sector combined with the location of the firms. Under Income Tax Ordinance 1984, section 46BB, newly established firms between July 1, 2019 and June 30, 2024 are eligible for reduced income taxes.

The business belonging to the selected sectors can enjoy tax exemption on a varied rate and reduced tax for various periods depending on the location of the operation.

Five-year tax exemption is offered to businesses located in Dhaka Division and Chattogram Division, but excluding the districts of Dhaka, Narayanganj, Gazipur, Chattogram, Rangamati, Bandarban and Khagrachari districts, the period of tax exemption is for five years, which will begin in the month of commencement of commercial production at the following rate.

Ten-year tax exemption is offered to businesses located in Rajshahi Division, Khulna Division, Sylhet Division and Barisal Division, but excluding areas under the city corporations. Businesses that set up in the districts of Rangamati, Bandarban and Khagracchari also enjoy this tax holiday period.

Import duty exemption

- Capital machineries are subject to reduced rate from customs duties.
- Raw materials to be used for producing export goods are exempt from import duties.

Incentives and facilities for export-oriented industries

Export-oriented industries (exporting more than 80% of their goods and services) regardless of their locations (i.e., within or outside EZ/ EZ) can benefit from the following privileges and facilities:

- Eligible to be exempted from income tax for 50% earnings from export (unless paying tax at reduced rate)
- No duty on export except for tobacco products
- Bonded warehousing facilities
- Duty drawback facilities
- Exporters of certain sectors enjoy additional benefits in the form of a subsidy or cash incentive based on some conditions

Public-Private Partnership (PPP) Projects

The following incentives and facilities are provided for certain Public Private Partnership (PPP) projects.

- 100 % exemption on Income tax for the next 10 years from the date of commercial operation;
- Exemption on capital gain tax on share capital, royalty, technical know-how and technical assistance;
- Income tax exemption for foreign technicians;

11.5 SME

Worldwide, SMEs are one of the major contributors to job creation and global economic development as they represent about 90% of the businesses and offer more than 50% of the employment opportunities (World Bank, 2021b). In emerging economies, SMEs are contributing about 40% of the GDP and creating 7 out of 10 jobs.

In Bangladesh, SMEs are considered as engines of economic growth that constitutes over 90 percent of business enterprises. SME contributes to GDP of 20.25 percent. Bangladesh has 17,384 micro-enterprises out of which 15,666 small and 6103 mediums, 3639 large-scale enterprises.

In 2020, the share of RMG exports was approximately 83% of the total exports and this was an increase from 2011 when it was 78.15% (EPB, 2021). RMG factories are associated with small factories or businesses through sub-contracting where SMEs are involved with the manufacturing of different types of garment accessories. Thus, the growth of the RMG sector also contributes to the creation of a supply chain network between the RMG and the SME sectors.

In the country, there are 68 lakh cottage industries and roughly 10 lakh small- and medium-sized businesses, 7.21% of which are owned by women.

11.6 Agriculture

Bangladesh is an agriculture-based nation. Agriculture is the main source of income for most people. For the fiscal year 2020–2021, agriculture's contribution to the national GDP was 11.63%, third-highest among all sectors.

Agricultural Land Use

According to an analysis of the upazilas' land use that Kalapara has the most single cropped area among the seven followed by Taltali (Table 11.4). In terms of double-cropped area, Galachipa comes in first, followed by Kalapara, Rangabali, and Patharghata. The most triple-cropped area is found in Barguna Sadar upazila, followed by Rangabali upazila. Kalapara has the most net cropped area, followed by Galachipa and Rangabali.

Table 11.4: Agricultural Land Use (In Ha)

	Annual Crop	SCA	DCA	TCA	Other	NCA	C.I (%)
Amtali	60	1500	12620	9139	150	23460	2.32
Barguna Sadar	175	6100	3370	15220	105	24970	2.36
Patharghata	60	1500	12650	3200	150	17560	2.08
Taltali	60	8260	4180	1600	160	14260	1.51
Galachipa	390	1000	24500	7625	175	33690	2.20
Rangabali	100	6200	14625	14250	175	35300	2.22
Kalapara	20	21300	17725	1200	175	40420	1.49

Note: SCA: Single Cropped area; DCA: Double Cropped area, TCA: Triple Cropped area.

(Source: Ibrahim, Zaman, Mostafizur, & Shahidullah, 2017)

11.7 Dominant Crop

In the study area, Single T. Aman is the most dominant crop. The Kalapara upazila in the study area has the highest area under T. Aman cultivation, accounting for 53.12% of its NCA (Table 11.5). Taltali upazila has allotted the most space for the single T. Aman pattern, which is 57.50% of its NCA. In Galachipa Upazila, T. Aman cultivation is at its lowest. The study area and other saline-prone locations have long-standing soil salinity issues, which is a barrier to crop intensification.

Table 11.5: Dominant T. Aman Crop Area of the Upazilas

Upazila	Area (ha)	% of upazila Net Cropped Area (NCA)
Galachipa	1000	3.04
Kalapara	21300	53.12
Rangabali	6200	18.18
Patharghata	1500	8.54
Taltali	8200	57.5
Barguna Sadar	6100	24.42
Amtali	1500	6.39

Source: Ibrahim, Zaman, Mostafizur, & Shahidullah, 2017

11.8 Development of Special Economic Zone

11.8.1 BEPZA

The government of Bangladesh has adopted a "Open Door Policy" to attract foreign investment in order to accelerate rapid economic growth of the country, particularly through industrialization. The

BEPZA is the official government body responsible for encouraging, attracting, and facilitating foreign investment in EPZs. The primary objective is to establish designated zones where potential investors would find a congenial investment climate free from cumbersome procedures. At present eight EPZs are operational, one EZ is in the development stage, and three new EPZ are in the planning phase. Currently, 3 lakh people are employed in 8 EPZ. Bangladesh exported 6,637 million USD in FY 2020-2021 only from the export processing zone which is 15% of the total exports of Bangladesh. The government of Bangladesh has decided to establish a new EPZ in Patuakhali which will provide 3 lakhs directly and indirectly employment in this region. The area of the PEPZ is 478.10 acres.

Table 11.6: Zone-wise Statistics of Industries Investment Export and Employment of EPZs

Name of EPZs	Number of Industry		Investment (Million US$)	Export (Million US$)	Employment (No.)
	In Operation	Under Implementation			
Chattogram EPZ	153	10	1836.91	34749.93	153948
Dhaka EPZ	94	4	1578.40	29874.87	71034
Adamjee EPZ	50	15	567.23	5675.37	46697
Cumilla EPZ	46	8	439.50	3737.02	34543
Karnaphuli EPZ	43	5	638.08	7439.68	70316
Ishwardi EPZ	19	13	157.36	1056.30	12691
Mongla EPZ	34	8	87.35	771.76	5989
Uttara EPZ	24	5	211.62	1476.68	28283
Total	**463**	**68**	**5516.45**	**84781.63**	**423501**

*Source: BEPZA. *Up to February 2021*

11.8.2 BEZA

The Bangladesh Economic Zones Act, 2010, gave birth to the Bangladesh Economic Zones Authority (BEZA), which the government of Bangladesh formally established on November 9, 2010. BEZA is working to create economic zones in prime locations throughout the nation with the goal of promoting rapid economic development through industry diversification and growth in employment, production, and export. To date, BEZA has been successful in obtaining clearance to build 97 economic zones across the nation, including 68 governments and 29 private EZs. BEZA authority planned a develop economic zone in Bhola.

11.9 Challenges in Economic and Industrial Development

Bangladesh is mainly an agricultural country. Agriculture has always been given priority and as a result industry have been ignored. Recently some agro-based industries have been set up. There are some reasons for which the country has lagged behind in heavy and medium-level industries. Industrialization in Bangladesh faces some challenges due to some structural constraints that hindered industrial growth. Let us now consider the challenges faced by the industry sector in general.

- Lack of adequate capital: Bangladesh being a poor country, people's saving is insufficient. As saving is poor, investment is also low. Again people's per capita income is not adequate. So their consumption is also low. Consequently, local market oriented industries are also very thin here.
- Weak investment base: Due to long colonial rule, economic discrimination and postliberation nationalization of industrialization, the growth of entrepreneurship has

been slow in Bangladesh. Besides, due to bureaucratic red-tapes and lack of investment climate, capital investment has not been developed here.

- Insufficient Infrastructure: Infrastructural facilities in our country are insufficient. Power supply, telecommunication, transport, gas, water supply etc. – all facilities are not adequate which have hindered process of industrialization in Bangladesh.
- Technological know-how: Lack of proper technological know-how is also another reason of our industrial backwardness.
- Lack of adequate resources: Lack of adequate raw materials and natural resources are also unfavorable for our industrialization.
- Shortage of Energy: acute shortage of energy and unreliable supply of power and other utilities such as gas and water.
- Unskilled human resources: Though Bangladesh has a huge population, most of them are unskilled. Country lacks skilled labor, specialists, professionals and technologists which also hamper our industrialization.
- Political instability: A good govt. policy and political stability are precondition for industrialization. Unfortunately, political instability has always been a common phenomenon here. This is a major hindrance towards the advancement of the industry sector of Bangladesh. Frequent strikes result in disruption of daily business. This hampers the smooth running of industries, they are unable to procure raw materials in time hence their production and even transportation is delayed. The politicians only think about themselves. As such, our industry cannot progress and compete with the outside world.
- Labor Unrest: There is a lack of trained workers in this country. Thus, there is a decline in the efficiency of the company. The companies also need to provide training (apprenticeship) to these laborers and hence quite an amount of money and time is spent on them. This challenge is faced by every company or firm in Bangladesh.
- Limited access to credit, its high cost, legal or illegal, and procedural complexities in obtaining credit from banks, Competition from dumped and smuggled imports, Lack of adequate law and order conditions, growing incidences of crime and extortion at every stage starting from production to distribution and marketing of the products.

11.10 Administration/Competent Authorities

Key aspect in the theme	Primary competent authority (CA)– and their mandates	Key support organisations (govt, NGO, donor, CBO, etc.)	Performance of CA and support organisations
Industrial development	• Ministry of Industries • Developing new policies and strategies for promotion, expansion and sustainable development of Industrial sector	• Bangladesh Chemical Industries Corporation (BCIC) • Bangladesh Sugar and Food Industries Corporation (BFSIC) • Bangladesh Steel and Engineering Corporation (BSEC) • Bangladesh Small and Cottage Industry Corporation (BSCIC) • Bangladesh Standards and Testing Institution (BSTI) • Bangladesh Industrial and Technical Assistance Center (BITAC)	Zila BSCIC office play a key role to industrial development in the area and others organization who's have no zila unit, central office play the role.

Key aspect in the theme	Primary competent authority (CA)– and their mandates	Key support organisations (govt, NGO, donor, CBO, etc.)	Performance of CA and support organisations
		• Bangladesh Institute of Management (BIM) • Department of Patents, Designs and Trademarks (DPDT) • National Productivity Organization (NPO) • Office of The Chief Inspector of Boilers • Bangladesh Accreditation Board (BAB) • Small and Medium Enterprise Foundation (SMEF) • Small, Micro and Cottage Industry Foundation (SMCIF)	
Development of Environment friendly Textiles and Garments sector	• Ministry of Textiles & Jute; • Bangladesh Garment Manufacturers and Exporters Association (BGMEA); • To establish a flourishing, safe and environment-friendly textiles and garment sector; • To increase productivity, employment opportunities and investment in the sector; • To strengthen the primary textile sector to fulfil local demand for textiles and to promote a medium and high value-added export-oriented garments industry;	• Bangladesh Handloom Board • Bangladesh Jute Mills Corporation • Bangladesh Textile Mills Corporation • Bangladesh Sericulture Board • Bangladesh Sericulture Research and Training Institute • Jute Diversification Promotion Center • Bangladesh Jute Corporation	Zila and Divisional office monitor and implement the project
Attract Foreign Investment	• Prime minister's office • To creating investment friendly environment and attracting FDI.	• Bangladesh Economic Zone (BEZA) • Bangladesh Export Processing Zone (BEPZA)	The zone office of BEZA and BEPZA implement the project.

11.11 Relevant Legislation and Regulations

Key aspect in the theme	Primary legislation	Accompanying or enabling regulations	Comments on adequacy or not re. legislation and regs
Industrial Development	National Industrial Policy, 2016	Perspective Plan 2021-2041	The new policy should include: environmentally-friendly industrialisation, growth-dependent planning, the creation of skilled human resources, and employment generation

Key aspect in the theme	Primary legislation	Accompanying or enabling regulations	Comments on adequacy or not re. legislation and regs
Development of Environment friendly Textiles and Garments sector	National Textile Policy, 2017	-	-
Leather Products Development	Leather and Leather Products Development Policy, 2019	-	-
Sustainable Brick Production	National Strategy for Sustainable Brick Production in Bangladesh 2017	-	-
Attract Foreign Investment	BEPZA Act, 1980	Bangladesh EPZ Labour Act, 2019	-
Attract Foreign Investment	BEZA Act, 2010	-	-

11.12 Policy Plans and Programs

Key PPPs relating to the theme	Main projects emanating from the PPPs	Main negative environmental impacts emanating from the projects	Main negative socio-economic impacts emanating from the projects
Industrial Policy, 2016	• Creating entrepreneurs by safeguarding national interest, development and expansion; • Creating enabling environment for promoting small and medium industries; • Establishing export-oriented industries and diversification; • Inspiring and assisting environment-friendly sustainable industries; • Developing specialized localized industries based on local agro, forest, natural, and marine resources; • Enhancing marketing capacity for industrial produce, with quality; • Encouraging foreign investment alongside local investments;	Cumulative environmental impacts of industries (GHG emissions, air pollution, waste waters, solid waste generation which cannot be fully avoided even if stringent regulatory conditions are complied with);	• Land acquisition and dispossession at the local level; • Possibility of both in-and out-migration; • Industrial zone-based activities not imposed (which may trigger unplanned development of industries
Natonal Textiles Policy, 2017	• Strategic development planning for the sustainable development of each sub-sector, including spinning, weaving, knitting, dyeing-printing-finishing, hosiery, home textiles, terry-towel, export oriented RMG, handloom sector, silk industry etc.; • Develop short-term, mid-term and long-term strategic plans to build a knowledgeable and skilled manpower base for the installation and operation of value	• Industrial zone-based activities not imposed. • Cumulative impact due to long term disposal of treated liquid and solid wastes into natural	• Chance of out-migration from the areas of textiles estates due to land acquisition. and in-migration of low-income people seeking new

Key PPPs relating to the theme	Main projects emanating from the PPPs	Main negative environmental impacts emanating from the projects	Main negative socio-economic impacts emanating from the projects
	added products manufacturing textile industries; • Promote waste management technologies in the polluting and waste generating industries; specially to take necessary steps to build Effluent Treatment Plant (ETP) in the dyeing, printing and washing industries in order to check water pollution; • Strengthen the Department of Textiles' monitoring cell to improve law enforcement; • Provide necessary support to Bangladeshi fashion houses for improving design and quality of the garment products; • Increase training centers, research and development, and usage of IT in the textile and apparel industries through governmental support; • Establish textile industrial parks to generate strong support for raw materials; • Establish design and fashion institute for textile industry; • Launch mechanism to meet the international standards of textile and clothing;	environment may generate residual impacts to the ecosystem causing bio-accumulation of hazardous materials to the consumers through food chain. • Lack of solid waste management directives (for both hazardous and nonhazardous) • Loss of farmland due to its acquisition for textiles infrastructure (Knit Villages, RMG park, textile parks, etc.), training and educational institutes establishment;	employment opportunities; • Rapid and unplanned urbanization in the textile and clothing industrial areas; • Unplanned extensive surface and groundwater abstraction of large industries may conflict with other water users such as domestic, animal husbandry and small agro-based industries at the downstream. •
Leather and Leather Products Development Policy, 2019	*Making the leather industry sustainable and ecofriendly* • Revision of existing environmental protection laws; • Issuing directives for resolving emergency problems and enforcing regulations; • Inclusion of environmental protection issues in relevant socio-economic strategies and policies; • Strengthening and consolidating the government's agency to enforce environmental protection laws; • Measures to ensure the proper collection and utilization of resources, encourage energy consumption and use of renewable energy;	• Loss of farmlands/wetlands due to its acquisition for leather industries, training and educational institutes establishment; • Cumulative impact due to long term disposal of treated liquid and solid wastes into natural environment	• High crop irrigation cost is leather production areas due to lack of water (taken for leather treatment); • Increased respiratory diseases, vomiting and skin diseases amongst people in areas the surrounding leather industries;

Key PPPs relating to the theme	Main projects emanating from the PPPs	Main negative environmental impacts emanating from the projects	Main negative socio-economic impacts emanating from the projects
	Ensuring clean production: • Measures to ensure sustainable development by reducing emissions, protecting environment and improving human health; • Encourage domestic and foreign companies to undertake research and adopt eco-friendly technologies to ensure production of world-class leather products; • Inclusion of cleaner product content in all strategies and plans related to leather industry development; • Implementation of provisions for setting up of local/central industrial waste refineries with industrial factories; *Sector and infrastructure development:* • Determine the location of solid waste and ensure its proper management; • Construction of modern cold storage for the conservation of raw leather in tannery cities; • Increase the construction of advanced animal slaughterhouses and effective waste management systems - developed in association with city corporations; • Establish vocational and leather institute to train skilled labour for the leather goods and footwear industries; • Take steps to increase the participation of women in the overall leather supply chain. *Occupational health and safety issues:* • Introduce corporate insurance to provide social security to the workers employed in the leather industry to ensure occupational health and safety;	may generate residual impacts to the ecosystem causing bio-accumulation of hazardous materials to the consumers through food chain. • Industrial zone-based activities not imposed • Chronic odour from raw hides and skin;	• Unplanned extensive surface and groundwater abstraction of industries may conflict with other water users such as domestic, animal husbandry at the downstream. Changes in profession, particularly for fishermen - due to reduced fish production as a result of aquatic pollution;
National Strategy for Sustainable Brick Production in Bangladesh, 2017	• Review current status of brick industry of Bangladesh including the Pyra-Kuakata region; • Identify emissions from and social and environmental impacts of brick kilns of Bangladesh including Pyra-Kuakata region. • Identify existing policies, projects and programs addressing brick issues, evaluate opportunities and barriers of Bangladesh including Pyra-Kuakata region.		Less labour intensive brick industry may reduce employment.

Key PPPs relating to the theme	**Main projects emanating from the PPPs**	**Main negative environmental impacts emanating from the projects**	**Main negative socio-economic impacts emanating from the projects**
	• Identify strategies and policy actions of Bangladesh including Pyra-Kuakata region for successful transition to cleaner and sustainable brick making industry. • Economic improvement of entrepreneurs to facilitate transition to cleaner brick production industry. • Institutional improvement to maximize the achievement of policy objectives.		
National Shipping Policy, 2000	• Development and maintenance of seaports, key channels and inland routes; • Establishment of communication network among key river ports, landing stations, inland container terminals and depots, development of existing seaports; • Rationalization of marine fleet and development of shipping sector to encourage investment; • Providing financial aid in directing and developing national shipping lines; • Establishing modern terminal/ inland container depots with sufficient container handling machineries and ancillary infrastructures and ensuring optimum usage of them; • Passenger and freight transport service with landing facilities for people of coastal islands; • Enforcing Marine Protection Act; • Enhancing dredging facilities for maintaining channel navigability; • Introduction of necessary institutional reforms to address the operational constraints of the port transit system with special reference to containers and privatization measures for port transit system will be made; • Adequate care will be taken while developing transport network and service so that these do not cause environmental pollution and affect ecological balance; and • Provision of duty-free or low duty import of engines and spares for mechanization of country boat will be made.	• Dredging can temporarily disturb/alter the river and coastal ecosystem, especially benthic communities; • Expansion of the shipbuilding, breaking and repairing industry is likely to result in increased pollution; • Change in land use required under this policy might cause land degradation; • Increased navigation may disturb aquatic habitats.	Risk of occupational health problems in ship breaking activities;

11.13 Drivers of Change

Key change	Main external drivers	Main internal drivers	Main actions to "fuel" or "brake" the drivers, depending on whether the change is good or bad
Land use	Housing	Employment	• Increase pressure on electricity, GW and Gas; and • decreasing agriculture land
Population density	Out Migration	Employment	• Increase pressure on utilities;
Women empowerment	Income security	Employment	-

11.14 Main issues

- Lack of adequate capital
- Weak investment base
- Insufficient Infrastructure
- Technological know-how.
- Lack of adequate raw and natural resources.
- Shortage of Energy such as gas and water.
- Unskilled human resources.
- Lack of trained workers in this country.
- Limited access to credit,
- Growing incidences of crime and extortion at every stage starting from production to distribution and marketing of the products.

12. Climate and Climate Change

12.1 Introduction

Bangladesh is vulnerable to geophysical and climatic hazards, including climate change. Its climate characteristics include high temperatures, heavy and highly variable (spatially and temporally) rainfall. Physical and climatic settings of the region, as well as the severity and duration of hazards, are significantly influenced by changes in these climatic variables. Planning for improved water management, agricultural growth and disaster management will be more effective by a better understanding of the characteristics and distribution of climatic patterns.

The PKCP Focusing on Eco-Tourism intends to achieve sustainable development of the Payra-Kuakata Coastal Region by integrated planning and implementation through multi organizational involvement and community participation for optimum utilization of resources and reduction of poverty. People in the Payra-Kuakata region live in an extremely dynamic estuarine environment facing many threats such as cyclone and storm surge, erosion, flood, drainage congestion, salinity intrusion, drought and ecosystem degradation. Climate change is increasing these threats which will likely affect almost every aspect of people's lives and livelihood choices. Also, the 'Payra-Kuakata coastal region' includes environmentally sensitive areas which need to be protected. In this case, considering these two interconnected needs, accomplishment of the objectives would require formulation and enforcement of an integrated development plan. For efficient integration of climate change adaptation planning, a deeper understanding of climatic variability, with a focus on the seasonal, decadal, and spatial elements in the Payra-Kuakata Coastal region, is required.

12.2 Institutional Settings, Relevant Legislations, Regulations, Policies and Plans

Bangladesh has embraced a people-centred development approach for its laws, programs, plans, and strategies. It has a number of policies aimed at promoting economic growth, ensuring the safety of people's access to food, healthcare, education, and land, regardless of their class, race, or gender, protecting the environment and biodiversity, ensuring effective water governance and management, launching numerous megaprojects aimed at advancing communication, technology, energy security, etc., and overall wellbeing of its population.

This section focuses on relevant authority and supporting organizations for different development sectors, their roles and responsibilities, achievement for the particular sector and the existing legislations and cross-cutting policies, plans and programmes of action.

Key aspect in the theme	Primary competent authority (CA)– and their mandates	Key support organisations (govt, NGO, donor, CBO, etc.)	Performance of CA and support organisations
Climate Change	*Ministry of Environment, Forest and Climate Change (MOEF&CC)* *(DOE, Forest Department, Bangladesh Rubber Board)* <u>Mandate</u> Ensuring sustainable living environment for the present and future population of the country through protection of the environment and biodiversity, control of environmental pollution, tackle climate change, development of forest resources and sustainable management of maritime resources (MoWR)	Ministry of Agriculture (MoA), Ministry of Disaster Management and Relief (MoDMR), Ministry of Energy, Power and Mineral Resources (MOEPMR), Finance Division, Economic Relations Division (ERD), Bangladesh Bank, Ministry of Planning MoP), Ministry of Water Resources (MOWR), Ministry of Fisheries & Livestock (MOF&L) Department of Fisheries, Department of livestock, Ministry of Local Government, Rural Development and Co-operatives (MOLGRD&C), Bangladesh Water Development Board (BWDB), Bangladesh Climate Change Resilience Fund (BCCRF), Center for Environmental and Geographic Information Service (CEGIS), Bangladesh Red Crescent Society, BRAC, CARE, Action Aid, IUCN etc.	Apart from integration of climate change into national policies, Bangladesh Government has already invested more than $10 billion on climate change initiatives, including building emergency cyclone shelters and resilient homes, adapting rural households' farming systems, strengthening river embankments and coastal polders (low-lying tracts of land vulnerable to flooding), and strengthening government agencies' capacity to respond to emergencies.
Delta morphology, river dynamics and Water Resources Management	*Ministry of Water Resources (BWDB, WARPO, Joint River Commission, River Research Institute, Bangladesh Haor and Wetland Development Board)* <u>Mandates</u> Regulation and development of river and river valleys, General policy and technical assistance in the field of irrigation, flood control works, construction and maintenance of water reservoirs, anti-water-logging, drainage and anti-erosions, land reclamation, estuary	MOA, Ministry of Shipping (MoS), MoFL, MoEFCC, Water Resources Planning organization (WARPO), BWDB, MoDMR, MoP, Department of Fisheries, MoLGRDC, Department of Public Health Engineering (DPHE), Bangladesh Water Partnership, Dhaka Water and Sewerage Authority (DWASA), Chittagong Water and Sewerage Authority (CWASA), CEGIS, Institute of Water Modelling (IWM), Water-Aid etc.	Water sector policies, projects and interventions are now emphasizing flood warning system, flood proofing and adopting responses to hazardous conditions, apart from structural interventions in flood control, drainage and irrigation. River training, bank protection and river dredging, small-scale irrigation pumps, irrigation canal network, drainage canal network, barrages, rubber dams; khal re-excavation, piped water supply using both surface and groundwater in big cities, sanitation services and hand tube-wells for drinking water in rural areas, dredging augmentation of river flows and for navigation purposes, hydropower generation etc. are in focus of the primary and

Key aspect in the theme	Primary competent authority (CA)– and their mandates	Key support organisations (govt, NGO, donor, CBO, etc.)	Performance of CA and support organisations
	control, anti-salinity measures and anti-desertification. Matters relating to Joint Rivers Commission; Common Border Rivers, Secretariat administration including financial matters, liaison with International Organization, treaties and agreements with other countries and world bodies relating to subjects allotted to this Ministry, particularly transboundary water management.		supporting organizations for improving water resource management.
Marine Resources and the Blue Economy	*The Ministry of Fisheries and Livestock for marine fisheries including blue economy, Ministry of Power, Energy and Mineral Resources (MPEMR) for exploring and extracting gas and oil resources, hydropower and managing blue economy, Ministry of Foreign Affairs(MoFA) for maritime affairs including blue economy, Ministry of Shipping for sea transport and port management, Prime Minister's Office (PMO) for overall coordination of blue economy* <u>Mandate of MoFL:</u> • Preparation of schemes and co-ordination of national policy in respect of fisheries. • Prevention and control of fish diseases. • Utilization of fish and fish wastes and development of fisheries resources and fishing. • Fish farms management and conservation of fish and other population of aquatic organisms of economic importance.	MOP, Ministry of Industries (MOI), Ministry of Science and Technology, (MoST), Bangladesh Oceanographic Research Institute, Ministry of Civil Aviation and Tourism, National Tourism Board, Bangladesh Marine Academy, Coast Guard Bangladesh, etc.	Bangladesh Government has already accorded priority to fishery, sea ports, inland waterway transportation, ship-recycling, ship building, coastal tourism, mariculture, ocean renewable energy, greening coastal belt, sea salt production etc. Also, the CA and supporting organizations are committed to the conservation and balanced development of natural resources keeping integrity of environmental and bio-diversity aspects while pursuing overall development.

Key aspect in the theme	Primary competent authority (CA)– and their mandates	Key support organisations (govt, NGO, donor, CBO, etc.)	Performance of CA and support organisations
	• Refrigeration and cold storage facilities • Improvement and augmentation of aquaculture and cultivation of pink pearls. • All matters relating to Marine Fisheries including permission for acquisition, licensing and monitoring of operation of fishing vessels including Factory Ship. • Fishing and fisheries beyond territorial waters (including deep sea fishing), fish harbour, fish quality-testing, laboratories and other ancillary organisations. • Utilisation of coastal land for brackish water shrimp culture. <u>Mandate of Ministry of Shipping:</u> • Incorporating the marine economy to achieve Vision 2041. • Increasing import revenue, ensuring food security, and reducing poverty through marine fishing and livestock farming • Growing opportunities for skill development and productive employment are provided by port management, ship industry growth, sustainable resource use of fisheries, and other factors. • Sustainable economic growth through increased production of fossil and renewable energy • Reducing the effects of climate change and natural disasters and ensuring marine governance through coastal belt construction, marine special planning,		

Key aspect in the theme	Primary competent authority (CA)– and their mandates	Key support organisations (govt, NGO, donor, CBO, etc.)	Performance of CA and support organisations
	marine pollution control, and biodiversity balancing. • Developing tourism, expanding maritime industries, and building artificial islands will all help the socioeconomic conditions of coastal residents		
Ecosystem and wildlife conservation including Forests	*Ministry of Environment, Forest and Climate Change* *(DoE, Forest Department, Forest Research Institute, BCCT, National Herbarium)* <u>Mandate</u> To ensure sustainable living environment for the present and future population of the country through protection of the environment and biodiversity, control of environmental pollution, tackling climate change, development of forest resources and sustainable management of maritime resources	Ministry of Agriculture, Ministry of Planning, Ministry of Water Resources, MOF&L, Department of Fisheries, Department of livestock, Ministry of Local Government, Rural Development and Co-operatives, BWDB, Department of Bangladesh Haor and Wetland Development (DBHWD), CEGIS	The declaration of protected areas, ecologically critical areas, creation of eco- and safari parks across the nation, etc., have put a significant contribution to biodiversity conservation. The majority of international treaties and conventions relating to the biodiversity conservation have also been ratified by the nation. As a signatory to these agreements, the government has created a number of legislative policies and innovations to preserve the nation's biodiversity.
Agriculture and Fisheries	<u>For Agriculture</u> Ministry of Agriculture (DAE, BRI, BARI, SRDI, BARC, BADC, Directorate of Agriculture Marketing, Barendra Multipurpose Development Authority (BMDA) etc. <u>Mandate:</u> To develop a self-sufficient and sustainable agricultural system through increasing agricultural productivity and modernization of agriculture marketing by adopting, inventing and transferring new technologies to ensure food security and reduction of poverty in accordance with the 8th	MOWR (BWDB, DBHWD), MOI, Ministry of Jute and Textiles, MOPEMR, Ministry of Food, Bangladesh Metrological Department (BMD), SPARRSO, Bangladesh Bank, BRAC, RDRS, etc.	The government supports advancing technology, diversifying crops, and increasing the production of non-seasonal crops alongside seasonal ones in order to sustainably grow the agricultural sector. Extending the development of the agro-based industries required the development of new varieties of salinity-tolerant seed and high-yielding paddy and jute varieties, as well as the provision of agricultural credit and subsidies. In addition, the government developed policies and action plans for agriculture and food security that are in line with the Sustainable Development Goals (SDGs). The government has prioritized the attainment of self-sufficiency in food grain production and the achievement of

Key aspect in the theme	Primary competent authority (CA)– and their mandates	Key support organisations (govt, NGO, donor, CBO, etc.)	Performance of CA and support organisations
	Five Year Plan, Sustainable Development Goals (SDGs) and the National Agriculture Policy. For Fisheries Ministry of fisheris and Livestock (Department of Fisheries, Fisheries Research Institute, BFDC, Bangladesh Marine Fisheries Academy, etc) Mandate Sustainable management of fisheries and livestock resources, increasing production through, research and extension services, variety development, market promotion including development of storage, processing facilities.		nutritional requirement by 2021. The government has brought fertilizer, electricity, diesel, sugarcane and other agricultural activities under subsidy program for increasing production and crop diversification. Besides, the government is transferring cash and other incentives directly to the farmers through mobile banking. Online Fertilizer Recommendation System adopted during the Awami League government is a revolutionary innovation added in the agriculture sector. Krishoker Digital Thikana (Farmers Digital Home) in another innovative brainchild launched by the government is a mobile phone applications aimed at bringing crop production technologies to the doorsteps of around 15 million farm households to boost yields. According to The State of Fish and Aquaculture 2018: FAO, Bangladesh ranked 3rd in inland fish production in the world. Previously in 2016, Bangladesh secured fourth position in fish production from inland open water. The government is continuing its activities to produce fish in open water, preserving endangered species of fishes, create sanctuaries for breeding and procreation of fishes, protect jatka and pursue environment friendly shrimp culture. The government strengthened quality control activities to conserve and expand to the export market for fish and fish products. In 2018, Bangladesh earned US$ 539 million by exporting around 69,000 metric tons of fish and fish products. About 17 million people of the country are directly or indirectly involved in the fisheries sector, which is 11 percent of the total population. In this, about 0.6 million new jobs are being created this year
Disaster management	Ministry of Disaster Management and Relief, Department of Disaster Management, National	MOA, Ministry of Shipping (MOS), MOF&L, MOEF&CC, Water Resources	Bangladesh has developed resilience in disaster management, mitigating climate change, adapting to it, and

Key aspect in the theme	Primary competent authority (CA)– and their mandates	Key support organisations (govt, NGO, donor, CBO, etc.)	Performance of CA and support organisations
	disaster Management Council, Directorate of Relief and Rehabilitation, Disaster Management Bureau, CPP, BDRCS, Planning Commission, Armed Forces, District Disaster Management Committee, Upazila Disaster Management Committee, Union Disaster Management Committee <u>Mandate of Department of Disaster Management:</u> The Department is charged with carrying out the goals of the Disaster Management Act by reducing overall vulnerability to disaster impacts through risk reduction activities, implementing effective humanitarian assistance programs to strengthen the capacity of the poor and disadvantaged, and bolstering and coordinating initiatives made by various government and non-government organizations related to disaster risk reduction and emergency preparedness. Executing the government's guidelines and advice on disaster management, as well as the country's disaster management principles and planning, is the responsibility of DDM.	Planning organization (WARPO), BWDB, MODM&R,MOP, Department of Fisheries, MOLGR&C, (BWDB), Department of Public Health Engineering (DPHE), Bangladesh Water Partnership, Dhaka Water and Sewerage Authority (DWASA) Chittagong Water and Sewerage Authority (CWASA),CEGIS, Institute of Water Modelling (IWM), Water-Aid	finding solutions based on nature. Bangladesh adheres to the current Sendai Framework for total disaster management, which covers prevention, preparedness, response, recovery, mitigation, rehabilitation, and funding for disaster management. Bangladesh Government has been a key player in climate diplomacy at the COP15 summit in Copenhagen in 2009 and other COP meetings that followed. Effective early warning systems, a thorough legal and institutional framework, NGO sector, and community-based disaster relief programs are the elements that distinguish Bangladesh as a "role model" for managing disasters. The Planning Commission has taken steps to integrate poverty, the environment, climate change, and disaster risk reduction into the process of developing budgets and plans for development. The increased capability of research organizations like IWM WARPO, CEGIS, BCAS, and others has also been demonstrated.
Land Use and Land Cover	Ministry of Lands (Directorate of Land Records and Surveys, Land Reforms Board and Appeals Board), Ministry of Law, Justice & Parliamentary Affairs (Registration Department) <u>Mandate of MoL:</u> • Land development tax and revenue collection,	The Ministry of Local Government, Rural Development and Cooperatives (MLGRD&C) and the Ministry of Housing and Public Works (MoHPW) (Local Government Division, LGD, Department of Public Health Engineering (DPHE), City Corporations; Pourashavas; and, Public Works Department (PWD),	Various programs have been launched by the Ministry of Land for the development of women and protecting their land rights. By updating land records and making sure having their names in digitized records, women are experiencing greater economic security. Shelters, flats, sanitary latrines, and tube wells are being provided for the landless slum dwellers, the families without land and those whose homes have been eroded by rivers. In addition to these, these families' members are given training and loans

Key aspect in the theme	Primary competent authority (CA)– and their mandates	Key support organisations (govt, NGO, donor, CBO, etc.)	Performance of CA and support organisations
	• Khash land management and settlement, • Watershed management, • Land acquisition and possession, • Land record and survey and training of land related officers/ employees • Formulating land laws and regulations • Reform activities and rehabilitation of landless scattered communities, • Land zoning activities, • Providing of khas settlement among the landless under char development and settlement project, • Land records development activities such as modernization i.e. providing land related services to the public in the shortest possible time <u>Mandate of MoLJ&PA:</u> • Updating records in ownership of land resulting from a sale, • collects immovable property transfer tax	National Housing Authority (NHA), Rajdhani Unnayan Katripakkha (RAJUK), Chittagong Development Authority (CDA), Khulna Development Authority (KDA), Rajshahi Development Authority (RDA), Housing and Building Research Institute (HBRI), Urban Development Directorate (UDD).)	for income-generating projects. Landless families also can receive assistance through government initiated, Cluster Village (Guccho-Gram) project.

12.3 Relevant Legislation and Regulations

Key aspect in the theme	Primary legislation	Accompanying or enabling regulations	Comments on adequacy or not re. legislation and regs
Climate Change	The Climate Change Trust Act, 2010	• Bangladesh Climate Change Strategy and Action Plan (BCCSAP), 2008 • Bangladesh Environment, Forestry and Climate Change Country Investment Plan, 2016 • National Adaptation Program of Action • National Sustainable Development Strategy • The Perspective Plan (Vision 2021) • 8th Five Year Plan • Bangladesh Delta Plan 2100 • National Adaptation Plan • Mujib Climate Prosperity Pan up to 2030	In response to the threats of disasters caused by climate change, the government developed the BCCSAP 2008, which was revised in 2009. The plan aimed at a pro-poor climate change strategy to eradicate poverty and achieve economic and social well-being of the people. 44 programmes have been addressed basing on six pillars; i) Food Security, Social Protection and Health, ii) Comprehensive Disaster Management, iii) Infrastructures, iv) Research and Knowledge Management, v) Mitigation and Low Carbon Development, and vi) Capacity Building and Institutional Strengthening. The Bangladesh Climate Change Trust Fund (BCCTF) has invested 449.3 million USD in 800 projects to implement key functions of the Bangladesh Climate Change Strategy and Action Plan (BCCSAP), which primarily focus on adaptation, mitigation, and climate change research. Again, the Bangladesh Delta Plan 2100, a 100-year strategy plan aiming at gradual sustainable growth through an adaptive delta management process, which reaffirms Bangladesh's commitment to reducing GHG emissions from key sectors. The plan intends to create a secure, climate-resilient, and prosperous delta by ensuring long-term water and food security, economic growth, and environmental sustainability, while also effectively decreasing natural disaster risk and fostering climate change resilience. A total of $37 billion is expected to be invested in 80 projects, with 34 of them being recognized as climate-sensitive. Bangladesh is currently preparing the National Adaptation Plan (NAP) which is focused at a medium to long term adaptation priorities, investment and enhancement of national capacity for integration of climate change adaptation in planning, budgeting and financial tracking process.

Key aspect in the theme	Primary legislation	Accompanying or enabling regulations	Comments on adequacy or not re. legislation and regs
Delta morphology, river dynamics and Water Resources Management	• Embankment and Drainage Act 1952 • The National River Conservation Commission Act, 2013 • Ba*n*gladesh Water Act 2013 • Bangladesh Water Rule 2018	National Water Policy, 1999	Though, the National Water Policy identified the issue of integrated river basin management, it has some specific problems in implementation level. The National Water Policy has not been updated since 1992, which is important to integrate many new issues, including climate change, rapid urbanization, rising population, industrialization, and economic development for better management of water resources. A clear specification is also required on the institutional setup for developed water management.
Marine Resources and the Blue Economy	• Territorial water and Maritime zones (Amendment) Act, 2021 • The Inland Shipping Ordinance, 1976 • The Marine Fisheries Ordinance, 1983 • Bangladesh Coast Guard Act, 2016 • Marine Fisheries Act, 2020	• National Water Policy, • Marine Fisheries Management Plan, • Integrated Coastal zone management policy, 2005	In the most policy paper related fisheries such as: Marine Fisheries Policy 1983 and Fisheries Policy 1998 reflected the regulatory matters such as: delegations of authority, licenses, registration for fishing and fishing vessels, prohibited fishing techniques etc., but a small section or a few lines in some policy papers dealt with the ecosystem, biological diversity, habitat, marine reserves, and sanctuaries. It appeared that real and diverse stakeholders who are directly involved in the sea, estuary, offshore islands, mangroves, and their contents were not also considered during the policy formulation process. The policies related fisheries doesn't also cover the integrated coastal zone development.
Ecosystem and wildlife conservation including Forests	• The Forest Act, 1927 • Bangladesh Environmental Conservation Act 1995 • Environmental Conservation Rules 1997 • Social Forestry Rules 2004 • Bangladesh Biodiversity Act, 2017 • Wildlife Act, 2012	• Bangladesh Environment, Forestry and Climate Change Country Investment Plan, 2016 • Bangladesh Delta Plan 2100 • National Adaptation Programme of Action (NAPA) • National Environmental Management Plan, 1995 • Environment Policy and Implementation Plan 1992 • National Environmental Policy, 1992	The majority of the current forest policies in Bangladesh did not specifically mention the concept or any ecosystem services, which would enhance the value of the process of making informed decisions and increase awareness among the stakeholders of how to manage forests and trees to reap multiple benefits. The Forest Act of 1927 does not involve any legal provisions for achieving this or for enhancing local communities' land-use rights and participation in forest management in particular regions, despite the fact that the National Forest Policy of 2016 addresses local communities' land-use rights for their access to traditional forest management. The majority of the policies made reference to water regulation and the need for hill forest watershed

Key aspect in the theme	Primary legislation	Accompanying or enabling regulations	Comments on adequacy or not re. legislation and regs
		• National Forest Policy, 2016 • Coastal Environmental Management Plan for Bangladesh 1988 • Bangladesh Delta Plan 2100 • National Adaptation Plan • National Biodiversity Strategy and Action Plan (NBSAP) • Forest Investment Plan 2017	management, but it is still unclear what management techniques for forests and trees will be required to provide these services. There is little chance that using forests will sustain or improve the numerous advantages from using land covered in trees in local livelihoods if these policies don't explicitly focus on the provisioning, regulating, and cultural ecosystem services.
Fisheries and Agriculture	• Fish and Fish Product (quality control) rules, 1997 • The Protection and Conservation of Fish act, 1950 • The Protection and Conservation of Fish Rule, 1985 • Fish Hatchery Act, 2020 • Fertilizer Management Act, 2006 • Pesticide Act 2018 • Plant Quarantine Act 2011 • Bangladesh Institute of Research and Training on Applied Nutrition Act 2012 • Bangabandhu National Agricultural Award Trust Act 2016 • Bangladesh wheat and maize research institute act 2017	• National Fisheries Strategy • National Agriculture Policy, 2018 • National Agriculture Extension Policy, 2012 • National Fisheries Policy, 1998 • Haor Master Plan 2012 • National Shrimp Policy, 2014 • National Agriculture Policy (Draft) 2018 • Underground water management rules 2018 (Draft) • Draft National Seed Policy 2018 • National Crop and Forest Biodiversity Policy-2012 • Integrated Minor Irrigation Policy-2017 • Agricultural Firm Labor Recruitment and Governance Policy 2017 • National Organic Agriculture Policy 2016 • Regulation for Declaring Out of Order of Vehicle and others equipment's	Instead of considering the entire rural economy, policies are quite often solely centered on agriculture. Decentralization of public administration is another issue that requires immediate attention because all crucial planning, policymaking, and decision-making functions and authorities are carried out at the apex level, while lower level offices are primarily responsible for implementation. The dominance of cereal food production, particularly rice production, as well as the ignorance to non-cereal crops like vegetables, fruits, and flowers, the lack of guidelines for utilizing poultry waste, the commercialization of tests for soil and water quality, are some other areas that are either not adequately addressed or are completely missed. The impact of food management and market development on production and producers' incentives, the links between the growth of the farm and non-farm sectors, the appropriate types of agriculture support, the dynamics of the new forms of agricultural production are some of the urgent issues that require immediate analysis. In the most policy paper related fisheries such as: Marine Fisheries Policy 1983 and Fisheries Policy 1998 reflected the regulatory matters such as: delegations of authority, licenses, registration for fishing and fishing vessels, prohibited fishing techniques etc., but a small section or a few lines in some policy papers dealt with the ecosystem, biological diversity, habitat, marine reserves, and

Key aspect in the theme	Primary legislation	Accompanying or enabling regulations	Comments on adequacy or not re. legislation and regs
	• Bangladesh Jute Research Institute Act 2017 • Bangladesh Agricultural Research Institute (BARI) Act 2017 • Bangladesh Rice Research Institute Act 2017 • Seed Act-2018 • Underground water management law- 2018 • Bangladesh Institute of Nuclear Agriculture (BINA) Act-2017	• National Agricultural Extension Policy-2015 (Draft) • National Agriculture Policy (NAP) 2013 • Amendment of Fertilizer Dealer Appointment & Distribution Policy-2009 • National Seed Policy (NSP) • Crop Variety and Technology Development Policy • Fertilizer Dealer Appointment & Distribution System • National Integrated Pest Management (IPM) Policy	sanctuaries. It appeared that real and diverse stakeholders who are directly involved in the sea, estuary, offshore islands, mangroves, and their contents were not also considered during the policy formulation process. The policies related fisheries doesn't also cover the integrated coastal zone development. In the existing fisheries, marine fisheries and related policies clauses for the conservation of biological diversity in estuarine, coastal brackish and marine water has not been addressed. It did not reflect any biodiversity value of the coastal or marine zones.
Land Use and Land Cover	• The Balumohal and Soil Management Act, 2010. • Land Reform Act, 2014 • 'Vested Property (Amendment) Law, 2011	• Non-agricultural khas land management and settlement policy 1995 • Khas Land Settlement Policy, 1997 • Non-agricultural Khas Land Settlement Policy, 1995 • The Acquisition and Requisition of Immovable Properties Ordinance, 1982'. • National Land Use Policy 2001 • Land use Policy (2001) • Coastal Zone Policy (CZP), 2005 • National Jalmohal Management Policy (2009) • Saltmohal Management Policy (1992); • Chringri-Mahal Management Policy, 1998';	The Land Use Policy of 2001 placed a strong emphasis on: minimizing agricultural loss, ending indiscriminate land use, developing policies and use for various regions, streamlining land acquisition, and synchronizing land usage with natural environment; preserving agricultural land to fulfil the rising demand for food population; making sure that land is used as efficiently as possible for agriculture, forestry, and fisheries using contemporary technology, rural and urban habitation, industry, infrastructure, etc.; rehabilitating landless individuals on recently reclaimed land (char land, reclaimed coastal areas), setting aside government-owned property for upcoming construction projects; promoting environmentally responsible land use; increasing the likelihood of income production through wise land use, resources for ensuring food security and reducing poverty; protecting natural forest, , river erosion and hilly areas. The current land use plan was approved in 2001. With the passage of time, new dimensions of issues over land usage have emerged. As such, diminishing climatic change, dwindling biodiversity, land

Key aspect in the theme	Primary legislation	Accompanying or enabling regulations	Comments on adequacy or not re. legislation and regs
		• BaluMohal and Sand Management Rules, 2011 • National Urban Sector Policy (2011); National Water Policy, 1999; • Environment Policy 1992; • National Rural Development Policy, 2001; • National Forest Policy 1994; • National Agriculture Policy, 2010; • National Wetland Policy; • National Environment Policy and Implementation Plan, 1992; • National Housing Policy 1993 and 2001	resources, and changes in frequency and severity of natural disasters, land use patterns, and rising trends in the non-agricultural sector, including Rural and urban settlements necessitate converting agricultural land to non-agriculture sector in a way that would address difficulties in meeting demand. Revision is required for this to make it applicable to the current land resources management context.
Disaster management	Disaster Management Act 2012	• National Plan for Disaster Management, 2016-20 • Disaster Management Policy 2015 • Standing Order on Disaster	Building resilience for sustainable human development is the theme that guides NPDM 2016–20, which acknowledges how DRR and ERM go hand in hand with building resilient communities. The SDGs' achievement was added to the NPDM 2016–20 as an overarching goal for disaster management. Infrastructure improvements and community-based DRR and ERM programs both have the potential to lessen setbacks toward SDGs. In the course of DRR and ERM, there are untapped opportunities for proactive planning and program development that are intended to improve SDG attainment.

12.4 Climate in the Study Area

12.4.1 Climate of Bangladesh

Bangladesh is situated in the sub-tropical regions but displays a tropical monsoon climate characterized by heavy seasonal rainfall variations, moderate warm temperatures, and high humidity along with four prominent seasons, namely winter (December-February) which is cool and dry, hot pre-monsoon (March-May) summer, hot and humid rainy monsoon (June-September) and hot, humid but drier autumn or post-monsoon (October-November) (Shahid, Wang, & Harun, 2014; Ludwig *et al*. 2018; MoEFCC, 2018). Hilly terrains in the eastern parts of the country cause the country to receive huge amounts of water during the monsoon season from June to September. The mean annual temperature in the country is about 25°C, ranging between 18°C in January and 30°C from April to May. The highest temperatures are between 38°C and 41°C. The average annual rainfall in the country is about 2,200 mm. About 80% of the total rainfall occurs from May to September (MoEFCC, 2018). Relative humidity remains below 60% and cloud cover during winter is the lowest, about 10% country-wide. This is due to the cold dry winds from the north-western part of India during the winter season. In contrast, the humidity is more than 80% with 80 – 90% cloud cover during monsoon. In general, climatic characteristics of Bangladesh can be classified based on its seasonality, variability in arrival and departure of monsoon and variability of regions or climatic sub-regions identified by Rashid (1991) as shown in following figure.

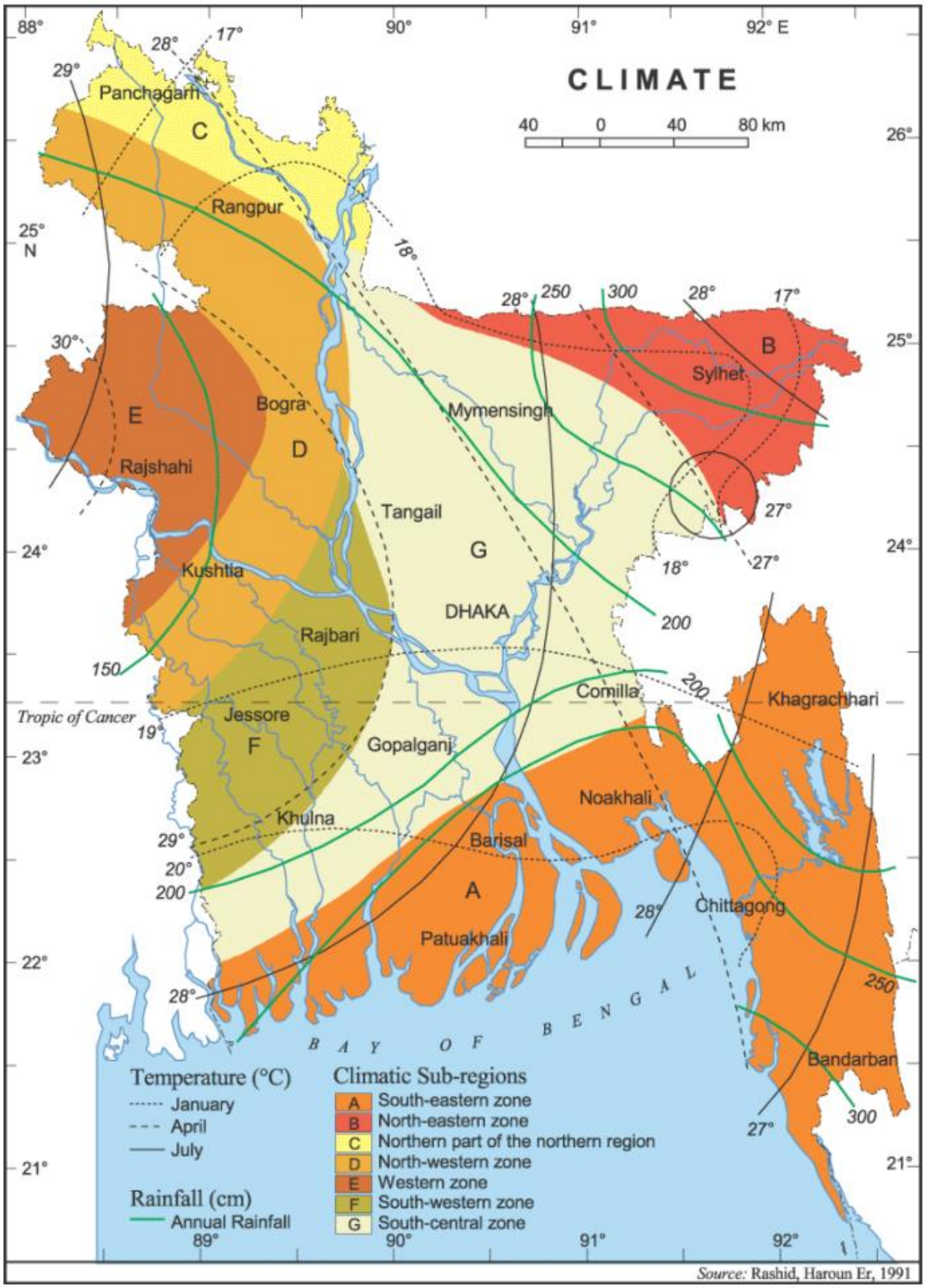


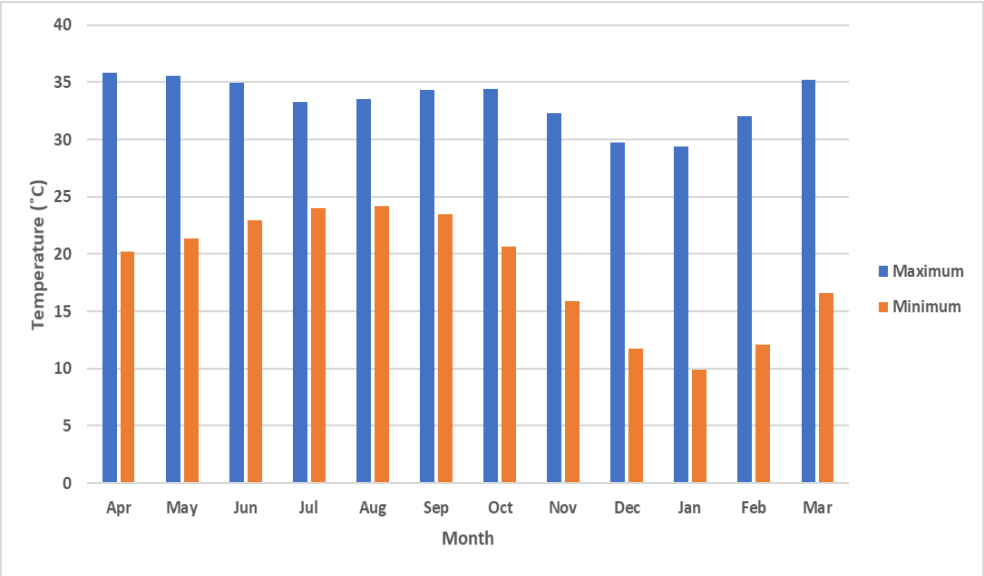
Figure 12.1: Climatic sub-regions of Bangladesh

12.4.2 Climate of Kalapara Upazilla, Patuakhali

Kalapara is situated between the longitudes of 90°05' and 90°20' East and the latitudes of 21°48' and 22°05' North. There are 217 villages, 1 paurashava, 9 paura wards, 58 mauzas, 9 union parishads, and 24 mahallas in the Kalapara upazila (BBS, 2011). The Kuakata beach in the Kalapara upazila is a significant tourist destination and so has a significant impact on the economy of the country. The following section will contain discussion on the present climatic pattern and future climate scenario of Kalapara upazilla, Patuakhali.

Temperature

The monthly average at Khepupara station for last 30 years (1988-2017) shows that maximum temperatures vary from 29.34°C to 35.86°C. April is the warmest month while the minimum temperature varies from of 9.91°C to 24.14°C. January is the coldest month. The monthly average of maximum and minimum temperature collected from Khepupara station is shown in Figure 12.2.

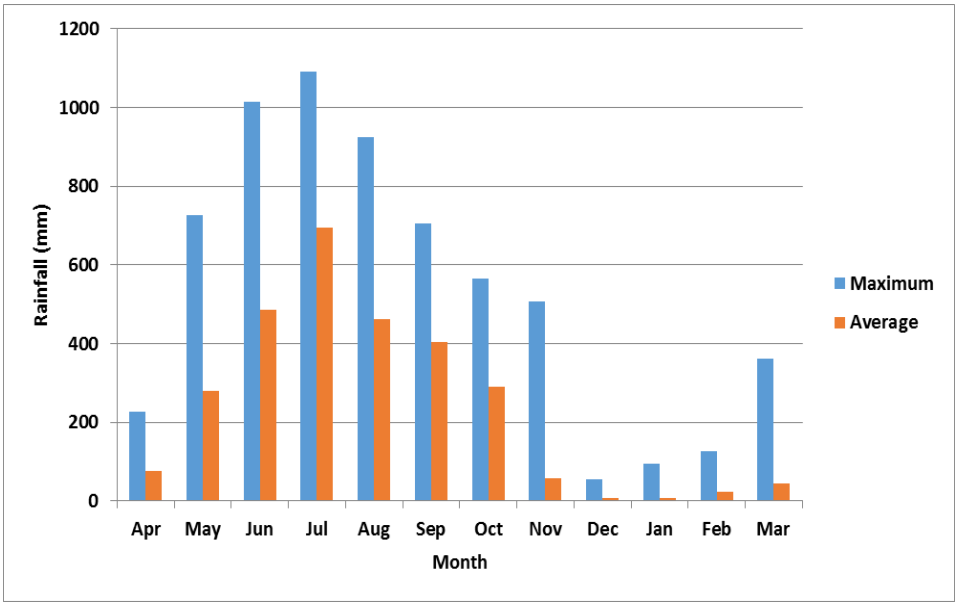


Source: Khepupara BMD station (1988-2017)

Figure 12.2: Monthly Temperature at Khepupara BMD station (1988-2017)

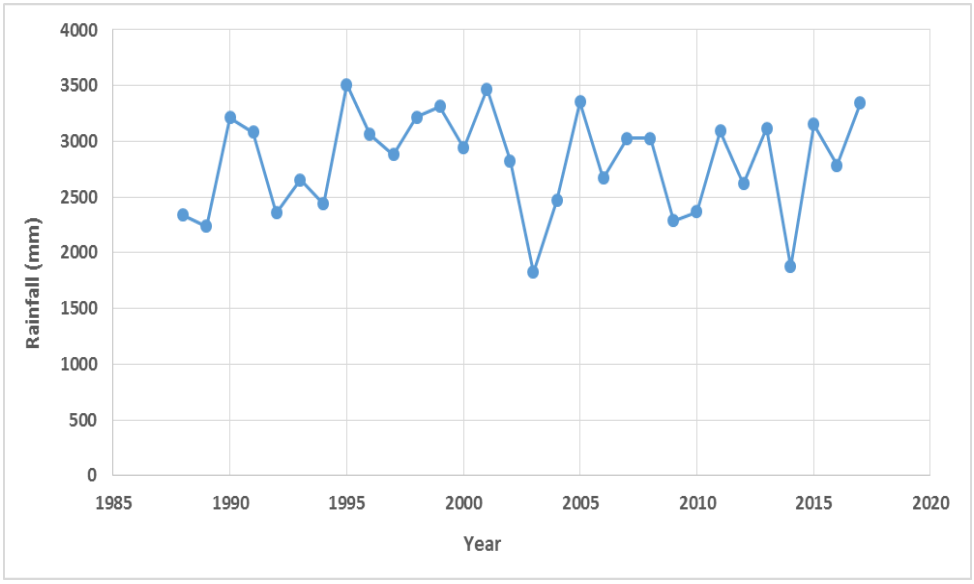
Rainfall

The monthly maximum and average rainfall data of last 30 years (1988-2017) is presented in Figure 3. The analysis of data shows that the monthly average rainfall varies from 290.16 mm to 694.7 mm in monsoon and the area received the maximum of 1092 mm rainfall in July, 2015. The historical maximum annual rainfall of this station was recorded as 3510 mm in 1995 and minimum was 1825 mm in 2003. The annual rainfall of this period is shown in Figure 12.4.



Source: Khepupara BMD station (1988-2017)

Figure 12.3: Monthly maximum and average rainfall at Khepupara BMD station (1988-2017)



Source: Khepupara BMD station (1988-2017)

Figure 12.4: Annual rainfall at Khepupara BMD station (1988-2017)

Sea level rise

There is evidence of recent sea-level changes along the southwest coast. The coastal areas of Bangladesh are generally divided into three regions - the Ganges Tidal Plain or the South-Western Coastal Region, the Meghna Deltaic Plain or the Central Coastal Region and the Chittagong Coastal Plain or Eastern Coastal Region. Trend analysis based on Sen's slope of 30 years BWDB, CPA and BIWTA tidal water level reveals that the upward trend in the south west Ganges tidal floodplain is 7-8 mm/year (DoE, 2016). The trend is 6-10 mm/year in the Meghna Estuarine flood plain and 11-21 mm/year in the Chittagong coastal plain areas (DoE, 2016).

Brown and Nicholls (2015) used data extracted from Holgate *et al*. (2013) and the Permanent Service for Mean Sea Level (2014) to illustrate that sea level rise varies from 4 mm/yr (Hiron Point) to 19 mm/yr (Khepupara).

The observed sea level rise trend in the coastal area of Bangladesh has been assessed in DoE (2016). The study collected water level data from coastal stations and conducted trend analysis. Following figure (Figure 12.5) shows the trends in observed water level at different locations across the coast of Bangladesh. Analysis of these figures shows trends of water level in the Ganges tidal floodplain of 7-8 mm/year. The overall trend in the coastal zone in the last 30 years has been varying between 6-21mm/year.

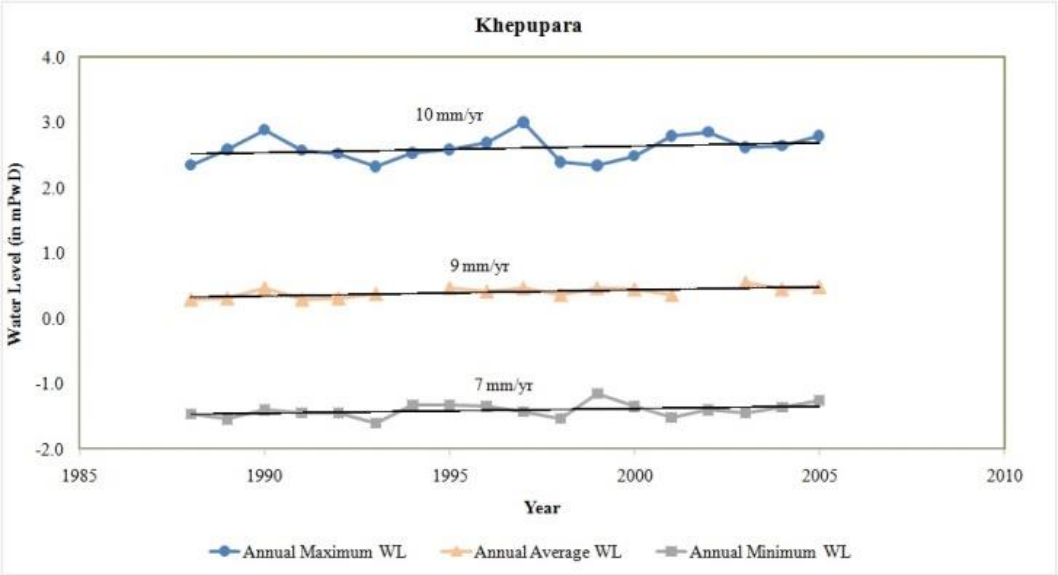
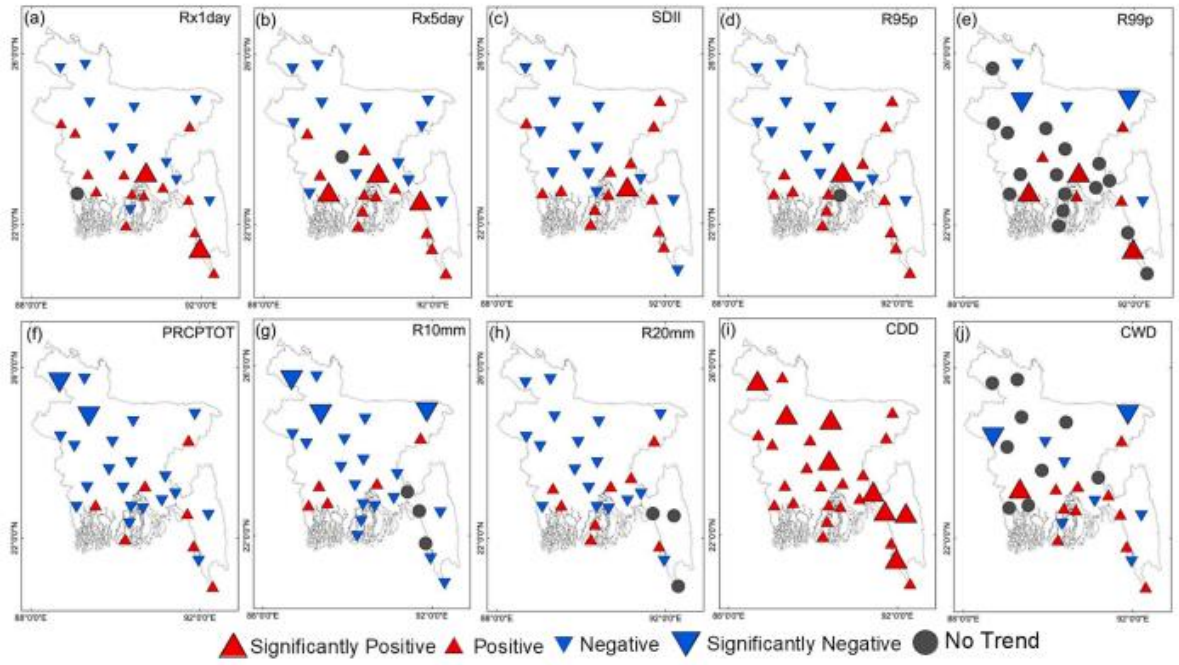


Figure 12.5: Trend Analysis of Sea Level Rise (1985-2005)

Spatiotemporal variation of extreme precipitation indices

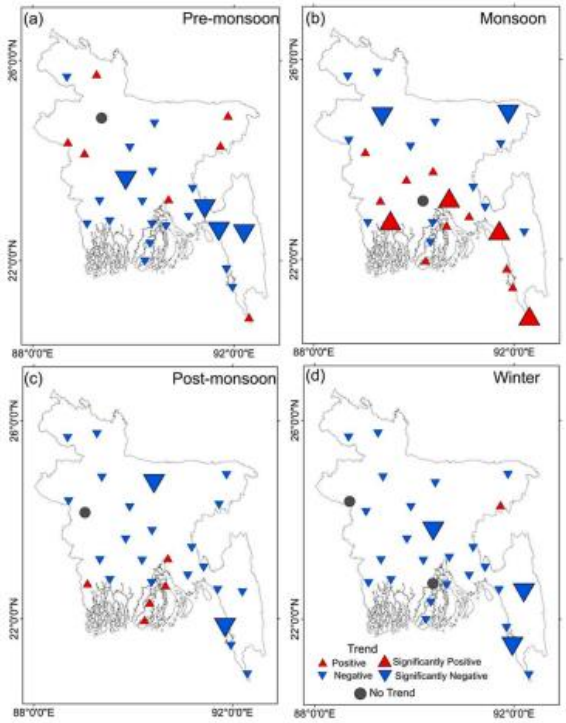
The spatiotemporal variation of extreme precipitation indices for Bangladesh at different locations has been analysed by Ezaz et al., (2021). The results of the analysis are presented in figure 12.6. The highest daily rainfall (Rx1day) and Highest five-day rainfall (Rx5day), show positive trends for the Payra-Kuakata coastal regions. Similar spatial patterns of trends are found for SDII (Fig. 12.6c) and R95p (Fig. 12.6d). For R99p, negative trends are found at Kalapara, Patuakhali (Fig. 12.6e). It shows negative trends in PRCPTOT, indicating a significantly decreasing signal (Fig. 12.6f). For the EPI duration indices, negative trends in R10mm can be seen across the region (Fig. 6g), while, showing significantly increasing trends in R20mm (Fig. 12.6h). For CDD, a spatially consistent pattern of positive trends (significant at eight stations) is found across the whole country (Fig. 12.6i), which indicates that the drought conditions have become worse for Bangladesh over the past. For CWD, positive trends over the region is seen (Fig. 12.6j).



Source: ezaz et al., 2021

Figure 12.6: Spatiotemporal distributions of the trends of the ten extreme precipitation indices at different meteorological stations of Bangladesh during 1987–2017: (a) Rx1day, (b) Rx5day, (c) SDII, (d) R95p, (e) R99p, (f) PRCPTOT, (g) R10mm, (h) R20mm, (i) CDD and (j) CWD

The seasonal patterns of trends in Rx1day (Fig. 12.7), the study region exhibits positive trends during the monsoon (Fig. 12.7b) and post-monsoon (Fig. 12.7c), and negative trends in pre-monsoon (Fig. 12.7a). The findings imply that the winter rainfall has a decreasing trend during the last decades.



The significance level is set to 0.05. (source: Ezaz et al., 2021)

Figure 12.7: Spatial distributions of the trends of Rx1day on seasonal scales during 1987–2017: (a) pre-monsoon, (b) monsoon, (c) post-monsoon, and (d) winter.

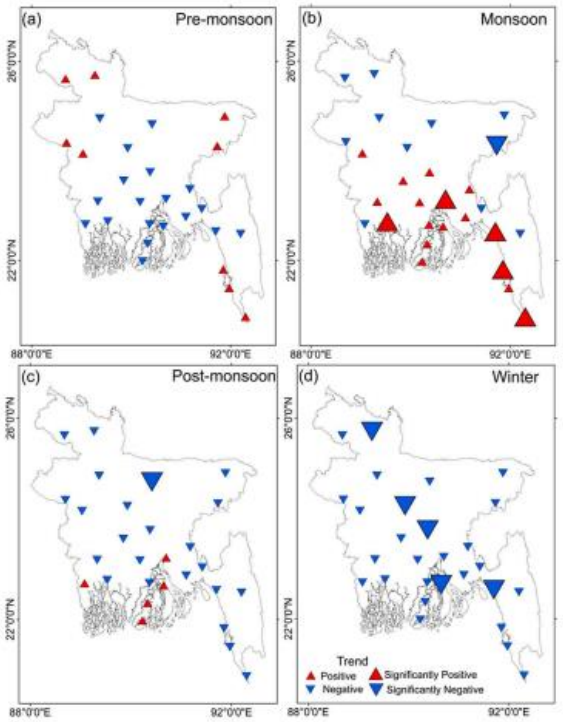


Figure 12.8: Spatial distributions of the trends of Rx5day on seasonal scales during 1987–2017: (a) pre-monsoon, (b) monsoon, (c) post-monsoon, and (d) winter.

Similarly, the spatial patterns of trends in Rx5day at seasonal scales are shown in Fig. 12.8. At the seasonal scale, Kalapara, Patuakhali demonstrate a positive trend during the monsoon season and post-monsoon season (Fig. 12.8b-c). For other seasons, the area shows downward trends (Fig. 12.8a, 12.8d). The decreasing trend in winter season implies that maximum 5-day rainfall is decreasing during winter similar to changes in maximum 1-day rainfall.

Cyclone and Storm Surge

As with temperature and rainfall, there is mixed evidence about whether the frequency of cyclones and tropical depressions affecting Bangladesh has increased. According to Roy *et al*. (2017), 123 cyclones and tropical depressions (TD) made landfall in Bangladesh over the period of 1877–2014. They suggest that about 60% of those cyclones and TDs made landfall in the southwest coastal region. 50-year timeseries data for cyclones (1960-2010) compiled by Saha and Khan (2014) suggest that while cyclone severity has increased, the percent of cyclones making landfall on the southwestern and central coast has also increased. Vissa *et al*. (2013) suggest that intensification of severe cyclones is likely to be linked with the increasing sea surface temperature and high enthalpy flux exchange and with available moisture content during post-monsoon over the Bay of Bengal.

According to Ahmed & Amir, 2012, Bangladeshi coastal areas faced fifty-two major cyclones in the 19th century and among them seven cyclones were in Kalapara. During last 10 years of the present century, coastal areas have faced at least four devastating cyclones of which two hit Kalapara Upazila. The number of death and loss of socio-economic condition are also increasing with the increasing number of cyclones.

12.5 Future Scenario of Climate Change in the Study Area

Future climate change anomalies have been assessed comparing the future projections of dynamically downscaled RCM simulations under different RCPs i.e. RCP4.5 and RCP8.5 with base period (1971-2000). Future changes in rainfall, maximum temperature and minimum temperature due to climate change has been analysed for the study area.

12.5.1 Temperature

Maximum Temperature

Future anomalies estimated from dynamically downscaled and bias corrected ensemble mean indicate increase of annual maximum temperature over the whole coastal zone irrespective of change in location. Ensemble mean (Table 12.1) reveals that maximum temperature may increase 1.1°C to 2.0°C in 2050s and 1.3°C to 3.4°C in 2085s considering both RCPs and different seasons.

Table 12.1: Change (Degree Celsius) in Maximum Temperature

Season	2050s		2085s	
	RCP4.5	RCP8.5	RCP4.5	RCP8.5
DJF	1.6	2.0	2.1	3.4
MAM	1.1	1.3	1.4	2.3
JJAS	1.5	1.8	1.8	2.7
ON	1.1	1.3	1.3	2.4

Minimum Temperature

Future anomalies estimated from bias corrected ensemble mean indicate increase of minimum temperature over the coastal zone. Ensemble mean presented in Table 12.2, reveals that minimum temperature may increase 1.5°C to 2.7°C in 2050s and 1.9°C to 4.9°C in 2085s considering both RCPs during different seasons.

Table 12.2: Change (Degree Celsius) in Minimum Temperature

Season	2050s		2085s	
	RCP4.5	RCP8.5	RCP4.5	RCP8.5
DJF	2.2	2.7	2.9	4.9
MAM	1.7	2.0	2.0	3.3
JJAS	1.5	1.8	1.9	3.2
ON	1.5	2.0	1.9	3.7

12.5.2 Rainfall

In coastal zone, annual rainfall has been found to be increased by 6% in 2050s and 8% in 2085s under RCP4.5 and 5% in 2050s and 16% in 2085s under RCP8.5 through analysing the anomalies derived from bias corrected ensemble mean. Table 12.3 illustrates the seasonal variations in future time slices. This shows higher increases during winter and pre-monsoon season. The monsoon rainfall is expected to increase in 2085s substantially, while post monsoon rainfall will decrease.

Table 12.3: Percent Change in Rainfall

Season	2050s		2085s	
	RCP4.5	RCP8.5	RCP4.5	RCP8.5
DJF	74.3	80.1	67.5	75.8
MAM	23.3	26.9	24.9	44.4
JJAS	1.0	-0.8	3.8	9.8
ON	-3.0	0.1	-5.1	-1.4

12.5.3 Sea Level Rise

IPCC (2013) predicts global mean sea level rise between 0.2 to 1m for low to high emission scenarios by 2100 for the Bay of Bengal. For the future, the IPCC projections for very high emissions (red, RCP 8.5) and very low emissions (indigo, RCP 2.6) are shown (IPCC, 2013) in following figure.

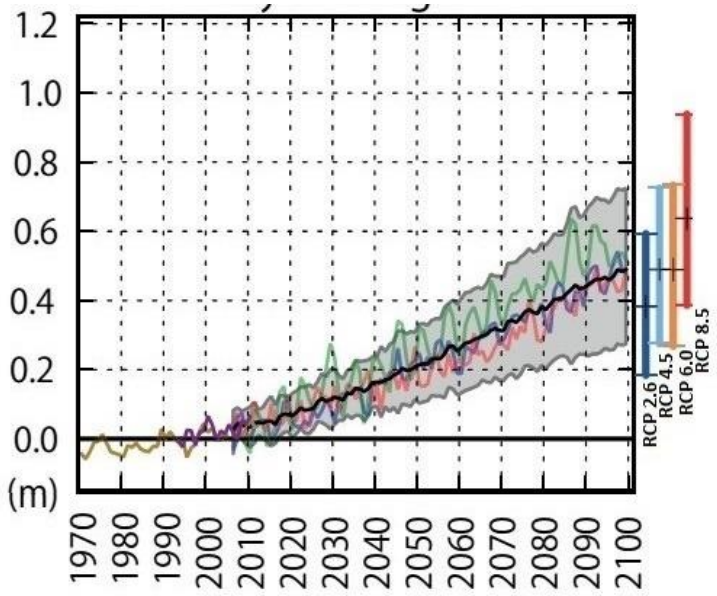


Figure 12.9: Sea level rise predictions for different RCPs in Bay of Bengal (IPCC, 2013)

12.5.4 Salinity

As an effect of global warming and sea level rise the cyclone and storm surge will impact more areas of coastal Bangladesh. This might cause inundation of 16-23% of coastal areas with districts of Barisal, Jhalokati and Pirojpur in southcentral region getting the major hit (CEGIS, 2020). The ocean areas of Bangladesh will face increasing sea temperature and consequent changes in pH and other constituents. This will impact the ecosystem in the Bay of Bengal. The salinity intrusion along the coastal Bangladesh will move further inland in the coming future. The 1 ppt salinity front will move 9-13 km inwards in the south west and south-central regions, while the 5ppt salinity front will move 25-37 km inwards. This will have serious impacts in agriculture, livelihoods and ecosystem in the coastal areas.

12.6 Impacts of Climate Change in the Study Area

12.6.1 Drivers of Climate Change

Understanding the causes of climate change and confidence in future projected changes depend directly on our ability to understand the physical drivers of climate change. This section describes the physical drivers, which are primarily associated with key changes induced by climate change.

Key change	Main external drivers	Main internal drivers	Main actions to "fuel" or "brake" the drivers, depending on whether the change is good or bad
Extreme temperature	• More greenhouse gas molecules are present in the atmosphere today, which results in the atmosphere absorbing more of the infrared energy emitted by the surface. The Earth's surface temperature increases as a result of some of the extra energy from a warmer atmosphere radiating back down to the surface. • The presence of heat waves is significantly influenced by the moisture in the atmosphere. They typically happen more frequently in dry, low-humidity environments. • The thermohaline circulation is a type of global ocean circulation that moves heat and water vertically and horizontally across the ocean's surface. This thermohaline circulation collapse causes warm surface waters from the tropics to move to the North Atlantic, and extra-warm water surfaces in the	• Anthropogenic activities have changed Earth's radiative balance and its albedo by adding GHGs, particles (aerosols), and aircraft contrails to the atmosphere, and through land-use changes. Changes in the radiative balance (or forcing) produce changes in temperature, precipitation, and other climate variables through a complex set of physical processes, many of which are coupled	• To provide shade and cooling through evapotranspiration, more trees and other vegetation should be planted to reduce surface and air temperatures. • A vegetative layer grown on a rooftop is known as a "green roof" or "rooftop garden." Green roofs absorb heat and act as insulators, which lowers energy costs associated with cooling and heating, enhances indoor comfort, and lessens heat stress brought on by heat waves. • Utilizing energy-efficient equipment and appliances can ease the strain on the electric grid during heat waves, ensuring a more dependable supply of electricity to the community.

Key change	Main external drivers	Main internal drivers	Main actions to "fuel" or "brake" the drivers, depending on whether the change is good or bad
	Pacific Ocean close to the equator. As a result, temperatures are generally warmer in Western Europe, some parts of Asia, and the Americas, while they are rapidly cooling in other parts of Europe. El Nino and La Nina are two examples of this.		
Rainfall Variability	• Changes in rainfall pattern could be attributed to the shifts in global wind pattern and direction. The places located on the windward side of the mountains receive more rainfall because when the moisture-laden winds strike the windward side of the mountains, it causes rainfall. On the other hand, the places located on the leeward side of the mountains get scarce rainfall. • A monsoon trough is a low-pressure area that causes the monsoon to be unpredictable in different regions and cause uneven rainfall.	• The temperature of the Earth is rising due to human-caused climate change. Warmer temperatures and extreme precipitation are related by various mechanisms. Warmer air can hold more water vapor, so most regions of the world experience extreme precipitation more frequently. Human activity is also causing a stronger water cycle, which pushes more water vapor away from the planet's hottest regions and toward its poles. Because of this, dry areas are becoming drier and wetter.	• Updating zoning laws to encourage the construction of infrastructure and buildings higher up or in less flood-prone areas. • Using flood control equipment • Reducing the amount of non-permeable surfaces like concrete and pavement that are used in developed areas, or substituting "green infrastructure" for pavement to lessen the risk of flooding and runoff during storms. • Offering flood insurance to cover property losses and interruptions to business operations. • To prevent dumping untreated sewage into nearby waterways, separate storm water systems from wastewater systems, use holding ponds, or expand water treatment capacity.

Key change	Main external drivers	Main internal drivers	Main actions to "fuel" or "brake" the drivers, depending on whether the change is good or bad
	• More rain falls in areas close to the coast than in areas far from the water. Cyclonic depressions, which have their origins over the ocean and typically cross coastal regions, bring about heavy and widespread rain in those regions. • The coastal, tropical, and plains receive more rainfall than the plateau and deserts because of latitudinal extent. • The rate of evaporation has a significant impact on both rainfall and evaporation. As more water evaporates, more precipitation will result. • Since they are essential components of the water cycle, clouds have an impact on both weather and climate. Because clouds move moisture from one place to another, they have an impact on the precipitation conditions over a specific area.	• Variation in rainfall patterns is also brought on by the impact of human activity on the surface vegetation. There is a lack of rainfall and ensuing drought in parts of Africa and Asia due to widespread deforestation.	
Sea Level Rise	• Thermal expansion brought on by the ocean warming (since water	• Sea level rise is indirectly caused by the heavy use of stored water and excessive	• Reducing the carbon footprint. • Safeguarding wetlands. During cyclones, wetlands serve as a natural barrier for coastal areas. Rainfall and waters from

Key change	Main external drivers	Main internal drivers	Main actions to "fuel" or "brake" the drivers, depending on whether the change is good or bad
	expands as it warms). • Increase of land-based ice melting, including glaciers and ice sheets • As a result of natural processes, such as the elevation of the Earth's crust over time as a result of tectonic plate movement. Therefore, the sea level will inevitably rise as tectonic plates move. • In different parts of the world, the Meridional Overturning Circulation (MOC) affects sea surface height (SSH) based on local temperature and salinity levels. The sea level rises as the MOC deteriorates.	groundwater extraction. The used water eventually ends up in the ocean. Surprisingly, research indicates that this water flow also contributes to the rise in sea level. • Deforestation and the destruction of wetlands can also increase the water flow in the oceans.	storm surges are absorbed by them. Participate in local wetland restoration initiatives by learning about them. • Hard surfaces increase runoff and erosion because they prevent water from penetrating the soil. For walkways, use stepping stones, and for patios, paver blocks. Use permeable pavement when repaving to allow water to seep into the ground. Rainwater should be directed to rain gardens and barrels. • Plant more plants and save trees. Plants clean the air and soak up rain. Reduce paper use to prevent trees from being cut down. Set all computers and printers to double-sided printing and reuse one-sided copies as scrap paper. • Increase your greenery to save trees. Plants absorb rain and purify the air. Reduce your paper usage to avoid clearing trees. Turn on double-sided printing on all computers and printers, and recycle one-sided copies as scrap paper. • Motor boat waves exacerbate erosion along shorelines. Use deeper water when operating, and be aware of "fragile area" and "slow no wake" signs. • Inland areas are shielded from wind and wave action by dunes and grasses, maintaining the shore. Stay on designated paths to avoid the fragile areas of dunes and sod banks. • It will be much easier to prepare for a strong storm surge if you are aware of the risk of flooding before the storm hits.

12.7 Climate Change Effects in the Study Area

12.7.1 Extreme Temperature

Climate change impacts in Bangladesh are associated with hotter summers and winters generally. Temperature is an extremely sensitive variable for crop production because each crop has a specific temperature range for vegetative and reproductive growth. The duration of rice plant's vegetative and reproductive phases gets reduced by the high temperature. Again, low temperature prolongs the tilling time of crop. High temperature (37°C or above) desiccate pollen grains, and during anthesis, can cause sterility. Also, increasing temperature is contributing to a rapid decomposition of organic matter and thus a loss through the production of CO_2. Additionally, Increased temperature not only directly reduce the crop production but also it has an indirect impact by stimulating the breeding of harmful insects, pests etc.

From a study conducted in Patuakhali (Hossain, 2015), it was seen that during Kharif-1 and Rabi seasons, due to increasing average minimum and maximum temperature, paddy, wheat and tuber crop production are decreasing. Another study (Amir, 2013) done in Kalapara Upazilla, Patuakhali shows that, 10 years ago the harvest of rice was less than the present harvest. In that time the local variety like aus and aman were the prominent crop varieties. But, now people are trying to cultivate HYV (High Yielding Variety) rather than the local variety, as the production of local variety of the agricultural products is hampered due to the occurrence of natural hazards. It is also found that now the prominence of the culture fishing is seen more (Amir, 2013).

A fish pond's surface and volume of water become reduced as a result of increased temperature causing evapotranspiration of water and increased metabolic activity in fish. Due to the fact that all aquatic organisms in pond culture systems utilize dissolved oxygen for respiration, critically low oxygen concentrations occur during the night, peaking just before daybreak. Fish suffer from hypoxic conditions as a result, and frequent occurrences of these conditions reduce the growth rate and reproductive output of cultured species.

A high temperature also increases body metabolism which will cause less growth in livestock. This leads to less meat, milk and egg production. Excessive heat acts on human health and individual performance causing discomfort, fatigue, heat cramps, heatstroke, heat exhaustion etc.

12.7.2 Erratic Rainfall

Rainfall is one of the major climatic factors that have a strong influence on crop production. Distribution in rainfall pattern is unusual and uneven at recent years as a result of climate change which has an adverse impact on crop agriculture. Rice is the most dominant crop growing in Patuakhali. It is observed that cultivation of Aus and Aman rice are hindered by variability of rainfall by a study (Rahman et al., 2015). This study also states that uncertain rainfall results delay sowing and transplanting of Aus and Aman rice. Heavy monsoon rainfall leads to delays in transplanting Aman rice. Late rainfall at the end of the rainy season causes great harm to vegetables in Rabi season. The farmers cannot cultivate vegetables in time because of rain water in their cropland. Variability in wetness of soil due to erratic rainfall, and therefore the sowing time of the crops, is also affected. During heavy rainfalls, the levels of dissolved O_2 and pH can decline in a pond. An extremely heavy rain also can result in pond flooding and also fish stocks escaping from enclosures.

12.7.3 Tidal Flooding due to Sea Level Rise

As a result of climate change, sea level rise, excessive rainfall during the monsoon and post monsoon season there prevail high tide in sea and river. Rahmanet al. (2015) revealed that high amount of tidal water sometimes causes tidal surge and coastal inundation almost every year causing serious damage to crop agriculture in Kalapara Upazilla of Patuakhali. It is also observed that crops are submerged by tide and root zone becomes weaker leading to slower growth or partial damage. Crops also float away by tide water causing full or partial damage. Due to excessive rainfall and tidal surge the riverbank is eroded. From the conducted field survey, it was found that loss of cultivable land and land degradation occurred due to river bank erosion has lead to yield reduction.

The location of the river estuary would change due to sea level rise, drastically altering the ecology and spawning grounds for fish. Penaid prawns grow and reproduce in brackish water, which is a mixture of fresh and salt water. Sea level rise would reverse this interface, altering the prawn's habitat. Shrimp hatcheries and shrimp farms are susceptible to the phenomenon since the area is exposed to sea level rise. When flooding occurs as a result of another sea level rise phenomenon, like overflowing shrimp ponds, the shrimp end up in the open water, which causes significant damage to the industry.

Flooding in Bangladesh's southern region in 2000 resulted in losses or damage to crops, fish farms, and other property worth at least US$500 million. (Sarwar, 2013)

Sea level rise will prolong and increase the frequency of flooding, which will have a significant impact on Aman production. Salinity, caused by the tidal flood will cause degradation of the soil's quality, resulting in a loss of agricultural production. Cholera outbreaks frequently happen following flooding in Kalapara upazilla, as the water supply gets contaminated due to floodwater and salinity. By one metre of sea level rise, salt mills and dry fish sector that are situated extremely close to the shore could be submerged. Also, due to the proximity of all amenities to the seaside, Kuakata's tourism industry will suffer the most.

12.7.4 Salt Water Intrusion

Salinity has a significant impact on a number of important factors that affect human health, including the availability of food, fresh water, physical safety, and the microbial habitat.

Low-lying coastal areas are gradually being inundated with saltwater due to sea level rise, which contaminates the soil. Through a number of estuaries and water inlets, surface water and groundwater are both connected to major rivers along the coastal belt. These water sources are contaminated by salt, influenced by rainfall, river flows, and up-stream water withdrawal. Although the salts can be dissipated by rainfall, it is more challenging due to climate change's increased frequency and intensity of extreme weather events including droughts and heat waves. With increasing scarcity of safe drinking water, the water resources become unsustainable for animals and fish to consume. Again, using groundwater more frequently for irrigation and drinking, further causing depletion of the water table and allowing more salt to leach into the soil. Numerous health issues, including cholera, diarrhea, and high blood pressure, affect people. People are consuming more salt than they should not just through water but also through the food they eat because it was grown there.

While salinity has made it easier to cultivate shrimp along the coastal belt, it has also exacerbated harmful effects on the variety of freshwater species. Due to their proximity to salt water, some inland freshwater species have gone extinct. There are 59 inland fish species, 57 sea species, 10 exotic species, 3 prawns, 4 shrimp, and 4 crabs in Bangladesh's Kalapara coastal region. The percentages of these fish species that fell into the categories of visible, threatened, endangered, and extinct were 45, 24, 19, and 12, respectively. The percentages of visible, threatened, endangered, and extinct marine fish species, on the other hand, were found to be 43, 21, 24, and 12 % respectively. Salinity and cyclones were shown to be two important factors in the extinction of fish species throughout the Kalapara Upazila's coastal region. (Alam et al., 2017)

The salinity in Kalapara Upazilla affects fodder crop regions on an annual basis to the amount of 200 ha, according to this study. Because of this, a critical issue for livestock and other animals is food scarcity. The heavy reliance on salinity-affected fodder crops has several unfavorable effects on animals, including diarrhea, skin conditions, liver fluke, loss of body weight, and immune system deterioration.

Additionally, the salinization of groundwater and surface water, land subsidence, pollution of agricultural lands and coastal waters by pond effluents and sludge, introduction of exotic species or pathogens into the coastal environment, loss of wild larvae, and subsequent loss of goods and services are all consequences of the salinity problem.

Households in locations with high inundation and salinization hazards have significantly higher dependency ratios, poverty incidence and out-migration rates than households in areas without such concerns. Increased soil salinity lowers the quality and productivity of high yielding variety rice, which has an adverse effect on its market price. Again, as the infiltration of saline water results in road

surfaces to blister and crack, the increased salinity of the ground water will result in increased maintenance costs for municipally paved roads. (Dasgupta et al., 2014)

12.7.5 Cyclone and Storm Surge

The Patuakhali district's Kalapara upazilla is one of Bangladesh's most disaster-prone areas. The historical data indicates that the Patuakhali district is almost always affected by cyclones that pass through Bangladesh. According to a study (Didar et al., 2014), every cyclone in Kalapara Upazila has a devastating effect on every facet of social life and the environment. Out of 116 hurricane shelters, 81 are used as educational facilities in the study area. On the other hand, cyclones severely damage or destroy other educational institutions. Cyclone Sidr of 2007 caused 94 fatalities and approximately 1678 serious injuries, according to the UNO office. In 2009, 152 people suffered serious injuries as a result of cyclone Aila. Many of the injured individuals are still alive. Among the injured people many are living with permanent disability.

Seawater flooded the low-lying coastal areas during the cyclone, destroying them.the majority of the fresh water resources on the surface and shallow groundwater aquifers. Again, cyclones destroy both earthen and semi-earthen roads, and dams are destroyed. As a result, providing relief to the affected people is challenging.

According to the Kalapara UNO office, cyclone Aila caused BDT worth of losses to the cottage industry. 30,000. There are 620 fishing nets totaling BDT 620 in nine union parishes and one pourashava. The cyclone Aila destroyed 3,850,500 homes. 500 acres of salt culture (area used for salt cultivation) that had a market value of about BDT were destroyed by Cyclone Aila. 1,500,000. About BDT was lost due to cyclone Aila in the industrial sector. 1,002,000 across 44 sectors. The cyclone Aila also destroyed about 385 fishing boats, causing a loss of about BDT. 2,995,000. Cyclone Mohashen is also worried about the same effects on people and property in the study area.

When cyclone SIDR hit, the rice crops in Aman were fully damaged by about 45% and nearly destroyed by about 40%, and when cyclone AILA hit, they were fully destroyed by about 40% and nearly destroyed by 40%. It has been noted that the months of April to May (pre-monsoon) and October to November have the highest cyclone risk (Post Monsoon). Following the monsoon, local farmers grow T-Aus, T-Aman, and a few other minor vegetables. These crops are extremely susceptible to storm surge. Storm surge causes damage to embankments and structures, and persistent water logging reduces crop yield.

12.8 Adaptation and Mitigation to Climate change

12.8.1 Adaptation Actions and Planning

Due to tidal inundation and salinity in Patuakhali, agriculture frequently observes a reduction in yield or, in some cases, complete destruction. Informed farmers can significantly impact the selection of adaptive measures. The region's primary source of income, agriculture, has been significantly altered as a result of degradation of the soil and groundwater and long-term effects on the ecosystem. As a result, the farming system in the area has dynamically changed, as shown by the blend of agricultural products from various regions, such as freshwater prawns, rice, fish, and vegetables and backrish shrimp. Salinity intrusion in Kalapara upazilla of Patuakhali also poses a serious threat to irrigation and drinking water quality from both an environmental and human perspective. The over-extracted water resources, low upstream flow, climate change etc. have been the deciding factor in this case.

It is anticipated that the effects of salinity levels can be mitigated until 12 ppt using a strategy that combines crop diversification, arable field management, and alternate cropping. Horticulture that is salt-resistant should be able to withstand salinity up to 15 ppt. Land zoning, however, is the most

suitable strategy to support agriculture, enhance farmers' socioeconomic conditions, and resolve conflicts between crop and shrimp farming for long-term adaptation planning, i.e., salinity levels up to 20 ppt. In salinity ranges between 7 and 20 ppt, managed aquifer recharge, pond excavation, pond sand filtering, and rainwater harvesting are found to be the most effective measures. (Peerzadi Rumana Hossain, 2018) The use of solar-powered desalination, seed banks, and the adoption of some techniques like zero tillage, sorjan system, applying potassium sulphate fertilizer, avoiding fallowing land during the Rabi season, drip irrigation with mulch in the raised bed, as well as saline and drought tolerant crop varieties can be effective in adapting to the devastating effects. The levelling of land, planting of crops during the Rabi season, rainwater collection, excavation or renovation of a mini-pond on higher ground for supplemental irrigation, and plastic sheets with a hole are all significantly correlated with access to extension services. Pond sand filter (PSF) is a common method for treating surface water in coastal areas to produce potable water.

The locals of Patuakhali, Kalapara upazilla, rely heavily on aquaculture for their subsistence as saltwater intrusion creates opportunities for shrimp farming along the coastal belt, but it also has detrimental effects on a variety of freshwater species. A combination of water hyacinths for heat stress reduction, cage fishing, early or premature harvests of cultured fish, horra pulling to remove toxic gases during heat stress, plenty of oxygen, pH balancing, and the addition of aquatic vegetation to the pond will keep the habitat condition as desired. The fodder crisis affects the livestock and poultry industries as well, which raises the cost of rearing animals. The portion of the Sundarbans mangrove habitats in the Kalapara upazilla get also degraded, which had an impact on the growth and biodiversity of the forest, the vegetation, the spread of the undesirable top-dying disease, and the production of fewer forest resources, such as fewer healthy trees, fewer wild animals, and fewer fish species. To ensure that rivers flow into the flood plain and to restart the natural process of land formation through sedimentation, large-scale tidal river management is proposed. This aims to lessen waterlogging, river bed siltation, and the effects of rising tides on the Sundarbans mangrove.

With the negative impact of soil and water salinity on crops, fish, and livestock, these changes triggered unemployment and outmigration severely. Provision of climate resilience fund or insurance mechanism or subsidies to recover losses and damages of disasters, facility of soft loan and hands-on training on different livelihood options, such as sewing, handicrafts, mixed farming, fish or livestock feeding and rearing, shop keeping, e-commerce, small scale climate-smart agriculture practices, floating or sac gardening, dry fish processing, floriculture, apiculture or nature based crab fattening, etc. can be effective adaptation strategies to mitigate the effects on livelihood options.

Moreover, better weather forecasting, water/environment monitoring, early warning systems, improved disease surveillance systems; durable and reliable access assets i.e. roads, power distribution system, water supply system, communications system; strengthen social capital; improve access to markets and fair trade; establish Aquaculture Management Areas; improve access to training and improved technology in the Char areas; promulgate clear and policies and regulations can overall will help for becoming the region more resilient in the face of any adverse events.

12.8.2 Mitigation Actions and Plans

Mangrove afforestation along the coastline is a great natural solution that also functions as a natural machine to reverse carbon emission, reduce storm impact and foster alternate livelihood for coastal dwellers. This unique ecosystem is a great combination of three things; as an embankment protection, source of livelihoods and climate change mitigation. The second most important measure needed is to manage coastal embankment project polders in ways that allow tidal water to enter them at appropriate times of the year in order to deposit sediment at sufficient rates to raise land levels in parallel with a rising sea-level and local land subsidence rates. Embankments will need to be raised

and strengthened as sea-level rises. The measures of mitigation action can be concluded that planting trees around their houses to reduce the intensity of storm surge attack, reduce erosion, diminish pressure on natural forest for household consumption as fuelwood. Unplanned industries and excess use of natural resources should be demoralized. Raising homestead and plinth level of houses can be useful to mitigate severe effects of coastal flooding. Using Ammonium Sulphate and Ammonium Phosphate can both be used as substitution of Urea, utilizing rice straw off-season, utilizing biofuel, adjusting manure spreaders for crop fertilizer requirements etc. can be important solution to reduce GHG production. Again, lowering fertilizer requirements, growing winter cover crops like winter rye, and reducing nitrate leaching are some solutions to N2O emissions. Farming of different varieties of climate resilient HYV crops, nationwide programs should be conducted to increase the awareness of the people about the elements of climate change.

13. Disaster Management

13.1 Introduction

The PKCP reasonably considered vulnerabilities of natural disasters especially cyclone and storm surge, river bank erosion, water logging and drainage congestion, salinity intrusion and arsenic contamination. The regional plan which was developed as a part of the PKCP duly proposed a number of Disaster Risk Reduction Measures for resilient infrastructures. For example, the regional plan proposed construction and rehabilitation of coastal embankment, flood control and drainage infrastructures, integration of DRR measures in road construction and urban services, construction of cyclone shelter, DRR measures for water supply infrastructures, disaster resilient water supply and sanitation, etc.

The OECD recognized SEA to be an efficient tool mainstream DRR in policies, plans and program[51] . The SEA brings further opportunity to explore appropriate DRR measures for PKCP and to ensure their implementation. In line with the OECD guideline, this SEA would analyze how the development objective of PKCP would be affected by the prevailing and possible disaster risk and how PPP can influence the vulnerabilities of the community to disaster risk. At the end, the SEA would explore and propose strategic DRR measures/plans for PKCP.

13.2 Disaster Management Policy, Plans, Programs and Compliance

13.2.1 Competent Authority/Implementing Agency

The Ministry of Disaster Management and Relief (MoDMR) is the key competent authority in the field of disaster management which is responsible for law and policy formulation. The Department of Disaster Management (DDM) is the implementing agency of the ministry which implement plans and program related to DDM, which are mostly dissemination of early warning, emergency response and relief, support to recovery etc. They also periodically assess the disaster risk and vulnerability and prepare relevant plans. However, responsibilities of infrastructural development work for disaster safety and building disaster resilience go to relevant ministries and their implementing agencies. For instance, Ministry of Water Resources is responsible for water management related infrastructure and Bangladesh Water Development Board is the implementing agency of the ministry. Similarly, Local Government Engineering Department (LGED) under the Ministry of Local Government and Rural Development is responsible for building rural infrastructures including cyclone shelter. The Department of Social Welfare (DSW) under the Ministry of Social Welfare implement a number of social protection programs like Vulnerable Group Feeding, Widow Allowance, Allowance for Disabilities, etc. The following table maps the organizations involved in disaster management.

[51] OECD, 2010. Strategic Environmental Assessment and Disaster Risk. DAC Network on Environment and Development Cooperation (ENVIRONET), OECD.

Table 13.1: Key Competent Authorities and Supporting Institutes in the Sector of Disaster Management

Key aspect in the theme	Primary competent authority (CA)– and their mandates	Key support organisations (govt, NGO, donor, CBO, etc.)	Performance of CA and support organisations
Disaster Management Policy and Plan formulation	Ministry of Disaster Management and Relief (MoDMR), Department of Disaster Management (DDM): <u>Mandate</u> Implement Disaster Management Act, 2012 Implement DRR activities, delivering humanitarian assistance, coordinate disaster management activities,	Ministry of Water Resources, Ministry of Local Government and Rural Development, Bangladesh Water Development Board, Local Government Engineering Department, Local Consultative Groups (LCG), World Bank, UN Organizations (e.g. UNDP, UNHCR, UNRCO, FAO, etc.) bilateral and multi-lateral development partners, IFRC, Humanitarian Coordination Task Team (HCTT), INGOs and NGOs.	The DDM has limited capacity at Upazila and District level. Such limitation of workforce at local level cause difficulties in ensuring effective operation of emergency response, and post-disaster damage assessment. Such limitation also affects the local level coordination with humanitarian organization especially at the time of disaster emergency and post disaster rehabilitation and recovery work when the number of NGOs and humanitarian agencies working in field rises to a large number.
Disaster warning and dissemination	MoDMR, DDM, Flood Forecasting Centre (FWC) of Bangladesh Water Development Board (BWDB), Cyclone Preparedness Program (CPP) Bangladesh Meteorological Department (BMD) FWC is the mandated organization of Flood warning, BMD is the mandated organization for early warning of other disasters. CPP of DDM is mandated organization dissemination of early warning.	Local Government (LG) Bangladesh Red Crescent Society (BDRC), NGOs	The mortality of the disaster in Bangladesh has reduced significantly due to their activities related to dissemination of early warning. However, there is still a visible opportunity of improving the early warning in terms of reliability, lead-time and accuracy.
Disaster emergency evacuation and rescue operation	MoDMR, DDM	CPP, LG, BDRC, IFRC, Humanitarian Coordination Task Team (HCTT), INGOs and NGOs	The mortality of the disaster in Bangladesh has reduced significantly due to their activities. Adoption of Forecast-based Financing helped them to act proactively.

Key aspect in the theme	Primary competent authority (CA)– and their mandates	Key support organisations (govt, NGO, donor, CBO, etc.)	Performance of CA and support organisations
Emergency response and recovery	MoDMR, DDM	Local Government, HCTT, Department of Social Welfare (DSW), Department of Agricultural Extension (DAE), Bangladesh Agriculture Development Corporation (BADC),	Mostly focused on emergency response. Although the long-term recovery is prioritized by policy and plan, successful implementation is challenged by resources.
Emergency Repair and long-term Recovery of Infrastructure	MoWR, BWDB, MoLGRD, LGED, Roads and Highway (RHD), Bangladesh Power Development Board (BPDB)	LG, LGI, Humanitarian Coordination Task Team (HCTT), INGOs and NGOs	Financial limitation often cause delay. Long term recovery is challenged by technical and financial difficulties as well. The adoption of BBB is in policy but long-term recovery often lacks reduction of pre-disaster vulnerability.
Water related disaster risk reduction and resilience building	BWDB, LGED, DAE, BADC, BWDB, LGED	LG, LGIs	The government recently prepared a 100 years' plan, Bangladesh Delta Plan 2100. The implementation of this plan largely depends on external resources. The work being implemented with government's own fund are mostly focused on frequent disaster of 20~30-year return period. Adopting DRR against extreme disaster needs further technological knowledge and financial resources.
Social Protection	Department of Social Welfare (DSW), DDM	LG, LGI, Development Partners	Direct payment to beneficiaries (Government to person, G2P) by mobile banking improved the delivery efficiency. There is an ongoing effort of digitalizing the process of beneficiary selection and lack of household level data and social registry/citizen registry often cause erroneous inclusion and exclusion.

13.2.2 Relevant Legislation and Regulation

The Disaster Management Act 2012 is the primary legislation in disaster management arena of the country. The legislation was enacted in 2012 which gives – i) the overall outline of the disaster management practices which should be carried out, ii) organization structure and coordination mechanism, iii) definition of the disasters and terminology to be used in practice. Under the Act, two rules have been enacted, one for regulating the disaster management funds and another for organizational structures and coordination. For effective operation of disaster management activities, the government have been publishing "Standing Order of Disaster" since 1997. The current Standing Order have been updated and published in 2019 which specifies the roles and responsibilities of different organizations, committees and agencies involved in disaster management activities. The SOD 2019 also recognized the contribution of Humanitarian Agencies and mentioned their roles and

responsibilities in the SOD. The following table discusses the adequacy and inadequacy of the key legislations in the disaster management field.

Table 13.2: Relevant Rules and Legislation in Disaster Management Sector

Key aspect in the theme	Primary legislation	Accompanying or enabling regulations	Comments on adequacy or not re. legislation and regs
Disaster Risk Management	Disaster Management Act 2012	Disaster Management Rules 2015, 2021 Disaster Management Plan 2021-2025	The DM Act 2012 defines the disasters for the country which included both natural and man-made disaster. It also covers the diseases out break and pandemic. The Act also outlines what should be the activities of disaster risk management covering preparedness, emergency response, rehabilitation and recovery. It outlines a coordination structure at national and local level. However, the major limitation is its complete implementation. However, government is gradually implementing and enforcing it. The link between environment and disaster management is missing. Management of disaster debris, post disaster environmental management, environmental management for disaster safety are not clearly highlighted in the legal documents.
Disaster Coordination	Disaster Management Act 2012	Disaster Management (Committee Formation and Activities), 2015 Standing Order on Disaster, 2019	The Act establishes a number of coordination bodies like National Disaster Management Council (NDMC) chaired by the Prime Minister; Inter-ministerial Disaster Management Coordination Committee; National Disaster Management Advisory Committee (NDMAC); National Platform for Disaster Risk Reduction (NPDRR), Earthquake Preparedness and Awareness Committee (EPAC); and Focal Point Operation Coordination Group of Disaster Management (FPOCG). However, the problem lies with the functionality of these committees. The activities and function of these committees are not taking place regularly as it has been outlined in the SOD 2019. The government has been publishing and updating the SOD since 1997. The current SOD recognizes and outlines the roles of NGOs and other humanitarian and research organizations as well. However, the true implementation/enforcement of this SOD is still in progress which means the coordination as outlined in the DM Action 2012 is still yet to be achieved.
Disaster Risk Financing	Disaster Management Act 2012	Disaster Management Act 2012	There is a good progress in setting up the National Disaster Response and Recovery Fund; National Disaster Risk Reduction Fund and Local Government's Disaster Management Fund. The Government is piloting forecast-based disaster financing to ensure preparedness is in place before the disaster event. The Five-Year Plans are giving more emphasis on Disaster Management, the budget and fund spent on activities related to disaster management are also separately accounted. The Insurance and other risk financing solutions are still on discussion tables.

Key aspect in the theme	Primary legislation	Accompanying or enabling regulations	Comments on adequacy or not re. legislation and regs
Social Protection	National Social Security Strategy (2015)	National Social Security Strategy (2015)	There are a number of social protection programs run by the government which have strong linkage with disaster management. However, there is no direct act or rules related to social protection. However, the government prepared the National Social Security Strategy (2015) to ensure effectiveness of social protection programs. The government is initiating shock responsive social protection program (SRSPP) to aid DRR. Currently, beneficiary selection, expansion and intensification of the SRSPP are challenged due to lack of house hold data base, transparency and resources limitation. Government to Person (G2P) Payment initiative improved the delivery mechanism but the beneficiary inclusion & exclusion error often undermines the overall success.

13.2.3 Impacts of Relevant PPPs

Government has been publishing National Disaster Management Plan time to time with the aim of building country's resilience against disasters. The NDMPs have always been prepared in line with the international frameworks like Hugo Framework, Sendai Framework, etc. The current plan is for 2021-2025 which proposes a number of programs and plans. For guiding the social protection programs and to align them with disaster management goals, government published National Social Security Strategy ion 2015. The following table discusses the key PPPs in the sectors of Disaster Management.

Table 13.3: PPPs relevant to Disaster Management

Key PPPs relating to the theme	Main projects emanating from the PPPs	Main negative environmental impacts emanating from the projects	Main negative socio-economic impacts emanating from the projects
National Disaster Management Plan 2010-2015; National Disaster Management Plan 2015-2020; National Disaster Management Plan 2021-2025	National Resilience Program Comprehensive Disaster Management Program Emergency Cyclone Recovery and Restoration Project Early Recovery Program Emergency Rehabilitation of Coastal Polders Forecast-based financing Capacity Development and Institutional Strengthening Construction of Cyclone Shelters	Mostly construction activities related impacts like noise, air pollution and water pollution from construction activities.	Land acquisition constructing embankments and rural roads
National Social Security Strategy 2015	Social Protection Program Shock Responsive Social Protection Program	No negative impacts	Risk of erroneous inclusion and exclusion in the social protection program
National Resilience Program	Gender Responsive and Risk Informed Development Planning	No negative environmental impacts from the institutional	No negative impacts

Key PPPs relating to the theme	Main projects emanating from the PPPs	Main negative environmental impacts emanating from the projects	Main negative socio-economic impacts emanating from the projects
	Strengthening disability inclusive, gender-responsive national capacities to address recurrent and mega disasters Strengthening disability inclusive, gender responsive community preparedness, response, and recovery capacities for recurrent and mega disasters constructing risk-informed, disability inclusive and gender-responsive infrastructure	strengthening activities. However, construction activities related impacts like noise, air pollution and water pollution might arise from construction of rural infrastructures like roads, bridges, etc.	

13.3 Natural Disaster Vulnerability and Risk

The coastal zone of Bangladesh is very dynamic due its active deltaic process and hydro-morphological behaviour of the rivers. Besides this, coastal lands have been the most vulnerable since time immemorial to many natural and anthropogenic hazards, including sea level rise (SLR) and land subsidence. In addition, coastal land use in Bangladesh has undergone major changes over the past half century due to large-scale polderization and intensive shrimp farming. The region is highly exposed and vulnerable to a number of natural disasters including flood (pluvial, fluvial and tidal flood), cyclone, storm-surge, river bank erosion, salinity intrusion, etc. However, these vulnerabilities and exposures are not homogenous across the coast. Heterogeneity of the socio-economic condition, settlement pattern, land use and physical settings across the coastal region make the different region within the coast differently vulnerable. For example, the south west region of the coastal zone is highly exposed and vulnerable to water logging whereas such problems are less severe in south-central region where the PKCP will take place. In the following section natural disasters, and vulnerabilities of the PKCP area are discussed with reference to national assessments, scientific literatures and field survey.

13.4 Hazards, Vulnerabilities and Risk of PKCP Project Area

The National Disaster Management Plan (2016-2020) declared flood, cyclone, storm-surge, tornado, earthquake, riverbank erosion, landslide, salinity intrusion, drought, tsunami, lightning and arsenic contamination as natural disaster. Among them, the PKCP area is exposed to almost all-natural disasters except landslide. Barguna district is at 4th and Patuakhali is 11th according to the INFORM sub-national multi-hazard risk ranking of the country which has been recently prepared by United National Resident Coordinator Office (UNRCO)[52]. According to the INFORM multi-hazard risk sub-national index upazilas of Barguna and Patuakhali are either very high or high (except Betagi and Bamna).

[52] United Nations Resident Coordinate Office of Bangladesh, 2022 INFORM Sub-National Risk Index of Bangladesh available at shorturl.at/lMQSU

13.4.1 Flood

Having low-lying elevation, almost fifty percent of coastal lands are featured with permanent or temporary inundation over the year which reduces the effectiveness of coastal land. Generally, flood types are fluvial, pluvial and fluvio-tidal floods. Being a coastal region, the PKCP area is exposed to fluvio-tidal flood and the pluvial floods. However, according to MRVA the overall flood risk level is low to moderate due to low level of flood intensity and low to moderate level of vulnerabilities to floods (Figure 13.1). The Risk Atlas of the Planning Commission also shows the similar risk level. Distribution of PKCP study area under different flood types are shown in Figure 13.1 to 13.3. Figture 13.2 and 13.3 illustrate the settlement affected by floods in recent times. The coastal polder in this region (Polder 41~48, Polder 55/1~4, etc.) played an important role in minimizing the risk of fluvio-tidal floods.

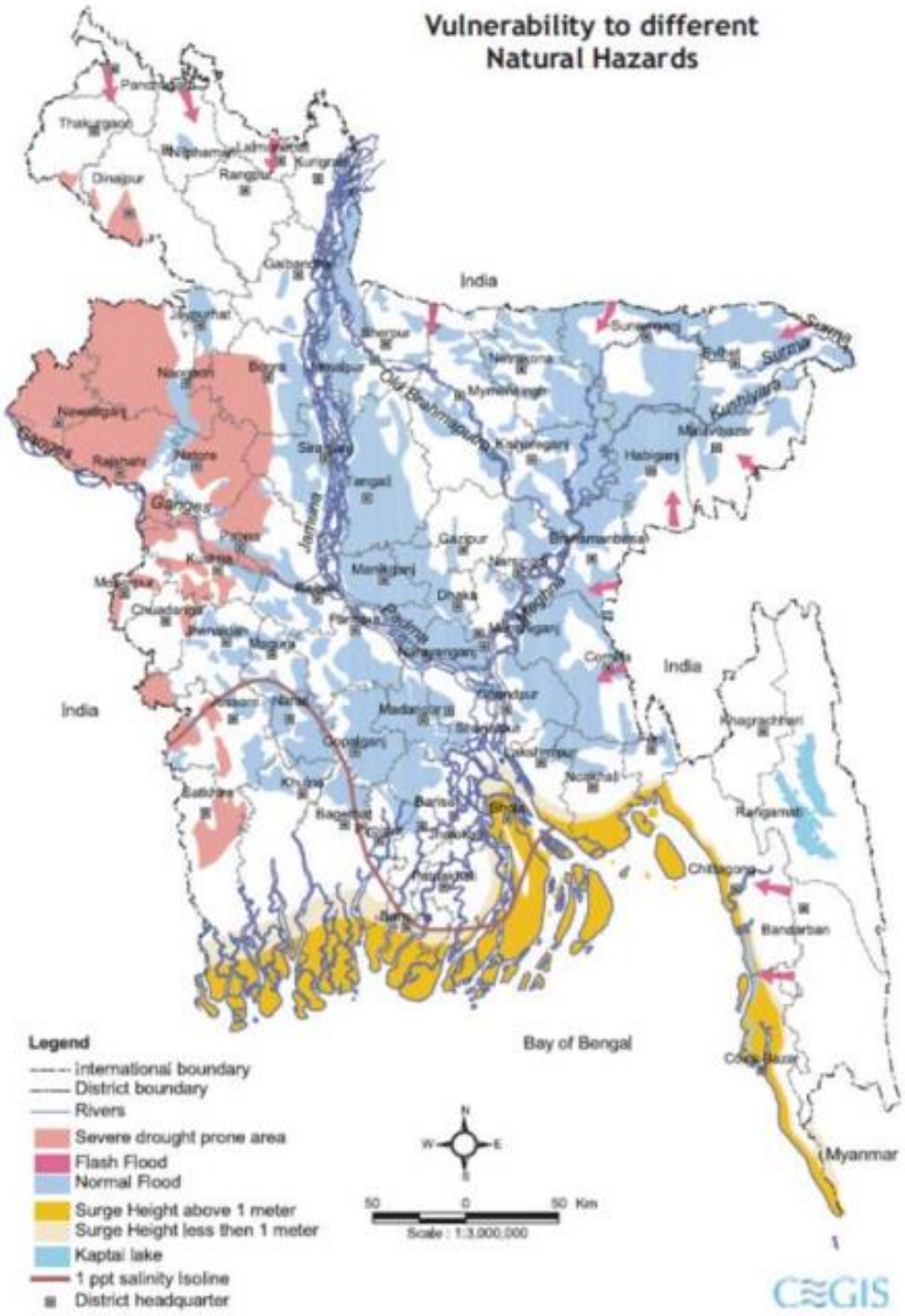
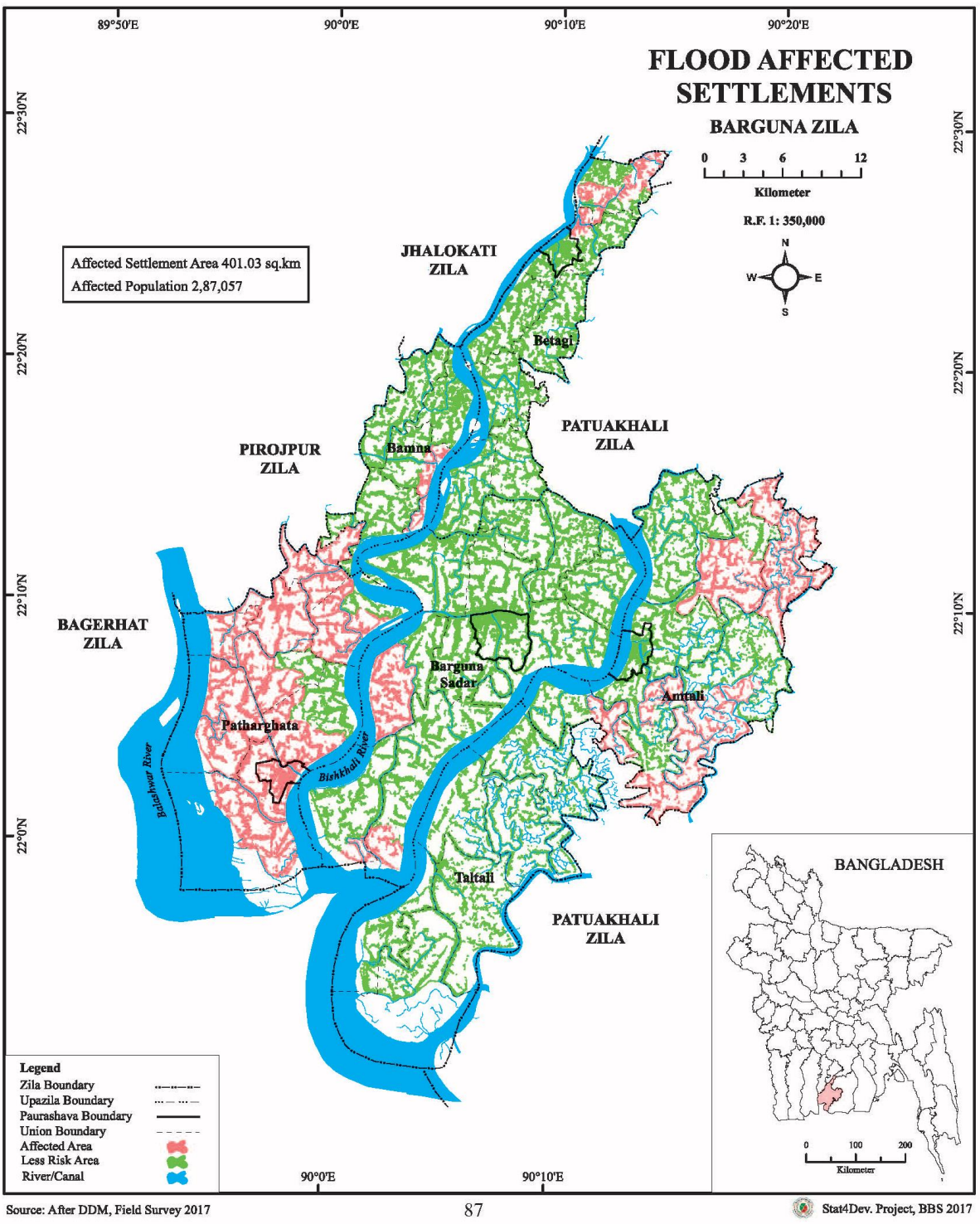
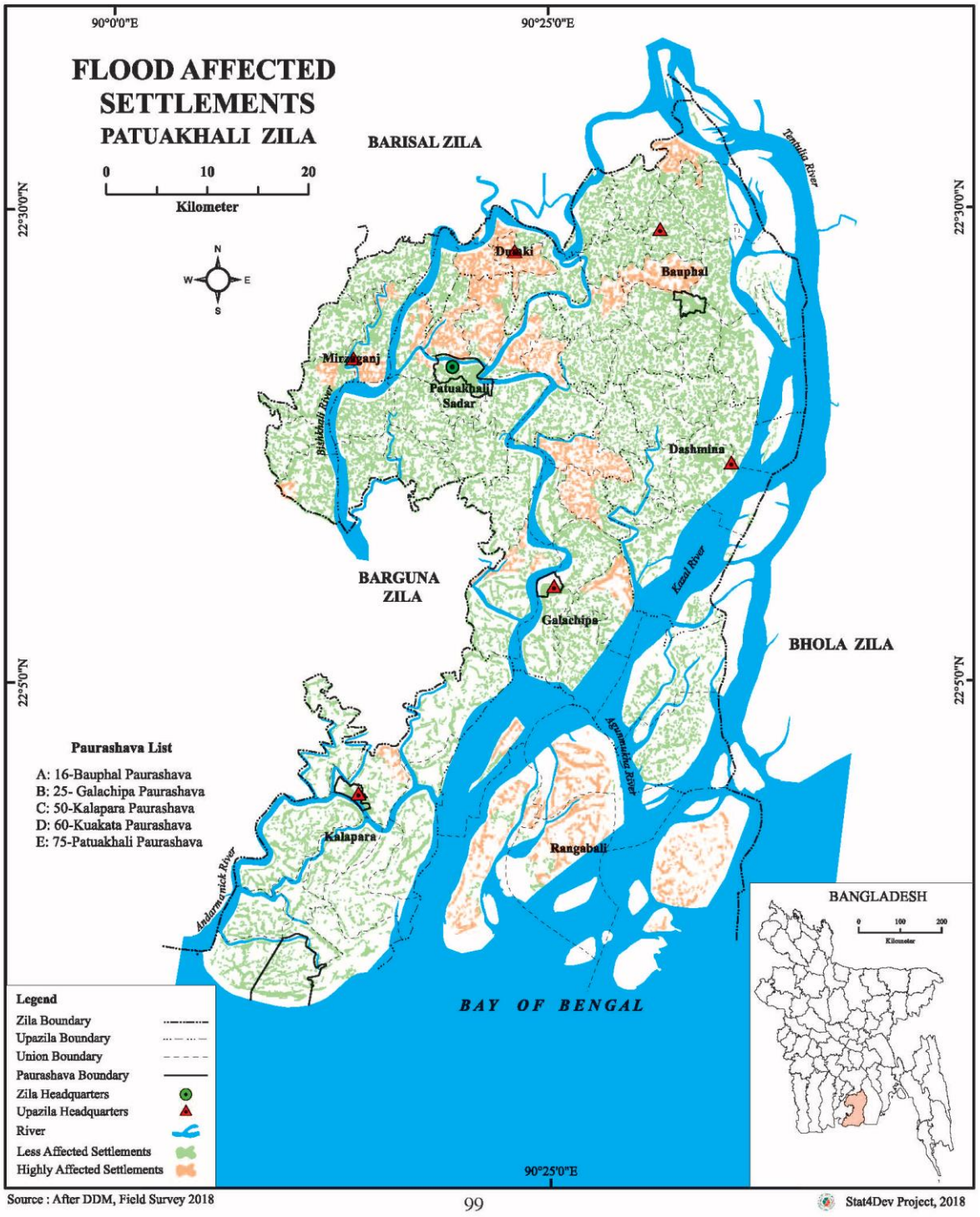


Figure 13.1: Maps of Areas Prone to Different Natural Hazards



Source: BBS (2018): Disaster Prone Area Atlas of Bangladesh-Barguna Zila

Figure 13.2: Flood affected area of Patharghata, Barguna Sadar, Amtali and Taltoli Upazila



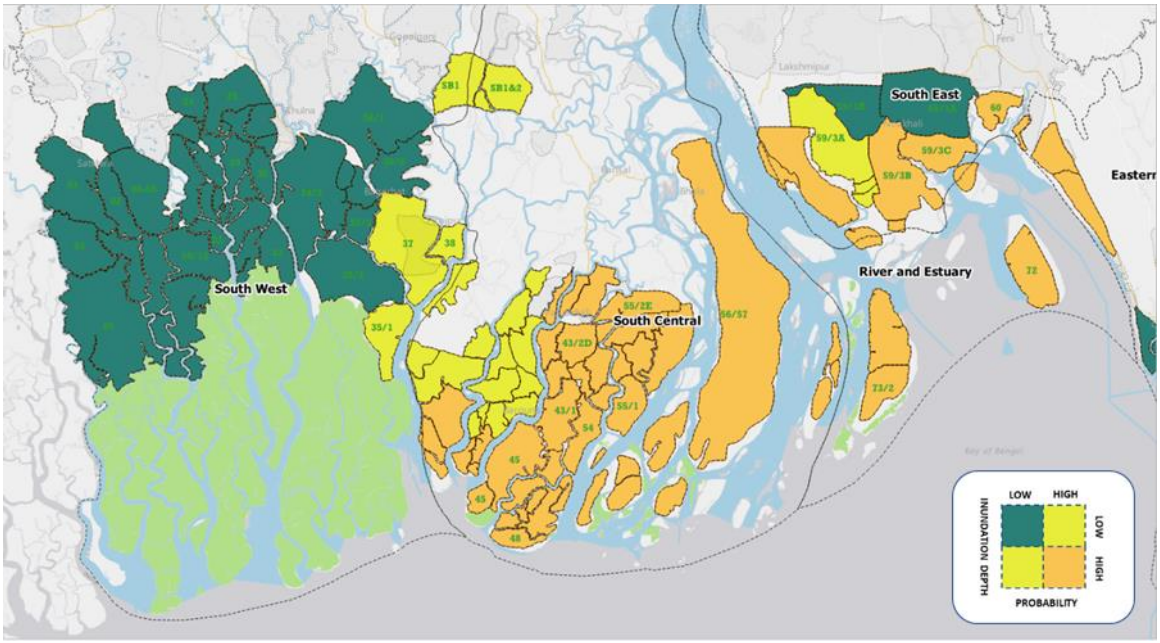
Source: BBS (2018): Disaster Prone Area Atlas of Bangladesh- Patuakhali Zila

Figure 13.3: Flood affected area of Kalapara, Galachipa and Rangabali Upazila

13.4.2 Tropical Cyclone and Storm Surges

Bangladesh is one of the worst sufferers of cyclone and storm surge in the world. The number of casualties increase when tropical cyclones from the Bay of Bengal accompanied by storm surges. On average, Bangladesh is hit by cyclones of varying severity two to three times a year. (Sabur, 2015). 21 tropical cyclones (wind speed >117 km/hr) and severe cyclones (wind speed between 87 to 117 km/hr) struck the Bangladesh coast between 1960 and 2010 (MoEFCC, 2018b).

The peak season of cyclone is pre-monsoon (May–June) and post-monsoon (October–November) when 70 % of total cyclone hit the coast (Sarwar 2005). A recent study conducted under CEIP-I project of BWDB carried out an assessment which classified the Patuakhali, Kuakata abd Barguna (partial) with high probability of cyclone and storm surge and with high inundation depth (Figure 13.4). Historically the south-central part of the coast (PKCP area is under south central) faced a number of severe cyclone and storm surge. The 1970 which claimed over 500,000 lives in the coast mostly affect the south-central part of the coastal zone. This region was also affected by cyclone 1991, and Cyclone Sidr (2007). The Figure 13.5 and 13.5 show the distribution of the settlement affected by recent cyclones in Barguna and Patuakhali districts.



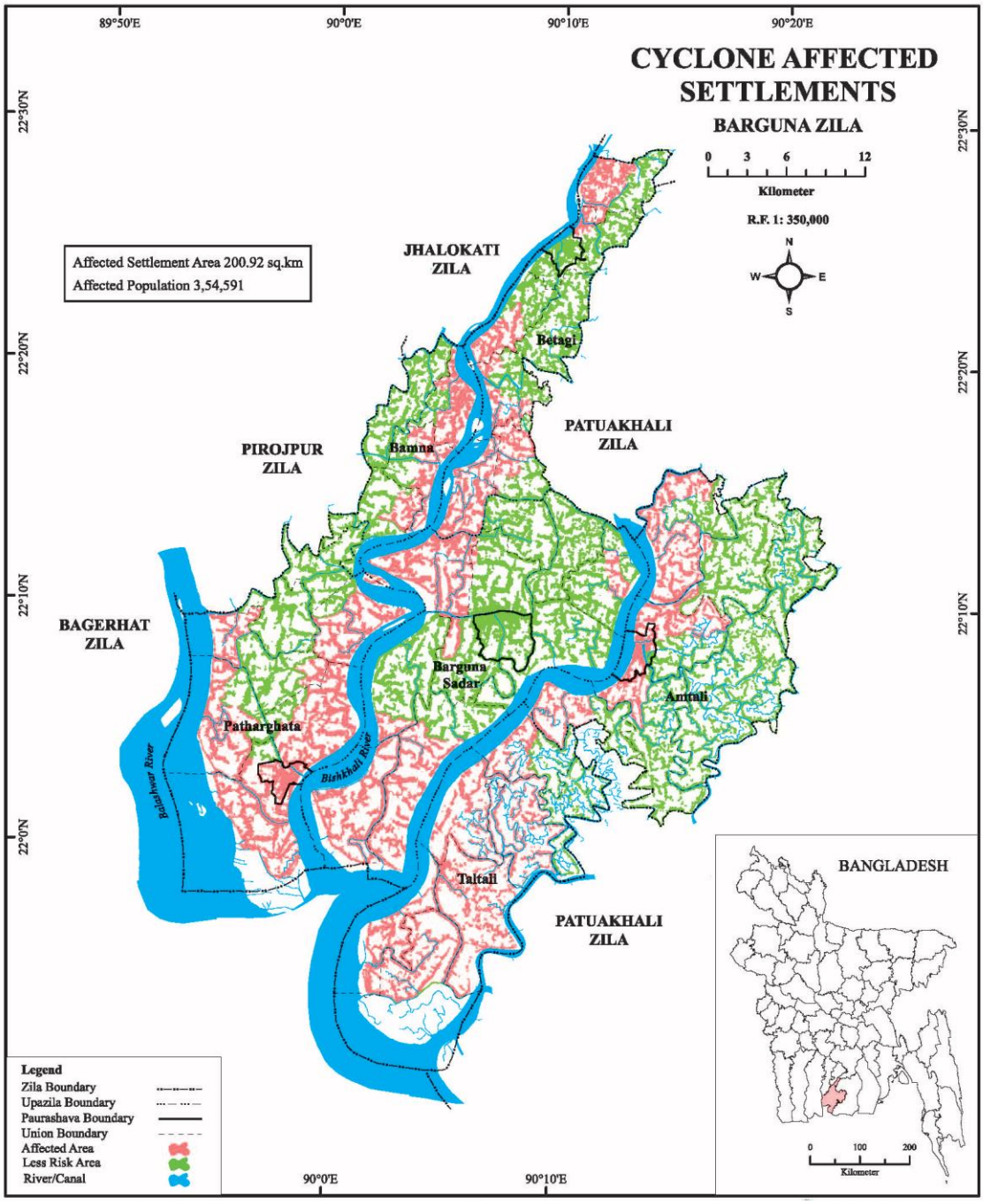
Source: SIBDP, 2022. Implementation Program Report of Extensive Coastal Zone. Support to Implementation of BDP 2100, General Economic Division, Planning Commission, Bangladesh

Figure 13.4: Simplified storm surge hazard map in the coastal region (based on storm surge modelling CEIP-I)

Recently, the Cyclone 'Mohaseen' made land fall between Bhola and Patuakhali districts of Barisal division, Bangladesh on May 16, 2013. Almost 10,42,340 people affected in the three coastal districts where Barguna is worst affected considering the scale and proportion of the population affected. Around 59% of population Barguna and 19% of population of Patuakhali district was affected respectively by 'Mohaseen' and Total no. of affected household was 1,74,399. Significant impact on agriculture also noted where Barguna was again the worst affected district in terms of cultivated land (57% was affected), followed by Patuakhali (46%).

The vulnerability to cyclone and storm surges is related to high population density, low development of infrastructures, limited availability of disaster resilient infrastructures, poor water supply and sanitation situation, and the physical settings. Although the coastal polders which were constructed to protect lands from salinity intrusion and tidal floods are in place, the role of coastal polders in storm-surge risk reduction is limited because they were not designed to protect storm surge, it only gives additional minutes to evacuate. Besides, due to a lack of maintenance, most of coastal

embankments nowadays are partially or completely eroded. (Sadik et. al., 2019 and Bernard et. al., 2021)[53].



Source: BBS (2018): Disaster Prone Area Atlas of Bangladesh-Barguna Zila

Figure 13.5: Cyclone Affected Zones (Risk Areas) in Patharghata, Barguna Sadar, Amtali and Taltali Upazilas

[53] Sadik, M. S., Nakagawa, H., Rahman, M. R., Shaw, R., Kawaike, K., Fujita, K., & Parvin, G. A. (2019). Recovery of Coastal Polder after Cyclone Aila in Koyra, Bangladesh. In H. Khatun, A. Baqee, & M. H. Kabir (Eds.), People at Risk (pp. 139–155). Disaster Research Training and Management Center, Dhaka University.

Source: BBS (2018): Disaster Prone Area Atlas of Bangladesh-Patuakhali Zila

Figure 13.6: Cyclone Affected Zones (Risk Areas) in Kalapara, Galachipa and Rangabali Upazilas

13.4.3 Coastal Erosion-Accretion

The coastal zone of Bengal delta is very dynamic because of the continuous erosion and accretion at the coastline. An estimated load of 1 billion tons of sediment carried out by the GBM basin which resulting accretion in the Bengal basin; on the other hand, tidal forces and wave action cause erosion to coastal lands (after Sarwar et al., 2013). Ahmed et al. (2018) published a study on coastal geospatial

analysis which identified a total of 2693.80 km^2 of coastal lands that experienced erosion and/or accretion (or both erosion and accretion) over the past thirty years from 1985 to 2015. The same study reported that out of the entire coastal area about 0.59 % (266.32 km^2) and 0.02 % (10.01 km^2) of the coastal lands exhibit high and very high susceptibility to erosion, respectively which is noteworthy for the densely populated coastal area of the country. The remaining 99.43 % of lands were identified as having moderate to very low susceptibility to erosion. Although the river bank area of the coastal region exhibits susceptibility to erosion, the estuarine area shows a net gain of land during 1989-2018 (Figure 13.7).

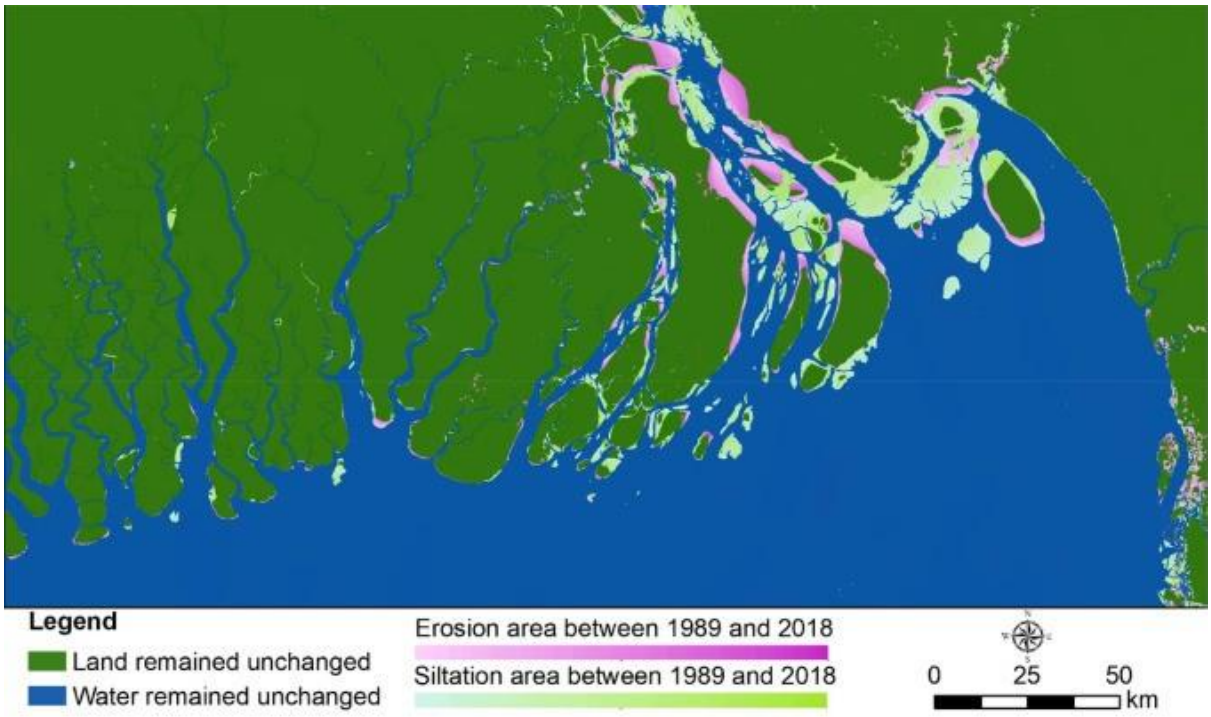
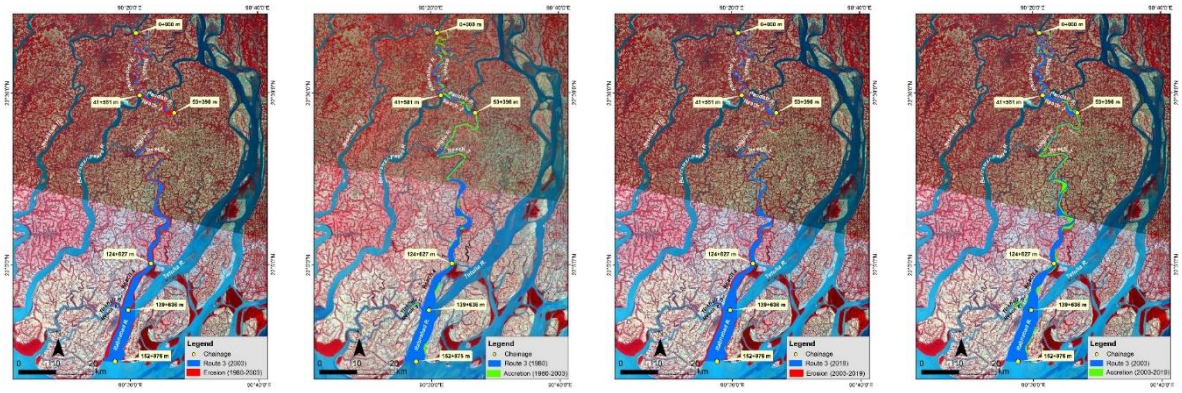


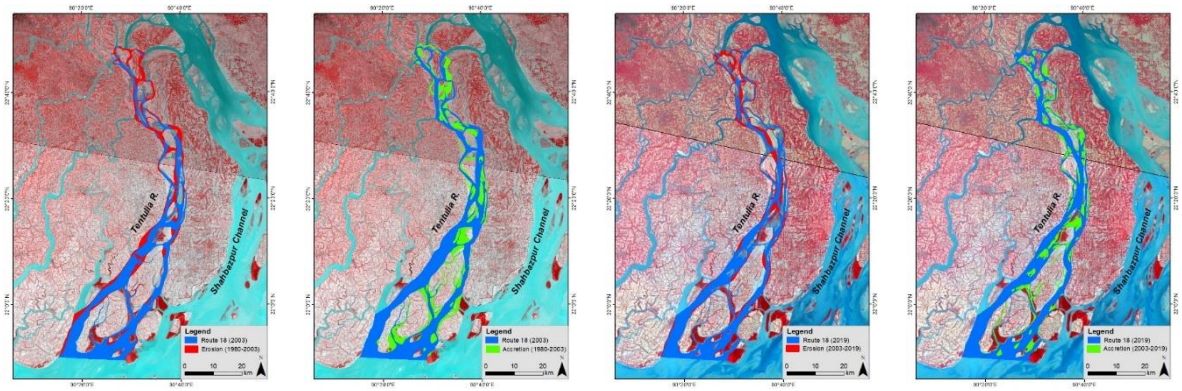
Figure 13.7: Coastal land expansion in northern Bay of Bengal (1989–2018)

Dark green represents regained land area that is unchanged, light green shows gradual reformation into a new island area, and pink represents land area lost into waterbodies. The net gain in land for Bangladesh during this period was around 1.15% (590 km2). (Source: Uddin et al., 2020).

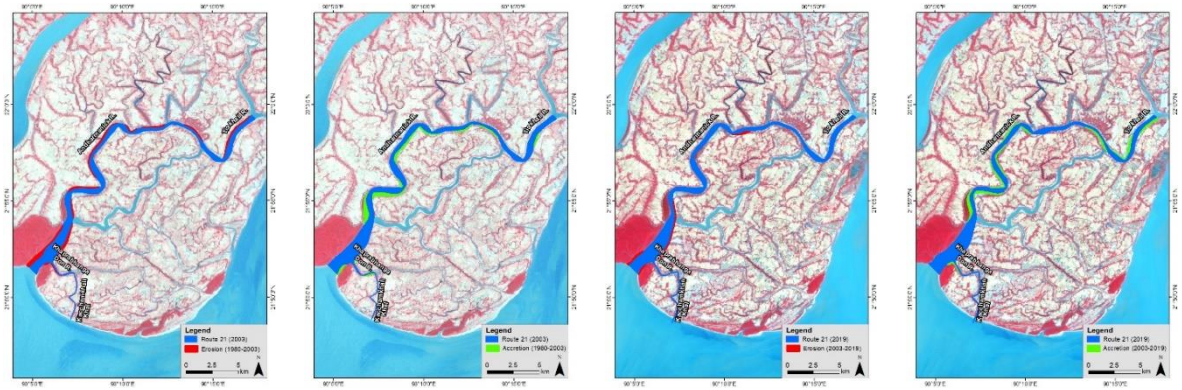
According to CEGIS estimate, the rate of erosion along the major river varies between 38.13 ha/year to 0.2ha/year. The high erosion was observed in Rabnabad river. The accretion rates vary between 56ha/year to 0.2ha/year. The highest accretion was observed in Lohalia river (Table 13.4 and Figure 13.8). In general, erosion is dominating in Rabnabad channel.



Erosion and accretion along the Khairabad, Pandab, Lohalia, Rabnaba during 1980-2019



Erosion Accretion along the Tentulia River



Erosion-Accretion of along the Tiakhali, Andarmanick, Khaprabhanga Don River and Kachamkhali khal during 1980-20019

Figure 13.8: Erosion Accretion along the major river in PKCP study area

Table 13.4: Erosion and Accretion along the major river in PKCP area

River Name	Time Span	Erosion (ha)	Rate of Erosion (ha/year)	Accretion (ha)	Rate of Accretion (ha/year)	Net (ha)*
Khairabad	1980-2003	156	6.50	111	4.63	-45
	2003-2019	61	3.59	27	1.59	-34
Pandab	1980-2003	263	10.96	114	4.75	-149
	2003-2019	75	4.41	71	4.18	-4
Lohalia	1980-2003	484	20.17	257	10.71	-227
	2003-2019	145	8.53	957	56.29	812
Rabnabad	1980-2003	915	38.13	129	5.38	-786
	2003-2019	386	22.71	196	11.53	-190
Tiakhali	1980-2003	26	1.08	21	0.88	-5
	2003-2019	6	0.35	31	1.82	25
Tentulia	1980-2003	15	1	22	1	7
	2003-2019	11	1	15	1	4
Tiakhali	1980-2003	25	1	7	0	-18
	2003-2019	0	0	53	2	53
Andarmanick	1980-2003	214	9	208	9	-6
	2003-2019	70	3	138	6	67
Khaprabhanga Don	1980-2003	5	0.2	5	0.2	0
	2003-2019	0	0	0	0	0

13.4.4 Salinity Intrusion

Because of the low elevation (1.5 to 11.8 meters above the mean sea level), coastal region of Bangladesh is highly affected by salinity intrusion. About 53% of coastal areas were affected by salinity (Minar et. Al., 2013). Several reports show that with the consequence of climate change, it gradually extends towards inland water and soil. In the wet season, coastal low land is directly inundated by saline water adding salt to soil. On the other hand, during the dry season, the decrease in freshwater flow from upstream accelerate the upward flow of groundwater saline water, which increases soil salinity in coastal areas. Moreover, ancient flood control interventions caused water logging in different parts of the coastal zone, when the embankments were flooded by extreme tidal surges; saline water was trapped inside the regulated area and became stagnant. The prolonged standing of saline water added salt to agricultural land turning it to saline soil (adopted from Sarwar et al., 2013).

Historic salinity data illustrate by CEGIS in 2021 shows an increase of water salinity in Khulna from 0.7 ppt to 16.8 ppt in the Rupsa River over 50 years (from 1962 to 2011). The low salinity (0 to 2 ppt) level was found in the south-central zone which was mostly because of the significant volume of freshwater flow from the Padma River and the Lower Meghna River. But in the last few years, salinity have begun to have an adverse effect on the rivers of Barisal division. A news item published by Prothom Alo on May 07, 2021[54] mentioned that according to the Soil Resource Development Institute

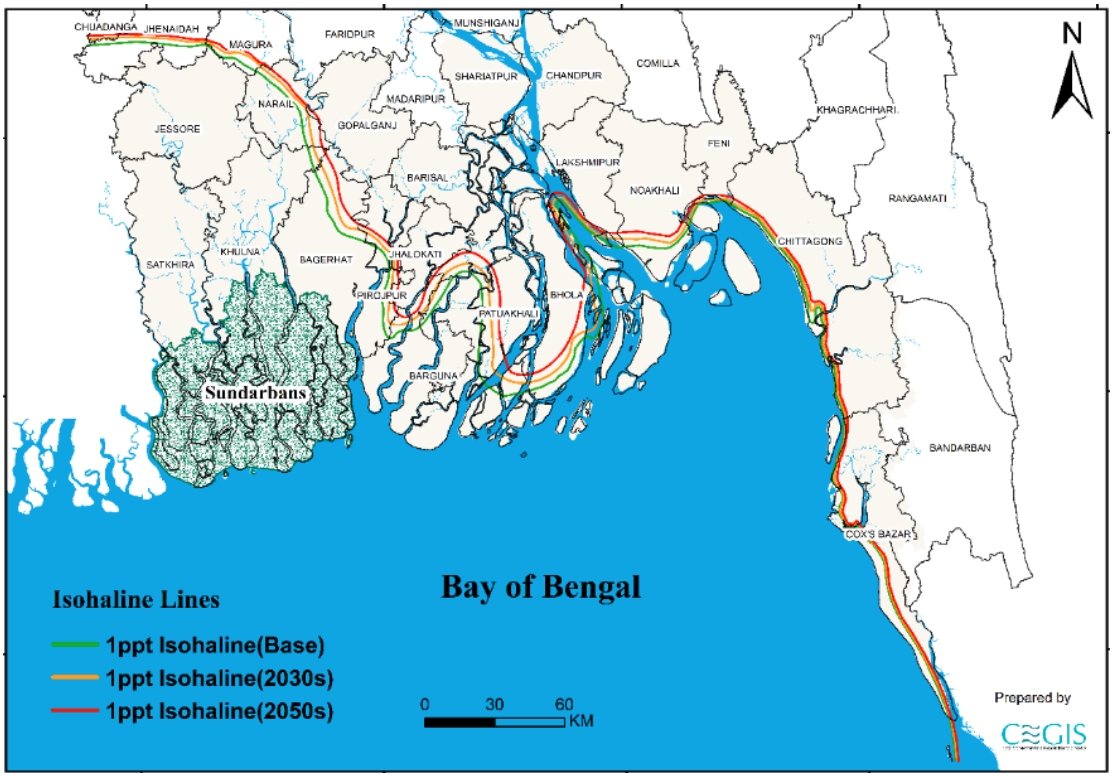
[54] https://en.prothomalo.com/bangladesh/salinity-affects-people-and-agriculture-in-barisal

(SRDI) data in April, the salinity level of Bishkhali River in Barguna was 2,084 µS/cm while the level was 3,071 micro Siemens against every centimetre of Lohalia River in Patuakhali. On the other, the salinity was 12,080 micro Siemens in the Amtali section of the Payra River and 14,040 Siemens in the Charduani section of the Baleshwar River. In March 2018, the level of salinity at Betagi Point of Bishkhali River in Barguna was 1725 micro Siemens. At that time in 2020, the level was 1,587 micro Siemens against each centimetre. Salinity intrusion in the southwest region reduces the freshwater supported area, resulting in decreased agricultural production in many parts of the coastal zone, especially the Khulna and Patuakhali region and small areas in the Noakhali and Chattogram.

The area of saline soil rising as observed by the Soil Resources Development Institute (SRDI) that soil salinity of coastal lands increased about 26.7% from 1973 to 2009, amounting to approximately 0.223 million hectares, where around 35,440 hectares of new land had become saline only between 2000 and 2009 (SRDI, 2010). Individual soil salinity of Noakhali, Jessore, Barisal and Barguna District which had increased by about 7 %, 11.5 %, 100 %, and 124.33 % respectively for the period 1970–2000 (Sarwar et al., 2013).

An assessment of the soil profile at Kalapara Upazila, Patuakhali district was studied by Khanam et. Al., in 2020 which shows that soils of the studied upazila were strongly acidic having mean pH value of 4.11, and 4.83 in 0-5, and 5-10 cm soil depth, respectively. The salinity condition of PKCP study area has analysed from DAE data and shown in Figure 13.9.

The Sea Level Rise would increase the salinity ingress. According to CEGIS analysis, the 1 ppt salinity affected areas will be increased by 7.5% in midterm, while the 5 ppt salinity area will increase by 9%. The situation will be worse on the western coast (Figure 13.9). This scenario of gradual salinity intrusion into the coastal areas of Bangladesh is very threatening to the primary production system (consist 30% of the country's cultivable land), coastal biodiversity and human health.



Source: CEGIS Bay of Bengal Model

Figure 13.9: Surface water salinity distribution in coastal Bangladesh due to climate change

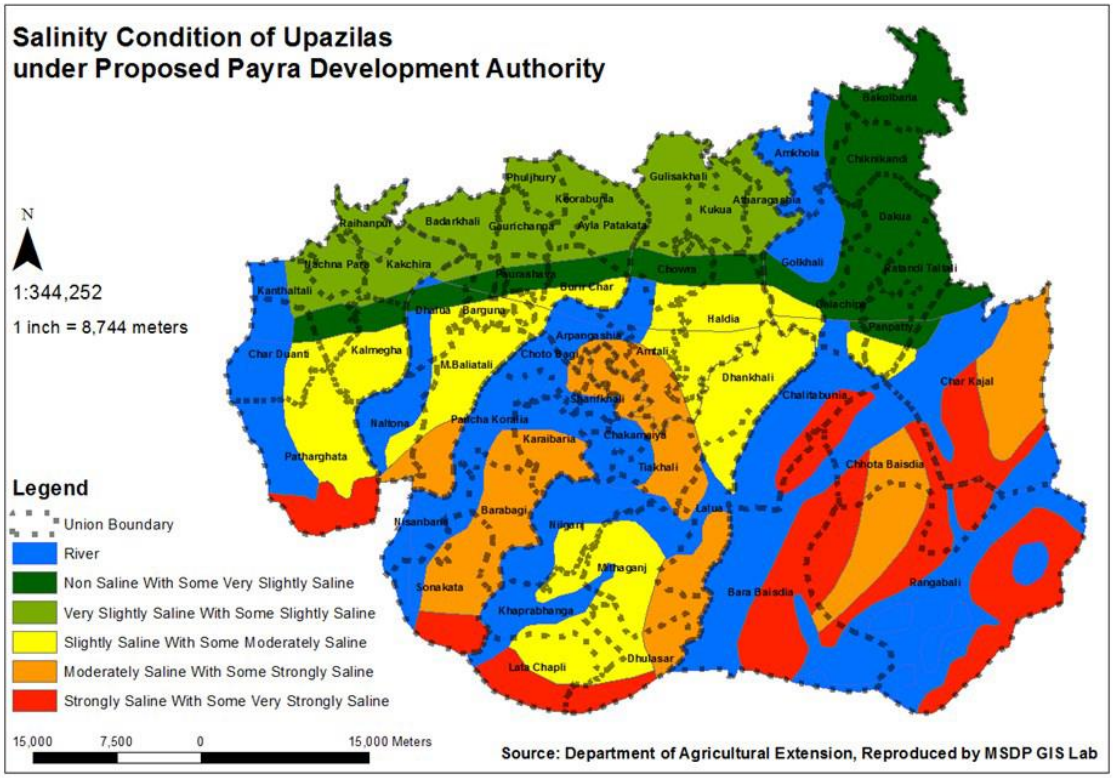


Figure 13.10: Salinity Condition of Upazilas under Proposed Payra Development Authority

13.4.5 Drought

The National Multi Hazard Vulnerability and Risk Assessment (MVRA) (DDM 2016)[55] categorized this region as a low risk to drought. The Bangladesh Climate and Disaster Risk Atlas (Planning Commission 2021[56]) categorized this region with low risk of Kharif Drought but medium risk of pre-kharif drought.

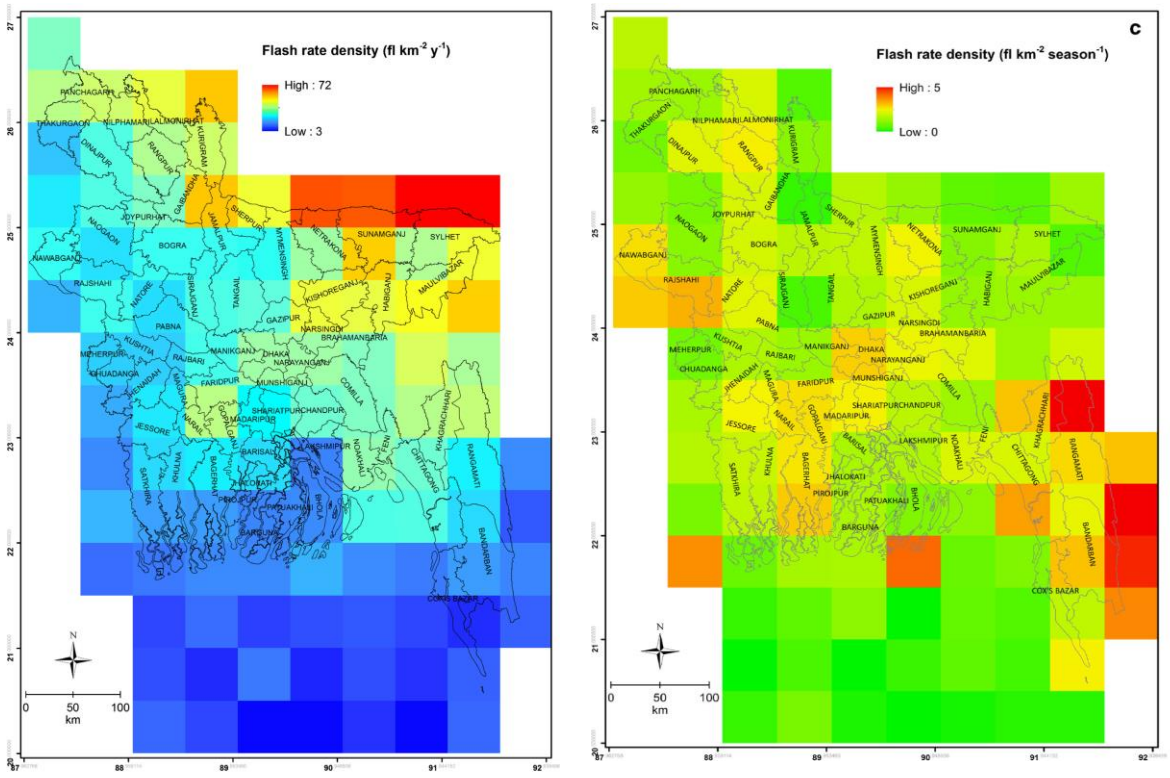
13.4.6 Lightning

In recent time, the lightning has ben reportedly increasing in the country. The Department of Disaster Management has recently declared the lightning as a natural disaster. Accordingly, the National Disaster Management Plan 2015~2020 and 2021-2025 included risk reduction measures against the lightning. Generally, lightning starts from March and remain active up to October-November. Lightning frequency, lightning injury and lightning death is the highest in May (Dewan et al., 2017). Dewan et al (2017) estimated 3,086 fatalities and 2,382 injuries from 1990 to mid-2016 due to lighting. 93% of the lightning mortality took place in rural area. He reported annual averages of 114 fatalities and 89 injuries during 1990-2016. The recent estimation of BBS (2022a), showed death rate due to lightning in the last six years was 368 persons/ year.

[55] Department of Disaster Management (DDM), 2016. Multi Hazard Risk and Vulnerability Assessment, Modeling and Mapping. Department of Disaster Management, Ministry of Disaster Management and Relief, Government of People's Republic of Bangladesh.

[56] Planning Commission, Ministry of Planning and Asian Development Bank. 2021. Bangladesh Climate and Disaster Risk Atlas: Hazards—Volume I. Dhaka, Bangladesh and Manila, Philippines.

Lightning incidents are generally low in coastal region. The annual flash rate density shows that the north-eastern region has highest flash rate. however, in post monsoon, the South-central region (PKCP area) exhibits high flash rate as well (Figure 13.11).



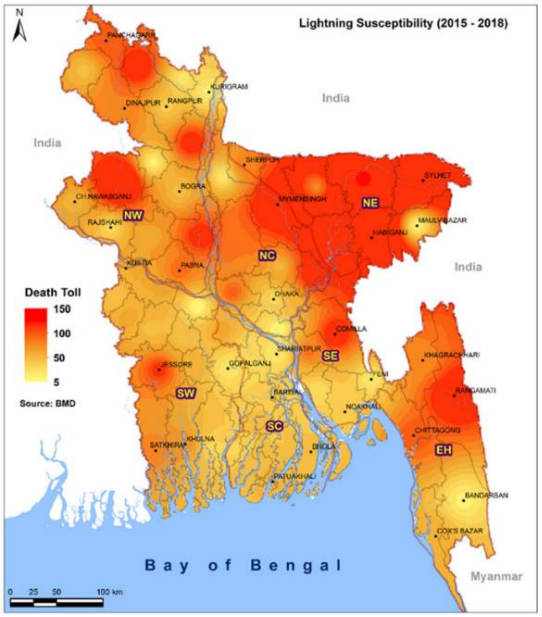
Flash rate density in a year

Flash rate density in Post-monsoon

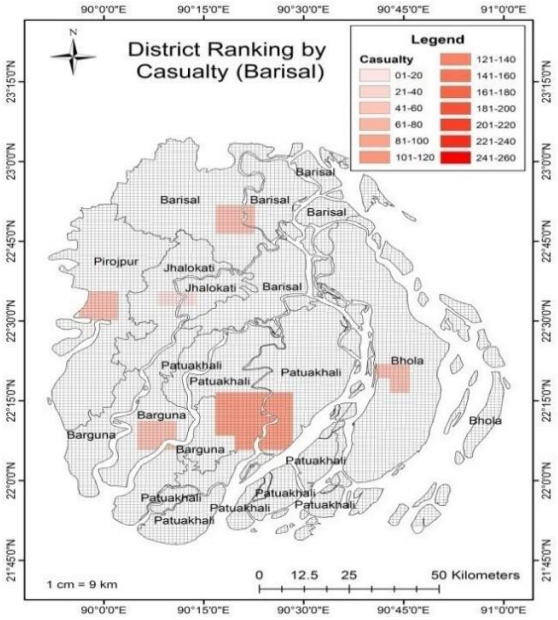
Source: Dewan et al., 2017

Figure 13.11: Flash rate Density of Lightning

An estimation showed there were 141 lighting event in thunderstorm days in Patuakhali district (Farukh et al. 2017) which needs to be taken into a consideration. From this study, it is revealed that Barguna is also prone to lightning injury and lightning death to a certain extent. Spatial distribution of lightning susceptibility from 2015-2018 in Bangladesh has analysed by CEGIS in 2021 from BMD data shown in Figure 13.12.



Lightning suseptability



Lighting casualty in Barisal

Source: Farukh et al., 2017

Figure 13.12: Spatial distribution of Lightning Susceptibility in Bangladesh

(Source: CEGIS analysis from BMD data)

13.5 Driver of Change

Bangladesh has been considered as a role model among the developing countries which remarkably reduced the disaster mortality by improving disaster awareness, evacuation behaviour, early warning dissemination and reducing vulnerability. However, there is still a long path to travel for reducing the disaster damage and building nation-wide disaster resilience.

Table 13.5: Drivers of Changes in Disaster Management Sector

Key change	Main external drivers	Main internal drivers	Main actions to "fuel" or "brake" the drivers, depending on whether the change is good or bad
Decrease of disaster mortality	International cooperation, global awareness and influence	• Early warning dissemination and cyclone shelter • Improvement of evacuation behaviour • Improvement of disaster governance	• Institutional strengthening by enacting law and streamlined DRR into policy and plans • Community Awareness and risk communication by local voluntary groups. • Partnership/cooperation with NGOs and international humanitarian agencies
Improvement of Disaster Safety	International cooperation, global awareness and influence	• Investment in DRR programs • Introducing a new regulatory tool – "Disaster Impact	Construction of cyclone shelter Construction of disaster safety infrastructure e.g. flood embankment, erosion protection work, etc.

Key change	Main external drivers	Main internal drivers	Main actions to "fuel" or "brake" the drivers, depending on whether the change is good or bad
		Assessment" for ensuring integration of DRR into infrastructural development project	
Improvement of delivery mechanism of social protection program	International cooperation, global awareness and influence	• Improving delivery mechanism • Introducing a systematic approach in beneficiaries' selection	Introducing Government to Person Payment (G2P) by mobile banking & banking channel.

13.6 Key Issues of Disaster Management

- The PKCP area has high vulnerability and risk to multi-hazard. Among different hazards, cyclone and storm surge are deadly and damaging. Therefore, any regional development plan should consider integrated disaster risk reduction against cyclone and storm surge in the plan
- Next to cyclone and storm surge, erosion is another threatening natural hazard here. Therefore, infrastructure along the river bank should have erosion protection measures.
- The Government has recently introduced a new regulatory requirement for project appraisal– the implementing agency must conduct Disaster Impact Assessment (DIA) for a project before submitting it to the Bangladesh Planning Commission for appraisal.
- The Department of Environment also require carrying out DIA together with EIA for any red category project.

14. Social Issues and Challenges

14.1 Population

14.1.1 Population Related Administration/Competent Authorities

Key aspect in the theme	Primary competent authority (CA)– and their mandates	Key support organisations (govt, NGO, donor, CBO, etc.)	Performance of CA and support organisations
Demography	MOHFW	NIPORT Department of Family Planning	To ensure quality reproductive health services. • Availability of family planning methods • Lower Fertility Rate • Increase Life Expectancy • Lower Growth Rate

14.1.2 Population Related Legislation and Regulations

Key aspect in the theme	Primary legislation	Accompanying or enabling regulations	Comments on adequacy or not re. legislation and regs
Demography	Not Available in BD till date		N/A

14.1.3 Population Related PPPs

Key PPPs relating to the theme	Main projects emanating from the PPPs	Main negative environmental impacts emanating from the projects	Main negative socio-economic impacts emanating from the projects
Population Policy 2012	No direct project is found.	Not applicable	Not applicable
Health and Population Sector Program (HPSP) (1998-2003)		Not applicable	one-stop' service model, to deliver basic health and family planning (FP) services to rural communities but in rural and remote areas it was tough to continue.
Health, Nutrition and Population Sector Program (HNPSP) (2003-2011)		Not applicable	User friendly and accessible quality HPN services are not provided due to lack of consciousness among the people and lack of technical manpower.
'Health, Population and Nutrition Sector Development Program (HPNSDP) (2011-2016)		Not applicable	Challenges to combat with the communicable diseases like Diabetic, cardio vascular diseases etc.
Health, Population and Nutrition Sector Programme (2017-2022)		Not applicable	There is a challenge combating with current pandemic COVID-19. inadequate and ineffective service delivery in the hilly, char and the coastal areas where provision of human resources remains a problem.

14.1.4 Drivers of Change

Key change	Main external drivers	Main internal drivers	Main actions to "fuel" or "brake" the drivers, depending on whether the change is good or bad
Reducing Total Fertility Rate and growth rate	Different Government programs	Changes in people's perceptions and consciousness	Support/ providing tool kits of family planning to the rural areas.
Reducing maternal Mortality Ratio	Programs for supporting child birth by skilled assistance	Consciousness among massive people	Increasing maternal and neonatal health service provide
Increasing Life expectancy	Providing quality health service	Increasing nutritional food security	Food security and increasing food production
Use of contraceptive	Providing contraceptive tool kits by different combined programs of NGO	People's awareness building regarding family planning	Availability of contraceptives at cheap rate

14.1.5 Main Issues Concerned with Population

- Population control through family planning program
- Use of contraceptive as an effective tool for family planning thus triggering population control
- Reducing TFR 1.32% in 2019 from 1.37% in 2015.
- Reducing maternal and neonatal mortality
- Bangladesh's shift from an ageing to an aged society following the above definition Bangladesh will transition to ageing in 2029, just 9 years from 2020. It will take only 18 years from "ageing" to shift to an "aged" society (i.e. in 2047).

Bangladesh is one of most densely populated countries in the world with an estimated 165.16 million people in 2022 (Preliminary Census Report, BBS 2022). According to the Population and Housing Census, 2022, the population of Patuakhlai and Barguna district is 2.74 million (BBS 2022). However, total seven (07) upazila (administrative unit of Districts) has been taken into consideration this SEA. As the very new census (2022) initial publication lacks of Upazila specific data thus previous census 2011 were taken as the base year and projected up to 2022 using most recent fertility, mortality migration trends as components of Cohort components method. Fertility and Life expectancy up to current date 2020 has been collected from Bangladesh Sample Vital Statistics Survey 2020. Net migration rate includes the figure for the difference between the number of persons entering and leaving a country during the year per 1,000 persons (based on midyear population). The net migration rate indicates the contribution of migration to the overall level of population change. Net migration rate for male in 2011 is -1.57 per 1000 people in Bangladesh (CIA World Factbook) and current data shows -2.9. Thus migration data from base year (2011) to projected year (2022) used from-1.57 to -2.9. For projection the net migration for male and female is used -1.57 and for female -0.2 (BIDS, 2014). As no records of female net migration is available anywhere thus it is assumed -0.2 for female and it is constant up to 2022. Using all these component data following equation is used and applied through Spectrum application software (Stover and Kirneyer 1997).

$$P(t+n) = \sum(survived\ population + Births + Net\ Migrants)$$

The population of study area (07 Upazilas) in that year (the base year) was 12.82 million. Projections data includes that there will be 14 million people in the study area and in current year there will be

14.30 millon people are living in this area. The annual average growth rate of Barisal division is 0.79%(Preliminary Census Report, BBS 2022) while annual growth rate is assumed to be 1.18% in 2025 (8th five-year plan.

Table 14.1: Population in the study area with projection up to 2022

Districts	Upazila	Population in Million			
		Base year-2011	Projection-2015	Projection-2020	Projection-2022
Patuakhali	Kala Para	2.38	2.47	2.60	2.65
	Golachipa	2.59	2.69	2.82	2.88
	Rangabali	1.03	1.07	1.12	1.14
Barguna	Taltali	0.88	0.91	0.96	0.98
	Amtali	1.70	1.77	1.85	1.89
	Patharghata	1.64	1.71	1.80	1.83
	Barguna Sadar	2.61	2.72	2.85	2.91
Total		**12.82**	**13.33**	**14.00**	**14.30**

Bangladesh is now experiencing a demographic transition with lower fertility rate that is gradually decreasing growth rate has now been reduced to 1.32% in 2019 from 1.37% in 2015 (SVRS 2019). There has also been reduction in dropout rates and unmet needs which stood at 37% and 12% respectively (BDHS 2017-18).

In 1976, the government declared the then rapid growth of the population to be the country's number one problem and adopted a broad-based, multisectoral family planning programme along with an official population policy (GOB, 1994). Population planning was seen as an integral part of the total development process and was incorporated into the successive five-year plans. Policy guidelines and strategies for the population programme are formulated by the National Population Council. However, population growth was identified as one of the major national problems in the first Five Year Plan (1973–1978). The main objective of the Bangladesh Population Policy 2004 was to achieve net reproductive rate (NRR) of 1 by 2010 in order to have a stable population by 2060. But it did not prove possible to achieve this rate by 2010. So a revised population policy (2012) aimed to lower the TFR to 2.1 by increasing the rate of contraceptive user to 72%, and achieve NRR=1 by 2015. Other important objectives of the 2012 policy were to ensure the availability of family planning methods to eligible couples (by providing easy access to reproduction health services), to reduce infant and maternal mortality and to ensure gender and women's empowerment (BBS, 2015).

However, after completing a successful seventh five-year plan govt has fix some indicators and fix a target to be achieved by next five-year plan.

Table 14.2: Health and Population Target for the 8th Five Year Plan

Sl No	Indicator	Baseline and Source	8th Five Year Target (2025)
1.	Life expectancy at birth	72.6 (SVRS,2019)	74
2.	Maternal mortality ratio (per 100,000 live births)	165 (SVRS, 2019)	100
3.	Proportion of births attended by skilled health personnel	59% (MICS, 2019)	72%
4.	Neonatal mortality rate (per 1,000 live births)	15 (SVRS,2019)	14

Sl No	Indicator	Baseline and Source	8th Five Year Target (2025)
5.	Infant mortality Rate (per 1,000 live births)	21 (SVRS,2019)	18
6.	Under-five mortality rate (per 1,000 live births)	28 (SVRS, 2019)	27
7.	Total Fertility Rate (TFR)	2.04 (SVRS, 2019)	2.0
8.	Contraceptive Prevalence Rate (%)	63.4% (SVRS, 2019)	75%

Following Oizumi (2013) and others, a society is referred to as "ageing" if 7 per cent of the total population is 65 and above. A society is transition to an "aged" stage when the share of 65 and older population in total population is 14 per cent. The time required for Bangladesh's shift from an ageing to an aged society following the above definition Bangladesh will transition to ageing in 2029, just 9 years from 2020. It will take only 18 years from "ageing" to shift to an "aged" society (i.e. in 2047). In the study area the average aged population is 5.7% of total population. Here Patharghata upazila has the highest number of aged population (6.2%) compare to other upazials of study area. Government different initiatives and programs since independence reduce the population growth by popularizing different contraceptive use and prevention measure. Eventually TFR goes down however life expectancy is getting high with the passage of time that is leading to the aged society.

Lower fertility rates, however, tell half the story. Birth rates and child mortality combined with fertility rates paint a picture of the "demographic dividend"—more people of working age than children. (Ramisa, 2019). The demographic may boost the economy with increased number of people in work and having proper health provisions, and improved infrastructure, etc. Low child mortality, birth and fertility rates, could support achieving sustainable economic growth. However, a large number of the younger working population lack employment and job opportunities. The unemployment rate in Bangladesh is still high (10.6%). 29.8% of all youths are neither in education, nor in employment or training (NEET) (Ramisa, 2019). Similarly, there is rising income inequality. The poorest 5% earned 0.78% of the national income in 2010, but only 0.23% in 2019 (Ramisa, 2019). Life expectancy has improved from 70.7 in 2014 to 72.8 in 2020 (SVRS,2020) It is higher for females (74.5) than males (71.2) - the latter are more prone to accidents and chronic vulnerability to fatal diseases. The mortality rate for children is decreasing.

Bangladesh is considered to be one of the country's most vulnerable climate change due to a combination of factors: dense population in the coastal zone; 'feeble' economic conditions (IPCC, 2007); geographical location and low topographic relief, associated with tropical climate conditions. These challenges potentially exacerbate the risks of human and material losses, including impacts on agriculture production (Haque, 2018). People are very vulnerable to frequent disasters like tropical storms, cyclones and storm surges. It has been estimated that, by 2050, one in every seven people in Bangladesh will be displaced by climate change (The Humanitarian, 2015). About 28% of the population of Bangladesh live on the coast and are vulnerable to sea level rise and tidal flooding. The Environmental Justiuce Foundation (2018) suggests that up to 18 million people may have to move because of sea level rise alone in Bangladesh. Apart from regular storms, cyclones Sidr (2007), Aila (2009), Komen (2015), Bulbul (2019) and Amphan (2020) caused a huge loss (lives and livelihoods) amongst the coastal people. These events trigger affected people to migrate to the cities. Where they are forced to live in squalor in slums. On average, about 700,000 Bangladeshis are displaced each year by natural disasters (Mcdonnell, 2019.).

14.2 Livelihoods

14.2.1 Livelihoods Related Administration/Competent Authorities

Key aspect in the theme	Primary competent authority (CA)– and their mandates	Key support organisations (govt, NGO, donor, CBO, etc.)	Performance of CA and support organisations
Livelihood	• Ministry of Social Welfare • Ministry of Local Government and Rural Development • Ministry of Youth and Sports • Ministry of Industries	Department of Social Services Rural Development and Co-operative Division Local Govt. Authorities Department of Youth Development Bangladesh Small and Cottage Industries Corporation (BSCIC) PKSF BRAC, Proshika, CARE, ASA, Grameen Bank	• Training for Employment • Employment generation • Entrepreneur development • Support for employment • Micro-credit Support • Allowances under Social Safety Net program

14.2.2 Livelihoods Related Legislation and Regulations

Key aspect in the theme	Primary legislation	Accompanying or enabling regulations	Comments on adequacy or not re. legislation and regs
Livelihoods	• Cooperative Societies Act 2001 (Amendment 2013) • Rural Poverty Reduction Foundation Act, 1999 • Youth Welfare Fund Act 2016 • Bangladesh Small and Cottage Industries Corporation Act, 1957	Cooperative Societies Rules, 2004 (Amendment 2020)	Complicated arrangement for the formation of cooperative societies

14.2.3 Livelihoods Related PPPs

Key PPPs relating to the theme	Main projects emanating from the PPPs	Main negative environmental impacts emanating from the projects	Main negative socio-economic impacts emanating from the projects
Food/Cash for Work (F/CFW) Program, 1974	Test of Relief (TR)	Nil	Politically biased distribution causes low achievement of poverty reduction.
My Home and My Farm (Amar Bari Amar Farm) Program, 2009	Allocation of homestead and adjacent small farm	Land acquisition, especially floodplain areas often cause habitat degradation	Politically biased distribution causes low achievement of poverty reduction.
National Rural Development Policy, 2001	Rural livelihood Project	Nil	Nil

Key PPPs relating to the theme	Main projects emanating from the PPPs	Main negative environmental impacts emanating from the projects	Main negative socio-economic impacts emanating from the projects
National Social Welfare Policy 2005	• Old Age Allowance • Widow Allowance • Training program for improvement of poor, marginal, and destitute sections of society • Socio-economic development through training program of widow, separated and hard-to-reach poor	Nil	Politically biased distribution causes low achievement of poverty reduction.
SME Policy 2019	• Credit wholesaling • Training for entrepreneurial development	Nil	• Biasness and corruption in the selection of entrepreneurs • Harassment of service recipients • Decreasing tendency of recipients
National Industrial Policy-2016	BISIC industrial town, Borguna	Waste dumping and environmental degradation	• Influence of local powerful actors • Limited access of powerless and vulnerable groups

14.2.4 Drivers of Change

Key change	Main external drivers	Main internal drivers	Main actions to "fuel" or "brake" the drivers, depending on whether the change is good or bad
Environmental degradation	Industrial and infrastructural development	Absence of functional ETP	• Monitoring • Functional ETP
Employment generation	• Industrial and economic zone development • Port development • Development of linkage industries	Main objective of projects for employment generation	• Skill development training considering demand in industries • Fair recruitment • Functional and labour-friendly policies • Ensuring employee benefits • Formal contract with labourers
Dispossession and landlessness	• Vision of ambitious development • Fourth industrial revolution • Target for to become middle income country by 2030 and development country by 2041	Land acquisition for development	• Reduce land acquisition • Harassment-free compensation process • Transparency in land administration • Avoid fertile land for acquisition

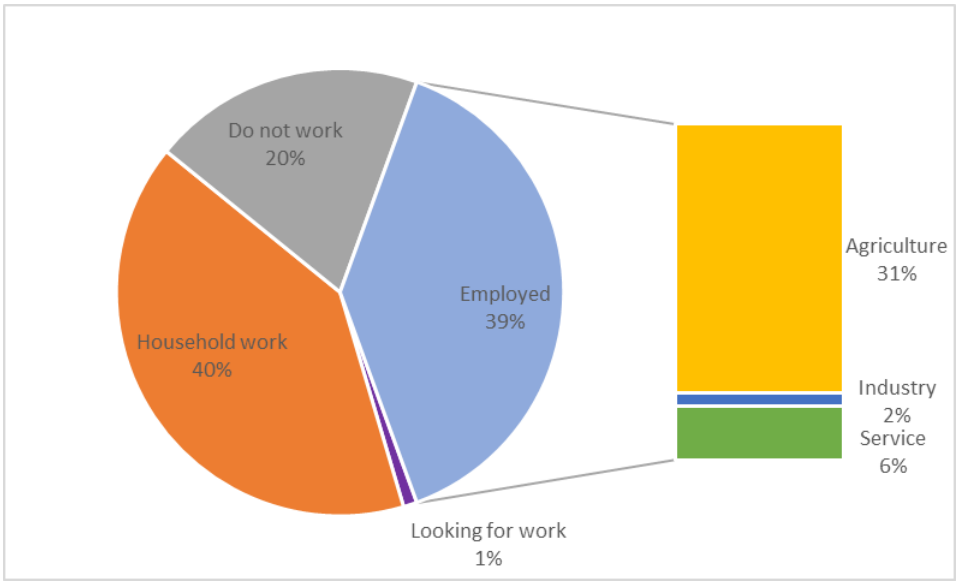
Key change	Main external drivers	Main internal drivers	Main actions to "fuel" or "brake" the drivers, depending on whether the change is good or bad
Entrepreneur development	• Investment tendency • Credit availability in various funders	Training and credit support	• Eliminating corruption • Particular policy/provision and willingness to include socially disadvantaged groups • Industrial focus on local raw material • Developing business hub by providing inactive to investors
Skill development	• Overseas employment opportunities • Diverse employment sectors	Training	• Tailor-made training considering the demand of the labour market • Assess the overseas labour market and design a principle for effective training
Low achievement in poverty reduction	• Political influence • Corrupt administration	• Lack of functional monitoring • Vague and ambitious targets	• Targets should be practical and need-based • An independent monitoring cell • Reducing political influence in resource management and distribution of grants and other supports

14.2.5 Main Issues Concerned with Livelihoods

- Discouraging land acquisition as much as possible
- Avoid fertile land for acquisition
- Effective and harassment-free compensation process
- Tailor-made training considering the market demand
- Developing local level entrepreneurship through training and fund support
- Business promotion based on local raw materials
- Effective initiative for eliminating corruption and political influence
- Focus on efficient and functional technologies to reduce environmental degradation
- Fair selection of beneficiaries and proper distribution of allowance
- Effective especial measures for the inclusion of socially disadvantaged and vulnerable groups of people.
- Engaging local communities in the development process.

According to BBS (2012), 39% of people are employed in three different sectors such as agriculture, industry and service. Considering the employed category, 31% of people are involved in the agriculture sector, 6% in the service sector and 2% in the industry sector. According to the estimation of Tiller (2019[57]), agriculture is the main source of livelihood in the study area, in which about 55.82% of households are dependent on agriculture, and about 16.17% are agriculture laborers (see Figure 14.1).

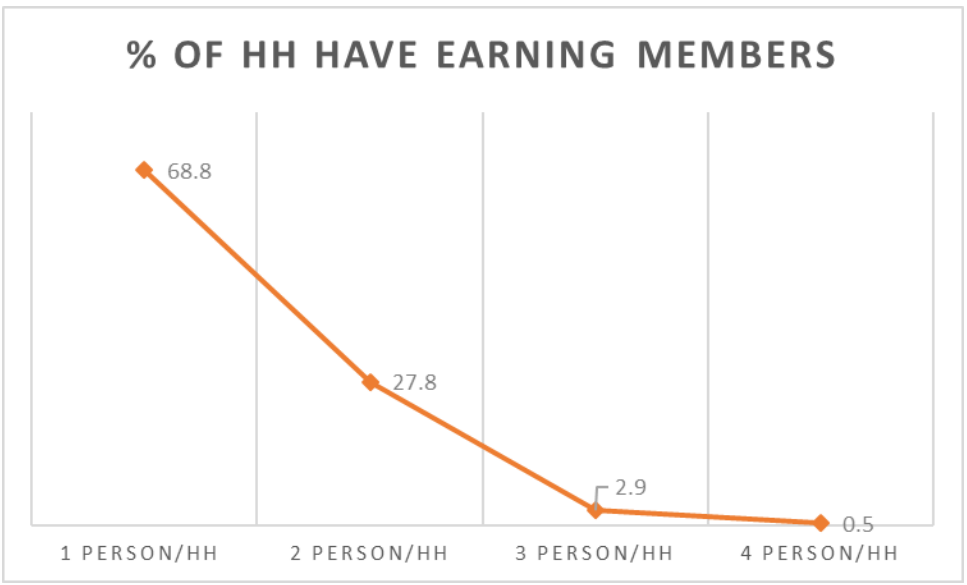
[57] Socio-Economic and Other Related Survey under "Preparation of Payra-Kuakata Comprehensive Plan focusing on Eco-Tourism (PKCP)" by tiller December 2019



Source: BBS, 2012

Figure 14.1: Livelihoods and occupation in the study area

The following figure shows the number of earners per household. Most households (68.8%)depend on single earners (Household survey, 2019). According to the survey findings, only 2% of households have an incidence of cross-border migration for economic reasons.



Source: HH survey, 2019

Figure 14.2: Distribution of households by the number of earners

According to the survey findings, most households (51%) have monthly earnings of less than or equal to BDT16,000. In contrast, only 8% of households earn more than 50,000 monthly (HH survey, 2019).

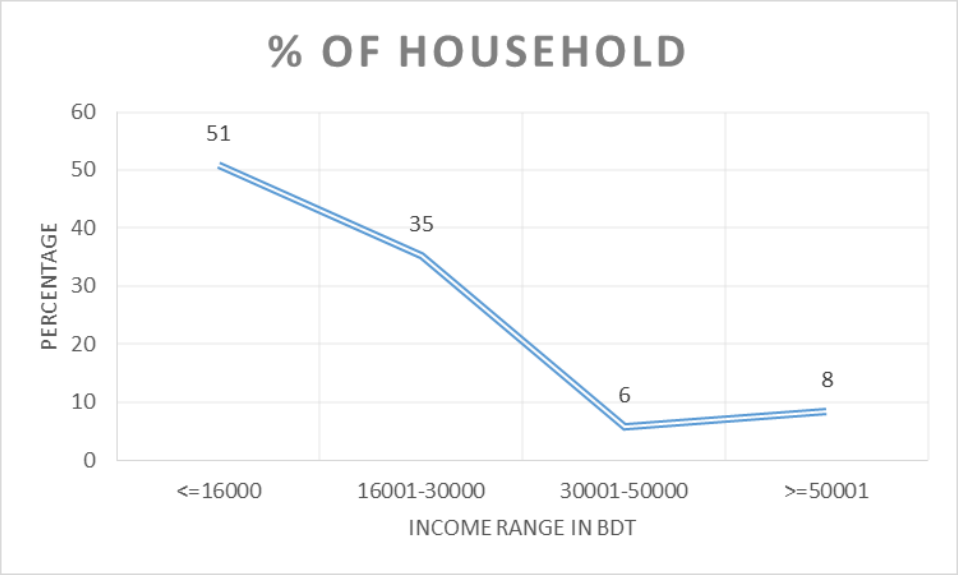


Figure 14.3: Distributio of Households by the Income Range

Only 7% of households reported having savings annually after meeting all household needs. However, about 40% of households reported having loans from various sources, including banks, NGOs, and other money lending agencies and local persons (HH survey, 2019).

14.3 Education

14.3.1 Education Related Administration/Competent Authorities

Key aspect in the theme	Primary competent authority (CA)– and their mandates	Key support organisations (govt, NGO, donor, CBO, etc.)	Performance of CA and support organisations
Education	• Ministry of Primary and Mass Education • Ministry of Education	• Directorate of Primary Education • Secondary and Higher Education Division • Technical and Madrasah Education Division • University Grant Commission (UGC) • Department of Public Works (PWD) • BRAC • UNESCO	• Ensuring Quality Education • Increasing Literacy Rate • Reducing School Drop-out rate • Infrastructural Development (Educational Institutions)

14.3.2 Education Related Legislation and Regulations

Key aspect in the theme	Primary legislation	Accompanying or enabling regulations	Comments on adequacy or not re. legislation and regs
Education	• Primary Education Act, 1990 • Bangladesh Technical Education Board Act, 2018 • Non-formal Education Act, 2014	No accompanying regulations	A draft education law titled as 'Education Act, 2016' has been publishes has brought in many significant changes in the education sector. The law is not yet published.

14.3.3 Education Related PPPs

Key PPPs relating to the theme	Main projects emanating from the PPPs	Main negative environmental impacts emanating from the projects	Main negative socio-economic impacts emanating from the projects
• National Education Policy 2010 • 7th Five Year Plan (2015) • Strategic Plan for Higher Education in Bangladesh: 2018-2030 • National Skills Development Policy (2011)	• The Primary Education Stipend Project (PESP) • Secondary Education Sector Investment Program (SESIP, 2013-2023). • Higher Secondary Stipend Project. • "Establishment of Autistic Academy" Project. • Secondary Education Stipend, 2nd phase Project. • Generation Breakthrough: A multi-pronged approach to primary prevention of Gender Based Violence and meeting SRHR needs of adolescents and youth in Bangladesh. • Female Secondary School Assistance Program (FSSAP) I and II • Higher Secondary Female Stipend Project (HSFSP),	Nil	Nil

14.3.4 Drivers of Change

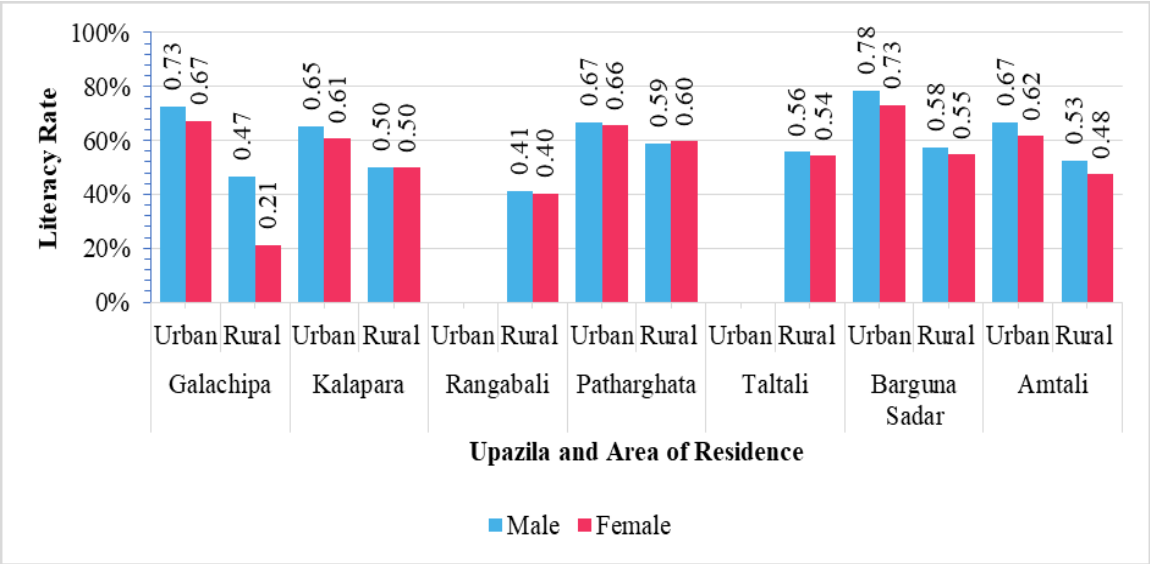
Key change	Main external drivers	Main internal drivers	Main actions to "fuel" or "brake" the drivers, depending on whether the change is good or bad
Enrolment in the pre-primary level has increased	Govt. Policy and Programme	People's consciousness about pre-primary education and the development of facilities in the rural and urban areas	• Initiatives must be taken to improve the quality of teachers engaged in pre-primary education. • Eliminate rote memorization practices by limiting use of exam guidebooks
The annual dropout rate has fallen gradually	Different government policies and programs to	People's perception of education and willingness to develop their socio-economic	Extracurricular activities and the education curriculum should be enjoyable for the students Using the national Poverty Map, introduce targeted school feeding

Key change	Main external drivers	Main internal drivers	Main actions to "fuel" or "brake" the drivers, depending on whether the change is good or bad
	reduce the dropout rate	situation through education	programs and health checkup facilities in poverty-stricken areas.
The net enrolment rate in primary education has increased over the year	Initiation of stipend for school-going students	People's perception of education and willingness to develop their socio-economic situation through education	Initiatives must be taken to improve the quality of teachers engaged in pre-primary education.
Enrolment rates in the secondary level have gone up for both boys and girls in recent years	Initiation of stipend for students play a vital role	People's perception of education and willingness to develop their socio-economic situation through education	• Initiatives must be taken to improve the quality of teachers engaged in pre-primary education. • Stipends at the secondary level to poor families' male members
Quality of Education	Focus on increasing the percentage of enrollment of students, rate of pass	• Lack of quality teachers and proper education in the classroom. • Teachers and Students are interested in private coaching rather than school and colleagues. • Proper follow-up of guardians and monitoring of students' daily activity	• More needful and creative training programs must be taken to improve the quality of teachers. • Increase teachers' wages to match South Asian/global standards • Prioritize technical, mathematical, and scientific education. • Review education quality in terms of learning and relevance to markets.

14.3.5 Main Issues Concerned with Education

- Achieving 100 percent net enrollment rate for primary and secondary education;
- Increasing enrollment rate in 12th class to 60%;
- Percentage of cohort reaching grade 5 to be increased to 10 from current 80 percent.
- Ensure inclusive and equitable quality education and promote life-long learning opportunities for all.
- To ensure the rights and the opportunities for education for all eradicating all differences;
- To put special emphasis on the extension of education;
- To give priority to primary and secondary education;
- To enable students to acquire skills in vocational education to facilitate self-employment, irrespective of levels of education;
- To take necessary steps to create facilities of playground, sports, games and physical exercises in all educational institutions;
- To extend the use of information and communication technology (ICT) instrumental in educational process at every level.

Bangladesh has achieved spectacular success in improving access to education as well as retention of students in education, along with gender parity in both primary and secondary education. But one major problem of the area under study is the disparity among the Upazilas in terms of educational facilities. However, each Upazila has Secondary Schools, Colleges, and Alia Madrasahs. In the studied Upazilas in both urban and rural areas, the literacy rate of males is higher than females except in the rural areas of Patharghata and Kalapara (Figure0.00). The literacy rate of females is equal to or greater than male literacy in these two areas. The Existence of a large number of schools in these areas might be a reason for this.



Source: Urban Development Directorate (UDD), 2021

Figure 14.4: Literacy Rate of the Upazilas by Sex and Area of Residence

Most of the remotely situated primary schools face multiple hazards, e.g. damage during cyclones and from erosion, with students and teachers vulnerable to water salinity. Some schools lack drinking water facilities, sanitation, electricity and communications. There is also an inadequate number of teachers to meet the increasing demand. In the rainy season, the roads become submerged and very muddy which makes it hazardous for students to travel to school. As a result, a significant percentage of students stay away from school, repeat years and eventually drop out. The overall drop-out rate from secondary education for boys tends to be slightly higher than for girls. For the poorest families, the opportunity cost of sending a relatively young child to school creates a major barrier to increasing the number of years of school participation.

14.4 Migration

14.4.1 Migration Related Administration/Competent Authorities

Key aspect in the theme	Primary competent authority (CA)– and their mandates	Key support organisations (govt, NGO, donor, CBO, etc.)	Performance of CA and support organisations
Migration	Ministry of Expatriates Welfare and Overseas	• BMET • Bangladesh Overseas Employment and Services Limited (BOESL) • IOM	• Strengthen government efforts to negotiate with existing and new potential labour-shortage host countries to export Bangladeshi workers; • Find ways to reduce the cost of out-migration through partnerships with job agencies that provide low-cost services; • Provide access to one-time credit to defray the cost of migration secured against future earnings based on a government programme administered by commercial banks; • Provide information and anti-exploitation services through the embassies; • Ensure that the exchange rate for remittance through the banking system is competitive with the curb market rates;

14.4.2 Migration Related Legislation and Regulations

Key aspect in the theme	Primary legislation	Accompanying or enabling regulations	Comments on adequacy or not re. legislation and regs
The Overseas Employment and Migration	The Overseas Employment and Migration Act 2013	The Overseas Employment and Migration Management Rules 2017	• Develop and execute a common welfare programme addressing four stages of migration; • Ensure that the roles and responsibilities are listed for BMET match with the same enlisted in the Migration policy 2016 • Ensure that roles and responsibilities are listed for Labour Wings, are specific enough and match with the same given in the migration act • Revise rule 15 and ensure that the arbitration rule is more elaborate and specific

14.4.3 Migration Related PPPs

Key PPPs relating to the theme	Main projects emanating from the PPPs	Main negative environmental impacts emanating from the projects	Main negative socio-economic impacts emanating from the projects
Expatriate Welfare and Overseas Employment Policy, 2016	• Establishment of 40 Technical Training center in 40 Upazilas • Providing driving training sessions for employment in home and abroad • Application of migration policy for decent work of migrant workers • Promoting Diaspora Investment and optimal use of remittance	NIL	NIL

14.4.4 Drivers of Shange

Key change	Main external drivers	Main internal drivers	Main actions to "fuel" or "brake" the drivers, depending on whether the change is good or bad
Internal Migration	• Provision of different economic zone • Livelihood Opportunity • Natural Calamities	• Employment opportunities in these economic zone area • Economic stability	Diversified livelihood opportunities with various incomes in the towns and cities are easily found and accessible in Urban areas, thus people have common tendency to migrate from rural to urban

14.4.5 Main Issues Concerned with Migration

- Village-to-city migration accounts for nearly two-thirds of all migration,
- About 7.62% of the total population of Bangladesh born in Barisal out of which 3.24 % migrated to other divisions (largest 1.62% in Dhaka and second largest 1.09% in Khulna division)
- Natural Calamities, Family quarrel, and tortured by spouse are found the main push factors of internal migration
- An estimated half a million people move to cities every year, mainly from coastal and rural areas and mainly driven by income diversification and changing farming patterns.

Bangladesh is a dynamic, deltaic country and, as result, most people have always had to be mobile. Rural to urban migration is common, mainly for economic reasons, to find employment and a chance to remit money back home. Village-to-city migration accounts for nearly two-thirds of all migration, with overseas migration less than a quarter (24%) and village-to-village migration 10% (Afsar 2005, cited by Martin, et al., 2013).

Internal migration is a major policy concern and the subject of heated public debate in Bangladesh. It has been identified as both the saviour and villain of national development - a driver of economic and industrial expansion and modernization, whilst also the cause of severe urban deprivation and a destroyer of traditional rural life (Marshal and Rahman, n.d).

Bivariate distribution of birth place and current residence of lifetime migrants by division has been assessed in Population distribution and Internal Migration in Bangladesh. Hence the study area belongs to the Barisal division, due to data insufficiency divisional migration data has been taken into consideration for internal migration. It was found that 7.62% of the total population of Bangladesh born in Barisal out of which 3.24 percent migrated to other divisions (largest 1.62% in Dhaka and second largest 1.09% in Khulna division) (BBS, 2015). Among the total population in Barisal division 75.06% people are found who live in Barisal division is native born and the remaining people migrated from other divisions (11.41% from Khulna and 7.58% from Dhaka. (BBS 2015). On the contrary in terms of out migration 57.67% of people are born in Barisal division are currently living in Barisal and the remaining people migrated to other divisions from Barisal (21.2% in Dhaka and 14.29% in Khulna, and 6.24% in Chittagong division).

Economic reasons were the main motivators for moving from one residence to another residence within the region. However, when moving from one region to another it was mostly for employment reasons followed by social reasons. The propensity to migration is usually influenced by a combination of push-pull factors. People migrated to cities and towns because they are attracted by livelihood opportunities. Regardless of skill, the migrated population can find diversified livelihood opportunities with various incomes in the towns and cities. Thus, the poor rural population considers migration a livelihood coping strategy. On the other hand, a considerable number of the population migrates to urban areas from villages for higher/better education, employment and investment opportunities. These privileged migrants occasionally create employment opportunities in urban areas for the poor migrants. The causes of migration are usually explained by using two broad categories, namely, push and pull factors. Analyzing both push and pull factors it is found that marriage is the most influential factors (50.47%), Business and employment (16.13%) consists the second largest pull factors for internal migrations, thus subsequently education (8.36%) and in search of work (7.33%) places is regarded as another pull factors (BBS, 2015). Natural Calamities, Family quarrel, and tortured by spouse are found the main push factors of internal migration. About 16.04% of rural to urban migration occurs due to some other reasons (BBS, 2015).

Rural-urban migration is resulting in urban resources becoming more scarce. Overcrowding in urban areas, particularly in city slums, and the absence of sanitation and sewerage systems, has increased the prevalence of waterborne and airborne diseases. The lack of job opportunities and the high risk of disease drives slum dwellers even further into poverty. High population density within urban centres is also a key issue (Bangladesh Delta Plan 2100).

One of the strategies for accelerated poverty reduction identified by the Perspective Plan of Bangladesh 2010-2021 is to facilitate migration from poor areas (given the poverty-reducing impact of remittances). The Bangladesh economy has become more integrated with the global market, largely due to the substantial out-migration of labour and consequent remittance inflows, etc.

Internal migration to urban areas is increasing sharply (Planning Commission 2010b). An estimated half a million people move to cities every year, mainly from coastal and rural areas (Islam 2012) and mainly driven by income diversification and changing farming patterns. The contribution of agriculture to rural household incomes dropped from 59& to 44% between 1987-1988 and 1999-2000. Over the same period, the share of services and remittances in their incomes grew from 35% to 49% (Afsar, 2005, cited by Martin *et al*., 2013). In effect, countryside has become a labour source for the cities (Toufique and Turton 2002, cited by Martin *et al.*, 2013).

International migration is also increasing, although it is still too costly for most Bangladeshi families (Black *et al*. 2011b). It could become a risky option for those with insufficient capital and institutional or social support (Martin *et al*., 2013).

International Migration

Bangladesh has benefitted tremendously from its large pool of legally migrant labour, especially to the Middle East, both in terms of job creation and huge inflow of remittance income that now accounts for over 5% of GDP. In addition to supporting the balance of payments and poverty reduction through direct income transfers, these remittances have been an important contributor to GDP growth and job creation within Bangladesh through the derived demand effects of expenditures from remittance income. While international migration is a part of the national employment strategy that is being covered in a separate strategy document, all policies relevant to developing the migrant labour force participation, such as training, cost-reduction of migrant labour supply, availability of loans to pay for the migration process, and availability of information, as well as policies to ensure labour safety and protection from exploitation will also benefit the youth population. Indeed, the youth population is the highest beneficiary of the international labour migration.

About 68,921 number of international migration were happened from 2005-2018 in Barguna and Patuakhali distrct. Table 000 shows the gender segregated international migrants in Patuakhli and Barguna district. Eventually the healthy flow of remittances to rural areas may support the growth of consumption and create new jobs in services in rural area. The overseas employment and remittances have played a major development role during the 6th and the 7th Plans, creating jobs, providing income and investment. The youth population has benefitted most from overseas jobs. Remittance inflows have not only lowered poverty through direct income transfers, they have contributed to transforming the rural economy by supporting activities and employment in a range of rural services including construction, housing, transport, trading, health, and education. The 8FYP will build on this solid track record and make further efforts to increase overseas employment and remittances. The COVID-19 has adversely affected overseas employment, but thankfully r emittance inflows have remained buoyant owing to the 2% incentive offered by the government.

Table 14.3: People employed overseas in Barisal and Patuakhali District: 2005-2018

District	Male	Female	Total
Barguna	26293	8999	35292
Patuakhali	24194	9435	33629
Total	**50487**	**18434**	**68921**

14.5 Gender

14.5.1 Gender Related Administration/Competent Authorities

Key aspect in the theme	Primary competent authority (CA)– and their mandates	Key support organisations (govt, NGO, donor, CBO, etc.)	Performance of CT and support organisations
Gender	Ministry of Women and Children Affairs	• Department of Social Service • Ain o Salish Kendra (ASK) • Naripokkho • Joyeeta • BRAC • UN Women • Save the Children • Unicef	• Provides distinct guidelines on prevention of child marriage, removal of discrimination and protection against disabled girls, enhanced recreational and cultural facilities for female children, and removal of mental and physical abuse of women. • Works to implement project for the protection of women rigths and justice

Key aspect in the theme	Primary competent authority (CA)– and their mandates	Key support organisations (govt, NGO, donor, CBO, etc.)	Performance of CT and support organisations
			• Provide Capacity Building training for women empower through livelihood generation

14.5.2 Gender Related Legislation and Regulations

Key aspect in the theme	Primary legislation	Accompanying or enabling regulations	Comments on adequacy or not re. legislation and regs
Gender	• Domestic Violence (Protection and Preservation) Act 2010 • Deoxyribonucleic Acid (DNA) Act, 2014 • Early Marriage Protection Act,2017	• Domestic Violence (Protection and Preservation) Rules, 2013 under • National Women Development Policy, 2011 • National Children Policy, 2011 • National Action Plan on Women, Peace and Security, 2019-2022	• The preventive and punishable measures should be Increased and enforced strictly. • The policy needs to emphasize entrepreneurship for women, and the provision of supportive facilities. • The policy needs a clear framework for its implementation

14.5.3 Gender Related PPPs

Key PPPs relating to the theme	Main projects emanating from the PPPs	Main negative environmental impacts emanating from the projects	Main negative socio-economic impacts emanating from the projects
National Women Development Policy, 2011	Vulnerable Group Development (VGD)	N/A	N/A
	"Maternity Allowance Program"	N/A	N/A
	Establishment of Joyeeta Foundation for Women Entrepreneurship	N/A	N/A
	Establishment of 60 One-Stop-Crisis Cell in 40 district's city hospitals and 20 Upazila hospitals	N/A	N/A
	Establishment of eight working women hostels in Dhaka, Chittagong, Rajshahi, Khulna and Jashore	N/A	N/A
	Rural Women Entrepreneurs Skill development Training Program (Sub-district level)	N/A	N/A
	Women Entrepreneurs skill Development center and hostel facilities Program.	N/A	N/A
	Rural Employment and Road Maintenance Programme		

14.5.4 Drivers of Change

Key change	Main external drivers	Main internal drivers	Main actions to "fuel" or "brake" the drivers, depending on whether the change is good or bad
Protection of Women and Children's Right Promoting Diversified Livelihoods through Skill Development	• Implementation of ICT Skill Development Program • Provide Loan, Maternity Leave, hostel facilities for working women	• Digitalization and Database for Vulnerable Group is required • Coverage and amount of VGD is required	• Required regular monitoring • Required research and adequate budget for the implementation of Porjects • Gender training is required for local implementing agencies and officials to administer gender issues during the implementation of the projects • IGA and other skill development training for capacity is required and also required to provide financial support for developing new entrepreneurship; • Ensuring Equity and Justice, it is required to build a level playing field and transparency in all aspects

14.5.5 MainIssues Concerned with Gender

- VGD aims at ensuring socio-economic development of the poverty stricken and destitute rural women of Bangladesh
- "Maternity Allowance Programme" plays a supporting role in reducing the risk of pregnant mothers and neo born babies in the rural areas.
- The Joyeeta Foundation have the aim to establish a separate distribution chain for the women entrepreneurs across the country and to establish a women friendly separate supply chain for production and distribution of their products through which women can develop their ability.
- Ensure women's participation in efforts to maintain peace and security and gender equality at the national and international level

Gender status refers to the position of women relative to men within a given situation. In Bangladesh, it remains in a status of inequality and is defined as differentiated social standards (as against biological standards) for men and women. In order to understand this phenomenon, therefore, it is very much required to look at some of the more common Human Development Indices such as demographic profile, the economic, social, and political and health indicators to assess gender relations in a particular situation. Bangladesh has made immense leadership in women empowerment and equality.

The Govt. has the goal to ensure female education, access to credit and market property rights and inheritance and reducing infant and maternal mortality. It is government policy to maintain and enhance the pace of change in this area through gender empowerment. It is expected that Bangladesh would substantially reduce gender discrimination by this perspective plan period. The government has adopted various policies, plans and program to eliminate discrimination against women and girls in all spheres and to promote women's equality. Men work outside whereas women involve in household level activities. Even, peasant community, women involve in post harvesting activities. In the study area which is located in the coastal region whereas women have different role in agriculture

and fisheries sectors. There are also unequal power relations deeply rooted on gender roles and potentials.

Women and girls are disadvantaged by multiple gender-based inequalities that include wage discrimination; limited mobility; limited decision-making authority within the household; risks of exploitation; abuse and violence; limited access to basic services and social and legal protections; and limited visibility in society. But there has been significant improvement in providing education for girls in this region. Though Govt. safety programs allowed various allowances for the elderly; widows, deserted and destitute women; maternity; urban low-income lactating mothers, disabled students. Gender base violence (i.e. physical, sexual, psychological and economic) against women and girls commonly found in the study area and can include abuse.

14.6 Culture, Heritage and Society (CHS)

14.6.1 CHS Related Administration/Competent Authorities

Key aspect in the theme	Primary competent authority (CA)– and their mandates	Key support organisations (govt, NGO, donor, CBO, etc.)	Performance of CT and support organisations
Culture and Heritage	Ministry of Cultural Affairs	• Department of Archaeology • Directorate of Archives and Library • Bangla Academy • Copyright Office • Bangladesh Folk Art & Crafts Foundation	• Protection and preservation of archaeological and historical artefacts; • Conducting Research and Archeological excavation for exploring archaeological artifacts • Protection of place of worship from misuse; • Preservation of Ethnic Cultural artifacts • Monitoring of historical and cultural artifacts • Formulation and implementation of policies on cultural issues; • Collecting, preserving, publishing and nourishing development of the cultural • heritage and anthropological artefacts of the Liberation War and contemporary • period; • Identifying the archaeological sites of the country and excavating, preserving • and displaying those; • Protecting copyright for the creative works; • Establishing, expanding and developing public and private libraries; • Undertaking research and publications on the language, culture and heritage; • Celebrating various events nationally, such as, 21st February the International • Mother Language Day, awarding 'Ekushey Podok', • Undertaking cultural treaties with different countries, exchange of Cultural • Programs and expanding cooperation in the international arena.

14.6.2 CHS Related Legislation and Regulations

Key aspect in the theme	Primary legislation	Accompanying or enabling regulations	Comments on adequacy or not re. legislation and regs
Culture and Heritage	• Antiquities Act 1968 • Small Ethnic Groups Cultural Organization Act 2010	National Cultural Policy, 2006	• Digitalization of archives and asset inventory required for successful monitoring and evaluation; • A guideline should be prepared how this policy can comply international convention for the protection and promotion of cultural heritage, historical sites and events;

14.6.3 CHS Related PPPs

Key PPPs relating to the theme	Main projects emanating from the PPPs	Main negative environmental impacts emanating from the projects	Main negative socio-economic impacts emanating from the projects
National Cultural Policy, 2006		-	-

14.6.4 Drivers of change;

Key change	Main external drivers	Main internal drivers	Main actions to "fuel" or "brake" the drivers, depending on whether the change is good or bad
Protection of Cultural Heritage	Archiving of Cultural Heritage on ethnic communities	Digitalization of archives and asset inventory required	• Required regular monitoring • Required research and adequate budget for exaction of archaeological assets;

14.6.5 Main Issues Concerned with CHS

- Protection and preservation of archaeological and historical artefacts
- Archiving of Cultural Heritage on ethnic communities required for promotion and protection
- Location and area specific project on culture and heritage required for promotion
- Required research and adequate budget for exaction of archaeological assets

Patuakhali district has a rich cultural heritage. Folklore in this region is famous for Jari and Bhatiali. The following literary and cultural organizations exist in this district. About more than 31 cultural organizations like Patuakhali Theater, Sabuj Sangha, Shaheed Smriti Pathagar, Patua Sahitya Parishad etc. are exist in this district.

Patuakhali is inhabited by several tribal ethnic groups such as the Magh and Chakma. Besides, there is Rakhine village of Kalapara upazila. They make different types of garments such as tat cloth, kamich, sari, lungi, towel etc. They are mainly Buddhist and follow polygamous status of marriage system. Having with their distinctive cultural pattern, their cultural pattern is also mixing with the mainstream communities. As a result, the value of diversified cultural patterns and practices is declining. Cultural hybridization and loss of traditional heritage and practices due to the development of communication system, tourism and spread of social media and satellite television are playing important role for this kind of cultural assimilation. Besides, they have to face different

problem because of lack of opportunity and not having separate ministry for getting enough facilities for their cultural development. Additionally, they have no enough budget to preserve, monitor and maintain archaeological and heritage sites, contributing to a decline in their aesthetic, historical and cultural value. Moreover, Patuakhali district is called as Sagarkanya. Kuakata Sea beach in the southernmost part of Bangladesh is the traditional beach of this district. Kuakata, the daughter of the sea, is a beautiful green land that attract tourist every year. The huge beach of 15 km length in the Bay of Bengal is rare in the world. In all seasons including winter, summer and monsoon, the beach is buzzing with the call of seasonal birds. It is possible to enjoy the various forms of the sea created by nature in different seasons.

14.7 Infrastructure Development

14.7.1 Infrastructure Related Administration/Competent Authorities

Key aspect in the theme	Primary competent authority (CA)– and their mandates	Key support organisations (govt, NGO, donor, CBO, etc.)	Performance of CA and support organisations
Infrastructure Development (Cyclone Shelter, Growth Center, Rural Market)	• Ministry of Disaster Management and Relief Ministry of Local Government, Rural Development and Co-operatives • Ministry of Public Administration	• Department of Disaster Management • Local Government Engineering Department • PWD • LGIs • IFAD, JICA, ADB Red Cross	• Cyclone shelter Development • Formation of Volunteer Group • Provide training on emergency response during the disaster period • Guideline for pre-disaster preparation
Vulnerable Groups	• Ministry of Women and Children Affairs • Ministry of food • The Ministry of Social Welfare	• Food planning and monitoring unit (FPMU) • World Food Programme (WFP)	• Social safety net programme • Women and children welfare

14.7.2 Infrastructure Related Legislation and Regulations

Key aspect in the theme	Primary legislation	Accompanying or enabling regulations	Comments on adequacy or not re. legislation and regs
Vulnerable Groups	• Children's Act, 2013 (Act No. 24 of 2013). • Women and Children Repression Prevention Act, 2000 • Domestic Violence (Prevention and Protection) Act, 2010	Nil	Nil

14.7.3 Infrastruture Related PPPs

Key PPPs relating to the theme	Main projects emanating from the PPPs	Main negative environmental impacts emanating from the projects	Main negative socio-economic impacts emanating from the projects
Food/Cash for Work (F/CFW) Program, 1974	Test of Relief (TR)	Nil	Lack of work as desired and biased selection process
National Women's Policy, 2011	Vulnerable Group Development (VGD)	Nil	Shortage of projects as per demand and biased selection process
National Children Policy, 2011	Pre-Primary Education for Child Development	Nil	Dropout rate due to poverty has not yet been reduced as expected
National Social Welfare Policy 2005	• Old Age Allowance • Widow Allowance • Training program for improvement of poor, marginal, and destitute sections of society • Socio-economic development through training program of widow, separated and hard-to-reach poor	Nil	Biased selection process

14.7.4 Drivers of Change

Key change	Main external drivers	Main internal drivers	Main actions to "fuel" or "brake" the drivers, depending on whether the change is good or bad
Women Employment generation	• Small and medium-sized enterprises • Industrial development	Main objective of projects for employment generation	• Skill and livelihood training training considering demand in industries • Fair recruitment
Skill development	Overseas employment opportunities for women	Arrange training proggrame	• Tailor-made training considering the demand of the labour market • Assess the overseas labour market and design a principle for effective training

14.7.5 Main Issues Concerned with Infrastrucure Develpoment

- Provision of various skill related training to empower women in the local level;
- Providing support to local women in entrepreneurship;
- Taking measures to prevent dropout of children at primary level;

Infrastructural development is the construction and development of fundamental services with the main objective of achieving economic growth and improvement in quality of life. Infrastructural development can be of different types including transportation, energy, water, social and green

infrastructure etc. [58] This Comprehensive Detailed Plan emphasizes social infrastructure development, including commercial areas and cyclone shelters.

Cyclone Shelters

A cyclone shelter is basically a solid elevated building that provides security and shelter during cyclones, storm surges and other natural hazards. There are around 2,500 cyclone shelters and multipurpose cyclone shelters along the 710 km long coast of Bangladesh.[59]

The project area falling within the coastal zone is affected by various natural disasters. Due to this, a number of cyclone shelters have been established in this region. According to the Regional Plan, total 242 cyclone shelters have been found in the study area where highest number of cyclone shelters are found in Patharghata upazila and lowest in Rangabali upazila. From this data the average number of cyclone shelters in this region is 30-35 whereas according to the Bangladesh National Portal, the average shelter is 50-60 per upazila. Based on the population, the distribution of cyclone shelters in the study area is insufficient in terms of availability cyclone shelter.

Table 14.4: Distribution of Existing Cyclone Shelter by Upazilas

Name of the upazila	Number of cyclone shelters
Galachipa	39
Kalapara	35
Rangabali	17
Patharghata	49
Taltali	33
Barguna Sadar	47
Amtali	22
Total	**242**

Source: Regional Plan of PKCP Focusing on Eco-Tourism, October, 2021

Proper distribution of cyclone shelters is not possible as shelters are insufficient than demand. Consequently, primary schools are used as cyclone shelters to meet the demand. Due to this, most of the shelters which are usable or moderately usable lack basic facilities like separate toilet facilities for women. Additionally, Killa is another important facility where livestock is accommodated which is not possible to be added in all cyclone sectors.

Commercial area development

Most of the land in this region is used for agriculture and contributes to the development of the local economy. The land in this region has potential for agriculture, fisheries and livestock due to the fertility and the availability of water sources. The commercial area development (growth center and rural market) will create a supply chain for agricultural and fishery products, benefit local farmers and promote local economic development. As a result, local farmers will be encouraged to produce more. In the PKCP area there are total 42 growth centers and 226 rural markets where Kalapara and

[58]https://simplicable.com/new/infrastructure-development-definition#:~:text=Type-,Infrastructure%20Development,improvements%20in%20quality%20of%20life.

[59] https://www.sciencedirect.com/science/article/pii/S1877705818301681

Patharghata have highest number of growth centers while Amtali has lowest number of growth centers. On the other hand, Amtali upazila has 47 rural markets which is the highest number of study area while Taltali has only 11 markets. If tourism is expanded in terms of comprehensive plan of the region, local infrastructure such as roads, communication systems will be developed as well as the growth center and rural market will be expanded too. Consequently, local markets for agricultural products will be created and overall development will be achieved through local economic growth.

Table 14.5: Distribution of Existing Growth center and Rural Market by Upazilas

Name of the upazila	Number of growth center	Number of rural market
Galachipa	8	43
Kalapara	10	34
Rangabali	1	21
Patharghata	10	39
Taltali	5	11
Barguna Sadar	5	31
Amtali	3	47
Total	**42**	**226**

Source: Regional Plan of PKCP Focusing on Eco-Tourism, October, 2021

14.8 Vulnerable Group

The vulnerable population in Bangladesh includes various social groups such as women, children, elderly people, ethnic and religious minorities, people with disabilities or physical impairments and low caste groups. All of these heterogeneous groups are generally affected by extreme poverty, natural disasters, and other external shocks that may affect their well-being. Similarly, their access to health and nutritional demand is limited and their participation ratio in education is low. (8th Five Years Plan).

Vulnerable community in the study area are considered as ethnic community, women and disable people. According to the Population Census 2011, about 2454 people of ethnic communities live in the study area. Where majority people are Rakhain (2345) in addition Chakma (38) and Marma (23) people live in this area. The ethnic people of Bangladesh are socially, culturally and economically deprived. As a result, they are socially isolated and have fewer opportunities than mainstream people in economic social and political spheres (8th Five years Plan). Like other regions of Bangladesh, the ethnic communities of this region are socially, economically and politically neglected and deprived.

Figure 14.5: Rakhain women weaving loom in Taltali, Barguna

Besides, it is estimated that approximately 2.1% of the people in this region are disable who are excluded and deprive from social and economic activities including employment, education, microfinance, land entitlement etc. Moreover, women have the limited access to income-generating activities and employment, resulting in women's vulnerability. Also their wage rates are very low which makes them very vulnerable. It found that women in the region also have limited access to employment, health services and education.

15. Pollution and Waste

15.1 Introduction

Naturally, '*Pollution and Waste*' is not necessarily to be together. There is a subtle difference between pollution and waste. Pollution always means that there are negative consequences, which distinctively differs from the waste as waste is not always harmful to animal or to the environment. The characteristics of waste is mainly determined by its management system.

In this section, at first, the existing conditions of the surface and underground water quality, noise level, ambient air quality, soil quality and its pollution rankings are explained. Later, the types of solid wastes, its generation rate and the ongoing waste management practices are looked into to have a clear notion of wastes in the given area. In addition to this, relevant legislation and its strength and weakness, respective PPPs and their implementation consequences, changes pattern and its causes are analyzed to draw a true picture of the theme '*pollution and waste*'. In a nutshell, this section of the report will deal with the ins and outs of the mentioned theme from its present condition to the management system.

15.2 Water Quality

The drainage systems i.e., rivers in Bangladesh are heterogeneous and very complex in nature; and such of those are not found anywhere in the world (Alam et al., 1990). This heterogeneity may be attributed to a number of factors including anthropogenic input, local environmental conditions, water discharge, water velocity, and the degree of temporal variability of surface water chemistry (Qadir et al., 2007). Though it is very difficult to understand the complex nature of structural elements in the surface, the total drainage system reflects the manifestations of the structural actions and their results in the area. Geological structural aspects have the potential to change the drainage system and will bring changes in the pattern of water flow (Alam, 2015). For the management and restoration of rivers, it is of utmost importance to understand how land use and land cover change influence the flow and water quality of rivers (e.g., Barbosa et al., 2012; Huang et al., 2013a, b).

Usually, development is deeply linked with the impacts in any landscape. This case gets even more attention to a nation that is built on an active delta with huge number of inland rivers-like Bangladesh. Therefore, it is realistic enough to have a glimpse of water quality status prior to launching of the Payra-Kuakata Comprehensive Plan in the South Central region.

To do so, water quality status of major rivers of the area is analyzed and presented here. According to the geographical settings, the major rivers are (i) Baleswar River, (ii) Bishkhali River, (iii) Buriswar-Payra River, (iv) Andarmanik River, (v) Galachipa-Ramnabad River, (vi) Tetulia River and (Vii) Donmanick River. The position of the rivers is presented in Figure 15.1. The pre-monsoon quality is evaluated to understand the state-of-the-art of surface water quality in the study area.

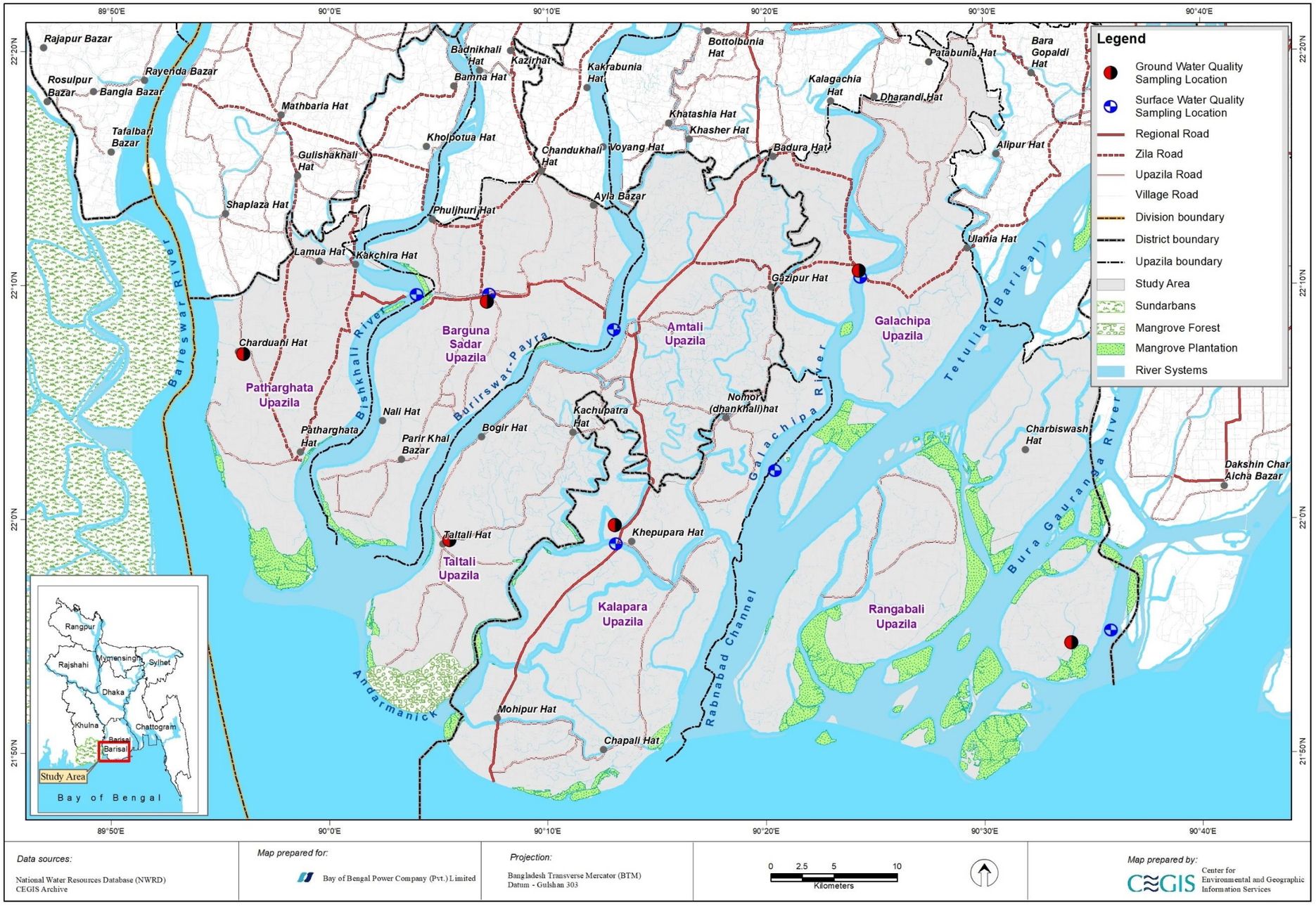


Figure 15.1: Location of Major Rivers in the Study Area

15.2.1 Water Quality of Major Rivers

The water quality status of major rivers in the Payra-Kuakata area are observed under four different categories of (i) physical and aggregate properties, (ii) inorganic non-metallic constituents, (iii) aggregate organic constituents, and (iv) metal constituents. This categorization will help to assess the characteristics of water quality by its chemical composition. In addition, to evaluate the water quality of major rivers, Environmental Quality Standards of Bangladesh is compared to the observed results particularly in favor of the quality of natural river water, standards for fisheries, and sustaining other aquatic life forms. The surface water quality statuses are presented in the Tables 15.1-15.5.

Physical and aggregate properties

Water temperature is a characteristic, that is a big deal for the water bodies for the tropical and sub-tropical humid regions. High water temperature works like an enzyme for some of the microscopic organisms along with the primary producers of the aquatic system which is then determining the water quality indirectly. In the coastal Bangladesh environment, usually, water temperatures are found from 30^0C to 32^0C in the pre-monsoon period. Usually, water temperature in the range of 20^0C-30^0C is the ideal situation. A higher temperature than the ideal situation changes phytoplankton composition in the presence of high nutrients. This case has not become an issue for a shorter time. Rather than pre-monsoon season, water temperature remains within the standard range in the study area. The buffering capacity of water (acidic or basic) remains in a balanced condition (6.5-8.5).

Water that has TDS less than 1,000 mg/l is usually considered one of the good characteristics of water quality. Except for the river Baleswar (2,000 mg/l) and Andarmanick (5,270 mg/l), all the other rivers show compliable TDS levels. High tidal influences (which contain a high amount of salt ions) directly from the Bay of Bengal (BoB) increase this TDS level. High EC in the Andarmanick river (11,420 mg/l) reflects the same reason there. As TDS gets higher, the same goes for the salinity in the Baleswar (5ppt) and the Andarmanik (6.8ppt) rivers. The salinity of other rivers lies less than the 1ppt range which is considered usually a good condition for the freshwater rivers.

Suspended matters, alkalinity, and hardness levels of the major rivers in the Payra-Kuakata area are found in favorable conditions for sustaining the fisheries and other aquatic lifeforms (Table 15.1). However, the turbid condition of the rivers is quite higher than the standards. In Bangladesh, usually, all the rivers show comparatively higher turbidity than any other pristine river condition. Firstly, Deltaic nature and secondly the catchment runoff make the river water turbid enough. Extremely high turbid water in the Donmanick river (329 NTU) is because of the availability of the char lands adjacent to the river length.

Inorganic non-metallic constituents

Inorganic constituents are the anions, which are free negatively charged ions. The source of the anions in the rivers of the Payra-Kaukata region is the Bay of Bengal mainly.

Chloride concentration ranged from 20 to 4,150 mg/l (Table 15.2) and is supported by the finding of Rahman et. al., 2013. The maximum recommended concentration of Cl^- in the surface water is 250/300 mg/l (DEP'2010, WHO'2011, and USEPA'2012). Comparing this limit as standard, most of the water samples of the study area have Cl^- within the permissible limit, which indicates their suitability for different usages (Sheikh and Islam, 2018; Khanom and Salehin 2012). The river Donmanick shows that chloride above the standard limit which is the ultimate result of the influence of the Bay of Bengal. Same pattern goes for the sodium as well. The range of sodium consists of between 6-2,432 mg/l. The standard sodium is about 200 mg/l in the who recommended drinking water quality standards. The high level of sodium is observed in the Donmanick river as the sampling point is at the mouth of the river where the Donmanick falls into the Bay of Bengal. High salts ion from the SEA is the main reason

behind this high sodium which we may call the natural causes. Likewise, potassium also found high at the Donmanick river (128 mg/l; 12 mg/l for drinking standards).

Regarding the limiting nutrients, which are nitrates and phosphates, nitrate is the limiting nutrient for marine environment where phosphate mostly is for freshwater bodies. In the rivers, nitrate more than 2.5 mg/l is considered as the comparatively higher concentrations for the aquatic lifeforms if the duration is long. All of the rivers contains higher concentration of nitrates where the Donmanick showed extremely high (26 mg/l). Therefore, the rivers have the nitrate issue which may be the both reasons of agricultural runoffs and the Bay influences. Unlike the nitrate, phosphate is found within the recommended range of 0.5 mg/l except the Donmanick (1.3 mg/l). There were no sulphate issues in the rivers of Payra-Kuakata area.

Aggregate Organic Constituents

Aggregate organic constituents are related to the dissolved oxygen the water body possesses. Dissolved oxygen indicates the available DO level in the water body while BOD and COD indicate the demand for DO because of the presence of organic matter.

Any water body indicates a good water quality that contains more than 5.0 mg/l in terms of DO presence. Less than 5 mg/l of DO in open water creates critical conditions for fisheries and other aquatic lifeforms. Therefore, except for the Andarmanik (4.0 mg/l), the DO level of the rivers in the Payra-Kuakata area are in favorable condition for the aquatic lifeforms. As the DO level is in good condition, therefore, the organic matters are also in the acceptable range. So, DO demands by the rivers are also in the recommended range of 10 mg/l (BOD). In addition, the COD level is also found in the tolerable range of less than 25mg/l for open water bodies in the region. Therefore, there is no critical issue has been found in the rivers of the Payra-Kuakata region in terms of the aggregate organic constitutes (Table 15.3).

Metal Constituents

Generally, iron is not a pollutant but above 5.0 mg/l can be toxic to plants in aerated soils, and can contribute to soil acidification and loss of essential phosphorus and molybdenum. The Total Iron (Fe) was found to be ranging from 0.4 mg/l to 3.3 mg/l. There is no standard of Iron for surface water in Bangladesh. Whereas a standard for sewage discharge to inland surface water bodies from the industrial unit is 2.0 mg/l (ECR'97: Rule 13) and the standard for drinking purposes is 0.3 to 1.0 mg/l (ECR'97: Rule 12). As per the EPR'86, the acceptable level of iron is 0.1 mg/l. Based on EPR'86, all the rivers contain higher iron in the region.

The concentration of Lead (0.001 mg/l to 0.006 mg/l), Chromium (0.008 mg/l to 0.029 mg/l), Copper (0.03 mg/l for all), Nickel (0.02 mg/l to 0.03 mg/l) and Zinc (0.03 mg/l to 0.04 mg/l) is within the standard of drinking water and industrial unit in Bangladesh (ECR'1997). According to the surface water standard of EPR'86, in terms of Pb, Cr, and Cu, all river water is safe for use. Shoeb et al., 2022 found a similar observation in terms of Pb and Cd concentration. Chromium in surface water may be attributed to industrial wastes especially tannery effluent (Sarkar et al., 2016; and, Saranraj et al., 2013) which is absent in the region. Naturally, Mn is high in the sediments and water in Bangladesh.

Only cadmium which is high in the Tetulia river has the concentration of 0.013 mg/l whereas the drinking water quality standards suggest the highest level of cadmium should be 0.005 mg/l.

Oil & Grease and Phenol Compounds

The Rivers in the Payra-Kuakata region are not polluted by oil & grease yet. All of the rivers showed a concentration of less than 2.0 mg/l whereas the permissible limit is 10 mg/l. Regarding phenolic

compounds, the usual acceptable level for drinking water is 0.002 mg/l. About that, phenols are slightly higher in the rivers of the given area. There is no standard for phenols and phenolic compounds for surface water in Bangladesh.

Table 15.1: Status of Physical and Aggregate Properties

Parameters	Unit	Baleswar	Bishkhali	Buriswar -Payra	Andarmanik (Upstream)	Galachipa-Ramnabad	Tetulia	Donmanick	BD Standards	Remarks
Temp.	^{0}C	31	31	30	33	31	30	30	20-30	Within the range
pH	Value	7.5	7.2	7.1	6.6	7.4	7.2	7.3	6.5-8.5	Within the range
TDS	mg/l	2000	86	74	5720	90	340	540	1000	Complied the standard except Andarmanik
EC	µS/cm	4000	173	148	11420	180	700	1080	1200	Complied the standard except Andarmanik
Salinity	ppt	5	0.1	0.1	6.8	0.1	0.1	0.6	0	Complied the standard except Andarmanik
TSS	mg/l	50	4	11	8	13	22	16	50-150	Within the range
Turbidity	NTU	60	49	52	64	94	60	329	50	Higher than the standard
Alkalinity	mg/l	25	30	40	30	18	20	45	20-120	Within the range
Hardness	mg/l	300	145	180	470	210	200	235	200-500	Within the range

Source: CEGIS Survey, May 2022

Table 15.2: Status of Inorganic Non-metallic Constituents

Parameters	Unit	Baleswar	Bishkhali	Buriswar-Payra	Andarmanik (Upstream)	Galachipa-Ramnabad	Tetulia	Donmanick	BD Standards/WHO*	Remarks
Chloride	mg/l	-	20	20	4150	20	22	300	250	Complied the standard except Andarmanik and Donmanick
Sodium	mg/l	50	6	6	2432	35	20	177	200*	Complied the standard except Andarmanik
Potassium	mg/l	-	3	4	128	4	5	14	12*	Complied the standard except Andarmanik
Nitrate	mg/l	2.0	8.5	6.6	5.4	6.3	1.5	26.2	2.5	Higher than the standard
Phosphate	mg/l	0.1	0.2	0.1	0.4	0.3	0.6	1.3	0.5	Complied the standard except Donmanick
Sulphate	mg/l	-	13	15	212	18	40	79	400	Complied the standard

Source: CEGIS Survey, May 2022

Table 15.3: Status of Aggregate Organic Constituents

Parameters	Unit	Baleswar	Bishkhali	Buriswar-Payra	Andarmanik (Upstream)	Galachipa-Ramnabad	Tetulia	Donmanick	BD Standards	Remarks
DO	mg/l	5.0	5	5	4	6	6	5	5 or more	Within the standard except Andarmanik
BOD	mg/l	3	2	2	1	1	4	4	Less than 10	Complied the standard
COD	mg/l	15	8	8	4	4	11	16	Less than 25	Complied the standard

Source: CEGIS Survey, May 2022

Table 15.4: Status of Metal Constituents

Parameters	Unit	Baleswar	Bishkhali	Buriswar-Payra	Andarmanik (Upstream)	Galachipa-Ramnabad	Tetulia	Donmanick	EPR'86, India	Remarks
Iron	mg/l	-	0.5	0.4	0.5	1.0	1.0	3.3	0.1	Higher than the standard
Zinc	mg/l	-	0.03	0.03	0.03	0.03	0.03	0.04	2	Complied the standard
Manganese	mg/l	-	0.05	0.23	0.13	0.07	0.24	0.20	3	Complied the standard
Lead	mg/l	-	0.005	0.005	0.002	0.005	0.005	0.001	2	Complied the standard
Chromium	mg/l	-	0.011	0.012	0.029	0.012	0.010	0.016	0.05 (BD, Drinking)	Complied the standard
Nickel	mg/l	-	0.030	0.030	0.030	0.030	0.069	0.020	5	Complied the standard
Copper	mg/l	-	0.030	0.030	0.030	0.030	0.011	0.030	1 (BD, Drinking)	Complied the standard
Cadmium	mg/l	-	0.00015	0.00015	0.00015	0.00015	0.013	0.00015	0.005 (BD, Drinking)	Complied the standard except Tetulia

Source: CEGIS Survey, May 2022

Table 15.5: Status of Oil & Grease and Phenol

Parameters	Unit	Baleswar	Bishkhali	Buriswar-Payra	Andarmanik (Upstream)	Galachipa-Ramnabad	Tetulia	Donmanick	Standards	Remarks
Oil & Grease	mg/l	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	10 (ECR'2017 ammed.)	Within the standard
Phenol	mg/l	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	-

Source: CEGIS Survey, May 2022

15.2.2 Groundwater Quality

The main source of drinking water in the study area is groundwater. Surface water and precipitation are also used for other reasons. The groundwater status is explained evaluating the water quality status of the upazilas of Barguna Sadar, Patharghata, Kalapara, Taltoli, Galachipa and Rangabali. The groundwater quality statuses are presented in Table 15.6-15.9.

Physical and Aggregate Properties

The groundwater temperature is ranged between 28^0C-30^0C which is completely complied with the Bangladesh Drinking Water Quality Standards (20^0C-30^0C). The water temperature usually varies based on the seasonality of Bangladesh. During winter, groundwater drops to around 20^0C-25^0C. These light changes haven't become an issue for the drinking purpose of the local community in the region. The quality pH is far more important than the water temperature. Both acidic and alkaline water is strictly prohibited to drink. The pH ranged from 6.2-7.1 in the slightly acidic study area. The drinking standard for pH is 6.5-8.5. The Patharghata and Galachipa Upazilas are lower than the recommended range of pH.

Both dissolved solids and electrical conductivity showed a wide spatial variation in the region. TDS ranges from 347 mg/l to 1870 mg/l. The recommendation for drinking water containing TDS is not more than 1000 mg/l usually. Groundwater from the Patharghata contains a comparatively higher TDS concentration of 1870 mg/l. When comes to electrical conductivity, the ideal quality of groundwater is only found in the Galachipa and Rangabali Upazila. The other Upazilas contained higher electrical conductivity than the recommended 200-800 µS/cm for drinking purposes. As EC is found comparatively higher, salinity comes as also higher in the region. The groundwater sources being considered for drinking purposes should not have any salinity whereas most of the sites have a salinity from 0.5-1.0ppt. Goswami et al. (2022) and Biswas et al. (2014) also found similar observations. The intrusion of salinity into the groundwater table might be the pivotal cause of this situation in the coastal aquifers of Bangladesh. Natural fresh groundwater has EC levels that are generally <300 µS/cm (Kemker 2014). Therefore, the conductivity conditions were not beyond the acceptable range, but the values reflect some amount of ionic contamination, which would be higher if polluted or brackish water is mixed with in the future. Groundwater of Barguna Sadar and Patharghata are strictly forbidden to use for the irrigation purposes. The rests are in moderate quality for the said purpose (UCCC'1974).

Regarding the turbidity, alkalinity, and hardness status of the groundwater, there were no issues were found. The water turbidity is less than the 10 NTU (BD Drinking Standards) except for the Patharghata (16 NTU) only. High TDS and EC makes this water a bit more turbid than the other sources. The water was not hard enough also to drink as the values fall are less than the recommended standard of 200-500 mg/l.

Status of Inorganic Non-metallic Constituents

The standard limit of chloride for groundwater in Bangladesh is 150-600 mg/l, and 1000 mg/l in coastal areas (ECR'97: Rule 12). The Chloride result (30 to 920 mg/l) revealed that except for Patharghata all the groundwater samples are within the drinking standard and suitable for drinking purposes. The study area is very close to the Bay of Bengal, which has suffered from high salinity and this issue may influence chloride contents in groundwater in the surrounding area (Tood, 1980; Mahmuduzzaman et al., 2014; Alam et al., 2017; Sarker et al., 2018). The sodium should be around 200 mg/l in the drinking water, but all of the sites contain higher sodium concentrations. Regarding potassium, except Barguna Sadar (21 mg/l) and Patharghata (43 mg/l), all have complied with the Bangladesh drinking water quality standards of 12 mg/l.

The nitrate values (3.6 to 13.3 mg/l) of the groundwater samples are within the ECR'97 and USEPA standard limit for groundwater except for Patharghata (13.3 mg/l). Nitrate of greater than 10 mg/l may be regarded as a probable indication of contamination from fertilizer, municipal wastewaters, feedlots, and septic systems (Amiri et al. 2014; Hounslow, 1995; Rahman et al., 2014). However, seawater intrusion into the aquifer may also increase the nitrates values. Excessive nitrate content in drinking water causes infant methemoglobinemia (blue baby) (Murray and Christie, 1993). As the phosphate and sulfate are ranged from 1.2-3.0 mg/l and 1-121 mg/l respectively, both of the nutrients are within the range of 6 mg/l for nitrate and 400 mg/l for sulfate (Bangladesh Drinking Water Standards).

Status of Aggregate Organic Constituents

Like other nutrients, oxygen is also needed and should be at the recommended level in the drinking sources. The standard DO level for drinking water is 6 mg/l. However, in the groundwater sources normally, the DO level is found a bit less in the concentrations. In the study area, it has been observed that all the groundwater sources gave a DO level of less than 3 mg/l. A Lower DO level in the drinking water sources is not a big problem for the human body if the site is not organically polluted. Lower DO or higher DO usually changes the taste of the water. High DO is sometimes corrosive to the water supply materials. The BOD should be less than 0.2 mg/l but which is found higher in all the groundwater sources. The range is between 1-3 mg/l. This means that the sources are polluted by organic materials. Direct parallel infiltration into the aquifer from the rivers may increase the organic materials in the sources. As BOD is high in the sources, naturally the COD should also be high and both cases are true in the context. COD is found more than the recommended standard of 4 mg/l in all of the groundwater sources in the Payra-Kuakata region.

Status of Metal Constituents

Generally, Iron is an indispensable element for human nutrition but above 5.0 mg/l can be toxic. The Total Iron (Fe) in the study area was found to be ranging from 0.01 mg/l to 0.19 mg/l. A similar result was found in Patuakhali district (Islam et al., 2017a). Considering the drinking water standard of Bangladesh (0.3 to 1.0 mg/l) and WHO'2004 (0.3 mg/l), the groundwater of the study area is suitable for drinking. Bodrud-Doza et al. (2016) and Rahman et al. (2018) reported higher Fe contents than the present study. This higher amount of Fe can affect the taste and flavor as well as promote the growth of iron bacteria in water and make it distasteful (Yagoub and Ahmed 2009, Rahman and Hashem 2019). Overexposure to Fe causes cancer (Beckman et al., 1999), diabetes (Ellervik et al., 2001), liver and heart diseases (Yang et al., 1998).

The Lead (Pb) concentration in all the groundwater samples (0.001 mg/l) is within the drinking standard of Bangladesh (0.05 mg/l), WHO'2004 (0.01 mg/l) and the EU (0.05 mg/l), and safe for drinking. Higher intake of Pb over time may exert bad effect on nervous, digestive, haematopoietic, cardiovascular, reproductive and immunological systems and kidneys (Venkatesh, 2004, Riess, 2007).

The Chromium concentration (0.0003 mg/l to 0.008 mg/l) of the ground water is within the drinking standard of Bangladesh (0.05 mg/l) and safe for drinking in terms of Cr concentration. Chromium becomes hazardous for public health if the daily intake is exceeded the WHO recommended value (0.05 mg/l) but the deficiency of Cr can cause the disturbance of glucose, protein, and lipid metabolism (Calabrese et al., 1985).

The Copper (0.03 mg/l) for all the groundwater samples is within the drinking standard of Bangladesh (ECR'1997) and WHO'2004 and safe for drinking. Overdose of Cu may cause Parkinson's disease (Gorell et al., 1997).

The Cadmium (Cd) concentration (0.00015 mg/l to 0.00016 mg/l) of the ground water is within the drinking standard of Bangladesh, EU and WHO (0.003 mg/l) and therefore safe for drinking. A very mild concentration of Cd intake can cause anemia, anosmia, cardiovascular diseases, renal problems, and hypertension (Sharma et al., 2006), while Cd intake over the permissible limit causes acute and chronic illness for human, and also treats as a carcinogenic agent (Nyamangara et al., 2008).

The manganese (Mn) concentration (0.03 mg/l to 0.66 mg/l) of the groundwater except for Rangabali is within the drinking water standard of Bangladesh (0.4 mg/l). The ingestion of a higher dose of Mn with drinking water affects adversely the nervous system (Crossgrove and Zheng, 2004).

The Nickel concentration (0.01 mg/l to 0.03 mg/l) of all the ground water is within the drinking water standard of Bangladesh and is safe for drinking.

The Zinc (Zn) concentration (0.03 mg/l to 0.04 mg/l) of all the groundwater is within the drinking standard of Bangladesh (5.0 mg/l) and is safe for drinking. Higher accumulation of Zn in the body exerts toxic and carcinogenic effects, and subsequently neurologic, hematological complications, hypertension, and kidney and liver function disorder (Rao et al., 2001).

Table 15.6: Status of Physical and Aggregate Properties

Parameters	Unit	Barguna Sadar	Patharghata	Kalapara	Taltoli	Galachipa	Rangabali	BD Standards	Remarks
Temp.	^{0}C	29	28	29	30	29	29	20-30	Within the range
pH	-	6.9	6.2	7.1	7	6.3	6.7	6.5-8.5	Within the range
TDS	mg/l	892	1870	585	767	347	390	1000	Complied the range
EC	µS/cm	1775	3800	1170	1531	692	770	200-800	Mostly higher the range
Salinity	ppt	0.7	2.1	0.7	0.8	0.4	0.4	0	Higher the range
TSS	mg/l	2	1	3	2	1	1	10	Complied the standard
Turbidity	NTU	1	16	1	1	1	1	10	Complied the standard except Patharghata
Alkalinity	mg/l	98	110	112	70	93	80	30-400	Complied the standard
Hardness	mg/l	165	160	120	145	130	125	200-500	Complied the standard

Source: CEGIS Survey, May 2022

Table 15.7: Status of Inorganic Non-metallic Constituents

Parameters	Unit	Barguna Sadar	Patharghata	Kalapara	Taltoli	Galachipa	Rangabali	BD Standards	Remarks
Chloride	mg/l	230	920	140	200	30	35	150-600	Within the range
Sodium	mg/l	425	850	324	421	187	212	200	Higher the standard except Galachipa
Potassium	mg/l	21	43	2	4	4	3	12	Mostly complied the standard except Barguna Sadar and Patharghata
Nitrate	mg/l	13.3	3.6	6.6	9.1	4.1	4.4	10	Complied the standard except Barguna Sadar
Phosphate	mg/l	1.4	2.5	1.2	3.8	2.7	3.0	6	Complied the standard
Sulphate	mg/l	2	121	4	5	1	3	400	Complied the standard

Source: CEGIS Survey, May 2022

Table 15.8: Status of Aggregate Organic Constituents

Parameters	Unit	Barguna Sadar	Patharghata	Kalapara	Taltoli	Galachipa	Rangabali	BD Standards	Remarks
DO	mg/l	2.4	2.5	2.2	2.8	2.6	2.2	6	Very low level of oxygen
BOD	mg/l	2	3	3	2	1	1	0.2	Higher than the standard
COD	mg/l	8	12	12	8	4	4	4	Mostly higher than the standard

Source: CEGIS Survey, May 2022

Table 15.9: Status of Metal Constituents

Parameters	Unit	Barguna Sadar	Patharghata	Kalapara	Taltoli	Galachipa	Rangabali	BD Standards	Remarks
Iron	mg/l	0.19	0.03	0.02	0.11	0.01	-	0.3-1.0	Within the range
Zinc	mg/l	0.04	0.03	0.03	0.03	0.03	0.03	5	Complied the standard
Manganese	mg/l	0.03	0.2	0.03	0.03	0.03	0.66	0.4	Mostly complied the standard except Patharghata and Rangabali
Lead	mg/l	0.001	0.001	0.001	0.001	0.001	0.001	0.05	Complied the standard
Chromium	mg/l	0.002	0.000	0.001	0.000	0.000	0.008	0.05	Complied the standard
Nickel	mg/l	0.030	0.010	0.020	0.030	0.020	0.030	0.1	Complied the standard
Copper	mg/l	0.030	0.030	0.030	0.030	0.030	0.030	1	Complied the standard
Cadmium	mg/l	0.00015	0.00016	0.00015	0.00015	0.00015	0.00015	0.005	Complied the standard

Source: CEGIS Survey, May 2022

15.2.3 Water Pollution

Water pollution is one of the major phenomena in the Barguna-Patuakhali region. Though the study area is not much susceptible to water pollution both the surface and groundwater are experiencing pollution. A lot of causes have been identified for water pollution. Water is being polluted by domestic sources, markets, clinical waste, and chemical fertilizers used in the agriculture field. Marine vehicles are also responsible for water pollution of rivers and Khals. However, as the area is in the coastal region, saline and iron have contaminated the water. Agricultural production, fisheries, and livestock are affected by higher salinity in the dry season.

Surface Water Pollution

Various surface water sources of the study area are regularly polluted by deliberate drainage of wastewater in respect of pH, EC, Turbidity, TDS, DO, Salinity, and Potassium content when compared with national standards. But the present pollution level is low due to the low density of the population and no industrial agglomeration. The main sources of surface water pollution are urban wastewater, sanitary sewage, solid waste dumping, and chemical fertilizer from agricultural fields.

Water Pollution by Municipality

Water pollution can be occurred by the municipal waste generated from the municipality. Mainly solid waste is produced from households, clinics, markets, and commercial institutions. Among them household food waste is prominent. Solid waste management practice in the study area is very poor and somewhere there is no management practice yet. In some areas, there is no dustbin for waste disposal. Therefore, most of people throw their garbage here and there and especially dump it into the river, canal, and khal, which cause serious environmental pollution and also sometimes clogged the existing drainage network. Untreated human excreta are disposed of in an unsanitary manner mainly in low-lying areas, khals, and water bodies. From the field survey, it is also found that there is no clinical waste management system.

Water Pollution by Industry

The industry is one of the major pollution sources. Pollutants from industry can pollute the water by changing its quality. In the study area, there is no severe water pollution-generating industry. Sawmills, rice mills, ice factories, bakeries, oil mills, dockyards, and cow firms are some of the industrial sectors which can cause surface water pollution. The wood-based industry is one of the most important industries in the study area.

Water Pollution by Agriculture

Surface water pollution can occur from agricultural runoff. Chemical fertilizer as well as the debris and solid waste from the agricultural land can be disposed of in the nearby water bodies. This process can change the quality of the water bodies and can create pollution of the water.

Groundwater Contamination

Various literature stated that the water table in the study area varies generally from 1.5 m to 3.0 m and does not go beyond the suction limit therefore shallow hand tube wells are used by the general population to abstract water from the ground. Some are using river and pond water for washing and bathing purposes. The shallow aquifers occur up to 150m in depth whereas the deeper aquifers occur at 200 to 300m in depth (GWTF, 2001). But most of the water from hand tube wells is iron and saline contaminated and in some cases arsenic contaminated. Consequently, most of the tube well water is not used for drinking but used for other domestic purposes. The water in the deep aquifer is also

severely saline-contaminated. Due to improper waste management, or somewhere lack of waste management the people keep the waste on the road beside the drain or khal. This open dumping can affect groundwater quality by contaminating it through leaching from this waste and sometimes from the septic tank.

15.2.4 Water Quality Related Competent Authority

Key aspect in the theme	**Primary competent authority (CA)– and their mandates**	**Key support organisations (govt, NGO, donor, CBO, etc.)**	**Performance of CA and support organisations**
Surface water quality	a. Ministry of Environment Forests and Climate Change b. Ministry of Water Resources c. Department of Environment *Mandate* • set and enforce environmental regulations; • control pollution; • setting water quality standards (WQS) for water use and discharge; d. Water Resources Planning Organization (WARPO) *Mandate* • provide advice on policy, planning, and regulation of water resources. e. Bangladesh Water Development Board (BWDB) *Mandate* • all forms of water management f. Department of Fisheries (DoF) g. Ministry of Ports, Shipping and Inland Water Transport	○ Joint Rivers Commission (JRC); ○ Bangladesh Haor and Wetland Development Board (BHWDB); ○ River Research Institute (RRI); ○ Bangladesh Inland Water Transport Authority (BIWTA); ○ Department of Public Health Engineering (DPHE); ○ Paurashava (Municipalities); ○ The World bank, ○ JICA; ○ Asian Development Bank; ○ The Barind Multipurpose Development Authority (BMDA); ○ United Nations Depelopment Programme; ○ Global Water Partnership (GWP); ○ CEGIS ○ IWM ○ Academicians (Universities and individual researchers);	**Primary authority** ○ Shortage of infrastructural facilities particularly DOE for sufficient laboratory and human capacity; ○ In WARPO, no regional offices for competent authority for each hydrological region; ○ Lack of Inter-ministerial coordination and cooperation which therefore affects the harmonization and ten inetegrated efforts of saving water quulaity; ○ Conflicting of interests among different departments like BWDB and BMDA that hinders the integrated approach and resource conservation; ○ Insufficient supervision and monitoring reuces the chance of further improvement of the water quality development; ○ Technical problem to launch Mobile Courts Operation at the field level under the existing laws of DoE; ○ Lack of Upazila level capacities for local water resources development; ○ Lack of proper management Information system (MIS) that affects the effective decision making process using upto date information; ○ Lack of coordination between the Public, private sector, and NGOs; ○ The DoE is currently working towards improved water quality monitoring, and estimation of pollution loads in rivers and watercourses;

Key aspect in the theme	Primary competent authority (CA)– and their mandates	Key support organisations (govt, NGO, donor, CBO, etc.)	Performance of CA and support organisations
			Supportive authorities **WARPO/BWDB/BADC/World Bank/ADB** Act as Secretariat to Executive committee of National Water Resources Council (NWRC) but facing issues on making the required planning respecting water regional demands and its future conservation, development and managment; 1. Lack of technical knowledge and the skilled human capacities; 2. Facing local challenges and barriers to protect the existing water bodies; 3. Facing the conflict of interests among the government and the resources users; 4. International donor organization is strict to their mandates which actually prioritize the hotspots instead of nationwide development;
Ground water quality	a. DPHE *Mandates* DPHE is responsible exclusive for water supply and sanitation facilities throughout the country excluding Dhaka & Chittagong cities and Narayanganj and Kadamrasul Pourashavas where WASAs operate. Provide advisory service to GoB in framing policy and action plans for WSS Provide support to the local government institutions (LGIs) in the development and O&M of the water & sanitation facilities. a. WASA Supply of water to the communities and the industries;	a. WARPO *Mandates* National Water Policy (1999) declared WARPO as apex organization for macro planning in the country and also Secretariat to Executive committee to National Water Resources Council (ECNWRC); the policy gave clear mandate on the following: 1. To provide administrative, technical, and legal support to the ECNWRC. 2. To advise the ECNWRC on policy, planning, and regulatory matters of water resources and related land and environmental management. 3. To prepare and periodically update the National Water Management Plan.	**Primary authority** 1. DPHE is unable to monitor groundwater quality nation wide due to shortage of human capcity and the laboratory facilities; 2. No integrated MIS for observing and recording the nation wide water quality data and information; 3. Lack of funding and training to make more skilled people for the nation wide supports; 4. WASA is reluctant to work with the other relvenat organization closely; 5. Lack of effective planning using the zonation of the development boundary/area; 6. No forcasting of the development by WASA depending on the urbanization or spatial planning of Bangladesh; **Supportive Authorities** **WaterAid**

Key aspect in the theme	Primary competent authority (CA)– and their mandates	Key support organisations (govt, NGO, donor, CBO, etc.)	Performance of CA and support organisations
		4. To setup and update the National Water Resources Database (NWRD) and Information Management System. 5. To act as a "clearing house" for all water sector projects identified by different agencies and reporting to the ECNWRC on their conformity to the NWMP. 6. To undertake any special study, as may be required by the ECNWRC, for fulfilling the objectives and programmes envisaged in the National Water Policy and the Bangladesh Water and Flood Management Strategy. b. WaterAid Bangladesh *Mandates* WaterAid is an international NGO focused exclusively on ensuring equitable access to safe water, sanitation and hygiene education (WASH) for the world's poorest communities.	WaterAid Bangladesh work to offer clean water, decent toilets and good hygiene to underprivileged people globally, through convincing the governments to change laws, linking policy makers with people on the ground, pooling knowledge and resources, and rallying support from people and organisations. However, only poor or outreach communities gets the poriority which creates complexity in performing the actions by the local authorities of Bangladesh; Sharing knowledge and lessons learnt with the government and other relevant stakeholders are very limitied in actions. WARPO does not have sufficient institutional capacity to initiate the collaboration between diverse stakeholders (such as LGED, DPHE, WASAs, NGOs, CBOs and the private sectors) required for developing the technical packages within the Water Act. WARPO will also need data and information from these institutions in order to develop effective regulations. **JICA** The performance of JICA is satisfactory in terms of water quality conseration and its further development including the relevant infrastructures;

15.2.5 Water Quality Related Legislations

Key aspect in the theme	Primary legislation	Accompanying or enabling regulations	Comments on adequacy or not re. legislation and regs
Surface water quality	• The Bangladesh Water Act (BWA, 2013) • National River Protection Commission Act 2013 • The National River Conservation	• Environment Conservation Rules 1997 (ECR, 1997) (including all amendments) • Ecologically Critical Area Management Rules 2016	• The ECR'1997 doesn't represent all the surface water quality standrads Bangladesh is needed at this moment. • In addition, there is no classification of the standards like for drinking, irrigation, fisheries, bathing, and inland water quality for all the water quality parameters; • The Water Act 2013 is broadly a strong policy. However, there are some aspects (such as water pollution

Key aspect in the theme	Primary legislation	Accompanying or enabling regulations	Comments on adequacy or not re. legislation and regs
	Commission Act, 2013 • Natural Water Bodies Protection Act 2000	• The Penal Code 1860 • Bangladesh Water Rules 2018 • National Environmental Management Plan, 1995	and drinking water provision) that are not adequately covered, and some contradictions with previous water policies and other connected policies. • Policy documents are sometimes unclear about the mandate and powers of individual water institutions, and there are contradictions in scope where it is not clear which agency is responsible for the implementation of particular activities • Interactions between institutions are one of the biggest challenges for implementing good water governance. Promotion of inter-ministry and inter-agency coordination would greatly improve the situation
Groundwater quality	The Bangladesh Water Act 2013	-	-
	The Water Supply and Sanitation Act (1996)	-	-

15.2.6 Water Quality Related PPPs

Key PPPs relating to the theme	Main projects emanating from the PPPs	Main negative environmental impacts emanating from the projects	Main negative socio-economic impacts emanating from the projects
The National Water Policy, 1999	• Protection, restoration and enhancement of water resources (Water and river basin); • Protection of water quality, including strengthening regulations concerning agrochemicals and industrial effluent; • zoning regulations for new industries and strengthening of the regulatory system; • Sanitation and potable water; • Participation of local communities in all water sector development; • utilisation, conservation and protection of water resources;	No environmental impacts	• Pressure on water allocation for other purposes; • Community rights and interests can be threatened; • Disparity in the allocation of rights due to unfair practices in local government; • Create conflicts between water user groups;
National Water	• Developing and managing water resources and water services;	• Loss of benthic communities;	Lack of proper capacity

Key PPPs relating to the theme	Main projects emanating from the PPPs	Main negative environmental impacts emanating from the projects	Main negative socio-economic impacts emanating from the projects
Management Plan, 2001	• Improve the quality of life through equitable, safe, and reliable access to water for production, health, and hygiene. • Clean water in sufficient and timely quantities for multi-purpose use and preservation of the aquatic and water depended ecosystems.	• Potential loss of floodplains due to flood protection works; • Unwarranted localized adverse impacts on the aquatic environment.	development at the grassroots level might introduce unnecessary complexities.
National Environment policy 2018	• Covers 24 sectors including several that are cross-cutting, e.g. development sectors, management of resources (biodiversity, land, water, energy, manpower, information, etc.), disaster management, sectoral developments, control of environmental pollution, etc. • Ensure sustainable development and maintain environmental protection, pollution control, biodiversity conservation, and deal with adverse impacts of climate change.	No environmental impacts	• Conservation and its restriction to access might create some social issues. No access or restriction may have to lead the umabaility of resourecs to the poor community; • May laso affects the livelihoods who are dependent to those ecosystems;
Bangladesh Delta Plan, 2100	• Enhance water security and efficiency of water usages; • Ensure sustainable and integrated river systems and estuaries management; • Develop effective institutions and equitable governance for in-country and trans-boundary Water Resources Management; • Optimal and integrated use of land and water resources;	• Increased backwater flow and thus sedimentation might occur due to polders; • Changes in the natural flow direction due to structures might changes the water quality; • Water resources management of dredging may destry the benthic habitat quality for the hotspots;	No social impacts
National Sustainable	• Promote integrated management of polders;	• Chemical fertilizer and pesticides in	No social impacts

Key PPPs relating to the theme	Main projects emanating from the PPPs	Main negative environmental impacts emanating from the projects	Main negative socio-economic impacts emanating from the projects
Development Strategy, 2010-2021	• Adopt an ecosystem approach to water resource management; • Increase institutional capacity of DoE;	agricultural activities may deteriorate water quality; • Salinization due to development of excess shrimp aquaculture	
First Perspective Plan of Bangladesh (First), 2010-2021	• Following the integrated water resource management framework for the best allocation of water to various uses; • Focusing on surface water irrigation and reduced use of groundwater; • Desalinization activities; • Protecting rivers against bank erosion and enhancing land reclamation; • Resuming negotiations with India and other upper riparian states for equitable water-sharing arrangements for all trans-boundary rivers, particularly major rivers	• Pollution of water bodies by fertilsers and pesticides; • Increased water pollution during infrastructure development;	• Conflicts between fishermen and other land uses in coastal areas. • Migration from rural to urban areas with stress on basic urban facilities;
The Coastal Zone Policy 2005 and Coastal Development Strategy, 2006	• Ensuring fresh and safe water availability (in the context of regional water resources management); • Water resources management to combat water related disasters, increase freshwater availability, improve navigation and economic activity;	• Increased water pollution due to improved river navigability and increased shipping (inland and sea); • Degradation of water quality due to shrimp aquaculture; • Increased siltation in rivers and inland water bodies;	• Increase population density and thereby vulnerability to natural disaster; • Increase social problem due degradation of environment by coastal polder;
Second Perspective Plan for the year: 2021-2041	• Enhance existing good practices for water conservation and management; • Implement programmes including flood control and prevention, polder management, dredging, river training, salinity management, etc.; • Implement integrated water resource management (IWRM) more widely, including flood early warning systems, irrigation improvements and demand side management;	• Dredging may affect the water quality; • Habitat destruction and salinization due to development of shrimp aquaculture inside polders; • Increased paved areas will result	• Conflicts between fishermen and other land uses in coastal areas. • Habitat and agricultural land will be destroyed due to industrialization. • Displacement of people might

Key PPPs relating to the theme	Main projects emanating from the PPPs	Main negative environmental impacts emanating from the projects	Main negative socio-economic impacts emanating from the projects
	• Encourage water reservoir/ rainwater harvesting in rainfed, coastal and hilly areas; • Develop small-scale water resources systems; • Monitor the maintenance of the small-scale water resources infrastructure.	in drainage congestion, less infiltration, more surface runoff and water pollution;	occur due to land acquisition and loss of their skilled profession;
National Environmental Policy, 1992	• Maintaining the ecological balance and overall development through protection and improvement of the environment; • Identifying and regulate polluting and environmentally degrading activities; • Ensuring environmentally sound development; • Ensuring sustainable and environmentally sound use of all natural resources	No negative impacts	Create conflict in water uses group;
National Environmental Management Plan, 1995	• Better management of scarce resources, • Reducing the rate of environmental degradation, • Improving the natural and manmade environment, • Conserving habitats and biodiversity, • Promoting sustainable development and • Improving quality indicators of human life	No negative impacts	Create conflicts between fisheries and agriculture users;
National Strategy for Water Supply and Sanitation, 2014	• Safe and sustainable water supply, sanitation, and hygiene services for all, leading to better health and well-being; • Protect and preserve human health, water supply, and sanitation facilities from the adverse impact of natural and man-made disasters and climate change;	No direct impacts	Implementation of water supply relevant infrastructure might affect social life and their livelihoods in the development areas;
National Water Policy (1999) (NWPo)	• Address issues related to the harnessing and development of all forms of surface water and groundwater and management of these resources in an efficient and equitable manner; • Accelerate the development of sustainable public and private water delivery systems with appropriate legal and financial measures and incentives, including delineation of water rights and water pricing;	No Signigifcant Negative Impacts	

Key PPPs relating to the theme	Main projects emanating from the PPPs	Main negative environmental impacts emanating from the projects	Main negative socio-economic impacts emanating from the projects
National Policy for Safe Water Supply and Sanitation (1998) (NPSWSS)	• NPSWSS targeted for achievement in phases in the near future: • Increasing the present coverage of safe drinking water in rural areas by lowering the average number of users per tube-well from the present 105 to 50 in the near future. • Making safe drinking water available to each household in the urban areas. • Ensuring supply of quality water through observance of accepted quality standards. • Removal of arsenic from drinking water and supply of arsenic free water from alternate sources in arsenic affected areas. • Taking measures in urban areas for removal of solid and liquid wastes and their use in various purposes.	No Signigifcant Negative Impacts	
National Policy on Arsenic Mitigation (2004)	• Removal of arsenic from drinking water and supply of arsenic free water from alternate sources in arsenic affected areas. • Raising awareness regarding the impact of ingestion of arsenic contaminated water; • Raising awareness about alternative arsenic free safe water sources and mitigation options; • Follow approved guidelines/protocols for installation of water supply technology options; • Assess the needs for water supply intervention based on the status of contamination at village level; • Provisions for protocols for diagnosis and management of arsenicosis patients; • Formulation and maintenance of an effective referral chain for complicated case management of arsenicosis patients; • Providing government support for test kit manufacturing within the country, through both public and private initiatives; • Capacity at local and community levels for installation, operation and maintenance of mitigation options including monitoring, information management and reporting;	No Negative Impact	

15.2.7 Drivers of Changes in Water Quality

Key change	Main external drivers	Main internal drivers	Main actions to "fuel" or "brake" the drivers, depending on whether the change is good or bad
Increase of surface water pollution by unplanned urbanization and industrialization	• Better economic growth at the city; • Communication dvelopemnt with the capital city Dhaka;	• Lack of proper waste management stakeholders and the treatment facilities; • Lack of awareness among the businessman and the communities;	• Planned urbanization; • Creating industrial zones having treatment facilities; • Soild waste management facility installation; • Awareness building among the communities; • Adoption of Pollution Pays Principle;
Increase of salinity intrusion towards upstream of the river	Tropical cyclones and tidal surges, decreases in rainfall, geological process of delta formation.	Water logging, embankment, dam, filling up of wetlands.	• Re-excavation of the dead canal or rivers; • Illegal infrastructure in wetlands should be removed; • Revive the freshwater wetlands; • Increase the freshwater flows into the main river systems;
Changes of wetlands into agricultural fields and intensive aquaculture	High population needs huge agricultural supports	• To meet the local demands and national demands; • Improve the socio-economic condition of the farmers and the fishermen;	• Population control should be a measure; • Awareness building on sustainable use of the wetlands and water bodies; • Surface water availability should be ensuring in proper measure in agriculture; • Tree plantation and social forestry program should have taken in non- vegetated fallow land;
Increase of suspended matters due to the surface runoff and erosion from the catchment activities like agriculture and others	• High demand of foods for the high population growth rate; • Crop damages and losses due to the frequent disastrous events;	• No treatment facilties for the agricultural runoffs and lack of awarnesses among the farmers; • Lack of proper land zoning and effective enforcement to manage the resources;	• Introduction of the good agricultural practices including ensuring of the good governance (locally and nationally); • Land zoning and its proper management ensuring the effective enforcement of the relavant legislations and regulations;

15.2.8 Issues Relevant to Water Quality

Surface water quality

- Increasing trend of TDS, EC and salinity intrusion into the mainland river systems particularly during the dry season;
- Higher influcences of SEA water rather than the upstream river water flows;
- High sodium in the rivers due to the Bay influences;
- Higher cadmium in the Tetulia rivers';
- City adjacent canals receive all kinds of soild wastes from municipality, fishery markets and other local markets and residentail areas;

Groundwater quality

- Slightly acidic in nature;
- Most of the areas contain high EC due to infiltration of saline water into the aquifers;
- Slightly saline water for drinking purposes;
- High sodium ion in the water;

15.3 Soil Quality and Contamination

15.3.1 Soil Quality

Barguna and Patuakhali districts occupy an extensive area of Ganges tidal floodplain (AEZ-13) land in the south-west of the country. The greater part of this region has smooth relief having large area of salinity. Non-calcareous Grey Floodplain soil is the major component of general soil types. Acid Sulphate soils also occupy significant part of the area where it is very strongly acidic during dry season. In general, most of the top soils are acidic and sub-soils are neutral to slightly alkaline. Recent soil quality data has been used to evaluate the status of agricultural field, urban and peri-urban fields in the study area. The physical properties of the soil are presented in Table 15.10.

Table 15.10: Physical Properties of the Soil Sample

Sampling site	Upazila Name	Particle density (g/cc)	Bulk Density (g/cc)	Porosity (%)
Agricultural field	Barguna sadar	2.07	1.34	35.12
	Barguna sadar	2.10	1.12	46.78
	Patuakhali sadar	2.46	1.36	44.69
	Galachipa	2.43	1.23	49.31
	Galachipa	2.29	1.29	43.59
	Rangabali	2.44	1.09	55.37
Urban area	Barguna sadar	2.45	1.42	41.97
	Kalapara	2.27	1.23	45.72
Peri-urban area	Patharghata	2.28	1.19	47.81
	Patharghata	2.43	1.39	42.76
	Taltoli	2.09	1.15	44.88
Mangrove forest	Kuakata	2.42	1.19	50.79
Average		**2.31**	**1.25**	**45.73**
Range		**2.07 to 2.46**	**1.09 to 1.42**	**35.12 to 55.37**

Source: CEGIS field visit, May 2022

Particle density

The particle density of soils ranged from 2.07 to 2.46 g/cc where the highest value (2.46 g/cc) was found in agricultural land followed by Urban area (2.45 g/cc), Peri-urban area (2.43 g/cc) and Mangrove forest (2.42 g/cc). The lowest value is also found in (2.07 g/cc) in agricultural land (Table 15.10). Similar results were also found by Tanu *et al.,* (2017) who reported that the particle density of coastal soil in Kuakata ranged from 2.22 to 3.30 g/cc.

Bulk density

Under all the land uses the bulk density of the soils ranged from 1.09 to 1.42 (g/cc) (Table 15.10). Relatively Bulk density values of soils of agricultural fields (1.09 g/cc) were lower than that of Urban area (1.42 g/cc) followed by peri-urban (1.39 g/cc) area (Table 15.10). A normal range of bulk densities for clay is 1.0 to 1.6 g/cm^3 and a normal range for sand is 1.2 to 1.8 g/cm^3 with potential root restriction occurring at 1.4 g/cm^3 for clay and 1.6 g/cm^3 for sand (Aubertin and Kardos; 1965). Hossain *et al.,* (2022) also reported that the bulk density of the soils of the studied area (Patuakhali and Kalapara Upazila) ranged from 1.30 to 1.47 gcm^3. Ranges of bulk density in soils were 1.09 to 1.42 g/cc while particle density was almost twice as high at 2.07 to 2.46 g/cc (Table 15.10) which denoted near the ideal conditions of the soil. These results were confirmatory with the results reported by Tanu *et al.,* (2017).

Porosity (%)

In the study area, variations in soil porosity were observed under various land use patterns. The soil porosity ranged from 35.12% to 55.37%, with the highest values being 55.37% and 50.79% in agriculture and mangrove forest, respectively, and the lowest values being 35.12% in agricultural fields at Barguna, following that, 41.97% in urban areas and 42.76% in peri-urban areas were recorded in Barguna Sadar and Patharghata Upazila (Table 15.10). Present status is also supported the findings of Tanu *et al*., (2017) who conducted a study on the Kuakata coastal area and observed excellent porosity (36 to 66 %) of all soil samples.

Table 15.11: Soil pH, EC and Soil Texture of the sampling sites

Sampling site	Soil pH	Electrical conductivity(EC) (dS/m)	Soil Texture			
			Sand	Silt	Clay	Type
Agricultural field	6.3	1.74	39.46	38.34	22.2	Loam
	4.5	1.34	43.61	36.25	20.14	Loam
	8.1	5.26	44.9	44.89	10.2	Loam
	7.7	2.24	41.47	44.4	14.13	Loam
	5.0	6.63	48.15	40.61	18.27	Loam
	8.0	4.30	55.38	34.48	10.14	Sandy Loam
Urban area	7.6	4.69	43.55	28.22	28.23	Clay Loam
	5.5	1.35	44.79	38.85	16.36	Loam
Peri urban area	7.3	5.29	48.51	39.13	12.36	Loam
	8.0	5.23	53.25	36.58	10.16	Sandy Loam
	4.1	0.78	47.1	42.73	10.17	Loam
Mangrove forest	7.3	1.47	57.19	32.62	10.19	Sandy Loam

Source: CEGIS field visit, May 2022

Soil pH

The soil pH is an important parameter that helps in the identification of the chemical nature of the soil (Kulshreshtha *et al*., 2003). The maximum pH value was found in Agricultural land (8.1) because of frequent land inundation by the tidal force of river occurred. And it might be the reason of high soil pH, followed by peri-urban area pH (8), Urban area pH (7.6) and Mangrove forest (7.3) which was found in Patualkhali, Patharghata, Barguna and Kuakata, respectively. The lowest value of pH was found in the peri-urban area (4.1) then in agricultural field pH (4.5) located in Barguna and Taltoli Upazila. The pH of soil samples in the study area ranged from 4.1 to 8.1 (Table 15.11) *i.e.* the soil sample was acidic to moderately alkaline according to the standard of Boyed *et al*., (2004).

It was noticeable that soil pH was so acidic in the peri-urban area (4.1). At the peri-urban area, all the local construction materials and market wastes are dumped which could be the reason of so acidic in nature. and it was collected from the road site land near a local construction and close to the Taltali Bazar. In addition to that, indiscriminate application of acid-forming nitrogenous fertilizers such as urea, ammonium chloride and ammonium sulfate for the commercial crops resulted in more acidic soil in Barguna Sadar and Taltoli area but it gradually increased (basic) towards the agricultural field.

Hossain *et al.,* (2013) who found highest soil pH ranges 2.0 to 8.5 in the coastal soils of Bangladesh which also showed by Anwar (1993) where he found the pH ranges of 6.2-7.8 in the Patuakhali and Barguna Districts.

Soil Electrical Conductivity (EC)

Soil electrical conductivity (EC) is a measure of the amount of salts in soil (salinity of soil). The EC values of the studied area varied from 0.78 to 6.63 dS/m (Table 15.11). The EC values indicated that the soils are non-saline to moderately saline in nature. According to SRDI, (2003) and BARC, (2005) the standard value of EC as non-saline (0–2 dS/m), slightly saline (2–4 dS/m), moderately saline (4–8 dS/m), saline (8–12 dS/m), and highly saline (>12 dS/m). Among other upazilas, Galachipa showed the highest EC value of 6.63 ds/cm.

Low flushing rate and slow groundwater movement, which is reflected in the area's low surface discharge of salt could be the main reason. The peri-urban area of Taltoli Upazilla recorded the lowest value of EC (0.78 dS/m) (Table 15.11). Lower EC may be caused by upstream and topographically higher areas, sloping topography, a significantly higher gradient, seasonal irrigation, and alternative agricultural patterns.

Soil Texture

Soil texture refers to the relative percentage of sand, silt and clay in a soil. Soil texture varies according to land use type. Different land use practices and studied areas provided various soil textures (Table 15.11). Agricultural lands contain Loam textured soil, indicating very good soil quality for agricultural uses. Another agricultural soil was taken from Char Montaz, which is newly deposited land, hence the sandy loam type of soil. The soil types in urban and peri-urban areas are loam & clay loam since these areas were formerly used for agricultural practices and are now used for urban development. As mangroves are tidal influenced, the soils are mostly sandy loam.

15.3.2 Soil Contamination

Soil pollution, influenced by both natural and anthropogenic factors, significantly reduces environmental quality. The natural concentration of heavy metals and metalloids like Cr, Ni, Cd, Cu, Pb and As in soils frequently increases due to human activities. The concentrations of heavy metals and metalloids in agricultural soils are well-known and have adversely affected many parts of the

world (Kheir, 2010; Sun *et al*., 2010), including Bangladesh (Islam *et al*., 2014). Soil is a dynamic natural resource for the survival of human life and regarded as the key receiver of persistent toxic heavy metals and metalloids due to expanding (Luo *et al*., 2007; Karim *et al*., 2014). In recent decades, there has been significant concern regarding soil contamination by various toxic metals due to expanding industrialization and urbanization (Chen *et al*., 2010; Sun *et al*., 2010). However, in urban areas heavy metals and metalloids may originate from various sources such as industrial activities, power generation, mining, smelting, waste spills or fossil fuel combustion and waste disposal (Wei and Yang, 2010; Li and Feng, 2012; Martin *et al*., 2014; Karim *et al*., 2014). The excessive input of heavy metals and metalloids into urban soils may lead to the deterioration of soil biology and function, changes in soil physicochemical properties which may create other environmental problems (Papa *et al*., 2010). Therefore, the accumulation of heavy metals and metalloids in soils is of increasing concern due to their potential risks and harmful effects on soil ecosystems (Cui *et al*., 2004; Li *et al*., 2009; Yu *et al*., 2012; Yuan *et al.*, 2014).

The Payra-Kuakata area has gained attention due to its environmental pollution and is facing serious threats caused by the district's rapid expansion, congestion and activities from industries (Islam *et al*., 2014a). In the study area, increasing air, water and soil pollution emanating from traffic congestion and industrial waste are serious problems that adversely affect public health. Islam *et al.* (2017) conducted a study on the Patuakhali district to identify the levels of heavy metals and metalloids in soils of different land uses. the objectives of this study are to address the problem of Cr, Ni, Cu, As, Cd and Pb pollution in different urban soils, to identify the sources of heavy metals and metalloids and to assess the ecological risk of heavy metals and metalloids in soils utilized for different land uses. Six heavy metals i.e., chromium, nickel, copper, arsenic, cadmium and lead in eight different land-use soils from the Patuakhali district in Bangladesh were assessed that was shown in (Table 15.12) to understand the scenario of the study area.

Table 15.12: Metal concentration (mgkg^{-1}) in soils of different land uses and guidelines value

Sites	Al (Mean±SD)	Cr (Mean±SD)	Ni (Mean±SD)	Cu (Mean±SD)	As (Mean±SD)	Cd (Mean±SD)	Pb (Mean±SD)
Brickfield (BF)	13±5.7	43±14	83±69	51±37	38±12	10±7.7	42±27
Ferry ghat (FG)	12±4.8	39±23	56±20	54±32	8.0±3.2	6.3±5.2	38±27
Launch terminal (LT)	15±11	47±23	76±49	73±31	15±12	5.8±5.1	137±78
Agriculture field (AF)	15±8.2	19±16	27±27	34±21	9.3±6.0	3.1±2.2	24±16
Residential area (RA)	15±7.1	10±11	31±24	28±22	3.3±2.7	2.4±1.3	33±23
Market (M)	16±6.7	14±8.1	21±5.8	77±44	6.3±4.8	1.5±0.93	17±20
Playground (PG)	14±5.5	22±19	28±23	21±18	3.0±2.9	4.8±5.2	27±22
Standard Value for Agricultural soil							
Background Value of Bangladeh soil (Kashem and Singh, 1999)	NA	NA	22	27	3	0.01-0.2	20.0
Dutch soil quality	NA	100	35	36	29	1	85

Sites	Al (Mean±SD)	Cr (Mean±SD)	Ni (Mean±SD)	Cu (Mean±SD)	As (Mean±SD)	Cd (Mean±SD)	Pb (Mean±SD)
standard (VROM, 2002)							
Canadian Environmental Quality Guidelines (CCME, 2003)	NA	64	50	63	12	1.4	70
China (Chen *et al.* 2018)	NA	200	50	100	NA	0.30	300
Netharlands (CCME, 2003)	NA	50	35	36	NA	3.00	85.00

Another study was conducted in Payra 1320 MW Thermal Power plant in Kalapara Upazila at Patuakhali District to detect heavy metals like Iron, Manganese, Zinc, Lead, Cadmium, Arsenic and Mercury in soil. For this study soil sample was collected from agricultural land in different location where the soil was contaminated by leaks and spills of oil, lubricants, or fuel from heavy equipment, improper handling of sanitary effluent or chemical/fuel storage. Such spills could have a long-term impact on soil quality.

15.3.3 Soil Quality Related Competent Authorities

Key aspect in the theme	Primary competent authority (CA)– and their mandates	Key support organisations (govt, NGO, donor, CBO, etc.)	Performance of CA and support organisations
Soil quality	• Ministry of Agriculture; • Soil Resources Development Insititutes;	BADC, BARC, BARI, BRRI, BAU, SAU, KU, BMDA, CEGIS, DAE, DoE, SCWMC, SMRC, FAO, PSTU, NARS, UNEP, UNDP;	• Well structured infrastructure and the performance of these organizations are very good as well; • Improving online and offline fertilizer recommendations system, as well as enhancing laboratory facilities, technical staff, and mobile soil testing laboratories in Upazilla level. • Currently is performing good except of saving agricultural products form natural disasters;

15.3.4 Legislations

Key aspect in the theme	Primary legislation	Accompanying or enabling regulations	Comments on adequacy or not re. legislation and regs
Soil Salinity	The Bangladesh Environment Conservation Act, 1995	○	• The act also specifies what should be done to prevent probable accidents that could result in environmental degradation and pollution (including soil, air, and water) and determining remedial action for such accidents; • Under this act If a person operating any industry, handling any hazardous substance or discharge any chemical substance shall be bound to render all assistance;

15.3.5 PPS

Key PPPs relating to the theme	Main projects emanating from the PPPs	Main negative environmental impacts emanating from the projects	Main negative socio-economic impacts emanating from the projects
National Agriculture Policy, 2018	• Reducing deleterious effect of pesticide residues; • Management of soil and water salinity;	• Increased agricultural activity causes pollution from fertilizer and pesticide residues and create pressure on grazing land; • Possible increase in soil salinity due to increased dry season irrigation (in case of long time stagnation of water that rarely happens);	Reduced soil fertility and, as a result, production losses which may affect the social lifes;
National Organic Agriculture Policy, 2016	• Sustainable organic agriculture Program. • Improve soil fertility by combining physical, chemical and biological Properties;	No direct impact	No direct impact
National Agricultural Extension Policy, 2015	To achieve land productivity, IPM, easy and un-interrupted supplies of inputs(good quality seed, providing fertilizer and improved distribution).	• Increased pollution by fertilizer and pesticide residues; • Increased conflicts in the coastal region between fishing and farming communities due to agricultural growth;	Because of the extensive use of chemical fertilizers, the soil may become contaminated, resulting in a loss of soil fertility, a decrease in production rate, and, ultimately, economic losses.

Key PPPs relating to the theme	Main projects emanating from the PPPs	Main negative environmental impacts emanating from the projects	Main negative socio-economic impacts emanating from the projects
National Food Policy, 2006	Increase agricultural productivity and regional crop diversification;	Possible increased pollution from fertilizer and pesticide residues due to increased agricultural activity;	No direct impact
The Coastal Zone Policy 2005 and Coastal Development Strategy, 2006	Reduction of vulnerabilities to natural disaster	Degradation of water and soil quality due to shrimp aquaculture	• River bank erosion washes out of road, embankment, land and settlements. • damage to rural infrastructure (roads, bridges, buildings, embankment) due to rising salinity (which reduces soil cohesiveness.

15.3.6 Drivers of Changes

Key change	Main external drivers	Main internal drivers	Main actions to "fuel" or "brake" the drivers, depending on whether the change is good or bad
Climate variability	International cooperation, global awareness and influence	• To control and restore salinized soils. • Reduce the increasing salinity in coastal areas, which has a negative impact on the environment. • Production of various crops has declined due to excessive salinity in soil.	• Community Awareness and risk communication by local voluntary groups. • Partnership/cooperation with NGOs and international humanitarian agencies
Salinity of irrigation water	International cooperation, global awareness and influence	• Increased irrigation for leaching Saline intrusion into groundwater aquifers. • Declining excessive salinity due to continuous irrigation.	• Land and water Conservation (eg. Humification, reduce tillage and rain water harvesting. • Control and management of saline ground water table. • Improve salt resistance rootstock and salt tolerant variety.
Mean sea – level rise	International cooperation, global awareness and influence	People living in coastal zones have been repeatedly affected by runoff or floods from rivers or the sea, which causes salt deposits on the soil which increased soil salinity and ultimately production losses.	• Provide adequate facilities and funds for maintaining flood/coastal embankments. • Provide improved spillways to protect the dam • minimizing seepage of saline river water through the ground or an embankment

15.3.7 Issues Relevant to Soil Quality

- Chances of increasing of soil salinity due to the dry period agricultural practices;
- Soil infertility at the urban and periurban areas because of soild waste and construction materials dumping near the agricultural fields;
- No updated soil quality maps or atlas;
- No data and information for the soil contamination by the heavy metals;

15.4 Air Quality and Pollution

15.4.1 Introduction

Air pollution at present mainly occurs from locally established industries, road traffics and others which can be identified and categorized by increasing industrialization, rapid urbanization, port activities–particularly at Payra and navigation throughout the water channel, power industries at Payra area, intensive farming and fast growing tourism.

On the other hand, wood based industries are prevalent in this region. Also, there are several small and medium industries which are used for different industrial purpose such as flour mills, rice mills, ice mills, saw mills, goldsmith, blacksmith, wood works, etc. These industries create sound and noise and pollute water and air. Besides, a number of heavy and small motorized vehicles move through the roads and extract some pollutant particle and emissions that also cause air pollution in and around stoppages and market areas[60].

In Bangladesh, increased burning of fossil fuel produces numerous airborne Hazardous particles i.e. nitrogen oxides (NOx), sulfur dioxide (SO_2), carbon monoxide (CO), particulate matter ($PM_{2.5}$ and PM_{10}), volatile organic compounds (VOCs), ozone (O_3), and heavy metals and finally released into atmosphere. These particles are responsible for the significant changes in the chemical composition and ultimately have acute and chronic effects on human health e.g. minor respiratory diseases, cancer, cardiovascular, immunologic, hematologic and reproductive systems disorders. In 2019 an estimation of about 1,73,500 deaths occurred in Bangladesh which are linked with air pollution[61].

Brick kilns in Patuakhali and Barguna districts are illegally using firewood instead of coal to fire the kilns. On average, about 2,400 tons of firewood are burned in a brick kiln per year, which pollutes the atmosphere and also threatens the natural environment. A source of Patuakhali Deputy Commissioner's (DC) office said there are only 32 approved brick kilns in the district, but there are around 80 brick kilns without approval in different areas of the district. There are 170 approved brick kilns in all six districts of Barisal division, but around double that number are running without approval from the district administrations concerned. A fireman of a brick kiln in Patuakhali Sadar upazila said at least 300 tons of firewood are needed to burn one round (six lacs) bricks. Thus, 2,400 tons are burned per year in a brick kiln as around eight rounds bricks are burned every season from

[60] INITIAL ENVIRONMENTAL EXAMINATION (IEE) on Coastal Towns Environmental Infrastructure Project (CTEIP), Ministry of Local Government, Rural Development and Cooperatives; May, 2016.

[61] Ahmed F., Rahman M. R., 2020., A review on air pollution status of Bangladesh and its effects on

Human health., Journal of Noakhali Science and Technology University (JNSTU), 4(1&2): 27-38 (2020)

December to April. About two lakh tons of firewood are burned every year in 80 brick kilns in the eight upazilas of Patuakhali district, a source said[62].

Projections of national emissions of particulate matter (TSP, PM_{10} and $PM_{2.5}$) and the main gaseous air pollutants (SO_2. NO_X) have been developed by IIASA16 using the GAINS17 Asia model for the period 2015–203018. Total emissions of PM_{10} and $PM_{2.5}$ are expected to grow by 17% and 15%, respectively, by 2030 [63]. Fuel combustion in stationary installations is expected to be the dominant source of CO_2 emissions in Bangladesh (66% in 2020, 73% in 2030). Emissions of CO_2 from fuel combustion are expected to be driven by electricity generation (40% in 2030) and industrial combustion (20% in 2030). It can be expected that newly-built fossil fuel-fired power plants will increase emissions of CO_2 considerably[64].

15.4.2 Air Quality of the Study Area

The results of ambient air quality parameters for all twelve (n=12) monitoring locations were tabulated in the Table 15.13. Result shows that all the parameters were found within the national ambient standards. The higher value of majority of parameters was found at AAQ-12 location in downwind side. The area is situated in the proximity of roadway and industrial complex, so, traffic movement might be responsible for elevated level of air quality parameters. Additionally, dust generating out of the site for any activity specifically and atmospheric aerosol over proximity of industrial and urban development area would dissipate quite well without resulting to any gross dust (particle matter) pollution.

Table 15.13: Air Quality of the Study Area

Unit	PM_{10} µg/m³	$PM_{2.2}$ µg/m³	SO_2 µg/m³	NO_x µg/m³	CO mg/m³	VOC µg/m³
Averaging Period	24h	24h	24h	24h	8h	-
AAQ-1	82.6	41.6	6.8	32.6	0.75	<4.2
AAQ-2	79.6	39.6	6.2	30.2	0.65	<4.2
AAQ-3	86.2	44.6	7.3	35.6	0.56	<4.2
AAQ-4	75.6	40.8	6.5	32.5	0.65	<4.2
AAQ-5	78.4	42.5	6.2	28.2	0.72	<4.2
AAQ-6	77.3	39.2	<6.0	26.9	0.68	<4.2
AAQ-7	79.4	38.6	<6.0	26.4	0.62	<4.2
AAQ-8	80.7	40.8	6.5	30.2	0.66	<4.2
AAQ-9	83.9	45.2	6.3	30.8	0.73	<4.2
AAQ-10	82.7	42.7	6.2	29.8	0.78	<4.2
AAQ-11	81.2	41.3	6.4	29.7	0.72	<4.2
AAQ-12	86.3	44.7	7.4	36.5	0.69	<4.2
Standard (National)	150	65	80	80 (Annual)	5 (8 Hr)	-
Standard (International)	150	75	125	200 (1Hr)	-	-

[62] https://www.thedailystar.net., September, 2015

[63] GAINS Asia https://gains.iiasa.ac.at/gains/ASN/index.login?accept_disclaimer=checked

[64] Strategic Environmental assessment report on South West Region of Bangladesh for Conserving the Outstanding Universal Value of the Sundarbans Project., November 2021.

However, the ambient air quality in the study area is fair enough to categorized it as suitable or clean enough for humans or the environment and posing no threat to the environment and ecological resources. Not a value of the criteria pollutant breached the air quality standard (Air Pollution Control Rules, 2022).

15.4.3 Administration/Competent Authorities

Key aspect in the theme	Primary competent authority (CA)– and their mandates	Key support organisations (govt, NGO, donor, CBO, etc.)	Performance of CA and support organisations
• Protecting the environment particularly from the negative impacts of development activities. • Biodiversity conservation, • pollution control (through monitoring), and processing • Environmental impact assessments (EIA)	Ministry of Environment, Forest and Climate Change {MoEFCC) The mandates are as- • Ensuring a sustainable living environment for the current and future population of the country • conservation of environment and biodiversity, • control of environmental pollution, coping with the impact of climate change • development of forest resources and sustainable management of marine resources	• Department of Forest; • Department of Environment; • Bangladesh Climate Change trust • International Institute for Environment and Development (IIED) • Center for Environmental and Geographic Information Services (CEGIS) • International Union for Conservation of Nature (IUCN) • Action Research for Community Adaptation in Bangladesh (ARCAB) • Bangladesh Paribesh Andolon (BAPA) • Bangladesh Environmental Lawyers Association (BELA)	• Conduct mobile courts against production and use of harmful polythene. • Reduce the emission of the motor vehicle, reduce/control noise pollution, reduce air pollution, and to prevent industrial pollution by ensuring the use of modern technology and though enforcement activities in necessary case. • Increase the use of improved technologies for brick kilns to reduce carbon emission • Implementation of Clean Development Mechanism program (CDM) in 6 districts to reduce carbon emission from organic waste • Improve living standard of people affected by climate change • Updating of Bangladesh Climate Change Strategy and Action Plan (BCCSAP) • Preparation and finalization of National Adaptation Plan • Creating green belt to protect marine cyclone through conservation of established coastal forest.

15.4.4 Relevant Legislation and Regulations

Key aspect in the theme	Primary legislation	Accompanying or enabling regulations	Comments on adequacy or not re. legislation and regs
• The requirements on environmental protection, • improvement of environmental standards, and • Control and abatement of environmental pollution.	• Environment Conservation Act (ECA) 1995 (amended 2000, 2002, 2007 and 2010) and • Environment Conservation Rules (ECR) 1997	• Ecologically Critical Area Management Rules 2016 • Noise Pollution Control Rules- 2006 • Bangladesh Climate Change Trust Act 2010 • The Ship Breaking and Recycling Rules-2011 • The Vehicle Act (1927) • The Motor Vehicles Ordinance (1983) • NG Safety Rules 1991 (amended 2003) • Brick Manufacturing and Brick Kiln Establishment (Amendment) Bill 2019 • Dangerous Cargoes Act 1953 • Explosives Act 1884, Explosive Rules-2008. • Explosive Substances Act 1908 and Explosive Substances (Amendment) Act, 1987. • Fire Prevention and Extinguish Act, 2003.	• only a few sections of the act and rules deal with conservation, protection and enrichment of the quality of the environment • the insufficient number of provisions regarding conservation is a significant barrier. • irrational classifications of industrial units in the Schedule-I of the rules is notable. Specifically, ship-breaking and assembling of batteries should be placed in the Red category instead of Orange-B with public toilets placed in the Orange-A category instead of the Orange-B category considering their impact on the environment. • Section 6 (e) puts a strict embargo on filling up the wetlands except for public interest. Here, the term public interest is inconspicuous and has not been defined anywhere in the act. • Section 6(a) says that the production and stocking of these sorts of bags are not prohibited if it is done for exporting purposes. This is a clear violation of the "No Harm Principle" established under Stockholm Conference, 1972 and the Rio Declaration, 1992, • Regulating smaller industries as they can relocate at any moment. While relocating the industries, only the level of pollution was taken into account but not the size of industry/s65

[65] https://www.tbsnews.net, September 20, 2022

15.4.5 Air Quality Related PPPs

Key PPPs relating to the theme	Main projects emanating from the PPPs	Main negative environmental impacts emanating from the projects	Main negative socio-economic impacts emanating from the projects
• The National Environment Policy (updated 2018) • National Environmental Management Action Plan 1995	• Air Quality Management Project (AQMP) • Clean Air and Sustainable Environment (CASE) project with assistance from International Development Association (IDA) / World Bank (WB) • Integrated and participatory project to control sound Pollution • Strengthening Capacity for Monitoring Environmental Emissions under the Paris Agreement in Bangladesh	Very minimal environmental impact due to Construction of foot over bridges (FOBs), traffic signals, one-way streets, separation of motorized and non-motorized traffic, and people with-disability (PWD) friendly sidewalks	No impact

15.4.6 Drivers of Change

Key change	Main external drivers	Main internal drivers	Main actions to "fuel" or "brake" the drivers, depending on whether the change is good or bad
• Emission inventory has been prepared for Dhaka and Chottogram district • Identification of the emission major sources • estimate and evaluate the impact of present emissions as well as future emissions, taking into account mitigation possibilities • understanding of the total emissions, as well as the sectors responsible for pollutants investigated • Decrease in particulate emissions per brick kilns adopting cleaner technologies and practices of 20-30% by the end of project period • Reduction in the GHG emissions per brick kilns adopting cleaner technologies and practices by 15-20% compared to the prevailing baseline status • A 10% decrease in the number of traffic accidents in the project areas by end of the project	• International conventions, • Global awareness on reduction of Greenhouse gas and • Influence on Environmental protection	• air pollution as the leading cause of mortality and morbidity related to environmental issues • Improvement in the National PPPs for reduction of Greenhouse gas and • Need for environmental enhancement, remediation, Environmental protection and benefits • impacts of air pollution include damages to crops and ecosystems, degraded visibility, soiling of buildings, and damage to water quality through air deposition of pollutants	• sector analysis reports, surveys, implementation evaluation and audits • institutional/ regulatory reforms and capacity building in the organizations that are variously responsible for environmental protection, and urban transportation planning and management • Applicability of the Bank's social safeguard policies

15.4.7 Main Issues Concerned with the Theme

- increasing industrialization, rapid urbanization, port activities–particularly at Payra and navigation activities throughout the water channel, power industries at Payra area, intensive farming and fast growing tourism;
- wood based industries are prevalent in this region. Also, there are several small and medium industries which are used for different industrial purpose such as flour mills, rice mills, ice mills, saw mills, goldsmith, blacksmith, wood works, etc. These industries create sound and noise and pollute water and air;
- Brick kilns in Patuakhali and Barguna districts are illegally using firewood instead of coal to fire the kilns. On average, about 2,400 tons of firewood are burned in a brick kiln per year, which pollutes the atmosphere and also threatens the natural environment;
- According to the 2018 Environmental Performance Index, poor air quality is the greatest environmental threat to public health; diseases related to airborne pollutants contributed to 65% of all life-years lost to environmentally related deaths and disabilities in 2016[66];

15.5 Noise Level and Pollution

Noise results from many human activities (transport, construction, industry and recreation) although noise from industries is not particularly significant due to their predominantly small scale. In some areas of the study area noise is an increasing problem, mainly due to commercial vessels (cargo and fishing) as well as tourist launches (using loudspeakers) - particularly during the winter. Sound pollution in Patuakali's Kuakata sea beach has turned acute as loudspeakers used by owners of engine-driven boats are affecting the hearing power of tourists. The owners mainly invite the tourists over loudspeakers to travel in their boats to visit different tourist spots, said locals. Tourist boats from Kuakata beach are visiting some of the most spectacular tourist spots including Fatrar forest of Taltoli upazila of Barguna, Haringhata forest of Patharghata upazila, Laldiar char and Katka of Sundarbans in Bagerhat. Kalapara Upazila Nirbahi Officer (UNO) Abu Hasnat Mohammad Shahidul Haque, also the member secretary of Kuakata Beach Management Committee, said he was not aware of the matter. Necessary steps will be taken to stop noise pollution, said the UNO[67].

As shown in a Department of Environment study conducted in 2017, approximately 11.7 percent of people in Bangladesh have lost their hearing because of noise pollution. The highest noise level in the major cities were found to be as following: Dhaka (132 decibels), Sylhet (131 decibels), Khulna (132 decibels), Barishal (131 decibels), Rangpur (130 decibels), Rajshahi (133 decibels), Mymensingh (131 decibels), and Chattogram (133 decibels)[68]. The study also revealed that around 11.7% of the population of Bangladesh has lost their hearing due to noise pollution. WHO has termed noise pollution as an underestimated threat that can cause hearing loss, cardiovascular problems, cognitive impairment, stress, and depression etc. In managing noise pollution WHO recommended three principles, i.e., precautionary principle, polluter pays principle, prevention principle[69].

[66] Friedrich, M.J. (2018). *Air Pollution Is Greatest Environmental Threat to Health. JAMA, 319(11), 1085*

[67] https://www.thedailystar.net/country/news/kuakata-beach-sound-pollution-unbearable-2024249

[68] https://www.observerbd.com/news.php?id=346767

[69] https://www.tbsnews.net/thoughts/noise-pollution-rules-largely-ignored-law-257044

On the other hand, the study area is having a number of small and large rivers, small to medium creeks, and many inland waterbodies which are connected with the rivers, creeks or channels. Vast numbers of water vessel and Ships, barges, trollers, tourist boats, fishing boats have been plying across thses water courses and hence underwater noise became a matter of concern throughout the study area.

Underwater noise, particularly from ship's engines and propellers, can have considerable impacts on aquatic mammals. There is currently no monitoring protocol to control noise pollution from shipping. Noise (engines, music, shouting) from vessels can disturb communities residing along the riverine system. A number of studies have shown that underwater-radiated noise from commercial ships and vessel (particularly from engines and propellers) may have both short- and long-term negative consequences on marine life, especially marine mammals [70]. The documented effects include behavioral and acoustic responses, auditory masking, and stress. Amer (2020) points out how cetaceans are particularly sensitive to acoustic disturbance and noise pollution with common impacts including: fatal stranding; hearing damage; long-term avoidance of the noisy area; higher energetic costs; stress responses; changes in vocalizations – leading to disruptions in reproduction, foraging, and migration; and the masking or obstruction of important vocalizations and sounds[71].

In a review of the literature on this problem, Erbe et al. (2019) note that there appears a bias to more easily accessible species (i.e., bottlenose dolphins and humpback whales), but there is a paucity of literature addressing vessel noise impacts on river dolphins, even though some of these species experience chronic noise from boats[72]. One recent study (Dey et al., 2019) in the Ganges River in Bihar State, India, showed that river dolphins showed enhanced activity during acute noise exposure and suppressed activity during chronic exposure. Increase in ambient noise levels altered dolphin acoustic responses, strongly masked echolocation clicks, and more than doubled metabolic stress. Noise impacts were further aggravated during dry-season river depth reduction. The authors suggest that maintaining ecological flows, downscaling of vessel traffic, and propeller modifications to reduce cavitation noise, could help mitigate noise impacts on Ganges river dolphins[73]. The International Maritime Organization has approved non-mandatory guidelines on reducing underwater noise from commercial shipping, to address the adverse impacts on marine life (IMO, 2014). The guidelines focus on primary sources of underwater noise, e.g. propellers, hull form, on-board machinery, and various operational and maintenance procedures such as hull cleaning. The IMO has also recommended that more research is needed.

In 2017, a resolution of the Conference of the Parties to the Convention on the Conservation of Migratory Species of Wild Animals (CMS) confirmed the need for international, national and regional limitation of harmful anthropogenic marine noise through management (including, where necessary, regulation) (CMS 2017). The resolution also included guidelines on Environmental Impact Assessment for Marine Noise generating Activities[74]. The World Dredging Association (WODA) has also submitted technical guidance on underwater sound in relation to dredging activities to the

[70]https://www.imo.org/en/MediaCentre/HotTopics/Pages/Noise

[71] Amer N. (2020) Cetaceans - Acoustic disturbance and noise pollution, Marine Connection

[72] Erbe C., Marley S.A., Schoeman T.P., Smith J.N., Trigg L.E and Embling C.B. (2019) The Effects of Ship Noise on Marine Mammals—A Review, Front. Mar. Sci., 11 October 2019

[73] Dey M. Krishnaswamy J. Morisaka T. and Kelkar N. (2019) Interacting Effects of Vessel Noise and Shallow River Depth Elevate Metabolic Stress in Ganges River Dolphins, *Sci Rep* **9,** 15426 (2019). https://doi.org/10.1038/s41598-019-51664-1

[74] CMS (2017) *Adverse Impacts of Anthropogenic Noise on Cetaceans and Other Migratory Species*, General UNEP/CMS/Resolution 12.14 adopted by the Conference of the Parties at its 12th Meeting (Manila, October 2017), Convention on Migratory Species

Scientific Group of the London Convention on the Prevention of Marine Pollution by Dumping of Wastes and other Matter, providing advice on managing the impacts of underwater sound, primarily from dredging[75].

15.5.1 Ambient Noise Level in the Study Area

In order to understand the ambient noise level of the study area, 26 locations were selected considering sensitivity and exposure level of the corresponding location. As per Noise Control Rules, 2006, 14 locations fell under commercial zone, 9 locations fell under mixed zone and the remaining three locations fell under residential zone. In Patharghata Upazila, the noise level for only three locations complied with the national standards at day time but exceeded for the night time. Nose level for the remaining locations were seen to be exceeded for both the morning and evening time. On the other hand, noise level exceeded at all 5 locations for both day and night time at Taltoli Upazila. Similarly, the noise levels at three locations at Kalapara Upazila, two locations at Barguna and one at Galachipa were observed to be complied with the national standard for day time and two locations at Barguna at night time. On the contrary the noise level all other locations for the respective upazila were seen to be exceeded the national standards for the corresponding zones. As per the observed dataset it can be clearly said that the areas are overcrowded and exposed to heavy noise. Particularly at evening time the areas become too noisy. The locations as categorized as Commercial and mixed zones were exposed with heavy noise so are the residential areas were.

Table 15.14: Noise Quality of Different Land Use Types in the Study Area

Patharghata					
Location ID	**Zone**	**Morning (dB)**	**Std. (Noise control rules, 2006) (dB)**	**Evening (dB)**	**Std. (Noise control rules, 2006) (dB)**
NL-1	Commercial	62	70	62	60
NL-2	Commercial	98	70	63	60
NL-3	Commercial	64	70	94	60
NL-4	Commercial	92	70	91	60
NL-5	mixed	52	60	58	50
NL-6	Residential Area	74	55	67	45
Taltoli					
Location ID	**Zone**	**Morning (dB)**	**Std. (Noise control rules, 2006) (dB)**	**Evening (dB)**	**Std. (Noise control rules, 2006) (dB)**
NL-1	mixed	61	60	65	50
NL-2	Commercial	87	70	94	60
NL-3	mixed	65	60	74	50
NL-4	mixed	80	60	95	50
NL-5	mixed	82	60	78	50

[75] https://www.imo.org/en/MediaCentre/HotTopics/Pages/Noise.aspx

Kalapara					
Location ID	**Zone**	**Morning (dB)**	**Std. (Noise control rules, 2006) (dB)**	**Evening (dB)**	**Std. (Noise control rules, 2006) (dB)**
NL-1	mixed	94	60	84	50
NL-2	mixed	52	60	56	50
NL-3	Commercial	75	70	86	60
NL-4	Commercial	73	70	81	60
NL-5	Residential Area	53	55	61	45
NL-6	Commercial	47	70	86	60
NL-7	Commercial	61	70	76	60
Barguna Sadar					
Location ID	**Zone**	**Morning (dB)**	**Std. (Noise control rules, 2006) (dB)**	**Evening (dB)**	**Std. (Noise control rules, 2006) (dB)**
NL-1	Commercial	75	70	59	60
NL-2	Commercial	63	70	53	60
NL-3	Commercial	61	70	74	60
Amtoli					
Location ID	**Zone**	**Morning (dB)**	**Std. (Noise control rules, 2006) (dB)**	**Evening (dB)**	**Std. (Noise control rules, 2006) (dB)**
NL-1	Commercial	74	70	89	60
NL-2	Residential Area	62	55	68	45
NL-3	Mixed	63	60	72	50
Galachipa					
Location ID	**Zone**	**Morning (dB)**	**Std. (Noise control rules, 2006) (dB)**	**Evening (dB)**	**Std. (Noise control rules, 2006) (dB)**
NL-1	Mixed	82	60	76	50
NL-2	Commercial	57	70	68	60

Source: CEGIS Survey, August - September, 2022

15.5.2 Administration/Competent Authorities

Key aspect in the theme	Primary competent authority (CA)– and their mandates	Key support organisations (govt, NGO, donor, CBO, etc.)	Performance of CT and support organisations
• Protecting environment from the adverse impacts of development activities. • Biodiversity conservation. • Pollution control through monitoring and adopting measures.	Ministry of Environment, Forest and Climate Change (MoEFCC) The mandates are as- • Ensuring a sustainable living environment for the current and future population of the country. • Conservation of environment and biodiversity. • Control of environmental pollution, coping with the impact of climate change. • Development of forest resources and sustainable management of marine resources.	• Forest Department (FD) • Department of Environment (DoE) • Bangladesh Climate Change Trust Fund (BCCTF) • International Institute for Environment and Development (IIED) • Center for Environmental and Geographic Information Services (CEGIS) • International Union for Conservation of Nature (IUCN) • Action Research for Community Adaptation in Bangladesh (ARCAB) • Bangladesh Paribesh Andolon (BAPA) • Bangladesh Environmental Lawyers Association (BELA)	• Reduce the emission of the motor vehicle, reduce/control noise pollution, reduce air pollution, and to prevent industrial pollution by ensuring the use of modern technology and though enforcement activities in necessary cases. • Implementation of Clean Development Mechanism (CDM) program in 6 districts to reduce carbon emission from organic waste. • Improve living standards of people affected by climate change. • Preparation and finalization of National Adaptation Plan (NAP). • Creating green belt to protect cyclone and storm surge through conservation of established coastal forest.

15.5.3 Relevant Legislation and Regulations

Key aspect in the theme	Primary legislation	Accompanying or enabling regulations	Comments on adequacy or not re. legislation and regs
• The requirements on environmental protection • Improvement of environmental standards and • Control and abatement of environmental pollution.	• Environment Conservation Act (ECA) 1995 (amended 2000, 2002, 2007 and 2010) and • Environment Conservation Rules (ECR) 1997	• Ecologically Critical Area Management Rules 2016 • Noise Pollution (Control) Rules-2006 • Bangladesh Climate Change Trust Act 2010 • The Ship Breaking and Recycling Rules-2011 • The Vehicle Act (1927) • The Motor Vehicles Ordinance (1983) • Dangerous Cargoes Act 1953 • Explosives Act 1884, Explosive Rules-2008. • Explosive Substances Act 1908 and Explosive Substances (Amendment) Act, 1987.	• Noise abatement law and policy can only be established and implemented successfully if basic knowledge and background material are available to the masses, including the authorities/administration • Exemptions have been made for religious activities held in mosques or temples, as well as activities commemorating key national holidays such as Independence Day, Bengali New Year, and International Mother Language Day. Specific standard need to be established in this regard. • Although noise and its management are not identified in any of the 17 goals of the Sustainable Development Goals (SDGs), noise is an issue cross-cutting through almost all of the goals. • Through the lens of the SDGs, there are scientific pieces of evidence showing how a failure to address sound pollution presents a significant challenge to the realisation of these goals. • It is necessary to include noise in school curricula and to establish scientific institutes to study acoustics and noise control. • Dissemination of noise control information to the mass people is an issue for education and public awareness.

15.5.4 Noise Related PPPs

Key PPPs relating to the theme	Main projects emanating from the PPPs	Main negative environmental impacts emanating from the projects	Main negative socio-economic impacts emanating from the projects
• The National Environment Policy (updated 2018) • National Environmental Management Action Plan 1995	• Integrated and participatory project to control sound Pollution ✓ There will also be a series of programs on television channels and radio, various electronic and print media, mobile phones and social media to broadcast TVC, text messages and notifications as well, he said. ✓ Also, 128 billboards and 60 signboards, 700,000 leaflets, 700,000 stickers, 1,000 folders, and 1,000 training manuals will be printed and distributed to raise awareness. ✓ Approximately 2,000 mobile courts and joint operations will be carried out across the country in this regard, Kabir said. ✓ A round-the-clock online monitoring of noise levels and roadside displays will be set up in certain areas on an experimental basis[76]	No Impact	No Impact

[76] https://archive.dhakatribune.com/bangladesh/2021/01/21/environment-minister-integrated-project-to-control-noise-pollution

15.5.5 Drivers of change

Key change	Main external drivers	Main internal drivers	Main actions to "fuel" or "brake" the drivers, depending on whether the change is good or bad
• Prominent source of noise pollution will be identified • Motivation and awareness among the people will be built up about the harmful effect of noise pollution • basic knowledge and background material will be available to the masses	• International conventions, • Global awareness Influence on Environmental protection	• people on a large scale have been suffering from hearing problems caused by noise pollution • Poor Public awareness towards negative impact of nose pollution • Improvement in the National PPPs and • Need for environmental enhancement, remediation, Environmental protection and benefit.	• sector analysis reports, surveys, implementation evaluation and audits • institutional/ regulatory reforms and capacity building in the organizations that are variously responsible for environmental protection, and urban transportation planning and management • Applicability of the Bank's social safeguard policies

15.5.6 Main issues concerned with the theme;

- Increasing industrialization, rapid urbanization, power industries at Payra and kalapara area and, fast-growing tourism
- people on a large scale have been suffering from hearing problems caused by noise pollution.
- Poor awareness towards negative impact of nose pollution.
- Inadequacies in the National PPPs.

15.6 Solid Waste and Management Aspects

15.6.1 Current Waste Management Scenario in Patuakhali and Barguna Municipality

In Patuakhali Municipality, waste was collected from the road, drain, household, clinic, market, hotels, restaurants, and dustbin, and gathered and transferred. The waste cleaner took off the waste, clean the drain, and keep the waste on the road beside the drain. The drain waste was transferred by a collection van and hand trolley for storing in a fixed place. Finally, the truck collected it from the sorting point to the dumping station. Dustbin waste is directly collected through the truck and disposed of at the final dumping sites. All the waste produced across Patuakhali municipality is dumped on the bank of the Lawkathi River, contributing to serious environmental pollution and subsequent health hazard. Figure 15.2 illustrates the current waste collection and disposal scenario of Patuakhali municipality.

Figure 15.2: Existing Solid Waste Management Process in Patuakhali Municipality

Likewise, the procedure for the management of waste in Barguna is comparable to that of the municipality of Patuakhali. Figure 15.3 illustrates current waste collection and disposal scenario of Barguna municipality.

Figure 15.3: **Existing Solid Waste Management Process in Barguna Municipality**

But in the case of both municipalities, the municipal authority did not maintain a systematic way of managing the waste. They did not consider odor problems, the health status of workforces, and the effects of open dumping on the topsoil and groundwater contamination. In maximum cases, open dumping of solid waste without proper sorting degrades soil production capacity and groundwater quality. The overall process of waste management of both municipalities is shown in **Figure 15.4.**

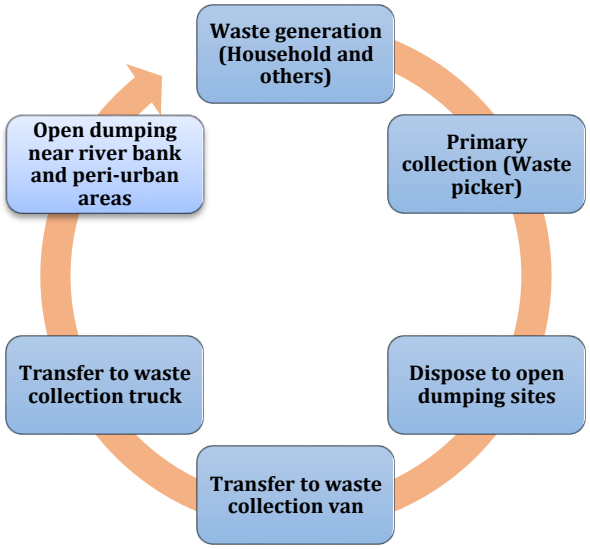


Figure 15.4: Current Waste Management Process of both Patuakhali and Barguna Municipality

15.6.2 Daily Waste Generation Rate

The daily waste generation rate is subjected to the areas of municipality and rural areas in Bangladesh. Usually, people of municipality generates more per capita wastes than the rural areas because of higher income at the municipality than the rural people. To generate the more representative waste volume for all the people in the study area, average waste generation rate is calculated from municipal and rural areas waste generation rate (Table 15.15). The highest waste generation rate is found at Barguna Sadar whereas the lowest is in Rangabali.

Table 15.15: Average Waste Generation Rate in the Study Area

Upazila	Barguna Sadar	Patharghata	Amtali	Taltoli	Kalapara	Galachipa	Rangabali
MSW Generation Rate/day	0.27	0.14	0.12	0.11	0.2	0.15	0.09
Rural Solid Waste Generation Rate/day	0.21	0.11	0.1	0.09	0.19	0.13	0.08
Average Waste Generation Rate/day	**0.24**	**0.13**	**0.11**	**0.10**	**0.20**	**0.14**	**0.09**

This average waste generation rate is used to calculate the daily upazila based waste generation status (Table 15.16). The 2011 population data has been projected for 2022 here and used for the waste volume calculation. In the study area, 2,278 tons of soild waste is being generated daily. Among them 698 tons of daily waste is generated in the Barguna Sadar area which scored the highest followed by Kalapara (530 tons), Galachipa (403.2 tons), Patharghata (237.9 tons) and the Amtali (207.9 tons). The rest Taltoli and Rangabali generates around 100 tons of sloid waste daily.

Table 15.16: Upazila based Waste Generation Status in the Study Area

Upazila	Barguna Sadar	Patharghata	Amtali	Taltali	Kala Para	Galachipa	Rangabali	Total Waste in Ton in 7 Upazillas
Population in Number[77]	2910000	1830000	1890000	980000	2650000	2880000	1140000	**2.278**
Average Daily Waste Generation Rate	0.24	0.13	0.11	0.10	0.20	0.14	0.09	
Total Waste in KG/day	698400	237900	207900	98000	530000	403200	102600	
Total Waste in Ton/day	**698.4**	**237.9**	**207.9**	**98.0**	**530.0**	**403.2**	**102.6**	

[77] Population and Housing Census, 2011 and the Population Projection for 2022. Bangladesh Compendium of Environmental Statistics 2009 (BBS, 2010)

15.6.3 Industrial/Factory Waste

Paurashava	Industrial waste generation status
Barguna Sadar Upazilla	Barguna district has no major industrial center. So, there is no severe environmental pollution generating industrial units situated within and/or nearby to the Barguna Sadar Upazilla. However, there are food processing industries, engineering industries (Car body building and repair), river offshore industries (launch, trawler body construction and repair), wood and timber factories, and chemical Industries (Tooth Powder, Agarbati, Syrup, Candles, Hairs, Oil, Ballpen, Jarda, Golzazal, Battery and Butter oil) and textiles. Cottage industries are presented in Barguna Sadar Upazilla.[78]
Patharghata	There is no severe environmental pollution generating industrial unit situated within and/or nearby the Patharghata Paurashava area. The wood-based industry is one of the most important industries in this area and there are 13 ice mills, 5 sawmills, 3 rice mills, 2 Bakery, 1 oil mill and 1 dockyard. It reflects the general agrarian character of the Planning area. All of those enterprises are proprietorship units meaning that the private sector dominates the industrial sector of the Pourashava.[79]
Amtoli	Amtoli pourashava has fewer industrial units than Barguna Sadar Upazilla and Patharghata Pourashava. Among manufacturing industries, there are about 18 sawmills, 10 flour mills, 1 soap factory, and 2 pen-manufacturing factories.[80]
Taltoli	There is no severe environmental pollution generating industrial unit situated within and/or nearby Kalapara Paurashava area. Recently, the government of Bangladesh announced plans to construct a coal-fired power station with a capacity of 350 MW in the Taltoli Upazila. In the long run, this power plant would result in the production of waste in both solid and liquid forms.
Kalapara	There is no severe environmental pollution generating industrial unit situated within and/or nearby Kalapara Paurashava area. 22 sawmills, 13 rice mills, ice factories, and 12 cow firms are situated in the Kalapara Paurashava area.[81]
Galachipa	Galachipa pourashava has fewer industrial units compared with other mentioned areas. Among manufacturing industries, there are about 18 sawmills, 178 rice mills and 2 ice factories are situated in the Galachipa Pourashava.[82]
Rangabali	There is no severe environmental pollution generating industrial unit situated within and/or nearby the Kalapara Paurashava area. A few rice mills, cold storage, welding factories and cottage industries are situated in this area.[83]

15.6.4 Waste Management

Barguna Sadar Upazilla

In the baseline condition (2017), 38% of waste is left unmanaged and 61% of waste is collected and dumped in an unhygienic manner. The informal sector recycles 1% of the garbage.

[78] http://sadar.barguna.gov.bd/en/site/page/oqi4-ব্যবসা-বাণিজ্য

[79] Patharghata Paurashava Master Plan: 2011-2031

[80] http://wikimapia.org/15223589/Amtali-Pourashava

[81] Kalapara Paurashava Master Plan: 2011-2031

[82] http://wikimapia.org/18351573/Galachipa-Upazila-HQ

[83] *https://en.banglapedia.org/index.php/Rangabali_Upazila*

Patharghata Upazilla

The condition of solid waste management at Patharghata Paurashava is very poor. According to the opinion of surveyed households, there is no dustbin at Patharghata Paurashava. Most of the people throw their garbage here and there and especially dump it into the river, canal and khal which cause serious environmental pollution and also sometimes clogged the existing drainage network. From the field survey, it is also found that there is no clinical waste management system.

Amtali Upazilla

Under the Head Assistant (Conservancy Inspector in charge) and a Conservancy Supervisor (employed on master role basis), the municipal solid waste management work of the Amtali Pourashava is served by 28 Conservancy Workers and 1 Driver. With 1 garbage truck (3 tons' capacity), 2 worn-out vans, 30 hand trolleys, the conservancy personnel collect waste from different points of the Pourashava, sweep streets and clean the drains. The monthly income of the conservancy workers ranges from Taka 1,200 to Taka 4,000. They work 4 days a week.

Taltoli Upazilla

Poor waste management is a problem in Taltoli Paurashava. The citizens of Taltoli Paurashava have been interviewed, and they have said that there are just a small number of waste bins available. However, there is no demarcation between biodegradable, plastic, glass, and medical waste bins. People dispose their wastes in open places or at the nearest ponds or canals. Also, the Payra river is nearest to the pourashava. So, most of the household and construction waste is being discharged to the riverside.

Kalapara Upazilla

No waste collection system is available in Kalapara Paurashava to handle/manage household/ kitchen market/clinical waste. Most of the people throw their waste here and there and especially dump to canal and khal which environmental pollution and also sometimes clogged the existing drainage network. Although at present, environmental pollution due to solid waste is not a serious problem on Kalapara Paurashava. Good solid waste management practices should be implemented for a better environment at Kalapara Paurashava.

Galachipa Upazilla

The Galachipa Pourashava has a Conservancy Inspector, 23 Conservancy Workers, and one driver. The Conservancy Inspector is in charge and is basically a tax assessor. The conservancy staff picks up trash from different parts of the Pourashava with a truck that can hold up to 3 tons of trash. They also sweep the streets and clean the drains. The income of the people who work at the conservancy ranges from Taka 2,250 to Taka 3,600 per month.

Rangabali Upazilla

Rangabali Paurashava has inadequate waste management system. Most individuals give away waste in rivers, canals, khals and open spaces causing environmental pollution and clogging drainage networks. No solid waste disposal sites or landfill sites are present in this area. Also, healthcare waste is not managed in a regular manner. Serious health issues might arise due to improper waste management system.

15.6.5 Administration/Competent Authorities of Wastes and Wastes Management

Key aspect in the theme	Primary competent authority (CA)– and their mandates	Key support organisations (govt, NGO, donor, CBO, etc.)	Performance of CA and support organisations
Wastes	Ministry of Environment, Forest and Climate Change <u>Mandate</u> • Implementing Solid Waste Management Rules, 2021 • Implementing Hazardous Waste and Shipwreck Waste Management Rules, 2011 • Medical Waste (Management and Processing) Rules, 2008 Local Government Division (LGD) <u>Mandate</u> • By 2030, reduce the adverse per capita environmental impact of cities, including municipal and other waste management • By 2030, substantially reduce waste generation through prevention, reduction, recycling, and reuse	• Department of Environment • All City corporations and Pourashavas in south west region of Bangladesh • United Nations Development Programme (UNDP), Japan International Cooperation Agency (JICA), World Health Organization (WHO), United Nations Children's Fund (UNICEF), Asian Development Bank (ADB), European Union (EU) • Waste Concern, Swisscontact • World Vision, An Organization for Socio-Economic Development (AOSED), Bangladesh Resource Improvement Center (BRIC), Jubo Unnayan Sogngatan (JUS), PRISM Bangladesh, RUSTIC	<u>Primary authority</u> • Low or inadequate structural development, insufficient transport coverage, inappropriate processing technology and treatment of solid and liquid waste • Weak enforcement of legislative procedure <u>Secondary authority</u> • In the formal system, the municipal authorities are solely accountable for the overall management of waste-related activities but the hygiene issues are not considered in this case; • Informal waste management is done by a huge labour force mainly engaged in the trade of recycling without any health concern • There is no provision of storage of wastes at household level resulted in dumping wastes in the community bins and designated open spaces

15.6.6 Relevant Legislation and Regulations of Wastes and Wastes Management

Key aspect in the theme	Primary legislation	Accompanying or enabling regulations	Comments on adequacy or not re. legislation and regs
Wastes	The Environment Conservation Act, 1995	Environment Pollution Control Ordinance of 1977	The Act covers the entire environmental malacies with a view to conserving, improving, controlling, and mitigating pollution of the environment. The key features of the Act can be summarized as it encloses stipulation for guideline in respect of regulation of the industries and other improvement actions discharge permit and promulgation of standard limit for discharging and emitting waste.

Key aspect in the theme	Primary legislation	Accompanying or enabling regulations	Comments on adequacy or not re. legislation and regs
	Environment Conservation Rules, 1997	The Environment Conservation Act, 1995	The 1997 Environmental Conservation Rules specify waste discharge quality standards for all industrial units and projects. However, there are several parameters that are not specified in the Rules that are toxic. For example, copper, cobalt, and aluminium are not specified in the waste quality standards.
	Solid Waste Management Regulations, 2021	Environmental Protection Act, 1995	The Regulations define the responsibilities of businesses involved in solid waste management and impose collection, recycling, and disposal obligations according to Extended Producer Responsibility (EPR) on manufacturers of non-biodegradable products such as glass, plastic, and bottles. In the main provisions of the regulations, responsibilities are mentioned without defining the categories of the manufacturers. These categories should be clearly highlighted along with the waste generators, consumers, and users.
	Hazardous Waste and Shipwreck Waste Management Rules, 2011	Environment Conservation Act, 1995	In case of solid waste management, it is mentioned to take special care in the handling of asbestos only. It is also needed to be clearly highlighted about other toxic wastes e.g., persistent organic pollutants (POP's), heavy metals and oil residues. The rules can be strongly implemented with considering the Ports Act, 1908 and the Bangladesh Labour Act, 2006 in case of waste management
	Medical Waste (Management and Processing) Rules, 2008	The Penal Code, 1860	Bangladesh Medical Waste Management and Processing Rules, 2008 may strictly adopt 'Duty of Care' principle whereby the medical professionals will be assessing risks of disposing medical waste in a particular manner and the 'Polluter Pays' principle where the producers of hazardous wastes, shall carry the responsibility of waste disposal to save environment.
	Local Level Legal Framework	The City Corporation Ordinances and Pourshava Ordinance 1977; Local Government (City Corporation) Act, 2009; Local Government (Paurashava) Act, 2009	A comprehensive set of regulatory guidelines need to be developed for managing all types of wastes generated in City corporations and Pourashavas including municipal, medical and e-waste. Such guidelines must deal with waste collection, segregation, transportation, and disposal at various stages with proper safety measures.
	Bangladesh Standards and Guidelines for Sludge Management, 2015	Environment Conservation Act, 1995	Adequate

15.6.7 Brief Description of Main Relevant PPPs

Key PPPs relating to the theme	Main projects emanating from the PPPs	Main negative environmental impacts emanating from the projects	Main negative socio-economic impacts emanating from the projects
National Environmental Policy, 2018	• Development of local and national contingency programmes • Programs to prevent coastal and marine pollution from ships	No Negative Impacts	No Negative Impacts
National Industrial Policy, 2016	Developing specialized localized industries based on local agro, forest, natural, and marine resources	Cumulative environmental impacts would be apparent as GHG emissions, air pollution, waste waters, solid waste generation from different industries	Land acquisition and dispossession at the local level
National Sanitation Strategy, 2005	• Facilitating adequate supply chain of "hygienic latrines" • Financing of sanitation programmes from public /donor/ private/ community resource mobilization	Construction of sewerage system and hygienic latrines might pollute local environment	No Negative Impacts
National 3R Strategy for Waste Management, 2010	• Establishing a National 3R focal point to organise/implement 3R strategies; • Arranging soft loans, tax holidays as well as land for establishment of treatment/recycling facilities; • Promote setting up common treatment, storage and disposal facilities especially in EZs and EPZ	No Negative Impacts	• Possible increased production costs of products due to increased capital investment and operational costs • In a few cases, costs for reusing and recycling might become higher than using/extracting new resources;
National Health Policy, 2011	• Ensure availability of primary health and emergency treatment facilities for all citizens; • Strengthen health, nutrition and delivery services, ensure their effective use, increase use of modern technologies and research; • Develop special units to provide health services, drugs and important equipment to climate change affected people	• Structural development (such as construction of health centres, hospitals, training institutes, etc.) might change existing land uses and pollute local environment (dust, noise, etc.); • Increased medical wastes and e-wastes which would degrade the overall	Land acquisition is needed for construction of new structures which would deteriorate human settlement;

Key PPPs relating to the theme	Main projects emanating from the PPPs	Main negative environmental impacts emanating from the projects	Main negative socio-economic impacts emanating from the projects
		environmental condition;	
National Sustainable Development Strategy, 2010-2021	• Encourage growth of micro, small and medium industries • Promoting source separation of waste; • Improve the sanitation system • Undertake necessary measures for effective enforcement of rules and regulations for proper running of ETP and CETP	• Reduction of forest coverage and increase in industrial waste; • Improper disposal of clinical waste;	Reduction in agricultural land would affect livelihood of farmers;

15.6.8 Drivers of Change

Key change	Main external drivers	Main internal drivers	Main actions to "fuel" or "brake" the drivers, depending on whether the change is good or bad
Suburban sprawl	Migration, population growth, commercialization	Increasing employment facilities, development of infrastructure, advancement of transport and communication,	• Regular management of Urban waste through 3R strategies. Strict implementation of waste management related rules and regulations through local administrative agencies; • Development of sanitary infrastructure, health services, and careful disposal of medical waste; • Waste generated from building constructions, should be managed in regular basis;
Industrial expansion	International cooperation, financial aid	Establishment of bridges, development of road transport system	• Regulate waste generation limit according to the scale of industry (small, medium, or large); • Promote waste management technologies in the polluting and waste generating industries; specially to take necessary steps to build Effluent Treatment Plant (ETP);
Increased tourism	Improved tourism management, investment to tourism sector	Establishment of bridges, development of road transport system and tourist spots, infrastructural development	• Limit the number of tourists within the carrying capacity; • Awareness building among the tourist to avoid waste throwing or dumping in tourist spots; • Involvement of govt. agencies and NGOs to reduce waste by following proper rules and regulations;

15.6.9 Main Waste Related Issues

- Absence of national policy to encourage recycling practice;
- Lack of proper handling rules and standards;
- Lack of finance, and inefficient tax collection;
- Inefficient practice of waste collection;

- Shortage of suitable lands for final disposal of solid wastes;
- Lack of awareness about environmental problems associated with solid wastes;
- Lack of effective partnership between public sector, private sectors and community groups;
- Chronic odour at the open dumping sites;
- Cause of water pollution;

16. Institutional Governance

16.1 Introduction

There is a common practice in Bangladesh for implementing any development project specially at the district level, where the central government holds a dominating position and execute the whole project. This authoritative relationship pattern created scope for government officials, including the Deputy Commissioner, Upazila Nirbahi Officer (UNO), and heads of district and sub-district administrative units to control the local institutions. In addition, the government uses legal provisions and frequently issues circulars to control their activities, conduct inquiries, and even suspend their operation. PKCP project will be executed over 07 upazilas under Barguna and Patuakhali district where the institutional arrangement and its' resource capability may not be sufficient in terms of project implementation especially for Environmental and Social (E&S) risk assessment and its mitigation measures. The proposed PKCP project will likely to have substantial impact on the society and environment, this report will review the competency of the existing institutional capacity at local level and their mode of communication with the central government to implement such type of sensitive project and how they will manage the risks and impacts throughout the project life cycle. This report will also try to discover the inherent gaps and deficiencies of the current arrangement and proposes an ideal organogram for the Implementing Agencies (IAs) so that the PKCP can be run smoothly while minimizing unwanted social and environmental impacts.

16.2 E&S Risk Control and Mitigation Governance in Bangladesh

16.2.1 Regulatory Practice

Development aims to achieve economic benefits and development without causing significant negative social and environmental impacts. As per Bangladesh Environmental Conservation Rules (ECR)'97, most the activities associated with PKCP components/sub-components are likely to fall under either Orange A, Orange B or Red categories. There will be environmental and social screening for all activities at the initial stage and based on screening results, and if recommended by the Department of Environment (DoE), further IEE or EIA will be carried out for specified activities. DoE is the regulatory body and the enforcement agency of all environmental related activities in development projects.

The Planning Commission is the central planning agency, and it resides within the Ministry of Planning. It guides the country's development strategy and approves all the development projects. The DoE is the technical arm of the MoEFCC and is the agency responsible for environmental planning, management, and monitoring of the project. The Ministry then compiles and finalizes an "environment opinion" based on information collected from its subordinate departments such as the DoE, Forest Department (FD), Bangladesh Climate Change Trust (BCCT), etc.

16.2.2 Relevant Policies, Acts and Laws Regarding the EIA Process

Policies, Laws and Regulations	Responsible Agency/Ministry	Potential Applicability
National Environmental Policy, 1992	MOEF	• Sets out policies to prevent environmental pollution and natural resource degradation. • States that EIAs must be conducted before projects are undertaken.
NEMAP, 1995	MOEF, DOE	• Proposes actions for sustainable development. • It particularly puts emphasis on different environmental pollution, hamper of natural drainage pattern and agricultural land acquisition due to development of transport system.
Environment Conservation Act, 1995	MOEF DOE	According to this Act no industrial unit or project shall be established or undertaken without obtaining, in the manner prescribed by rules, an ECC from the director general.
Environment Conservation Rules, 1997	MOEF DOE	The rule sets out procedure for issuing ECC.
Environmental Courts Act, 2000	MOEF DOE	Sets out policy for effective pursuance and completion of legal proceedings related to environmental crimes.
National Land Use Policy, 2001	Ministry of Land	Provides guidelines for the protection of agricultural land, waterbodies and the optimal use of other land, as well as for restriction or minimization of the acquisition of land for non-productive use.
Bangladesh Climate Change Strategy and Action Plan, 2009	MOEF	Prioritizes adaptation and disaster risk reduction. The climate change action plan is built on six pillars. One of them is research and knowledge management to predict the likely scale and timing of climate change impacts on different sectors.

16.2.3 SEA Practice in Bangladesh

The practice of EIA in Bangladesh has started with some guidelines in 1992 for infrastructure development in the water sector through the Flood Action Plan (FAP). The process of EIA in Bangladesh includes screening, scoping, alternative analysis, identification and assessment of impacts, and preparation of an EMP.

Though the quality is improving, current EIA process has many weaknesses like lack of impact monitoring, inadequate implementation of mitigation measures, absence of public consultancy meeting (PCM), lack of Cumulative Impact Assessment (CIA) from multiple projects in the same site etc. SEA can compliment EIA regarding understanding of cumulative impacts.

The first example of SEA was the Dhaka Metropolitan Development Plan (2007) and Policies for Mainstreaming SEA in the Urban Development of Greater Dhaka (WB, 2007). The second SEA example was done by the GoB in its funding and done almost 10+ years apart named "Strategic Environmental Assessment (SEA) of the southwest region of Bangladesh for conserving Outstanding Universal Value of the Sundarbans (2020–2022)". CEGIS conducted this voluntary SEA with the consent of the Haor Board as an associate document of the Haor Master Plan.

Whilst there is no legislative requirement for SEA in Bangladesh, there are policies and planning documents where the requirements for SEA were mentioned. The two most important documents ensuring environmental governance in Bangladesh are the 7th 5-year Plan and National

Environmental Policy 2018. Good planning and strategies are necessary to make better-informed decisions. Vision 2021, Vision 2041, and the 7thFYP (FY2016–FY2020) all emphasized the incorporation of SEA in the ongoing national development strategies (GED/GOB, 2015).

The following figure has shown the evolution of EIA to SEA in Bangladesh from different time period.

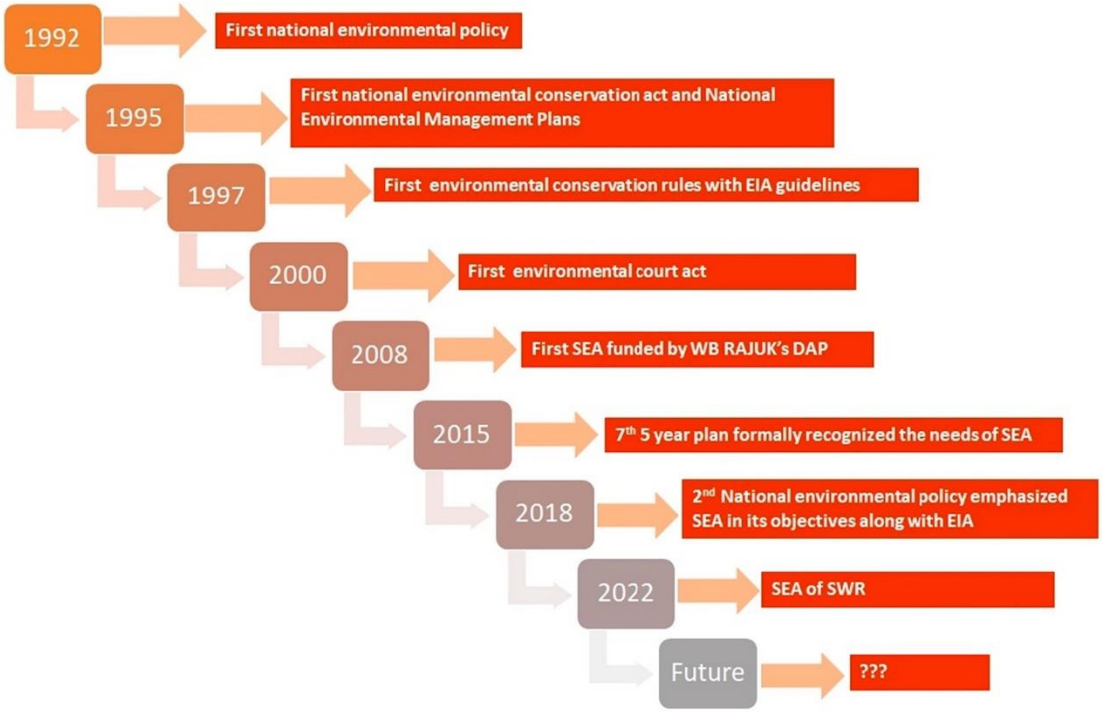


Figure 16.1: Study framework: Evolution of EIA to SEA in Bangladesh (from 1992 to 2022)

The ongoing SEA for the proposed PKCP programme indicates the government is focusing on the conducting SEA for all major policies, plans and programmes (PPPs) in Bangladesh.

16.2.4 Organizations and Coordination

Since the proposed PKCP is a large scale programme, various organizations need to work together to manage E&S risks in different sectors. For this we identified the following departments and we will assess their knowledge and capacity to implement the necessary mitigation actions. It is important to establish cross-sectoral coordination and collaboration with water, land, fisheries, and planning ministries to adopt common but differentiated responsibility for policy, planning, and budgeting processes for investment in an integrated program to create green, clean, and healthy livelihood opportunities for economic transformation. Based on the nature of the PKCP we have identified the following organizations/ Agencies to be assessed:

- DOE (Department of Environment)
- UDD (Urban Development Directorate)
- BWDB (Bangladesh Water Development Board)
- BIWTA (Bangladesh Inland Water Transport Authority)
- BFD (Bangladesh Forest Department)
- DoF (Department of Fisheries)
- BPC (Bangladesh Parjatan Corporation)
- Tourism Board

16.3 Current E&S Risk Management Capacities, and Gap of Major Agencies of PKCP

The Consultant will conduct a preliminary assessment of the capacity of the relevant implementing agencies (IAs) to manage environmental and social risk in accordance with the Environmental and Social management rules and policies in Bangladesh. The assessment has been conducted on the basis of existing capacity of the organizations, their current practices and their capability and knowledge to manage this type of programme. A number of the key officials from different departments will be interviewed telephonically and by email to gather their opinion in terms of resource availability and technical capacity. Through these conversations the gaps and requirements will be identified and consultant will make some recommendation to fill those gaps.

16.3.1 E&S Risk Management Regulatory Authority

The management status will be evaluated using the following table during stakeholder analysis via face to face conversion with the respective line agencies officials. A detail plan will be shared prior to the assessment.

- E&S Risk Management Workforce (e.g. E&S Unit/Cell, etc.)
  - Permanent or project-based?
  - An individual? Or an established unit?
  - Career Development Pathway for E&S Professionals?
  - Adequate Training?
- Existing E&S Risk Management Policy (other than Govt. Policy)?
- ESMP System (e.g. ISO 14001, etc.)
- E&S Risk Mitigation Tools for Project Planning
  - IEE, EIA, ESIA, SEA, ESMP, etc.

Institution	Person interviewed with designation	Conversation summary	Current capacity	Remarks
DOE	-	-	-	-
UDD	-	-	-	-
BWDB	-	-	-	-
BIWTA	-	-	-	-
BFD	-	-	-	-
DoF	-	-	-	-
BPC	-	-	-	-
Tourism Board	-	-	-	-
-	-	-	-	-

17. Conclusions

The baseline report presents the base situation of the relevant resources those are going to be triggered or hit by the development activities directly and/or indirectly. Proper information gathering on the identified resources and aspects, its sequential organization and finally presentation is the ultimate goal of the baseline report. Establishing the true base situation shapes the SEA assessment particularly the nature and the magnitude of the impacts. In addition, base situation influences the recommendation an SEA suggests. It is therefore, needs the validation and upgradation sharing with all the stakeholders the described sector relates.

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Appendices

Appendix A: Flora of Fifferent Life-form in the Study Area (Patuakhali and Barguna Districts)

A. Aquatic Habitat

Location: Kumir Mara khal, East Sonatola, Nilganj, Ward-3

GPS Coordinates: 21 56 49N, 90 10 42E

SN	Species Name	English Name	Scientific Name	Usage
1	Water Hyacinth	Water Hyacinth	*Eichhornia crassipes*	Fertilizer
2	Spyrogyra	Spyrogyra	*Spyrogyra*	Medicinal
3	Pani kolmi	Water spinach	*Ipomoea aquatica*	Medicinal
4	Sachi /Helencha	Helencha	*Enhydra fluctuans*	Vegetable
5	Tiger Fern	Tiger Fern	*Nephrolepis exaltata*	-
6	Dhol kolmi	Monkey brush vine	*Ipomoea carnea*	Fencing
7	Saluk	Blue water lily	*Nymphaea nouchali*	Vegetable
8	Nitila	Nitila	*Vachellia nilotica*	Forage and fodder
9	Hargoja	Holly Mangrove	*Acanthus ilicifolius*	Medicinal
10	Kara	Kara	To be identified	-
11	Paninol	Paninol	*Lindernia anagallis*	Fo, TH
12	Telakucha	Ivy gourd	*Coccinia grandis*	Vegetable
13	Hogla	Southern cattail	*Typha elephantiana*	make mats. Baskets, ropes
14	White water lily	White water lily	*Nymphaea alba*	Vegetable
15	Mutha	Java grass	*Cyperus* sp.	Domestic food
16	Setgadhab	Setgadhab	To be Identify	-
17	Katanuta	spiny amaranth	*Amaranthus spinosus*	Medicine
18	Selvenia	Salvania	*Salvania*	-
19	Kochu	Taro	*Colocasia esculenta*	Medicine, Food
20	Cyprass	Cyprass	*Cyprass*	Fodder
21	Cotokash	Cotokash	To be identified	Fodder
22	Siltatu	Siltatu	To be identified	-
23	Nolkhagra	Common reed	*Phragmites australis*	Thatching
24	Umbrella sheds	Umbrella sheds	To be identified	Medicine
25	Chitki	Roast potato plant	*Phyllanthus reticulatus*	Food, medicinal
26	Topa pana	Water lettuce	*Pistia stratiotes*	Fertilizer
27	Susni	Dwarf waterclover	*Marsilea minuta*	Medicinal
28	Thankuni	Asiatic pennywort	*Centella asiatica*	Vegetable
29	Water Hati suri	Water Hati suri	To be identified	Food
30	Hazardana	Corn spurge	*Phyllanthus niruri*	Medicine
31	Kanaybashi	Benghal dayflower	*Commelina benghalensis*	Medicine
32	Pagoler gota	Pagoler gota	*Croton tiglium*	Medicine
33	Potpoti	Minnieroot	*Ruellia tuberosa*	-

SN	Species Name	English Name	Scientific Name	Usage
34	Keyakata	Keyakata	Camellia sinensis	Medicine
35	Boloi	Boloi	To be identified	-
36	Bonpalong	Golden dock	*Rumex maritimus* L.	Medicinal
37	Abedi	Abedi	To be identified	Medicine

Location: Mora Nodi Location: 6 no ward, Nachnapara, Amtoli

GPS Coordinates: 22 06 52N, 90 14 17E

SN	Species Name	English Name	Scientic Name	Usage
1	Kochuripana	Water Hyacinth	*Eichhornia crassipes*	Fertilizer
2	Biskatali	Pale persicaria	*Polygonum barbatum*	Medicine
3	Synodone	Synodone	To be identify	-
4	Sachisak	Sissoo Spinach / Brazilian Spinach / Sessile Joyweed / Dwarf Copper Leaf	*Alternanthera sessilis*	Vegetable
5	Siyal mutro	Mexican poppy	*Argemone mexicana*	Medicine
6	Boro setgodhobi	Boro setgodhobi	To be identify	Medicine
7	Keshraj	False daisy	*Eclipta prostrata*	Medicine
8	Kolkasunda	Kolkasunda	*Senna sophera*	Medicine
9	Pani nol	Paninol	*Lindernia anagallis*	Medicine,fodder
10	Jermany lota	Jermany lota	*Mikania micrantha*	Fooder, fertilizer
11	Mutha	Nut grass	*Cyperus rotundus*	Domestic food
12	Bethina	Bethina	To be identify	-
13	Sati	Sati	To be identify	-
14	Kanaybashi	Benghal dayflower / Tropical spiderwort / Wandering Jew	*Commelina benghalensis*	Medicine
15	Agola	Mosquito ferns	*Azolla*	-
16	Selvonia	Salvania	*Salvania*	-
17	Bondhone	Licorice Weed / Goatweed / Scoparia-weed / Sweet-broom	*Scoparia dulcis*	Medicine
18	Topa pana	Topa pana	*Pistia stratiotes*	Fertilizer
19	Amrul	Creeping Woodsorrel	*Oxalis corniculata*	V, M
20	Hijol	Itchytree / Mango-pine	*Barringtonia acutangula*	Food, Medicine
21	Kalokeshi	False daisy	*Eclipta prostrata*	Medicine

Location: 6 no Ward, Ulania, Mativanga, Golachipa

GPS Coordinates: 22 09 13N, 90 26 46E

SN	Species Name	English Name	Scientic Name	Usage
1	Kochuripana	Water Hyacinth	*Eichhornia crassipes*	Fertilizer
2	Chadmala	water snowflake	*Nymphoides indica*	Fish food
3	Topapana	Topapana	*Pistia stratiotes*	Fertilizer
4	Helencha	Helencha	*Enhydra fluctuans*	Vegetable
5	Ketardam	Kesordam	*Ludwigia abscendens*	Medicine
6	Bethua	White goosefoot	*Chenopodium album*	V
7	Kesuti	Kesuti	To be identified	-
8	Siltata	Siltata	To be identified	-
9	Bonjhal	Blistering Ammannia	*Ammannia baccifera*	M
10	Sada Sapla	Sada Sapla	*Nymphaea alba*	Vegetable
11	Chati dhora	Chati dhora	*To be identified*	-
12	Pani kolmi	Water spinach / River spinach	*Ipomoea aquatica*	Vegetable
13	Salvania	Salvania	*Salvania*	
14	Ajola	Mosquito ferns	*Azolla*	
15	Thankuni	Asiatic pennywort	*Centella asiatica*	Vegetable
16	Marselia	Marselia	*Ruma* spp	Medicine
17	Bondhone	Licorice Weed / Goatweed / Scoparia-weed / Sweet-broom	*Scoparia dulcis*	Medicine
18	Telekucha	Lvy Gourd	*Coccinia grandis*	Vegetable
19	Dholkolmi	Monkey brush vine	*Ipomoea carnea*	Fencing
20	Kochu	Taro	*Colocasia esculenta*	Vegetable
21	Paninol	Paninol	*Lindernia anagallis*	Medicine, fodder
22	Premkata	Amorseco / Lesser Spear Grass	*Chrysopogon aciculatus*	Fodder
23	Khudipana	Common duckmeat / Greater duckweed	*Spirodela polyrhiza*	Fish food
24	Nytila	Nytila	To be identify	-
25	Kara	Kara	To be identify	-
26	Pani bansh	Pani bansh	To be identify	-
27	Spyrogyra	Spyrogyra	*Spyrogyra*	
28	Nol	Common Reed	*Phragmites australis*	Thatching

B. Terrestrial Habitat

Name: Kathaltoli, **Lolcation:** South kathaltoli, Kathaltoli, Patharghata

GPS Coordinates: 22 7 48N, 89 55 46.3E

SN	Species Name	English Name	Scientic Name	Usage
1	Chambul	Chambul		T
2	Taal	Asian palmyra palm	*Borassus flabellifer*	Fr,T
3	Tetul	Tamarind	*Tamarindus indica*	FR
4	Supari	Betel Nut	*Areca catechu*	Fr
5	Rain tree	Albizia Saman/ Rain Tree	*Samanea saman*	T
6	Narikel	Coconut	*Cocos nucifera*	Fr, T
7	Lebu	Lemon	*Citrus limon*	Vg
8	Kola	Banana	*Musa*	Fr
9	Lichu	Lychee	*Litchi chinensis*	FR
10	Boroi	Indian Jujube	*Ziziphus mauritiana*	Fr
11	Eucalyptus	Eucalyptus	*Eucalyptus*	T
12	Jica	Indian Ash Tree	*Lannea coromandelica*	Fe,
13	Desi Gaab	Gaub/ Indian Persimmon/Malabar ebony	*Diospyros malabarica*	Fr
14	Akashmoni	Earleaf Acacia	*Acacia auriculiformis*	T
15	Kath badam	Country Almond	*Terminalia catappa*	FR,T
16	Koroch	Koronja/ Pongam Tree	*Pongamia pinnata*	Fu
17	Jaam	Java Plum	*Syzygium jambolanum*	Fr
18	Aam	Mango Tree	*Mangifera indica*	Fr
19	Tiger fern	Tiger fern	*Achrosticum aureum*	M
20	Daton	Orangeberry/ Gin Berry	*Glycosmis pentaphylla*	M,TC
21	Beghchita	Beghchita		M
22	Sofeda	Sapodilla	*Manilkara zapota*	FR
23	Mahagoni	Mahogany	*Swietenia*	T
24	Dumur	Ficus Tree	*Ficus benjamina*	M,VG
25	Kanaybeshi	Benghal Dayflower/ Wandering Jew	*Commelina benghalensis*	M
26	Bonbashok	Adulsa/ Vasaka	*Justicia adhatoda*	M
27	Kochu	Taro	*Colocasia esculenta*	M
28	Keyakata	Thatch Screwpine	*Pandanus tectorius*	M
29	Nipobolas	Nipobolas		M
30	Drinaris	Drinaris		M
31	Fern	Fern	*Cyatheales*	M
32	Sola	Sola	*Aeschynomene aspera*	M
33	Bonjhal	Blistering Ammannia	*Ammannia baccifera*	M
34	Vaat	Bhat/ Hill Glory Bower	*Clerodendrum viscosum*	M
35	Chalta	Elephant Apple	*Dillenia indica*	Fr

SN	Species Name	English Name	Scientic Name	Usage
36	Epil epil	River Tamarind	*Leucaena leucocephala*	T
37	Bilati gaab	Velvet Apple	*Diospyros discolor*	Fr
38	Tela kochu	Lvy Gourd	*Coccinia grandis Voigt*	M
39	Siris	Lebbeck	*Albizia lebbeck*	T
40	Shimul	Silk Cotton	*Bombax*	C
41	Kolkashunda	Coffee Senna	*Senna occidentalis*	M
42	Koye babla	Madras Thorn	*Pithecellobium dulce*	Fu, Fr
43	Akanda	Giant calotrope	*Calotropis gigantea*	M
44	Amloki	Amla	*Phyllanthus emblica*	Fr,M
45	Kotbel	Wood-apple	*Limonia acidissima*	FR
46	Bel	Bael	*Aegle marmelos*	Fr
47	Sukhodorson	Poison Bulb	*Crinum asiaticum*	M
48	Arjun	Arjun	*Terminalia arjuna*	M
49	Kadam	Burflower Tree	*Neolamarckia cadamba*	Fu
50	Bot	Indian Banyan	*Ficus benghalensis*	As
51	Jogot modon	Willow-leaved Justicia	*Gendarussa vulgaris*	M
52	Sati	Sati		M

Location: 4No Keorabunia, Patharghata

GPS Coordinates: 22 2 37N, 89 58 11E

SN	Species Name	English Name	Scientic Name
1	Taal	Asian palmyra palm	*Borassus flabellifer*
2	Khejur	Date Palm	*Phoenix dactylifera*
3	Babla	Gum Arabic Tree	*Acacia senegal*
4	Shimul	Silk Cotton	*Bombax*
5	Dumur	Ficus Tree	*Ficus benjamina*
6	Kala koroi	Black Siris	*Albizia lebbeck*
7	Bot	Indian Banyan	*Ficus benghalensis*
8	Rain tree	Albizia Saman/ Rain Tree	*Samanea saman*
9	Pakur	Indian Banyan	*Ficus benghalensis*
10	kola	Banana	*Musa*
11	Sirish	Lebbeck	*Albizia lebbeck*
12	Koroch	Koronja/ Pongam Tree	*Pongamia pinnata*
13	Aam	Mango Tree	*Mangifera indica*
14	Kakra	Bruguiera gymnorhiza	*Bruguiera gymnorhiza*
15	Fern	Fern	*Cyatheales*
16	Kolkasunda	Coffee Senna	*Senna occidentalis*
17	Kochu	Taro	*Colocasia esculenta*
18	Vaat	Bhat/ Hill Glory Bower	*Clerodendrum infortunatum*

SN	Species Name	English Name	Scientic Name
19	Boroi	Indian Jujube	*Ziziphus mauritiana*
20	Soti	Soti	
21	Sele	Sele	
22	Foska begun	Foska begun	
23	Akanda	Giant calotrope	*Calotropis gigantea*
24	Amrul	Creeping woodsorrel	*Oxalis corniculata*
25	dryneria	Dyneria	
26	Biskatali	Water pepper	*Persicaria hydropiper*
27	Narikel	Coconut	*Cocos nucifera*
28	Supari	Betel Nut	*Areca catechu*
29	Kotbel	Wood-apple	*Limonia acidissima*
30	Holde shola	Holde shola	
31	Bonjhal	Blistering Ammannia	*Ammannia baccifera*

Name: Lotabaria, Location: 9No Keorabunia, Barguna Sadar

GPS Coordinates: 22 10 17.7N, 90 10 25.7E

SN	Species Name	English Name	Scientic Name
1	Chambul	Chambul	
2	Chalta	Elephant Apple	*Dillenia indica*
3	Kola	Banana	*Musa*
4	Supari	Betel Nut	*Areca catechu*
5	Bilati Gaab	Velvet Apple	*Diospyros discolor*
6	mahagoni	Mahogany	*Swietenia*
7	Khejur	Date Palm	*Phoenix dactylifera*
8	Taal	Asian palmyra palm	*Borassus flabellifer*
9	Lebu	Lemon	*Citrus limon*
10	Aam	Mango Tree	*Mangifera indica*
11	Jamrul	Java apple	*Syzygium samarangense*
12	Peyara	Guava	*Psidium guajava*
13	Ata	Sugar apple	*Annona squamosa*
14	Kanthal	Jackfruit	*Artocarpus heterophyllus*
15	Neem	Neem Tree	*Azadirachta indica*
16	Kadam	Burflower Tree	*Neolamarckia cadamba*
17	Kochu	Taro	*Colocasia esculenta*
18	Kathbadam	Country Almond	*Terminalia catappa*
19	Daton	Orangeberry/ Gin Berry	*Glycosmis pentaphylla*
20	Vaat	Bhat/ Hill Glory Bower	*Clerodendrum infortunatum*
21	Bondhone	Licorice Weed / Goatweed / Scoparia-weed / Sweet-broom	*Scoparia dulcis*

SN	Species Name	English Name	Scientic Name
22	Kamranga	Carambola	*Averrhoa carambola*
23	Desi Gaab	Gaub/ Indian Persimmon/Malabar ebony	
24	Siyal mutro	Mexican poppy	*Argemone mexicana*
25	Thankuni	Asiatic pennywort	*Centella asiatica*
26	Tentul	Tamarind	*Tamarindus indica*
27	Akashmoni	Earleaf Acacia	*Acacia auriculiformis*
28	Shimul	Silk Cotton	*Bombax*
29	arjun	Arjun	*Terminalia arjuna*
30	Amra	Hog Plum	*Spondias mombin*
31	Khudijam	Khudijam	*Syzygium caryophyllatum*
32	Bonshimul	Cotton Tree	*Bombax ceiba*
33	Venna	Castor Bean Tree	*Ricinus Communis*
34	Narikel	Coconut	*Cocos nucifera*
35	Pitali	False White Teak	*Mallotus nudiflorus*
36	Keora	Sonneratia apetala	*Sonneratia apetala*

Location: College Branch Road, College Branch Road

GPS Coordinates: 22 10 17.7N, 90 10 25.7E

SN	Species Name	English Name	Scientic Name
1	Kath Badam	Country Almond	Terminalia catappa
2	Epil epil	River Tamarind	Leucaena leucocephala
3	Narikel	Coconut	Cocos nucifera
4	Deshi neem	Neem Tree	Azadirachta indica
5	Tetul	Tamarind	Tamarindus indica
6	Mahagoni	Mahogany	Swietenia
7	Siris	Lebbeck	Albizia lebbeck
8	Kola	Banana	Musa
9	Dumur	Ficus Tree	Ficus benjamina
10	Bon dumur	Bon dumur	
11	Seora	Sand Paper Tree	Streblus asper
12	Kochu	Taro	Colocasia esculenta
13	Telakucha	Lvy Gourd	Coccinia grandis Voigt
14	Sofeda	Sapodilla	Manilkara zapota
15	Amloki	Amla	Phyllanthus emblica
16	Chambul	Chambul	
17	Supari	Betel Nut	Areca catechu
18	Kanthal	Jackfruit	Artocarpus heterophyllus
19	Zeramani lota	Zeramani lota	

Location: Boro Onkujanpaea, 1No ward, Nishanbari, Taltoli, Barguna

GPS Coordinates: 21 57 24N, 90 4 29E

SN	Species Name	English Name	Scientic Name
1	Bonshimul	Cotton Tree	*Bombax ceiba*
2	Chambul	Chambul	
3	Mahagoni	Mahogany	*Swietenia*
4	Kocha	Kocha	
5	Taal	Pulm Tree	
6	Khejur	Date Palm	*Phoenix dactylifera*
7	Ora/Choilla	Ora/Choilla	
8	Akashmoni	Earleaf Acacia	*Acacia auriculiformis*
9	Koroi	Lebbeck	*Albizia lebbeck*
10	Jaam	Java Plum	*Syzygium jambolanum*
11	Eucalyptus	Eucalyptus	*Eucalyptus globulus*
12	Tentul	Tamarind	*Tamarindus indica*
13	Dumur	Ficus Tree	*Ficus benjamina*
14	Narikel	Coconut	*Cocos nucifera*
15	Kathbadam	Country Almond	*Terminalia catappa*
16	Akanda	Giant calotrope	*Calotropis gigantea*
17	Tiger fern	Tiger fern	*Achrosticum aureum*
18	Babla	Gum arabic tree	*Vachellia nilotica*
19	Hargoja	Holly Mangrove	*Acanthus ilicifolius*
20	kola	Banana	*Musa*
21	Arjun	Arjun	*Terminalia arjuna*
22	Bansh	Bansh	
23	Krisnochora	Royal poinciana	*Delonix regia*
24	Sirish	Lebbeck	*Albizia lebbeck*
25	Keshraj	False Daisy/Karisalankanni	*Ectipta prostrata*
26	Boloi	Sea hibiscus	*Hibiscus tiliaceus*
27	Gewa	Excoecaria agallocha	*Excoecaria agallocha*
28	Peyara	Guava	*Psidium guajava*
29	Shil koroi	Shil koroi	*Albizia lucidior*
30	Bel	Bael	*Aegle marmelos*
31	Sofeda	Sapodilla	*Manilkara zapota*
32	Aam	Mango Tree	*Mangifera indica*
33	Bot	Indian Banyan	*Ficus benghalensis*
34	Kanthal	Jackfruit	*Artocarpus heterophyllus*
35	Golpata	Nipa palm	*Nypa fruticans*
36	Lebu	Lemon	*Citrus limon*
37	Boroi	Indian Jujube	*Ziziphus mauritiana*

SN	Species Name	English Name	Scientic Name
38	Lichu	Lychee	*Litchi chinensis*
39	Supari	Betel Nut	*Areca catechu*
40	Jamrul	Java apple	*Syzygium samarangense*
41	koroncha	Bengal currant	*Carissa carandas*
42	Deshi gaab	Gaub/ Indian Persimmon/Malabar ebony	
43	Setachit	Setachit	
44	Chot boroi	Indian Jujube	*Ziziphus mauritiana*
45	Katanote	Katanote	
46	Premkata	Lesser Spear Grass	*Chrysopogon aciculatus*
47	Vaat	Bhat/ Hill Glory Bower	*Clerodendrum infortunatum*
48	Shimul	Silk Cotton	*Bombax*
49	Sisso	Indian rosewood	*Dalbergia sissoo*
50	Dhutra	Datura metel	*Datura metel*
51	Bonpalong	Wight's Sow-Thistle	*Sonchus wightianus*
52	Bonnjhal	Blistering Ammannia	*Ammannia*

C. Mangrove Habitat

Location: Haringhata Ecopark, Cholhati, Hariyantana, Patharghata, Barguna

GPS Coordinates: 21 58 32N, 89 57 50E

SN	Species Name	English Name	Scientific Name	Usage
1	Koye babla	Madras Thorn	*Pithecellobium dulce*	Fu, F, T
2	Neem	Neem	*Azadirachta indica*	M
3	Rain tree	Albizia Saman/ Rain Tree	*Samanea saman*	T
4	Arjun	Arjun	*Terminalia arjuna*	M
5	Jolpai	Jolpai	*Elaeocarpus serratus*	F
6	Passur	Passur	*Xylocarpus moluccensis*	T, M
7	Tetul	Tamarind	*Tamarindus indica*	F
8	Tiger fern	Tiger fern	*Nephrolepsis exaltata*	M
9	Gewa	Blinding tree / Buta buta tree	*Excoecaria agallocha*	M, In
10	Nona Jhau	Nona Jhau	*Tamarix dioica*	M
11	Keora	Keora	*Sonneratia apetala*	Fu, T, M, Aromatic
12	Golpata	Golpata	*Nypa fruticans*	Th
13	Sola	Sola	*Aeschynomene aspera*	Th
14	Baen	Baen	*Phaseolus vulgaris*	Fu, M
15	Ora	Ora	*Pereskia aculeata*	V
16	Koroch	Koronja/ Pongam Tree	*Pongamia pinnata*	Fu
17	Kali lota	Kali lota	*Derris scandens*	Thatching
18	Sundori	Sundori	*Heritiera fomes*	T, M
19	Keya kata	Thatch Screwpine	*Pandanus tectorius*	M

SN	Species Name	English Name	Scientific Name	Usage
20	Bon Amra	Wild Mango	*Spondias pinnata*	M
21	Akasmoni	Earleaf acacia	*Acacia auriculiformis*	Fu, T, O
22	Bot	Banyan	*Ficus benghalensis*	Fu, M
23	Shali	Shali	*To be identify*	M
24	Sirish	Lebbeck	*Albizia lebbeck*	T
25	Bawali	Bawali	*To be identify*	M, VG
26	Hargoja	Holly-leaved acanthus / Sea holly	*Acanthus ilicifolius*	M
27	Latum	False White Teak	*Mallotus nudiflorus*	W
28	Biranipoda	Pandan	*Pandanus amaryllifolius*	M
29	Gyneria	Gyneria	*To be identify*	M
30	Shundori lota	Dungun	*Brownlowia tersa*	Fencing or as fuelwood

Location: Tengra Giri Wildlife Sanctuary, Cholhati, Hariyantana, Patharghata, Barguna

GPS Coordinates: 21 58 32N, 89 57 50E

SN	Species Name	English Name	Scientific Name	Usage
1	Keora	Keora	*Sonneratia apetala*	Fu, T, M, Aromatic
2	Gewa	Blinding tree / Buta buta tree	*Excoecaria agallocha*	M, In
3	Shundari	Shundari	*Heritiera fomes*	T, M
4	Amoor	Amorseco / Lesser Spear Grass	*Chrysopogon aciculatus*	M
5	Kakra	Kakra	*Bruguiera gymnorhiza*	Fu
6	Passur	Passur	*Xylocarpus moluccensis*	T, M
7	Bain	Bain	*Avicennia officinalis*	Fu, M
8	Hetal	Mangrove Date Palm	*Phoenix paludosa*	F, Th
9	Kalilata	Kali lota	*Derris trifoliata*	Thatching
10	Golpata	Nipa palm	*Nypa fruticans*	Th
11	Shundari Lata	Dungun	*Brownlowia tersa*	Fencing or as fuelwood
12	Hargoja	Holly-leaved acanthus / Sea holly	*Acanthus ilicifolius*	M
13	Keya kata	Thatch Screwpine	*Pandanus tectorius*	M
14	Bet kata	Bet kata	*Calamus tenuis*	Th
15	Nona jhau	Nona jhau	*Tamarix gallica*	M
16	Koromja	Bengal currant	*Carissa carandas*	Fr
17	Bon lebu	Mangrove lime	*Merope angulata*	F
18	Bon boroi	Jackal jujube / Small-fruited jujube / Wild jujube	*Ziziphus oenopolia*	Fo
19	Gila Lata	Box bean	*Entada phaseoloides*	M
20	Bawali lata	Bawali lata	To be identified	M

SN	Species Name	English Name	Scientific Name	Usage
21	Mama kola	Finlayson's creeper	*Finlaysonia obovata Wa ll*	M
22	Kechki mula	Kechki mula	To be identified	F
23	Boloi	Boloi	To be identified	Fo
24	Dhansi	Dhansi	To be identified	M
25	Uri ghas	Santa Maria feverfew	*Parthenium hysterophorus*	Fo, Th
26	Jhana Garjan	Jhana Garjan	To be identified	T
27	Goran	Goran	*Ceriops decandra*	T
28	Singra	Singra	*Cynometra ramiflora*	T
29	Haru	Haru	To be identified	M
30	Mohajoni Lata	Mohajoni Lata	*Derris scandens*	M
31	Kata Boroi	Zunna berry	*Ziziphus rugosa*	F
32	Chot Boroi	Jujab	*Ziziphus xylopyrus*	F
33	Rentri korai	Monkey pod tree / Albizia Saman	*Samania Saman*	T
34	Shil korai	Shil korai /Albizia lucidior	*Albizia Lebbeck*	T
35	Deshi gaab	Gaub/ Indian Persimmon/Malabar ebony	*Diospyros malabarica*	W
36	Taal	Asian palmyra palm	*Borassus flabellifer*	Fr
37	Koye babla	Madras Thorn	*Pithecellobium dulce*	Fu
38	Peyara	Guava	*Psidium guajava*	Fr
39	loitta kata	loitta kata	To be identified	Fo
40	Monjuri lata	Chinese honeysuckle / Rangoon creeper	*Quisqualis indica*	M
41	Kumari lata	Kumari lata	*Smilax zeylanica*	M
42	Bon lakur	Bon lakur	To be identified	M
43	Ajairagas	Ajairagas	To be identified	M
44	Pani nol	Pani nol	*Lindernia anagallis*	Th
45	Bon kochu	Taro	*Colocasia esculenta*	V
46	Tambul	Tambul	To be identified	Fo
47	Pani Shundori	Pani Shundori	To be identified	-
48	Bot	Banyan	*Ficus benghalensis*	Fu, M
49	Abedi Lata	Abedi Lata	To be identified	Fo
50	Mudmudi Lata	Mudmudi Lata	To be identified	-
51	Buno Am	Buno Am	To be identified	M
52	Hurmui	Hurmui		M
53	Buno Jaam	Shoebutton ardisia / Duck's eye / Coralberry	*Ardisia elliptica*	Fo
54	Dyneria	Dyneria	*Agalomorpha*	M

Location: Lebur Char, Trimohoni, Jhaubon, Leburchar, Kuakata, Patuakhali

GPS Coordinates: 21 51 56N, 90 5 21.32E

SN	Species Name	English Name	Scientific Name	Usage
1	Nona Jhau	Nona Jhau	*Tamarix gallica*	M
2	Shet Akanda	Giant calotrope	*Calotropis gigantea*	M
3	Deshi neem	Neem Tree	*Azadirachta indica*	M
4	Gewa	Blinding tree / Buta buta tree	*Excoecaria agallocha*	M, In
5	Hargoja	Holly-leaved acanthus / Sea holly	*Acanthus ilicifolius*	M
6	Cynodon	Scutch grass	*Cynodon dactylon*	Fo, M
7	Keora	Keora	*Sonneratia apetala*	Fu, T, M, Aromatic
8	Baen	Baen	*Avicennia officinalis*	Fu, M
9	Shiltatu	Shiltatu	To be identify	-
10	Bondhone	Licorice Weed / Goatweed / Scoparia-weed / Sweet-broom	*Scoparia dulcis*	M
11	Amrul	Creeping Woodsorrel	*Oxalis corniculata*	V, M
12	Bonpalong	Toothed dock / Aegean dock	*Rumex dentatus*	M
13	Kolka shunda	Kolka shunda	To be identify	M
14	Akashmoni	Earleaf acacia	*Acacia Auriculiformis*	Fu, T, O
15	Taal	Asian palmyra palm	*Borassus flabellifer*	Fr
16	Babla	Gum arabic tree	*Vachellia nilotica*	Fo
17	Sagor Lata	Bayhops / Bay-hops	*Ipomoea pes-caprae*	As
18	Paam	Palms	*Arecaceae*	-
19	boroi	Indian jujube	*Ziziphus mauritiana*	Fr
20	Shewra	Sand Paper Tree / Siamese rough bush Tree / Toothbrush Tree	*Streblus asper*	M
21	Shornolata	Dodders	*Cuscuta*	M
22	Singra	Singra	*Cynometra ramiflora*	M
23	Hijol	Itchytree / Mango-pine	*Barringtonia acutangula*	T, Fu, M
24	Korocha	Koronja/ Pongam Tree	*Pongamia pinnata*	Fu
25	Mutkamuri	Mutkamuri	To be Identify	-
26	Boloi	Boloi	To be Identify	-
27	Sada korai	White Siris /White Karoi	*Albizia procera*	T, Fu, M
28	Golpata	Nipa palm	*Nypa fruticans*	Th
29	Arjun	Arjun	*Terminalia arjuna*	M
30	Bon boroi	Jackal jujube / Small-fruited jujube / Wild jujube	*Ziziphus oenopolia*	-
31	Bot	Banyan	*Ficus benghalensis*	Fu, M
32	Bantulsi	Mesosphaerum suaveolens	*Hyptis suaveolens*	M
33	Shundori	Shundori	*Heriteria fomes*	T, M

Location: Ghora Padma Beach Mangrove, Cholabunia, Joyalbhanga, Barguna Sadar

GPS Coordinates: 50.92N, 90 3 19.24E

SN	Species Name	English Name	Scientic Name	Usage
1	Keora	Keora	*Sonneratia apetala*	Fu, T, M, Aromatic
2	Baen	Baen	*Phaseolus vulgaris*	Fu, M
3	Ora	Ora	*Pereskia aculeata*	V
4	Uri ghas	Santa Maria feverfew	*Parthenium hysterophorus*	Fo

Location: Taltali Char Mangrove, Barishal Tap Bbiddut, Taltoli, Barguna

GPS Coordionates: 21 58 24N, 90 4 21E

SN	Species Name	English/Common Name	Scientic Name	Usage
1	Ora	Ora	*Pereskia aculeata*	V
2	Keora	Keora	*Sonneratia apetala*	Fu, T, M, Aromatic
3	Baen	Baen	*Phaseolus vulgaris*	Fu, M
4	Pani Kochu	Pani Kochu	*Colocasia esculenta*	V
5	Pani Nol	Pani Nol	*Lindernia anagallis*	Fo, TH
6	Hargoja	Holly-leaved acanthus / Sea holly	*Acanthus ilicifolius*	M

Location: Kuakata Mangrove, Kuakata Beach

GPS Coordinates: 21 48 36.90N, 90 8 9.56E

SN	Species Name	English Name	Scientific Name	Usage
1	Hijol	Itchytree / Mango-pine	*Barringtonia acutangula*	T, Fu, M
2	Nona jhau	Nona jhau	*Tamarix gallica*	M
3	Gewa	Blinding tree / Buta buta tree	*Excoecaria agallocha*	M, In
4	Shundori	Shundori	*Heritiera fomes*	T, M
5	Keora	Keora	*Sonneratia apetala*	Fu, T, M, Aromatic
6	Kalilota	Kali lota	*Derris trifoliata*	-
7	Akanda	Giant calotrope	*Calotropis gigantea*	M
8	Khoye Babla	Madras Thorn	*Pithecellobium dulce*	Fu, F, T
9	Singra	Singra	*Cynometra ramiflora*	M
10	Bon am	Bon am	*To be Identefied*	M
11	Daton	Orangeberry/ Gin Berry	*Glycosmis pentaphylla*	M,TC
12	Akashmoni	Earleaf acacia	*Acacia Auriculiformis*	Fu, T, O
13	Arjun	Arjun	*Terminalia arjuna*	M
14	Epilepil	River Tamarind	*Leucaena leucocephala*	Fo, In, Fu
15	Gamari	Gamhar	*Gmelina arborea*	In, M
16	Kumari lota	Kumari lata	*Smilax zeylanica*	M
17	Sada Korai	White Siris /White Karoi	*Albizia procera*	T, Fu, M
18	Bilati Gaab	Velvet apple	*Diospyros blancoi*	Fr, W
19	Kanthal	Jackfruit	*Artocarpus heterophyllus*	Fr, T
20	Horitoki	Myrobalan	*Terminalia chebula*	M

SN	Species Name	English Name	Scientific Name	Usage
21	Kathbadam	Country Almond	*Terminalia catappa*	O, Fr, T
22	Sirish	Lebbeck	*Albizia lebbeck*	T
23	Khoyer	Khoyer	*Senegalia catechu*	F, Fo, M, W
24	Deshi neem	Neem Tree	*Azadirachta indica*	M
25	Ghora neem	Chinaberry	*Melia azedarach*	M
26	Golpata	Nipa palm	*Nypa fruticans*	Th
27	Kakra	Kakra	*Bruguiera gymnorhiza*	Fu
28	Amdewa	Amdewa	*To be Identified*	M
29	Keya kata	Thatch Screwpine	*Pandanus tectorius*	M
30	Bon boroi	Jackal jujube / Small-fruited jujube / Wild jujube	*Ziziphus oenopolia*	Fo
31	Lech boroi	Lech boroi	To be Identified	Fo
32	Sagor Lata	Bayhops / Bay-hops	*Ipomoea pes-caprae*	As
33	Tetul	Tamarind	*Tamarindus indica*	Fr
34	Venna	Castor Bean Tree	*Ricinus Communis*	M
35	Bonjhal	Blistering Ammannia	*Ammannia baccifera*	M
36	Sissoo	Indian rosewood	*Dalbergia sissoo*	M, T
37	Sornolata	Dodders	*Cuscuta*	M
38	Fern	Fern	*Cyatheales*	M
39	Kochu	Taro	*Colocasia esculenta*	V
40	Tiger fern	Tiger fern	*Nephrolepsis exaltata*	M
41	Thankuni	Asiatic pennywort	*Centella asiatica*	M, V
42	Durba	Scutch grass	*Cynodon dactylon*	Fo, M
43	Murmuri lata	Corky Debbar Tree	*Polyalthia suberosa*	Fo
44	Malvaceae	Malvaceae	To be Identified	O
45	Sati sak	Sissoo Spinach / Brazilian Spinach / Sessile Joyweed / Dwarf Copper Leaf	*Alternanthera sessilis*	V
46	Bethua	White goosefoot	*Chenopodium album*	V
47	Kalkasondi	Coffee Senna	*Senna occidentalis*	M
48	Ajayra lata	Ajayra lata	To be Identified	G
49	Gano darma	Ganoderma	*Ganoderma* sp.	M
50	Sati dhora	Sati dhora	To be Identified	M
51	Pemkata	Amorseco / Lesser Spear Grass	*Chrysopogon aciculatus*	Fo
52	Jam	Java Plum	*Syzygium cumini*	Fr, T
53	Dewa	Monkey Fruit / Monkey Jack	*Artocarpus lacucha*	Fr, M
54	Khudi jam	Khudi jam	*Syzygium caryophyllatum*	F
55	Lojjabati	Shameplant	*Mimosa pudica*	M
56	Baen	Baen	*Avicennia officinalis*	Fu, M
57	Dryneria	Dryneria	*Agalomorpha*	M
58	Hetal	Mangrove Date Palm	*Phoenix paludosa*	F, Th

Appendix B: Observed Fauna in the Study Area (Patuakhali and Barguna Districts)

Class	Order	Family	Scientific Name	English Name	NOI
Amphibia	Anura	Ranidae	*Hylarana leptoglossa*	Cope's Frog	2
Amphibia	Anura	Dicroglossidae	*Hoplobatrachus crassus*	Jerdon's Bullfrog	1
Amphibia	Anura	Dicroglossidae	*Fejervarya nepalensis*	Nepal Wart Frog	2
Amphibia	Anura	Dicroglossidae	*Hoplobatrachus tigerinus*	Indian Bullfrog	1
Amphibia	Anura	Bufonidae	*Duttaphrynus melanostictus*	Asian Common Toad	2
Amphibia	Anura	Dicroglossidae	*Euphlyctis cyanophlyctis*	Skipper Frog	14
Amphibia	Anura	Dicroglossidae	*Euphlyctis kalasgramensis*	Skipper Frog	6
Amphibia	Anura	Dicroglossidae	*Hoplobatrachus tigerinus*	Indian Bullfrog	2
Amphibia	Anura	Dicroglossidae	*Polypedates leucomystax*	Common Tree Frog	7
Amphibia	Anura	Dicroglossidae	*Fejervarya asmati*	Asmat's Cricket Frog	3
Amphibia	Anura	Dicroglossidae	*Fejervarya pierrei*	Pierre's Cricket Frog	2
Amphibia	Anura	Dicroglossidae	*Euphlyctis cyanophlyctis*	Skipper Frog	14
Amphibia	Anura	Dicroglossidae	*Euphlyctis cyanophlyctis*	Skipper Frog	14
Amphibia	Anura	Dicroglossidae	*Euphlyctis kalasgramensis*	Skipper Frog	6
Amphibia	Anura	Dicroglossidae	*Hoplobatrachus tigerinus*	Indian Bullfrog	2
Amphibia	Anura	Dicroglossidae	*Polypedates leucomystax*	Common Tree Frog	7
Amphibia	Anura	Dicroglossidae	*Fejervarya asmati*	Asmat's Cricket Frog	3
Amphibia	Anura	Dicroglossidae	*Fejervarya pierrei*	Pierre's Cricket Frog	2
Amphibia	Anura	Ranidae	*Hylarana leptoglossa*	Cope's Frog	2
Amphibia	Anura	Dicroglossidae	*Hoplobatrachus crassus*	Jerdon's Bullfrog	1
Amphibia	Anura	Dicroglossidae	*Fejervarya nepalensis*	Nepal Wart Frog	2
Amphibia	Anura	Dicroglossidae	*Hoplobatrachus tigerinus*	Indian Bullfrog	1
Amphibia	Anura	Bufonidae	*Duttaphrynus melanostictus*	Asian Common Toad	2

Class	Order	Family	Scientific Name	English Name	NOI
Amphibia	Anura	Ranidae	*Hylarana leptoglossa*	Cope's Frog	2
Amphibia	Anura	Dicroglossidae	*Hoplobatrachus crassus*	Jerdon's Bullfrog	1
Amphibia	Anura	Microhylidae	*Microhyla*	Microhylid Frog	2
Amphibia	Anura	Dicroglossidae	*Polypedates leucomystax*	Common Tree Frog	3
Amphibia	Anura	Dicroglossidae	*Fejervarya asmati*	Asmat's Cricket Frog	5
Reptiles	Testudines	Geoemydidae	*Pangshura tecta*	Roofed Turtle	1
Amphibian	Anura	Dicroglossidae	*Euphlyctis cyanophlyctis*	Skipper Frog	14
Amphibian	Anura	Dicroglossidae	*Euphlyctis kalasgramensis*	Skipper Frog	12
Reptiles	Squamata	Gekkonidae	*Hemidactylus frenatus*	Common House Gecko	2
Reptiles	Squamata	Natricidae	*Xenochrophis piscator*	Checkered Keelback	2
Aves	Piciformes	Picidae	*Chrysocolaptes guttacristatus*	Greater Flameback	1
Reptiles	Testudines	Geoemydidae	*Pangshura tecta*	Roofed Turtle	1
Reptiles	Squamata	Gekkonidae	*Hemidactylus frenatus*	Common House Gecko	2
Reptiles	Squamata	Gekkonidae	*Hemidactylus frenatus*	Common House Gecko	5
Aves	Passeriformes	Picnonotidae	*Pycnonotus jocosus*	Red-whiskered Bulbul	3
Aves	Accipitriformes	Accipitridae	*Nisaetus cirrhatus*	Changeable HawkEagle	1
Aves	Accipitriformes	Accipitridae	*Spilornis cheela*	Crested Serpent Eagle	1
Aves	Passeriformes	Dicruridiae	*Dicrurus paradiseus*	Greater Racket-tailed Drongo	2
Aves	Accipitriformes	Accipitridae	*Haliastur indus*	Brahminy Kite	2
Aves	Passeriformes	Timalidae	*Turdoides earlei*	Striated Babbler	16
Aves	Charadriformes	Scolopacidae	*Actitis hypoleucos*	Common Sandpiper	2
Aves	Coraciformes	Alcedinidae	*Alcedo meninting*	Blue-eared Kingfisher	2
Aves	Coraciformes	Alcedinidae	*Todiramphus chloris*	Collared Kingfisher	1
Aves	Passeriformes	Nectarinidae	*Nectarinia asiatica*	Purple Sunbird	3
Aves	Passeriformes	Sturnidae	*Acridotheres tristis*	Common Myna	17
Aves	Pelecaniformes	Ardidae	*Ardeola grayii*	Indian Pond Heron	21
Aves	Columbiformes	Columbidae	*Columba livia*	Rock Dove	11
Aves	Columbiformes	Columbidae	*Spilopelia chinensis*	Eastern Spotted Dove	18
Aves	Passeriformes	Sturnidae	*Acridotheres fuscus*	Jungle Myna	17

Class	Order	Family	Scientific Name	English Name	NOI
Aves	Passeriformes	Corvidae	*Dendrocitta vagabunda*	Rufous Treepie	2
Aves	Passeriformes	Nectarinidae	*Nectarinia zeylonica*	Purple-rumped Sunbird	4
Aves	Passeriformes	Muscicapidae	*Copsychus saularis*	Oriental Magpie Robin	4
Aves	Passeriformes	Ptcnonotidae	*Pycnonotus cafer*	Red-vented Bulbul	2
Aves	Passeriformes	Dicruridiae	*Dicrurus macrocercus*	Black Drongo	7
Aves	Passeriformes	Estrilidae	*Lonchura punctulata*	Scaly-breasted Munia	2
Aves	Passeriformes	Zestropodidae	*Zosterops palpebrosus*	Oriental White-eye	12
Aves	Accipitriformes	Accipitridae	*Ichthyophaga ichthyaetus*	Grey-headed Fisheagle	1
Aves	Passeriformes	Sturnidae	*Sturnus malabaricus*	Chestnut-tailed Starling	3
Aves	Passeriformes	Aegithinidae	*Aegithina tiphia*	Common Iora	2
Aves	Coraciformes	Alcedinidae	*Halcyon smyrnensis*	White-breasted Kingfisher	4
Aves	Columbiformes	Columbidae	*Streptopelia decaocto*	Eurasian Collared Dove	3
Aves	Columbiformes	Columbidae	*Streptopelia tranquebarica*	Red Turtle Dove	2
Aves	Pelecaniformes	Ardidae	*Ardea alba*	Great White Egret	1
Aves	Pelecaniformes	Ardidae	*Ardea intermedia*	Intermediate Egret	2
Aves	Pelecaniformes	Ardidae	*Egretta garzetta*	Little Egret	2
Aves	Pelecaniformes	Ardidae	*Bubulcus ibis*	Cattle Egret	12
Aves	Passeriformes	Oriolidae	*Oriolus xanthornus*	Black-hooded Oriole	2
Aves	Passeriformes	Rhipiduridae	*Rhipidura albicollis*	White-throated Fantail	2
Aves	Passeriformes	Nectarinidae	*Arachnothera longirostra*	Little Spiderhunter	2
Aves	Passeriformes	Corvidae	*Corvus levaillantii*	Jungle Crow	2
Aves	Passeriformes	Corvidae	*Corvus splendens*	House Crow	2
Aves	Passeriformes	Sturnidae	*Acridotheres ginginianus*	Bank Myna	1
Aves	Passeriformes	Ploceidae	*Ploceus philippinus*	Baya Weaver	5
Aves	Passeriformes	Sturnidae	*Acridotheres tristis*	Common Myna	12
Aves	Passeriformes	Sturnidae	*Sturnus contra*	Asian Pied Starling	7
Aves	Passeriformes	Sturnidae	*Acridotheres ginginianus*	Bank Myna	4
Aves	Passeriformes	Sylvidae	*Orthotomus sutorius*	Common Tailorbird	6
Aves	Passeriformes	Campephagidae	*Pericrocotus cinnamomeus*	Small Minivet	10

Class	Order	Family	Scientific Name	English Name	NOI
Aves	Columbiformes	Columbidae	*Columba livia*	Rock Dove	7
Aves	Passeriformes	Ptcnonotidae	*Pycnonotus cafer*	Red-vented Bulbul	4
Aves	Passeriformes	Paridae	*Parus major*	Great Tit	4
Aves	Coraciformes	Alcedinidae	*Pelargopsis capensis*	Stork-billed Kingfisher	1
Aves	Coraciformes	Alcedinidae	*Ceryle rudis*	Pied Kingfisher	2
Aves	Passeriformes	Zestropodidae	*Zosterops palpebrosus*	Oriental White-eye	3
Aves	Passeriformes	Dicruridiae	*Dicrurus macrocercus*	Black Drongo	4
Aves	Cuculiformes	Cuculidae	*Centropus sinensis*	Greater Coucal	7
Aves	Passeriformes	Cicticolidae	*Prinia inornata*	Plain Prinia	2
Aves	Passeriformes	Lanidae	*Lanius schach*	Long-tailed Shrike	4
Aves	Caprimulgiformes	Apodidea	*Cypsiurus balasiensis*	Asian Palm Swift	1
Aves	Passeriformes	Corvidae	*Dendrocitta vagabunda*	Rufous Treepie	2
Aves	Piciformes	Picidae	*Dinopium benghalense*	Black-rumped Flameback	3
Aves	Passeriformes	Nectarinidae	*Arachnothera longirostra*	Little Spiderhunter	2
Aves	Passeriformes	Rhipiduridae	*Rhipidura albicollis*	White-throated Fantail	2
Aves	Pelecaniformes	Ardidae	*Ardeola grayii*	Indian Pond Heron	1
Aves	Pelecaniformes	Ardidae	*Bubulcus ibis*	Cattle Egret	2
Aves	Accipitriformes	Accipitridae	*Haliastur indus*	Brahminy Kite	3
Aves	Galliformes	Phasianidae	*Gallus gallus*	Red Junglefowl	2
Aves	Piciformes	Picidae	*Dinopium benghalense*	Black-rumped Flameback	2
Aves	Passeriformes	Estrilidae	*Lonchura malabarica*	White-throated Munia	2
Aves	Cuculiformes	Cuculidae	*Cacomantis merulinus*	Plaintive Cuckoo	3
Aves	Cuculiformes	Cuculidae	*Eudynamys scolopaceus*	Western Koel	2
Aves	Cuculiformes	Cuculidae	*Centropus sinensis*	Greater Coucal	1
Aves	Passeriformes	Rhipiduridae	*Rhipidura albicollis*	White-throated Fantail	2
Aves	Piciformes	Picidae	*Dendrocopos macei*	Fulvous-breasted Woodpecker	2
Aves	Passeriformes	Muscicapidae	*Copsychus saularis*	Oriental Magpie Robin	4
Aves	Passeriformes	Monarchidae	*Hypothymis azurea*	Black-naped Monarch	2

Class	Order	Family	Scientific Name	English Name	NOI
Aves	Coraciformes	Alcedinidae	*Pelargopsis capensis*	Stork-billed Kingfisher	4
Aves	Coraciformes	Alcedinidae	*Todiramphus chloris*	Collared Kingfisher	4
Aves	Passeriformes	Passeridae	*Passer domesticus*	House Sparrow	3
Aves	Passeriformes	Nectarinidae	*Nectarinia asiatica*	Purple Sunbird	4
Aves	Passeriformes	Dicruridiae	*Dicrurus macrocercus*	Black Drongo	7
Aves	Coraciformes	Alcedinidae	*Alcedo atthis*	Common Kingfisher	4
Aves	Columbiformes	Columbidae	*Treron phoenicopterus*	Yellow Footed Green Pigeon	8
Aves	Columbiformes	Columbidae	*Treron bicinctus*	Orange-breasted Green Pigeon	6
Aves	Psittaciformes	Psittacidae	*Psittacula krameri*	Rose-ringed Parakeet	4
Aves	Pelecaniformes	Ardidae	*Bubulcus ibis*	Cattle Egret	7
Aves	Pelecaniformes	Ardidae	*Egretta garzetta*	Little Egret	4
Aves	Caprimulgiformes	Apodidea	*Apus nipalensis*	House Swift	2
Aves	Caprimulgiformes	Apodidea	*Cypsiurus balasiensis*	Asian Palm Swift	2
Aves	Cuculiformes	Cuculidae	*Centropus sinensis*	Greater Coucal	3
Aves	Pelecaniformes	Ardidae	*Nycticorax nycticorax*	Black-crowned Night Heron	7
Aves	Passeriformes	Ploceidae	*Ploceus philippinus*	Baya Weaver	2
Aves	Pelecaniformes	Ardidae	*Ardea purpurea*	Purple Heron	1
Aves	Pelecaniformes	Ardidae	*Ardea alba*	Great White Egret	4
Aves	Pelecaniformes	Ardidae	*Ardea intermedia*	Intermediate Egret	3
Aves	Pelecaniformes	Ardidae	*Egretta garzetta*	Little Egret	7
Aves	Pelecaniformes	Ardidae	*Bubulcus ibis*	Cattle Egret	2
Aves	Passeriformes	Sturnidae	*Acridotheres ginginianus*	Bank Myna	5
Aves	Columbiformes	Columbidae	*Streptopelia decaocto*	Eurasian Collared Dove	2
Aves	Cuculiformes	Cuculidae	*Cacomantis merulinus*	Plaintive Cuckoo	1
Aves	Columbiformes	Columbidae	*Spilopelia chinensis*	Eastern Spotted Dove	7
Aves	Columbiformes	Columbidae	*Eudynamys scolopaceus*	Western Koel	3
Aves	Piciformes	Picidae	*Dinopium benghalense*	Black-rumped Flameback	4
Aves	Passeriformes	Artamidae	*Artamus fuscus*	Ashy Woodswallow	2
Aves	Passeriformes	Sylvidae	*Orthotomus sutorius*	Common Tailorbird	3
Aves	Passeriformes	Cicticolidae	*Prinia inornata*	Plain Prinia	2
Aves	Passeriformes	Corvidae	*Corvus levaillantii*	Jungle Crow	1
Aves	Passeriformes	Corvidae	*Corvus splendens*	House Crow	5
Aves	Cuculiformes	Cuculidae	*Cuculus micropterus*	Indian Cuckoo	2

Class	Order	Family	Scientific Name	English Name	NOI
Aves	Passeriformes	Timalidae	*Turdoides striata*	Jungle Babbler	12
Aves	Passeriformes	Campephagidae	*Pericrocotus cinnamomeus*	Small Minivet	7
Aves	Suliformes	Phalacrocoracidae	*Microcarbo niger*	Little Cormorant	3
Aves	Passeriformes	Sturnidae	*Sturnus contra*	Asian Pied Starling	2
Aves	Columbiformes	Columbidae	*Treron phoenicopterus*	Yellow Footed Green Pigeon	2
Aves	Pelecaniformes	Ardidae	*Ardeola grayii*	Indian Pond Heron	5
Aves	Pelecaniformes	Ardidae	*Bubulcus ibis*	Cattle Egret	2
Aves	Accipitriformes	Accipitridae	*Haliastur indus*	Brahminy Kite	2
Aves	Passeriformes	Sturnidae	*Acridotheres ginginianus*	Bank Myna	2
Aves	Passeriformes	Cicticolidae	*Cisticola juncidis*	Zitting Cisticola	3
Aves	Anseriformes	Anatidae	*Dendrocygna javanica*	Lesser Whistling Duck	2
Aves	Columbiformes	Columbidae	*Columba livia*	Rock Dove	2
Aves	Columbiformes	Columbidae	*Treron phoenicopterus*	Yellow Footed Green Pigeon	2
Aves	Cuculiformes	Cuculidae	*Phaenicophaeus tristis*	Green-billed Malkoha	2
Aves	Cuculiformes	Cuculidae	*Hierococcyx varius*	Common HawkCuckoo	1
Aves	Accipitriformes	Accipitridae	*Nisaetus cirrhatus*	Changeable HawkEagle	1
Aves	Accipitriformes	Accipitridae	*Spilornis cheela*	Crested Serpent Eagle	1
Aves	Passeriformes	Campephagidae	*Coracina macei*	Large Cuckooshrike	6
Aves	Coraciformes	Alcedinidae	*Alcedo meninting*	Blue-eared Kingfisher	2
Aves	Coraciformes	Alcedinidae	*Todiramphus chloris*	Collared Kingfisher	1
Aves	Passeriformes	Nectarinidae	*Nectarinia asiatica*	Purple Sunbird	3
Aves	Passeriformes	Sturnidae	*Acridotheres tristis*	Common Myna	17
Aves	Pelecaniformes	Ardidae	*Ardeola grayii*	Indian Pond Heron	15
Aves	Columbiformes	Columbidae	*Spilopelia chinensis*	Eastern Spotted Dove	18
Aves	Passeriformes	Sturnidae	*Acridotheres fuscus*	Jungle Myna	17
Aves	Passeriformes	Corvidae	*Dendrocitta vagabunda*	Rufous Treepie	2
Aves	Passeriformes	Nectarinidae	*Nectarinia zeylonica*	Purple-rumped Sunbird	4
Aves	Passeriformes	Muscicapidae	*Copsychus saularis*	Oriental Magpie Robin	4
Aves	Passeriformes	Ptcnonotidae	*Pycnonotus cafer*	Red-vented Bulbul	2

Class	Order	Family	Scientific Name	English Name	NOI
Aves	Passeriformes	Dicruridiae	*Dicrurus macrocercus*	Black Drongo	7
Aves	Passeriformes	Estrilidae	*Lonchura punctulata*	Scaly-breasted Munia	2
Aves	Passeriformes	Zestropodidae	*Zosterops palpebrosus*	Oriental White-eye	12
Aves	Accipitriformes	Accipitridae	*Ichthyophaga ichthyaetus*	Grey-headed Fisheagle	1
Aves	Passeriformes	Sturnidae	*Sturnus malabaricus*	Chestnut-tailed Starling	3
Aves	Passeriformes	Aegithinidae	*Aegithina tiphia*	Common Iora	2
Aves	Coraciformes	Alcedinidae	*Halcyon smyrnensis*	White-breasted Kingfisher	4
Aves	Columbiformes	Columbidae	*Streptopelia decaocto*	Eurasian Collared Dove	3
Aves	Columbiformes	Columbidae	*Streptopelia tranquebarica*	Red Turtle Dove	2
Aves	Pelecaniformes	Ardidae	*Ardea alba*	Great White Egret	1
Aves	Pelecaniformes	Ardidae	*Ardea intermedia*	Intermediate Egret	2
Aves	Pelecaniformes	Ardidae	*Egretta garzetta*	Little Egret	2
Aves	Pelecaniformes	Ardidae	*Bubulcus ibis*	Cattle Egret	12
Aves	Passeriformes	Oriolidae	*Oriolus xanthornus*	Black-hooded Oriole	2
Aves	Passeriformes	Rhipiduridae	*Rhipidura albicollis*	White-throated Fantail	2
Aves	Passeriformes	Nectarinidae	*Arachnothera longirostra*	Little Spiderhunter	2
Aves	Passeriformes	Corvidae	*Corvus levaillantii*	Jungle Crow	2
Aves	Passeriformes	Corvidae	*Corvus splendens*	House Crow	2
Aves	Passeriformes	Sturnidae	*Acridotheres ginginianus*	Bank Myna	1
Aves	Piciformes	Picidae	*Dinopium benghalense*	Black-rumped Flameback	2
Aves	Passeriformes	Estrilidae	*Lonchura malabarica*	White-throated Munia	2
Aves	Cuculiformes	Cuculidae	*Cacomantis merulinus*	Plaintive Cuckoo	3
Aves	Cuculiformes	Cuculidae	*Eudynamys scolopaceus*	Western Koel	2
Aves	Cuculiformes	Cuculidae	*Centropus sinensis*	Greater Coucal	1
Aves	Passeriformes	Rhipiduridae	*Rhipidura albicollis*	White-throated Fantail	2
Aves	Piciformes	Picidae	*Dendrocopos macei*	Fulvous-breasted Woodpecker	2
Aves	Passeriformes	Muscicapidae	*Copsychus saularis*	Oriental Magpie Robin	4

Class	Order	Family	Scientific Name	English Name	NOI
Aves	Passeriformes	Monarchidae	*Hypothymis azurea*	Black-naped Monarch	2
Aves	Coraciformes	Alcedinidae	*Pelargopsis capensis*	Stork-billed Kingfisher	4
Mammals	Carnivora	Indian Grey Mongoose	*Herpestes edwardsii*	Herpestes edwardsii	2
Mammals	Cetartiodactyla	Suidae	*Sus scrofa*	Wild Boar	2
Mammals	Cetartiodactyla	Delphinidae	*Orcaella brevirostris*	Irrawaddy Dolphin	2
Mammals	Carnivora	Felidae	*Prionailurus viverrinus*	Fishing Cat	1
Mammals	Carnivora	Mustelidae	*Lutrogale perspicillata*	Smooth-coated Otter	2
Mammals	Carnivora	Canidae	*Canis aureus*	Golden Jacka	10
Mammals	Carnivora	Canidae	*Canis aureus*	Golden Jacka	10

Note: NOI: No. of observed Individuals

Appendix C: Energy Statistics of Bangladesh

Energy statistics for Bangladesh up to 2017 are taken from the International Energy Agency[84] and the data on GDP and population from the World Bank[85].

TPES – structure - fuels

The structure of total primary energy supply (TPES) in terms of fuels 2010-2018 is presented in the following Table:

Table 1: Structure of TPES in terms of fuels in Bangladesh 2010 - 2018

	Unit	2010	2011	2012	2013	2014	2015	2016	2017	2018
Total	ktoe	**30054**	**31052**	**32643**	**33898**	**34997**	**37786**	**39555**	**40523**	**41901**
Coal		811	748	903	988	926	2270	1602	1984	2202
Crude oil		1442	1421	1502	1445	1568	1401	1705	1591	1502
Oil products		2297	3143	3568	3289	3761	3582	3609	4237	5001
Natural gas		16629	16749	17583	18960	19447	21135	23102	23071	23011
Nuclear		0	0	0	0	0	0	0	0	0
Hydro		66	79	71	82	54	52	88	90	93
Geothermal, solar, etc.		0	0	0	12	13	14	15	16	26
Biofuels, waste		8809	8911	9016	9123	9229	9333	9434	9534	9628
Indicators										
Population	million	147.6	149.3	151.0	152.8	154.5	156.3	158.0	159.7	161.4
GDP[86]	USD billion	115.2	122.7	130.7	138.6	147.0	156.6	167.8	180.0	194.1
TPES/capita	toe/ capita	0.204	0.208	0.216	0.222	0.227	0.242	0.250	0.252	0.259
TPES/GDP	toe/ 1000 USD	0.261	0.253	0.250	0.246	0.238	0.241	0.236	0.225	0.216

Source: Energy data: International Energy Agency (IEA), Population and GDP World Bank:

It can be concluded that during the period 2010 - 2018:

- Consumption of TPES showed an increase of more than 39 % between 2010 and 2018;
- Share of natural gas in TPES was 54 – 58% (with slightly increasing trend);

84International Energy Agency (IEA):

https://www.iea.org/data-and-statistics/data-tables?country=BANGLADESH&energy=Balances&year=2017

85 Population: World Bank: https://data.worldbank.org/indicator/SP.POP.TOTL?end=2018&locations=BD&start=1960&view=chart ; GDP: World Bank: https://data.worldbank.org/indicator/NY.GDP.MKTP.KD?locations=BD

86 GDP in constant prices 2010.

- Share of biofuels and waste in TPES showed a slightly decreasing trend (from more than 29% in 2010 to almost 23% in 2018);
- Share of oil products in TPES is increasing (from almost 8% in 2010 to almost 12% in 2018;
- Share of coal in TPES increased from less than 3 till 2014 to more than 5% in 2015 and after;
- Share of crude oil in TPES lies between 3 and 5%;
- Share of hydro energy in TPES is negligible (less than 0.3%);
- Share of geothermal and solar energy in TPES is "zero plus" (less than 0.1%);
- TPES per capita has increased from 0.202 toe in 2010 to 0.259 toe in 2018 but is still very low (the world average in 2017 was 1.9 toe[87]);
- Energy intensity on national economy has decreased from 0.261 toe/1000 USD in 2010 to 0.216 toe/1000 USD in 2018 but is still slightly higher than the world average (0.2 toe/1000 USD in 2017[88]).

TPES – structure - origin

The structure of TPES in terms of origin in Bangladesh between 2010 and 2018 is presented in the Following Table:

Table 2: Structure of TPES in terms of origin in Bangladesh 2010 - 2018

	Unit	2010	2011	2012	2013	2014	2015	2016	2017	2018
Total	ktoe	**30054**	**31052**	**32643**	**33898**	**34997**	**37786**	**39555**	**40523**	**41901**
Production		26101	26314	27326	28857	29466	31171	33537	33708	33636
Imports		4536	5557	5649	5640	6184	7072	6505	7377	7939
Exports		-233	-183	-133	-109	-86	-43	-107	-43	-3
Share of import in TPES	%	15.1	17.9	17.3	16.6	17.7	18.7	16.4	18.2	18.9

Source: International Energy Agency (IEA)

It can be concluded that during the period 2010 - 2017:

- Production of energy in terms of TPES showed an increasing trend (increase by almost 29% between 2010 and 2018);
- Imports of energy in terms of TPES showed a strong increasing trend (increase by 75 % between 2010 and 2017);
- Imports of energy were 15 – 19% of TPES.

87https://www.iea.org/data-and- statistics/?country=WORLD&fuel=Key%20indicators&indicator=Total%20primary%20 energy%20supply%20(TPES)%20per%20capita

88https://www.iea.org/data-and-statistics/?country=WORLD&fuel=Key%20indicators&indicator=Total%20primary%20 energy%20supply%20(TPES)%20by%20GDP

The structure of energy commodities in terms of origin between 2010 and 2018 is presented in the Following Table:

Table 3: Structure of energy commodities in terms of origin in Bangladesh 2010 - 2018

	Unit	2010	2011	2012	2013	2014	2015	2016	2017	2018
Gas-domestic	PJ	773.5	779.2	817.9	882.0	904.7	983.2	1074.7	1073.3	1070.5
Gas-import		-	-	-	-	-	-	-	-	-
Coal-domestic	ktoe	352	333	417	427	473	338	511	580	461
Coal-import		400	462	500	500	494	1825	1092	1404	1741
Crude oil - domestic	Kt	-	-	-	-	-	-	-	-	-
Crude oil -import	a	1275	1211	1266	1183	1308	1093	1308	1166	1087
Gas/diesel - domestic	a	372	378	375	386	362	389	333	407	499
Gas/diesel - import	a	2187	2956	2619	2609	2904	2975	3130	3716	3458
Fuel oil - domestic	a	341	367	275	323	302	299	363	443	304
Fuel oil - import	a		231	681	804	1016	692	335	521	677

Source: International Energy Agency (IEA)

It can be concluded that during the period 2010 - 2018:

- Actual consumption of natural gas was fully met from domestic sources;
- Crude oil was all imported;
- Consumption of coal, fuel oil and gas/diesel was mainly met by imports;
- Export of energy showed a strongly decreasing trend - from 0.8% of TPES in 2010 to less than 0.1% in 2018, and can be considered more or less negligible.

Production of Electricity

The production of electricity in Bangladesh between 2011 and 2021 in terms of fuels is presented in the Following Table:

Table 4: Electricity production in terms of fuels in Bangladesh 2011 - 2021

	Unit	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Total	GWh	**44205**	**48909**	**53174**	**55880**	**59043**	**68911**	**73157**	**78612**	**70,533**	**71,419**	**80423**
Coal		827	936	1225	1100	997	1102	1031	1500	1230	2968	4997
Oil		4191	5991	6692	8209	9666	11384	13332	16292	13448	9600	18106
Gas		38263	40858	44169	45799	47624	55325	57572	59437	48306	51290	48403
Hydro		924	824	948	623	600	1920	1041	1086	725	825	655
Solar PV				136	145	154	165	177	291	39	62	158
Wind				4	4	4	5	5	6	-	-	-

Source: Bangladesh Power Development Board

It can be concluded that during the period 2011 - 2021:

- Production of electricity in Bangladesh is increasing between 2011 and 2021
- Share of gas in production of electricity showed a decreasing trend
- Share of oil in production of electricity increased almost six fold

- Share of coal in production of electricity in Bangladesh was below 6.21%
- Share of hydropower stations in production of electricity in Bangladesh was more or less stable between 2011 and 2021;

Total final consumption of energy

The final consumption of energy in Bangladesh 2012 and 2020 in total and per sectors is presented in the following table:

Table 5: Final consumption of energy in Bangladesh 2010 - 2018

	Unit	2012	2013	2014	2015	2016	2017	2018
Total	ktoe	**24560**	**24851**	**25652**	**28043**	**28999**	**30817**	**32256**
Industry		5772	6150	6365	8170	8004	8911	9410
Transport		3031	2874	3103	3252	3448	3828	4172
Residential		12518	12673	13129	13645	14475	14934	15546
Commercial and public services		431	445	469	489	532	545	667
Agriculture / forestry		1237	1142	1160	1062	1142	1260	1200
Non-specified		63	42	43	45	52	56	136
Non-energy use		1506	1526	1382	1381	1345	1263	1125

Source: Energy data: International Energy Agency (IEA, Population and GDP: World Bank:

It can be concluded that during the period 2012 - 2018:

- Total final consumption of energy of Bangladesh showed an increasing trend
- Share of industry in total final consumption of Bangladesh showed an increasing trend
- Share of transport in total final consumption of Bangladesh was more or less stable below 13%;
- Share of residential sector in total final consumption of Bangladesh showed a slightly decreasing trend
- Share of commercial and public services sector of total final consumption in Bangladesh was more or less stable and represents around 2%;
- Share of agriculture and forestry in total final consumption of Bangladesh was more or less stable (>4%);

Final consumption of electricity

The final consumption of electricity in Bangladesh 2010 and 2018 in total and per sectors is presented in Table 36:

Table 6: Final consumption of electricity in Bangladesh from FY 2010-11 to FY 2020-21

Year	Total Generation (GWh)	Total Population (In million)	Total Sale MkWh)	Per Capita Generation (kWh)	Per Capita Consumption (kWh)
2010-11	31,355	150	26,587	209.46	177.60
2011-12	35,118	152	29,974	231.65	197.72
2012-13	42,195	156	36,233	270.83	213.56
2013-14	42,195	156	36,233	270.83	232.56

Year	Total Generation (GWh)	Total Population (In million)	Total Sale MkWh)	Per Capita Generation (kWh)	Per Capita Consumption (kWh)
2014-15	45,836	158	39,624	290.28	250.95
2015-16	52,193	160	45,299	326.41	293.30
2016-17	57,276	162	50,264	354.10	310.75
2017-18	62,677	164	55,103	383.00	336.71
2018-19	70,533	166	62,037	426.05	374.73
2019-20	71,419	168	63,364	426.23	378.16
2020-21	80,423	169	71,470	475.00	422.13

Source: World Bank Data from 1970-2000; BBS & Bangladesh Bank Data Book.

It can be concluded that during the period FY 2010-11 to FY 2020-21:

- Total final consumption of electricity of Bangladesh showed a very strong increasing trend
- Generation electricity increased from 31,355 GWh in FY 2010-11 to 80,423 GWh in FY 2020-21
- Consumption of electricity per capita increased from 166.42 kWh in FY2010-11 to 422.13 kWh in FY 2020-21
- Total Sale of electricity increased from 26,587 in FY 2010-11 to 71,470 in FY 2020-21.

BPDP Statistics

Key information from the BPDP Annual Report 2020-2021[89] is presented in the Following Table:

Table 7: Key Information from Annual Report 2020-2021, BPDB

S.N	Particulars	Year 2020-2021
1	Installed Capacity of Power Plants as of June (MW)	
	a) Public Sector:	
	i) BPDB	6013
	ii) APSCL	1444
	iii) EGCB	957
	iv) RPCL	182
	v) NWPGCL	1401
	vi) B-R Powerjen Ltd. (BRPL)	149
	vii) Joint Venture (BCPCL)	1244
	b) Private Sector :	
	i) IPP/SIPP	8141
	ii) Rental	1089
	c) REB (for PBS's only)	251
	d) Power Import	1,160

89 http://bd.bpdb.gov.bd/bpdb/index.php/site/annual_reports/c4ff-123d-dae0-575b-7a77-a1c0-2f7e-a806-a836-2fdd

S.N	Particulars	Year 2020-2021
	e) System Total Installed Capacity (MW)	22031
2	Maximum Peak Generation (MW)	13792
3	Maximum Peak Demand (MW)	14500
4	**Net Energy generation (GWh):**	
	i) Public Sectors	31916
	ii) Joint Venture	3812
	iii) Private Sectors (IPP, SIPP and Rental)	34822
	iv) Power Import	8103
	v) Total Generation (In account of Single Buyer)	78653
	b) REB (for PBS's only)	1770
	c) System Total Generation (GWh)	80423
5	Per Unit Generation Cost in Public & Private (Tk/Kwh)	6.61
6	a) Fuel Cost for Thermal Plants in Public Sector (MTk)	57215
	b) Per Unit fuel Cost for thermal Plants (Tk/KWh)	1.79
7	Annual Plant Factor of Public Sector's Power Plants (%)	39.8
8	System load factor (%)	65.10
9	BPDB's Commercial Activities as Single Buyer :	
	a) Bulk Sales Unit to Utilities (GWh)	76323
	b) Bulk Billing Amount (MTk)	401345
	c) Bulk Collection Amount (MTk)	397608
	d) Accounts Receivables to Utilities (MTk)	82704
10	Transmission Loss (%)	3.07
11	Ave. Bulk Electricity Supply cost Taka/kWh	6.81
12	BPDB's Commercial Activities with in Distribution Zones :	
	a) Energy Imports for Retail Sale (MKWh)	12309
	b) Retail Sales Unit (MKWh)	11489
	c) Retail Billing Amount (MTk)	83141
	d) Retail Collection Amount (MTk)	84899
	e) Accounts Receivables to Retail Consumers (MTk)	15466
	f) Collection/Bill Ratio (%)	102.11
	g) Collection/Import Ratio (%)	95.31
	h) Distribution System loss (%)	8.50
13	Transmission and Distribution (T & D) system Loss (%)	11.11
14	Total Number of consumers of BPDB (Nos.)	3451534
15	Total Population in the Country (Million)	169.31
16	Per capita generation (kWh) (grid)	475
17	Per capita Consumption (kWh) (grid)	422
18	Net profit/(loss) (MTk)	1292.75