Government of the People's Republic of Bangladesh

Jamuna River Economic Corridor Development Program, Phase 1

Environmental and Social Impact Assessment (Main Report)

April 2022

Prepared by:

CEGIS

Center for Environmental and Geographic Information Services

On behalf of

Bangladesh Water Development Board &

Bangladesh Inland Water Transport Authority

Jamuna River Economic Corridor Development Program, Project 1

Draft Environmental and Social Impact Assessment

April 2022

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Abbreviations and Acronyms

ADB	Asian Development Bank
ADDs	Acoustic Deterrent Devices
ADP	Annual development program
AEZs	Agro-Ecological Zones
AIIB	Asian Infrastructure Investment Bank
AOI	Area of Influence
AtoN	Aids to Navigation
BAA	Biodiversity Area of Analysis
BBS	Bangladesh Bureau of Statistics
BCCSAP	Bangladesh Climate Change Strategy and Action Plan
BDP	Bangladesh Delta Plan
BFD	Bangladesh Forest Department
BIWTA	Bangladesh Inland Water Transport Authority
BIWTA	Bangladesh Inland Water Transport Authority
BMD	Bangladesh Meteorological Department
BMD	Bangladesh Meteorological Department
BMP	Biodiversity Management Plan
BNBC	Bangladesh National Building Code
BOD	Biochemical Oxygen Demand
BOQs	Bills of quantities
BRE	Brahmaputra Right bank Embankment
BWDB	Bangladesh Water Development Board
CBOs	Community Based Organization
CDD	Community-driven Development
CEIA	Cumulative Environmental Impact Assessment
CEIP	Coastal Embankment Improvement Project
CERC	Contingent emergency response component
CESAP	Construction Environmental and Social Action Plan
CEVNI	“Code Européen des Voies de la Navigation Intérieure”
CH	Critical Habitat
CHS	Community Health and Safety
CIA	Cummulative Impact Assessment
CIA	Cumulative Impact Assessment
CLP	Char Livelihood Program
CoC	Code of Conduct
CR	Critically Endangered
CSC	Construction Supervision Consultant
CSR	Corporate Social Responsibility
DC	Deputy Commissioner
DDM	Department of Disaster Management

DLRS	Department of Land Records and Survey
DMF	Daily Monitoring Forms
DO	Dissolved Oxygen
DoE	Department of Environment
DoF	Department of Fisheries
DP	Development Partner
DPSIR	Driver Pressure State Impact Response
DRF	Disaster Risk Financing
DSAS	Digital shoreline Analysis System
E&F	Environment & Forest
E&S	Environment and social
E&SRM	Environment and Social Risk Management
EBAA	Environmental Baseline Area of Analysis
ECA	Environmental Conservation Act
ECR	Environmental conservation Rules
EHS	Environment, Health, and Safety
EHSGs	Environmental Health and Safety Guidelines
EHSGs	Environmental Health and Safety Guidelines
EN	Endangered
ENM	Ecological niche modeling
EPRP	Emergency preparedness and response plan
EQS	Environmental Quality Standards
ES	Executive Summary
ESCOPs	Environmental and social codes of practice
ESCP	Environmental and Social Commitment Plan
ESF	Environmental and Social Framework
ESIA	Environmental and Social Impact Assessment
ESMF	Environmental and Social Management Framework
ESMP	Environmental and Social Management Plan
ESS	Environmental and Social Standards
FGD	Focus Group Discussions
FRERMIP	Flood and Riverbank Erosion Risk Management Investment Program
GBV	Gender Based Violence
GDP	Gross Domestic Product
GIIP	Good International Industry Practice
GOB	Government of Bangladesh
GPN	Good Practice Note
GRC	Grievance Redress Committee
GRM	Grievance redress mechanism
GRM	Grievance Redress Mechanism
GRM	Grievance Redress Mechanism
HF	High frequency
HH	Households

HRACs	Hazard Risks Assessment Codes
IA	Implementation agency
IBAT	International Biodiversity Assessment Tool
ICTPs	International Conventions, Treaties, and Protocols
IENC	Inland Electronic Navigational Chart
IFC	International Finance Corporation
ILO	International Labour Organization
IPC	Instruction of Payment Certificate
IPP	Indigenous Peoples Plan
IRC	Incident Response Center
JHA	Job Hazard Analysis
JLB	Jamuna Left Bank
JNCC	Joint Nature Conservation Committee
JRB	Jamuna Right Bank
JRECD	Jamuna River Economic Corridor Development Program
KBA	Key Biodiversity Areas
KPI	Key Performance indicators
L&FS	Life and Fire Safety
LGED	Local Government Engineering Department
LMP	Labor Management Procedures
LOO	Likelihood of Occurrence
MCA	Multi-Criteria-Analysis
MoEF	Ministry of Environment and Forest
MoH	Ministry of Health
MoS	Ministry of Shipping
MoWR	Ministry of Water Resources
MSL	Mean Sea Level
NCR	Non-compliance Report
NEQS	National Environmental Quality Standards
NGOs	Non-Government Organizations
NOAA	National Oceanic and Atmospheric Administration
NWRD	National Water Resources Database
OHS	Occupational Health and Safety
PAP	Project Affected Person
PAPs	Project Affected Persons
PD	Project Director
PIU	Project Implementation Unit
PMO	Project Management Office
PoC	Persons of Concern
POEs	Panel-of-Experts
PPE	Personal Protective Equipment
PTS	Thresholds for Onset of Permanent
PTW	Permit to Work

PWD	Public Works Department
RAC	Resettlement Assessment Committee
RAP	Resettlement Action Plan
R-CIA	Rapid Cumulative Impact Assessment
RFI	Request for Inspection
RIS	River Information Services
RIS	River Information System
RMIP	River Management Improvement Project
RPF	Resettlement Policy Framework
RRA	Rapid Rural Appraisal
SAA	Socio-economic Area of Analysis
SAAO	Sub-Assistant Agricultural Officer
SEA/SH	Sexual Exploitation and Abuse and Sexual Harassment
SEL	Sound Exposure Level
SEP	Stakeholder Engagement Plan
SNN	Social Safety Net
SOP	Series of Project
SPM	Suspended Particulate Matter
SRDI	Soil Resource Development Institute
STDs	Sexually Transmitted Diseases
TBPG	Top Block Permeable Groyne
TBPG	Top Blocked Permeable Groyne
TOR	Terms of Reference
TTS	Temporary Threshold Shifts
VECs	Valued Environmental Components
VESC	Valued Environmental and Social Components
WB	World Bank
WBG	World Bank Group

Executive Summary

Background

The multi-channel braided Brahmaputra-Jamuna River is a river that has undergone many changes over the past 150 years. Each year, riverbank erosion and seasonal flooding devours many settlements and infrastructure resulting in significant displacement of an estimated one million people annually, creating a cycle of poverty and landlessness. Considering these severe losses and potential diminished socio-economic return on investment, the Bangladesh Government, with the technical and financial assistance from the World Bank (WB), intends to develop and execute the Jamuna River Economic Corridor Development Program (JRECDP or "the Program"). The JRECDP is aligned with the country's first long-term plan, the Bangladesh Delta Plan 2100, which has as its development objective (DO) "to increase climate resilience and economic productivity along the Jamuna River".

Jamuna River Economic Corridor Development Program

The Program is planned to be executed as a series of three distinct projects along an approximately 200 km stretch of the Jamuna River (Figure 1). This series of projects (SOP) is estimated to cost US$2.8 billion, of which US$1.1 billion may come from the World Bank, with the remainder to be financed by the Government of Bangladesh (GoB) and other development partners (DPs) such as the Asian Infrastructure Investment Bank (AIIB), over a 15-year period.

The Program will combine Aids to Navigation and Level D+ River Information Services (RIS) with Riverbank Protection Structures, something that is unprecedented in Bangladesh. It will introduce "Dynamic Navigation" as a step toward rationalizing needed dredging. The JRECDP will also include much needed institutional capacity development.

The three proposed projects that make up the SOPs of the Program are as follows:

- Project 1: consists of an innovative river training structure for two pilot sites with dredging of a small section of river, aids to navigation for the entire program area, hydro-dynamic modelling and hydrographic survey, institutional capacity building, and establishing a disaster financing instrument.
- Project 2: will involve the expansion of innovative river structures, conventional river-protection, scaled-up dredging, navigation development, implementation of disaster risk financing in priority areas, and institutional capacity building.
- Project 3: aims to provide further scaling up to develop the resilient Jamuna Economic Corridor.

Project 1 of the SOP will be implemented over a period of 4.5 years (2023-2028) preparing the groundwork for future projects. Project 2 will overlap Project 1 with riverbank protection works extending along a 100 km stretch of the river over a period of 6.5 years (2025-2031). Project 3 will commence toward the end of Project 2 and cover 250 km of river over a period of 7.5 years (2030-2037).

This Environmental and Social Impact Assessment (ESIA) covers only Project 1 of the SOP, specifically involving small-scale piloting of river protection works at two sites, temporary bank protection in a char, small scale dredging, aids to navigation, and Community Driven Development (for small civil works, e.g., buoys maintenance and char protection). The location map for Project 1 activities is shown in Figure 1.

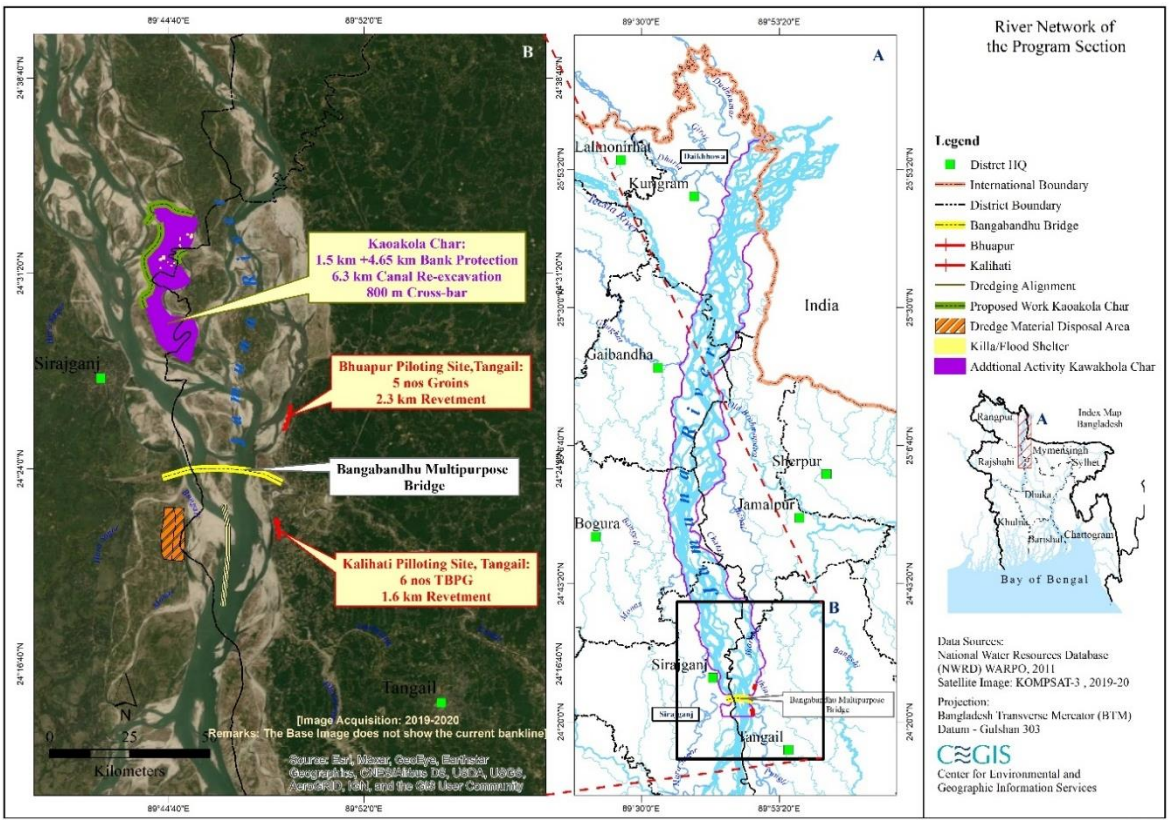


Figure 1: Location Map of the JRECDP SOP 1

Description of Project 1

Project 1 of the SOP will lay the foundation for successful implementation of the JRECDP. The Project Development Objectives of Project 1 include: (a) enhancing resilience of Jamuna River's riverbanks to flooding and erosion; (b) improving navigability of the Jamuna River; and (c) strengthening sector institutional capacity.

A total of USD 135 million will be invested in Project 1 over the 4.5-year period, combining for the first time in Bangladesh investments in river structures, navigation channel development, disaster risk financing solutions, and community engagement. The Project will be implemented by Bangladesh Water Development Board (BWDB) under the Ministry of Water Resources and Bangladesh Inland Water Transport Authority (BIWTA) under the Ministry of Shipping.

Project 1 will have five components as follows:

- **Component 1** (USD 45 million, to be implemented by BWDB) – Flood and bank erosion management: Most of the activities with material environmental and social (E&S) impacts are associated with Component 1. These include: construction, and operations and maintenance (O&M) of riverbank protection structures (integrated green and grey infrastructure), i.e., piloting Top Blocked Permeable Groynes (TBPG), revetments, and embankments at two pilot sites (Bhuapur in Tangail and Kalihati in Tangail); limited-scale dredging; and preparatory activities for subsequent projects including preparation of a National Rivers Master Plan.

  The infrastructure designed and constructed in this component of Project 1 will be climate adapted, designed to withstand 1-in-300-year and 1-in-100-year floods. Component 1 will also include construction, operation and maintenance of revetments to protect the river banks at a site in Kaoakhola. The Kaoakhola protective works will be approximately 1,500 m long at Boroitola, and about 4,650 m long at Mechra / Arjuna; and Small-scale dredging and excavation will be undertaken in Kalihati and Kaoakhola as part of a routine to protect the river bank. A dredge spoil

management plan will be prepared for flood refuge creation and land reclamation. Component 1 will also finance land acquisition and compensation.

Component 1 will be implemented in four sub-components – sub-component 1.1: works and O&M; sub-component 1.2: Land acquisition and compensation; sub-component 1.3: institutional strengthening and sub-component 1.4: preparation of the second project. The salient features of component 1 of the project is presented in Table 1.

Table 1: Salient features of Component 1 of the Project

Pilot Site	Major Activities	
Bhuapur	Groyne Construction	5 Groynes
	Total number of piles	366 (0.9m dia, 45m~50m length in 2 rows)
	Embankment and Revetment	2.3km embankment with CC block protection
		214,030 number of CC block will be placed in the 16 m crest elevation for a length of 2.3 km
	Sand filled Geobag placement/ Dumping	67, 284 numbers of 250kg geobags under water (For toe and earthen embankment protection purpose)
	Land Take	17 acre of land acquisition
Kalihati-Tangail	Groyne Construction	6 Groynes
	Total number of piles	540 (0.75m dia, 45m~50m length in 3 rows)
	Embankment and Revetment	1.6 km embankment with CC block protection
	CC Block	266,184 numbers of CC block in the 15.6m crest elevation for a length of 1.6 km
	Sand filled Geobag placement/ Dumping	195,300 numbers of 250kg of geobags in 5 layers (For toe and earthen embankment protection purpose)
	Dredging	7.65 km length 100m width 6m depth
	Land Take	12 acres of land acquisition
Additional work Kaoakola	Bank Protection by Geobags	1.5km at Boroitola 4.65 km at Mechra
	Cana re-excavation	6.3km
	Cross dam (across a canal)	800m
	CDD work	Village platform, Flood Shelter
	Land acquisition	Not estimated, "negotiated settlement" will be followed if needed

- **Component 2** (USD 70 million to be implemented by BIWTA) – Navigation channel development: Activities include - Aids to Navigation, Level D+ hydrography and RIS; test out prototype navigation structures designed for Jamuna; institutional strengthening of navigation agency BIWTA; and preparatory activities for future projects of the SOP, including a Navigation Master Plan.

  Component 2 will have four sub-components: Sub-component 2.1 – Hydrography and RIS; Sub-component 2.2 – Prototype structures; Sub-component 2.3 – Institutional strengthening; and Sub-component 2.4 – Preparation of the second project.

- **Component 3** (USD10 million to be implemented by BWDB) – Financial protection of communities: As part of the preparedness and recovery phases of disaster management, this component is inherently climate change adaptive, offering financial protection (i.e., macro or meso-

level insurance, community protection fund) to the communities soon after payout-eligible flood events occur.

This component will have two sub-components: Sub-component 3.1 – Design and development of prearranged financial solutions; and Sub-component 3.2 – Institutional strengthening.

- **Component 4** (USD 10 million, to be implemented by BWDB and BIWTA) – Community Engagement and Project Management: Activities related to community-driven development (CDD) includes: disaster risk awareness and preparedness; buoys management; and Kaoakola char development. The project management activities include support to BWDB and BIWTA project implementation unit (PIU).
- **Component 5** (zero cost component) – Contingent emergency response component (CERC). A provisional zero cost component is included, that will allow for rapid reallocation of loan proceeds from other project components during an emergency, including climate events, under streamlined procurement and disbursement procedures. This component may also serve as a conduit for additional funds to be channeled to the project in such circumstances. The conditions for accessing funds under this component will be described in the Project Implementation Manual.

Major physical activities that will be implemented under Component 1 will be limited to an approximately 4 km reach of the river. Salient features of Component 1 are presented in Table 1. Component 2 will be implemented along the whole 250 km reach of the Jamuna River selected for the Project. The location of installation of Navigation aids will be decided at a later date.

Purpose and Scope of the ESIA

The project E&S risk is classified as 'High', because Project 1 will include preparatory works for high-risk activities envisioned for the future Project 2 in the SOP. In general, current Project 1 interventions are small-scale and 'piloting' in nature. Thus, the E&S risks are not expected to be significant and can be mitigated with appropriate measures. Most importantly, the overall benefits of the project are expected to outweigh significantly the anticipated E&S challenges.

This ESIA has been undertaken for activities associated with all five components of Project 1, based on the feasibility study and will be updated during the implementation stage when detailed information on project design and hydro-dynamic modeling results become available. The ESIA covers all components of Project 1. However, as noted above, most of the physical interventions are associated with Component 1 of Project 1. The physical activities of Component 2 (installation of navigation aids) and Component 2 (CDD works) are considered to have low E&S risk. No physical works are associated with Components 3 or 5, both of which are considered to provide net positive benefits to the Project.

Policy, Legal and Regulatory Framework

All applicable national acts, rules, and policies, as well as World Bank environmental and social standards (ESS) and international conventions and treaties related to this river management project have been carefully studied and analyzed. Project 1 of the JRECDP is a "Red Category" project, the highest category as per Bangladesh's Environmental Conservation Rules 1997 (ECR). As per the ECR 1997, the PIU (i.e., BWDB and BIWTA) must obtain an Environmental Clearance Certificate (ECC) from the Department of Environment (DoE) before initiating any physical activities. The procedure of obtaining an ECC for a Red Category project can be summarized as follows:

> *Carrying out Environmental Impact Assessment → Application to DoE → Approval of EIA → Obtaining Site Clearance Certificate and ECC → The ECC is subject to annual renewal.*

The most relevant pieces of legislation include: the Alluvial Lands Act 1920 and its amendments (important in the context of land ownership in the Jamuna River corridor); Environment Conservation Act 1995 (with amendments); Environmental Conservation Rules (ECR) 1997 and Amendments; Protection and Conservation of Fish Rules (1985); Water Act (2013); Inland Water Transport Authority Ordinance (1958);

Acquisition and Requisition of Immovable Property Act 2017 (ARIPA) (the key piece of legislation for land acquisition and requisition in Bangladesh; Bangladesh Wildlife (Protection and Safety) Act (2012); and the Biodiversity Act (2017). These as well as all occupational Health and Safety (OHS) related laws are critically examined and set for compliance to protect the environmental and social aspects including terrestrial and aquatic ecology, and fisheries, and maintain air and water quality during the construction and operation stages of the proposed project.

Project 1 has been deemed to have "High" E&S risk under the WB's Environmental and Social Framework (ESF). Based on a review of the WB's ten ESF ESS (ESS 1 to 10) ESS1 – Assessment & Management of Environmental & Social Risks & Impacts, ESS2 – Labour & Working Conditions, ESS3 – Resource Efficiency & Pollution Prevention & Management, ESS4 – Community Health & Safety, ESS5 – Land Acquisition, Restrictions on Land Use & Involuntary Resettlement, ESS6 – Biodiversity Conservation and Sustainable Management of Living Natural Resources, and ESS10 – Stakeholder Engagement & Information Disclosure are relevant to Project 1. The review included a gap analysis between ESS requirements and national legislation. Where gaps were identified, the Project will adopt the most stringent standards.

Operational Policy (OP) 7.50 'Projects on International Waterways' is triggered for the Project because long-term morpho dynamic responses to river structures and navigation improvement may affect the Jamuna River's upstream as well as downstream. Projects in Disputed Areas (OP 7.60) is not relevant to the project as none of the sites are located within disputed territory.

Analysis of Alternatives

The Feasibility Study assessed 18 locations in 6 Districts (Kurigram, Gaibandha, Jamalpur, Bogra, Sirajganj and Tangail) along both banks of the Jamuna River within the Program Area. Based on a multi-criteria analysis covering both technical and E&S criteria and input from the Bangladesh Water Development Board (BWDB), Ministry of Water Resources (MoWR) and other relevant stakeholders, two (2) pilot sites were selected in Project 1 at Bhuapur and Kalihati, respectively at which TBPG, revetments, and embankments will be installed. The E&S sub-criteria used in the multi-criteria analysis included: protection of local settlement and critical infrastructures; impacts on navigation; gradual changes of river course; impacts on agricultural lands; impacts on natural habitats; protected areas and sanctuaries; future land use change; and climate change adaptation.

Various alternatives for riverbank protection and river training structures were assessed. These included: impermeable groyne; Top Block Permeable Groyne (TBPG); targeted dredging and dumping; permeable groyne in series; and hard point revetment; The TBPG structure has been determined as a suitable protective measure having low E&S risk. However, it needs piloting for monitoring its performance before upscaling it in future subsequent SOPs. A major environmental advantage of TBPG as indicated by the feasibility study is that TBPG is less aggressive than hard structures such as spurs in affecting river channel dynamics. TBPG would, therefore, contribute to gradual changes in the river course which might have environmental benefits.

Various alternative locations and designs were considered for Kalihati dredging. The selected alternative was assessed as the most realistic, complementing the site Char and morphological conditions. Other alternatives were rejected due to proximity of the right bank, which might cause bank erosion. A number of dredging technologies and types of equipment were evaluated. However, the type of dredger will be finalized by the contractor in their bid or in the method statement prior to commencement of the work.

Having considered some unavoidable negative impacts from various river management infrastructure methods, it is concluded that the "No Project" alternative is not a preferred alternative due to its inability to build resilience against riverbank erosion. It also lacks the potential for contribution to national economic development, socio-economic benefits and moving the country towards developed nation status.

In addition, anticipated negative impacts of proposed Project 1 activities can be avoided or minimized by implementing appropriate mitigation measures.

Environmental and Social Baseline

Delineation of the Study area

The baseline study area for ESIA was delineated differentially for environmental, social and biodiversity baselines. The study area for environmental baseline was defined as Environmental Baseline Area of Analysis (EBAA). The study area for social baseline was defined as Socio-economic Area of Analysis (SAA). Similarly, the biodiversity baseline was assessed considering the study area defined as Biodiversity Area of Analysis (BAA).

The **Environmental Baseline Area of Analysis (EBAA)** has been derived considering areas that are likely to have direct and indirect impacts on its ambient environment by the construction and operation activities at both Project 1 Pilot Sites. To analyze and measure the impacts resulting from project implementation, the required environmental baseline data are derived from primary field surveys of the pilot areas and available secondary data. The Center for Environmental and Geographic Information Services (CEGIS) environmental team visited the pilot sites and collected site-specific data for physical and biological environmental aspects relevant to the ESIA.

The **Socio-economic Area of Analysis (SAA)** covers the combined Project Area of Influence (AOI) of Project 1 of the JRECDP SOP, which includes the direct impact area, indirect area, and control area beyond the Project AOI. The Project AOI covers the 1 km buffer area of the project footprint area at each site. The SAA also covers the entire unions (the lowest rural administrative unit) intersected by the project footprint. In addition, a brief of the socio-economic condition (vulnerability, poverty, livelihoods) of the overall program area was presented considering the Program AOI, which is a 5 km buffer of the program section of the river.

The Biodiversity Area of Analysis (BAA) for Project 1 was defined as the natural and physical boundaries covering the river area between the banks, floodplains and charlands. The BAA map covers a total area of 17,584 ha. The following criteria were considered while delineating the BAA:

- Project Footprint (around 12 ha) and Project AOI (both direct and indirect, a total of 4645 ha);
- Impact of Noise from the Piling (piling will be the major noise generating activity);
- River area covering alluvial corridor, floodplain, and chars between the banks;
- Physical boundary (e.g., the countryside limit of the floodplain of the left-bank was considered up to an existing road);
- Possible hydrological impacts of the activities; and
- Control area (upstream area, downstream area and the habitats along the opposite bank of the river which are beyond the limit of project AOI).

Environmental Baseline Conditions

The Jamuna River tributaries in the eastern and central parts of the Eastern Himalayas have very high elevations that range from between 1,000 to 5,000 m (masl). This compares to the Program and Project area of the Jamuna River where the elevation ranges from 9 to 28.4 m (masl).

Jamuna river is a highly braided river with multiple channels separated by numerous small sand bars and chars lands. The average river width varies from 8 to 12 km. Although there was an increasing trend of river widening up to 2010, the widening process has recently slowed down. The river width at Kalihati varied between 4.8 km to 7.6 km during the period 1973 to 2020. Whereas the width of the river at Bhuapur varied 8.1 km to 9.9 km during the period 1973 to 2020.

Erosion is a predominant morphological feature in the Jamuna River, with the bank erosion of both the left and right banks within the Program area averaging 2,025 ha/year for the period 1973 to 2020. Both of the

selected pilot sites are currently exposed to high riverbank erosion. The Kalihati site is eroding at a rate of 48.33 m/year and the Bhuapur site is eroding at a rate of 32.5m/year, respectively.

The rainfall varies greatly in a year, the monthly rainfall varies from 10 mm to 1200 mm. Maximum rainfall occurs in August and September. Over the past 59 years, the total annual rainfall varied from about 1000 mm to nearly 5000 mm. In the last 59 years there were 11 heavy rainfall events with 200 to 300 mm of rain and 7 extreme rainfall events with more than 300 mm of rain in the EBAA.

The water level in the Brahmaputra in the EBAA attains its peak in July-August and the lowest flow occurs in February. In the EBAA, maximum water level is 15.11 m Public Works Datum (PWD) in the month of August while the minimum water level is 6.13 m PWD in the months of February and March (based on the water level during the period 1980 to 2009).

Generally, June to October is monsoon season when river discharge is high and the November to April period is dry season when river discharge is low. The river discharge varies widely in a year. The mean monthly discharge for the last 40 year varies from 103128.8 m^3/sec (September) to 14968.6 m^3/sec (February). The historically recorded maximum discharge of 103,129 m^3/sec occurred in September, 1998 and the historically recorded minimum was 2037 m^3/sec which occurred in March 2013.

The Jamuna River is considered to be one of the most heavily sediment-laden large rivers in the world. Estimates indicate that the river carries 13 million tons of suspended load during the flood season.

The DoE conducts monthly water quality monitoring of the river. The dissolved oxygen (DO) values ranged from 5.44 mg/l to 11.36 mg/l in dry seasons and 5.62 mg/l to 8.05 mg/l in wet seasons. Biological Oxygen Demand (BOD) values ranged between 0 mg/l and 5.1 mg/l, except in the dry season of 2013 (16 mg/l). The pH values ranged between 6.74 to 8.22. The onsite water quality analysis found surface water temperature varying between 24-25 °C, and turbidity ranging between 1.85 to 8.9 nephalometric turbidity units (NTU). The major water pollution sources are domestic. The river flows across a densely populated area with 800 person/km^2. A large portion of the domestic waste and wastewater from these settlements ends up in water. Another possible source of pollution can be agricultural lands where intensive use fertilizers and pesticides occurs. Urea, TSP, MP, Gypsum and, in a few cases, Zn are commonly used fertilizers. The residue or breakdown product of these pesticides might remain in the river water and sediment. Secondary literature sources suggest that there is an increasing trend of micro-plastics in the Jamuna River and that the sources are mostly transboundary.

Air pollution is localized and comparatively moderate in the Project AOI, as very few industries are located in the area. The air quality analysis recorded, Suspended Particulate Matter (SPM) varying 261 to 593 µg/m^3, NO_x 6.35 – 11.9 µg/m^3, and not detectable SO_2 in the EBAA.

Usually, the project area experiences calm and quiet conditions as there are no noticeable noise generating sources. The main sources of local noise include rural vehicles, river vessels, diesel engine-based pumps, trucks and commercial activities. The average noise levels in the EBAA were recorded as 30-50 weighted decibel average (dBA), which complies with both national (ECR, 2006) and international standards (IFC 2007).

Biodiversity and Living Natural Resources

The BAA included: (i) the riverine zone consisting of river and alluvial areas, mudflats, sand-bars and submersible chars; and (ii) the floodplain zone consisting of terrestrial areas, attached chars (river islands), croplands, grasslands, homestead vegetation, planted forest areas, freshwater, sand-mining and storage areas, and built-up areas of common landcover and land use occurring in these habitats. There are mostly three types of ecosystems - terrestrial, freshwater and charlands.

Habitat mapping, that was undertaken on the basis of land use and land cover analysis, identified seven types of habitats (i.e. newly emerged charlands and mudflats, riverbanks, agriculture lands, embayment area, arboreal habitat, and river water area). Among them, charlands & mudflats and river water area are natural habitats. The rest is modified habitat. The floodplain and old charlands are dominated by modified

habitats such as agricultural lands, settlements and developed areas. The river supports a high diversity of fish, amphibians, reptiles, birds, and mammals along with many invertebrate and floral species. The river and adjacent areas support ecologically significant habitats, including important fish habitat, breeding grounds for threatened reptiles (e.g., Gharial), movement corridors for birds and habitat for large aquatic mammals (e.g., Ganges River Dolphin). The river and adjacent areas also support many ecosystem services, most notably the commercially important fishery.

According to the IBAT data list, the river reaches within the project area are a part of the Jamuna-Brahmaputra Important Bird and Biodiversity Area (IBA), Madhupur National Park (which is located 32.7 km away) and two Dolphin sanctuaries (which are located 35.8 km and 36.8 km, respectively from the Project site). In addition, the GoB has recently declared a fish sanctuary (fishing prohibited area) which occurs in the BAA as well. The screening of the protected area in line with the ESS 6 requirements is presented in Table 2.

Table 2: Legally Protected and Internationally Recognized Area of High Biodiversity Value in and around the BAA

Area Name	Distance from BAA	Status and Designation	IUCN Category	Alignment with ESS6	Screening Results
Silanda Nagdemra Dolphin Sanctuary	35.8 km	Legally protected area by GoB, listed in the IBAT	VI	Qualify as legally protected areas	Both sanctuaries are far from the site but relevant to the project site due to potential impacts to river dolphin, therefore included in the Biodiversity Risk Assessment
Nagarbari Mohonganj Dolphin Sanctuary	36.8 km				
Madhupur National Park Key Biodiversity Area	32.7 km	Legally protected area by GoB, and Important Bird Area, listed in the IBAT	IV	Qualifies as a legally protected area	Terrestrial National Park not connected with the Jamuna River hydrology. Not relevant to the proposed intervention and excluded from the risk assessment
Jamuna Brahmaputra River Key Biodiversity Area	0 km	Important Bird Area, listed in the IBAT Not legally protected	Not applicable	Qualifies as an internationally recognized area but is unmanaged	Relevant, included in the risk assessment
Bangabandhu Bridge Eco Park	7 km	GoB designated eco-park for scenic beauty, Legally Protected, not listed in the IBAT	Unknown	Qualifies as legally protected area.	Relevant, included in the risk assessment
Jamuna River Fish Sanctuary	0	GoB Designated Fish Sanctuary, not listed in the IBAT	Unknown	Relevance is not linked with ecosystem management	Has relevance to proposed mitigation and is therefore included in the Biodiversity Risk Assessment

Key Biodiversity Features

Following are the key biodiversity features of the area:

- A total of 76 floral species were identified in the area, including at least 40 tree species, 33 herbs and shrubs, and 3 bamboo species;
- A total of 332 vertebrate species were identified, including 25 species of mammals, 223 bird species, 36 reptile species, 15 amphibian species and 77 fish species. The Integrated Biodiversity Assessment Tool (IBAT) species list and national sources indicate a total of 38 critically endangered (CR) and endangered (EN) species (including 2 mammals, 13 reptiles, 9 birds, 13 fish and a floral species) within the 50km buffer area of the Program area. Among them, 27 species are likely to be present in the BAA, including Ganges River Dolphin, Gharial, Fishing Cat, Three-striped Roofed Turtle, Black Softshell Turtle, Pallas's Fish-eagle, Black-bellied Tern, Indian Skimmer, and several fish species.
- From the fisheries point of view, the island chars are very important for the river fisheries. The embayment area near char is also highly important for fisheries which serves as grazing and nursing ground for small species of fish, including *Cabdio morar* (Piyali) *Ailia punctata* (Banshpata), *Ailia coila* (Kajuli), *Eutropiichthys vacha* (Bacha), *Mystus cavasius* (Golsha), C*lupisoma garua* (Gharua), *Glossogobius giuris* (Baila), *Salmostoma acinaces* (Chela), *Gudusia chapra* (Chapila). The Jamuna River is also a major spawning site for major carp species. In 2020, the Department of Fisheries identified 22 spawning sites in the Jamuna River. The scouring area and eroding bank area of the river is highly favourable for Big Cat Fish (Boal and Air).
- In homestead areas planted fruit trees (e.g., Bel, Khuksha, Olive, Am, Payara, Jam, Boroi, Tal, Chalta, Khejur), firewood (Rain tree, Dewa) and timber (Arjun, Krishnachura, Eucalyptus, Rain Tree, Sissoo, Jarul) are commonly found. Common riparian species are Boroi (*Zizyphus mauritiana*), sisso (*Dalbergia sisso*), *Eucalyptus* spp., pitali (*Trewia nudiflora*), shimul (*Bombax ceiba*), rain tree (*Albizia saman*), ban palang (*Rumex maritimus*), ghagra (*Xanthium indicum*), bankhira (*Croton bonplandianum*), amrul (*Oxalis corniculata*), durba (*Cynodon dactylon*). Common aquatic floras are Nal (*Phragmites karka*), Dhol Kolmi (*Ipomoea carnea*), Kachuripana (*Pontederia crassipes*), Maloncho (*Alternanthera philoxeroides*), Thankuni (*Centella asiatica*).

The bio-calendar of area wildlife and fishes are influenced by river hydrology. Monsoon season is important for breeding for most of the wildlife and dry season is important for breeding of Dolphin and Gharial. Fish production is also influenced by water discharge and water depth, and seasonal life cycle, of these fish groups. Monsoon season is important for spawning, nursing, growing, and foraging of major carp species.

Critical Habitats

Using the IBAT dataset, and available national and local assessments, critical habitat assessment was conducted in line with WB ESF ESS6. The IBAT listed a total of 903 species including 9 globally Critically Endangered (CR) and 18 globally Endangered species. The list of species was further updated with the data from IUCN Red List of Bangladesh (IUCN Bangladesh 2015). While determining the conservation status, priority was given to the national red list ratings and global IUCN Red list status. Thereafter, the relevance of critical habitat was assessed for each species on the basis of expert judgment. The critical habitat assessment found Gharial, Ganges River Dolphin, Fishing Cat, and two fishes (*Bagarius bagarius* and *Chitala chitala*) qualify as having critical habitat features. Among them, the Ganges River Dolphin, Fishing Cat and the two fish species trigger the "net gain requirement."

Socioeconomic Baseline

The population living along the banks of the Jamuna River are highly vulnerable to river flooding and bank erosion. An earlier survey found that 35% of the population living along the Jamuna River and its chars have been displaced 3 to 5 times in their lifetime by river bank erosion. Field visits undertaken by CEGIS in June 2021 and September 2021 to both the pilot sites identified that there are community driven areas, with many households, schools (primary and high), mosques, madrasas and temples that are at considerable risk of flooding and damage due to bank erosion.

This region is considered as being the highest poverty-stricken area. In general, the population in the SAA has a low development status on the basis of: (i) human capital (i.e., low literacy/education, skill levels); (ii) financial capital (i.e., 50-60% of the population belong to lower and/or upper poverty level); and (iii) physical capital (i.e., poor housing, little or no land; nearly two-thirds living on the old embankment and chars are landless).

In the SAA a total of 26,307 households with a population of 116,450 are living, which is comprised of 50.7% males and 49.3% females. The sex ratio is 103, which refers to 103 males per 100 females. The average density is 1,112 persons per km^2. The average household size is 4.4 persons, with most households comprised of 3 to 4 members (BBS, 2012; projected for 2020). In terms of employment in the SAA, the workforce has been distributed into three sectors: agriculture; service; and industry. According to Bangladesh Bureau of Statistics (BBS) 2012 data, agriculture is the dominant mode of livelihood in the Program AOI, estimated at 83%. This group is comprised of crop farmers (including sharecroppers), fishers (both professional and seasonal), and livestock and poultry farmers. The second-largest employment sector is the service sector, which refers to salaried employees such as those working in offices, teaching, and people involved in the transportation service. About 19% of people in the project area are engaged in the service sector. This is comparatively lower in the Program AOI (13%). Also, involvement in the commercial/industrial sector (including garment production) is higher in the SAA (8%) than that of the program AOI (4%).

The divorce rate is quite higher in this area. Around 8.5% women are widows. Traditionally women are very conservative in this area due religious and social bindings, which limits their participation in the public atmosphere. Women have lower participation in economic activities (i.e., in Bhuapur only 3% women are employed, and in Kalihati the figure is only 0.9%), they mostly manage household work. There is a difference in wage rate between men and women, with women being paid less for equivalent work. The literacy rate among the women is also lower than men (around 45% men and 35% women are literate). During stakeholder consultation, women also reported sexual exploitation and abuse / sexual harassment (SEA/SH) by their partners. Only a very few women who have well-off paternal families raise their voices and seek justice.

There are no known indigenous people or small ethnic minority groups or settlements in the Project AOI or Program AOI. There are no known cultural heritage or historical sites within the project footprint area

Environmental, Social, Labor, Occupational Health and Safety, Community Health and Safety, and Security (E&S) Risks, Impacts and Mitigation Measures

The impacts assessment covered the negative E&S impacts and risks. E&S impacts and risk were identified for Valued Environmental and Social Components which were selected through a process of literature review, expert judgment and expert consultation. The E&S impacts and risks were identified through a brainstorming session among the team members, taking the feedback from the baseline surveys and stakeholder consultations. Impacts were qualitatively evaluated following a systematic approach on the basis of their significance which was defined by magnitude and sensitivity of the impacts. The magnitude was determined on the basis of duration, spatial extent, reversibility, compliance to legal standards, and likelihood of occurrence. The significance of an impact was categorized as “High”, “Substantial”, “Moderate”, and “Low”. Once an impact was evaluated, appropriate mitigation measures were identified following the mitigation hierarchy. The E&S impacts and risks with “substantial” and “high” significance along with mitigation measures and residual impacts are summarized in Table 3 (found toward the end of this executive summary).

Assessment and Management of E&S Risk and Impacts (ESS1)

As noted previously, most of the activities with material E&S impacts are related to Component 1 of Project 1.

Analysis of environmental and social impacts and risks for Project 1 focused on: (i) river hydrology and morphology, including flood risk and erosion; (ii) water quality; (iii) air quality; (iv) noise and vibration; (v) impacts on biodiversity, including impacts on modified, natural and critical habitats, and legally protected and internationally recognized areas of high biodiversity value; and (v) socio-economy, including livelihoods, economic activities, occupational health and safety, labor conditions, community health and safety, and SEA / SH.

Impacts and risks during pre-construction and construction period

The significant E&S impacts and risks during the pre-construction and construction phases are mostly related to land acquisition and resettlement, labor influx, pollution from construction activities and dredging. Among the construction activities, in-situ pile driving would cause increased noise levels. There would be a need of driving 366 piles at the Bhuapur and 540 piles at the Kalihati sites. Noise level (Lmax) from pile construction is estimated to be 84.93 decibels (dB) at 50 m, 77.40 dB at 100 m, 59.93 dB at 500 m, 52.40 dB at 1km, and 44.88 dB at 2km from the source. Dredging, waste from construction sites, and dumping of sand-filled geobags would cause increased turbidity in the water column, with additional potential risk of water pollution from oil spills from a dredger. However, these construction phase impacts will be mitigated by implementing the Environmental and Social Codes of Practices (ESCOP) and mitigation measures. Similarly, air pollution from construction activities, most likely from dust dispersion. will be mitigated by the ESCOP, GIIP and mitigation measures. There is a risk of public disturbance and nuisance due to construction activities which will be mitigated by the ESCOP and mitigation measures. There is also a risk of exclusion of vulnerable groups from project's stakeholder consultation and project benefits. A separate Stakeholder Engagement Plan (SEP) has been prepared to manage such risk. The construction activities might also put additional pressure on existing facilities like health, sanitation, road networks, and navigation. As noted above, the major and substantial impacts and mitigation measures along with residual impact are presented in the Table 3.

Impacts and risks during Operation and Maintenance period

The operation phase impacts are mostly related to the change of river course or planform following the installation of TBPG and dredging. Generally, bank protection works shifts the erosion risk downstream. However, such risk is low because of the project's scale, adoption of less aggressive river training works, careful siting of project activities and dredging alignment minimizing the risk of downstream erosion. In addition, disaster risk financing solutions (e.g., disaster insurance, recovery funds) and disaster preparedness and awareness building have been considered to manage such risk.

Component 2 of the project anticipates a nominal increase in inland cargo and passenger movements (additional 2 million tons cargo and 5 million passengers annually by 2030). There is a risk of ship generated pollution. The project considers E&S risk management capacity building of the BIWTA, developing standard ship operational procedures, and introducing prototypes of environmentally friendly cargo vessels and pontoons.

Following the mitigation measures, the residual risks for the above impacts are lowered to mostly low with a few mediums from their pre-mitigation risk levels of substantial and highs. Therefore, provided that the appropriate mitigation measures are undertaken, this project is not expected to have any major long term negative residual impacts.

Labor and Working Condition (ESS2)

A separate Labor Management Procedure (LMP) has been prepared which identifies labor issues and outlines the mitigation measures. The LMP has identified four types of laborers / workers who will be engaged in the Project: (i) direct (PIU staff seconded by the Government and the consultants); (ii) contracted (or-sub-contracted) laborers; (iii) community workers and (iv) Primary Supply Worker. The total number of labor in a site would be maximum 200 which can occur during the peak time of construction.

Risks include: health and safety of workers; employment of child labor; non-payment of wages by employer; non-payment of benefits (compensation, bonus, maternity benefits etc.) by employer; discrimination in employment (e.g., abrupt termination of employment, working conditions, wages or benefits); risk of SEA/SH (e.g., increasing demands placed on sex workers, risk of trafficking, verbal abuse/teasing); and health risks of labor relating to HIV/AIDS, COVID-19 and other sexually transmitted diseases.

The LMP specifically outlines the project's position with respect to SEA/SH and trafficking. The LMP assesses the adequacy of national labor laws and identifies the commonalities and gaps between the WB's ESF standards and legislation of Bangladesh. The LMP incorporates Occupational Health and Safety (OHS) measures ensuring appropriate implementation of ESS4 and includes a component on responses to COVID-19. Given the current pandemic situation, the BWDB will follow the WB's interim note on COVID-19.

An OHS plan has been presented to serve as a practical outline for the Contractor to manage OHS risks as per the WB's ESS2 requirements, Bangladesh's regulatory framework, and requirements that will be stated in the Contract. The most common categories of hazards associated with Project 1 activities include: (a) equipment mobilization and construction materials transport through public roads; (b) piling/excavating; (c) continuous noise exposure during piling and as a result of exposure to noise generated by other machinery; (d) scaffolding ladder work; (e) COVID-19 pandemic; (f) ergonomic hazards; and (g) drowning due to vessels sinking / life lost during work near/on water. A Risk ranking matrix has been prepared to identify and assess all potential work-related hazards and their severities and eventually propose controls to reduce the risks of injuries and illness by establishing processes and standard operating procedures (SOPs) in accordance with good international industry practice (GIIP). Based on the risk matrix, hazards are graded from "warning" to "serious" to "catastrophic".

The specific mitigation measures to be adopted are:

- The Project will prohibit the recruitment of children and use of forced labor;
- Labor practices and issues related to labor influx will be monitored, managed and translated into regular practice. Responsible parties' actions will be periodically reported for the record;
- Recruitment of skilled personnel with relevant experience and knowledge to support implementation of the LMP;
- Establishment of a standard grievance redress mechanism (GRM);
- Ensuring that the Worker Code of Conduct and individual Contract Agreement are read and signed by the worker at the time of recruitment;
- Provision of safe water for drinking and domestic use for workers on site and in construction camps in accordance with Schedule 3(b) of ECR, 1997;
- Provision of medical facilities on site and in construction camps and access to health care;
- Labor camps will be constructed in compliance with GIIP as described in Workers' Accommodation: Processes and Standards (IFC-EBRD 2009)[1];
- Training of workers on OHS;

[1] https://www.ifc.org/wps/wcm/connect/topics_ext_content/ifc_external_corporate_site/sustainability-at-ifc/publications/publications_gpn_workersaccommodation

- Performing an OHS risk analysis will be undertaken before any task and a task specific job hazard analysis (JHA) plan will be developed by the Contractor (an outline has been provided in the ESIA);
- No Personnel can enter the construction area without the appropriate personal protective equipment (PPE) and no worker shall perform a task unless they have undergone appropriate training.

Resource Efficiency and Pollution Prevention and Management (ESS3)

The riverbank protection works and groyne construction will require different materials such as earth, aggregates, boulders, and sand. It appears that most of the construction materials are available within Bangladesh. Other important materials such as coarse aggregates, bitumen, strands, expansion joints, and steep pot bearings would also be purchased from local vendors who generally import these materials from India. These sources should have low E&S impacts, insofar as they will not come from areas affecting natural habitats and will not be dependent on the use of child labor or forced labor.

There might be a need for removal and/or compaction of topsoil in the event that cleanup and removal of spilled hazardous materials is required. There will also be potential noise, water and air pollution (mostly dust spreading) impacts from construction activities.

Earthwork will be undertaken which requires the movement of 126,522.5 m^3 of earth at the Kalihati site and 122,591 m^3 at the Bhuapur site by truck/boat or any other means, which will cause noise and vibration along the transportation routes. Pile driving will involve the use of vibratory hammers which produce less noise than impact pile drivers.

Pile driving of 17,185.53 m at the Bhuapur site and 28,568.7 m at the Kalihati site will increase the ambient noise levels up to a harmful level for local communities' in close proximity to the pilot sites.

There will be no use of groundwater for construction purposes (e.g., for production of concrete or dust control). Groundwater will be used for drinking and other domestic purposes.

The ESIA includes a number of ESCOP to manage pollution risks during construction. These include:

- ESCOP 1: Waste Management
- ESCOP 2: Fuels and Hazardous Goods Management
- ESCOP 3: Water Resources Management
- ESCOP 4: Drainage Management
- ESCOP 5: Soil Quality Management
- ESCOP 6: Erosion and Sediment Control
- ESCOP 7: Topsoil Management
- ESCOP 8: Topography and Landscaping
- ESCOP 9: Quarry Areas Development and Operation
- ESCOP 10: Air Quality Management
- ESCOP 11: Noise and Vibration Management
- ESCOP 12: Protection of Flora
- ESCOP 13: Protection of Fauna
- ESCOP 14: Road Transport and Road Traffic Management
- ESCOP 15: Construction Camp Management
- ESCOP 16: Cultural and Religious Issues (including management of cultural heritage / chance find procedure)
- ESCOP 17: Workers Health and Safety
- ESCOP 18: Construction and Operation Phase Security
- ESCOP 19: Operation of Heavy Equipment Management
- ESCOP 20: Excavation
- ESCOP 21: Lifting and Material handling

- ESCOP 22: Dredging and Disposal

In line with these ESCOP, the Contractor shall prepare in advance of any works a work plan detailing the following: type and numbers of equipment required; estimated volume of material to be cut or excavated; details of approved disposal sites; arrangements made for transport of excavated materials to the approved disposal sites; dust suppression measures at excavation sites and along transportation routes; methods of stacking and/or handling the excavated material at the disposal sites including a rehabilitation plan of the disposal site; and health and safety measures and emergency response plan for the entire operation shall.

The Contractor will also prepare a Construction Environmental and Social Action Plan (CESAP) demonstrating the manner in which it will comply with the requirements of site-specific management plans, ESCOPs and the mitigation measures proposed in the Environmental and Social Management Plan (ESMP) of this ESIA Report. The CESAP will be submitted within 90 days of Contractor's mobilization but before commencing any works and will be approved by the Engineer.

Community Health and Safety (ESS4)

Community related hazards will result from project construction activities and operation. Such risk generally includes the health, safety, and security risks and impacts on project-affected communities. However, given the nature of the Project, the CHS risks are mostly associated with the construction phase of the Project. A risk ranking matrix has been prepared to identify associated construction and operation related hazards with their likelihood and magnitude to set the appropriate preventive measures to reduce or lessen the impacts on nearby communities. Some unavoidable hazards have been ranked as serious to catastrophic in the risk matrix, including: (a) spread of communicable diseases (e.g., Tuberculosis -TB); COVID-19); (b) vector-borne diseases; (c) sexual exploitation and abuse, and sexual harassment (SEA/SH); and (d) use of public roads for construction equipment / vehicles. The potential increase in incidences of communicable and vector-borne diseases is primarily associated with the influx of workers into nearby communities. The CHS risks associated with the operation period includes failure of the river bank protection due to either faulty design or natural extreme events, false sense of security from river bank protection, and ship accidents.

To reduce or control the possibility of injuries and fatalities associated with potential hazards to project-affected communities, a CHS Plan will be prepared for the Project. Project management will establish a Health and Safety Committee to monitor and supervise the implementation of measures set by the authority. In addition to the CHS Plan, the Contractor will develop an Emergency Preparedness and Response Plan (EPRP). To guide the Contractor in preparing the detailed CHS Plan, an outline of a CHS Plan that includes impact and risk mitigation measures, has been prepared and is included as an annex to the ESIA.

As the proposed Project 1 pilot sites occur in rural settings, where a moderate influx of workers will be engaged for construction, the gender-based violence (GBV) and SEA/SH risk is rated as 'substantial'. Project induced SEA / SH risks will be managed through a SEA/SH Response Plan that has been developed in accordance with the World Bank Good Practice Note on Major Civil Works.

Land Acquisition, Restrictions on Land Use, and Involuntary Resettlement (ESS5)

Project 1 will require a total of 522.35 acres (211.39 ha) of land for construction of revetments, disposal of dredged materials and construction of flood shelters (under CDD). A summary of the land requirements and possible procedures for land acquisition are provided in Table 4. At this stage, a Resettlement Policy Framework (RPF) has been prepared as design revisions are ongoing.

Table 4: Land Requirements and Probable Procedure of Land Take

Project Activity	Land Requirement	Procedure for Land Acquisition	PAP
Construction of Revetment and	11.86 acres (4,8 ha)	Land acquisition and Resettlement,	25 (Male 13, Female 12)

Embankment at Kalihati site			Displacement of 78 houses
Construction of Revetment and Embankment at Bhuapur site	17.05 acres (6.9 ha)	Land acquisition and Resettlement	367 (Male 185 Female 181) Displacement of 4 houses
Disposal of Dredged material (Kalihati site dredging)	415 acres (167.95 ha)	Not required. Shirajgongj Economic Zone has requested BWDB to fill their 415 acres (167.95 ha) of land up to 3m height by dredged material.	No PAPs
Kaoakola Char protection and construction of flood shelter	78.44 acres (31.74 ha)	Negotiated Settlement by using the modality "willing-buyer willing-seller or "voluntary land donation"[2]	120 (Male 65, Female 55) No displacement of structures

Based on the RPF, a Resettlement Action Plan (RAP) compliant with ESS5 will be developed, disclosed, and implemented before invitation of bids for construction works. This RAP will detail compensation assessments, criteria for eligibility and entitlements, and livelihood restoration support measures including, but not limited to: assistance to re-establish business/enterprises; assistance to affected wage-laborers and regular employees; compensatory allowance for lost rental income and tenants; compensation for lost workdays of temporary wage laborers; assistance to affected tenants' farmers and sharecroppers; special allowance for vulnerably poor women-headed households (WHHs); income and livelihood restoration program and employment opportunities to be offered to the project-affected persons (PAPs) during construction; and budget and institutional arrangements for implementation. The RAP will be prepared before the floating of the bids for construction.

Biodiversity Conservation and Sustainable Management of Living Natural Resources (ESS6)

The biodiversity impacts and risks of Project 1 activities would be mostly low to moderate due to the scale of the interventions. The site-specific impacts on biodiversity include: disturbance to aquatic and terrestrial ecosystems; displacement of individuals and populations of species; alteration of habitats; alteration to population dynamics; changes in species composition; and isolation or fragmentation of habitats. The key impacts during the construction phase include:

- Disturbance to the Brahmaputra-Jamuna River Key Biodiversity Area (KBA);
- Loss of mixed, but mostly modified, habitats along the riverbanks;
- Risk of increasing disturbance and reduction of suitability in the natural habitats (river area, mudflats, chars) due to pollution (noise, water pollution, etc.) from construction activities including dredging;
- Loss/disturbance to benthos and the riverbed due to dredging;
- Disturbance of nocturnal wildlife due to installation of navigation aids and devices;
- Risk of physical injury to Ganges River Dolphins, and Gharial through collision;

[2] The ownership situation in the chars has not been legally determined which limits any legal procedures of land acquisition. Therefore, negotiated settlement is preferred where there would be scope defining the ownership based on social recognition. It is acknowledged that voluntary land donation is potential risky, but until the Project design is finalized he feasibility study team requests to have the both voluntary land donation and negotiated settlement retained as options.

- Disturbance to Dolphins, fishing cats and Gharial due to noise of construction activities such as pile driving
- Temporal loss of habitat of Baghair (*Bagarius bagarius*) and Chital (*Chitala chitala*) fish;
- Risk of disturbance to Dolphins and Gharial due to increased light and sound associated with increased navigation post-construction;
- Risk of disturbance to aquatic wildlife in the river and chars (frogs, turtles, fishes, reptile) due to increased light and sound.

The risks and impacts associated with the operation phase of the Project includes contraction of mudflats river area (alluvial zone) and Charlands and concomitant reduction in natural habitat at these locations, and potential damage due to ship related pollution.

The assessment of the critical habitats triggered by Gharial (*Gavialis gangeticus),* Ganges River Dolphin *(Platanista gangetica), Fishing cat (Prionailurus viverrinus),* Baghair (*Bagarius bagarius) and* Chital (*Chitala chitala)* indicates that most of the impacts can be avoided and/or mitigated (Table 5).

Table 5: Screening of Critical Habitats

Species triggring critical habitats	**Potential Project Risks and Impacts**	**Net Gain Requirements**
Gharial *Gavialis gangeticus*	There is a potential disturbance to Gharial through dredging, noise emissions associated with piling and the increased presence of workers associated with construction activities. However, a minimal population of Gharial is expected if any at all and mitigation to flush sensitive species away from construction works is considered sufficient to avoid any potential impacts.	Impacts can be avoided; net gain is therefore not required
Ganges River Dolphin *Platanista gangetica*	Dolphin might be disturbed by dredging operation and pile diving for groyne construction.	Mitigation will be necessary; net gain will, therefore, be required. Engagement with specialists and staff from nearby dolphin sanctuaries is needed to explore the option for net gain.
Prionailurus viverrinus Fishing Cat	Was not found in survey period but the BAA does include suitable habitat for this species. Fishing cats will not be impacted by dredging activities but construction works on the river bank. The presence of workers may raise the levels of disturbance, although impacts will be minimal.	Mitigation is required to discourage construction workers from disturbing this species, including indiscriminate killing and engaging in illegal wildlife trade. A residual impact needs to be determined, and minimal **net gain may be required.**
Baghair *Bagarius bagarius* Chital *Chitala chitala*	Eroding river bank is the preferred foraging habitat. The proposed intervention would alter this habitat by preventing the erosion, filling the scoured area with sand-filled geobags although the overall impact of the pilot phase to these fish will be low.	There is no known reliable mitigation, however, a residual impact assessment will be constrained by the lack of data on these species. The Department of Fisheries will be consulted to investigate opportunities for

		developing effective mitigation.

Indigenous People (ESS7)

Based on the criteria defined in the WB ESS7, there are no indigenous people found in the SAA. This was validated with the social impact assessment and was confirmed by the WB Team.

Cultural Heritage (ESS8)

There are no known cultural heritage or historical sites in the SAA except some recently built mosques, and temples. None of them occur within the project footprints. Therefore, no material impact on cultural heritage is expected.

In case of any chance finds, proper management plans will be prepared in compliance with GOB archaeological regulations and ESF requirements. A chance find procedure is incorporated in ESCOP 16 – Cultural and Religious Issues.

Financial Intermediaries (ESS9)

Financing of Project 1 will not involve the use of financial intermediaries. Therefore, ESS9 does not apply.

Stakeholder Consultation and Disclosure and Feedback (ESS 10)

Several stakeholder consultation meetings were conducted for Project 1 during the preparation of the ESIA. A total of 19 consultation meetings were conducted across June, September and November 2021, and January and February 2022 with local people including local government officials, elected members of the local government institutions and local officers of the implementing agencies (IAs). During the consultations local people raised several concerns, including: (i) continued erosion and loss of land; (ii) lack of appropriate measures for bank protection and river stabilization; (iii) lack of support and/or policy to assist those who are displaced by the erosion processes; (iv) loss of livelihood and limited alternative sources for support and survival; and (v) poverty and marginalization among the displaced and vulnerable groups. These concerns were considered in undertaking the impact assessment. The IAs also considered these concerns during preparation of the feasibility studies. In general, the PAPs are willing to contribute land for proposed activities in exchange for compensation payments. However, the PAPs expressed their concerns over the complexity and adversity related to receiving compensation related to land acquisition. They clearly indicated the need for a transparent procedure.

Based on these initial meetings, local stakeholders have indicated support for the Project with an expectation that the Project will save them from the riverbank erosion. For any sort of communication, local people prefer notifications via mobile phone and organizations prefer notifications via official letters. Stakeholders also mentioned their preference for daytime meetings at a location that is readily accessible by all.

Since it is essential that stakeholder consultation continue during the project planning, implementation, and operation stages, a standalone Stakeholder Engagement Plan (SEP) has been prepared alongside the ESIA. The SEP complies with the GOB regulations and the WB's ESS 10. The SEP outlines the ways in which Project 1 will engage all stakeholders – for example, national/regional stakeholders, PAPs, vulnerable communities, different interested groups, local community people, different occupational groups, women's groups, laborers, and contractors, and provide them with a mechanism through which stakeholders can raise concerns, provide feedback, or make positive and negative comments about project related impacts and benefits.

Rapid Cumulative Impact Assessment

A Rapid Cumulative Impact Assessment (R-CIA) evaluates changes resulting from the proposed JRECDP Project 1 interventions when combined with impacts of previous and foreseeable future development in

Jamuna River and its downstream areas (IFC, 2013[3]). Interventions considered in the R-CIA include: (a) Flood and Riverbank Erosion Risk Management Investment Program (FRERMIP); (b) dredging activities and other river stabilization works; (c) Bangabandhu Railway Bridge; (d) upstream water diversion and hydroelectric projects; (e) Integrated Jamuna-Padma Rivers Stabilization and Land Reclamation Project; (f) Sustainable Restoration of Connectivity of Major Navigation Routes; (g) Enhancement of Agricultural Productivity towards Food Security in Char Lands; and (h) Restoration of Buriganga River (New Dhaleswari-Pungli-Bongshai-Turag-Buriganga River System.

Based on the review of secondary information and transparent and meaningful consultations, three valued environmental components (VECs) are identified: (a) Flood and Erosion Risk, (b) Aquatic Biodiversity, (c) Rural/Char Livelihood. The cumulative impacts are related to the river narrowing resulting from river stabilization works (under present past, present and future projects) which will increase the water flow velocity that will, in turn, increase the risk of seasonal flooding and change the erosion-accretion pattern in the outfalls of Jamuna River such as Padma and Meghna. The cumulative impacts and their significance are presented in the Table 6.

Table 6: Cumulative Risks and Impacts and their Significance

Cumulative Impacts and Risk	Magnitude	Sensitivity	Significance
VEC 1: Flood and Erosion Risk			
Risk of rising erosion in the downstream of Jamuna River, at confluence area	M	S	M
Increase of rising flood risk in the charlands	S	H	H
Increase of rising flood risk at the at the outfall of Jamuna – Padma confluence	M	S	M
VEC 2: Aquatic Biodiversity			
Reduction of Fish Habitats and Spawning area (e.g., mudflats, embayments, shallow water zones, floodplains)	M	S	M
Impacts on Fish Migration (longitudinal and lateral)	S	S	S
Loss of aquatic biodiversity (especially Turtle, Dolphin, Reptiles, Fish) due to reduction of mudflats, embayment, shallow water zone, floodplain area	M	H	S
Disturbance to migratory birds	M	S	M
VEC 3: Char and Rural Livelihood			
Risk of displacement of people living in the Chars due to increased risk of flood and erosion	M	H	S
Risk of exclusion of People Living in the Chars from Benefits of the Programs	M	H	S
Risk of displacement due to land acquisition	M	H	S

Table 6 shows that most of the cumulative risks and impacts are substantial to moderate (except one impact on VEC 1 which is high). These cumulative risks will require a range of coordinated and collaborative management actions including detailed master plans, strategic interventions, regional hydrological modelling results, and synchronization among the Jamuna, Padma and Meghna River management plans. The R-CIA will be complemented by a further comprehensive cumulative impact assessment (CIA) taking Padma and Meghna rivers and estuarine areas into consideration during subsequent JRECDP project

[3] 2013. Good Practice Handbook; Cumulative Impact Assessment and Management Guidance for the Private Sector in Emerging Markets. International Finance Corporation (IFC).

phases. The detailed CIA will be carried out during implementation of Project 1 as further detailed information becomes available. In the interim, the R-CIA provides a set of high-level strategies and management actions which need to be further explored and elaborated while carrying out the detailed CIA during implementation of SOP1, when further detailed information will be available.

Environmental and Social Management Plan (ESMP)

An ESMP has been prepared to mitigate the project's environmental and social risks and impacts. It includes mitigation measures, capacity building, responsibilities and reporting system and budget.

The ESMP includes different types of mitigation and control measures and sub-plans for addressing significant impacts and risks, including: (i) general and non-site-specific measures in the form of ESCOPs to address general construction and operation matters identified as medium and minor/low significance prior to mitigation and prevention; (ii) project specific and, to the extent possible, site-specific mitigation measures; (iii) CESAP with site-specific and contract-specific management plans to be prepared by the Contractors that will be submitted within 90-days of a contractor's mobilization and be approved by the Engineer; (iv) OHS Management System Processes and SOPs to be prepared by the Contractors; and (v) proposed ESMP sub-plans to address significant impacts and cumulative impacts on the Ganges River Dolphin (on which impacts are determined to be potentially significant).

The ESMP includes several sub-plans, including: (i) Occupational Health and Safety Plan; (ii) Community Health and Safety Plan; (iii) Labor Management Procedure; (iv) Flood Management Plan; (v) Ship Pollution Management Plan; (vi) Fisheries Management Plan; (vii) Biodiversity management Plan; (viii) No net loss/Net Gain Strategy; (ix)Dredged material Disposal Plan; and (x) Social management Plan.

- Occupational Health and Safety (OHS) Plan: Contractors will prepare an OHS Plan based on the framework proposed in this ESIA, which include Contractors' high-level policy, processes and standard operating procedures for high-risk activities to safeguard works and community health and safety.
- Community Health and Safety Plan: Contractors will prepare a CHS Plan to addresses the health, safety, and security risks and impacts on project-affected communities and the corresponding responsibility of Borrowers to avoid or minimize such risks and impacts, with particular attention to people who, because of their particular circumstances, may be vulnerable.
- Labor Management Procedure (LMP): The LMP sets out the approaches and measures to meet and mitigate the national requirements as well as the objectives of the WB's ESF specific objectives of ESS 2 and ESS4.
- Flood Management Plan: Dredging at Kalihati site might contribute dynamism of river planform at Tangail-Kalihati reach and areas downstream. Any major change in river planform might contribute to flooding. Hence, few recommendations are made to manage future flooding.
- Ship Pollution Management Plan: Component 2 of Project 1 is anticipated to contribute to inland water transport growth. Therefore, there is the potential for spills and leaks of petrochemicals and increased noise pollution during operation stages. The ESMP proposes ship operation procedures and standard refueling practices and capacity building of BIWTA for monitoring and enforcement.
- Fisheries Management Plan: The pilot sites are within the boundary of Jamuna River Fish Sanctuary. The critical habitat assessment indicates two fish species Baghair and Chital triggering Critical Habitat criteria of ESS6. A fisheries management plan is proposed with the aim of achieving "no net loss" of fisheries habitat and "net gain" of Baghair and Chital. The following are proposed in the Fisheries Management plan:
    - Fish diversity management by the creation of artificial fish habitats, including introducing various fish habitat structures; and
    - Fish habitat management and cooperation with the Department of Fisheries.

- Biodiversity management Plan: The ESMP proposes to conduct an encounter, abundance and habitat Survey in the Project Area for species triggering Critical Habitat criteria of ESS6 (Dolphin, Gharial, Baghair, Fishing cat, and Chital) to support the biodiversity off-set plan to achieve the net gain. In addition, a wildlife survey in the program influence area is also proposed to monitor the changes in wildlife status, composition, distribution and diversity.
- No net loss/Net Gain Strategy: It is expected that temporal loss of natural habitats (i.e., mudflats, embayment area, newly emerged charlands downstream of the dredging area). This is a natural and ongoing process but the additional impact resulting from Project 1 is expected to be low. The proposed intervention might accelerate the process at a few locations. In addition, disturbance to Dolphin, fishing cat and Gharial due to pile driving activities is expected and temporal loss/shifting of habitat for Baghair fish (*Bagarius bagarius*). The Baghair prefers the high velocity zone. The proposed interventions are expected to deflect the current high velocity flow regime towards mid channel. Therefore, the following strategies are taken in the ESMP:
    - Biodiversity Offset Strategy for Dolphin
    - Management of Bagair and Chital
- Dredged Material Disposal Plan: An estimated 7 million m^3 of dredged material will be generated from Project 1 activities. Safe disposal of this material is required. Two export processing zones are planned on public and private sector lands in Sirajganj. The generated dredged material will be utilized to fill these lands up to 3.5 m high. The ESMP proposes measures for environmental management and institutional arrangements.
- Social management Plan: Land acquisition will be required for Project 1 interventions. All PAPs, thus, will receive: (i) compensation (as required, to match replacement value); and/or (ii) replacement land, structures, seedlings, other resettlement assistance such as shifting allowance, assistance with rebuilding structures, and/or compensation for loss of workdays/income. The ESMP proposes to compensate the following people:
    - Persons who have formal legal rights to land or assets;
    - Persons who do not have formal legal rights to land or assets, but have a claim to land or assets that is recognized or recognizable under national law; or
    - Persons who have no recognizable legal right or claim to the land or assets they occupy or use.

The ESMP also includes a Livelihood Restoration Plan, Biodiversity Off-set Strategy addressing no net loss/net gain, Fisheries Management Plan, Ship Pollution Management Plan (for operation period), Dredge Material Management Plan, and a number of future research studies to aid the preparation of the subsequent projects of the SOP.

The total cost of ESMP implementation is estimated to be USD 11,688,692. This includes USD 1,918,694 with Civil Works for Contractor, USD 7,860,900 with PIU for capacity building and consulting services, USD 588,235 for additional studies, USD 279,986 for RPF, and USD 897,976 for livelihood restoration and development.

Environmental and Social Monitoring

The PIU, in collaboration with environmental regulatory authority, will implement the Environmental and Social Monitoring Plan as a component of the ESMP to monitor ESMP implementation and impacts. The E&S monitoring plan is presented in Table 7.

Assessment of Implementing Agencies for Capacity building for E & S Risk Management

Though both IAs have experience working with Bank funded projects under the Operational Policies/Bank Procedures (OP/BP), JRECDP Project 1 will be the first project for both IAs under the ESF. The ESIA team conducted series of interviews with senior staff from both IAs to understand the current capacity, gaps and the need to strengthen capacity to manage E&S risks in line with the ESF. Currently, the E&S risk

management capacity of the both IAs is institutionally limited by inadequate workforce and human resource policies and practices. Given the fact that the scale of Project 1 is limited, an ad hoc approach through inclusion of project-based E&S specialists in the PIU has been proposed. However, for Projects 2 and 3 of the SOP, a long-term plan has been proposed which involves - creating an E&S Risk Management Wing for BWDB and an E&S Risk Management Directorate for BIWTA. Based on information obtained from this interview process and in keeping with the WB's ESF, IA-specific modified organograms have been prepared in consultation with the IAs and feedback from senior management for future capacity building in their respective agencies, including resources and training needs.

Taking the all the above impacts, mitigation measures, ESMP and institutional capacity and strengthening into consideration, it can be concluded that the overall residual E&S risk of the JRECDP Project 1 would be 'Low'. However, to achieve the environmental and social outcomes consistent with the WB's ESS, institutional strengthening, monitoring of mitigation measures and ESMP implementation are required.

Grievance Redress Mechanism

The IAs will establish a standalone Grievance Redress Mechanism (GRM) to address stakeholder complaints and grievances associated with Project 1. The GRM is intended to address issues and complaints in an efficient, timely, and cost-effective manner. The GRM will be two-tiered, i.e., Field level and Project level to receive, evaluate, and facilitate the resolution of affected people's concerns, complaints, and grievances. The GRM aims to provide a time-bound and transparent mechanism to receive and resolve social and environmental concerns linked to the project. The GRM has been elaborated in the SEP prepared for the project.

In addition to this general GRM, there will be a separate standalone Labor GRM and SEA/SH responsible GRM. The GRM model will be based on the Project Level GRM Model of Good Practice Note of the World Bank. The details of the GRMs have been described in the SEA/SH Action Plan, and LMP as well as in the SEP prepared as a standalone document alongside this ESIA.

Conclusion

The proposed activities of the SOP 1 are very small scale in comparison with the overall JRECDP. Key impacts identified with Project 1, most of which are construction related, include: noise impacts primarily associated with pile driving; air quality impacts primarily related to fugitive dust dispersion, rock crushing, soil excavation and relocation, and dredge spoils piles; biodiversity impacts to the listed species such as Ganges River Dolphin, Gharial and two fish species, and their respective critical habitat; impacts on fisheries resulting from habitat modifications that affect fish diversity and abundance; impacts on agriculture from loss of standing crops due to land acquisition; SEA/SH impacts; and impacts related to communicable and vector-borne diseases associated with labor force influx. Most of the pre-mitigation impacts are assessed to be substantial to moderate. The construction related impacts which are mostly local, can be easily mitigated by adoption of ESCOPs and GIIPs. The operation and maintenance phase impacts can be managed by the mitigation plan and ESMP proposed in this ESIA.

Client capacity for managing E&S risks in line with the WB's ESF has been determined to be limited and, therefore, institutional strengthening and capacity building of the IAs is required. The Project will improve the E&S risk management capacity of both IAs to ensure ESMP are implemented and monitored in line with the ESF.

Based on the above, the residual impacts of the Project 1 are assessed to be low.

Table 2: Mitigation measures for impacts with initial risk ratings of Substantial (S) and High (H)

Impacts	Risk Rating Before Mitigation	Rationale	Mitigation Measures	Residual Risk Rating
Noise impacts from pile driving (cast in-situ bored pile, vibratory hammer)	Substantial (S)	The risk of noise from construction/driving of 540 x 45-50 m long 0.75 m diameter bored-piles at the Kalihati site and 366 x 45-50 m long 0.9 m diameter piles at the Bhuapur Site will generate significant noise. Pile driving of a total 17,185.53 m in Bhuapur and 28,568.7 m in Kalihati sites will increase the ambient noise level up to a harmful level for local communities and wildlife in close proximity to the pilot sites. The maximum resulting noise (Lmax) of pile driving can reach up to 84.93 dB at a distance of 50m; diminishing to 40.47 dB at a distance of 4 km. However, there are no sensitive receptors (e.g., institutions, settlements, etc.) within 100 m. The main noise impacts will be expected on the birds, Dolphins, and other aquatic animals in the river. The loud noise can alter the behavior of the Ganges River Dolphins and potentially disturb migratory birds. It is expected that the noise impacts during construction will be site specific, medium duration, temporary and reversible. Noise pollution during the operations phase of Project 1 will not be significant, as only a nominal increase in vessel traffic is anticipated.	• Require contractors to prepare and submit to the PIU a "Pile Driving Plan" following JNCC Guidelines to be approved before commencing any works at the pilot sites • Source control requirements may have the added benefits of promoting technological advances in the development of quieter equipment. • Equipment modifications, such as dampening of metal surfaces, are effective in reducing noise due to vibration. Another possibility is the redesign of a particular piece of equipment to achieve quieter noise levels • Sound aprons are useful when the shielding must be frequently removed or if only partial covering is possible. • Enclosures for stationary work may be constructed of wood or any other suitable material and typically surround the specific operation area and equipment. • The use of electric powered equipment is typically quieter than diesel, and hydraulic powered equipment is quieter than pneumatic power • Using vehicles and equipment in good conditions • Use vibratory hammer. Under those conditions where impact hammers are required for reasons of seismic stability or substrate type, it is recommended that the pile be driven as deep as	Medium (M)

Impacts	Risk Rating Before Mitigation	Rationale	Mitigation Measures	Residual Risk Rating
			possible with a vibratory hammer prior to the use of the impact hammer. • Monitor sound levels during pile driving at various distances within the mitigation zone to ensure that noise levels do not exceed the DoE, WB or any other international recognized criteria such as those in the World Bank Group General Environmental Health and Safety Guidelines (EHSGs) on Noise. • Incorporate the use of clear "ramp-up" (i.e., "soft-start") procedures, whereby sound energy input to the marine environment is gradually or incrementally increased from levels unlikely to cause significant behavioral impact on aquatic mammals to the full output necessary for completion of the activity. • Implement measures to attenuate the sound when sound pressure levels exceed the DoE, WB or any other internationally recognized criteria. Methods to reduce the sound pressure levels include, but are not limited to: ○ Incorporate the use of fully enclosing or confined bubble curtains, encircling absorptive barriers (e.g., isolation casings, cofferdams) or other demonstrably effective noise reduction methods at the immediate works site, in order to reduce underwater sound propagation from on-site operations. Studies have shown that such methods can provide a significant	

Impacts	Risk Rating Before Mitigation	Rationale	Mitigation Measures	Residual Risk Rating
			reduction in sound input to the wider aquatic environment in the order of 10-30 dB. • Use a hydraulic hammer if impact driving cannot be avoided. The force of the hammer blow can be controlled with hydraulic hammers, and reducing the impact force will reduce the intensity of the resulting sound • Gradually ramp up the sound levels (pile diving) to scare the dolphins, gharial and other important reptiles away before piling commences. Use pingers upstream and downstream to chase away dolphins and aquatic reptiles. Monitor area for these creatures to ensure they are well away from the piling site – scare them away using pingers if they are within the high noise emission zone prior to noisy construction activities.	
Air quality impacts from dust dispersion while carrying the construction materials; rock crushing, mixing of construction materials, soils and material stock-piles, dredged material disposed sites;	S	During the construction phase fugitive dust will be generated on a longer-term basis from stationary sources such as quarries, borrow pits, especially during dry season. Exhaust emissions from the operation of construction machinery (e.g., Nitrogen Oxides (NOx), Sulfur Oxides (SOx) and Carbon Monoxide (CO)) will increase PM10 and PM2.5 levels. Dust emission will also occur while transporting construction materials, e.g., sand, gravel, rock, cement, etc., on local earth roads. Fixed sources such as generator sets, construction equipment e.g., compressors and excavation/ grading activities will impact air quality during	• Vehicle speed restriction (e.g., 20 km/h) must be enforced to control dust generation • Construction materials must be covered to protect from wind action • Spray water regularly for suppressing fugitive dust • dump trucks carrying sand or other fines containing materials have their loads covered when under way to mitigate dust generation from the loads • An appropriate freeboard must be maintained in trucks hauling construction materials • Introducing pollution free/new technology in construction activities	Low (L)

Impacts	Risk Rating Before Mitigation	Rationale	Mitigation Measures	Residual Risk Rating
and exhaust emissions from the ships		rock crushing, mixing of construction materials, open burning of waste materials, dust generated by quarries, borrow pits, haul roads, unpaved roads, and dust generated from soils and material stock-piles. Furthermore, construction works which are very significant parts of the project tasks, involve operation of different types of fuel burning machineries. Continuous emission of pollutants from the machineries can cause air pollution which may travel farther from the project boundary following the wind. River banks are common places for different species to live and wade by especially, birds and turtles. Using poor-quality fuel and technical faults of any equipment may cause greater emission.	• Approved pollution control devices to be fitted in equipment and machinery • Establish grass carpeting in the unpaved area where possible • Regular air monitoring will be carried out near the sensitive receptors to ensure ambient air quality remains within the limits defined by national standards	
Impacts on biodiversity from disturbance to Brahmaputra-Jamuna River KBA; Contraction of mudflats, river area (alluvial zone), Charlands like natural habitat at site; and Risk of increasing disturbance and	M	On site disturbance includes impacts on sensitive species of biodiversity significance and poorly known species of frogs and snakes. Generally, construction activities, like pile driving, excavation, concreting operation may affect these species, along with several threatened bird species. The site-specific impacts on biodiversity include disturbance on aquatic and terrestrial ecosystem, displacement of individuals and populations of species, alteration of habitats, alteration in population dynamics, changes in species composition and isolation or fragmentation of habitats.	● Conduct continuous inspection for leaks prior to and during each construction activity (e.g., concrete pouring) ● All pouring of concrete, sealing of joints, application of water-proofing paint or protective systems, curing agents, etc. for outfalls must be completed in dry weather ● To prevent input of construction materials into the river, concrete structural elements shall be pre-cast ● Locations where concrete or other wet materials are to be used, bunded steel decks must be used to capture any spilled concrete, alkaline water displaced from inside tubular steel piles or spilled sealants or other materials ● Areas reserved for future development at the site shall be made up with green by growing grasses and shrubs and herbs	L

Impacts	Risk Rating Before Mitigation	Rationale	Mitigation Measures	Residual Risk Rating
reduction of suitability in the natural habitats (river area, mudflats, chars) due to pollution (Noise, water pollution, etc.) from construction activities including dredging		Among the important species of Jamuna River and its adjacent areas, Dolphin, Fishing Cat, Gharial, Narrow-headed Soft-shell Turtle, Ganges Soft-shell Turtle, Painted Stork, Black-bellied Tern and migratory birds can be potentially impacted. The project activities might take place in the area of occupancy and extent of occurrence that may have impact on these important species. The proposed groyne would ultimately increase sedimentation processes along the protected bank and gradually contract the river width at site by reclaiming lands. The dredging longitudinally across the charland near the Kalihati site would also result in loss of mudflats which is currently potential for habitats for winter-visiting migratory birds. The dredging and the resultant change in the flow might increase erosion at the chars & mudflats which are also potentially habitats with high biodiversity values. However, the net loss can be assumed to be zero as the proposed groyne would result in gradual land reclamation and bank protection would also protect natural habitats and modified habitats along the bank. There is a risk of water pollution and noise from construction activities especially from pile driving, dredging, transportation of primary supply, etc. The construction activities and dredging thus results in a risk of reduction of suitability. The noise, waste, and pollution from construction	● Measures described above for mitigating noise and air pollution are also relevant	

Impacts	Risk Rating Before Mitigation	Rationale	Mitigation Measures	Residual Risk Rating
		activities and dredging also increase disturbance to the wildlife present or likely to be present in those habitats.		
Impacts on Species and biodiversity features triggering critical habitat criteria	S	The main impacts on critical habitats are from increasing disturbance and reduction of suitable, natural habitats (river area, mudflats, chars) due to pollution (Noise, water pollution, etc.) from construction activities including dredging; increased risk of physical injury to Dolphin, and Gharial through collision; disturbance to Dolphin, fishing cat and Gharial due to noise of construction activities such as pile driving; and temporal loss of habitat of Baghair fish (Bagarius bagarius) and Chital (Chitala chitala).	● Require contractors to prepare and submit to the PIU a "Pile Driving Plan" that incorporates measure to minimize impacts following JNCC Guidelines to be approved before commencing any works at the pilot sites ● Placement of assorted CC blocks and geobags at the toe of the revetments and groynes to favour Baghair habits ● Implement a strict prohibition of any disturbance/killing/trading of Dolphin, Fishing Cat, Baghair, and other species triggering critical habitat criteria ● Measures described above for mitigating noise and air pollution and biodiversity loss are also relevant	L
Impacts on fisheries from disappearance of scour habitats at the riverbank side due to bank protection work; Change in fish habitats (embayment area, mudflats, alluvial area, etc.); and Degradation of	S	The riverbank protection by concrete blocks at the eroded sides would need sloping and leveling of the intervened bank. The bank side may have scour holes which function as resting places for various species of fish like Eels (Boro Baim- *Mastacembelus armatus*), catfishes (Air- *Sperata aor,* Rita- *Rita rita,* Boal- *Wallago attu*) and other small fishes (Punti- *Puntius sophore,* Gulsha- *Mystus cavasius,* Baila- *Glossogobius giuris*). Sloping and leveling the riverbank may cause disappearance of scour holes of the riverbank in the project site. Following the impacts of the proposed interventions on river hydro-morphology, it can	● Prohibit fishing by the project worker in the declared fish sanctuary area (including the project AOI) ● Placement of assorted CC blocks and geobags at the toe of the revetments and groynes to favor Baghair habitats ● Mitigation measures described above for noise and air pollution are also relevant	L

Impacts	Risk Rating Before Mitigation	Rationale	Mitigation Measures	Residual Risk Rating
fish habitat condition at the Jetty site due to discarding plastic bottles, polythene and food packaging waste by the passengers		be assumed that fish habitats in the intervened reach would be gradually contracted by the proposed groynes. The mudflats and floodplain area (e.g. chars) would be reduced. However, the total alluvial area (river area excluding char and mudflats) might be increased if chars are eroded. At this stage it is difficult to quantitatively assess the loss because the hydro-dynamic modeling results are not available and these expected changes will not take place immediately, rather gradually. Formation and disappearance of embayment area which is considered as local important fish habitat is a natural trend in Jamuna River. The dredging might open a current embayment area in the char and might turn it into a channel. However, similar habitat might form naturally in nearby areas. The bank protection work under this project will be implemented at four (04) locations along the river reach. The banks may have several scour holes where various species of fish, such as eels (*Baim*), catfish (*Air, Rita, Boal, Bacha*), and small fishes (*Punti, Tengra, Gulsha, Gutum*) take shelter there in the wet season. Implementation of the bank protection work by setting up concrete blocks will transform the muddy bank habitat to a concrete habitat. Therefore, the fish species that take shelter and graze in the muddy bank may be shifted and would not be able to adapt to the		

Impacts	Risk Rating Before Mitigation	Rationale	Mitigation Measures	Residual Risk Rating
		changed habitat. However, the CC blocks used for bank protection may serve a special habitat for certain fish species such as eels (Baim) and large catfish (Air, Rita, Boal) and carp (Kalibaush). In addition, establishing geo-bag may create special fish habitat, as algae, phytoplankton and other microphytes may grow on their surface. Therefore, fish species who prefer algae and microphytes would aggregate in the altered habitat. Hence, changes in fish composition at the bank protection sites may have insignificant impact on fisheries resources.		
Impacts on agriculture from Loss of Standing Crop/Crop Production due to land reacquisition (for bank protection work, labor camp, construction sites, etc.)	S	Project 1 will need to acquire approximately 29 acres (11.74 ha) of land and involuntarily resettle 82 households. This is a temporary impact as the agricultural lands will return to being used for crop production following the end of the construction period.	A Resettlement Policy Framework has been prepared to guide the land acquisition and resettlement to align with the ESS5. A livelihood Restoration Plan has also been developed to mitigate the risk related to sources of livelihood such as income	L
SEA/SH impacts from Women trafficking and sexual assault may increase due	S	The project involves moderate to substantial socio-economic and SEA / SH risk due to influx of the labor force. However, given the projected size of the labor force and scale of the Project, the	● Awareness raising and sensitization on GBV for all stakeholders including the community and vulnerable populations,	L

Impacts	Risk Rating Before Mitigation	Rationale	Mitigation Measures	Residual Risk Rating
to low density of population and weak communication facility		proposed mitigation measures will reduce the risk from Substantial to low.	● GBV service provider mapping to refer incidents of GBV from the GRM or any other reporting mechanism that may be established through the project. ● Establish an effective grievance redress mechanism (GRM) with multiple channels to complaints about SEA/SH and establish SEA/SH allegations reporting channels ● Institutional capacity strengthening of both IAs with dedicated SEA/SH Specialist in the PIUs ● Receive and process GBV complaints ● Take direct sanctions against perpetrator ● Refer victim/ survivor will to medical and legal service providers ● Follow up registered cases and ensure safety of client	
Social impacts from COVID-19 and other communicable diseases risk	S	The labor influx can result in increased risk of COVID-19 transmission as well as other communicable diseases such as TB, especially workers that come from outside the community.	● Main mitigation measures include following national, local, and the World Bank's COVID-19 protocols.	L

Table 7: Environmental and Social Monitoring Plan

Components Monitoring	Monitoring Indicators	Locations	Frequency	Type/Duration of Sampling	Implemented by	
					Monitoring	Supervision
Pre-construction phase monitoring						
Compensation amount	Compensation received or not	Project site	Half yearly	Consultation with the land and structure owners, squatters, other affected people, and relevant authority	Third party Monitoring and submit report to the project authority.	PIU
Livelihood Condition and Employment Status	Occupational change In employment Household income and expenditure	Project area and adjacent project area (within 2 km)	-	Household survey and FGD	Third party Monitoring and submit report to the project authority.	PIU
Grievance Mechanism	Establishment of GRM Operation, Procedures, Records and Documents	At work site	Monthly	visual inspection and enquiry to know the Grievance Mechanism	Third party Monitoring	PIU
Construction phase monitoring						
Air Quality	SPM, PM2.5, PM10	Construction site	Quarterly	24-hour	Third party Monitoring	PIU
Water Quality	Total alkalinity, Ammonium Nitrogen, BOD5, COD, EC, Oil and Grease, Turbidity, TSS, TDS, TS, etc.	Construction site, 1km upstream and 1km downstream of each site	Monthly	Grab Sampling	Third party Monitoring	PIU
Noise	Day time (6:00 – 21:00) and Night time (21:00 – 6:00) L_{10}, L_{90}	Construction Site Construction Camp Nearby Sensitive Locations	Monthly	Three Sample during day time and one sample during night, 15 min sampling each time.	Third party Monitoring	PIU
Disaster Risk	Flood level, Flood Duration, Flooding depth, erosion and accretion, Disaster Risk Awareness,	Construction sites, upstream area, especially Charlands area nearby the construction sites	Seasonally	Survey, Satellite Image Analysis, FGD, KII	Third party Monitoring	PIU
River Plan Form	Bankline, Flood zone, Alluvial zone,	River reach along the proposed revetment line	Annually	Survey, Satellite Image Analysis	Third party Monitoring	PIU
Livelihood and Employment	Labor Engagement for project activity		Quarterly	Household survey and FGD	Third party Monitoring and submit report to the project authority.	Project Authority

Components Monitoring	Monitoring Indicators	Locations	Frequency	Type/Duration of Sampling	Implemented by	
					Monitoring	Supervision
Gender SEA-SH	Implementation of SEA-SH action plan	Pilot/ Subproject sites	Quarterly	Both quantitative and qualitative assessment	Independent third-party monitoring	CSC and PIU
Occupational Health and Safety	First-aid Cases Medical Treatment Cases Lost Time Injury Number of near misses Number of Walk-through Inspections by Project Managers, Construction Managers, Health and Safety Officer and OHS supervisors	Construction site, Construction Camp	In various frequencies	Walkthrough, inspections, and incident reporting	Contractor	CSC, PIU
Community Health, Safety and Security	Rates of COVID-19 and other communicable disease (Chikungunya and Dengue, and other vector-borne diseases), Project related safety and security incidents, Number of grievances or claims of Project related impacts on the community.	Worksites and community close proximity of the project	In various frequencies	Inspection and interview of labor, project personnel and community members followed by a checklist	Contractor	CSC and PIU
Health and Sanitation	Availability of Potable Water, Drinking water quality, Availability of Hygienic Toilet	Construction/labor camps	Monthly	Inspection and interview of labor, project personnel	Third party Monitoring	PIU
Grievance Mechanism	Operation, Procedures, Records and Documents	At work site	Monthly	Visual inspection and enquiry to know the Grievance Mechanism	Third party Monitoring	PIU
Fish biodiversity	Fish Habitat, Fish Composition and population structure	4 revetment construction sites in Kaoakola, 3 sites along the canal to be reexcavated 2 locations along the each of the piloting sites 2 sites along the dredging area Pontoon sites	Six-monthly upto 1 years after the construction	In-situ investigation and Test	Third party Monitoring	PIU

Components Monitoring	Monitoring Indicators	Locations	Frequency	Type/Duration of Sampling	Implemented by	
					Monitoring	Supervision
River Dolphin and large aquatic species	Number of individuals	Noise impact zone	Weekly for 3 months post pile driving activities	Count numbers of dolphins surfacing.	Third party Monitoring	PIU
Operation/Post-Construction						
Air Quality	SPM, PM2.5, PM10	Near the Pontoon to be constructed Piloted sites	Monthly upto two years of construction	24 hour	E&SRM wing of BWDB	BWDB and DoE
Water Quality	Total alkalinity, Ammonium Nitrogen, BOD5, COD, EC, Oil and Grease, Turbidity, TSS, TDS, TS, etc.	3 sites along the re-excaveted canals 3 sites in Kaoakola revetment 2 locations in each C1 piloting sites	Monthly up to two years of construction	Grab Sampling	E&SRM wing of BWDB	BWDB and DoE
		Sensitive receptors along the Navigational Routes, Terminal areas	Monthly up to two years of construction After that, querterly	Grab Sampling	E&SRM wing of BWDB and BIWTA	BWDB, BIWTA and DoE
Noise	Day time (6:00 – 21:00) and Night time (21:00 – 6:00) L_{10}, L_{90}	Sensitive receptors along the Navigational Routes, Terminal areas	Monthly up to two years of construction	Three Sample during day time and one sample during night, 15 min sampling each time.	E&SRM wing of BIWTA	BIWTA and DoE
Disaster Risk	Flood level, Flood Duration, Flooding depth, erosion and accretion, Disaster Risk Awareness,	Piloted sites, upstream area, especially Charlands area nearby the piloted sites	Bi-annually	Survey, Satellite Image Analysis, FGD, KII	E&SRM wing of BWDB	BWDB and DoE
Operation and Maintenance of Embankment, Revetment and TBPG	Hydraulic condition, anthropogenic activities, performance, embankment failure, O&M activities, etc.	Piloting sites	Bi-annually	Survey, KII, Interview of BWDB officials	E&SRM wing of BWDB	BWDB and DoE
River Plan Form	Bankline, Flood zone, Alluvial zone,	River reach along the proposed revetment line	Annually	Survey, Satellite Image Analysis	E&SRM wing of BWDB	BWDB and DoE
Ship Pollution	Emission from Ships Incidents of waste and wastewater discharge, oil spillage from ship, etc.	Terminal areas, Sensitive areas along the navigational routes	Quarterly up to two years after construction	Exhaust monitoring (randomly selected sample ships)	E&SRM wing of BIWTA	BIWTA and DoE

Components Monitoring	Monitoring Indicators	Locations	Frequency	Type/Duration of Sampling	Implemented by	
					Monitoring	Supervision
Ship Inspection.	Ship Conditions Waste Management Facilities Waste Water Management Facilities Emission, energy efficiency, OHS, etc.	At Ship	At every 2 years of obtaining licensee from BIWTA	Inspection and Auditing	E&SRM wing of BIWTA	BIWTA and DoE
Ship Terminals E&S risk	Site Condition Operation efficiency of Ship waste collection and management facilities Operation efficiency of Ship waste and wastewater collection and management facilities	Ship Terminals	Quarterly up to two years after construction after that Bi-annually	Inspection and Auditing	E&SRM wing of BIWTA	BIWTA and DoE
Social Development and Disaster Resilience	Disaster Awareness, Social development, climate migration, Income equity, livelihood condition, WATSAN condition, disaster damage, perception on piloted works, etc.	Villages protected by proposed piloting activities and vulnerable villages near the piloting sites	Biannually	Survey, Document checking, Institutional survey, KII, Household Survey, FGD	E&SRM wing of BWDB	BWDB and DoE
Disaster Risk Financing (Community	Insurance (or other DRF solution) coverage, enrolment, insurance (or other DRF solution) benefits, etc.				E&SRM wing of BWDB	BWDB and DoE

Bangla Version of the Executive Summary

যমুনা নদী অর্থনৈতিক করিডোর উন্নয়ন কর্মসূচী, প্রকল্প-১

খসড়া পরিবেশগত এবং সামাজিক প্রভাব মূল্যায়ন

[সারসংক্ষেপ]

এপ্রিল ২০২২

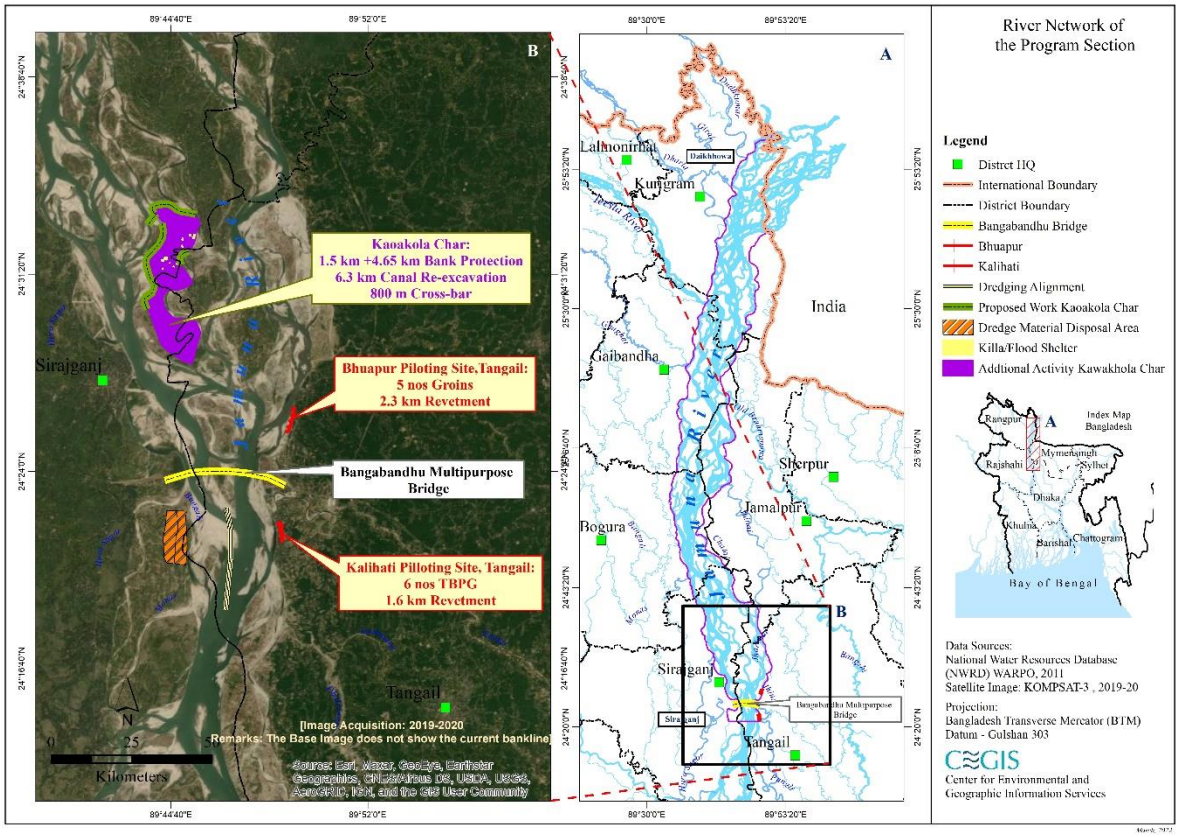
পটভূমি

যমুনা-বক্ষপুত্র বাংলাদেশের একটি খরস্রোতা নদী যা বিগত ১৫০ বছর ধরে বিভিন্ন পরিবর্তনের মধ্য দিয়ে আজকের অবস্থায় এসে পৌঁছেছে। প্রত্যেক বছর এই নদীর ভাঙ্গনে ও বন্যায় প্রায় ১০ লক্ষ লোক গৃহহীন হয়ে অতি মানবেতর জীবনযাপন করে। এই ভাঙ্গন ও ক্ষতির কথা মাথায় রেখে বাংলাদেশ সরকার বিশ্বব্যাংক ও AIIB এর আর্থিক ও প্রযুক্তিগত সহায়তা নিয়ে "যমুনা নদী অর্থনৈতিক করিডোর উন্নয়ন উন্নয়ন কর্মসূচী" প্রণয়ন করার সিদ্ধান্ত গ্রহণ করেছে। আলোচ্য কর্মসূচী প্রকল্প-১ হবে বাংলাদেশ ডেল্টাপ্লান-২১০০ বাস্তবায়নের প্রথম পদক্ষেপ যার মূল উদ্দেশ্য হল জলবায়ু স্থিতিস্থাপকতা বৃদ্ধি ও অর্থনৈতিক উৎপাদনশীলতা বৃদ্ধি ও অর্থনৈতিক উৎপাদনশীলতা বৃদ্ধি করা।

যমুনা নদী অর্থনৈতিক করিডোর উন্নয়ন কর্মসূচী

পুরো পোগ্রামটি বাস্তবায়িত হবে ধারাবাহিক প্রকল্পের মাধ্যমে যেখানে ৩টি পৃথক প্রকল্প যমুনা নদীর মোট ২৫০ কিলোমিটার এলাকা জুড়ে কার্যকর করা হবে। কর্মসূচীর মোট ব্যয়ভার ধরা হয়েছে ২.৮ বিলিয়ন ইউএস ডলার যার মধ্যে বিশ্বব্যাংক ১.১ বিলিয়ন ইউএস ডলার অর্থায়ন করবে। বাকী অর্থ আসবে বাংলাদেশ সরকার ও অন্যান্য দাতাগোষ্ঠী থেকে।

তিনটি পৃথক প্রকল্পের মধ্যে প্রকল্প-১ এর দ্বারা নদীর অবকাঠামোগত উন্নয়ন, সীমিত আকারে নদী খনন, নদী শাসন, হাইড্রোগ্রাফিক জরিপ প্রাতিষ্ঠানিক উন্নয়ন ও ক্ষমতা বৃদ্ধায়ন এবং সর্বোপরি দুর্যোগ অর্থায়ন এর ব্যবস্থা করা হবে। প্রকল্প-২ মূলত নদী শাসন, নদীর অবকাঠামোগত উন্নয়ন, বৃহৎ আকারে নদী খনন, নদীর নাব্যতা বৃদ্ধি এবং সর্বপরি দূর্যোগ অর্থায়নের ওপর গুরুত্ব দেয়া হবে। প্রকল্প-৩ আসলে যমুনা নদীর সার্বিক স্থিতিস্থাপকতা উন্নয়ন ও উন্নয়নের জন্য কাজ করা হবে।



চিত্র ১- প্রকল্পের অবস্থান

প্রকল্প-১

প্রকল্পটি ৪.৫ (২০২৩-২০২৮) পর্যন্ত ধরে পরিচালিত হবে। এই প্রকল্পের ব্যায়ভার ধরা হয়েছে ১৩৫ মিলিয়ন ইউএস ডলার। এই প্রকল্পের প্রধান উদ্দেশ্য হল (১) যমুনা নদীর ভাঙ্গন, বন্যা রক্ষায় নদীর পাড়ের স্থিতিস্থাপকতা বৃদ্ধি করা। বাংলাদেশ পানি উন্নয়ন

বোর্ড (বাপাউবো) এবং বাংলাদেশ আভ্যন্তরিন নৌ-পরিবহন কর্তৃপক্ষ (বিআইডাব্লুটিএ) প্রকল্পে প্রধান বাস্তবায়ন সংস্থা হিসেবে দায়িত্ব পালন করবে

প্রকল্প-১ এর মধ্যে মোট ৫টি কম্পোনেন্ট থাকবে।

কম্পোনেন্ট-১ ঃ বন্যা ও নদীভঙ্গন ব্যবস্থাপনা

বাংলাদেশ পানি উন্নয়ন বোর্ড বাংলাদেশ পানি উন্নয়ন বোর্ড (বাপাউবো) এর মাধ্যমে কম্পোনেন্ট-১ বাস্তবায়িত হবে যার মোট ব্যয়ভার আনুমানিক ৪৫ মিলিয়ন ইউ এস ডলার । প্রকল্পটি বাস্তবায়নের জন্য টাংগাইল জেলার ভূঞাপুর ও কালিহাতী নামক দুটি এলাকাকে পরীক্ষামূলক সাইট হিসেবে বেছে নেয়া হয়েছে। নদীর তীর রক্ষাকারী বাঁধ নির্মাণ, ও ভাঙ্গন রোধ করা তাই কম্পোনেন্ট এর প্রধান উদ্দেশ্যে, Top blocked Permeable Groyne এর মাধ্যমে নদীর পাড় রক্ষা, সীমিত আকারে নদী-খনন, জাতীয় নদী মহা পরিকল্পনা প্রস্তুত এই প্রকল্পের প্রধান লক্ষ্য।

এই কম্পোনেন্ট এর আওতায় আরও কিছু কাজ হবে। যার মধ্যে কাওয়াকোলা চর প্রতিরক্ষা বাঁধ নির্মাণ এবং খাল খনন অন্যতম। চরের মেছরা ও আরজুনা এলাকায় ১৫০০মি., ৪৬৫০মি. পরীক্ষা বাঁধ নির্মাণ করা হবে। সীমিত পরিসরে ও চরের ভেতরকার খাল খনন ও কালীহাতি এলাকায় নদী খনন কর্মসূচী ও এই কম্পোনেন্টে এর আওতায় করা হবে।

কম্পোনেন্ট-২ ঃ নদীর গতিপথ উন্নয়ন ঃ

এই কম্পোনেন্টেটি বিআইডাব্লুটিএ পরিচালন করবে যার মোট ব্যায়ভার ধরা হয়েছে ৭০ মিলিয়ন ইউ এস ডলার। নদীর গতিপথ উন্নয়ন, লেভেল-D হাইড্রোগ্রাফী এবং RIS; বিআইডাব্লুটিএ এর প্রাতিষ্ঠানিক ক্ষমতা উন্নয়ন এবং সর্বোপরি জাতীয় নদী মহাপরিকল্পনা প্রস্তুতকারনই এই কম্পোন্টে এর প্রধান কর্মসূচী।

কম্পোনেন্ট-৩ ঃ এলাকাবাসীর অর্থায়ন নিশ্চিতকরন

বাপাউবো পরিচালিত এই কম্পোনেন্ট এর মোট ব্যয় ধরা হয়েছে ১০ মিলিয়ন ইউ এস ডলার। দুর্যোগ ব্যবস্থাপনার অংশ হিসেবে এলাকাবাসী বন্যা ও দুর্যোগ পরবর্তি অর্থনৈতিক সুবিধা নিশ্চিতকরণ এবং কমিউনিটি প্রটেকশান তহবিল গঠনই এই কম্পোনেন্ট এর মূল উদ্দেশ্য।

কম্পোনেন্ট-৪ ঃ সম্প্রদায়িক সংযুক্তি ও প্রকল্প পরিচালনাঃ

এই কম্পোনেন্টটি বাপাউবো ও বিআইডাব্লুটিএ যৌথভাবে পরিচালনা করবে যার ব্যয় ধরা হয়েছে ১০ মিলিয়ন ডলার। এই কম্পোনেন্টের সকল কাজ এলাকার স্থানীয় জনগণের মাধ্যমে পরিচালিত হবে। উল্লেখযোগ্য কাজগুলির মধ্যে দুর্যোগ সতর্কতা ও যথাযথ প্রস্তুতি গ্রহন (Buoys) বয়া ব্যবস্থাপনা, কাওয়াকোলা চর উন্নয়ন উল্লেখযোগ্য, প্রকল্প ব্যবস্থাপনা কাজের মধ্যে বাপাউবো ও বিআইডাব্লুটিএ এর প্রকল্প পরিচালনা ইউনিট কে সহায়তা করা একটি প্রধান দায়িত্ব।

সারণী ১ - এক নজরে এই প্রকল্পের কার্যক্রম

পাইলট এলাকা	প্রধান প্রধান কার্যক্রম	
ভূঞাপুর	গ্রোইন নির্মাণ	৫টি গ্রোইন নির্মিত হবে
	পাইল এর সংখ্যা	৩৬৬ মি. ৪৫-৫০মি. দৈঘ্য ২টি সারি
	নদীর তীরের রিভেটমেন্ট	২.৩ কি.মি. যা CC ব্লক দিয়ে করা হবে
		২১৪০৩০ টি ব্লক দয়া হবে।
	বালুভর্তি ব্যাগ স্থাপন	৬৭২৮৪ টি -২৫০ কেজি ওজনের জিওব্যাগ ফেলা হবে
	জমির পরিমাণ	১৭ একর

কালীহাতী	গ্রোইন নির্মাণ	৬টি
	পাইল সংখ্যা	৫৪০ (০.৭৫ মি. দৈর্ঘ্য, ৪৫-৫০মি. ৩টি সারি)
	নদী তীরের রিভেটমেন্ট	১.৬ কি.মি. সেটা CC ব্লক দিয়ে করা হবে।
	বালুভর্তি জিওব্যাগ স্থাপন	১৯৫৩০০ টি ২৫০ কেজি ওজনের ব্যাগ ৫টি স্তরে স্থাপন করা হবে।
	নদী খনন	৭.৬৫ কি.মি. দৈঘ্য; ১০০ মি. প্রস্থ্য ও ৬ মিঃ গভীর
	জমির পরিমাণ	১২ একর জমি লাগবে
	জিওব্যাগ জিরে বাঁধ রক্ষা	১.৫ কি.মি. বরইতলা ঘাট ৪.৬৫ কি.মি. মেছরা ঘাট
	খাল খনন	৬.৩ কি. মি.
	বাঁধ নির্মাণ	৪০০ মি.
	CDD কার্যক্রম	বন্যা ও দুর্যোগ আশ্রয় কেন্দ্র
	জমির পরিমাণ	৭৮.৪৪ একর Negotiated Settlement অথবা স্বেচ্ছায় ভূমিদান এর মাধ্যমে নেয়া হবে

ESIA এর উদ্দেশ্য ঃ কর্মসূচীর ২য় পকল্পের কাজের ধরণ ও প্রকল্প ১ এর সময়কালে প্রকল্প ২-এর প্রস্তুতির জন্য প্রকল্পের পরিবেশ ও সামাজিক ঝুঁকি হিসেবে চিহ্নিত করা হয়েছে। সাধারণভাবে বর্তমান প্রকল্পের কর্মশালা সীমিত আকারে পরিচালিত হবে যার ফলে পরিবেশ ও সামাজিক ঝুঁকি খুব বেশী তীব্র হবে না বলে আশা করা যায় এবং যদিও কিছু ঝুঁকির সম্ভাবনা থাকে সেগুলি যথাযথ ব্যবস্থার মাধ্যমে সহজেই প্রশমন করা যাবে। এই ESIA টি ফিজিবিলিটি স্টাডি এর ওপর ভিত্তি করে করা হয়েছে যেটা কিনা বাস্তবায়ন ধাপে আবারও হালনাগাদ করা হবে যখন পরিপূর্ণ প্রকল্প নকশা ও হাইড্রো ডাইনামিক মডেলিং এর ফলাফল পাওয়া যাবে।

আইনি ও প্রতিষ্ঠানিক কাঠামো

বাংলাদেশ পরিবেশ সংরক্ষণ বিধিমালা ১৯৯৭ অনুযায়ী এই কর্মসূচীকে লাল (Red) হিসেবে এ- বিশ্বব্যাংক এর Risk Rating এর মাধ্যমে এই প্রকল্পের পরিবেশ ও সামাজিক ঝুঁকির পরিমাণ উচ্চ হবে বলে ধারনা করা যায়। ERC 97 এর নিয়ম অনুযায়ী বাপাউবো ও বিআইডাব্লুটিএ এর প্রকল্প অঞ্চলকে ইউনিটকে অবশ্যই পরিবেশ অধিদপ্তর হতে পরিবেশ ছাড়পত্র সংগ্রহ করতে হবে। যে কোন উচ্চ ঝুঁকিপূর্ণ প্রকল্প নিম্নক্ত উপায়ে পরিবেশ ছাড়পত্র পেতে পারে।

পরিবেশের প্রভাব মূল্যায়ণ → পরিবেশ অধিদপ্তর বরারবর আবেদন → EIA ছাড়পত্র জায়গার ছাড়পত্রের সনদ ও ECC - ECC বাৎসরিক নবায়ন এর ভিত্তিতে করা হয়।

বাংলাদেশের প্রধান আইনগুলোর মধ্যে পরিবেশ সংরক্ষণ আইন ১৯৯৫, পরিবেশ সংরক্ষণ বিধিমালা ১৯৯৭, পানি চুক্তি ২০১৩; মাছ সংরক্ষণ বিধিমালা ১৯৮৫, অভ্যন্তরিত নৌ-পরিবহন কর্তৃপক্ষ অধ্যাদেশ ১৯৫৮, জীববৈচিত্র্য আইন ২০১৭ উল্লেখযোগ্য। পাশাপাশি বিশ্বব্যাংকের ১০টি সামাজিক মানদন্ড যথাযথভাবে পর্যালোচনা করা হয়েছে। উক্ত মানদন্ডগুলির সাথে বাংলাদেশের

আইনগুলি সামঞ্জস্য রয়েছে প্রকল্পটি পরিচালিত হবে এর সেখানে বাংলাদেশের আইন অনুপস্থিত সেখানে দাতা সংস্থার আইন দ্বারা ঝুঁকি মোকাবেলা করা হবে।

বিকল্প বিশ্লেষণ

সঞ্চালক সংস্থার সিদ্ধান্ত গ্রহণের সুবিধার্থে এবং পরিবেশের ওপর ক্ষতিকর প্রভাব রোধ করতে সকল কাজের কিছু বিকল্প চিন্তা ও পরিকল্পনা বিশ্লেষণ করা হয়েছে। প্রকল্প এলাকা নির্বাচনের জন্য ৬ জেলার ১৮টি এলাকা প্রাথমিকভাবে নির্বাচন করা হয়েছেল। ক্ষতির তীব্রতা ও প্রয়োজনীয়তার গুরুত্ব বিবেচনায় এনে উক্ত ১৮টি এলাকার মধ্যে ২টি এলাকা বাস্তবায়ন সংস্থা (বাপাউবো) পাইলোটিং প্রকল্প এলাকা হিসেবে বিবেচনা করে। উক্ত এলাকাগুলো হল টাংঙ্গাইল জেলা, ভূঞাপুর ও কালিহাতী। প্রযুক্তি নির্বাচনের ক্ষেত্রে বালু-ভর্তি জিওব্যাগ স্থাপন, বান্ডেল প্রযক্তি পানি পরিবাহী গ্রোইন, পানি অপরিবাহী গ্রোইন ও অন্যান্য প্রযুক্তি বিশ্লেষণ করা হয়েছিল। পরিবেশবান্ধব ও অন্যান্য সুযোগ সুবিধা বিচার বিশ্লেষণ করে Top Block permeable Groyne (TBPG) প্রযুক্তি টিকেই বাস্তবায়নের জন্য বিবেচনা করা হচ্ছে।

কালিহাতী এলাকায় নদী খননের জন্য কোন ড্রেজার ব্যাবহার করা হবে সেটা সঞ্চালক সংস্থার ও সংশ্লিষ্ট সকল গোষ্ঠীর সাথে আলোচনা করে সিদ্ধান্ত নেয়া হবে।

বর্তমান পরিবেশগত ও সামাজিক অবস্থা

ESIA এর বেসলাইন সাধারনত পরিবেশ, সামাজিক ও জীববৈচিত্র্যের ওপর পরিচালনা করা হয়।

পরিবেশগত বেসলাইন এলাকা বলতে বুঝার কোন প্রকল্পের নির্মাণ ও পরিচালনা দ্বারা সৃষ্টি প্রত্যক্ষ ও পরোক্ষ প্রভাব উক্ত এলাকার কত দ্রুত পর্যন্ত পরিবেশের উপর প্রভাব ফেলছে। CEGIS এর নিকট অভিজ্ঞ দল প্রাথমিকভাবে উক্ত এলাকা পরিদর্শন করে এলাকাভিত্তিক ফিজিক্যাল ও বায়োলজিক্যাল উপাত্ত সংগ্রহ করে এই বেসলাইন তৈরি করেছে।

আর্থসামাজিক বেসলাইন তৈরি করা হয়েছে সম্মিলিত প্রকল্পের প্রভাব প্রত্যক্ষ ও পরোক্ষ প্রভাব এবং প্রকল্প AoI এর বাইরেও প্রকল্প নিয়ন্ত্রক এলাকা নিয়ে এর সাথে কর্মসূচীর ৫ কিলোমিটার বাফার এলাকা ধরে আর্থসামাজিক অবস্থা কি বর্ণনা করা হয়েছে। জীববৈচিত্র্য বেসলাইন চিহ্নিত করা হয়েছে প্রাকৃতিক ও ফিজিক্যাল সীমানা নিয়ে সেখানে নদীর প্রবাহ, চর এলাকা, প্লাবনভূমি প্রভৃতি অন্তর্ভূক্ত করা হয়েছে সেটার পরিমাণ আনুমানিক ১৭৫৮৪ হেক্টর।

পরিবেশগত অবস্থা

যমুনা নদী প্রায় ৮-১২ কি.মি. প্রসস্থ সেখানে প্রাকৃতিকভাবে বিভিন্ন ছোট বড় অসংখ্য চ্যানেল, বালুচর ও বিভিন্ন জৈবিক আবাস্থল গড়ে উঠেছে। কালিহাতী এলাকায় নদীর প্রসস্থতা ৪.৮-৭.৬ কি.মি. (১৯৭৩-২০২০) এবং ভূঞাপুর এলাকায় ৮.১-৯.৯কি.মি. পর্যন্ত প্রসস্থতা লক্ষ্য করা যায়।১৯৭৩-২০২০ পরিসংখ্যান অনুযায়ী কালিহাতী এলাকায় বছরে ৪৮.৩৩ মি. এবং ভূঞ্চাপুর এলাকায় ৩২.৫ মি. ভাঙ্গন পরিলক্ষিত হয়।

বাৎসরিক বৃষ্টিপাতের পরিমাণ বছওে ১০০০ মিলি থেকে ৫০০০ মিলি পর্যন্ত পরিবতিত হয়। গত ৫৯ বছরের পরিসংখ্যান লক্ষ্য করলে দেখা যায় সে উক্ত এলাকায় ১১ বার ভারী বৃষ্টিপাত ২০০-৩০০ মিলি) এবং ৭ বার অতিভারী (৩০০+মি.মি.) বৃষ্টিপাত লক্ষ্য করা যায় জুন থেকে অক্টোবর এর মধ্যে সর্বোচ্চ পানি প্রবাহ লক্ষ্য করা যায় এবং নভেম্বর থেকে এপ্রিল মাসে সর্বনিম্ন পানিপ্রবাহ দেখা যায়। গত ৪০ বছরের গড় পানি প্রবাহ ছিল ১০৩১২৮.৮ মিটার^3 / সেকেন্ড (সেপ্টেম্বর) থেকে ১৪৯৬৮.৬ মিটার^3 /সেকেন্ড (ফেব্রুয়ারী).

বায়ুদূষণ মোটামুটি সীমিত কারণ উল্লেখযোগ্য কোন কলকারখানা এই এলাকায় নাই। বায়ু পর্যবেক্ষণ করে দেখা গেছে। এখানে SPM ২৬১ থেকে ৫৯৩ m^3, No-৬.৩৫-১১.৯ m/m^3 পরিমাণ বিদ্যমান থাকে।

গড় শব্দদূষণ ৩০-৫০ dBA যাহা ECR ২০০৬ এবং IFC -২০০৭ আইনের দ্বারা মেনে চলে।

জীববৈচিত্র্য এবং প্রাকৃতিক সম্পদ

দুইটা ভাগে ভাগ করা যায় (১) নদীতীলবর্তি এলাকা যেখানে পলি এলাকা, কর্দমাক্ত এলাকা, বালুচর এবং অর্ধনিমজ্জিত চর এলাকা অবস্থিত (২) প্লাবনভূমি যাহা স্থলজ ভূমি চর, শস্যভূমি, ঘাস, গৃহস্থলী সবজিবাগান, বালি উত্তোলন ও সংরক্ষণ এলাকা এবং অন্যান্য সাধারণ ভূমি ও গাছপালা অন্তর্ভূক্ত।

ভূমির সীমা ও ব্যবহারের ওপর ভিত্তি করে বাসস্থান মানচিত্র তৈরি করা হয় যেখানে ৭ ধরনের বাসস্থান লক্ষ্য করা গেছে। এগুলি হল সদ্য গঠিত চর এবং কর্দমক্ত এলাকা, নদীর পাড়, কৃষিভূমি, কোল (Embayment), বৃক্ষরাজী এবং নদীর পানির আবাসস্থল। চর ও কর্দমক্ত এলাকাগুলি প্রাকৃতিক আবাসস্থল এবং বাকিগুলি পরিবর্তিত আবাসস্থল হিসেবে চিহ্নিত করা হয়। নদী ও এর পাশ্ববর্তী এলাকাগুলি বাস্তসংস্থানের গুরুত্তপূর্ণ আবাস্থলকে সাহায্য করে যার মধ্যে মাছ, প্রজননভূমি, বিভিন্ন ধরনের সীরসৃপ (ঘড়িয়াল) স্তন্যপায়ী প্রানী (শুশুক) ইত্যাদি গুরুত্তপূর্ণ।

এর তথ্য অনুযায়ী যমুনা ব্রহ্মপুত্র নদী এলাকার গুরুত্বপূর্ণ পাখি এবং অন্যান্য জীববৈচিত্র্যে সমৃদ্ধ এলাকা। মধুপুর জাতীয় উদ্যান (৩২.৭ কি.মি. দূরে) এবং ২টি শুশুক অভয়ারন্য (৩৫.৮কি.মি.এবং ৩৬.৮ কি.মি.) দূরে অবস্থিত। প্রকল্প এলাকায় প্রায় ৭৬ প্রজাতির উদ্ভিদ দেখতে পাওয়া যায় যার মধ্যে ৪০ প্রজাতীর গাছ ৩৩ প্রজাতির ঘাস ও গুল্ম এবং ৩ টি কাঁশ প্রজাতির দেখা যায়।

৩৩২ প্রজাতির মেরুদন্ডী প্রাণীর মেধ্যে ২৫ টি স্তন্যপায়ী ২২৩ প্রজাতির পাখি ৩৬ প্রজাতির সরিসৃপ ১৫ প্রজাতি উভচর ও ৭৭ প্রজাতির মাছ দেখতে পাওয়া যায়। উল্লেখযোগ্য মাছের মধ্যে পিয়ালী, বাঁশপাতা, কাজুলী, বাছা, গোলসা, ঘারুয়া, বাইলা, চ্যালা, চাপিলা মাছ অন্যতম। গৃহস্থালী ফলগাছের মধ্যে খুখসা, অলিভ, আম, জাম, বরই, পেয়ারা, চালতা, খেজুর প্রভৃতি উল্লেখযোগ্য।

ক্রিটিক্যাল আবাসস্থল/Critical habitat

IBAT এর তথ্য অনুযায়ী এবং অন্যান্য জাতীয় পর্যবেক্ষণ পর্যালোচনা করে ESS-6 এর সাথে মিল রেখে Critical habitat মূল্যায়ন করা হয়েছে।

IBAT মোট ৯০৩ প্রজাতির তালিকা তৈরী করেছে যার মধ্যে ৯টি আন্তর্জাতিকভাবে মহাবিপন্ন Endangered (CR) এবং ১৮টি প্রজাতি Globally Endangered হিসেবে চিহ্নিত করা হয়েছে। Critical habitat এর মধ্যে মেছো বিড়াল ঘড়িয়াল ও অন্যান্য দুইটি মাছ প্রজাতি (বাঘাইড় ও চিতল) অন্যতম। শুশুক এবং ২টা মাছ প্রজাতিকে "Net Gain Requirement" হিসেবে চিহ্নিত করা যায়।

আর্থ সামাজিক অবস্থা

যমুনার তীরে বসবাসকারী জনগোষ্ঠী নদী বন্যা এবং নদীর তীর ভাঙনের জন্য অত্যন্ত ঝুঁকিপূর্ণ। পূর্বের একটি জরিপে দেখা গেছে যে যমুনা নদী এবং এর চরগুলির ধারে বসবাসকারী জনসংখ্যার ৩৫% তাদের জীবদ্দশায় ৩/৪ বার নদী তীর ভাঙনের কারণে বাস্তুচ্যুত হয়েছে। জুন ২০২১ এবং সেপ্টেম্বর ২০২১ উভয় পাইলট সাইটগুলিতে ঈউএওঝ দ্বারা পরিচালিত মাঠ পরিদর্শনগুলি চিহ্নিত করেছে যেখানে অনেক পরিবার, স্কুল (প্রাথমিক এবং উচ্চ), মসজিদ, মাদ্রাসা এবং মন্দিরগুলি বন্যা এবং ক্ষতির যথেষ্ট ঝুঁকিতে রয়েছে। এই এলাকায় মোট ২৬,৩০৭ টি পরিবার বাস করছে যার জনসংখ্যা ১,১৬,৪৫০ জন, যার মধ্যে ৫০.৭% পুরুষ এবং ৪৯.৩% মহিলা রয়েছে। লিঙ্গ অনুপাত হল ১০৩, যা প্রতি ১০০ জন মহিলার ১০৩ জন পুরুষকে বোঝায়। গড় ঘনত্ব প্রতি বর্গ কিলোমিটারে ১,১১২জন। গড় পরিবারের আকার হল ৪.৪ জন, বেশিরভাগ পরিবারে ৩ থেকে ৪ জন সদস্য রয়েছে (ইইঝ, ২০১২: ২০২০এর জন্য হিসেব করা হয়েছে) কর্মসংস্থানের পরিপ্রেক্ষিতে, শ্রমশক্তিকে তিনটি সেক্টরে ভাগ করা হয়েছে: কৃষি, চাকুরী এবং শিল্প। ২০১২ এর তথ্য অনুসারে, এই এলাকায় কৃষি হল জীবিকা নির্বাহের প্রধান মাধ্যম, আনুমানিক ৮৩%। এই গোষ্ঠীর মধ্যে কৃষকদের অন্তর্ভুক্ত রয়েছে, যার মধ্যে রয়েছে বর্গা চাষী, জেলে (পেশাগত এবং মৌসুমী), এবং গবাদি পশু ও হাঁস-মুরগির খামারিরা। দ্বিতীয় বৃহত্তম কর্মসংস্থানের খাত হল চাকুরী খাত, যা অফিস, শিক্ষকতা ইত্যাদিতে কর্মরত বেতনভোগী কর্মচারী এবং পরিবহন পরিষেবার সাথে জড়িত ব্যক্তিদের বোঝায়. প্রকল্প এলাকার প্রায় ১৯% লোক চাকুরী খাতে নিয়োজিত, যা প্রোগ্রাম অঙও (১৩%) তে তুলনামূলকভাবে কম। এছাড়াও, বাণিজ্যিক/শিল্প খাতে (পোশাক উৎপাদন সহ) সম্পৃক্ততা প্রোগ্রাম অঙও (৪%) থেকে ঝঅঅ (৮%) তে বেশি। এই এলাকায় বিবাহ বিচ্ছেদের হার বেশ বেশি। প্রায় ৮.৫% মহিলা বিধবা। ঐতিহ্যগতভাবে নারীরা ধর্মীয় ও সামাজিক বন্ধনের কারণে এই এলাকায় অত্যন্ত রক্ষণশীল, যা জনসাধারণের পরিবেশে তাদের অংশগ্রহণকে সীমিত করে। অর্থনৈতিক কর্মকান্ডে নারীদের অংশগ্রহণ কম (ভূয়াপুরে মাত্র ৩% নারী কর্মরত, এবং কালিহাতীতে এই সংখ্যা ০.৯%)। মহিলা বেশিরভাগ গৃহস্থালির কাজ পরিচালনা করে। নারী ও পুরুষ এর মজুরির হারে পার্থক্য রয়েছে, নারীদের বেতন কম। মহিলাদের মধ্যে সাক্ষরতার হারও পুরুষের তুলনায় কম (প্রায় ৪৫% পুরুষ এবং ৩৫% মহিলা শিক্ষিত)। পরামর্শের সময় মহিলারা তাদের অংশীদারদের দ্বারা যৌন হয়রানির ও অভিযোগ করেছেন। খুব কম সংখ্যক মহিলা যাদের একটি সচ্ছল পৈতৃক পরিবার আছে তারাই আওয়াজ তোলেন এবং বিচার চান। আলোচ্য প্রকল্প এলাকা সীমানার মধ্যে কোন পরিচিত আদিবাসী বা ক্ষুদ্র জাতিগত সংখ্যালঘু গোষ্ঠী বা বসতি নেই। প্রকল্পের এলাকার মধ্যে কোনো পরিচিত সাংস্কৃতিক ঐতিহ্য বা ঐতিহাসিক স্থান নেই।

পরিবেশ, সামাজিক, শ্রমিক, পেশাগত স্বাস্থ্য ও শ্রমিক নিরাপত্তা, সাম্প্রদায়ীক নিরাপত্তা এবং সুরক্ষা বিষয়ক প্রভাব ও তাহার প্রশমন পন্থা ঃ

প্রভাব মূল্যায়ন সাধারণত ক্ষতিকর প্রভাবগুলিকে উল্লেখ করা হয়েছে। বিভিন্ন নথি পত্র পর্যালোচনা, বিশেষজ্ঞের মতামত ও আলোচনা সাপেক্ষে গুরুত্বপর্ন কিছু পরিবেশ ও সামাজিক ক্ষেত্রের E & S ঝুঁকি চিহ্নিত করা হয়েছে।

ঝুঁকিগুলি ঃ তাৎপর্য ও প্রভাব বিচার বিবেচনা করে উক্ত ঝুঁকিগুলিকে "উচ্চ" "উল্লেখযোগ্য" এবং "নিম্ন" ভাগে ভাগ করা হয়েছে।

নির্মাণ ও নির্মাণ পূর্ববর্তী কাছের প্রভাব (ESS1)

উল্ল্যেখযোগ্য কর্মসূচীর মধ্যে জমি অধিগ্রহণ এবং পূনর্বাসন, শ্রমিক সংগ্রহ নির্মাণ ও ড্রেজিং সংক্রান্ত দূষণ ইত্যাদি। In-Situ পাইলিং এর মাধ্যমে শব্দ দূষণ বাড়তে পারে। উল্লেখ্য যে ভূঞাপুর ৩৬৬ এবং কালিহাতীতে ৫৪০টি পাইল নির্মাণ হবে। শব্দের মাত্রা আনুমানিক ৮৪.৯৩ ডেসিবেল ৫০ মিটারের মধ্যে ৭৭.৪০ ডেসিবেল ১০০ সিঃ এর মধ্যে, ৫৯.৯৩ ডেসিবেল ৫০০ এর মধ্যে, ৫২.৪০ ডেসিবেল ১ কি.মি. এর মধ্যে এবং ৪৪.৮৮ ডেসিবেল ২কি.মি. এর মধ্যে পরিলক্ষিত হবে। নির্মাণ বর্জ্য ও ড্রেজিং নদীর পানির অসচ্ছতা বাড়িয়ে পানি দূষণ করবে। ESCOP এর মাধ্যমে উক্ত ক্ষতিকর প্রভাবগুলি প্রশমিত করা যেতে পারে। নির্মাণ কাজের দ্বারা সৃষ্ট জনসাধারণের সমস্যা ও বিরক্তি গুলো ESCOP ও অন্যান্য পন্থার মাধ্যমে দূর করা যায়।

শ্রমিক ও কাজের পরিবেশ (ESS2) ঃ

শ্রমিক ব্যবস্থাপনা পদ্ধতি এর মাধ্যমে আমরা ৪ (চার) ধরনের শ্রমিক/কর্মকর্তা নিয়োগের ব্যাপারে ধারনা করতে পারি (১) সরাসরি সরকার কর্তৃক নিয়োজিত কর্মকর্তা এবং পরামর্শদাতা (২) চুক্তি ভিত্তিক শ্রমিক (৩) স্থানীয় সাম্রদায়িক শ্রমিক (৪) সরবরাহকারী শ্রমিক।

যে সকল স্বাস্থগত ঝুঁকি এই প্রকল্পে আসতে পারে তারমধ্যে শিশুশ্রম, শ্রমিকদের মজুরী না দেয়া, অন্যান্য সুযোগ সুবিধা থেকে বঞ্চিত করা, অসামঞ্জস্য মজুরী, যৌন নর্যাতন/যৌন হয়রানী কোভিড-১৯, এইচ আই ভি / এইডস বিষয়গুলি অন্যতম।

উক্ত ঝুঁকিগুলি নিরসনের লক্ষ্যে একটা পৃথক শ্রম ব্যবস্থাপনা পদ্ধতি (LMP) তৈরী করা হবে সেটা বাংলাদেশের বিদ্যমান আইন কানুন মেনে চলবে এবং বিশ্বব্যাংকের নির্ধারিত পরিবেশ ও সামাজিক মানদন্ডের সাথে কি কি পার্থক্য আছে সেগুলি খুঁজে বের করবে। আলোচ্য শ্রম ব্যবস্থাপনা পদ্ধতি শ্রমিকদের স্বাস্থ নিরাপত্তা নিশ্চিত করার পাশাপাশি বিশ্বব্যাংকের মানদন্ড-৪ এর নির্দেশিকাও মেনে চলবে।

বাস্তবায়ন সংস্থা কোভিড-১৯ সংক্রামন রোধে সকল বিধিনিষেধ মেনে চলার পাশাপাশি বিশ্বব্যাংকের অন্তর্বতীকালীন নির্দেশিকাও (WB Interim Note) মেনে চলবে।কিছু ঝুঁকি প্রতিরোধ ব্যবস্থা নীচে লিপিবদ্ধ করা হল ঃ

- প্রকল্পটি শিশুশ্রম এবং জোর পূর্বক কাজে নিয়োগ কে প্রহিত করবে।
- অভিজ্ঞ এবং দক্ষ কর্মকর্তা নিয়োগ দিতে হবে যার শ্রম ব্যাবস্থাপনা পদ্ধতির সঠিক প্রণয়ন করতে সক্ষম
- সঠিক অভিযোগ প্রতিকার ব্যবস্থা (GRM) চালু করতে হবে
- শ্রমিকদের স্বাস্থ সম্মত বাসস্থান স্থাপন এবং বিশুদ্ধ পানি সরবরাহ নিশ্চিত করতে হবে
- নির্মাণ এলাকায় এবং শ্রমিকদেও বাসস্থানে পর্যাপ্ত চিকিৎসা ব্যবস্থার ব্যবস্থা করতে হবে
- শ্রমিক বাসস্থান অবশ্যই GIIP এ উল্লেখিত নিয়ম মেনে তৈরি করতে হবে
- শ্রম স্বাস্থ্য ও নিরাপত্তার ওপর শ্রমিকদের যথেষ্ঠ প্রশিক্ষণ দিতে হবে
- যে কোন কাজের পূর্বে OHS ঝুঁকি বিশ্লেষণ করে কন্ট্রাকটর OHS প্লান তৈরি করবে
- সঠিক এবং যথাযথ প্রতিরক্ষা মূলক সরঞ্জাম ছাড়া কাজের জায়গায় ঢোকা যাবে না

সম্পদ দক্ষতা এবং দূষণ রোধ ও ব্যবস্থাপনা **(ESS ৩)**

তীর সুরক্ষা কাজ এবং গ্রোয়েন নির্মাণের জন্য মাটি, বালি, নুড়ি, চূর্ণ পাথরের সমষ্টি, গোলাকার শীলা খন্ড এবং বালির মতো বিভিন্ন উপকরণের প্রয়োজন হবে। দেখা যাচ্ছে যে অধিকাংশ নির্মাণ সামগ্রী বাংলাদেশের মধ্যেই পাওয়া যায়। অন্যান্য গুরত্বপূর্ণ উপকরণ যেমন মোটা এগ্রিগেট, বিটুমেন, স্ট্যান্ড, এক্সপেনশন জয়েন্ট, বিয়ারিংগুলিও স্থানীয় বিক্রেতাদের কাছ থেকে কেনা হবে যারা সাধারণত ভারত থেকে এই উপকরণগুলি আমদানি করে। সাধারণত এই উতসগুলিতে পরিবেশগত ও সামাজিক প্রভাব কম।

প্রাকৃতিক আবাসস্থলকে প্রভাবিত করে না এমন এলাকার উৎস থেকে কিংবা শিশুশ্রম বা জোরপূর্বক শ্রম ব্যবহার করা হয় এমন উৎস থেকে মালামাল সংগ্রহ করা হবে না ।

ভূয়াপুরে ১৭১৮৫.৫৩ মিটার এবং কালিহাতী সাইটে ২৮৫৬৮.৭ মিটার পাইল ড্রাইভিং চারপাশের শব্দ বৃদ্ধি করতে পারে যাহা পাইলট সাইটের কাছাকাছি স্থানীয় সম্প্রদায়ের ওপর একটি ক্ষতিকারক ক্ষতিকর প্রভাব ফেলতে পারে। পাইলিং এর সময় যেন উচ্চমাত্রার শব্দ সৃষ্টি যে না হয় সেইজন্য ভাইব্রেটরি হ্যামার ব্যবহার করা হবে। নির্মাণ কাজে ভূগর্ভস্থ পানি ব্যবহার করা হবে না। ভূগর্ভস্থ পানি শুধুমাত্র পানীয় এবং অন্যান্য গৃহস্থালী কাজে ব্যবহার করা হবে। নির্মাণের সময় দূষণের ঝুঁকিগুলি পরিচালনা করার জন্য ESIA-তে বেশ কয়েকটি ESCOP রয়েছে:

ESCOP 1: বর্জ্য ব্যবস্থাপনা

ESCOP 2: জ্বালানি এবং বিপজ্জনক পণ্য ব্যবস্থাপনা

ESCOP 3: জল সম্পদ ব্যবস্থাপনা

ESCOP 4: পানি নিষ্কাশন ব্যবস্থাপনা

ESCOP 5: মাটির গুণমান ব্যবস্থাপনা

ESCOP 6: ক্ষয় ও পলি নিয়ন্ত্রণ

ESCOP 7: উপরের মৃত্তিকা ব্যবস্থাপনা

ESCOP 8: টপোগ্রাফি এবং ল্যান্ডস্কেপিং

ESCOP 9: খাদ/আকর এলাকা উন্নয়ন এবং অপারেশন

ESCOP 10: বায়ুর গুণমান ব্যবস্থাপনা

ESCOP 11: শব্দ এবং কম্পন ব্যবস্থাপনা

ESCOP 12: উদ্ভিদের সুরক্ষা

ESCOP 13: প্রাণীজগতের সুরক্ষা

ESCOP 14: সড়ক পরিবহন এবং সড়ক ট্রাফিক ব্যবস্থাপনা

ESCOP 15: নির্মাণ শিবির ব্যবস্থাপনা

ESCOP 16: সাংস্কৃতিক এবং ধর্মীয় সমস্যা

ESCOP 17: শ্রমিকদের স্বাস্থ্য ও নিরাপত্তা

ESCOP 18: নির্মাণ এবং অপারেশন ফেজ নিরাপত্তা

ESCOP 19: ভারী যন্ত্রপাতি ব্যবস্থাপনার অপারেশন

ESCOP 20: খনন

ESCOP 21: উত্তোলন এবং উপাদান হ্যান্ডলিং

ESCOP 22: ড্রেজিং এবং নিষ্পত্তি

সমাজ, স্বাস্থ্য ও নিরাপত্তা (ESS4) ঃ

এই বিষয়টি বিশ্বব্যাংকের সামাজিক মানদন্ড-৪ এর সাথে সম্পৃক্ত।

সামাজিক বিপদ/ঝুঁকিগুলি সাধারণত প্রকল্পের নির্মাণ ও অপারেশন ধাপে বেশি পরিলক্ষিত হয়। এগুলির মধ্যে সংক্রামক রোগের বিস্তার (যক্ষা, করোনা ভাইরাস), ভেক্টর-বাহিত রোগ, যৌন নির্যাতন/যৌন হয়রানী, এলাকার রাস্তা ব্যবহার ঝুঁকিগুলি অন্যতম,

উক্ত ঝুঁকি নিরসনের লক্ষ্যে প্রকল্প ব্যবস্থাপনা কমিটি একটি স্বাস্থ্য ও নিরাপত্তা বিষয়ক দল গঠন করবে যারা ঝুঁকি প্রশমন ব্যবস্থাগুলি ঠিকমত মেনে চলা হচ্ছে কিনা সেগুলি নিশ্চিত করবে।

CHS প্লান তৈরি করার পাশাপাশি কন্ট্রাকটর একটি জরুরী দুর্যোগ মোকাবেলা পরিকল্পনাও (EPRP) তৈরি করবে।

যেহেতু পরীক্ষামূলক এলাকাগুলি গ্রামের ভেতর অবস্থিত সেহেতু মোটামুটি ভাল পরিমাণ শ্রমিক কাজে নিযুক্ত থাকবে। যার ফলে যৌননির্যাতন/যৌন হয়রানি সংক্রান্ত ঝুঁকিগুলি উল্লেখযোগ্য ঝুঁকিপূর্ণ (Substantial) হিসবে বিবেচিত হবে।

<u>ভূমি অধিগ্রহন, ভূমি ব্যবহারের নিষেধাজ্ঞা এবং অনিচ্ছকৃত পূনর্বাসন</u> (<u>ESS5</u>)ঃ

প্রস্তাবিত প্রকল্পের জন্য মোট ৫২২.৩৫ একর জমির প্রয়োজন হবে রিভেটমেন্ট নির্মাণ, খনন সামগ্রীর যথাযথ নিষ্পত্তি এবং বন্যার আশ্রয়কেন্দ্র নির্মাণের জন্য (CDD এর অধীনে) জমির প্রয়োজনীয়তার পরিমান ও জমির অধিগ্রহণের সম্ভাব্য পদ্ধতি নীচের টেবিলে উল্লেখ করা । যেহেতু নকশা সংশোধনের কাজ চলছে এই পর্যায়ে একটি পূনর্বাসন নীতি কাঠামো তৈরি করা হচেছ।

প্রকল্প কর্মসূচী	জমির পরিমান	জমি নেয়ার পদ্ধতি	প্রকল্পের দ্বারা ক্ষতিগ্রহস্থ মানুষ
রিভেটমেন্ট নির্মাণ এবং কালিহাতী পাড় নির্মাণ	১১.৮৬ একর	ভূমি অধিগ্রহন ও পূনর্বাসন	২৫ (১৩ জন পরুষ, ১২জন মহিলা) ৭৮টি ঘর উচ্ছেদ
রিভেটমেন্ট নির্মাণ ও ভূঁঞাপুর এলাকার পাড় নির্মাণ	১৭.০৫ একর	ভূমি অধিগ্রহন ও পূনর্বাসন	৩৬৭ (১৮৫ জন পরুষ, ১৮১ জন মহিলা) ৪টি ঘর উচ্ছেদ
কালিহাতী এলাকার ড্রেজিং সামগ্রীর নিষ্পত্তি	৪১৫ একর	সিরাজগঞ্জ অর্থনৈতিক এলাকা বাপাউবো কে তাদের ৪১৫ একর জায়গা ভরাট করার অনুরোধ করেছে	নেই
কাওয়াকোলা চর রক্ষা ও বন্যা আশ্রয়কেন্দ্র নির্মাণ	৭৮.৪৪ একর	ক্রেতা বিক্রেতার ইচ্ছায় নিষ্পত্তি বা স্বেচ্ছায় জমি দান পদ্ধতি	১২০ (৬৫ জন পরুষ, ৫৫ জন মহিলা)

<u>জীব বৈচিত্র্য রক্ষা এবং টেকসই প্রাকৃতিক সম্পদ ব্যবস্থাপনা (ESS6)ঃ-</u>

প্রকল্প-১ এর কার্যক্রম এর মাধ্যমে জীব বৈচিত্র্যের উপর ঝঁকিগুলি সাধারনত অল্প থেকে মাঝারী ধরনের ঝঁকি থাকবে । ঝুঁকিগুলির মধ্যে জলজ ও স্থলজ বাস্তুতন্ত্রের ব্যাগাত , বিভিন্ন প্রজাতির বাসস্থানের পরিবর্তন প্রজাতির গঠনের পরিবর্তন , আবাস্থলের বিচ্ছিন্নতা অন্যতম।

নির্মাণ পর্যায়ে প্রধান প্রভাবগুলি হলঃ

- তীর সংলগ্ন পরিবর্তিত আবাসস্থলের ক্ষতি
- প্রাকৃতিক আবাসস্থলের উপর ব্যাঘাত বাড়তে পারে কারন নির্মাণ কাজের জন্য বায়ু দূষণ শব্দ দূষন এবং পানি-দূষন ও বেড়ে যাবে।
- ড্রেজিং এর কারণে নদী তলদেশের প্রজাতির ক্ষতি হতে পারে
- নেভিগেশন সামগ্রী এবং নিশাচর বন্যপ্রানীর ব্যাঘাত পারে।
- সংঘর্ষের কারনে ঘড়িয়াল এবং শুশুক শারীরিক আঘাতের ঝুঁকি ।
- বাঘাইর এবং চিতল মাছের আবাসস্থলের সাময়িক ক্ষতি ।
- আলো ও শব্দের কারনে শুশুক ও ঘড়িয়ালের চলাচলের ব্যাঘাত ঘঠতে পারে, এছাড়া ও নদী ও চরের জলজ প্রাণীর (ব্যাঙ, কচ্ছপ, মাছ, সরীসৃপ) উপর ও ঝুঁকি নেমে আসতে পারে।

প্রকল্পের অপারেশন পর্যায়ে যে, সকল ঝুঁকির সম্ভাবনা আছে তার মধ্যে কাঁদামুক্ত এলাকা সংকোচন, পলি অঞ্চলের পরিমান কমে যাওয়া চরাঞ্চলের মত প্রাকৃতিক আবাসস্থল নষ্ট হওয়া জাহাজের মাধ্যমে দূষন ইত্যাদি উল্লোখ যোগ্য ।

আদিবাসী মানুষ (ESS7)ঃ

বিশ্বব্যাংকের সামজিক দন্ড-৭ এর বৈশিষ্ট্যের উপর ভিত্তি করে উক্ত সামাজিক ক্ষেত্রে কোন আদিবাসী পাওয়া যায়না, এটি সামাজিক প্রভাব মূল্যায়নের মাধ্যমে নিশ্চিত করা হয়েছে। এবং বিশ্ব ব্যাংকের টিম দ্বারা নিশ্চিত করা হয়েছে।

সাংস্কৃতিক ঐতিহ্য (ESS 8)ঃ

সম্প্রতি কিছু মসজিদ এবং মন্দির ছাড়া আলোচ্য এলাকায় কোনো পরিচিত সাংস্কৃতিক ঐতিহ্য বা ঐতিহাসিক স্থান নেই, যেহেতু উক্ত স্থাপনাগুলি কোনটাই প্রকল্পের নির্মানাধীন এলাকায় পড়েনা সেহেতু সাংস্কৃতিক ঐতিহ্যের ওপর কোন বস্তুগত প্রভাব পড়বে না।

তদুপরি যদি কোন ঐতিহ্য পাওয়া যায় বাংলাদেশের প্রচলিত আইন, প্রত্নতাত্ত্বিক বিধিমালা ও FSF মেনে যথাযথ ব্যবস্থাপনা পরিকল্পনা প্রস্তুত করা হবে। ।

আর্থিক মধ্যস্থতাকারী (**ESS 10)**

প্রকল্প ১ এর অর্থায়নে কোন আর্থিক মধ্যস্থতাকারী জড়িত নাই। অতএব, **ESS9** প্রযোজ্য নয়

জনগন এর সাথে পরামর্শ ও জন-অবহিতকরন (ESS 10) ঃ

এই ESAA তৈরি করার সময় ধারাবাহিক প্রকল্প-১ এর জন্য বেশ কিছু পরামর্শ সভা করা হয়েছিল, ২০২১ এর জুন থেকে শুরু করে ২০২২সালের ফেব্রুয়ারী পর্যন্ত স্থানীয় সরকারি কর্মকর্তা স্থানীয় সরকারী প্রতিষ্ঠানের নির্বাচিত সদস্যবৃন্দ, এবং বাস্তবায়ন সংস্থার স্থানীয় কর্মকর্তাদের IAS উপস্থিতি স্থানীয় জনগনের সাথে মোট-১৯টি পরামর্শ সভা করা হয়েছিল। উক্ত সভায় সে সকল বিষয় গুলি জনগন উপস্থাপন করেছিল সেগুলি হলঃ

- ক্রমাগত নদী ভাঙ্গন ও জমির ক্ষতিসাধন
- তীর রক্ষা ও নদী স্থিতিশীল করতে উপযুক্ত ব্যবস্থার অভাব
- ভাংগনে বাস্তুচ্যুতদের সহায়তা করার জন্য সমর্থন ও নীতির অভাব ।
- সর্বোপরি জীবন জীবীকার ক্ষতি এবং বেঁচে থাকতে বিকল্প আয়ের সীমিত উৎস

যেহেতু প্রকল্প পরিকল্পনা , স্টোকহোল্ডার বাস্তবায়ন ও অপারেশন চলাকালে এই ধরনের সভা অব্যাহত রাখতে হবে তাই (ESIA) করার পাশাপাশি একটি আলাদা স্টোকহোল্ডার এনগেজমেন্ট প্লান (SEP) প্রস্তুত করা হচ্ছে। এই SEP বাংলাদেশের প্রচলিত বিধি নিষেধ ও বিশ্বব্যাংকের প্রনিত সামাজিক মানদন্ড-১০(ESS 10) মেনে চলে, উদাহরন স্বরূপ জাতীয়/আঞ্চলিক স্টোকহোল্ডার প্রকল্প প্রভাবিত মানুষ,দূর্বল সম্প্রদায়, স্থানীয় সম্প্রদায়ের জনগন , বিভিন্ন পেশার মানুষ মহিলা গোষ্ঠী, শ্রমিক, ঠিকাদার ইত্যাদি । সর্বোপরি সব ধরনের জনগন যাতে তাদের স্বাধীন মতামত এবং ইতিবাচক ও নেতিবাচক মন্তব্য প্রদান করতে পারে তার জন্য একটি সহজ ব্যবস্থা প্রদান করা।

অন্যান্য চলমান ও সম্ভব্য ভবিষ্যৎ প্রকল্প এবং এই প্রকল্পের সামস্টিক প্রভাব নিরুপন (R-CIA) ঃ

R-CIA এর মূল উদ্দেশ্য হল JRECDP এর প্রকল্প-১ এর কার্যক্রমের দ্বারা যমুনা নদীর ওপর পূর্ববর্তী ও ভবিষ্যতের বিভিন্ন কার্যক্রমের সম্মিলিত প্রভাব নিরুপন করা যাহা IFC (2009) এর নির্দেশিকা অনুসরন করে করা হবে।

R-CIA এর জন্য যে সকল প্রজেক্ট গুলি বিবেচনা করা হয়েছে সেগুলি হলঃ

(১) FREMIP বন্যাও তীর ক্ষয় ঝুঁকি ব্যবস্থাপনা বিনিয়োগ কার্যসূচী
(২) ড্রেজিং কার্যক্রম ও অন্যান্য নদী স্থিতিশীকরন কাজ
(৩) বঙ্গবন্ধু রেলওয়ে সেতু
(৪) উজানের পানি ডাইভারশন Water diversion ও হাইড্রো প্রকল্প
(৫) সম্বনিত যমুনা পদ্মা নদী স্থিতিশীলকরন ও ভূমি পুনরুদ্ধার প্রকল্প
(৬) প্রধান নৌ-চলাচলের রুটের সংযোগের টেকসই পুনরুদ্ধার
(৭) বুড়িগঙ্গা নদীর পূনরুদ্ধার প্রকল্প (নতুন ধলেশ্বরী -পূংলী-বাংশাই তুরাগ বুড়িগংঙ্গা নদী ব্যবস্থা)

তথ্য পর্যালোচনা করে এবং স্বচ্ছ ও অর্থপূর্ন পরামর্শের ভিত্তিতে তিনটি (৩) মূল্যবান পরিবেশগত উপাদান (VEC) চিহ্নিত করা হয়েছে।

(ক) বন্যা ও নদীভাঙ্গন

(খ) জলজ জীব বৈচিত্র্য

(গ) গ্রামীন/ চরাঞ্চলের জীবিকা

সামস্টিক প্রভাবগুলি নদীর শাসন ও সঙ্কোচোন এর সাথে সম্পৃক্ত। নদী সংকুচিত হলে, চরাঞ্চলে ও ভাটিতে বন্যা ও নদী ভাঙ্গন বৃদ্ধি পেতে পারে। বেশিরভাগ সামস্টিক ঝুঁকিগুলি উল্লেখযোগ্য থেকে মাঝারী ধরনের। এই ঝুঁকি মোকাবেলায় বিশদ মাস্টার প্লান কৌশলগত হস্তক্ষেপ, আঞ্চলিক হাইড্রোলোজিক্যাল মডেলিং এবং যমুনা পদ্মা এবং মেঘনা নদীর সম্মিলিত ও সমন্বয় মূল পরিকল্পনা গ্রহন করার পাশাপাশি সহযোগিতামূলক ব্যবস্থাপনার প্রয়োজন হবে।

পরিবেশ ও সামাজিক ব্যবস্থাপনা পরিকল্পনা (ESMP) ঃ

ESMP প্রকল্পের পরিবেশগত ও সামাজিক ঝুঁকি ও প্রভাবগুলি, প্রশমিত করার জন্য ডিজাইন করা হচ্ছে, এটার মধ্যে রয়েছে প্রশমন ব্যবস্থা সক্ষমতা বৃদ্ধি রিপোটিং সিস্টেম এবং বাজেট ESMP তে ঝুঁকি ও প্রভাব প্রশমন ও নিয়ন্ত্রন ব্যাবস্থা উল্লেখ করা হয়েছে যার মধ্যে রয়েছে

(১) সাধারন নির্মান কাজ ও অপারেশনের সময় সৃষ্ট ঝুঁকিগুলি প্রশমিত করতে পরিবেশ ও সামাজিক কোড ESCOP এর প্রচলন
(২) নিদিষ্ট প্রকল্প এবং যতটা সম্ভব সাইট নির্দিষ্ট প্রশমন ব্যবস্থা।
(৩) নির্মাণ কাজের পরিবেশগত ও সামাজিক অ্যাকশান প্লান (CESAD) যাহা কন্ট্রাকটারকে ৯০ দিনের মধ্যে জমা দিতে হবে।
(৪) ঠিকাদারদের দ্বারা প্রস্তুত করা (OHS) ব্যবস্থাপনা সিস্টেম প্রক্রিয়া এবং স্ট্যান্ডার্ড অপারেটিং পদ্ধতি
(৫) তাৎপর্যপূর্ন ও ক্রমবর্ধমান প্রভাবগুলিকে চিহ্নিত করতে (ESMP) উপপরিকল্পনা প্রস্তুত করন।

ESMP তে কিছু কিছু উপ-পরিকল্পনা আছে যেগুলি হলঃ

(১) পেশাগত স্বাস্থ্য ও নিরাপত্তা পরিকল্পনা (OHS Plan)
(২) বন্যা ব্যাবস্থাপনা পরিকল্পনা
(৩) জাহাজ দূষন ব্যবস্থাপনা পরিকল্পনা
(৪) উৎস ব্যবস্থাপনা পরিকল্পনা
(৫) জীববৈচিত্র্য ব্যাবস্থাপনা পরিকল্পনা
(৬) নেট লস / নেট লাভের কৌশল
(৭) ড্রেজিং সামগ্রী নিষ্পত্তি পরিকল্পনা
(৮) সামাজিক ব্যাবস্থাপনা পরিকল্পনা
(৯) জীবিকা পুনরুদ্ধার পরিকল্পনা

ESMP বাস্তবায়নের মোট খরচ ধরা হয়েছে ১১.৬৮৮,৬৯২ ডলার । এর মধ্যে USD ১৯.১৮,৬৯৪ সিভিল কাজের জন্য : ৭৮৬০৯০০ ডলার PIU এর ক্ষমতা বৃদ্ধি ও পরামর্শ পরিসেবার জন্য ঃ USD ৫৮৮২৩৫ অতিরিক্ত গবেষনার জন্যঃ USD ২৭৯৯৯৮৬ RFP এর জন্য এবং USD ৮৯৭৯৭৬ জীবীকা পুনরুদ্ধার এবং উন্নয়নের জন্য ।

পরিবেশ ও সামাজিক পর্যবেক্ষনঃ-

PIU পরিবেশ নিয়ন্ত্রক কর্তৃপকক্ষের সহযোগীতায় ESMP প্রনয়ন হচ্ছে কিনা সঠিকভাবে পর্যাবেক্ষন করবে। এই পর্যবেক্ষন পরিকল্পনা সারনি ৮ এ উপস্থাপন করা হয়েছে।

ঝুঁকি ব্যাবস্থাপনায় বাস্তবায়নকারী **সংস্থার কর্মদক্ষতার মূল্যায়নঃ**

যদিও উভয় সঞ্চালক সংস্থার বিশ্বব্যাংকের প্রকল্প পরিচালনার অভিজ্ঞতা আছে কিন্তু বিশ্বব্যাংকের নতুন আরোপিত পরিবেশও সামাজিক মানদন্ডের ESF এর আশুতার কাজ এটাই প্রথম । নতুন আরোপিত এই প্রস্তাবনায় পরিবেশ ও সামাজিক বিষয়গুলি খুবই গুরুত্বর সাথে বিবেচনা করা হয়েছে বলে সঞ্চালক সংস্থাকে দক্ষ ও যথেষ্ঠ লোকবল নিয়োগ নিশ্চিত করতে হবে। ESIA দলটি

পরিবেশ ও সামাজিক ঝুঁকি পরিচালনার বর্তমান ক্ষমতা,ফাঁক এবং ক্ষমতা প্রয়জনীয়তা বোঝার জন্য উভয় সঞ্চালক সংস্থার উচ্চ-পদস্থ কর্মকর্তাদের সাথে ধারাবাহিক সাক্ষাৎকার পরিচালনা করেছে। উক্ত সাক্ষাতকারে জানা যায় বর্তমানে উভয় সঞ্চালক সংস্থার পরিবেশ ও সামাজিক ঝুঁকি ব্যবস্থাপন ক্ষমতা অপর্যাপ্ত কর্মীও অপ্রতুল অনশীলন দ্বারা পরিচালিত সেহেতু প্রকল্প-১ এর পরিধী সীমিত তাই একটি অ্যাড-হক পদ্ধতির মাধ্যমে PIU তে পরিবেশ ও সামাজিক বিশেষজ্ঞদের অন্তর্ভূক্তির প্রস্তাব করা হয়েছে।

যাই হোক, ধারাবাহিক প্রকল্পের SOP আসন্ন প্রকল্পের জন্য একটি দীর্ঘমেয়াদী পরিকল্পনা প্রস্তাব করা হয়েছে যার মধ্যে বাপাউবো এবং বিআইডাব্লুটিএ এর জন্য একটি পরিবেশ ও সামাজিক ঝুঁকি ব্যবস্থাপনা শাখা বা দপ্তর তৈরি করা ।

উক্ত সাক্ষাতকার থেকে প্রাপ্ত তথ্যের ওপর ভিত্তি করে বিশ্বব্যাংকের ESF এর সাথে সংগতি রেখে একটি পরিবর্তিত প্রতিষ্ঠানিক চার্ট Organogram প্রস্তুত করা হয়েছে যেটা কিনা সঞ্চালক সংস্থার সাথে আলোচনা করে তাদের মতামত নিয়ে ভবিষ্যত ক্ষমতা বৃদ্ধির জন্য করা হয়েছে।

অভিযোগ প্রতিকার ব্যবস্থা GRM

প্রকল্প-১ এর থেকে উদ্ভুত সমস্যা ও সকল শ্রেণীর স্টোকহোল্ডার অভিযোগ দাখিল ও তার আশু প্রতিকারের জন্য উভয় সঞ্চালক সংস্থা পৃথক পৃথক অভিযোগ নিশপত্তি প্রক্রিয়া GRM প্রতিষ্ঠা করবে । ক্ষতিগ্রস্থ মানুষের উদ্বেগ অভিযোগ গ্রহন ও সঠিখ সমাধানের জন্য GRM হবে ২ স্তরের যেমন মাঠ পর্যায়ের ও প্রকল্প স্তরের প্রকল্পের জন্য প্রস্তুত SEP তে GRM এর বিস্তারিত বিবরন দেয়া হয়েছে।

উপসংহার ঃ

প্রকল্প-১ এর প্রস্তাবিত কার্যক্রম সামগ্রিক যমুনা নদী অর্থনৈতিক করিডোর উন্নয়ন কর্মসূচীর JRECDP তুলনায় খুব ছোট আকারের বলে বেশিরভাগ প্রভাব ও ঝুঁকি গুলো যথেষ্ঠ থেকে মাঝারী বলে মূল্যায়ন করা হয়েছে। অপারেশন ও রক্ষনাবেক্ষন পর্যায়ের প্রভাবগুলি ESMP এবং অন্যান্য প্রশমন ব্যবস্থার মাধ্যমে নিয়ন্ত্রন করা যাবে এবং নির্মান পর্যায়ের প্রভাবগুলি সাধারনত এলাকা ভিত্তিক যাহা ESCOP এবংGIIP গ্রহনের মাধ্যমে সহজেই দূর করা যাবে । এই প্রকল্পের মাধ্যমে উভয় সঞ্চালক সংস্থার পরিবেশ ও সামাজিক ঝুঁকি মোকাবেলায়র ক্ষমতা বৃদ্ধি পাবে এবং ESF এর সাথে সামাজের সামাঞ্জস্য রেখে ESMP সঠিকভাবে বাস্তবায়ন ও পর্যবেক্ষন নিশ্চিত করা সহজ হবে। অতএব প্রকল্প-১ এর অবশিষ্ট প্রভাবগুলি কম বলে মূল্যায়ন করা হয়।

সারণী **৩:** উল্লেখযোগ্য (S) ও উচ্চ (H) ঝুঁকি এবং প্রভাব গুলোর রেটিং সহ প্রশমনের ব্যবস্থা

প্রভাব	প্রশমন এর পূর্বে ঝুঁকি নির্ধারণ	যুক্তি	প্রশমন ব্যবস্থা	প্রশমন পরবর্তী ঝুঁকি নির্ধারণ
পাইল ড্রাইভিং থেকে শব্দের প্রভাব (কাস্ট ইন-সিটু বোরড পাইল, ভাইব্রেটরি হ্যামার)	উল্লেখযোগ্য (S)	কালিহাতী সাইটে ৫৪০ x ৪৫-৫০ মিটার দীর্ঘ ০.৭৫ মিটার ব্যাসের বোর-পাইল এবং ভুঞাপুর সাইটে ৩৬৬ x ৪৫-৫০ মিটার দীর্ঘ ০.৯ মিটার ব্যাসের পাইল নির্মাণ/ড্রাইভিং থেকে উল্লেখযোগ্য শব্দ উৎপন্ন করবে যা শব্দ ঝুঁকি তৈরি করবে। ভুঞাপুর ১৭,১৮৫.৫৩ মিটার এবং কালিহাতী সাইটে ২৮৫৬৮.৭ মিটার পাইল ড্রাইভিং পাইলট সাইটের কাছাকাছি স্থানীয় সম্প্রদায় এবং বন্যপ্রাণীদের জন্য ক্ষতিকারক স্তরে শব্দের মাত্রা বাড়িয়ে দেবে। পাইল ড্রাইভিং এর ফলাফল হিসাবে সর্বাধিক শব্দ (ল্যাক্স) ৫০ মিটার দূরত্বে ৮৪.৯৩ ডেসিবেল পর্যন্ত পৌঁছাতে পারে; ৪ কিমি দূরত্বে ৪০.৪৭ ডেসিবেল হ্রাস পাবে। যাইহোক, ১০০ মিটারের মধ্যে কোন সংবেদনশীল রিসেপ্টর (যেমন, প্রতিষ্ঠান, বসতি, ইত্যাদি) নেই। শব্দের প্রভাব প্রধানত পাখি, শুশুক এবং নদীর অন্যান্য জলজ প্রাণীর উপর পড়বে। উচ্চ শব্দ মিঠা পানির শুশুকদের আচরণ পরিবর্তন করতে পারে এবং সম্ভাব্য পরিযায়ী পাখিদের বিরক্ত করতে পারবে।	• ঠিকাদারদের পাইলট সাইটে কোনো কাজ শুরু করার আগে জেএনসিসি)JNCC) নির্দেশিকা অনুসরণ করে পি আই ইউ (PIU)-এর কাছে একটি "পাইল ড্রাইভিং প্ল্যান" প্রস্তুত এবং জমা দেওয়া প্রয়োজন। • আধুনিক এবং উন্নত প্রযুক্তির ব্যবহার এবং নিরব যান্ত্রপাতির ব্যবহার শব্দের উৎস নিয়ন্ত্রন এ ভুমিকা রাখবে। • যন্ত্রপাতি পরিবর্তন, যেমন ধাতব পৃষ্ঠতল স্যাঁতসেঁতে করা, কম্পনের কারণে শব্দ কমাতে কার্যকর। আরেকটি সম্ভাবনা হল নিম্ন শব্দের মাত্রা অর্জনের জন্য সরঞ্জামের একটি নির্দিষ্ট অংশের পুনরায় ডিজাইন করা • স্থির কাজের জন্য ঘেরগুলি কাঠ বা অন্য কোনও উপযুক্ত উপাদান দিয়ে তৈরি করা যেতে পারে এবং যা সাধারণত নির্দিষ্ট এলাকা এবং সরঞ্জামকে ঘিরে থাকে। • বৈদ্যুতিক চালিত সরঞ্জামের ব্যবহার সাধারণত ডিজেলের চেয়ে শান্ত হয় এবং হাইড্রোলিক চালিত সরঞ্জামগুলি বায়ুসংক্রান্ত শক্তির চেয়ে শান্ত হয় • উন্নত অবস্থায় যানবাহন এবং সরঞ্জাম ব্যবহার করা • ভাইব্রেটরি হাতুড়ি ব্যবহার করা যেতে পারে। সেসব পরিস্থিতিতে যেখানে সিসমিক স্থায়িত্ব বা সাবস্ট্রেট টাইপের কারণে ইমপ্যাক্ট হ্যামারের প্রয়োজন হয়, ইমপ্যাক্ট হ্যামার ব্যবহারের আগে কম্পনকারী হাতুড়ি দিয়ে পাইলটিকে যতটা সম্ভব গভীরভাবে চালিত করার পরামর্শ দেওয়া হয়।	মাঝারি (M)

প্রভাব	প্রশমন এর পূর্বে ঝুঁকি নির্ধারণ	যুক্তি	প্রশমন ব্যবস্থা	প্রশমন পরবর্তী ঝুঁকি নির্ধারণ
			• প্রশমন অঞ্চলের মধ্যে বিভিন্ন দূরত্বে পাইল ড্রাইভিং করার সময় শব্দের মাত্রা পর্যবেক্ষণ করতে হবে যাতে শব্দের মাত্রা পরিবেশ অধিদাপ্তর, বিশ্বব্যাংক বা অন্য কোনো আন্তর্জাতিক স্বীকৃত মানদণ্ড যেমন বিশ্বব্যাংক গ্রুপের সাধারণ পরিবেশগত স্বাস্থ্য ও নিরাপত্তা নির্দেশিকা ই এইচ এস জি এস (EHSGs) এর চেয়ে বেশি না হয়। • পরিষ্কার অর্থাৎ) "আপ-র‍্যাম্প", "সফ্ট পদ্ধতির ("স্টার্ট-ব্যবহার করতে হবে, যার মাধ্যমে সামুদ্রিক পরিবেশে শব্দ শক্তির ইনপুট ধীরে ধীরে বা ক্রমবর্ধমান মাত্রা থেকে বৃদ্ধি পায়, এবং কার্যক্রম সমাপ্তির পর্যন্ত যা জলজ স্তন্যপায়ী প্রাণীর উপর উল্লেখযোগ্য আচরণগত প্রভাব সৃষ্টি করতে অসম্ভাব্য । • শব্দের চাপের মাত্রা পরিবেশ অধিদাপ্তর বা অন্য কোনো আন্তর্জাতিকভাবে স্বীকৃত মাপদণ্ডের চেয়ে বেশি হলে শব্দ কমানোর ব্যবস্থা প্রয়োগ করতে হবে। শব্দ চাপের মাত্রা কমানোর জন্য নিচের পদ্ধতি গুলির রয়েছে, তবে পদ্ধতি গুলির বাইরেও আরও পদ্ধতি রয়েছে: ○ সম্পূর্ণরূপে অবরুদ্ধ বা সীমাবদ্ধ বাবল কার্টেন এর ব্যবহার, শোষণকারী বাধা যেমন), বিচ্ছিন্ন আবরণ, কফেরড্যাম বা তাৎক্ষণিক কাজের জায়গায় অন্যান্য (কার্যকর শব্দ কমানোর পদ্ধতির ব্যবহার অন্তর্ভুক্ত করতে হবে, যাতে অপারেশন সাইট থেকে পানির নিচে শব্দ প্রয়োগ কম হয়। গবেষণায় দেখা গেছে যে এই ধরনের	

প্রভাব	প্রশমন এর পূর্বে ঝুঁকি নির্ধারণ	যুক্তি	প্রশমন ব্যবস্থা	প্রশমন পরবর্তী ঝুঁকি নির্ধারণ
			পদ্ধতিগুলি জলজ পরিবেশে ১০-৩০ ডেসি বেল পর্যন্ত শব্দের মাত্রা উল্লেখযোগ্য ভাবে হ্রাস করতে পারে। ○ যদি ড্রাইভিং প্রভাব এড়ানো সম্ভব না হয় একটি হাইড্রোলিক হাতুড়ি ব্যবহার করা যেতে পারে। হাতুড়ির আঘাতের শক্তি হাইড্রোলিক হাতুড়ি দিয়ে নিয়ন্ত্রিত করা যেতে পারে এবং প্রভাব শক্তি হ্রাস করা ফলে শব্দের তীব্রতা হ্রাস পাবে। • ডলফিন, ঘড়িয়াল এবং অন্যান্য গুরুত্বপূর্ণ সরীসৃপগুলিকে পাইলিং শুরু করার আগে ভয় দেখানোর জন্য ধীরে ধীরে শব্দের মাত্রা বাড়ানো। ডলফিন এবং জলজ সরীসৃপ তাড়ানোর জন্য উজানে এবং নিচের দিকে পিঙ্গার ব্যবহার করা। তারা পাইলিং সাইট থেকে ভালোভাবে দূরে আছে তা নিশ্চিত করার জন্য এই প্রাণীদের জন্য এলাকা পর্যবেক্ষণ করা- নির্মাণ কার্যক্রমের আগে তারা উচ্চ শব্দ নির্গমন অঞ্চলের মধ্যে থাকলে পিঙ্গার ব্যবহার করে তাদের ভয় দেখানো।	
নির্মাণ সামগ্রী বহন করার সময় ধূলিকণা বিচ্ছুরণ, শিলা চূর্ণ, নির্মাণ সামগ্রীর মিশ্রণ, মাটি এবং উপাদানের স্তূপ, ড্রেজ করা উপাদান	উল্লেখযোগ্য (S)	নির্মাণ পর্যায়ে দ্রুত ধাবমান ধূলিকণা দীর্ঘমেয়াদী ভিত্তিতে স্থির উৎস যেমন কোয়ারি, বররও পিত, থেকে উৎপন্ন হবে বিশেষ করে শুষ্ক মৌসুমে । নির্মাণ যন্ত্রপাতির কার্যক্রম থেকে নির্গমন যেমন, নাইট্রোজেন অক্সাইড)NOx), সালফার অক্সাইড)SOx) এবং কার্বন মনোক্সাইড)CO), PM10 এবং PM2.5 এর মাত্রা বৃদ্ধি করবে. স্থানীয় মাটির রাস্তায় নির্মাণ সামগ্রী, যেমন, বালি, নুড়ি, শিলা, সিমেন্ট ইত্যাদি পরিবহনের সময়ও ধুলো নির্গমন ঘটবে।	• ধূলিকণা নিয়ন্ত্রণের জন্য যানবাহনের গতি সীমাবদ্ধতা যেমন), ২০ কিমিঅবশ্যই প্রয়োগ করতে হবে (ঘন্টা/ • বায়ুর প্রভাব থেকে রক্ষা করার জন্য নির্মাণ সামগ্রী অবশ্যই আবৃত করতে হবে • দ্রুত ধাবমান ধুলো দমনের জন্য নিয়মিত জল স্প্রে করুন • বালি বা অন্যান্য সুক্ষ কণা বহনকারী ডাম্প ট্রাকগুলি থেকে ধূলিকণা নির্গমন কমানোর জন্য তাদের বহনকারী বস্তু ঢেকে রাখে	নিম্ন(L)

প্রভাব	প্রশমন এর পূর্বে ঝুঁকি নির্ধারণ	যুক্তি	প্রশমন ব্যবস্থা	প্রশমন পরবর্তী ঝুঁকি নির্ধারণ
ডিসপজড সাইট; এবং জাহাজ ক্ষয় থেকে নিষ্কাশন নির্গমন বায়ুর গুণমানের উপর প্রভাব ফেলবে;		স্থির উৎস যেমন জেনারেটর সেট, নির্মাণ সরঞ্জাম যেমন, কম্প্রেসার এবং খনন/গ্রেডিং, নির্মাণ সামগ্রীর মিশ্রণ, বর্জ্য পদার্থের উন্মুক্ত পোড়ানো, কোয়ারি থেকে উৎপন্ন ধুলো, বররও পিট, ঢালাই রাস্তা, কাঁচা রাস্তা, এবং মাটি এবং উপাদান স্টক-স্তূপ থেকে উৎপন্ন ধুলো শিলা চূর্ণ করার সময় বায়ুর গুণমানকে প্রভাবিত করবে। এছাড়া, প্রকল্পের কাজগুলির অত্যন্ত গুরুত্বপূর্ণরনির্মাণ কাজ যা বিভিন্ন ধরণের জ্বালানী পোড়ানো মেশিনের পরিচালনা জড়িত। মেশিনারিজ থেকে ক্রমাগত দূষণকারী নির্গমন বায়ু দূষণের কারণ হতে পারে যা বায়ু অনুসরণ করে প্রকল্পের সীমানা থেকে দূরে যেতে পারে। নদীর তীরে বিভিন্ন প্রজাতির বসবাস এবং বিশেষ করে পাখি এবং কচ্ছপদের জন্য সাধারণ স্থান। নিম্নমানের জ্বালানি ব্যবহার করা এবং যেকোনো যন্ত্রপাতির প্রযুক্তিগত ত্রুটি বেশি নির্গমনের কারণ হতে পারে।	• নির্মাণ সামগ্রী বহনকারী ট্রাকগুলিতে একটি উপযুক্ত ফ্রিবোর্ড অবশ্যই বজায় রাখতে হবে • নির্মাণ কার্যক্রমে দূষণমুক্তনতুন প্রযুক্তির প্রবর্তন/ • অনুমোদিত দূষণ নিয়ন্ত্রণ ডিভাইস সরঞ্জাম এবং যন্ত্রপাতি লাগাতে হবে • যেখানে সম্ভব কাঁচা জায়গায় ঘাসের গালিচা স্থাপন করুন • পরিবেষ্টিত বায়ুর গুণমান যেন জাতীয় মান দ্বারা সংজ্ঞায়িত সীমার মধ্যে থাকে তা নিশ্চিত করতে সংবেদনশীল রিসেপ্টরগুলির কাছে নিয়মিত বায়ু পর্যবেক্ষণ করা হবে।	
বিপর্যয় থেকে ব্রহ্মপুত্র-যমুনা নদী র কেবিএ (KBA) এর জীববৈচিত্র্যের উপর প্রভাব; কাদামাটির, নদীর এলাকা (পলি অঞ্চল), চর প্রাকৃতিক আবাসস্থলের সংকোচন;	মাঝারি (M)	সাইটের সমস্যার মধ্যে রয়েছে জীববৈচিত্র্যের সংবেদনশীল প্রজাতি যেমন ব্যাঙ এবং সাপে এবং কম পরিচিত প্রজাতির উপর প্রভাব। সাধারণত, নির্মাণ কার্যক্রম, যেমন পাইল ড্রাইভিং, খনন, কংক্রিটিং অপারেশন এই প্রজাতিগুলিকেপাশাপাশি বেশ কয়েকটি হুমকির সম্মুখীন পাখির প্রজাতি কে প্রভাবিত করতে পারে, । জীববৈচিত্র্যের উপর সাইট-নির্দিষ্ট প্রভাবগুলির মধ্যে রয়েছে জলজ এবং স্থলজ বাস্তুতন্ত্রের ব্যাঘাত, ব্যক্তি এবং প্রজাতির জনসংখ্যার স্থানচ্যুতি, বাসস্থানের পরিবর্তন, জনসংখ্যার গতিশীলতার	● প্রতিটি নির্মাণ কার্যক্রমের আগে এবং চলাকালীন সময় ত্রুটি নির্ণয়ের জন্য ক্রমাগত পরিদর্শন পরিচালনা প্রয়োজন (যেমন, কংক্রিট ঢালাই চলাকালীন সময়) ● সমস্ত কংক্রিট ঢালাই, জয়েন্টগুলি সিল করা, ওয়াটার-প্রুফিং পেইন্ট প্রয়োগ বা প্রতিরক্ষামূলক ব্যবস্থা, শুষ্ক করণ এর জন্য নিরাময়কারী এজেন্ট ইত্যাদি শুষ্ক আবহাওয়ায় সম্পন্ন করতে হবে ● নদীতে নির্মাণ সামগ্রীর প্রবেশ রোধ করার জন্য, কংক্রিটের কাঠামোগত উপাদানগুলিকে প্রি-কাস্ট করতে হবে	নিম্ন (L)

প্রভাব	প্রশমন এর পূর্বে ঝুঁকি নির্ধারণ	যুক্তি	প্রশমন ব্যবস্থা	প্রশমন পরবর্তী ঝুঁকি নির্ধারণ
এবং ড্রেজিং সহ নির্মাণ কার্যক্রম থেকে দূষণ (কোলাহল, পানি দূষণ ইত্যাদি) কারণে প্রাকৃতিক আবাসস্থলে (নদীর এলাকা, কাদামাটি, চর) ক্রমবর্ধমান ব্যাঘাত এবং উপযুক্ততা হ্রাসের ঝুঁকি।		পরিবর্তন, প্রজাতির গঠনের পরিবর্তন এবং আবাসস্থলের বিচ্ছিন্নতা বা খণ্ডিতকরণ। যমুনা নদী ও তার সংলগ্ন এলাকার গুরুত্বপূর্ণ প্রজাতির মধ্যে শুশুক, মেছো বিড়াল, ঘড়িয়াল, ছিম কাছিম, গঙ্গা কাছিম, রাঙ্গা মানিকজোড়, কালো পেট পান চিল এবং পরিযায়ী পাখি সম্ভাব্যভাবে প্রভাবিত হতে পারে। প্রকল্পের কার্যক্রম এই গুরুত্বপূর্ণ প্রজাতির উপর প্রভাব ফেলতে পারে এমন এলাকায় কার্যক্রম সংঘটনের পরিমাণে ঘটতে পারে। প্রস্তাবিত গ্রোইন শেষ পর্যন্ত সুরক্ষিত তীর বরাবর অবক্ষেপণ প্রক্রিয়া বৃদ্ধি করবে এবং জমি পুনরুদ্ধার করে ধীরে ধীরে নদীর প্রস্থকে সংকুচিত করবে। কালিহাতী সাইটের কাছাকাছি চরভূমি জুড়ে ড্রেজিংয়ের ফলে কাদামাটিরর স্তর নষ্ট হবে যা বর্তমানে শীতকালে পরিযায়ী পাখিদের আবাসস্থলের জন্য খুবই উপযুক্ত স্থান। যাইহোক, নিট ক্ষতি শূন্য বলে ধরে নেওয়া যেতে পারে কারণ প্রস্তাবিত গ্রোইন ধীরে ধীরে জমি পুনরুদ্ধার করবে এবং ব্যাঙ্ক সুরক্ষা প্রাকৃতিক আবাসস্থল এবং তীর বরাবর পরিবর্তিত আবাসস্থলগুলিকেও রক্ষা করবে। নির্মাণ কার্যক্রম বিশেষ করে পাইল ড্রাইভিং, ড্রেজিং, প্রাথমিক সরবরাহ পরিবহন ইত্যাদি থেকে পানি দূষণ এবং শব্দের ঝুঁকি রয়েছে। নির্মাণ কার্যক্রম এবং ড্রেজিং এর ফলে উপযুক্ততা হ্রাসের ঝুঁকি রয়েছে।	● যেসব স্থানে কংক্রিট বা অন্যান্য ভেজা উপকরণ ব্যবহার করা হবে, সেখানে ছিটকে যাওয়া কংক্রিট, নলাকার স্টিলের স্তূপ বা ছিটকে যাওয়া সিলান্ট বা অন্যান্য উপকরণের ভেতর থেকে স্থানচ্যুত ক্ষারীয় জল ক্যাপচার করতে বান্ডেড স্টিলের ডেক ব্যবহার করতে হবে। ● সাইটের ভবিষ্যৎ উন্নয়নের জন্য সংরক্ষিত এলাকাগুলি ঘাস এবং গুল্ম এবং ভেষজ গাছের দ্বারা সবুজে তৈরি করা হবে ● শব্দ এবং বায়ু দূষণ কমানোর জন্য উপরে বর্ণিত ব্যবস্থাগুলিও প্রাসঙ্গিক	

প্রভাব	প্রশমন এর পূর্বে ঝুঁকি নির্ধারণ	যুক্তি	প্রশমন ব্যবস্থা	প্রশমন পরবর্তী ঝুঁকি নির্ধারণ
		নির্মাণ কার্যক্রম এবং ড্রেজিং থেকে আওয়াজ, বর্জ্য এবং দূষণ উক্ত এলাকার আবাসস্থলে উপস্থিত বন্যপ্রাণীদের বিরক্তি বাড়াবে।		
গুরুত্বপূর্ণ বাসস্থানের মানদণ্ডকে ট্রিগার করে প্রজাতি এবং জীববৈচিত্র্য বৈশিষ্ট্যের উপর প্রভাব	উল্লেখযোগ্য (S)	গুরুত্বপূর্ণ আবাসস্থলের উপর প্রধান প্রভাবগুলি হল ড্রেজিং সহ নির্মাণ কার্যক্রম থেকে দূষণ (কোলাহল, জল দূষণ ইত্যাদি) এর কারণে উপযুক্ত, প্রাকৃতিক আবাসস্থলের (নদীর এলাকা, কাদামাটি, চর) হ্রাস; সংঘর্ষের মাধ্যমে শুশুক এবং ঘড়িয়ালের শারীরিক আঘাতের ঝুঁকি বেড়ে যাওয়া; শুশুক, মেছ বিড়াল এবং ঘড়িয়ালের সমস্যা যেমন পাইল ড্রাইভিং এর মতো নির্মাণ কার্যক্রমের শব্দের কারণে; এবং বাঘাইর এবং চিতল এর আবাসস্থলের সাময়িক ক্ষতি।	● ঠিকাদারদের পিআইইউ-এর কাছে একটি "পাইল ড্রাইভিং প্ল্যান" প্রস্তুত এবং জমা দিতে হবে যা পাইলট সাইটগুলিতে কোনও কাজ শুরু করার আগে অনুমোদনের জন্য জেএনসিসয)JNCC) নির্দেশিকা অনুসরণ করে প্রভাবগুলি হ্রাস করার জন্য পরিমাপকে অন্তর্ভুক্ত করে। ● উপকুল বরাবর ক্ষয়া রোধে বিভিন্ন আকারের সি সি ব্লক এবং জিও ব্যাগ স্থাপন করা এবং পাথর এর দেওয়াল আবরন দেওয়া যা বাঘাইর এর জন্য সুবিধাজনক। ● শুশুক, মেছো বিড়াল, বাঘাইর, এবং অন্যান্য প্রজাতির উপর যেকোনো বিঘ্ন/হত্যা/বাণিজ্যের কঠোর নিষেধাজ্ঞা কার্যকর করতে হবে যা গুরুতর বাসস্থানের মানদণ্ডকে ট্রিগার করে ● শব্দ এবং বায়ু দূষণ এবং জীববৈচিত্র্যের ক্ষতি কমানোর জন্য উপরে বর্ণিত ব্যবস্থাগুলিও প্রাসঙ্গিক	নিম্ন (L)
তীর রক্ষার কাজের কারণে নদীতীরবর্তী অঞ্চলের আবাসস্থল	উল্লেখযোগ্য (S)	ক্ষয়প্রাপ্ত পার্শ্বে কংক্রিট ব্লক দ্বারা নদীর তীর রক্ষার জন্য হস্তক্ষেপকৃত তীরের ঢালু এবং সমতলকরণ প্রয়োজন হবে। নদীর	● ঘোষিত মৎস্য অভয়ারণ্য এলাকায় (প্রকল্প AOI সহ) প্রকল্প কর্মীর দ্বারা মাছ ধরা নিষিদ্ধ করণ	নিম্ন (L)

প্রভাব	প্রশমন এর পূর্বে ঝুঁকি নির্ধারণ	যুক্তি	প্রশমন ব্যবস্থা	প্রশমন পরবর্তী ঝুঁকি নির্ধারণ
হারিয়ে যাওয়ায় মৎস্য সম্পদ এর উপর প্রভাব; মাছের আবাসস্থলের পরিবর্তন (এমবেমেন্ট এলাকা, কাদা মাটি, পলি অঞ্চল ইত্যাদি); এবং যাত্রীদের দ্বারা প্লাস্টিকের বোতল, পলিথিন এবং খাদ্য প্যাকেজিং বর্জ্য ফেলে দেওয়ার কারণে জেটিতে মাছের আবাসস্থলের অবস্থার অবনতি		পাড়ের পাশে ছিদ্রযুক্ত ছিদ্র থাকতে পারে যা বিভিন্ন প্রজাতির মাছের বিশ্রামের স্থান হিসাবে কাজ করে যেমন বাইম জাতীয় মাছ (বড় বাইম- *Mastacembelus armatus*), ক্যাট ফিশ (আইড়- *Sperata aor*, রিটা- *Rita rita*, বোয়াল- *Wallago attu*) এবং অন্যান্য ছোট মাছ (পুটি- *Puntius sophore*, গুলশা - *Mystus cavasius*, বাইলা - *Glossogobius giuris*). নদীতীর ঢালু এবং সমতলকরণ প্রকল্প সাইটে নদীর তীরের গর্তগুলি অদৃশ্য হয়ে যেতে পারে। নদী হাইড্রো মরফোলজিতে প্রস্তাবিত হস্তক্ষেপের প্রভাব অনুসরণ-করে, এটা অনুমান করা যেতে পারে যে হস্তক্ষেপে মাছের আবাসস্থল প্রস্তাবিত গ্রোইন দ্বারা ধীরে ধীরে সংকুচিত হবে। কাদা মাটি এবং প্লাবনভূমি এলাকা হ্রাস করা হবে। (যেমন চর) যাইহোক, চরগুলো ক্ষয় হলে মোট পলি অঞ্চল চর এবং কাদা) মাটি ব্যতীত নদীর এলাকাবৃদ্ধি পেতে পারে (। এই পর্যায়ে ক্ষতির পরিমাণগতভাবে মূল্যায়ন করা কঠিন কারণ হাইড্রো ডাইনামিক মডেলিং ফলাফল পাওয়া যায় না এবং এই-প্রত্যাশিত পরিবর্তনগুলিসাথে সাথে ঘটবে না, বরং ধীরে ধীরে। যমুনা নদীতে স্থানীয় গুরুত্বপূর্ণ মাছের আবাসস্থল হিসেবে বিবেচিত এম্বেমেন্ট এলাকা তৈরি ও বিলীন হওয়া একটি প্রাকৃতিক প্রবণতা। ড্রেজিং চরে একটি বর্তমান এমবেমেন্ট এলাকা খুলতে পারে এবং এটি একটি চ্যানেলে পরিণত হতে পারে। যাইহোক, অনুরূপ বাসস্থান প্রাকৃতিকভাবে কাছাকাছি এলাকায় তৈরি হতে পারে।	● উপকুল বরাবর ক্ষয় রোধে বিভিন্ন আকারের সি সি ব্লক এবং জিও ব্যাগ প্রতিস্থাপন করা এবং পাথর এর দেওয়াল আবরন দেওয়া যা বাঘাইর এর জন্য সুবিধাজনক। ● শব্দ এবং বায়ু দূষণের জন্য উপরে বর্ণিত প্রশমন ব্যবস্থাও প্রাসঙ্গিক	

প্রভাব	প্রশমন এর পূর্বে ঝুঁকি নির্ধারণ	যুক্তি	প্রশমন ব্যবস্থা	প্রশমন পরবর্তী ঝুঁকি নির্ধারণ
		এই প্রকল্পের আওতায় নদীর তীরে চারটি (০৪ টি) স্থানে নদী তীর সুরক্ষা কাজ বাস্তবায়িত হবে। পাড়ে বেশ কিছু ছিদ্র থাকতে পারে যেখানে বিভিন্ন প্রজাতির মাছ যেমন, বাইম, ক্যাটফিশ আইর, রিটা, বোয়াল, বাচা এবং ছোট মাছ (পুঁটি, টেংরা, গুলশা, গুতুম) বরষা মৌসুমে সেখানে আশ্রয় নেয়। কংক্রিট ব্লক স্থাপনের মাধ্যমে নদী তীর সুরক্ষা কাজের বাস্তবায়ন কর্দমাক্ত জাতীয় নদীর তীর আবাসস্থলকে একটি কংক্রিটের আবাসস্থলে রূপান্তরিত করবে। অতএব, যে মাছের প্রজাতিগুলি কর্দমাক্ত তীরে আশ্রয় নেয় এবং চারণ করে সেগুলি স্থানান্তরিত হতে পারে এবং পরিবর্তিত বাসস্থানের সাথে খাপ খাইয়ে নিতে সক্ষম হবে না। যাইহোক, নদীর তীর সুরক্ষার জন্য ব্যবহৃত সিসি ব্লকগুলি নির্দিষ্ট মাছের প্রজাতি যেমন বাইম এবং বড় ক্যাটফিশ আইর, রিটা, বোয়াল এবং কার্প (কালিবাউশ) এর জন্য একটি বিশেষ আবাস পরিবেশন করতে পারে। উপরন্তু, জিও ব্যাগ স্থাপন করা মাছের বিশেষ বাসস্থান তৈরি-করতে পারে, কারণ শেওলা, ফাইটোপ্ল্যাঙ্কটন এবং অন্যান্য মাইক্রোফাইট তাদের পৃষ্ঠে বৃদ্ধি পেতে পারে। অতএব, মাছের প্রজাতি যারা শেওলা এবং মাইক্রোফাইট পছন্দ করে তারা পরিবর্তিত আবাসস্থলে একত্রিত হবে। তাই, ব্যাঙ্ক সুরক্ষা সাইটগুলিতে মাছের গঠনের পরিবর্তনগুলি মৎস্য সম্পদের উপর নগণ্য প্রভাব ফেলতে পারে।		

প্রভাব	প্রশমন এর পূর্বে ঝুঁকি নির্ধারণ	যুক্তি	প্রশমন ব্যবস্থা	প্রশমন পরবর্তী ঝুঁকি নির্ধারণ
জমি পুনঃঅধিগ্রহণের কারণে স্থায়ী ফসল/ফসল উৎপাদনের ক্ষতি থেকে কৃষির উপর প্রভাব (নদীর তীর সুরক্ষা কাজ, শ্রমিকদের আবাসস্থল, নির্মাণ সাইট, ইত্যাদির জন্য)	উল্লেখযোগ্য (S)	প্রকল্প ১-এর জন্য প্রায় ২৯ একর (১১.৭৪হেক্টর) জমি অধিগ্রহণ করতে হবে এবং ৮২ টি পরিবারকে অনিচ্ছাকৃতভাবে পুনর্বাসন করতে হবে। এটি একটি অস্থায়ী প্রভাব কারণ নির্মাণের সময় শেষ হওয়ার পরে কৃষি জমিগুলি ফসল উৎপাদনের জন্য ব্যবহার করা হবে।	ইএসেস ৫ (ESS5) এর সাথে সামঞ্জস্য করার জন্য ভূমি অধিগ্রহণ এবং পুনর্বাসনকে গাইড করার জন্য একটি পুনর্বাসন নীতি কাঠামো প্রস্তুত করা হয়েছে। আয়ের মতো জীবিকার উৎস সম্পর্কিত ঝুঁকি কমাতে একটি জীবিকা পুনরুদ্ধার পরিকল্পনাও তৈরি করা হয়েছে।	নিম্ন (L)
জনসংখ্যার কম ঘনত্ব এবং দুর্বল যোগাযোগ সুবিধার কারণে নারী পাচার এবং ধর্ষণ থেকে SEA/SH প্রভাব বাড়তে পারে	উল্লেখযোগ্য (S)	শ্রমশক্তির প্রবাহের কারণে এই প্রকল্পে মাঝারি থেকে যথেষ্ট আর্থ-সামাজিক এবং SEA/SH ঝুঁকি জড়িত। যাইহোক, প্রকল্পের শ্রমশক্তি এবং স্কেল এর অনুমানকৃত আকারের পরিপ্রেক্ষিতে, প্রস্তাবিত প্রশমন ব্যবস্থাগুলি ঝুঁকিকে যথেষ্ট থেকে নিম্নে কমিয়ে দেবে।	● সম্প্রদায়ের সকল মানুষ এবং ঝুঁকিপূর্ণ জনসংখ্যা সহ সকল স্টেকহোল্ডারদের জন্য GBV সম্পর্কে সচেতনতা বৃদ্ধি এবং সংবেদনশীলতা তৈরি ● জিবিভি(GBV) পরিষেবা প্রদানকারীর ম্যাপিং জিআরএম (GRM) থেকে জিবিভি(GBV) -এর ঘটনা বা অন্য কোনো রিপোর্টিং প্রক্রিয়া যা প্রকল্পের মাধ্যমে প্রতিষ্ঠিত হতে পারে।	নিম্ন (L)

প্রভাব	প্রশমন এর পূর্বে ঝুঁকি নির্ধারণ	যুক্তি	প্রশমন ব্যবস্থা	প্রশমন পরবর্তী ঝুঁকি নির্ধারণ
			● SEA/SH সম্পর্কে অভিযোগের জন্য একাধিক চ্যানেলের সাথে একটি কার্যকর অভিযোগ প্রতিকার ব্যবস্থা (জিআরএম) স্থাপন করা এবং SEA/SH অভিযোগ রিপোর্টিং চ্যানেল স্থাপন করা ● পি আই এউ (PIU)-তে নিবেদিত SEA/SH বিশেষজ্ঞের সাথে উভয় আই এ (IA)-এর প্রাতিষ্ঠানিক ক্ষমতা শক্তিশালীকরণ ● GBV (জিবিভি) এর অভিযোগ গ্রহণ ও প্রক্রিয়া করা ● অপরাধীর বিরুদ্ধে সরাসরি নিষেধাজ্ঞা গ্রহন ● চিকিৎসা ও আইনি পরিষেবা প্রদানকারীদের কাছে ভিকটিম/ বেঁচে থাকা ভুক্তভোগী কে প্রেরন করুন ● নিবন্ধিত মামলা অনুসরণ করা এবং গ্রাহকের নিরাপত্তা নিশ্চিত করা	
কোভিড-19 ঝুঁকি থেকে সামাজিক প্রভাব	উল্লেখযোগ্য (S)	বাইরে থেকে শ্রমিক আগমনের ফলে কোভিড-19 সংক্রমণের ঝুঁকি বেড়ে যেতে পারে, বিশেষ করে শ্রমিকরা যারা উক্ত এলাকার বাইরে থেকে আসে।	● প্রধান প্রশমন ব্যবস্থার মধ্যে রয়েছে জাতীয়, স্থানীয় এবং বিশ্বব্যাংকের কোভিড ১৯ প্রোটোকল-অনুসরণ করা।	নিম্ন (L)

1. Introduction

1.1 Overview

The Jamuna is highly braided, morphologically dynamic river that serves as an important navigational route within Bangladesh. It enfolds the Bangladesh-India Protocol Route of navigation. Further, the Jamuna is linked with the Yarlung Tsangpo-Brahmaputra River system in the upstream, which makes it an international waterway. The Jamuna River is also a part of the Bangladesh-India Protocol Routes for navigation (**Figure 1.1**). The Jamuna River is economically important; it is also significant considering the ecosystem and social and cultural life of people of this riparian country. The riverine and riparian areas act as ecotone zone for numerous wild animals thus serves or hosts an enormous diversity of habitats. The river waterbody is an important ground to many important species including highly threatened Gangetic River Dolphin and critically endangered Gharial. Accordingly, the Government of Bangladesh (GOB) has declared in 2013 two sanctuaries in the Jamuna River systems; (i) Shilanda-Nagdemra Dolphin Sanctuary (IUCN Category VI) and (ii) Nagarbari-Mohanganj Dolphin Sanctuary (IUCN Category VI). The government has also declared a Fish Sanctuary covering around 12 km reach of the river around the Banglabandhu Multipurpose Bridge of Jamuna River in 2021. The sandbars or Chars of the river serve important habitats to reptilian species (Gharial, Ganges Softshell Turtle, Narrow-headed Softshell Turtle).

The Jamuna has 56 large Chars and 226 small sandy and vegetated Chars.[4] As a dynamic process, new Chars (often called sandbars) appear and disappear every year; however, many such Chars continue to grow with additional deposits over the years. According to one source, an estimated 6 million people live in the Char areas within the riverine reach from Chilmari to Sirajganj.[5] Therefore, the river and especially the Chars and Char settlements constitute very important social and ecosystem in the proposed program/project areas. The erosions and accretions of land in the Jamuna systems thus have great impacts on life and livelihoods of the people in the Chars and the *upazilas* (subdistrict) along the Jamuna reach, which are also highly susceptible to floods every year. As a result, the regions close to the river are known for high poverty, especially the northern districts (Kurigram, Gaibandha, Jamalpur, etc.). Each year thousands of people from Jamuna River Chars and its floodplain experience displacement (temporary or permanent) due to bank erosions and floods.[6] The government, through its *Bangladesh Delta Development Plan 2100,* has given priority to disaster risk reduction by linking river management (i.e., stabilization and bank protection against flooding and erosion) with comprehensive socio-economic development program. However, the morphological dynamism, ecological richness, and socio-economic vulnerability require that any large-scale intervention in Jamuna River demands careful assessments of the socio-economic and environmental aspects of the river systems.

[4] *Banglapedia* available at https://en.banglapedia.org/index.php/Jamuna_River

[5] Mohammad Zaman and Mustafa Alam (eds) *Living on the Edge: Char Dwellers in Bangladesh*, Springer 2021.

[6] Ferdous, M. R., Wesselink, A., Brandimarte, L., Slager, K., Zwarteveen, M., & Baldassarre, G. Di. (2019). The Costs of Living with Floods in the Jamuna Floodplain in Bangladesh. *Water* 2019, Vol. 11, Page 1238, 11(6), 1238. https://doi.org/10.3390/W11061238

Source: World Bank 2021. Terms of Reference of the E&S Consulting Services for Jamuna River Economic Development Program

Figure 1.1: Bangladesh-India Protocol Routes

1.2 Background and Project History

The multi-channel braided Brahmaputra-Jamuna has continuously been shifting westward since 1936.[7] The Jamuna is a river of "many changes" over its development in the past 150 years.[8] The changes in the river courses affect valuable cultivable lands and settlements on both banks. This results in displacement of an estimated one million people annually and creates a cycle of poverty and landlessness.[9] To tackle this onslaught and reduce the risk of flood and erosion disasters, the Bangladesh Water Development Board

[7] Zaman, M.Q. The Socioeconomic and Political Dynamics of Adjustment to Riverbank Erosion Hazard and Population Resettlement in the Brahmaputra-Jamuna Floodplain. PhD Dissertation, Dept of Anthropology, University of Manitoba, Winnipeg, Canada, 1988.

[8] Ahmad, Nafis. An Economic Geography of East Pakistan. London: Oxford University Press, 1968; also see, AFM Kamaluddin, Changing River Courses in Bangladesh: A Historical Appraisal. Journal of the Bangladesh National Geographical Association, Vo. 12(1), 1973.

[9] Galay, V.J. River Channel Shifting on Large Rivers in Bangladesh. International Symposium on River Sedimentation, Beijing, China 1980.

(BWDB) built a 180-km long flood protection embankment, namely the Brahmaputra Right bank Embankment (BRE) with World Bank assistance in early 1960s covering Pabna-Sirajganj, Bogura and Rangpur Districts, following the recommendations of the Krugg Mission.[10] The BWDB constructed flood control embankments and various other kinds of infrastructure since then and this river has experienced the most protective works of various types and scale to date[11]. Even so, the recent evaluation shows that the performance and stability of various structures vary in terms of reducing erosion rates and their influences on the overall morphology of the river[12].

The BWDB has been working on the idea for stabilization of the Jamuna River for many years. For instance, the Ministry of Water Resources (MoWR) had prepared several plans for Jamuna River under different initiatives, e.g., FAP1 (During 1991-1994), Feasibility study of Capital Dredging (2015), BUET-BWDB joint initiative on developing concept paper on managing Brahmaputra-Jamuna River (2019), formulation of River Stabilization and Development: Jamuna-Padma and Dependent Areas under the Flood and Riverbank Erosion Risk Management Investment Program (FRERMIP). The Bangladesh Delta Plan 2100 also included a plan for Jamuna River Stabilization which was mostly based on the Master Plan prepared by BWDB during Feasibility Study for Capital Dredging. The BWDB had proposed another project – River Management Improvement Project (RMIP) for river stabilization, which was not approved by the ECNEC[13] as it fell short of emphasis on river dredging and river navigation and channelization. Within this backdrop, the MoOWR, with the technical assistance from the World Bank (WB), has now prepared the Jamuna River Economic Corridor Development Program (JRECDP/the Program) with a comprehensive approach to riverbank protection, river training, river dredging for navigation, development of Jamuna River protocol route between Bangladesh and India, institutional strengthening of the implementation agencies (IAs) and disaster risk financing.

The Jamuna River Economic Corridor Development Program (JRECDP), with potential funding from the World Bank Group and other Development Partners (DPs), is expected to aid and help the GoB in achieving the Bangladesh Delta Plan 2100 (BDP2100). The program aims to contribute to the economic goals of the BDP2100 by (a) enhancing resilience against riverbank erosion and flooding; (b) developing river navigation capacity; (c) strengthening sector institutional capacity and collaboration. The lead implementing agencies (IAs) of the project are the Bangladesh Water Development Board (BWDB) and Bangladesh Inland Water Transport Authority (BIWTA), respectively, under the Ministry of Water Resources (MoWR) and Ministry of Shipping (MoS).

1.3 The Program Framework and Project

The Jamuna River Economic Corridor Development Program (the Program) with potential funding of 2.8 Billion USD (of which 1.1 billion USD would come from the World Bank and the rest from the Government of Bangladesh and others[14]) will be implemented through the Series of Project (SOP) approach over a 15 years period.

The first Project of the SOP, the Project 1 (the Project), will be implemented over 4.5 years (2023-2028) as a preparation of future projects. The SOP-Project 2 will be for 6.5 years during 2025-2031 (around 100km

[10] In 1956, the Government of then East Pakistan, following the recommendations of the United Nations Krug Mission, established the East Pakistan Water and Power Development Authority (EPWAPDA) to plan, implement and monitor water resources development in the country. The EPWAPDA was renamed BWDB after 1971. For a brief overview of the Krug Mission plan and its critique, see M. Q. Zaman, Rivers of Life: Living with Floods in Bangladesh, Asian Survey, Vol. 33(10), 1993.

[11] Sarker, M.H. et al. 2011. Riverbank Protection Measures in the Brahmaputra-Jamuna River: Bangladesh Experience

[12] Recent survey and estimation by CEGIS.

[13] Executive Committee of the National Economic Council (ECNEC) chaired by the Prime Minister which is the Highest level body for project appraisal.

[14] Asian Infrastructure Investment Bank, British Department for International Development (DFID)

of riverbank protection) and SOP-Project 3 will be for 7.5 years during 2030-2037 (along the 250km of river reach).

This ESIA is for the SOP-Project 1 which has five components:

- Component 1 (C1): Flood and Riverbank Erosion Management (USD45million) mostly covering the activities like construction and O&M of riverbank protection structures at 2-3 pilot sites; limited-scale dredging; land acquisition and resettlement; institutional strengthening; and preparatory studies for future projects. Bangladesh Water Development Board (BWDB) will implement this.
- Component 2 (C2): Navigation Channel Development (USD 70 million) mostly covering aids to navigation, hydrography and River Information Services (RIS), testing prototype navigation structures, institutional strengthening and preparatory studies. Bangladesh Inland Water Transport Authority (BIWTA) will be the implementing agency.
- Component 3 (C3): Financial Protection of the Community (USD10 million) mostly offering financial protection (macro or meso level insurance), community protection fund) to the community as a part of the preparedness and recovery. This would also include institutional strengthening. BWDB will be the implementing Agency (IA).
- Component 4 (C4): Community Engagement and Project Management (USD 10 Million) covering Community Engagement in Disaster-Risk Awareness & Preparedness; Buoys management, and CDDs (for small civil works e.g. buoys maintenance & Char protection). The project management sub-component would cover equipment, furniture, and consultancy services on fiduciary, E&S, and M&E cost of Project Implementation Unit of the both IAs.
- Component 5 (C5): Contingent Emergency Response Component (CERC), a "zero amount" component to allow rapid reallocation of loan proceeds from other project components during an emergency, including climate events, under streamlined procurement and disbursement procedures.

1.4 Environmental and Social Impact Assessment Study

This ESIA study has been conducted for Project activities that are already known and with sites identified based on feasibility study which will be updated later with detail design and construction methodology before implementation. The major intervention planned for in Project 1 is piloting of a scaled-down river training technology in two selected sites (2.23 km stretch for Bhuapur and 1.71 km stretch for Kalihati[15]) and installing aids to navigation.

To facilitate project preparation and to support the Implementing Agencies, i.e., Bangladesh Water Development Board and the Bangladesh Inland Water Transport Authority, the Center for Environmental and Geographic Information Services has been engaged for preparing the E&S documents as per the requirement of Environmental and Social Framework (ESF) of the Bank. These include:

- ESIA of Project 1 along with Environmental and Social Management Plan (ESMP) including a Biodiversity Management Plan, and Rapid Cumulative Impact Assessment (R-CIA)
- Stakeholder Engagement Plan (SEP)
- Preliminary assessment of the Gender and SEA/SH issues under Project 1, as part of ESIA/ESMP
- Labor Management Procedures (LMP)
- Resettlement Policy Framework (RPF)

[15] Draft Feasibility Report of C1, dated March 2022.

- Environmental and Social Commitment Plan (ESCP)

1.4.1 The Scope of ESIA

This ESIA generally covers the all four components of the SOP-Project 1. However, it is Component 1 that mostly involves the physical interventions. The physical activities of component 2 are limited to installation of navigation aids. The major activities and assessment carried out under this ESIA include the following:

- Identifying all relevant potential environmental and social impacts;
- Identifying and providing gap-filling measures between GoB laws/policies and the ESSs;
- Assessing the risks and related disruptions on community livelihood and preparing corresponding livelihood restoration plan;
- Assessing the requirement of private land acquisition and related impacts;
- Identifying the disadvantaged and vulnerable individuals or groups and propose ways to integrate them in the program design;
- Preparing ESMPs for both implementing agencies based on the risk-mitigation hierarchy;
- Assessing the biodiversity baseline and risk in line with the ESS 6 covering Habitat Mapping, Critical Habitat assessment, biodiversity assessment, "no net loss" and "net gain" assessment, identification of mitigation measures following mitigation hierarchy and preparing biodiversity offset strategy for biodiversity features triggering critical habitat criteria;
- Assessing the E&S risk management capacity of the borrower (BWDB and BIWTA) and incorporate the relevant findings in the ESIA;
- Carrying out a Rapid Cumulative Impact Assessment (R-CIA) focused on identification of valued environmental components and potential cumulative impacts which will be further studied later during implementation phase as a full Cumulative Impact Assessment (CIA) during SOP-Project 2;
- Preparing institutional implementation and monitoring arrangement to effectively manage E&S risks; and
- Stakeholder consultations to cover groups/ communities/ stakeholders to solicit their views and suggestions on actions and measures for inclusion in the ESIA/ESMP.

1.4.2 Areas of Influence

The Project includes construction of embankment, revetment and Groynes at two pilot sites (Figure 1.2): (i) Bhuapur (in Bhuapur Upazila) and (ii) Kalihati (partially covering the Kalihati Upazila and Tangail Upazila) in Tangail District. Both are located on the left bank of the Jamuna River. The Project also include (a) Navigation aids to the entire Program area; (b) Disaster risk financing; (c) Capacity building and project management; and (d) Contingent emergency response component (CERC).

While preparing the ESIA and other E&S documents, the area of influence (AoI) is defined as:

- Program AOI is the 5km buffer area laterally from the bankline of the 200km program stretch (within Bangladesh). The Program AOI is selected to cover biodiversity baseline and assessment of the entire river width and the floodplains. However, this coverage will be revisited when the hydrodynamic modeling outcome is available from the Consultant.
- Project AOI is the 1km immediate buffer area laterally from the bankline and the edge of the interventions up and downstream of the proposed Groynes at two pilot sites under C1. and the stretch of the river considered for aids to navigation. This buffer is considered to cover the noise impacts of 0.9 m diameter bored pile driving activities. Up and downstream coverages can revisit once the hydro-dynamic modeling outcome is available.
- Cumulative AOI is the 471 km length to cover both JRECDP and the Flood and Riverbank Erosion Risk Management Investment Program (FRERMIP) areas. This length is considered to

address impacts of upstream interventions from Indian Border to downstream stretches of Jamuna, Padma, and Meghna River systems. A 5 km buffer can be considered from the each bank to cover the floodplains, however, this can be confirmed after the hydro-dynamic modelling outcome is available. CIA AOI consists of 'Rivers, floodplains, Confluences' ecological hotspot, and Charlands.

- The study area for environmental baseline, social baseline and biodiversity baseline have been defined separately based on the Project AOI and other relevant criteria which have been discussed in the respective chapters.

Figure 1.2 presents the Program section, project sites and the study area of RCIA.

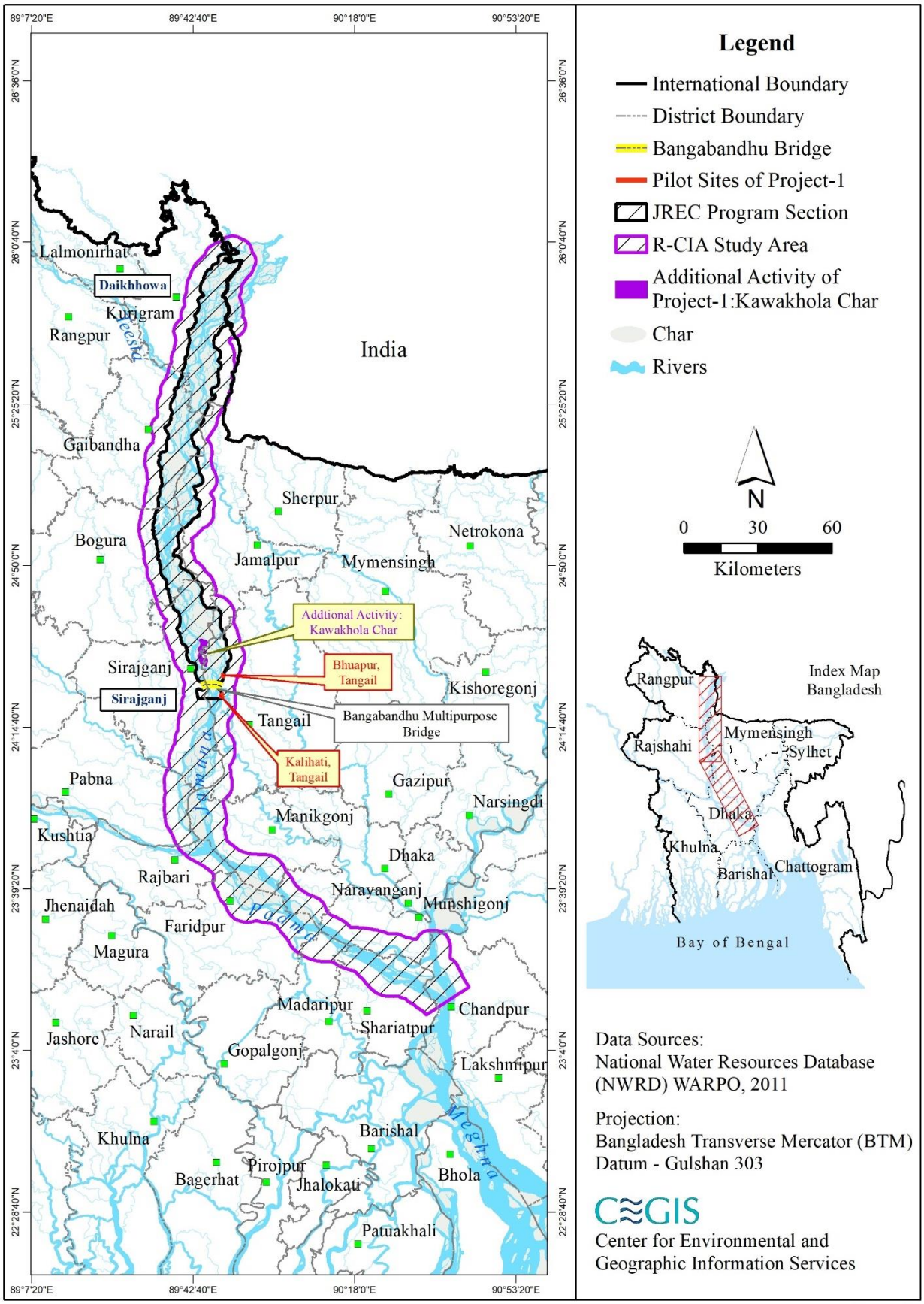


Figure 1.2: Program Section, Project 1 Sites and the Study Area of Rapid Cumulative Impact Assessment

1.4.3 Study Methodology

The Methodology of the ESIA was designed to follow the approach and methods, which are briefly presented below:

- A preliminary field survey was conducted during 15 to 26 June 2021. Four teams were engaged to visit the short-listed sites of first round. The Biodiversity Team consisted of four members. Gender Team also included four members, the Social Team composed of 6 persons and the Environmental Team included two persons.
- Field surveys at four short-listed sites of second round were conducted during 13 to 17 September 2021. The team consisted of three persons (a sociologist, an environmental specialist and a water resources engineer). The outcome of the field visits was positive and the team collected information and data those are used in the preparation of the ESIA.
- A field survey was conducted at the two selected sites (Bhuapur and Kalihati) during 1 October to 4 October, 2021. The team included two social specialists, a zoologist/fisheries specialist, a bio-diversity specialist and an environmental specialist.
- Utilizing the surveys conducted by the design consultants, engineering designs, modeling outcomes, and related analysis which have been reported in the Feasibility Study (FS) report.
- Collection, analysis and review of existing environmental quality (air, noise, soil, and water) data.
- Conduct baseline environmental quality, ecological, wildlife, and fisheries surveys.
- Detailed review and analysis of available statistical and spatial databases for relevant environmental and social parameters in project areas such as terrain, soils, land use, hydrogeology, river morphology, protected areas, demographic Characteristics, health and education.
- Utilize national baseline data for health and safety practices in the construction and inland water transport.
- Stakeholder consultations with experts, executing and implementing agencies; relevant government agencies at national and district levels; NGOs, CBOs, Focus Group Discussions, and consultations with affected community.

1.4.4 Stakeholders Consultation and FGDs

Guided by the Stakeholder Engagement Plan (SEP), the E&S team was engaged with extensive consultation with various stakeholders (during June 2021, September-October 2021, and February 2022) including IAs, local and national institutions, focus group discussions (FGDs), and public consultation in locations of physical interventions. Specific FGDs was done to include Char dwellers and livelihood groups (fishers, farmers, and boat operators, etc.). The outcome of consultation has been utilized for identifying the important/valued environmental and social components and design the mitigation, focusing the actual field scenario by fulfilling the expectation of the stakeholders.

1.4.5 Study Team

The study team consists of national and international experts from multiple disciplines.

The consultants and other members are led by the International Team Leader and Co-Team Leader in active coordination with the Deputy Team Leader, E&S task leaders and the CEGIS Project Leader. The team composition is presented in **Annex 1.1** with extensive in-house support from CEGIS.

1.4.6 Document Structure

The ESIA document is comprised of an executive summary, the following fourteen chapters, ten annexes.

Executive Summary: The Executive Summary (ES) briefly discuss the major findings of the ESIA along with the summary of each chapter.

Chapter 1: Introduction- The overview and background of the project along with the history of project activities in Jamuna River are discussed. The brief of the project activities, objectives, methodology, study area, and study team are addressed concisely.

Chapter 2: Policy, Legal and Regulatory Framework- The legal provisions related to environmental protection relevant to the planning stage and operational activities of Jamuna River Economic Corridor Development Program (JRECDP) are identified and discussed under the scope of the ESIA study.

Chapter 3: Analysis of Alternatives- The alternatives considered during project planning and design phase have been discussed in this chapter. It also includes analysis of the alternatives for technical robustness, economic, social, and environmental consequences.

Chapter 4: Project Description- This chapter first introduces the overall Program Framework, its implementation modalities, financial arrangements. Then it gives a detail description of the SOP-Project 1. The details includes description of the components, the pilot sites, construction outline with specifics, costs and schedule of the program.

Chapter 5: Environmental Baseline Conditions - All details of the program area covering the physical environment, topography, climate, morphological, hydrological, geological, geomorphological aspects have been addressed in chapter 5. The environmental quality (water, air, noise) has also been assessed in this chapter.

Chapter 6: Biodiversity Baseline Condition - Biodiversity of the program area is a significant part in natural ecosystem. In this chapter, the habitat, ecosystem and biodiversity types, diversity of wildlife (amphibia to mammalia) with their threatened lists, species of conservation significance, ecosystem services, fish and fisheries resources with details of fish production etc. have been included.

Chapter 7: Socioeconomic Baseline Condition - To provide a baseline of socio-economic and demographic indicators against which to measure the impacts of the JRECDP project over time, this chapter assesses the influence area against a number of social economic indicators, which are detailed out in the chapter.

Chapter 8: Potential Significant Impacts, Risks and Mitigation Measures- The potential risks and impacts of the project area on community and livelihood, agriculture, fisheries, biodiversity, river morphology, river course, environmental (air, water, noise) impacts, and disaster risks have been addressed and discussed in detail with their mitigation measures.

Chapter 9: Occupational Health and Safety- This chapter describes all activities related to OHS which are planned and directed with consistent, approved, health and safety management practices, procedures or standards, in compliance with ESS2 and WBG environment health and safety guidelines.

Chapter 10: Community Health and Safety- The project activities, equipment, and infrastructure can increase community exposure to health risks and may also experience an acceleration or intensification of impacts. This chapter addresses the health, safety, and security risks and impacts on project-affected communities and the corresponding responsibility of borrowers to avoid or minimize such risks and impacts.

Chapter 11: Rapid Cumulative Impact Assessment- This chapter discusses the rapid cumulative impact assessment of the proposed JRECDP, Project 1 interventions. The objective of the current cumulative impact assessment is to evaluate the combined effects of existing projects and proposed developments within the RCIA study area.

Chapter 12: Environmental and Social Management Plan- This chapter depicts the environmental and social management plan (ESMP) of the project which is based on ESMP implementation practices in other bank funded projects in the region and other good international industry practices. The basic objective of the ESMP is to manage adverse impacts and risks of proposed project interventions in a way that minimizes the impact and risk on the environment, workers, and community.

*Chapter 13: Stakeholders Consultation and Disclosure- T*his chapter summarises the feedback received from the stakeholders and how those were incorporated in the project plan and ESIA as well.

Chapter 14: Institutional Arrangements and Capacity Building- This chapter includes the present institutional arrangements and capacity of the implementation agencies, assess the gap of the IAs in

implementing the E&S impacts and risks, and prepare recommendations for capacity building. In addition, the chapter also includes the capacity requirements of the contractors and consultants and other stakeholders to implement the Project and training needs assessment.

The annexes are:

- Annex 1.1: Team Composition of the ESIA
- Annex 2.1: National Acts and Regulations
- Annex 6.1: Biodiversity Baseline Report
- Annex 6.2: Results from Integrated Biodiversity Assessment Tool
- Annex 6.3: List of Species Sighted in the Biodiversity Assessment Asea
- Annex 6.4: Dolphin Conservation Actions Recommended by Dolphin Conservation Plan 2020-2030
- Annex 9.1: OHS Risk Matrix
- Annex 10-1: Summary of the Community Health and Safety Impacts and Risks
- Annex 12-1: Environmental and Social Code of Practices (ESCOP)
- Annex 12.2: Draft TOR for Contracting NGO/Social Consulting Firm to Design Livelihood Restoration and Development
- Annex 13.1: Stakeholder Consultation

2. Policy, Legal and Regulatory Framework

2.1 Introduction

The emerging environmental scenario calls for attention to conservation and judicious use of natural resources. Some legal and institutional requirements govern all the Development projects in Bangladesh. So, assessing relevant legal provisions, policies, strategies, and institutional issues is very important for any project proponent or developer before executing a program or plan. The proponent must be aware of these requirements and comply with the provisions as applicable and necessary.

It is also understood that the project is also intended to receive international financing for project execution, and there are specific environmental and social safeguard requirements of the international financial institution, hence the World Bank.

The Department of Environment (DoE) under the Ministry of Environment and Forest (MoEF) of Bangladesh looks after the environmental approval process. The key regulations that govern this process are the Environment Conservation Act - ECA, 1995 (including all amendments) and the Environment Conservation Rules - ECR, 1997 (including all modifications), and the pillar to protect the environment in Bangladesh.

The Project Implementing Unit (PIU) (i.e. BWDB and BIWTA) must obtain Environmental Clearance Certificate (ECC) from the Department of Environment (DoE) before initiating any physical activities. The ECC obtaining procedure form 'Red Category' project can be summarized as follows:

Carrying out Environmental Impact Assessment → Application to DoE → Approval of EIA → Obtaining Site Clearance Certificate and ECC → The ECC is subject to annual renewal.

All legal provisions relevant to environmental protection applicable to the planning stage and operational activities of the JRECDP were identified under the scope of the ESIA study. Table 2.1 presents the relevant national environmental regulations, and other laws and policies.

Table 2.1: List of Relevant National Policy and Legislative

Issue	Bangladeshi Legislation or Regulation	Remarks
Prevention and Protection of the environment and Climate change	The Environment Court Act, 2010	Applicable- As this allows the government to take necessary legal action against any parties which creates environmental hazards/ damage to the environment. This act helps to plan mitigation measures.
	Environmental Conservation Act (1995) and all of its amendments (2000, 2002 and 2010))	Applicable- The proposed Project will pose a conspicuous threat to the environment during the construction and operation phases. This Act will be followed through the entire project's life cycle. The mitigation measures
	Environmental Conservation Rules (ECR), 1997 and Amendments	Applicable- This Project falls under the "Red" category and requires clearance before the commencement of any project activities. In addition, it is stipulated that environmental quality standards and other relevant requirements shall comply during the project life cycle. As per this law the IAs have initiated procedure for obtaining Environmental Clearance Certificates from the regulatory authority i.e. Department of Environment.
	National Environment Policy, 1992	Applicable- As the proposed project has the likeliness of having an impact on the surrounding environment. While preparing ESMP, this policy helped to design the outline and measures.
	National Environment Management Plan 1995	Applicable- As related to habitat conservation and biodiversity, including environmental management and quality of life. The Mitigation plan and ESMP have been prepared in line with this plan.
	Bangladesh Climate Change Strategy and Action Plan (BCCSAP) 2009	Applicable- This project will save lives and land from erosion and flooding and offset the carbon footprint by using an environment-friendly development mechanism. This action plan helped to design the overall program and the project.
Fisheries	Protection and Conservation of Fish Rules (1985)	Applicable- The Project requires compliance with any rules set out to protect fish in the inland waters of Bangladesh. This rule helped to identify potential risk on fisheries and to identify appropriate mitigation measures.
	National Fisheries Policy, 1996 & 1998	Applicable- As the policy provided guidelines for protecting fish species, the subject project has a likeliness of impact on waterways and fish species. This policy helped to outline the fish management plan.
Water	National Water Policy (1999)	Applicable- There will be a clear chance to pollute the water body and its resources during the construction and waterway transportation. The CDD component of the project was planned in line with the policy. The Water Resources Management Plan under the ESMP was prepared in line with the policy as well.
	National Water Management Plan, 2001 (Approved in 2004)	Applicable- this plan gives guidance on planning and designing the Water Management Infrastructures including erosion protection of riverbank of Jamuna River.
	Water Act-2013	Applicable- As this Act is applicable for the surface water, groundwater, seawater, rainwater, and water in the atmosphere in the territory of Bangladesh. This act helped to identify the mitigation measures against the impacts on water and water resources.

Issue	Bangladeshi Legislation or Regulation	Remarks
	Inland Water Transport Authority Ordinance (1958)	Applicable- As this Act is directly related to the development, maintenance, and control of inland water transport and certain inland navigable waterways. It helped to identify the mitigation measures.
	The Embankment and Drainage Act 1952	Applicable As this Act aims to consolidate the laws relating to embankment and drainage and to make better provision for the construction, maintenance, management. It helped to design the overall project.
	Bangladesh Water Rules 2018	Applicable as this rule is related to the Water Act 2013. It helped to prepare the ESMP.
Agricultural and land use	National Agriculture Policy, 1999	Applicable- As this policy particularly emphasis on research on the development of improved varieties and technologies for cultivation in water-logged and salinity affected areas. It helped to prepare the ESMP.
	National Agricultural Extension Policy 2013	Applicable- This is an extended policy for transferring technologies to crop, fisheries, and livestock sector development. Here, key elements of the lesson learned from existing policy, macroeconomic scenario, agroecology /bio-ecological zones, and current issues in agriculture such as natural disaster. It helped to prepare the ESMP.
	National Land Use Policy (MoL,2001)	Applicable- As this policy has focused on the land reclamation process. Through this project, there will be an opportunity to resume some land using proper embankment protection technology. It helped to prepare the ESMP.
	Acquisition and Requisition of Immovable Property Act, 2017 (ARIPA, 2017)	Applicable- As this Act will ensure to resettlement procedure and compensate the landless inhabitant due to land acquisition during the construction phase. It helped to prepare the RPF and compensation plan.
Wildlife & Biodiversity	Bangladesh Wildlife (Preservation) Order (1973) and Act (1974)	Applicable- As this order empowers the government to declare areas as game reserves, wildlife sanctuaries, and national parks to protect the country's wildlife. It helped to prepare biodiversity management plan of the ESMP.
	Bangladesh Wildlife (Protection and Safety) Act 2012	Applicable- As this Act is to provide for the conservation and safety of biodiversity, forest, and wildlife of Bangladesh by repealing the existing law relating to the country's conservation and management of wildlife. It helped to prepare biodiversity management plan of the ESMP.
	National Biodiversity Strategy and Action Plan of Bangladesh 2016-2021	Applicable- As this strategy has national targets for the biodiversity and presents guiding framework for biodiversity conservation, ensuring sustainable use of its components along with fair and equitable sharing of benefits arising out of utilization of genetic resources. It helped to prepare biodiversity management plan of the ESMP.
	5th National Report of Bangladesh to the Convention on Biological Diversity, 2015	Applicable-The report presents different aspects of biodiversity in Bangladesh addressing the status and trends of biodiversity, progresses on implementation of National Biodiversity Strategy and Action Plan. It helped to prepare biodiversity management plan of the ESMP.

Issue	Bangladeshi Legislation or Regulation	Remarks
	Biodiversity Act- 2017	Applicable- As this Act regulates the Biodiversity conservation and sustainable use of its water body and resources. It helped to prepare biodiversity management plan of the ESMP.
Health and Safety and Labor management	Bangladesh Labour Act, 2006 (with amendments in 2013 and 2018)	Applicable- This law is related to the condition of employment and occupational health and safety and is also associated with worker's compensation if any fatal injury or death happens during the project implementation phase. It helped to prepare the LMP.
	Bangladesh Labour Rules, 2015	Applicable- As these regulations have provided some guidelines in terms of how the Bangladesh Labour Act, 2006 will be implemented, e.g., appointment letter, holiday, worker's health and safety, payment of wages, and other key issues. It helped to prepare the LMP.
	Fatal Accidents Act, 1855	Applicable- As the proposed project has possibilities of unplanned accidental events during the project life cycle; hence this law is applicable. It helped to identify occupational health and safety measures and plan.
Land Acquisition and Resettlement	The Alluvion and Diluvion Regulation, 1825 and the Alluvial Lands Act, 1920	Applicable- as this Regulation and Act are used for declaring the rules to be observed in determining claims to lands gained by alluvion, or by dereliction of a river or the sea. These rules are applicable for the prevention of disputes concerning the possession of certain lands in Bangladesh gained by alluvion, or by dereliction of a river or the sea. The RPF prepared for this Project duly considered this regulation and act.
	Acquisition and Requisition of Immovable Property Act, 2017 (ARIPA, 2017)	Applicable- As this Act will ensure to resettlement procedure and compensate the landless inhabitant due to land acquisition during the construction phase. It helped to prepare the RPF and compensation plan.
SEA/SH	The Penal Code 1860	Applicable: As it defines how to define and legally deal severe form of physical violence against women e.g. rape, physical assault it fall short to deal other form of gender based violence and sexual harassment e.g. harassment without physical contact.
	Women and Children Repression Prevention Act, 2000 Domestic Violance (Prevention and Protection Act, 2010	Applicable as it further defines the legal actions criminalizing various forms of violence against women.

2.2 Project-Relevant International Conventions, Treaties and Protocols (ICTPs) in Force in Bangladesh

Bangladesh is a signatory to many International Conventions, Treaties, and Protocols (ICTPs). These instruments vary in their importance, effectiveness, level of commitment, and urgency to act on, with each having several obligations and consequent implications. Like many other developing countries, Bangladesh needs capacity enhancement support to fully implement the convention provisions. Table 2.2 presents applicable Key Project-related treaties and conventions.

Table 2.2: Relevant Treaties and Conventions

Treaty or Convention	Year	Brief Description	Relevant Department
Paris Protection of birds	1950	Conservation of birds in the wild state	DoE/DoF
Ramsar Convention	1971	Protection of wetlands	DoE/DoF
Protocol Waterfowl Habitat	1982	Amendment of Ramsar Convention to protect specific habitats for waterfowl	DoE/DoF
CITES convention, 1973	1981	Aim is to ensure that international trade in specimens of wild animals and plants does not threaten the survival of the species.	DoE/DoF
Bonn Convention	1979	Conservation of migratory species of wild animals	DoE/DoF
Prevention and Control of Occupational hazards	1974	Protect workers against occupational exposure to carcinogenic substances and agents	MoH
Occupational hazards due to air pollution, noise & vibration (Geneva)	1977	Protect workers against occupational hazards in the working environment	MoH
Occupational safety and health in the working environment (Geneva)	1981	Prevent accidents and injury to health by minimizing hazards in the working environment	MoH
Occupational Health services	1985	To promote a safe and healthy working environment	MoH
Convention on oil pollution damage (Brussels)	1969	Civil liability on oil pollution damage from ships	DoE/MoS
Convention on oil pollution	1990	Legal framework and preparedness for control of oil pollution	DoE/MoS
Vienna convention	1985	Protection of ozone layer	DoE
London Protocol	1990	Control of global emissions that deplete the ozone layer	DoE
UN framework convention on climate change (Rio de Janeiro)	1992	Regulation of greenhouse gases emissions	DoE
Convention on Biological Diversity (Rio de Janeiro)	1992	Conservation of biodiversity, sustainable use of its components, and access to genetic resources	DoE
International Convention on Climate Changes (Kyoto Protocol)	1997	An international treaty on climate change and emission of greenhouse gases	DoE
Protocol on biological safety (Cartagena protocol)	2000	Biological safety in transport and use of genetically modified organisms	DoE
Basel Convention, 1989	1993	Designed to reduce the movements of hazardous waste between nations, and specifically to prevent transfer of hazardous waste from developed to less developed countries.	DOE

2.3 The World Bank's Environmental and Social Framework (ESF)

The Environmental and Social Safeguards (ESS) of the World Bank's Environmental and Social Framework (ESF) replacing the previous World Bank safeguard policies are not responsibility of the borrowers to comply with. The ESF ESS focus on globally accepted practices and interventions by which the borrowers can efficiently implement their development programs keeping the environmental and social impact of the people and landscapes at a minimal level. The World Bank's support in the ESF-related matter aims to enhance the national regulations' capacity to evaluate and facilitate the JRECDP consistent with good international practice in technical, environmental, social, and health and safety standards. The Bank undertakes environmental and social risk screening of the proposed projects that are classified into one of four categories High Risk, Substantial Risk, Moderate Risk and Low Risk depending on their type, location, sensitivity, the scale of the project, and the nature and magnitude of its potential environmental and social risks and impacts and the capacity and commitment of the Borrower.

The JRECDP SOP has been rated as a high-risk category project. The Environmental Risk of SOP 1 has been rated as Moderate to Substantial and the Social risk of the SOP 1 has been rated as high. The salient parameters include substantial Project E&S and OHS risks, low regulatory and institutional capacity, and low technical capacity. However, many associated risks and impacts can be mitigated if appropriate and timely measures are taken. While preparing the ESIA the ESSs were duly considered and the Implementing Agencies agrees to fulfil the requirements of ESSs. The relevant ESS standards of the World Bank are mentioned below:

- ESS 1. Assessment and Management of Environmental and Social Risks and Impacts,
- ESS 2. Labor and Working Conditions,
- ESS 3. Resource Efficiency and Pollution Prevention and Management,
- ESS 4. Community Health and Safety,
- ESS 5. Land Acquisition, Restriction on Land Use and Involuntary Resettlement,
- ESS 6. Biodiversity Conservation and Sustainable Management of Living Natural Resources,
- ESS 8. Cultural Heritage, and
- ESS 10. Stakeholder Engagement and Information Disclosure.

2.4 Comparison of ESF and National Guidelines and How to Fill the Gaps

Table 2.3: Comparison between ESF and National Regulatory Framework

Environmental and Social Standards (ESS)	Relevant to Project (Yes/No)	Main requirements of ESS	Relevant National Laws and Guidelines	Gaps and how to address them
ESS1 – Assessment, and Management of Environmental and Social Risks and Impacts	Yes	• The Borrower will conduct an environmental and social assessment of the proposed project to assess the environmental and social risks and impacts throughout the project life cycle. The assessment will be proportionate to the risks and impacts of the project. • Undertake stakeholder engagement and disclose appropriate information in accordance with ESS 10. • Develop an ESCP, and implement all measures and actions set out in the legal agreement, including the ESCP. • Conduct monitoring and reporting on the environmental and social performance of the project against the ESS's. • The project will apply the country's applicable policy framework, national laws and regulations, institutional capabilities, and the relevant requirements of the Environmental Health and Safety Guidelines (EHSGs). • The environmental and social assessment will apply a mitigation hierarchy, which will: (a) Anticipate and avoid risks and impacts; (b) Where avoidance is not possible, minimize or reduce risks and impacts to acceptable levels; (c) Once risks and impacts have been minimized or reduced, mitigate; and (d) Where significant residual impacts remain, compensate for or offset them, where technically and financially feasible. • The Borrower will conduct Environmental and Social Audits in existing Projects or Activities. This will cover the risks and impacts identified in ESSs1–10. The audit will also review issues not covered by the ESSs, to the extent that they represent vital risks and impacts in the project's circumstances. • The Borrower will conduct an Environmental and social management framework (ESMF) to examine the risks, impacts,	• National Environmental Policy, 1992 • National Environmental Management Action Plan, 1995 • Environmental conservation Rules (ECR), 1997 and subsequent amendments • Environment Conservation Act, 1995 and subsequent amendments • Bangladesh Climate Change Strategy and Action Plan (BCCSAP), 2009	• ESIA screening and scoping may not cover all of the ESSs. Physical interventions of the project are screened to ensure they meet all ESSs requirements. • The stakeholder engagement during the conduct of the ESIA is limited in scope and procedures compared to ESS10 requirements. This ESIA comprehensively covered the criteria stipulated in the ESS10: A detail Stakeholder Engagement plan will be prepared and Information Disclosure, including the ESIA disclosure in IAs and World Bank's websites. • ECR 1997 (and subsequent amendments) does not require analysis of alternatives, which has been extensively covered in the ESIA as per ESS1 to identify ways of project footprints, technology selection, and design to apply mitigation hierarchy. • Mitigation measures do not follow any hierarchy of application, which is being covered to comply with ESS1. The ESIA adopted mitigation hirerchy as per the ESS1.

Environmental and Social Standards (ESS)	Relevant to Project (Yes/No)	Main requirements of ESS	Relevant National Laws and Guidelines	Gaps and how to address them
		and/or series of subprojects. The risks and impacts cannot be determined until the program or subproject details have been identified.		• There is no requirement in national policy to prepare an IAs commitment plan. The both IAs have prepared ESCP as per the ESS1. Also, an ESCP is being included in the ESIA to comply with ESS1. The national laws do not specifically require identification of and consultation with the "disadvantaged and marginalized groups/peoples" which is a mandatory requirement under ESS1.
ESS2 – Labor and Working Conditions	Yes	• The Borrower will develop and implement Labour Management Procedures applicable to the project. • The Borrower will identify potential risks of child labor, forced labor, and severe safety issues related to primary suppliers. A child under the minimum age will not be employed or engaged in connection with the project. • Measures relating to occupational health and safety will be applied to the project. The OHS measures will include the requirements of ESS2. They will consider the General Environmental Health and Safety Guidelines (EHSGs) and, as appropriate, the industry-specific EHSGs and other GIIP. The OHS measures will be designed and implemented to address (a) identification of hazards, (b) provision of preventive and protective measures, (c) training of project workers, (d) documentation, reporting, and remedies of occupational incidents, and (e) emergency response arrangements. • The Borrower will make reasonable efforts to ascertain that third parties who engage contracted workers are legitimate and reliable entities and have in place labor-management	Bangladesh Labor Act, 2006 (amended in 2013, 2015, and 2018)	• The Bangladesh Labor Act does not make it mandatory for development interventions to be assessed and reviewed in labor and working conditions, including OHS, during construction. An OHS plan is prepared to comply with ESS2, which will be further extended by the Contractor during construction stage. • The labor act does not require development projects to prepare labor management plans/procedures. This ESIA prepared a labor-management procedure to comply with ESS2 covering direct, contracted, community, primary supply workers, and government civil servants. The procedure also covered management of worker relations, including workers specific GRM, terms and conditions of employment, non-

Environmental and Social Standards (ESS)	Relevant to Project (Yes/No)	Main requirements of ESS	Relevant National Laws and Guidelines	Gaps and how to address them
		procedures applicable to the project that will allow them to operate. • The Borrower will require measures to be implemented to ascertain that community workers are provided voluntarily as an outcome of individual or community agreement.		discrimination and equal opportunity, protection of workforce, and prohibition. • No Child below 14 is permitted to work. Child above 14 but below 18 can work if s/he is a trainee or s/he has certificate of fitness from the designated official of the government. Otherwise, all forms of child labor is prohibited since the 2018-amendment of Labor Act. • A Labor Mangement Procedure along with Worker Code of Conduct has been prepared in line with the ESS2 which will be followed by the contractor and the PIU as well.
ESS3 – Recourse and Efficiency, Pollution Prevention and Management	Yes	• Resource Efficiency: The Borrower will implement technically and financially feasible measures for improving the efficient consumption of energy, water, and raw materials, as well as other resources. • Pollution prevention and management: The Borrower will avoid the release of pollutants or, when avoidance is not feasible, comply with the national or EHSG standards, whichever is most stringent. This applies to the release of contaminants to air, water, and land due to routine, non-routine, and accidental circumstances, with the potential for local, regional, and transboundary impacts.	• Environmental Conservation Act (ECA) 1995 • Noise Pollution Rules (2006) • National Fisheries Policy, 1998 • Water Supply and Sanitation Act, 1996 • National Water Bodies Protection Act, 2000 • National Agriculture Policy, 2013	Existing national energy and water conservation policies, laws, and regulations require development projects to assess resource efficiency issues and incorporate them into their ES risk management plans. GOB has rules and regulations that address pollution prevention, such as ECA 95, ECR 97, Rules for hazardous waste management, and strategies for adaptation and mitigation to climate change. While existing regulations address many ESS3 requirements, there are gaps in many cases, such as lack of rules directly addressing the issues related to sourcing of construction material, resource efficiency, etc. The Feasibility team prepared the project design (design of the Groyne and revetment

Environmental and Social Standards (ESS)	Relevant to Project (Yes/No)	Main requirements of ESS	Relevant National Laws and Guidelines	Gaps and how to address them
			• Environment Court Act, 2000 and amendment in 2002	work, dredging, etc.) considering the resources efficiency as per the ESS3 throuhg a systematic analysis of alternatives. The ESIA prepared various pollution prevention plans e.e. water pollution, noise, air pollution, ship pollution, etc.
ESS4 – Community Health and Safety	Yes	• Evaluation of the risks and impacts on health and safety of the affected communities during project cycle and mitigation measures • The Borrower will design, construct and operate structural elements of the project in accordance with national legal requirements, Environmental Health and Safety Guidelines (EHSGs), and Good International Industry Practices, considering safety risks to communities, climate change, and natural hazards. • The Borrower will establish and implement appropriate quality management systems to anticipate and minimize risks and impacts that community service projects may have on community health and safety. In such circumstances, the Borrower will also apply the concept of universal access, where technically and financially feasible. • The Borrower will identify, evaluate, and monitor the potential traffic and road safety risks to workers, affected communities, and road users throughout the project life cycle and, where appropriate, will develop measures and plans to address them. The Borrower will incorporate technically and financially feasible road safety measures into the project design to prevent and mitigate potential road safety risks to road users and affected communities. • The Borrower will identify the project's potential risks and impacts on ecosystem services that may be exacerbated by climate change. Adverse impacts will be avoided, and if they are	• Noise Pollution (Control) Rules 2006 • National Strategy for Waste Management • National Policy for Safe Drinking Water Supply and Sanitation (1998) • National Water Management Plan, 2001 (Approved in 2004) • Bangladesh Climate Change Strategy and Action Plan (BCCSAP) 2009	There are no direct laws or policies on community health and safety in the existing GoB regulatory systems (laws, rules, policies, and acts). Hence, the World Bank ESS4 will fulfill and ensure the community health and safety issue partially. The gaps will be addressed through suitable provisions in ESMP and the contractor's obligation as part of the Contractor's ESMP for CHS. In addition, the contractor will be responsible for implementing the ESMP regarding community health and safety, which includes the OHS plan, Labor Management Plan, Workers Camp Management Plan, Traffic and Road Safety Management Plan, etc. The national law also does not consider SEA/SH compliant GRM, workers' Code of Conduct, provisions of SEA/SH service providers and institutional capacity building on SEA/SH risk management. A standalone Action Plan against the SEASH impact and risk has been prepared covering the ESS4 requirement.

Environmental and Social Standards (ESS)	Relevant to Project (Yes/No)	Main requirements of ESS	Relevant National Laws and Guidelines	Gaps and how to address them
		unavoidable, the Borrower will implement appropriate mitigation measures. • The Borrower will avoid or minimize the potential for community exposure to water-related and vector-borne diseases and hazardous material. • The Borrower will take measures to avoid or minimize the transmission of communicable diseases associated with the influx of temporary or permanent project labor. • The Borrower will avoid or minimize the potential for community exposure to hazardous materials and substances that the project may release. • The Borrower will identify and implement measures to address emergency events, including both natural and man-made hazards. • The Borrower, while retains direct or contracted workers to provide security to safeguard its personnel and property, will assess risks posed by these security arrangements to those within and outside the project site.		
ESS5 – Land Acquisition, Restrictions on Land Use, and Involuntary Resettlement (Project Design)	Relevant	• The Borrower will demonstrate that involuntary land acquisition or restrictions on land use are limited to direct project requirements for clearly specified project purposes within a specified period. • The Borrower will offer affected person compensation at replacement cost and other assistance as necessary to help them improve or at least restore their living standards or livelihoods. • The Borrower will take possession of acquired land and related assets only after compensation following ESS5 has been made available and, where applicable, displaced people have been resettled and moving allowances have been provided to the displaced persons in addition to compensation.	The Acquisition and Requisition of Immovable Property Act, 2017	• Bangladesh: ARIPA2017 • It does not require the preparation of RAP • Does not provide compensation or assistance to those who do not have a formal legal claim to the land • Does not provide transitional allowances for restoration of livelihoods for informal settlers • Consultation with affected communities is not legally required • No provision to give special attention to the vulnerable groups

Environmental and Social Standards (ESS)	Relevant to Project (Yes/No)	Main requirements of ESS	Relevant National Laws and Guidelines	Gaps and how to address them
		• The Borrower will engage with affected communities, including host communities, through the process of stakeholder engagement described in ESS10. • The Borrower will ensure that a grievance mechanism for the project is in place, in accordance withESS10, as early as possible in project development to address specific concerns about compensation, relocation, or livelihood restoration measures raised by displaced persons (or others) in a timely fashion. • The Borrower will conduct a census to identify the persons[16] who will be affected by the project, to establish an inventory of land and assets to be involved, to determine who will be eligible for compensation and assistance, and to discourage ineligible persons, such as opportunistic settlers, from claiming benefits. • The Borrower will prepare a resettlement plan/framework proportionate to the risks and impacts associated with the project by establishing the roles and responsibilities relating to financing and implementation and include arrangements for contingency financing to meet unanticipated costs, as well as arrangements for a timely and coordinated response to unforeseen circumstances impeding progress toward desired outcomes. The total fees of resettlement activities necessary to achieve the project's objectives are included in the project's total costs. • The Borrower will establish procedures to monitor and evaluate the implementation of the plan and will take corrective action as necessary during implementation to achieve the objectives of ESS5.		• There is no provision for voluntary land donation Gap Filling measures: • A Resettlement Policy Framework has been prepared in line with the ESS5. It gives the following guideline: • RAP/s will be prepared for all interventions regarding the land acquisition or requisition during the construction phase, and without the approval of RAP/s by the Bank, construction works will not be started. • All affected persons, including titled, non-titled encroachers, will be identified for the compensation and assistance at total replacement cost. The cut-off date for non-title holders will be considered the date of the census survey. • If the compensation according to the ARIPA 2017 do not meet the replacement cost, additional top-up payments will ensure replacement cost at the current market price together with transitional support • Extensive consultations will be carried out during all phases of the project. A separate SEP will be prepared.

[16] Affected persons may be classified as persons: (a) Who have formal legal rights to land or assets; (b) Who do not have formal legal rights to land or assets, but have a claim to land or assets that is recognized or recognizable under national law; or (c) Who have no recognizable legal right or claim to the land or assets they occupy or use.

Environmental and Social Standards (ESS)	Relevant to Project (Yes/No)	Main requirements of ESS	Relevant National Laws and Guidelines	Gaps and how to address them
				• The project will pay particular attention to the vulnerable groups, i.e., additional grants, livelihood training, job opportunities during construction, etc. • The RPF clearly describes requirements to meet in case of voluntary land donation procedures and Negotiated Settlement.
ESS6 – Biodiversity Conservation and Sustainable Management of Living Natural Resources	Yes	• The Borrower will avoid adverse impacts on biodiversity and habitats. • When avoidance of adverse impacts is not possible, the Borrower will implement measures to minimize the negative effects and restore biodiversity in accordance with the mitigation hierarchy provided in ESS1 and with the requirements of ESS6. • The Borrower will ensure that competent biodiversity expertise is utilized to conduct the environmental and social assessment and the verification of the effectiveness and feasibility of mitigation measures. • The Borrower will develop and implement a Biodiversity Management Plan where significant risks and adverse impacts have been identified.	• National Biodiversity Strategy and Action Plan (2004) • The Forest Act, 1927 and subsequent amendments in 1982 and 1989 • National Forest Policy, 1994 • Wildlife Conservation (Protection and Safety) Act, 2012 • Bangladesh Biodiversity Act, 2017	Though these strategies and action plans cover bio-diversity conservation but do not directly cover the issues related to ecosystem services. World Bank ESS6 standard will be considered during the assessment of project impact. The ESIA covered habitat assessment, critical habitat assessment, and fulfilled other requirements. The ESMP covered the 'no net loss' and 'net gain' requirements.
ESS7 - Indigenous Peoples/Sub-Saharan African Historically Underserved Traditional Local Communities	No (The ESIA confired and the WB team agreed), there is no indigenous people living in	• The Borrower will assess the nature and degree of the expected direct and indirect economic, social, cultural (including cultural heritage), and environmental impacts on Indigenous Peoples who are present in, or have a collective attachment to, the project area. • The Borrower will prepare a consultation strategy and identify how affected Indigenous Peoples will participate in project design and implementation.	• East Bengal State Acquisition and Tenancy Act, 1950 • The Acquisition and Requisition of Immovable Property Act, 2017 • Bangladesh Water Act, 2013	The land Right is managed by East Bengal State Acquisition and Tenancy Act, 1950. The participation of people, requirement of considering social impacts or impacts on community are required by EIA Guideline, Water Act 2013 and Participatory Water Management Rules 2014. Although, there is no explicit mentioning of indigenous people, the relevant rules are applicable to them as well.

Environmental and Social Standards (ESS)	Relevant to Project (Yes/No)	Main requirements of ESS	Relevant National Laws and Guidelines	Gaps and how to address them
	the project AOI as well as in the study area.	• The Borrower's proposed measures and actions will be developed in consultation with the affected Indigenous Peoples and contained in a time-bound Indigenous Peoples plan. • The Borrower will proactively engage with the relevant Indigenous Peoples to ensure their ownership and participation in project design, implementation, monitoring, and evaluation and consult with them about the cultural appropriateness of proposed services or facilities. It will seek to identify and address any economic or social constraints (including those relating to gender) that may limit opportunities to benefit from, or participate in, the project. • The Borrower will design and implement the project to provide affected Indigenous Peoples equitable access to project benefits. • The Borrower will minimize and/or compensate for the adverse impacts in a culturally appropriate manner proportionate to the nature and scale of such effects and the form and degree of vulnerability of the affected Indigenous Peoples. • The Borrower will take appropriate measures to recognize, respect, and protect peoples ("in voluntary isolation," "isolated peoples" or "in initial contact,") land and territories, environment, health, and culture, as well as measures to avoid all undesired contact with them as a consequence of the project. The aspects of the project that would result in such undesired contact will not be processed further. • The Borrower will ensure that a grievance mechanism is established for the project, as described in ESS10, which is culturally appropriate and accessible to affected Indigenous Peoples	• Participatory Water Management Rules, 2014 • EA guideline for Water management Project	However, requirements are not clearly explained as it has been illustrated in the ESF which results in ignorance and negligence. The requirements of GRM targeting the indigenous people is not required by national law.
ESS8 – Cultural Heritage	Yes	• The Borrower will determine the potential risks and impacts of the project's proposed activities on cultural heritage. • The Borrower will avoid impacts on cultural heritage. When avoidance of impacts is not possible, the Borrower will identify	• Antiquity Act, 1968: • Antiquity Preserving Rules, 1986	The Antiquity Act 1968 and Antiquity Preserving Rules, 1986 generally protect archeological sites and designated cultural/historical sites. The EIA guidelines generally advised avoidance of impacts on

Environmental and Social Standards (ESS)	Relevant to Project (Yes/No)	Main requirements of ESS	Relevant National Laws and Guidelines	Gaps and how to address them
		and implement measures to address impacts on cultural heritage in accordance with the mitigation hierarchy of ESS1. Where appropriate, the Borrower will develop a Cultural Heritage Management Plan. • The Borrower will implement globally recognized practices for field-based study, documentation, and protection of cultural heritage in connection with the project, including contractors and other third parties. A chance finds procedure is a project-specific procedure that will be followed if previously unknown cultural heritage is encountered during project activities. It will be included in all contracts relating to the project's construction, including excavations, demolition, earth movement, flooding, or other changes in the physical environment.	• Bangladesh National Building Code, 1993 • EIA Guidelines of DoE	culture and heritage while construction and operation of any project. However, there is no specific and clearly defined procedures on how to ensure protection of cultural heritage during project implementation. Although the ESIA found no known cultural heritage within the study area, a chance finding procedure has beem included in the ESIA (as an Environmental and Social Code of Conduct)
ESS9 – Financial Intermediaries	No (Confirmed by WB team)		This ESS is not relevant to the project and hence and hence not assessed	Not assessed
ESS10 – Stakeholder Engagement and Information Disclosure	Yes	• Engage with stakeholders in meaningful consultations during the project life cycle, commencing as early as the project development stage to get information on the project design. The nature, scope, and frequency of stakeholder engagement will be proportionate to the nature and scale of the project and its potential risks and impacts. • Borrowers will provide stakeholders with timely, relevant, and accessible information and consult with them in a culturally appropriate manner, free of manipulation, interference, coercion, discrimination, and intimidation. • The process of stakeholder engagement will involve (i) stakeholder identification and analysis; (ii) planning how the engagement with stakeholders will take place; (iii) disclosure of information; (iv) consultation with stakeholders; (v) addressing and responding to grievances; and (vi) reporting to stakeholders.	• Environmental conservation Rules, 1997 and subsequent amendments • Environmental Conservation Act (ECA) 1995 • Noise Pollution Rules (2006) • Bangladesh Water Act, 2013 • Participatory Water Management Rules, 2014	In case of water management project, it is required by the Rules (Water Act 2013, Participatory Water Management Rules 2014 and the Guideline for EA) to engage the local people and relevant stakeholders in project planning, construction and operation. The ECR 1997 allows for public consultation as part of the preparation of ESIA reports. However, there is a gap in systematic engagement of the people throughout the project life cycle as it has been illustrated by ESS10. Under this project, a Stakeholder Engagement Plan (SEP) has been prepared to ensure such engagement with stakeholders and information disclosure to stakeholders

Environmental and Social Standards (ESS)	Relevant to Project (Yes/No)	Main requirements of ESS	Relevant National Laws and Guidelines	Gaps and how to address them
		• The Borrower will maintain and disclose as part of the environmental and social assessment, a documented record of stakeholder engagement, including a description of the stakeholders consulted, a summary of the feedback received and a brief explanation of how the feedback was taken into account, or the reasons why it was not being considered.	• Guideline for Environmental Assessment for Water Sector Project	occurs at various stages of the Program / Project

2.5 WBG General EHS Guidelines, 2007

The EHS Guidelines are technical reference documents with general and industry-specific examples of Good International Industry Practice (GIIP). They are referred to in the World Bank's Environmental and Social Framework and IFC's Performance Standards.

The World Bank Group requires borrowers/clients to apply the appropriate levels or measures of the EHS Guidelines. When host country regulations differ from the levels and measures presented in the EHS Guidelines, projects will be required to achieve whichever is more stringent.

The General EHS Guidelines contain the following information:

1. Environmental

- Air Emissions and Ambient Air Quality
- Energy Conservation
- Wastewater and Ambient Water Quality
- Water Conservation
- Hazardous Materials Management
- Waste Management
- Noise
- Contaminated Land

2. Occupational Health and Safety

- General Facility Design and Operation
- Communication and Training
- Physical Hazards
- Chemical Hazards
- Biological Hazards
- Radiological Hazards
- Personal Protective Equipment (PPE)
- Special Hazard Environments
- Monitoring

3. Community Health and Safety

- Water Quality and Availability
- Structural Safety of Project Infrastructure
- Life and Fire Safety (L&FS)
- Traffic Safety
- Transport of Hazardous Materials
- Disease Prevention
- Emergency Preparedness and Response

4. Construction and Decommissioning

- Environment
- Occupational Health and Safety
- Community Health and Safety

3. Project Description

3.1 Jamuna River Economic Corridor Development Program Framework

The JRECDP has adopted the Series of Project (SOP) approach and has been planned to be implemented over three series of projects (Figure 3.1). SOP 1 (Project 1) focused on piloting of an innovative river training structure for two pilot sites with dredging of a small section, aids to navigation for the entire program area, hydro-dynamic modeling and hydrographic survey, institutional measures like capacity building, and setting up a disaster financing instrument. SOP 2 will be focused on the expansion of innovative river structures, conventional river-protection, scaled-up dredging, navigation development, disaster risk financing implementation in priority areas, and institution capacity building. SOP 3 aims for further scaling up to develop the resilient Jamuna Economic Corridor. This ESIA is prepared for SOP 1. SOP 1 targets carrying out feasibility level studies, preparing E&S documents (which will be updated at a detailed design stage), appraisal of the planned activities, obtaining approval from the Bank.

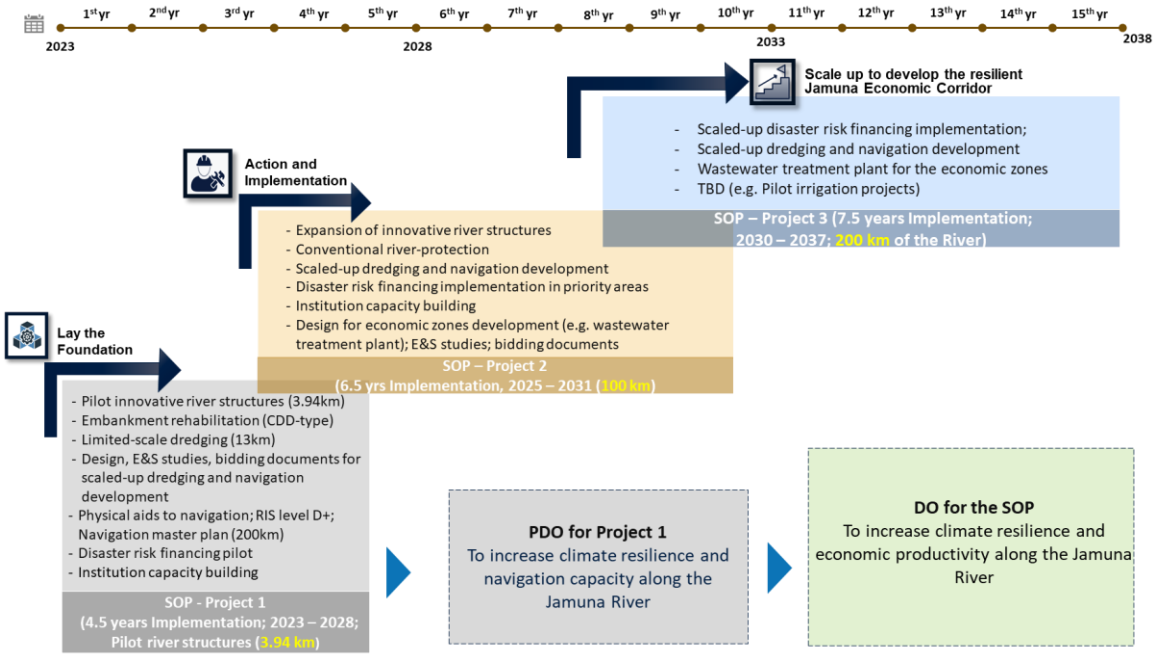


Figure 3.1: Series of Projects of Jamuna River Economic Corridor Development Program

3.2 Proposed Project

This ESIA study is conducted for SOP 1(the Project) and based on feasibility studies. The Project invests USD145 million over four and half years, combining investments in river structures, navigation channel development, disaster risk financing solutions, and community engagement for the first time in Bangladesh. Through this multisectoral approach, all phases of disaster management cycle—mitigation, preparedness, response, and recovery—are supported to deal with flood and bank erosion.[1] Total works will be limited to USD70 million only under Component 1, and the rest of the financing would be used for procurement of

[1] Emergency managers think of disasters as recurring events with four phases. Mitigation includes actions taken to prevent or reduce the cause, impact, and consequences of disasters. Preparedness refers to planning, training, and educational activities for events that cannot be mitigated. The response phase occurs in the immediate aftermath of a disaster, and personal safety and wellbeing during response depend on the level of preparedness. Recovery means restoration efforts that occur toward returning to a normal state. https://training.fema.gov/emiweb/downloads/is111_unit%204.pdf

goods, O&M,[2] and TA. Components may be implemented in different sections of the Jamuna River, within the 250 km stretch between Daikhowa and Aricha.

The proposed project is comprised of four components which are provided below and the location map is presented in Figure 3.2:

- Component 1: Flood and bank erosion management, to be implemented by BWDB
- Component 2: Navigation channel development, to be implemented by BIWTA
- Component 3: Financial Protection of Communities, to be implemented by BWDB
- Component 4: Community Engagement and Project Management, to be implemented by BWDB and BIWTA
- Component 5: Contingent Emergency Response Component (CERC), to be implemented by BWDB and BIWTA

3.2.1 Component 1: Flood and Riverbank Erosion Management

The Component 1 will finance the piloting of an innovative technology of river training and bank protection works are proposed. Top-blocked permeable Groyne (TBPG) is considered in two pilot sites. TBPG is a type of intervention which works like a permeable Groyne in the bottom and impermeable at the top. Alongside with this TBPG, suitable other river training structures in line with the building with nature are proposed in the design. A list of these interventions is presented below:

- Geo-bag and geo-textiles: For toe and earthen embankment protection purpose, geobags and geo-textiles will be used. It is estimated that about 67, 284 numbers of 250kg geobags, 3 layers for Bhuapur site and 195,300 numbers of 250kg of geobags, 5 layers for Kalihati site required.
- CC Block Revetment: CC block revetments are considered in the design along the bank to stop riverbank erosion. Revetments do not obstruct the natural flow of river and protect the bank against impacts of wave and current induced forces. It is estimated that 214,030 number of CC block will be placed in the 16 m crest elevation for a length of 2,110m in Bhuapur site and 266,184 numbers of CC block in the 15.6m crest elevation for a length of 1,625m length in Kalihati site.
- Cohesive Materials and Vegetations in the Bank: Excavated soil and readily available cohesive soil will be used in the bank for bank protection purpose in between the Groynes.
- Other Measures: Other relevant and applicable adaptive measures like bio engineering will be used in the implementation.

BWDB will be the implementing agency of Component 1.

The TBPG will be piloted at two sites – i) Bhuapur in Bhuapur upazila and ii) Kalihati in Kalihati and Tangail Sadar Upazila of Tangail district (Figure 3.2) for piloting the selected technology. Two pilot sites are about 6-7 km apart, Bhuapur site is in the upstream and Kalihati is in the downstream side (Figure 3.2). At a very later stage, the Government requested some additional work at Kaoakola (also spelled as Kawakhola) Char of Jamuna near Sirajganj and dredging. Descriptions of activities at 2 pilot sites and the Kaokola Char are provided in the sub sections following the Figure 3.2.

[2] The GoB does not provide any O&M budget for the infrastructures completed under an ongoing project. O&M budget will be provided only after the project's closure.

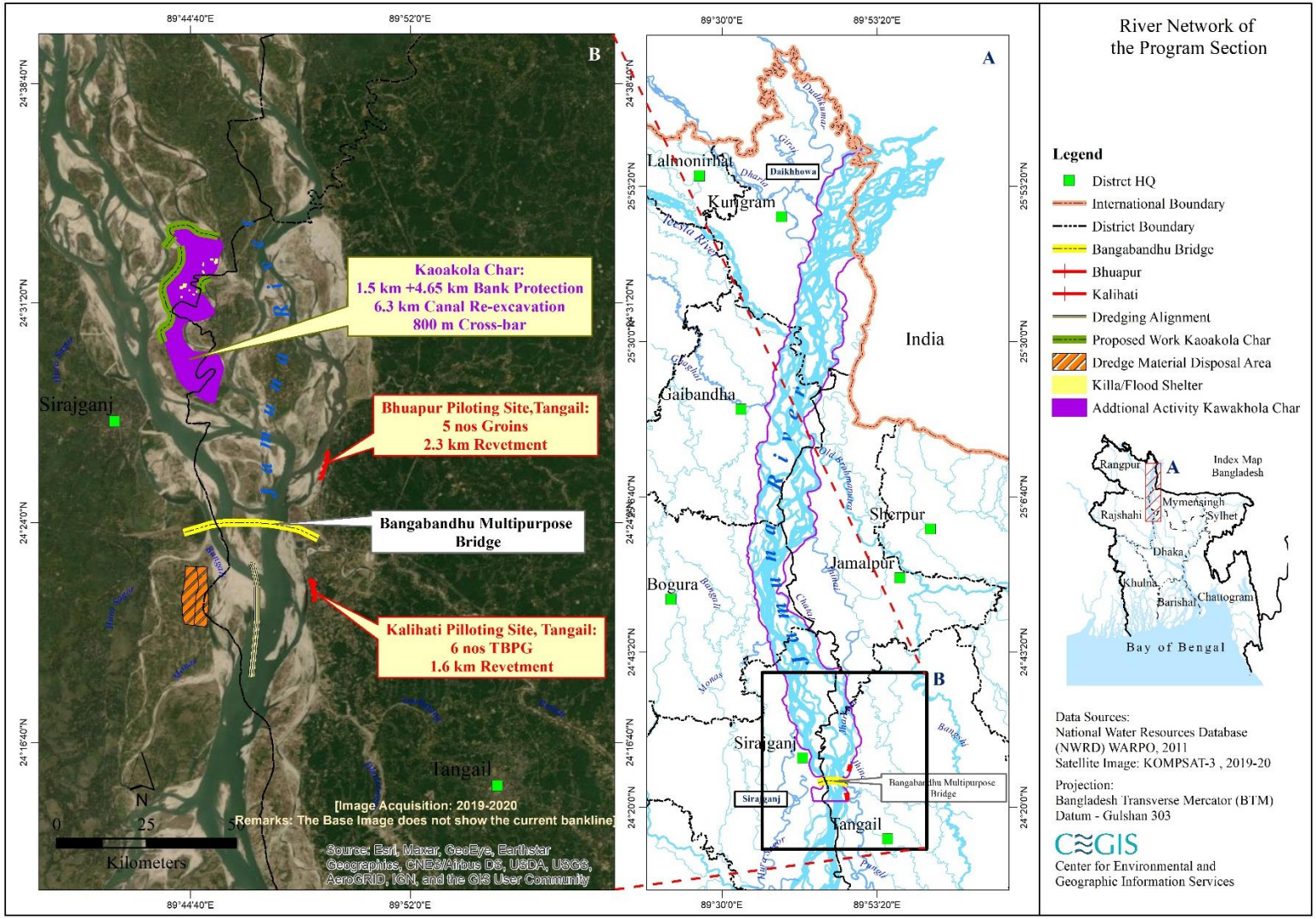


Figure 3.2: Map of the Project Location

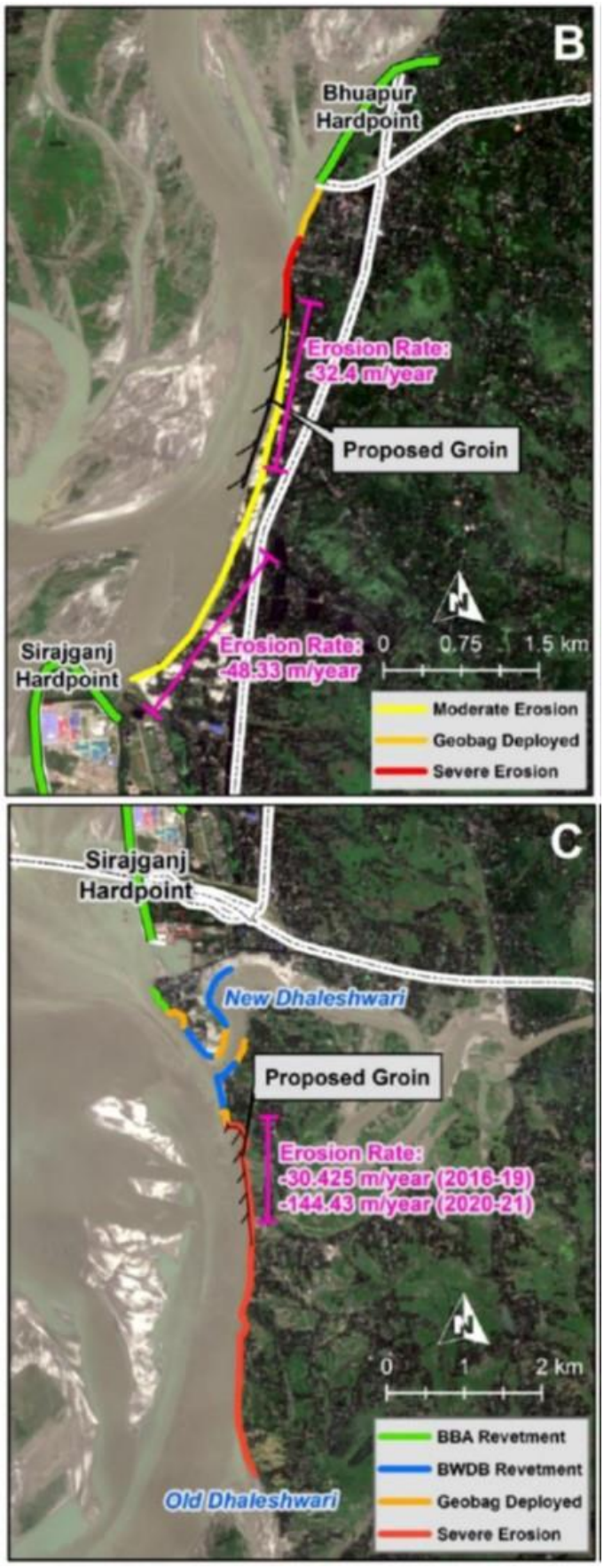


Figure 3.3: Two Selected Sites for Piloting of River Training Works

Selected Pilot Site 1-Bhuapur, Tangail

This segment is located along the left bank of the Jamuna River and about 2 km upstream of the Left Guide Bund of the Bangabandhu Bridge in Bhuapur Upazila of Tangail District (Figure 3.3). Gobindashi bazar is a famous growth center and launch ghat nearby. This area is under consideration in the Proposed Tangail Economic Zone under Bangladesh Economic Zones Authority for development of equipped Jetty with adequate facility and upgradation of the launch ghat to handle industrial cargo for improve movement of passengers and goods and also to connect to other ports and Exim gateways.

Bhuapur, Tangail Pilot Site conceptual design included 2.3 km of river protection works with five Groynes, four with lengths of 185 m each and the fifth one with a length of 150m. In addition, compacted earthfill embankment of 1:2 slopes in both riverside and countryside will be constructed. The slope will consist of geotextile filter (≥3 mm), 150 mm filled top soil, and closed turf. The bottom portion of the riverside will be filled with 250kg geobags on top of the geotextile filter (Figure 3.4).

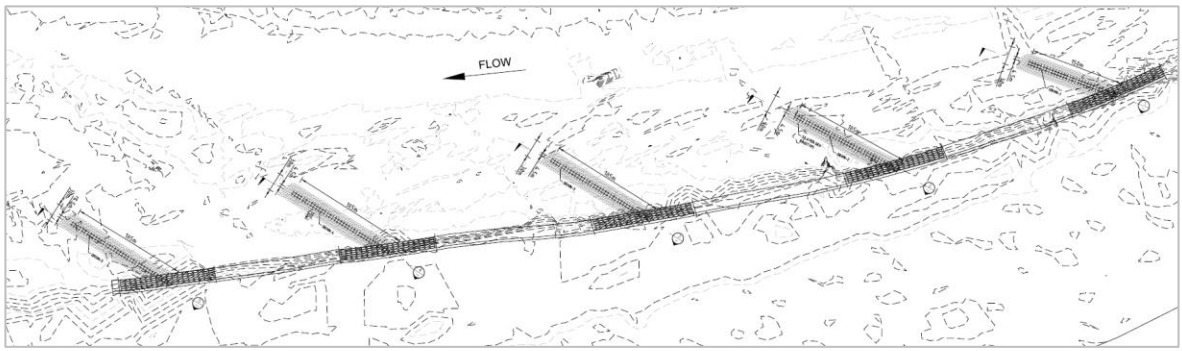


Figure 3.4: Conceptual Design of Bhuapur, Tangail (Pilot Site 1)

Field surveys conducted at the Bhuapur site has shown that the site has been exposed to moderate erosion in the last monsoon. Some existing vulnerable settlements, bazar and other structural development were found along the bank-line as well, and along some locations vertical erosion pattern was observed. Analysis conducted by C1 Consultant shown that within the dry period of 2018 to the recent post-monsoon period of 2021, the erosion-rate along the pilot reach has been approximately -27 m/year while it was nearly -32.4 m/year along the riverbank of Gobindashi and -48.33 m/year near the Jamuna bridge guide bund.

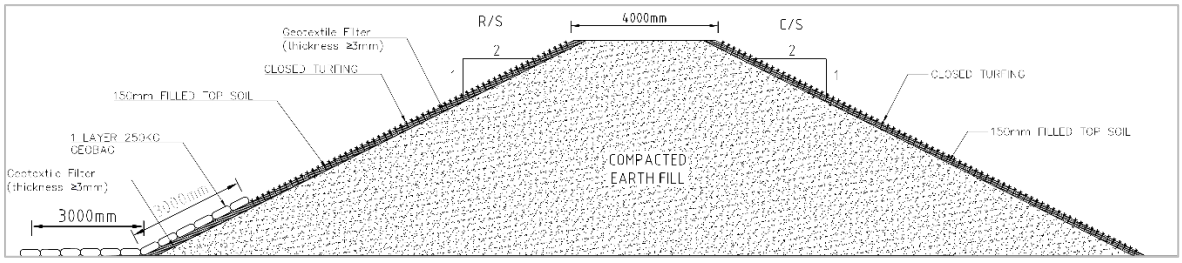


Figure 3.5: Typical Embankment Cross-section

Selected Pilot Site 2-Kalihati, Tangail

The second pilot site is located at Alipur which falls under Kalihati and Sadar upazila of Tangail district. This site is also located along the left bank of Jamuna, only around 3.5 km downstream of Bangabandhu Multipurpose Bridge (Figure 3.3). The site is just around 500m downstream of Dhaleshwari (new)-Pungli river offtake. Currently the river bank from the offtake area to the proposed site is protected by revetment. The pilot river protection work consists of around 1.6 km length of embankment (cross section is shown in Figure 3.5) with 6 Groynes (Figure 3.6). Groyne 1 has a length of 80 m, Groyne 2 with a length of 190 m and Groynes 3 to 6 are with a length of 150 m each.

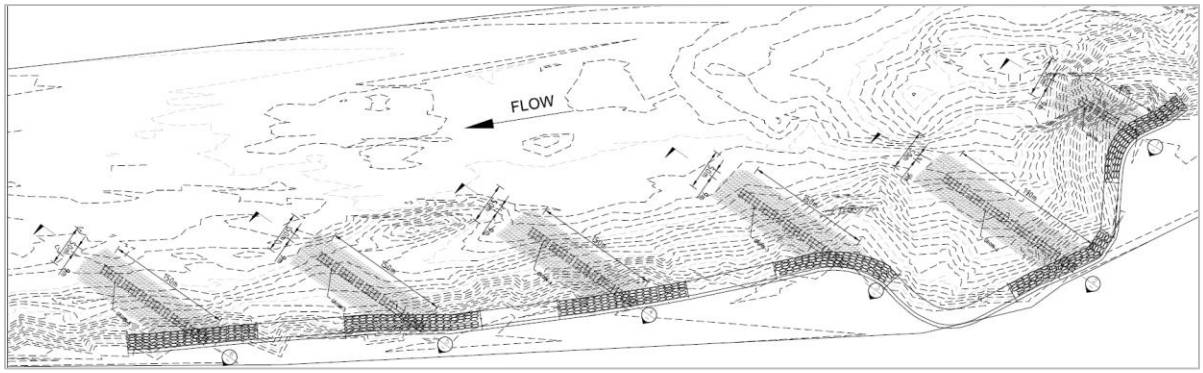


Figure 3.6: Conceptual Design of Alipur, Tangail Pilot Site 2

Currently severe erosion has been observed at Alipur along the both protected river bank and unprotected river bank area. Kalihati site has also been exposed to continual erosion in the last few years (Figure 3.7). Systematic analysis using remote sensing techniques have shown that the site at Tangail Sadar section has faced a high degree of riverbank erosion since 2016, especially at the downstream end of the new Dhaleshwari offtake owing to the thalweg shifting towards the left bank-line, which resulted from the downstream movement of the right-bank Char system near the Jamuna Multi-purpose bridge. The average rate of erosion at the most erosion-prone reach (d/s of the new Dhaleshwari offtake) was nearly -30.425 m/year during 2016-19, it became approximately -144.43 m/year during 2020-21. Almost the entire reach was exposed to significant to severe degree of erosion along the bank-line, which has been deteriorated during the last one and half years (from March 2020 to October 2021).

Figure 3.7: Riverbank Erosion along the Kalihati Site

3.2.2 Limited Dredging

Component 1 of the project also supports limited dredging. Following is a brief description of the additional activities under Component 1.

Dredging in Kalihati Site

A technical analysis of the Kalihati site conducted by the design consultant identified that Jamuna main channel shifted towards the left bankline during 2018-2021. To regain the channel alignment along the site, design consultant proposed a canal dredging through the Chars/Island, which can improve the channel conveyance capacity and sediment carrying capacity near the site (Figure 3.8).

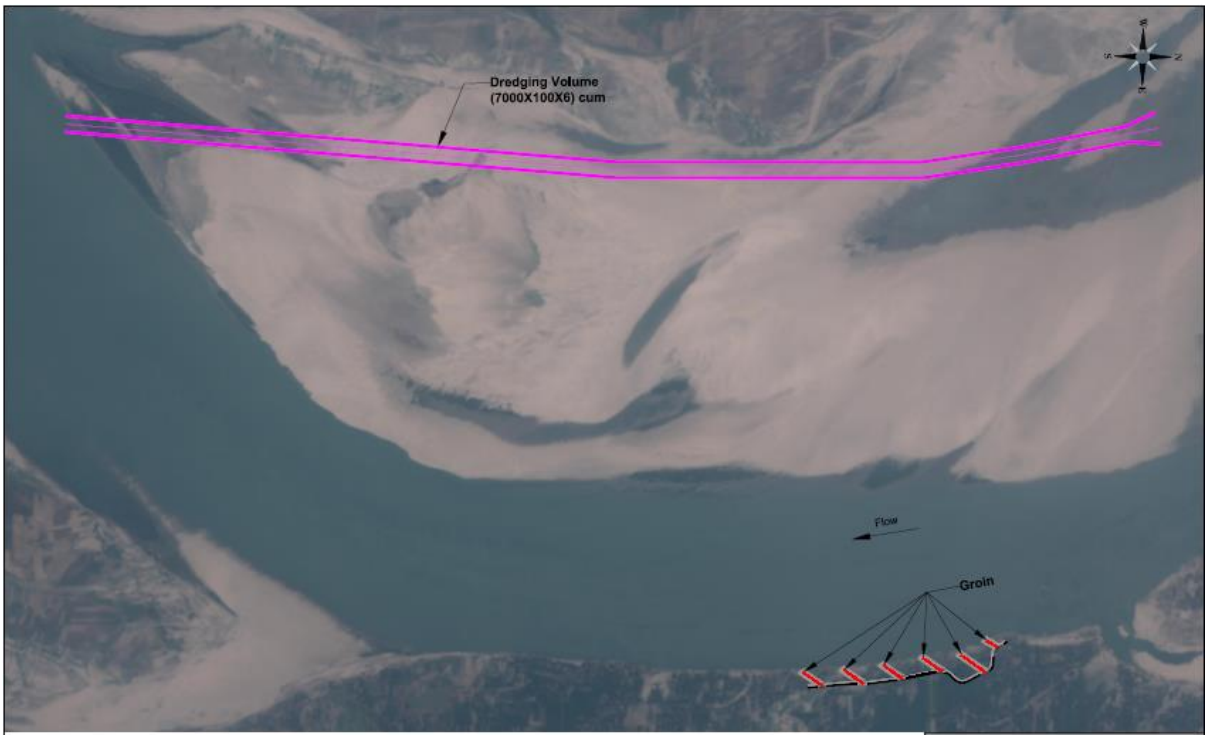


Figure 3.8: Kalihati Site with Dredging

Kaoakola Char Development

Kaoakola union is situated under Sirajganj Sadar, Sirajganj. This is an island in the middle of Jamuna River opposite of Sirajganj town. The island is divided and crossed by few canals. During field reconnaissance survey, a canal that detached a small portion of the island from the main island was identified. Local people use this canal as a route for transportation of crops, post flood water drainage, pre-monsoon irrigation and communication. There is a navigation port at the canal mouth which is also exposed to severe erosion. Kaoakola is over 15 to 20 years old island. During monsoon, most of the village gets inundated, and the canal gets sedimented during post monsoon season. Therefore, during dry season, this canal loses its drainage and retention capacity, navigability, and transportability. In this regard, the re-excavation of the canal and protective work of the port will help year-round transportation of the population. In addition, as per demand from local people during the stakeholder consultation, an upstream section of the island also needs protective bank works for long-term stability of the Kaoakola Char. The following are components of Kaoakola Char Development activities (Figure 3.9):

- Revetments will be constructed and maintained in Kaoakola and Mechhra and Arjuna to protect the river banks. Kaoakola protective work will be approximately 1,500 m length and Mechhra and Arjuna protective work will be about 4,650 m long, respectively.
- Dredging and re-excavation of canal will be conducted in Kaoakola as part of a routine to protect the riverbank. Kaoakola dredging will be the re-excavation of an existing canal, which become dry during the dry season, demands increasing the depth to support water transport as a vital and only mode of transport for the communities in Kaoakola and Mechhra unions. The length of the canal re-excavation is estimated as 6,265 m. In order to protect the bank from upstream water flow, an 800 m bund will be constructed, which will help water flow year-round in the re-excavated canal. Generated dredged material from canal re-excavation will be used for flood proofing by the formation of killa (raised flood platform) and Kakua-Gohaliabari dredging material will be used for filling two export processing zones (one government owned and one privately owned) in Rajapur union of Sirajganj district.
- Community-driven development (CDD) contracts (direct contracting to Labor Contracting Society (LCS), 40% women), for small civil works contracts under the Component 4.

Figure 3.9: Kaoakola Char Development

3.2.3 Component 2: Navigation Channel Development

Component 2 under Project 1 will install aids to navigation which generally include installation of buoys, lateral buoys, safe water buoys, isolated danger buoys, signs and markings for waterways, etc. In addition, there are two pilots under consideration under Component 2 are, Optimal Barge Prototype and Floating and Movable Jetty design, construction, and Operation and Maintenance for 5 years. Apart from the intervention, the existing hydrographic Charts will be updated by carrying out hydrographic survey.

The Component 2 will also consider the dynamic navigation in principle and develop a Jamuna River Navigation Master Plan. A bilateral IWT agreement between Bangladesh and India will also be drafted during Project 1. The further work of channel development following the River Navigation Master Plan shall be implemented in Project 2 of the program.

Sub-component: Hydrographic surveys and RIS

The Jamuna Riverbed is constantly changing, due to the extreme river dynamics. Sand banks are migrating along the river, channels are moving from one side of the river to the other, etc. Therefore, it is of utmost importance to have frequent updates of navigation Charts, which should be made available for the shippers on the river. To prepare these navigation Charts, following steps are considered under Component 2. The

subcomponent invests in developing and operating an RIS system that incorporates the following five services to meet the RIS maturity Level D+ of the PIANC standards:[17]

- **Physical aids to navigation** are any sort of signal or guidance equipment which helps navigation, both day and night, such as traffic signs, buoys, fog signals, and day beacons. Locations with high navigation challenges will be prioritized, and aids will be repositioned based on hydrography survey results, several times a year.
- **Very high frequency (VHF)** radar aids situational awareness and communications between vessels and shore-based stations. The Project will equip the shore-based stations, train station operators, and specify VHF requirements on board.
- **Hydrography and Inland Electronic Navigational Chart (IENC)** provide updated knowledge on the river geomorphology based on the information gathered by hydrographic survey vessels. They have multiple uses, showing routes to vessels, allowing physical aids to navigation to be repositioned along the best route before the start of the dry season, helping locate bottlenecks where dredging is needed, and offering data to deal with the impact of climate change on waterways.
- **Automatic Identification System (AIS)** will be installed between the Bangladesh–Indian border in the upstream and the Sirajganj bridge in the downstream. This will allow tracking and monitoring of the traffic on the Jamuna River.
- **Notice to skippers (NTS)** uses the vessel's position and heading to inform the skipper of important information that might affect the voyage. To provide this service, an international NTS standard needs to be adopted and published, with links to the waterway data systems to ensure the applicable notices are triggered.

Physical Aids to Navigation

Buoys

For river navigation, a standard has been put in place by the United Nations' Economic Commission for Europe (Commission Economique pour l'Europe des Nations Unies, 2009). This standard is called CEVNI, which stands for "Code Européen des Voies de la Navigation Intérieure". In this standard, the shapes, colors, lights and their frequency are described for every type of buoy. For the lateral buoys, it is important to define what is defined as right and left side of the river. The right bank and left bank are defined, looking downstream. For the buoys, lateral buoys, safe water buoys and isolated danger buoys will be discussed in more detail. These will be numbered in a specific way. This numbering follows the conventional direction of buoyage, which means from downstream to upstream.

i. Lateral buoys

The buoys indicate the right and left side of the channel to be followed. Preferably, the shape and color of the buoy and the top sign are different. Also, the lights, which are mounted on the buoys for night navigation, have a different color and rhythm (Figure 3.10).

[17] PIANC is the World Association for Waterborne Transport Infrastructure, established in 1885. It provides guidance and advice for a sustainable waterborne transport infrastructure to ports, marinas, and waterways. According to Workgroup 201 (Framework for Inland Waterways) and Workgroup 125 (RIS Guidelines), Level D+ falls under the intermediate class, where five of the eight assessment criteria are met. Currently, navigation in the Jamuna River does not meet any of the criteria.

For the buoys to indicate the right side of the channel, a red cylindrical shaped buoy is proposed, with a red cylindrical top sign. However, top signs are not required but optional. A rhythmic red light is installed for night-time navigation.

For the buoys to indicate the left side of the channel, a green conical shaped buoy is proposed with a green conical top sign, pointing upwards. A rhythmic green light is installed for night-time navigation.

Normally a lateral green and red buoy are not installed in the same section of the river. However, when there is a very narrow passage in the river (e.g., passage below bridges), they can be used in the same section, forming a gate.

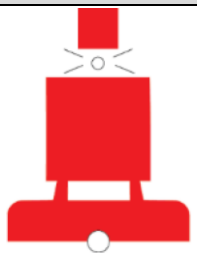
	Right side buoys	**Left side buoys**
		
Color	Red	Green
Shape of buoy	Cylindrical	Conical
Top sign	Cylindrical	Conical
Light	Rhythmic red	Rhythmic green
Numbering	Even numbers, from downstream to upstream	Odd numbers, from downstream to upstream

Figure 3.10: Summary of Requirements for Lateral Buoys according to CEVNI

ii. Safe water buoys

Safe water buoys (Figure 3.11) serve to indicate that there is navigable depth all around the buoys. These buoys can also be used as center line marks or mid-channel marks, to indicate entrance channel of a port or an estuary approach or a landfall. The buoy is spherical- or pillar-shaped with red and white vertical stripes. The top sign is a single red sphere. For the night-time navigation, a white light is installed which has a rhythm isophase, occulting and one long flash every 10 seconds.

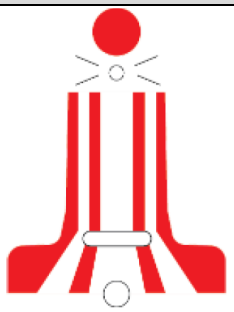
	Safe water buoy
	
Color	Red and white vertical stripes
Shape of buoy	Spherical or pillar
Top sign	Single red sphere
Light	White with rhythm isophase, occulting, one long flash every 10 s
Numbering	From downstream to upstream

Figure 3.11: Summary of Requirements for Safe Water Buoys according to CEVNI

iii. Isolated danger buoys

An isolated danger buoy (Figure 3.12) is a mark erected on or moored on or above an isolated danger, which has navigable water all around it. It can have any shape but is generally a pillar or spar buoy. The buoy consists of red and black horizontal stripes, and has two black spheres as top sign, one above the other. A white light is mounted on the isolated danger buoys, which uses the group flashing rhythm, consisting of groups of two flashes.

	Isolated danger buoy
	
Color	Red and black horizontal stripes
Shape of buoy	Generally, pillar or spar
Top sign	Two black spheres, one above the other
Light	Group flashing (2) white light
Numbering	From downstream to upstream

Figure 3.12: Summary of Requirements for Isolated Danger Buoys according to CEVNI

Signs and Marking for waterways

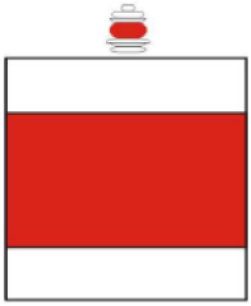
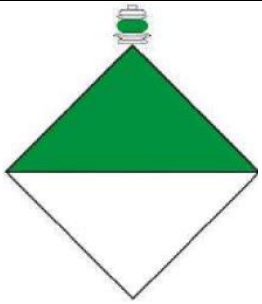
Next to marks floating on the river (buoys), fixed marks can be installed as well. These shore marks will be installed on the riverbank and will work together with the buoys on the river to ensure a continuous buoyage system along the river.

i. Hug the bank marks

Hug the bank marks (3.13) are marks on land indicating the position of the fairway in relation to the banks. These marks are located on the bank close to the river's edge and indicate the position of the fairway in relation to the bank. Together with the buoyage of the waterway, these panels mark the fairway at points where it approaches a bank. They also serve as landmarks.

For hug the bank marks on the right bank, a square board with the sides horizontal and vertical is used. The color of the board is red, with two horizontal white stripes, one at the top and one at the bottom. A red light is installed on top, with a rhythm which is different from the rhythm of the lateral red buoys. Similar to the lateral red buoys, the numbering is only using even numbers.

For hug the bank marks on the left bank, a square board with the diagonals horizontal and vertical is used. The color of the board is green (upper half) and white (lower half). For night-time navigation, a green light is installed on top, with a rhythm which is different from the rhythm of the lateral green buoys. Similar to the lateral green buoys, the numbering is only using odd numbers.

	Hug the right bank	**Hug the left bank**
		
Color	Red and white	Green and white

Shape of mark	Square board with sides horizontal and vertical	Square board with diagonals horizontal and vertical
Light	Red with different rhythm than lateral red buoys	Green with different rhythm than lateral green buoys
Numbering	Even numbers, from downstream to upstream	Odd numbers, from downstream to upstream

Figure 3.13: Summary of Requirements for Hug the Bank Marks according to CEVNI

ii. Cross-over marks

Cross-over marks (3.14) indicate at which point the fairway passes from one bank to another and also gives the axis of this cross-over. Cross-over marks should always be combined with the hug the bank marks, which are discussed in the previous section. Cross-over marks can also serve as landmarks.

For the cross-over marks at the right bank, a square board with the sides horizontal and vertical is used. The board is colored yellow with a central vertical black stripe. A yellow light is installed on top of the board, which is flashing or occulting with an even number Characteristic other than the group-flashing rhythm with a group of two flashes. Similar to the lateral red buoys and the hug the bank marks at the right side, the numbering only takes into account the even numbers.

For the cross-over marks at the left bank, a square board with the diagonals horizontal and vertical is used. The board is colored yellow with a central vertical black stripe. A yellow light is installed on top of the board, which is flashing or occulting with an odd number Characteristic other than the group-flashing rhythm with a group of three flashes. Similar to the lateral green buoys and the hug the bank marks on the left side, the numbering only takes into account the odd numbers.

	Right bank cross-over mark	**Left bank cross-over mark**
		
Color	Yellow and black	Yellow and black
Shape of mark	Square board with sides horizontal and vertical	Square board with diagonals horizontal and vertical
Light	Yellow light, flashing or occulting with an even number Characteristic other than the group-flashing rhythm with a group of two flashes	Yellow light, flashing or occultingwith an odd number Characteristic other than the group-flashing rhythm with a group of three flashes
Numbering	Even numbers, from downstream to upstream	Odd numbers, from downstream to upstream

Figure 3.14: Summary of Requirements for Cross-over Marks according to CEVNI

iii. Prohibitive Signs

Prohibitive signs can be placed that indicate the approach of a narrow channel (restricted area) and organize the right of way of overtaking or passing vessels.

In case of vessels or convoys meeting (passing) or overtaking in sections where the channel is not unquestionably wide enough for vessels to pass (narrow channels) the prohibitive signs in Figure 3.15 or Figure 4.13 will be placed. Vessels or convoys proceeding upstream shall stop at the approach of vessels or convoys proceeding downstream and wait until they have passed through the section.

Overtaking is permitted only if the overtaking vessel has made certain that it can be accomplished without danger. The vessel being overtaken shall facilitate overtaking as far as it is necessary and possible.

	No passing or overtaking	**No passing or overtaking of convoys by convoys**
		
Color	Red, white and black	Red, white and black
Shape of mark	Crossed rectangular board with single arrows	Crossed rectangular board withdouble arrows
Light	n/a	n/a
Numbering	n/a	n/a

Figure 3.15: Summary of Requirements for No Passing or Overtaking Marks according to CEVNI

iv. Restrictive signs

In addition, or alternative to the prohibitive sign the following restrictive signs will be placed to indicate the approach of a narrow channel (restricted area). These signs do not indicate the right of way. Rules of the road for the fairway should prescribe the appropriate behaviour in case vessels or convoys approach a narrow section indicated by either of the signs in Figure 3.16. Vessels or convoys proceeding upstream shall give right of way to vessels or convoys proceeding downstream and wait until they have passed through the section. To determine if any vessels or convoys are approaching the restricted area, actions prescribed by the mandatory signs in the next section can be used.

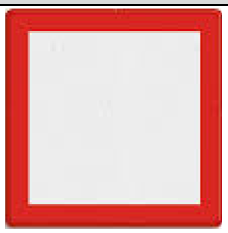
	Width of passage or channel limited	**There are restrictions on navigation: make enquiries**
		
Color	Red, white and black	Red, white and black
Shape of mark	Square board with red border and two opposing black triangles, with or without a number	Square white board with red border
Light	n/a	n/a
Numbering	n/a	n/a

Figure 3.16: Summary of Restrictive Signs according to CEVNI

v. Mandatory signs

On sections where signs indicate that passage is restricted (narrow channels) mandatory signs will be used in addition to the prohibitive or restricted signs described above. The mandatory signs prescribe an action to be performed. To avoid that vessels or convoys enter a narrow channel, vessels or convoys proceeding downstream as well as upstream shall perform the action indicated by the mandatory signs in Figure 3.17.

VHF should be used to announce on the prescribed communication channel that the vessel or convoy is approaching the narrow section. Vessels or convoys must be contactable through this communication channel. Where view is restricted, vessels shall sound one long blast before entering a narrow section; if necessary, especially if the narrow section is long, they shall repeat this signal while passing through it.

After exchanging information, vessels or convoys proceeding upstream shall stop at the approach of vessels or convoys proceeding downstream and wait until they have passed through the section.

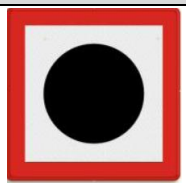
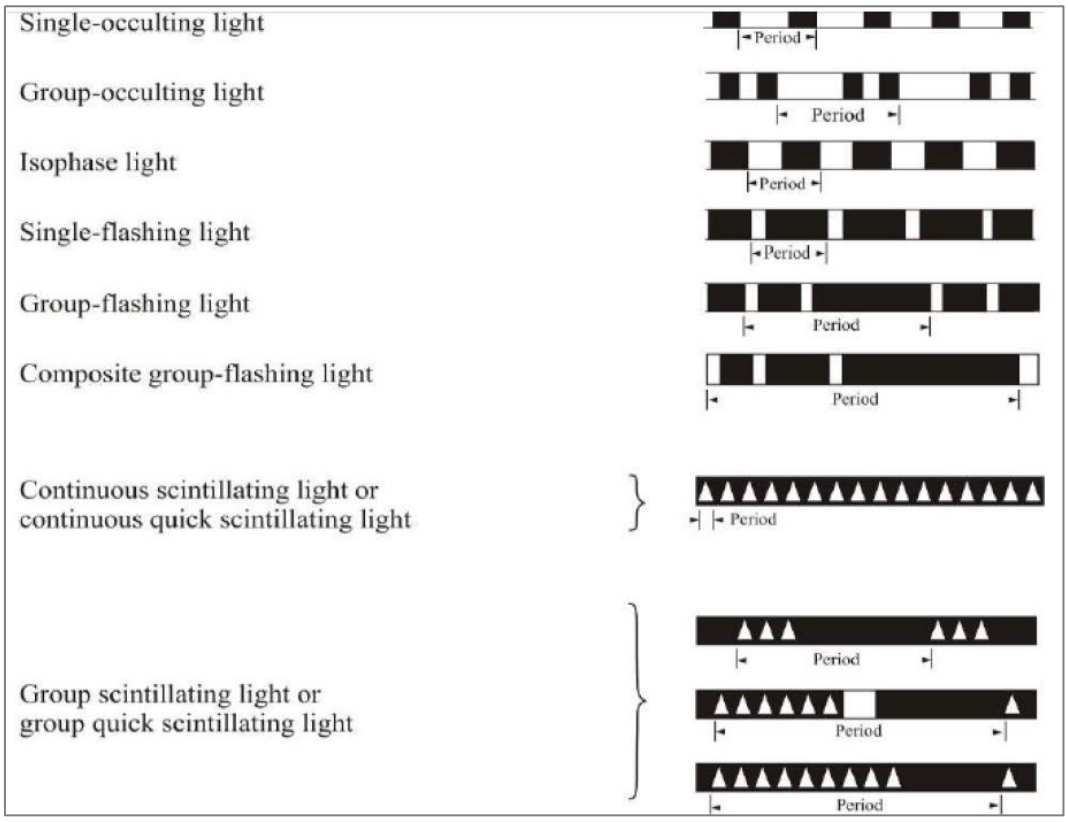
	VHF Call Sign	Give a sound signal
		
Color	Red, white and black	Red, white and black
Shape of mark	Square board with red border, marked with 'VHF' and channel number	Square board with red border andblack circle
Light	n/a	n/a
Numbering	n/a	n/a

Figure 3.17: Summary of Requirements for Mandatory Signs according to CEVNI

vi. Night-time navigation

For night-time navigation, there will be lights installed on the AtoN. Next to a difference in color, there is also a difference in rhythm of emitting light. The different rhythm used in navigation are summarized in Figure 3.18. Reference will be made to these rhythms during the description of the different AtoN.



Source: Commission Economique pour l'Europe des Nations Unies, 2009

Figure 3.18: Rhythm of Light Sequences, Used in Navigation

Sub-component 2.2: Prototype Structures

This subcomponent will test pilot structures that could kick-start innovative thinking in the IWT sector, including through commercialization. Those identified include design, commission, delivery, and O&M of a prototype cargo vessel and cargo-handling pontoons, both of which cater to the specific conditions of the

Jamuna River and require public investment to spur innovation. The cargo vessel will consider environmentally friendly design.[18]

Subcomponent 2.3: Institutional strengthening

To fulfill its role as the IA responsible for Component 2 implementation, including O&M, the BIWTA will carry out following institutional strengthening activities that are assessed as lacking or weak. A gender strategy will be prepared by the BIWTA to promote gender equality in its human resource practice and incorporate gender aspects in the planning documents.

- The **Jamuna River Navigation Master Plan** will be prepared, which will design a comprehensive short- and long-term action plan that aims to improve the navigability and safety of the waterway. A detailed traffic forecast and a market study will be included, examining cross-border cargo demand to determine viable cargo tonnage, lowest allowable depth, required dredging, and terminal locations.
- The **Resource Management and Operations Plan** will be developed to define the BIWTA's resource and capacity requirements needed for ITW improvements envisioned under the Project. It will take stock of the existing gaps, develop an adapted organizational structure, outline the technical tasks to be carried out, assign personnel at headquarters and in the district- and upazilla-level offices, propose an inventory of required equipment, and prepare the annual budgets.
- **Cross-border IWT dialogue** will seek to continue strengthening collaboration with the Government of India and finding areas for synergy along the Jamuna River. The Project plans to finance reviewing the current status and drafting a stronger IWT legal framework for the Jamuna River that goes beyond the existing protocol. Bilateral workshops will be organized to discuss the findings and the proposal, with an aim to reach formal agreements and endorsements where possible.
- **Capacity building of the BIWTA staff** will entail upgrading the BIWTA's existing crew training centers to modernize the curriculum 19 and equipment in line with the internationally recognized Standards of Training, Certification, and Watchkeeping (STCW).20 Relevant local and international study tours will be organized. A selected set of training will be developed for the line ministry officials and other IWT stakeholders, including the private sector such as cargo owners and logistics firms, to apprise them of IWT opportunities, new technology, and safety issues.

[18] For example, applying filters to new diesel engines to reduce the nano dust particles emissions is highly recommended. Other pragmatic recommendations include use of clean types of anti-fouling paints on the underwater part of the hull, as opposed to heavy metal paint; reduction of surface paintings containing air contaminants; environmentally friendly practices in shipbuilding techniques and operations; adequate metal working operations; use of recyclable materials; and barge waste management and collection, including bilge oil.

[19] A mix of traditional and emerging themes will be incorporated in the curriculum, such as waterways development and management, surveying, dredging, terminal management, traffic safety, procurement, E&S, performance-based dredging, monitoring of inspections and certifications, green IWT vessels, and multimodal logistics and supply chain development.

[20] The STCW was first set by the International Maritime Organization in 1978. It prescribes the minimum standards relating to training, certification, and watchkeeping for seafarers that countries are obliged to meet or exceed.

Subcomponent 2.4: Preparation for the second project

Feasibility studies for the second project in the SoP will be prepared, including E&S and draft bid documents.

3.2.4 Component 3: Financial Protection of the Communities

As part of the preparedness and recovery phases in disaster management, this component is inherently climate change adaptive, offering financial protection to the communities soon after payout-eligible flood events occur. The arrangement will reduce the disaster-related financial burden of the target group, mostly smallholders who are one of the most vulnerable people along the Jamuna River (paragraph 13). Relevant institutions will be strengthened as well.

- Subcomponent 3.1: Design and development of prearranged financial solutions. The type, scope, size, governance, and delivery channels will be detailed based on technical studies, focusing on gender-balanced access. Two solutions are being considered:
    - Macro- or meso-level insurance. The policy will be held by government entities that will offer disaster relief payments to communities when payout-eligible flood events occur. This solution aims to ensure budget stability of government entities while responding to the needs of communities.
    - Community protection fund. This fund can cover perils that are outside the scope of the macro- or meso-level solution, such as smaller floods or excessive loss.
- Subcomponent 3.2: Institutional strengthening: Any gaps in the institutional and legislative environment needed for the proposed solutions will be identified and addressed. A gender strategy will be prepared by the BWDB to ensure women's access to disaster risk financing and relevant livelihood opportunities. Further, relevant stakeholders, including the MoWR, the Ministry of Finance (MoF), the MoA, the MoDMR, the insurance sector, and NGOs will be trained for managing and executing the solutions once developed.

3.2.5 Component 4: Community Engagement and Project Management

- Subcomponent 4.1: Community driven development. The Project puts people along the Jamuna River at the center, directly engaging and empowering them, forming pilot river initiative groups that promote participatory planning, decision making, and monitoring.[21] Their use of Labor Contracting Societies (LCS)[22] will be encouraged to offer income generating activities. At least a third of their members will be women, who will be an entry point to consult on the SoP's gender aspects. A gender strategy will be prepared by the BWDB and BIWTA to ensure women's access to livelihood opportunities and offer tailored training on women's leadership and skills development. The river initiative groups would deal with the following subjects on a mutually unexclusive basis:

[21] Composed of elected members, with adequate representation of women and youth, river initiative groups may be trained to support villagers to voice their needs and priorities, identify gaps, and provide feedback on the proposed second project. Regular community and village dialogues could be facilitated through them, specifically reaching out to vulnerable people and remote areas. They can also facilitate the grievance redress mechanism (GRM) process and citizen engagement evaluation.

[22] The PWMR encourages that water management organizations, such as river initiative groups, hire LCS for some works and O&M. LCS are required to have at least 30 percent female laborers to ensure their access to income-generating opportunities.

- **Disaster risk awareness and preparedness** will be enhanced in select communities by apprising them of contingency planning and early action protocols, including in Component 1 sites to deal with potential, albeit unlikely, collapse of the structures induced by climate disasters. Targeted training will be delivered to communities to help them understand the financial protection to be offered through Component 3 and post-shock labor opportunities through LCS.
- **Buoys management** cannot be done solely by the BIWTA, and help from local communities is a must. River initiative groups will be formed in select communities to encourage their ownership of the asset and inform how villagers can avoid behaviors that may incur damages to buoys. [23] LCS will be contracted to perform basic maintenance and report any abnormalities that they cannot handle to the BIWTA as soon as possible.
- **Kawakhola *Char* development** will engage communities from planning and design stages. LCS will be contracted to do some relevant civil works.

- **Subcomponent 4.2: Project management.** It will support the BWDB and BIWTA's Project Implementation Units (PIUs) for implementing the Project. Costs to be covered include equipment, furniture, and consultancy services on fiduciary, E&S, and M&E.

3.2.6 Component 5: Contingent Emergency Response Component (CERC)

A provisional zero amount component is included, which will allow for rapid reallocation of loan proceeds from other project components during an emergency, including climate events, under streamlined procurement and disbursement procedures. This component may also serve as a conduit for additional funds to be channeled to the project in such circumstances. The conditions for accessing funds under this component will be described in the Project Implementation Manual.

3.3 Construction Methodology

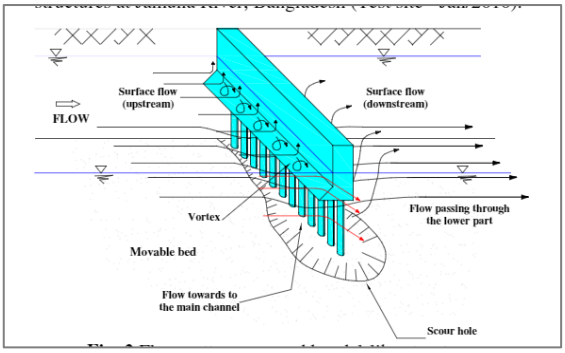
3.3.1 Component 1: Riverbank Protection and River Training

River training, bank protection works and aids to navigation are the major components of this project. The overall construction process of Groynes and bank protection works are provided below:

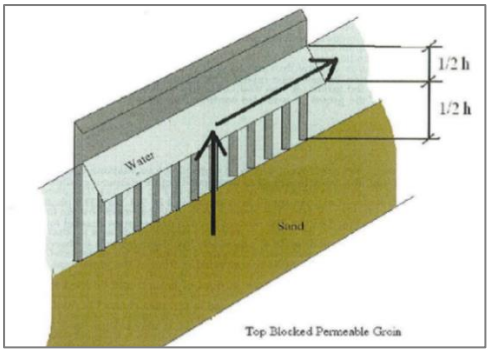
Construction of Groynes

Groynes are structures built from the riverbank into the river. There is a preferred angle between the Groyne and the bank depending on the purpose of the Groyne. Groynes are stone, gravel, rock, earth or pile structures. Generally, Groynes are used to divert the river flow away from the critical zones of bank to protect it from the erosive action of the river, they are also used to constrict the width of the river so that the river will increase its depth, which is important for navigation. The main design criteria to be considered during design are spacing of Groynes, length of Groynes, the crest level of Groynes (i.e., either at flood plain level or at embankment level), and the possible scour at the head of the Groyne. Groynes can be classified in different way: according to the method and materials of construction and permeable or impermeable. In this project Top Blocked Permeable Groyne will be constructed (Figure 3.19 and Figure 3.20).

[23] For example, local fishermen would be advised to avoid casting their driftnet close to buoys and not to attach their boats to buoys. Any community members whose village is near a buoy can report when they see it is drifting, missing a lantern, or damaged by a ship. They can also help avoid stealing of its lantern and remove debris near it, like sticks and bamboo.



(Teraguchi et. al. 2011)[24]



(Khaleduzzaman, 2014)[25]

Figure 3.19: Sketch of Permanent-Type Top Blocked Permeable Groyne

Bandal-like structure (temporary TBPG) at Kazipur (Rahman et.al 2020)[26]

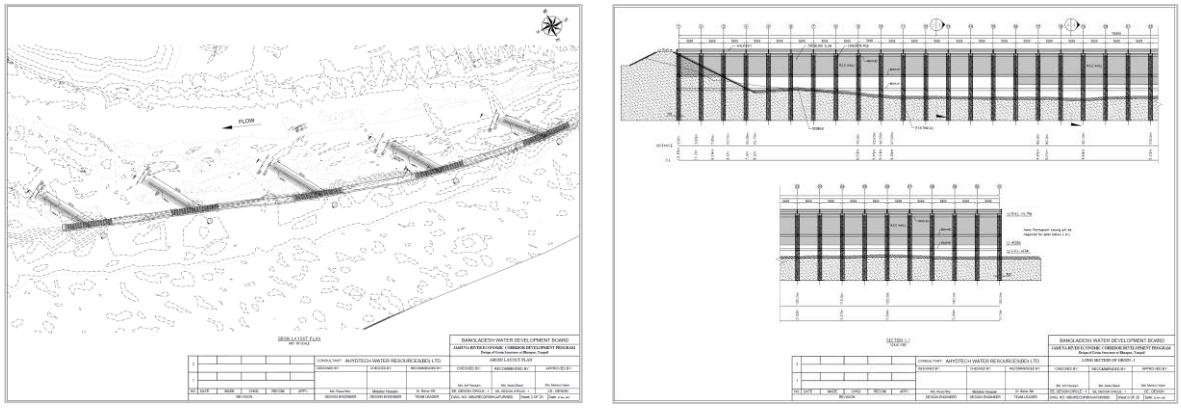
Figure 3.20: Typical Examples of Top Blocked Permeable Groynes

Top Blocked Permeable Groyne (TBPG) include different features such as spacing, angle, length, height of Groyne, and height of top block. The construction work of TBPG involves piling structures with reinforced cement concrete (RCC). Three layers of piles will be constructed into the riverbed. The diameter of each RCC pile is about 0.75 m and the distance between the pile is 5 m. Generally, protrusion length of the permeable Groyne is determined by the distance between riverbank to the local scour hole. The length of the proposed Groynes varies from 80m to 190 m and the angle of the groynes in Bhuapur site are about 40 degrees with the riverbank. The TBPG is designed by blockage of water from top to the low water level and the remaining part of the Groyne has opening for passage of water. Top blockage will be made of RCC. Top blocked permeable Groyne has been considered in two pilot sites. Lengths of 2.3 km for Bhuapur and 1.6 km for Kalihati along the left bank of Jamuna River are considered (Figure 3.21 and 3.22).

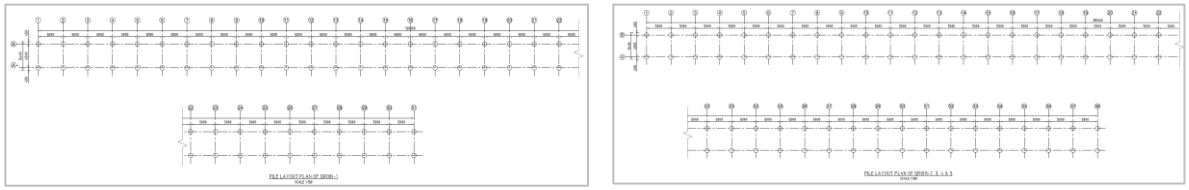
[24] Teraguchi, H., Nakagawa, H., Kawaike, Kenji., Baba, Y., Zhang, Hao., 2011 Alternative Method for River Training Works: Bandal-Like Structures. Journal of Japan Society for Civil Engineers (Hydraulic Engineering) 67(4).

[25] Khaleduzzaman, A T M, 2014. Experimental Study on River Course Stabilization and Restoration by using Groin-like Structures. M.Sc. Thesis, Graduate School of Engineering, Department of Civil Engineering Kyoto University

[26] Rahman A M., Rahman M.M., Shampa, Haque, A., Dustegir, MM., Nishat NJ., Nakagawa, H., Hossain, M., 2020. Performance Evaluation of Bandal-like Structure for Sediment Management in Braided Jamuna River. Proceedings of the 22nd IAHR-APD Congress 2020, Sapporo, Japan.



Bhuapur Groyne Layout plan



Pile layout plan for Bhuapur Groynes

Figure 3.21: Design of Bhuapur Groyne

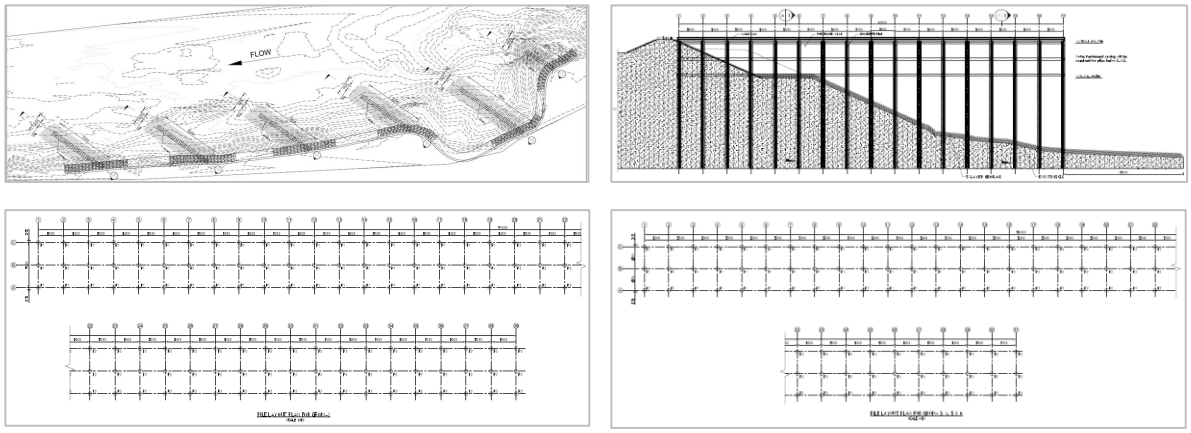


Figure 3.22: Design of Kalihati Groyne

Construction process of bank protection work

The design has considered geotextile filter, C/C blocks and geobags and presented in Figure 3.21 and Figure 3.22. Construction of riverbank protection involves following three components (Figure 3.23):

- Wave protection built above low water level, consisting of concrete blocks/geobags placed on a geo-textile filter layer.
- Underwater slope protection consisting of three layers of C.C block/sand-filled geo-bags large enough to be stable under design flow velocities, and providing a tight cover layer including filter properties.
- Toe aprons consisting of multiple layers of C.C block/geo-bags for self-launching in case of scour.

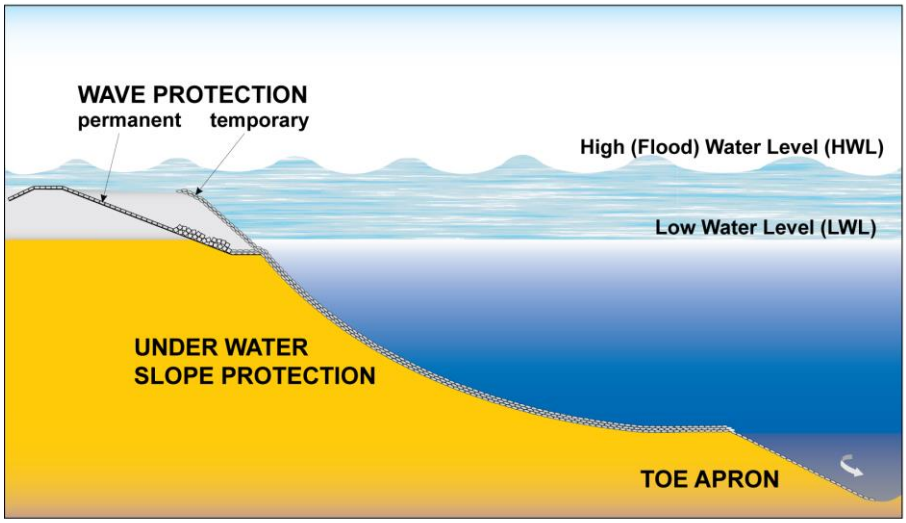


Figure 3.23: The Three Elements of Riverbank Protection

3.4 Resource Requirements

The construction materials required for Groynes, river bank protection work and other project components will include sand, geo-textile, stone chips, brick chips, cement, steel for concrete reinforcement and other accessories (Table 3.1). Some of these materials, i.e., sand will be obtained from within the project influence area. Other materials such as cement, steel, and brick chips will be procured from local/national markets, whereas some of the other materials may have to be imported. The quantities of construction materials required for the subsequent Projects will be determined during the detailed design of those works. In addition, one prototype barge and one movable jetty may be procured from overseas and transport to the project locations. There will be buoys with lights and signs required for aids-to navigation may be procured locally or from international market.

Table 3.1: Resources for Each Pilot Site

Item	Unit	Quantity	
		Bhuapur	Kalihati
Land for embankment	Acres	17.05	11.861
Groynes	No.	5	6
CC blocks	No.	214030 (16m crest elevation, 2110m length)	266184 (15.6m crest elevation, 1625m length)
Geobag	No.	67284 (250kg, 3 layer)	195300 (250kg, 5 layer)
Piles	No.	366 (900mm dia, 45-50m length, 2 rows)	540 (750mm dia, 45-50m length, 3 rows)
Sand (for filer layers)	Cum	720.945	747.188
Earth work	Cum	122591	126522.5
M.S. bar	Kg	5,353,867.255	4,780,425.805

3.4.1 Manpower

During the construction phase, technical, skilled, semi-skilled, and short service workers will be required. These will include engineers, technicians, supervisors, surveyors, mechanics, foremen, machine operators, drivers and skilled and unskilled labour (see **Table 3.2**). Local community will be able to avail some employment opportunities during Project 1. Total number of project staffs are estimated to be about 200 for each pilot site.

Table 3.2: Required Manpower during Construction

Category	Persons (Approximate)
Engineer	12
Machinery Operators	30
Mechanics	5
Surveyors	10
Skilled Laborers	40
Un-skilled Laborers	100
Total	**197**

During the O&M phase, the regular staff of the BWDB and BIWTA will carry out the monitoring, repair, and maintenance works.

3.4.2 Construction Equipment and Machinery

Construction machinery and equipment will be needed for the construction activities. A tentative list of these machinery and equipment is listed below:

- Crane
- Dump-trucks
- Pile driver
- Excavators
- Barges
- Engine Boats
- Vibrators
- Compactors
- Mixture Machines
- Mixing Plants
- Trucks
- Tractors
- Generators

3.5 Construction Camp

Construction camps for each construction site are to be established by the contractor. The contractor will select the location of the camp through consultation with the local union parishad chairman and the local community. Moreover, they will have to obtain permission from the authorized BWDB representative. Tube wells may be installed in the labor camps premises for obtaining water for drinking and other purposes ensuring the drinking water quality standard of WHO. Water quality will be tested for heavy metals (As, Fe, Mn, and Hg, etc.) presence prior to allow the groundwater for drinking. For sanitation, latrines will be constructed along with septic tanks for safe disposal of sewage. Location of these camps is not known at this stage however the key criteria to be used by the contractor while selecting the sites are listed below.

- Community consultations will be carried out to select the camp sites
- Agricultural land will be avoided as far as possible
- Government-owned (Khas) lands will be given priority while selecting the camp sites
- If private land is used for camp sites, a fair rent will be paid to the land owner.
- Camps will not be established near sensitive receptors such as schools
- Camps will not be established near any sensitive habitat

- Camps will not be established that could affect any *khal*, *beel* or river.
- Camp sites will be approved by construction supervision consultants.
- Contractor will prepare and implement a labor camp management plan which will include enforcing a Code of Conduct for the workers.

The ESMP has also mentioned these criteria which will be a part of the Biding document to ensure contractors fufills these criteria.

3.6 Other Activities in Jamuna River

A brief description of other activities in Jamuna River are presented below.

3.6.1 FRERMIP

BWDB has been implementing a program called Flood and River Bank Erosion Risk Management Investment Program (FRERMIP) in partnership with Department of Disaster Management with the funding support from the Asian Development Bank and Government of Netherlands. FREMIP falls with the Project AoI (Kalihati Site).

The expected outcomes of FRERMIP are:

- Flood and riverbank erosion risk mitigation functioning at priority river reaches;
- A strengthened institutional system for flood and riverbank erosion risk management; and
- The FRERMIP is a multi-phased program phased into three projects/tranches. The program area covers Jamuna River reach at the downstream of the Bangabandhu Multi-Purpose Bridge (also called lower Jamuna) and Padma River. The Tranche 1 (2014-2020) constructed river bank stabilization measures along the 60 km reach. The feasibility study of tranche 2 (January 2020 to December 2023) has also been completed and the implementation is in progress. The Tranche 3 will be implemented during (2021-2024). The estimated budget for tranche 1 is $103.27 million and $361.27 million for Tranche 2, respectively.

The FRERMIP has three components:

- Flood and River bank Erosion Risk Management:
  a. 17.8 km riverbank revetment construction, and further construction of 34.8 km has been planned under Tranche 1.
  b. 21.3 km embankment has been constructed and further construction of 68.3 km has been planned under Tranche 2
- Strengthened Institutional System for Flood and Erosion Risk Management: It includes institutional capacity building by training, establishing scheme inventory and mapping system, Smart Project Monitoring and Management System, and conduction of several studies for knowledge development; and
- Project Management.

Currently, the DPP of the Project 2 is at ECNEC[27] for approval. The loan (around 157 million USD) and grant (around 18 million USD) have already been approved by the competent authorities. BWDB expects the decision of DPP approval will be made by November 2021. Meanwhile the advance tendering of supply

[27] Executive Committee of the National Economic Council (ECNEC) is the highest authority headed by the Honorable Prime Minister to approval the DPP of a project.

packages, construction companies, etc. are in progress. Recruitment of the consultants for the PMU is in final stage as well.

3.6.2 Indian Line of Credit

BIWTA commenced a maintenance dredging work in Jamuna River funded by BD-India line of credit. Such dredging work was executed by the dredging department of BIWTA in an approach similar to dredging work carried out under revenue budget or maintenance budget. Therefore, there was no Project Management Unit established for managing the dredging work funded by BD-India LOC.

A memorandum of understanding was signed on April 8, 2017 between Bangladesh and India to develop the navigable fairway round the year between Sirajganj and Daikhhowa (175 km) and Ashuganj to Zakiganj (295 km). BIWTA commenced a maintenance dredging work in these routes. The Project duration covers the period of 2019 to 2026, which is focused primarily on dredging, 2 years of capital dredging and 5 years maintenance dredging. Government of India will bear 80% of the cost and Bangladesh Government pays the remaining 20%. BIWTA will collect the waterway usage Charges. The goal of the Project is to create at least 2.25 m draft, 25 m width navigation channel, to enable 2,000ton vessels to sail round the year, mainly during daytime and targeting one-way cargo traffic to India's Assam area. Development of these routes will enhance trade, facilitate movement of transit cargo to the landlocked Assam State of India.

So far, only a maintenance dredging has been executed along the route between Chilmari and Shaheber Agla of Jamuna during November 2019 to December 2019 by the dredging department of BIWTA to facilitate movement of Indian cargo, following an approach similar to dredging work carried out under revenue budget or maintenance budget. It is noted that there has been no Project Management Unit established for managing the dredging work funded by BD-India LOC. A Joint Monitoring Committee (JMC) was established whose responsibility was to conduct surveys and dredging of 'no man's land' areas between the two countries, finalize the payment procedure of the dredging contractor and monitor the dredging of the Sirajganj-Daikhowa and Ashuganj-Zakiganj stretches..[28]. Details of inland and transit cargo traffic in the route is presented in Table 3.3. The Ministry of Shipping of Bangladesh forwarded pro-forma for clearance of the Indian home and external affair ministries but the approvals are yet to receive. Both countries agreed during the third meeting of JMC in February 2020 to appoint a Project Management Consultant (PMC). Accordingly, the MoS of Bangladesh commenced a tender and sent the evaluation report to the Inland Waterways Authority of India for the appointment of a PMC but approval from India is yet to receive. Meanwhile, the validity of the tender submitted by the consulting firms expired. Bangladesh requested the tender participants to extend the validity and only WAPCOS Ltd. extended its validity. The implementation of overall work (development of fairway between Sirajganj to Daikhhowa) is being delayed due to several administrative issues like:

- Conducting survey in the "No man's land" area
- Delay in administrative approval of the proposal sent by the Ministry of Shipping of Bangladesh to Indian Counter-part.
- Low/no feasibility of capital dredging but only maintenance dredging in the reach between Sirajganj to Daikhhowa (as assessed by the BITWA and MoS-Bangladesh).

Table 3.3: Passenger, Inland and Transit Trade Cargo Traffic in the Route

Name of River Ports	2015-16	2016-17	2017-18	2018-19	2019-20
Inland Cargo					
Nagabari-Kazirhat-Noradoho	2,541,000	2,648,000	2,712,000	3,700,000	3,000,000

[28] https://m.theindependentbd.com/home/printnews/240186?fbclid=IwAR0EgB6ETW5kkTLIwcOQDnEH8q2ezvvqiuGgTPxEg8kMg0O9VumS30CU0aI

Baghabari-Balashi	290,000	314,000	332,000	160,000	180,000
Chilmari	n/a	n/a	n/a	37,000	39,000
Transit Trade					
Kolkata - Dhubri (Pandu)	2,430	352	2,386	n/a	6,082
Dhubri (Pandu) - Kolkata	n/a	n/a	n/a	n/a	2,004

Source: BIWTA, 2021 (Memo No. 18.11.0000.124.64.002.12/10)

3.6.3 Restoration of Buriganga River (New Dhaleswari-Pungli-Bongshai-Turag-Buriganga River System)

BWDB had originally prepared a DPP entitled "Augmentation of Buriganga flow by silted uplinks with Jamuna" on the basis of a study "Feasibility & Mathematical Model Study of Approaching and Investigating for Streategy for Rehabilitating the Buriganga-Turag-Shitalakhya River System and Augmentation of Dry Season flow in the Buriganga River" in 2006 which was not approved by the Government because no financial resource was found. Later in April 2010, the government approved the revised DPP with the budget of BDT 9,440.9 million. The aim of this project is to receive 245 cumec water from Jamuna to Pungli during dry season and ultimately discharge 141 cumc flow to the Buriganga. BWDB has been implementing the project since 2010. The construction of the project is still in progress with several revision due to field condition and inadequate planning. As per the latest revision, the project budget stands at BDT11,255,93 million[29]. With the recent changes in the project components, which include, i) construction of sediment basin and guide bank at the off-take of new alignment of Dhaleswari-Pungli river; ii) dredging of new alignment of Dhaleswari – Pungli river, iii) foundation treatment of bridges on the dredging allignment, etc. Currently, BWDB is implementing dredging operation at offtake area, and completed revetment work (guide bank) near off-take area. The project implementation period has been extended to 173% and the budget has been increased by around 181% as per the monitoring report of the IMED. Inadequacy in planning, preparing the DPP on the basis of older mathmatical modeling study, selection of options without adequate investigations and their impacts, shifting of the river, high sedimentation, etc. were the major reasons of the long-delay of the projects. BWDB later conducted a detail feasibility study by the AVIC-ENG and CHWE and accordingly, the DPP has been revised by including a number of project components considering the impacts of the project on Fisheries, existing bridges, sustainability, etc., which are –

- Dropping the idea of constructing regulator and fish-passes at the off-take of New Dhaleswari-Pungli river and adding the construction of sediment basin in the off-take area.
- Including the foundation treatment of the existing bridges considering the impacts of dredging on the existing bridges.

IMED has also recommended to change the location of the off-take area to further upstream to allow more flow towards the Pungli River.

The project has a strong relationship with the proposed pilot site Alipur, Tangail under C1 component of the JRECDP. Because, this site is located near the off-take area of the Dhaleshwari Pungli river. The piloting work includes construction of Groynes, revetment works and river dredging for erosion protection. Currently, the riverbank at the downstream of the off-take area is severely eroding.

3.7 Defining and Screening Associated Facilities

"Associated Facilities" means facilities or activities that are not funded as part of the project. For facilities or activities to be Associated Facilities as per the ESS1, they must meet the following three criteria:

[29] IMED 2019. Final Report of the In-depth Monitoring of Buriganga River Restoration Project (New Dhaleswari-Pungli-Bongshai-Turag-Buriganga River System) (in Bangla), Implementation Monitoring and Evaluation Division, Ministry of Planning

- *Criteria 1:* directly and significantly related to the project;
- *Criteria 2:* carried out, or planned to be carried out, contemporaneously with the project; and
- *Criteria 3:* necessary for the project to be viable and would not have been constructed, expanded or conducted if the project did not exist.

Table 3.4 presents an assessment whether the facilities stated in the TOR as associated facilities are associated to Project 1 of JRECDP or not based on ESS1. It is concluded that none of the facilities is qualified as associated facilities as per the ESS1.

Table 3.4: Assessment of the Facilities to be Considered as Associated Facilities as per ESS1

Facility Name	Criteria Triggered			Conclusion
	Criteria 1	Criteria 2	Criteria 3	
FRERMIP	No	Likely	No	This is an existing project under implementation prior with no direct or indirect relation with JRECDP. The viability the project does not depend on another.
ILOC	No	Uncertain	No	his is an existing project with uncertainty of implementation conceptualized prior to the inception of JRECDP. The viability the project does not depend on another.
Restoration of Buriganga	No	Likely	No	This is an existing project under implementation prior to the inception of JRECDP. The viability the project does not depend on another.

Although these aforementioned projects have not triggered the definition of association facility, a standalone E&S Audit of FRERMIP and ILCO was conducted because these projects are also taking place in the neighbourhood of the Project 1 of JRECDM and share similar objectives.

3.8 Operational and Maintenance Requirements

River training and bank protection work is a major component of the project. The life and security of the project largely depend on the performance of the erosion protection works. It has been observed that inadequate monitoring of the completed work and lack of proper O&M activities due to limited funding provisions cause greater damage to the bank protection. Hence, regular monitoring and proper O&M activities of bank protection work with the availability of sustained fund with BWDB must be ensured to keep the program functional. The BWDB receives fund from the government under the annual development program (ADP) for operation and maintenance of its infrastructure under different projects. Records indicate that the BWDB has been receiving on average about 17 percent of the total requirement for O&M, which reveals that the BWDB could not respond to all maintenance needs. For attaining sustainable maintenance of proposed project, the allocation for O&M in the ADP to be adequate as per actual need or there need to find a way to involve the beneficiaries directly in contributing to O&M. It may be noted here that funds available for maintenance are often less than optimal, so it is important to make the best use of available funds and the estimates of O&M components should be well supported by appropriate justification. On the other hand, BIWTA also receives fund from the government for their operation and maintenance work like BWDB. O&M works of proposed project can be divided into three categories and they are presented below.

a) **Routine Maintenance**: Routine maintenance includes preventative activities such as repair of displaced blocks if any in the slope of the bank revetment work, repair of the piles and other parts under top blocked permeable Groynes, repair work at optimal Barge and movable Jetty etc. The objective of routine maintenance is to keep overall protection including all its elements in good functional order, thereby reducing the need of periodic maintenance eventually avoiding high rehabilitation costs. The works are simple, generally inexpensive and cost effective and may need to be carried out round the year, almost continuously or as and when required.

b) **Periodic Maintenance**: This is less frequent than routine maintenance and is likely to include repair of sliding of bank protection work, and maintenance of Groynes, Jetty etc., after rainy season. BWDB and BIWTA engineering personnel will identify periodic maintenance works during surveys and inspections or on information from its field staffs.

c) **Emergency Maintenance:** This type of maintenance is similar to periodic maintenance, but involves a potentially catastrophic situation that would likely cause significant damage to the infrastructure if not repaired immediately. Emergency maintenance may include repair of major sliding of bank revetment work which if not taken care on emergency basis may cause further damage. A component of the BWDB O&M budget should be set aside for natural or human caused calamities. Necessary funding and authorization to execute emergency maintenance should be readily available whenever required.

3.9 Construction Timeline and Implementation Schedule

The construction period for the proposed Project 1 work will be 2 years. Similarly, after the implementation of the project, the monitoring period will be 2 years.

3.10 Overall Estimation of Cost

A tentative estimated cost of Project and overall program is presented in Table 3.5. This estimate will be updated based on the engineering design of both Components 1 and 2.

Table 3.5: Program Costings and Implementing Agency (IA) by Component (USD, Millions)

Components	Project 1	Implementing Agency
1. Flood and bank erosion management	45	BWDB
2. Navigation channel development	70	BIWTA
3. Financial protection of communities	10	BWDB
4. Community engagement and project management	10	BWDB & BIWTA
5. Contingent emergency response	-	BWDB & BIWTA
Total	**135**	

Source: Pre-appraisal Stage Information, TTL, the World Bank, February 15, 2022

4. Analysis of Alternatives

This chapter describes various alternatives considered during project planning and design phase.

4.1 Without Project Alternative

The Jamuna River is a very dynamic river and one of the three major rivers in Bangladesh. Migration of channels and shifting of bank lines are very frequent in this river. It is so dynamic that visible changes can be found even within a year. It can be said that Jamuna will continue this dynamic nature without any human intervention or project implementation.

The average width of the Jamuna River has increased from 8 km to 12 km in the last 46 years. In the recent decade (2010-2020), the average width of the river remains stable which indicates that the river is in an adjusting phase with nature. But width may be changed due to human interventions in the waterbody, e.g., construction of a bridge.

Erosion in the Jamuna River is very high, though the rate of erosion has been on a decreasing trend in recent years. The study reach of Jamuna (from the Bangladesh-India border to Sirajganj) had an erosion rate of 970 ha/year in the last decade (2010-2020). Naturally, this rate may decrease in the future but it will not end without any project or infrastructure.

As the flow and sediment of Jamuna will be the same; erosion, flooding, dynamic nature, and channel migration will continue to affect severely the population residing close to the bank line and impact the overall economy of the country. In the light of above discussion, it can be easily assessed that the "No Project Option" will not only be an impediment in the national economy but will also have a negative effect on local and regional development and quality of life. Therefore, this alternative was not given further consideration.

4.2 Strategic Alternatives

4.2.1 Riverbank Stabilization vs. River Course Stabilization

Riverbank stabilization refers to riverbank protection which is an inert or living construction providing bank fixation but also an obstacle for the lateral connection of the river to the canals and streams connecting the floodplains. The main purpose of constructing riverbank protection works are flood mitigation, defense, protection, navigation, guiding the flow, sediment control, etc. To fulfil these objectives, different types of riverbank protection work can be constructed such as Flow diversion, Groynes/Spurs, Bandals, Hardpoints, Revetment, etc. (Figure 4.1). Among them, bandals are considered to be effective in small rivers with low velocity. Otherwise, for major rivers with high currents, Groynes, revetments, spurs, etc. are considered.

Bandals at small rivers

Revetment at Alatuli in Chapainawabganj Sadar upazila

Figure 4.1: Riverbank Stabilization through Protection Works

River course stabilization is also an outcome of part of riverbank protection works which not only protect river banks from degradation but also prevent lateral migration of alluvial channels. River course stabilization is considered for multichannel/braided rivers with high dynamicity. Two main approaches for riverbank stabilization are:

Strengthening the bank

- Hard Approaches: Riverbank riprap & retaining walls (Figure 4.2)
- Softer Approaches: Bioengineering and vegetation

Reducing Hydrodynamic force

- Flow control structures: Guide bund, Groyne/spur

Spur

Riprap

Figure 4.2: River Course Stabilization through Protection Works

For river course stabilization of the Jamuna River, five master plans for stabilization so far have been developed and proposed recently, which are:

1. River Stabilization and Development: Jamuna-Padma and Dependent Areas (FRERMIP, 2020)
2. Concept Paper on Managing Brahmaputra-Jamuna River System (BUET/BWDB, 2019);
3. Brahmaputra-Jamuna River Economic Corridor Development Program (IWM, 2019);
4. Planning for Flood Management in Bangladesh (the Ganges and Brahmaputra Basin), Yellow River Engineering Consulting (2019); and
5. Feasibility Study of Capital Dredging and Sustainable River Management in Bangladesh, (BWDB, September 2015).

Since the development of the JRECDP is in process and the master plan and a detail feasibility study are yet to be prepared, it is difficult how the JRECDP is synchronized to the earlier plan. However, the JRECDP SOP has been conceptualized to start with river bank stabilization and gradually moving towards river course stabilization integrating the room for river concept. **Table 4.1** summarizes the similarities and differences between the various plans.

Table 4.1: Comparison of River Stabilization Plans

Plans	FRERMIP	BUET-BWDB	IWM	Yellow River Engineering Cons.	Capital Dredging Project	JRECDP
Planning Time Frame	2100 (Long-term); 2050 (medium-term)	2100	Not described	2035	15 years	7+ years in three phases
Spatial Extent	Jamuna, Padma River including major distributaries	Jamuna	Jamuna	Jamuna-Padma-Ganges	Jamuna-Padma	Jamuna River from Doikhawa to Bangabandhu Bridge
Integration with Delta Plan	Compatible-time frame and adaptive planning (DAPP) approach adopted	Adaptive dredging	Not described	Not described	Not described	It is mentioned that the program has been designed to contribute BDP 2100 goals
Plan Goals	Reduce flood risk by stabilizing main rivers, improve quantity and quality of distributary branches, improve water transport, promoting safe development of reclaimed Char land	Free flowing Jamuna within braided corridor. Provide optimized ecological, socio-economic and environmental services	Stabilizing Jamuna to utilize its potential for inland transport and reclamation of Char land	Establish a flood control engineering system to increase security against flooding and erosion for mainstream and tributaries.	Channelization of Jamuna and Padma River to stabilize river, improve navigation, reclaim land	(a) boosting resilience against riverbank erosion and flooding; (b) improving river navigation capacity; (c) strengthening sector institutional capacity and collaboration.
River stabilization strategy	Establish a stabilized corridor for conveying water and sediment to minimize future widening, promote natural restoration of former floodplain and promote long-term stability of distributary channels.	Dredging of active and developing channels aided by modelling simulations and real-time bathymetric data. Free-flowing	River training to limit further erosion and promote reclamation of floodplain and Chars	Comprehensive strengthening of embankments, riverbanks. Dredging if necessary, to control deposition that threatens channel stability	Capital dredging up to 9.8 billion m3 in stabilized channel protected by revetment	Gradual narrowing down of the river by river training. Room for river, Dynamic management for navigation until stabilization of the river, intelligent dredging for navigation
River Training Methods	Primarily bend control with guiding revetments	Mainly dredging, continuous protection of embankments by revetments	Permeable Groynes to protect embankments, floodplain and raised Chars	Bend- node control using revetments and Groynes with set-back embankments	Continuous revetment confining dredged channel	Revetment, and Groynes

Plans	FRERMIP	BUET-BWDB	IWM	Yellow River Engineering Cons.	Capital Dredging Project	JRECDP
Stabilized channel pattern	Primarily single or two channels, meandering to anabranched pattern. Braided reach of Jamuna (R-1, R-2) retains multi-channel pattern until future conditions improve	Wide, braided corridor with set-back flood embankments protected by continuous revetments	Braided	Generally, follows existing flow paths with a meandering or anabranched planform	Mostly a single thread meandering channel	Not planned yet
Width of stabilized river corridor	Jamuna Flood Corridor: 6.0 to 6.5 km Jamuna Alluvial Corridor: 3 km Padma Alluvial Corridor: 4 km Padma Flood Corridor: 8.0 to 10 km	Varies 11.5 km -15 km	Varies between 5-8 km	Jamuna: 4 km main channel, 2 km branch channel Padma: 3.5km main channel, 1.5 km branch channel	4 km	6-8 km/10km (to be decided during the implementation of SOP 1)
Land reclamation strategy	Combination of accelerating natural floodplain accretion, dredging, structural measures	3 options, total area varies from 375km2 to 644 km2	Filling by dredging (up to 2 billion cubic meter)	Cultivable land increased between stabilized bank and set-back embankment	Dredged fill behind embankments	Not planned yet. Probably by dredging and river training work
Distributary Channel Rehabilitation	Offtake control tied in to stabilized main channel. Dredging distributary channels	Modified openings (not specified), recurring dredging, new embankments	Not described	Not described	Dredging	Not planned
Navigation Channel Improvement	Dredging along stabilized main river channels to maintain improved transport in dry season	Not described	Dredging along stabilized main river channels to maintain improved transport in dry season	Not described	Stable channel alignment maintained by dredging	Start with dynamic approach with Performance based dredging, gradual increase of LAD, a Master Plan is in process.
Environmental/social impacts	SESA completed which indicated high E&S risk	Not described	Not described	A generic Environmental Assessment was conducted indicating high risk	Very Large	High Social Risk and Substantial Environmental Risk as per the Risk Rating

Plans	FRERMIP	BUET-BWDB	IWM	Yellow River Engineering Cons.	Capital Dredging Project	JRECDP
Estimated Cost	USD 7.26 billion (61,700 Crore BDT)	Unknown, expected to be very high due to continuous revetment, very high capital & maintenance dredging	USD12.4 billion (105,000 Crore BDT)	USD 5.59 billion (47,500 Crore BDT)	>USD 110 billion (935,000 Crore BDT) based on annual costs over 15 years	Phase 1: 100mUSD Phase 2: 1.2 Billion USD Phase 3: 1.5 billion USD
Focus of First Ten Years	Mid-lower) Jamuna (Reach 3) + Padma	Not described	Not described	Not described	Not described	Jamuna River from Doikhawa to Bangabandhu Bridge
Comments		Dredging volumes are expected to be exceptionally large (up to 3.6 billion cubic meters), which is unlikely to be feasible with present technology. Impacts of sediment removals not defined.	Previous experience with permeable Groynes has had limited success and been superseded by other more effective methods.		Cost based on an annual average investment of USD 7.7 billion (BDT 640 billion BDT) for 15 years	The overall master plan is not ready yet
Impacts		Simulation shows approx. 5 m degradation at Indian border (pg. 87 & Fig 4-22)	Simulations show >10 m of degradation near Indian border			Hydro-dynamic modeling is not available

4.2.2 Dynamic Navigation Management vs. Stabilized Navigation Corridor

Whenever the equilibrium of a river is disturbed by man-made structures or natural causes, the river tends to attain a new equilibrium condition by scouring the bed or by depositing the sediment on the riverbed or bank by changing its planform. **Dynamic River Management** refers management of recovering hydro-morphological resilience for functions such as flood protection, navigation, etc. (Figure 4.3).

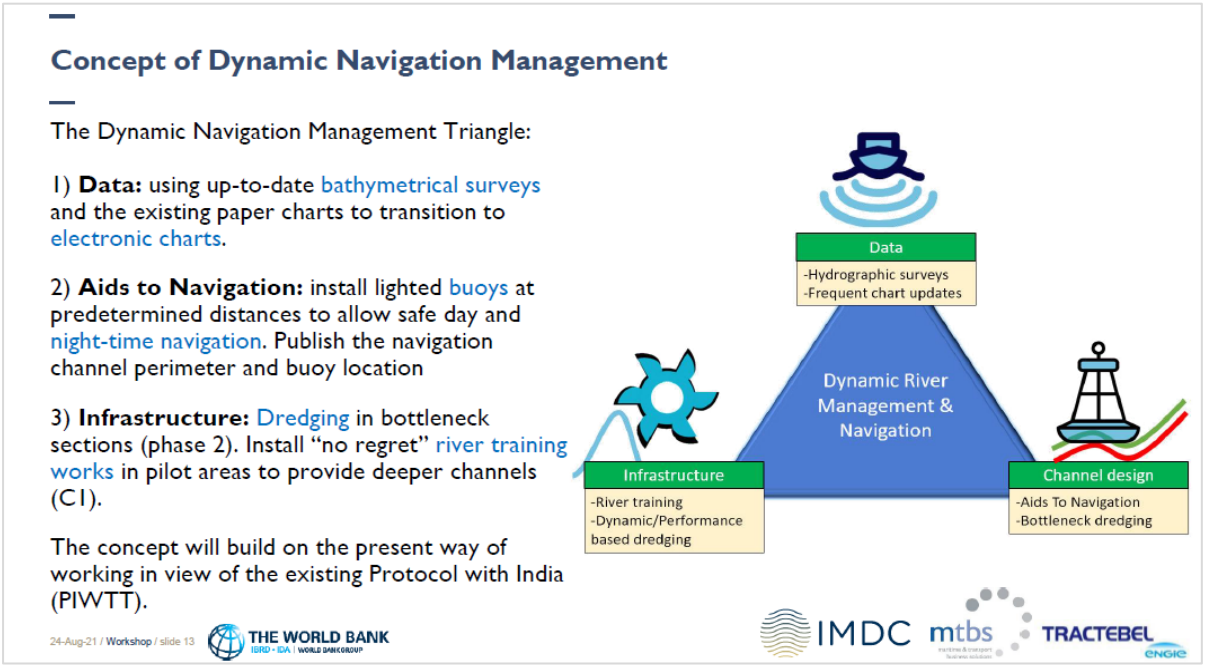


Figure 4.3: The Concept of Dynamic Navigation Management

A stabilized **navigation corridor** approach is based on the stabilized river corridor which does not consider that the river bank and the deepest channel of the river would be dynamic. The section of a navigable waterway allocated to the movement of vessels will also be fixed and stabilized by series of river training work. It involves aggressive control of the river course which is very difficult, expensive and associated with substantial environmental and social risk for a river like Jamuna.

This project has been conceptualized taking dynamic navigation management into consideration.

4.2.3 Aggressive Narrowing Down of the River vs Room for River

Aggressive narrowing down of the river can occur by human intervention. However, narrowing down of the river can consequence heavy flood during monsoon due to lack of enough drainage system. Moreover, narrowing down can result in severe morphological changes both upstream and downstream of the river. Though narrowing down a river can increase the depth of the river to facilitate navigation sometimes, but enough drainage systems should be ensured to prevent an extreme flood. The aggressive narrowing down has high E&S risk as well. It is considered to be highly threatening to the survival of wildlife of Jamuna River.

The **Room for the River** program is a Dutch flood mitigation initiative that focuses on creating "room for the river" to manage higher water levels in rivers by lowering the levels of flood plains, creating water buffers, relocating levees, increasing the depth of side channels, and the construction of flood bypasses. Making "room for the river" allows landscapes along rivers to be restored to act as "natural water sponges" in the event of a flood. The major stages followed by the program are shown in **Figure 4.4** and the project area during low flow and high flow are also shown in **Figure 4.5**.

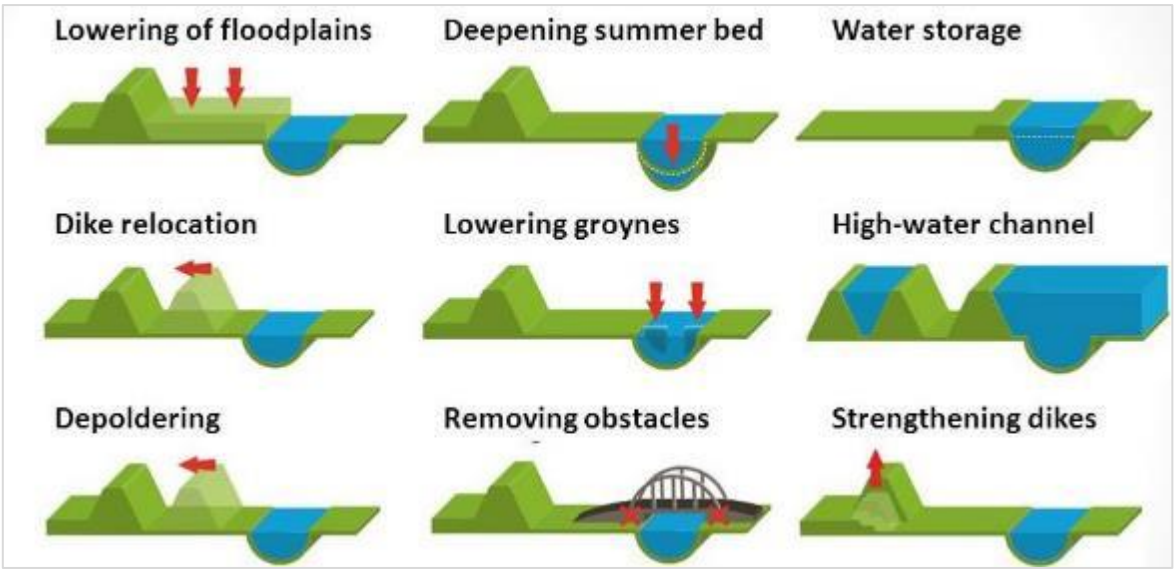


Figure 4.4: Stages followed in the "Room for River" Project

During High Flow During Low Flow

Figure 4.5: Room for River Example from Netherlands during Low and High Flow

The room for river concept is now advocated and generally adopted by the BDP 2100 and is in consideration under JRECDP as well. The above options are presented from various studies in Bangladesh or other similar river systems in the world. The preferred alternative may be selected by the design consultant after the completion of the hydro-dynamic modelling under Component 1 and Navigation Master Plan and RIS Level D+ under Component 2 of Project 1, To guide Project 2 investment, the Component 1 River Training Model and the Component 2 Navigation Model will interact, to have one coordinated river stabilization and dynamic navigation strategy, which will rationalize the dredging cost and determine optimal locations of the river training structures.

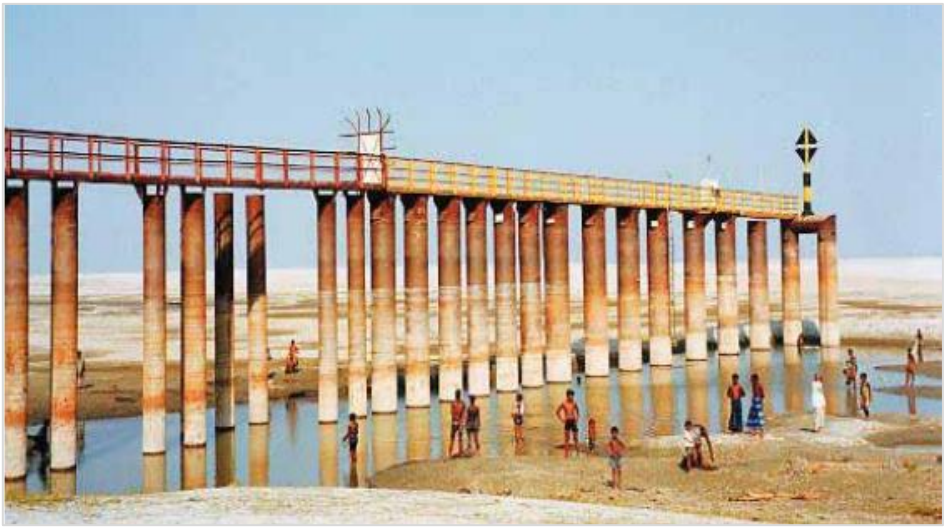
During the implementation of Project 1, further assessment will be conducted on how to incorporate the room for river concept in the JRECDP.

4.3 Technological Alternatives for River Trainings

4.3.1 Permeable Groynes

Permeable Groynes permit water through it but with a reduced velocity of flow. Groynes built using materials such as wood, steel, rock or sandbags, etc. come under this category. This type of Groyne is suitable when a river is carrying a certain amount of sediment in suspension. Permeable Groyne simply obstructs the flow, reducing its velocity and causing silt deposition (Figure 4.6). They are, therefore, best suited for rivers carrying huge sediment loads in suspension. In a comparatively clear river, they use

erosive strength of the current and thus, prevent local bank erosion. Permeable Groyne does not change the flow abruptly; they are cheaper & perhaps best for silt-laden rivers.



Source: Erik Mosselman, 2016[30]

Figure 4.6: Permeable Groyne at Kamarjani of Jamuna River

4.3.2 Impermeable Groynes

Impermeable Groynes do not permit water to flow through them (Figure 4.7). They are made of materials such as rock, gravel, gabions, etc. Since they are impermeable, the water may overflow during peak conditions hence, a thick protection layer is necessary for this type of Groynes. Impermeable Groynes are also called solid Groynes or embankment Groynes. The head of the Groynes needs special protection and it is generally provided with a launching apron in addition to the increased pitching.

Rock Groyne

Concrete Groyne

Figure 4.7: Impermeable Groyne

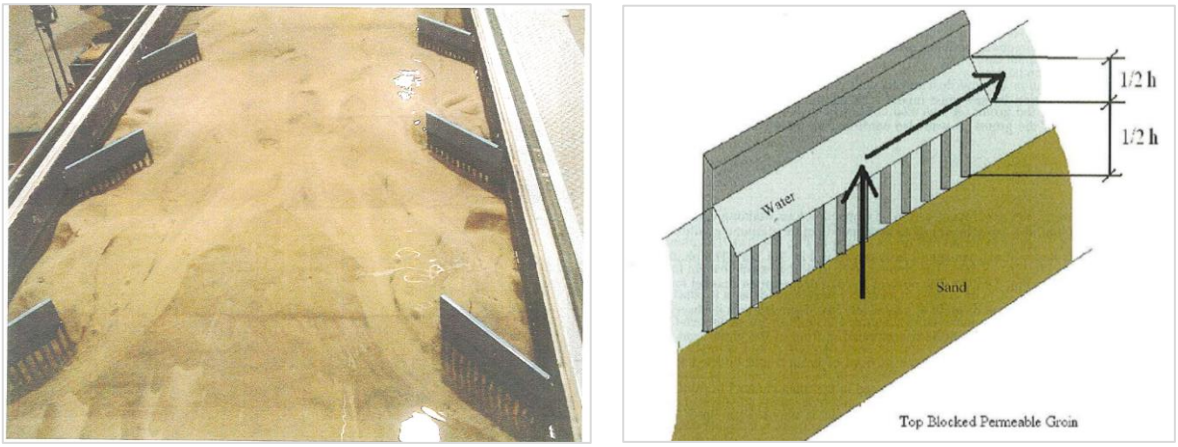
4.3.3 Top –Blocked Permeable Groynes

Top blocked permeable Groynes (TBPG) are one type of permeable Groynes including impermeable bandal plate at the top and permeable Groyne at the bottom (Figure 4.8). Top blocked permeable Groynes is one kind of bandal like structure. It is an improvised technology of such bandal like structure. In this type of structure, multiple reinforced concrete piles are installed instead of bamboo or wood and the upper part of the piles (Above the low water level) is blocked using steel sheet or concrete wall-like structure to divert

[30]http://www.bluegoldbd.org/wordpress/wp-content/uploads/2017/11/IF-09aDeltares-Review-of-IWM-study-River-bank-erosion-P29.pdf

the river flow towards mid-channel. This type of structure is effective to flow diversion having no return current and Groyne field velocity is less than the permeable Groyne.

Project 1 of JRECDP is considering piloting of TBPG in 2 sites because TBPG does not drastically narrow down the river and aggressively reflect the flow which would have significant E&S impacts.



Source: Khaleduzzaman, 2014[31]

Figure 4.8: Top-Blocked Permeable Groyne (Bandal like Structure)

4.4 Site Selection Alternatives

Based on the Feasibility study report of March 2022 conducted by the design Consultant, for detailed design of river training piloting scheme under JRECDP (Project 1), **18** suitable sites are selected **under 6 Districts (Sirajganj, Tangail, Jamalpur, Kurigram, Gaibandha, and Bogura,)** along the reach of Jamuna River in both banks from the border line of Bangladesh – India. Among of those 17 sites some sites are already well protected, some are outside of the study area and finally some are less prone to risk and the flow occurs seasonally in the channel.

However, after assessing all the present conditions of these sites, the following sites were selected for Multi-criteria analysis:

1. Kazipur from Sirajganj district
2. Chhangachha from Sirajganj district
3. Nishchintapur from Sirajganj district
4. Kalihati from Tangail district
5. Bhuapur from Tangail district
6. Bahadurabad from Jamalpur district
7. Pingna from Jamalpur district
8. Kulkandi from Jamalpur district
9. Rowmari from Kurigram district
10. Hatia from Kurigram district

[31] Khaleduzzaman, A T M, 2014. Experimental Study on River Course Stabilization and Restoration by using Groin-like Structures. M.Sc. Thesis, Graduate School of Engineering, Department of Civil Engineering. Kyoto University

11. Chandipur from Gaibandha district
12. Fulchari from Gaibandha district
13. Katlamari from Gaibandha district
14. Kutubpur from Bogura district

For selecting the pilot sites, the Consultant developed a Multi-Criteria-Analysis (MCA) framework (Table 4.2) which includes several environmental and social criteria like interference with Dolphin sanctuary, climate change adaptation, loss of agricultural land, impacts on distributaries and tributaries. Each selected site was assessed according to the criteria and given score. At last, scores were added and the sites were ranked according to the highest scores. BWDB Field Division Engineers and other officials advised, recommended and guided to formulate this criterion within a framework of MCA and ranked the sites with scoring the criterions for selecting the Pilot sites.

After assessing local site condition, morphological analysis of pre-selected suitable sites and consultation of BWDB Field Division Engineers the Multi-Criteria-Analysis (MCA) table was scored and ranked the following two (2) sites as Pilot sites to implement the proposed pilot river training and riverbank protection structure:

1. Bhuapur from Tangail district (Score 90)
2. Kalihati from Tangail district (Score 88)

Design Consultant has performed Multi-Criteria Analysis of all the potential sites, as shown in Table 4.2. Finally, the Government has selected the Bhuapur and Kalihati sites from these four sites for piloting of the Project 1 (Figure 4.9).

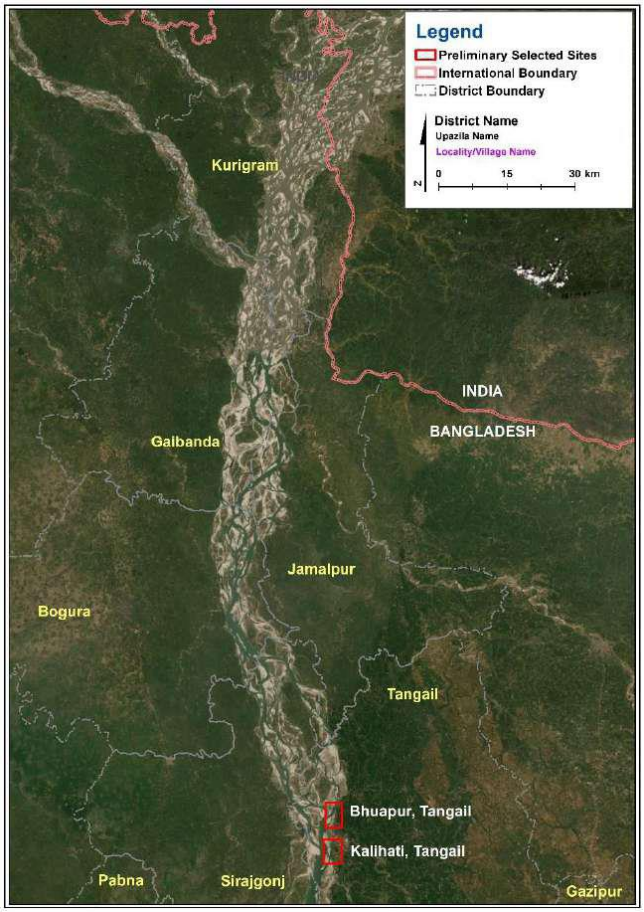


Figure 4.9: Location of Two Selected Sites for Pilot Study

Table 4.2: Multi Criteria Analysis for Site Selection

				Preliminary Selected Sites													
	District Name			Sirajganj			Tangail		Jamalpur			Kurigram		Gaibandha			Bogura
#	Criteria	Sub-Criteria	Maximum Score	Kazipur	Chhangachha	Nishchintapur	Kalihati	Bhuapur	Bahadurabad	Pingna	Kulkandi	Rowmari	Hatia	Chandipur	Fulchari	Katlamari	Kutubpur
1	Morphological Predictability	i) Locations that presently are being eroded, OR, periodically being eroded as reported by local stakeholders	4	4	4	4	4	4	4	4	3	3	4	2	4	4	4
		ii) Erosion prediction by CEGIS Report	2	1	1	1	1	2	1	1	1	1	1	1	2	1	1
		iii) Hydro-dynamic model results	4	3	4	4	3	3	2	3	4	2	4	2	2	4	4
		iv) Protection to Jamuna Right Bank Embankment	4	1	2	4	1	4	4	1	1	4	1	4	4	1	4
		v) No probable impact on existing river intake, offtake and ports	4	4	4	3	4	4	3	4	4	4	4	3	3	4	4
2	Gradual River Training (narrowing) for River Course Stabilization	i) Gradual River width narrowing need at pilot location, to meet final planform	14	12	10	10	14	14	8	11	9	12	9	11	9	12	11
		ii) River Bank Protection need	5	4	3	5	5	5	5	4	2	2	2	5	5	2	5
		iii) River bank building (sedimentation) need/potential	6	5	5	3	5	5	4	5	5	5	5	4	3	2	4
3	Navigation	i) Navigation improvement via increased LAD potential	15	14	9	9	11	12	10	13	8	12	8	12	12	10	9
		ii) Improve preliminary navigation along the alignment received from C2 for No-regret option, OR, channel convergence via river flow diversion	5	3	2	1	5	4	3	3	2	2	3	4	4	5	2
4	Accessibility	i) Accessibility to riverbank (proximity) via main/service road network during wet season	5	5	4	1	5	5	3	5	3	3	3	5	4	1	1
		ii) Accessibility to riverbank via navigable channel during dry season	3	3	2	1	3	3	3	3	2	3	3	2	3	3	3
5	Construction	i) Accessibility for Construction	7	7	3	1	7	7	7	7	5	7	5	6	5	1	2
		ii) Difficulties for drilling concrete piles due to presense of CC blocks at riverbed/riverbank slope	5	5	5	5	5	2	2	5	1	2	1	5	5	5	5
		iii) Depth of Water during dry period	3	2	2	3	3	3	1	2	1	1	1	3	3	1	1
6	Social Issues	i) Positive impact to local settlement & critical infrastructures (school, dense settlements, growth center, hospitals etc.)	3	3	3	3	3	2	3	3	1	1	1	3	3	3	3
		ii) Positive Impact to Agriculture	2	2	1	2	1	2	2	2	2	2	2	1	2	2	2
7	Environment	i) No Interference with Natrual Reserves and Sanctuaries (Dolphin)	5	3	3	3	4	5	5	3	3	3	3	3	4	3	3
		ii) Present and Potential Future Land Use	2	2	1	1	2	2	2	2	2	2	2	1	2	1	2
		iii) Climate Change adaptation	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
		Total Score	100	85	70	66	88	90	74	83	61	73	64	79	81	67	72
			RANKING	3	10	12	2	1	7	4	14	8	13	6	5	11	9

Source: Feasibility study report, March 2022

4.5 Dredging Alternatives at Kalihati Site

The design Consultant has developed a sub-model to identify and confirm the dredging alignment and proposed three alternative dredging options. These three alternatives are shown on Figure 4.10.

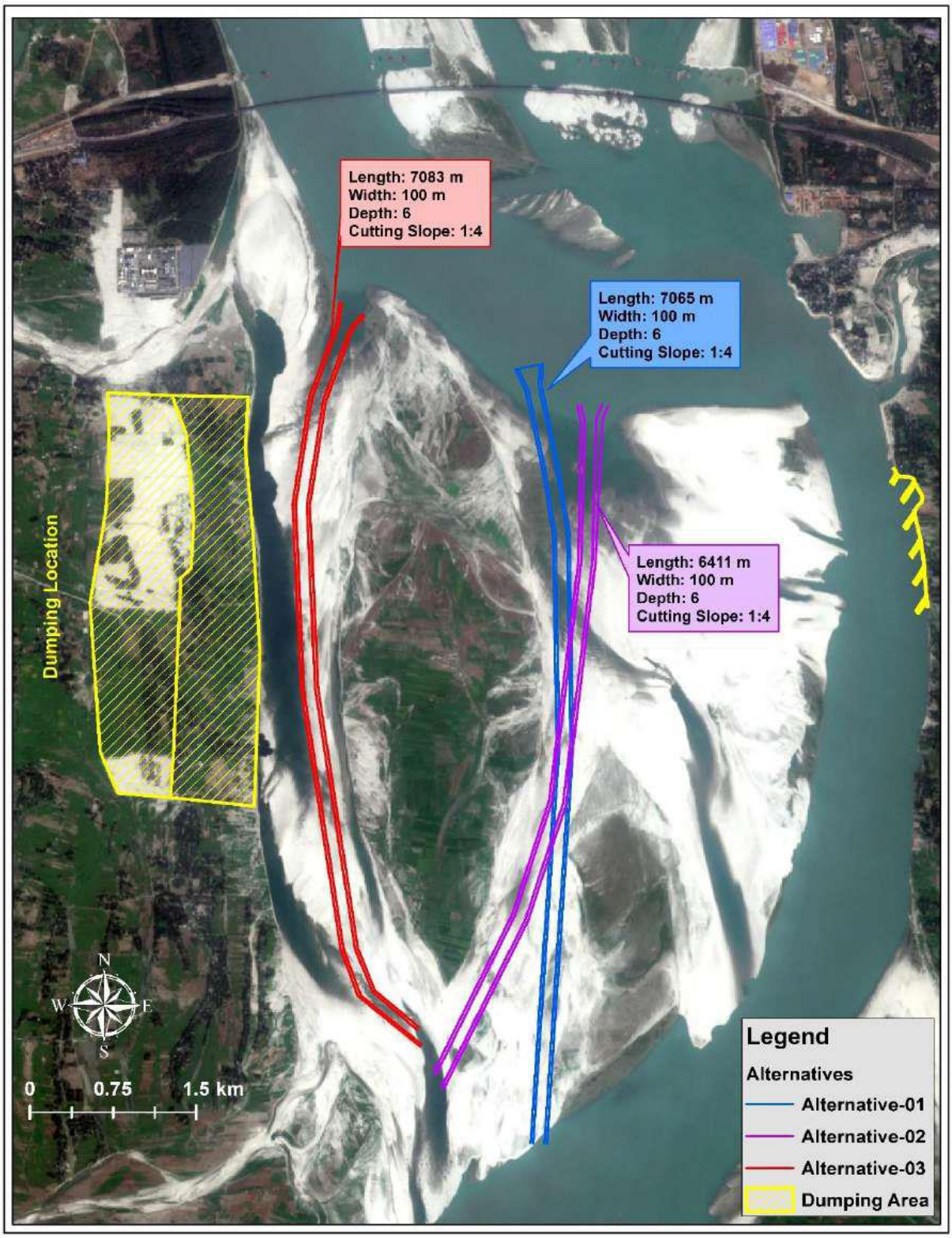


Figure 4.10: Alternative Alignment of Dredging at Kalihati Site

Details and comparison of each dredging options are presented below:

- Alternative 1 is located in the middle of Jamuna River. This option has 7 km long, 100 m wide and 6 m depth of dredging. This excavated canal will have slope of 5 cm in 1 km.
- Alternative 2 has 6.4km long, 100m wide and 6m depth of dredging. This option is not considered due to the Char and morphological condition.
- Third option, Alternative 3 has 7 km long, 100 m wide and 6 m depth of dredging, which is similar to the Alternative 01. This option of dredging is located near and along the river right bank.

Based on Jamuna River morphology, sediment transport and hydrodynamics, Alternative 1 is more realistic matching with the site Char and morphological condition. Alternative 03 is the least preferred option because of its proximity near the right bank, which might create potential bank erosion in the right bank. Therefore, we have selected Alternative 01 for the proposed canal dredging.

4.6 Technological Alternative of Dredger

This Section will represent a narrative description of different types, methods and capabilities of commonly deployed dredger in Bangladesh in terms of economic and environmental perspective. Finally, a suitable dredger option will be selected by comparing their relative performance and which will meet a range of selection factors set by the responsible authority in Project 1. Dredging will be required in the Char front of Kalihati site to protect the bank and to reduce the impact on the pilot site. In addition, some very limited dredging may be required for the landing area of the movable jetties.

Some key environmental and social issues should be considered while selecting type of dredger are:

- Low risk of sediment dispersal during excavation
- Low risk of sediment releases from lifting
- Low risk of leakage from transportation

Based on the feasibility report in 2nd July 2021 conducted by IMDC the following dredger categories can be considered. The dredging technology will be decided during the Implementation of Project 1 considering dredging efficacy, economics, environmental and social issues.

4.6.1 Backhoe Dredger

A backhoe dredger consists of a pontoon, which is equipped with a hydraulic excavator (Figure 4.11). On the pontoons, spuds are mostly installed to stabilize and secure the pontoon during operations. The excavator is used to excavate the riverbed, bucket by bucket. A backhoe dredger can be used to excavate soft to hard soils as well as blasted rock. The bucket is emptied most of the time in a barge, which is moored alongside the pontoon, on which the excavator is mounted. A disadvantage is the fact that this might lead to high cycle times between the excavation and the dumping on the deposit area.

Source: http://www.workboatsales.com/vessel/50-45m-backhoe-dredger-for-sale/

Figure 4.11: Backhoe Dredger and Barge

4.6.2 Cutter Suction Dredger

A cutter suction dredger is a vessel which is equipped with a rotating cutter head for cutting and fragmenting harder soils and possibly rock (Figure 4.12). It should be noted that, like a backhoe dredger, the cutter suction dredger is a stationary dredger, which means that the dredger remains on the same location during dredging. This is ensured using spuds. By means of winches and anchors, the cutter suction dredger swings sideways and the cutter head cuts and removes the soil. The material is sucked up by the dredge pumps. The dredged material can be discharged into a barge, which is moored alongside the cutter suction dredger, but it can also be discharged through a floating pipeline and pipes on shore, to the deposit area. The production for cutter suction dredgers is dependent on the power of the used pumps and the properties of the dredged material.

Source: https://products.damen.com/en/ranges/cutter-suction-dredger/csd350/deliveries/csd-350-yn561106

Figure 4.12: Cutter Suction Dredger

4.6.3 Trailing Suction Hopper Dredger

A Trailing Suction Hopper Dredger (Figure 4.13) is a self-driven dredging vessel. It consists of hoppers or trailers with bottom gates or valves. The material is loaded in hopper hydraulically when this hopper or trailer is filled, the bottom valves or gates are closed and the hopper is raised up with cranes or winches. This dredger is most commonly used in open water: rivers, canals, estuaries and the open sea dredging.

Suitable mostly for harbor maintenance and pipe trenching, a hopper dredger is a self-propelling vessel that holds its load in a large onboard hold knows as the hopper. They can carry the load over large distances and can empty it by opening the bottom doors or by pumping the load offshore. Hopper dredges mostly dredge the soft non-rock soils and because of their high production rates can carry out land reclamation projects easily.

Source: https://www.marineinsight.com/types-of-ships/different-types-of-dredgers-used-in-the-maritime-industry/

Figure 4.13: Trailing Suction Hopper Dredger

4.6.4 DOP Pump

Another possibility is the use of a DOP pump (Figure 4.14). A DOP pump is a submersible dredge pump, dedicated to slurry transport. It has a wear-resistant, hydraulically (or electrically) driven dredge pump at its heart. Low maintenance and maximum uptime are ensured due to the heavy-duty design of the slurry pump, and a high operational efficiency is obtained thanks to the large spherical passage of the impeller. The DOP pump can be easily installed on an excavator. The power pack of the excavator should be sufficient as power supply for the DOP pump. The advantage of the DOP pump is that the transport of the dredged material can be directly done by floating pipelines and pipes onshore to the disposal area, or if wanted into a barge.

Source: https://www.hydrauvision.com/en/rental/dop-pumps

Figure 4.14: DOP Pump

5. Environmental Baseline

5.1 Study Area

The study area for the Environmental Baseline Area of Analysis EBAA (Figure 5.1) has been derived considering areas that are likely to have direct and indirect impact on its ambient environment by construction and operation activities of both Pilot Site 1 and 2 of JRECDP. It is assumed that the environmental impact will not only be limited within the project footprint area but it would have impacts on the nearby floodplain areas, hydro-morphological and road networks and other part of the proposed sites.

The following criteria were considered while delineating the EBAA:

- Project Footprint and Project Area of Influence[32]
- Direct and indirect impact area
- Impact of Noise from the Piling (piling will be the major activities)
- Air pollution including dust generation and water pollution might spread out up to the left bank of the project footprint.
- River area covering alluvial corridor, floodplain, and Chars between the banks etc.
- Possible hydro-morphological Impacts of the intervention due to the short distance of Jamuna Bridge from both sites.
- Impact on Significant Environmental Receptor of the nearby Chars and floodplain.
- Control area (upstream area, downstream area and the habitats along the opposite bank of the river which are beyond the limit of project AOI)

In addition to the EBAA where a detailed baseline analysis was done, a brief baseline assessment was also conducted for the Program AOI[33] since the activities of Component 2 will take place in the entire Program Section of the Jamuna River. Component 2 of stage-1 of this phase is primarily comprised of installation of navigational aids, Very High Frequency (VHF) Radar, Hydrography and Inland Electronic Navigational Chart (IENC) preparation and updating. As the precise locations for these activities has yet to be selected, the AOI of the overall program, 5km buffer area of the 200km program stretch (within Bangladesh) has considered. The 5km buffer for the Program is selected to cover all the possible impacts from Component 2 of the entire river width and the floodplains.

5.2 Topography and Landform

The Higher Himalayas, from which major tributaries of the Brahmaputra originate, are snow-capped most of the year? and have tremendously rugged topography. The gradient of its tributaries in the eastern and central parts of the Eastern Himalayas are very high, with elevations, from as high as 5000 m (MSL) to as low as 1000 m (MSL). In the Bengal Basin, the gradient of the Jamuna River is very low (i.e., 0.10–0.06 m/km). However, the Brahmaputra-Jamuna enters Bangladesh through Kurigram, decreases its gradient drastically and has become a classic example of a braided river. The lower gradient has made this river highly susceptible to channel migration and avulsion. Along the Brahmaputra-Jamuna, there are many

[32]The Project AOI (Kalihati and Bhuapur sites) has been defined as the 1km buffer area laterally from the bankline and the edge of the interventions up and downstream of the proposed groins.

[33] A 5km buffer area of the Program Section of the Jamuna river.

diyaras and Chars.[34] The soil and topography of Chars and diaras[35] vary considerably. The elevation between the lowest and highest points of these Chars and diaras may be as much as 5m. In general, the Project AOI is mostly flat and holds a lower topographic variation. From the digital elevation map of Bangladesh, it is found that the elevation varies from 9.47 to 28.88 mPWD.

5.3 Geology

The bed load of the Jamuna River consists of fine sand and silt and is largely governed by the Himalayan erosional activities. The exposed geology of the study area is alluvial sand, alluvial silt, alluvial silt and clay and young gravelly sand (Figure: 5.2). These sediments are Characterized by high water content and are loosely compacted. The Characteristics of the sediments and the high volume of materials imposed on the channels by the flow system cause the rivers to turn continuously, adjusting their bed configurations to differing flow regimes. In this regard, sediments in the Jamuna are not only deposited in millions of tons but are also highly susceptible to erosion when flow conditions alter. The Jamuna and its adjoining area hold the sedimentary material from the Cenozoic to the present time. The overall sedimentary thickness in the program area may be 15km.

The project AOI mostly falls under Rangpur Platform and Bogura shelf (Figure: 5.3) which are two parts of Stable Pre-Cambrian Platform in Bangladesh under Bengal Basin. As Brahmaputra-Jamuna is one of the geologically youngest rivers in the world, the frequent tectonic activities between the Asian plate and Himalayan plate have made this river tectonically active, especially the southern end of the study area.

According to the National Water Resources Database (NWRD) and Bangladesh National Building Code (BNBC), 1993, Bangladesh is divided in to three seismic zones (Figure-5.4). The Project AOI falls under zone-III. Therefore, all structural interventions in the study area must consider the seismic design.

5.4 Physiography, Land-cover and Land-use

Physiographically, the eastern side of the program area is covered by the floodplain areas of the Active Brahmaputra-Jamuna Floodplain, Young Brahmaputra-Jamuna Floodplain and Old Brahmaputra Floodplain (Figure-5.5). Active Brahmaputra-Jamuna Floodplain is the current dynamic floodplains of Brahmaputra-Jamuna. Young Brahmaputra-Jamuna floodplain is the meander floodplains of Brahmaputra-Jamuna. Basically, this is a floodplain area and frequently affected by monsoon rain, seasonal floods, flash floods and riverbank erosion. On the other hand, physiographically, most of the areas of the western side of the study area are covered by the Teesta Meander Floodplain and Karatoya-Bangali Floodplain. Flooding is mainly shallow and generates considerable silt and clay deposits over the floodplain areas. Both pilot sites are located in the Active Brahmaputra-Jamuna Floodplain area.

The land use pattern in the area is of mixed type having agricultural, grassland, wetland and residential uses (Figure-5.6). The main landuse patterns of the Program AOI and its surrounding area are agriculture (32.86%), settlements (3.47%), River and Khals (25.63%), and sandbars (35.16%). The land cover and land use of the piloting sites are further discussed in the later section.

[34] Char is usually means, any accretion in a river course or estuary.

[35] Diara is the piece of land that has got created in the middle of the river Ganges as a result of deposition of sands over the decades

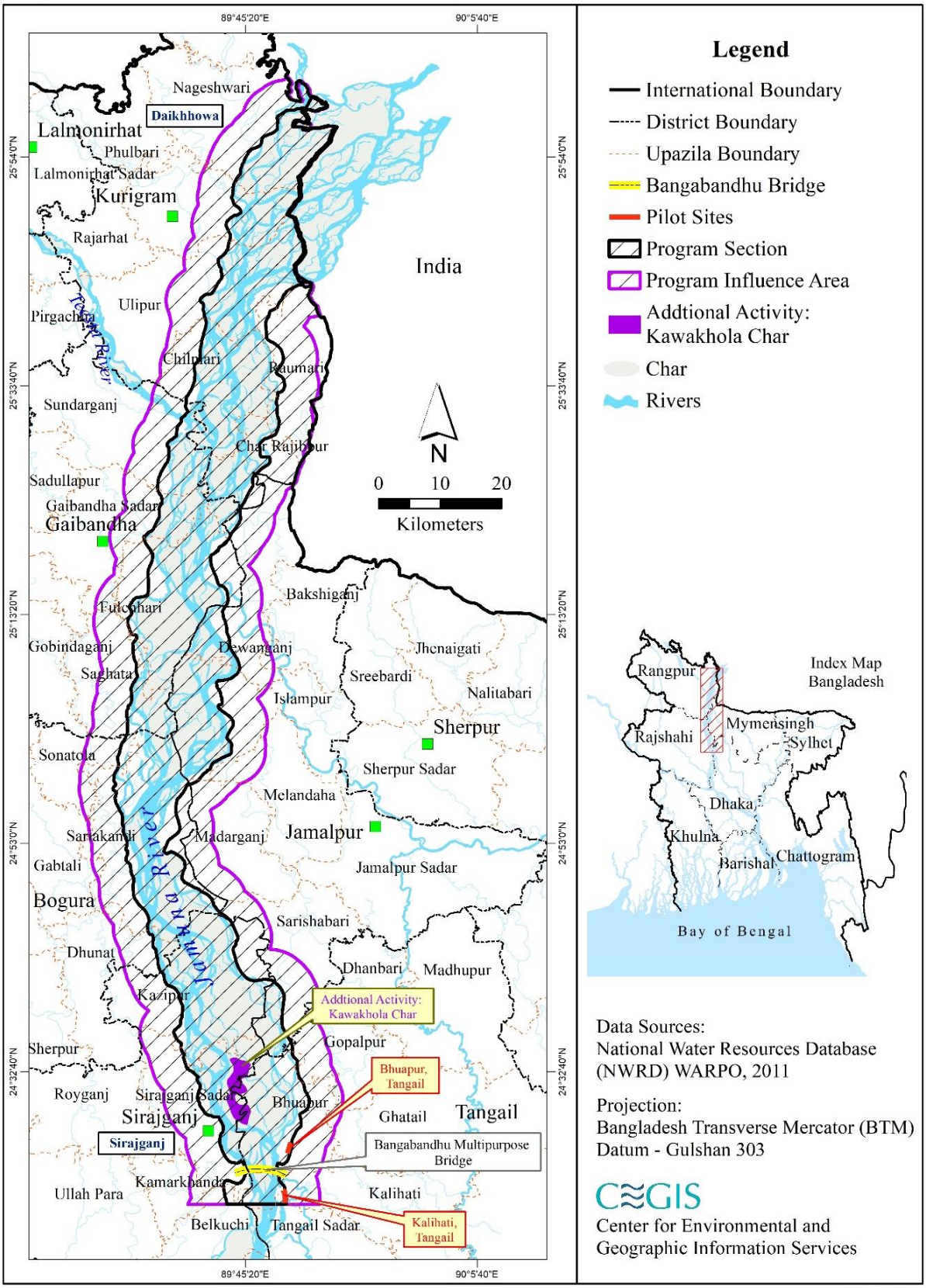


Figure 5.1: Map of the Environmental Baseline Area of Analysis

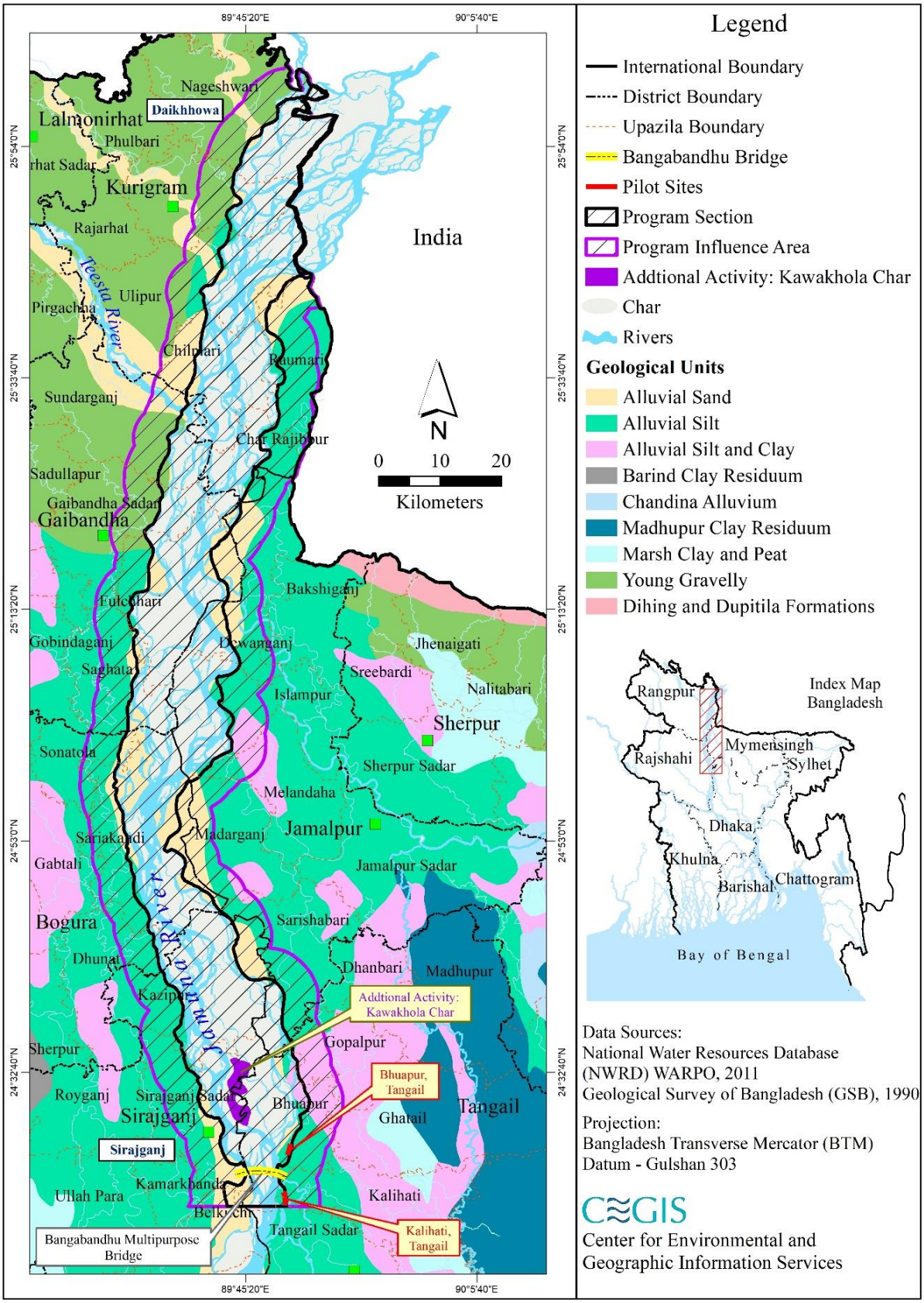


Figure 5.2: Surface Geological Features of the Program AOI and EBAA

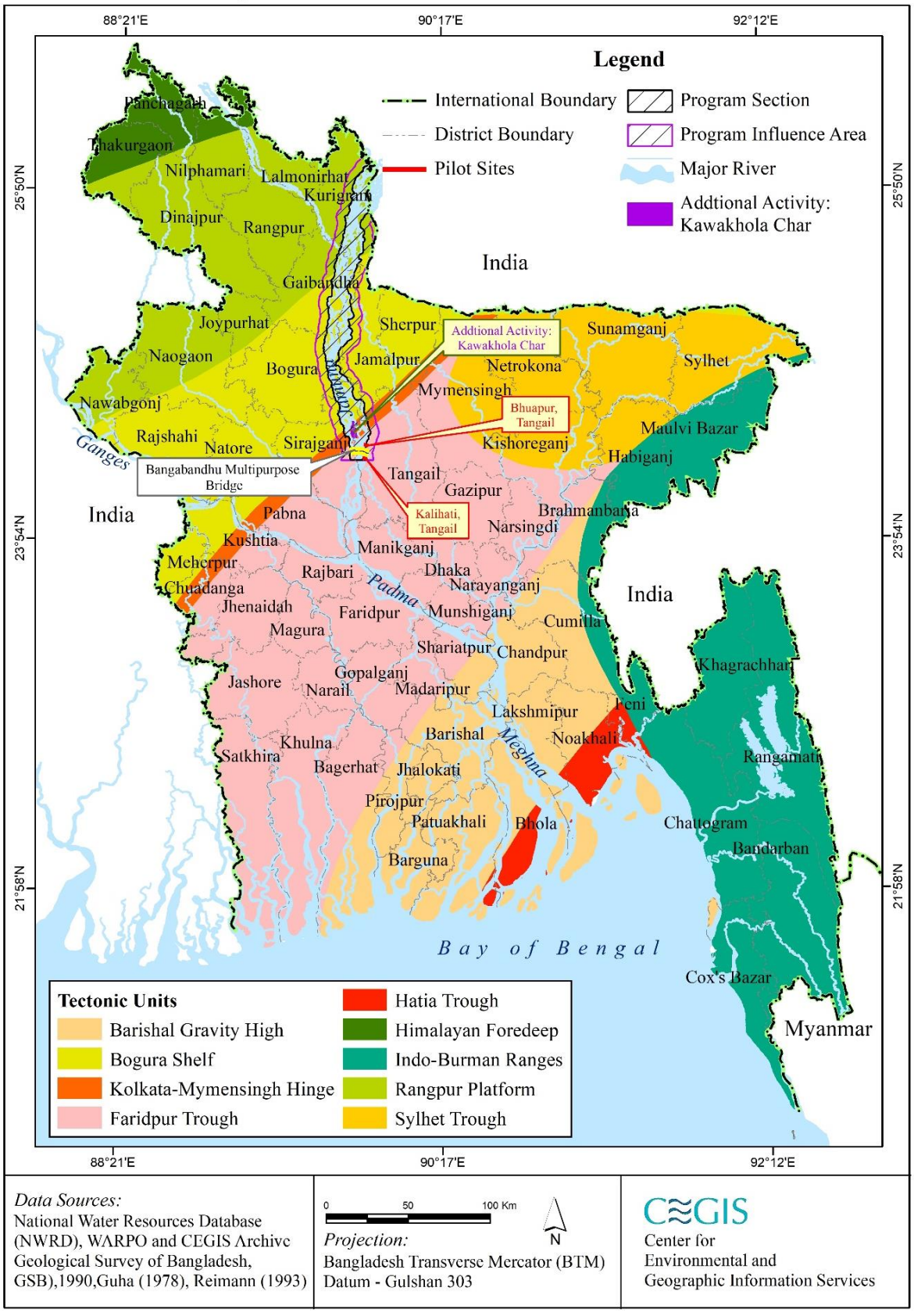


Figure 5.3: Tectonic Elements of Bangladesh and along the Program and EBAA

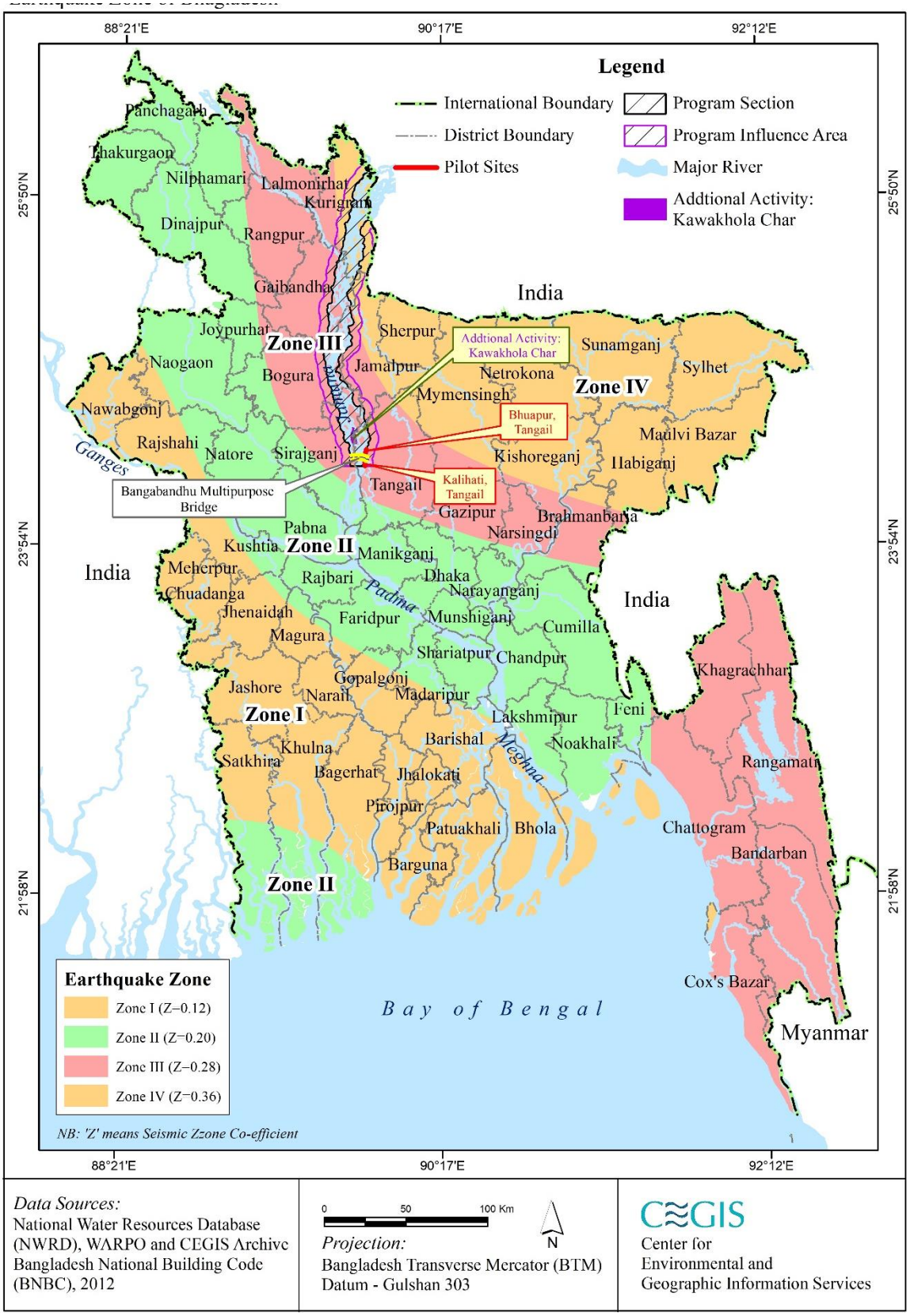


Figure 5.4: The Earthquake/Seismic Zones of Bangladesh and along the Program AOI and EBAA

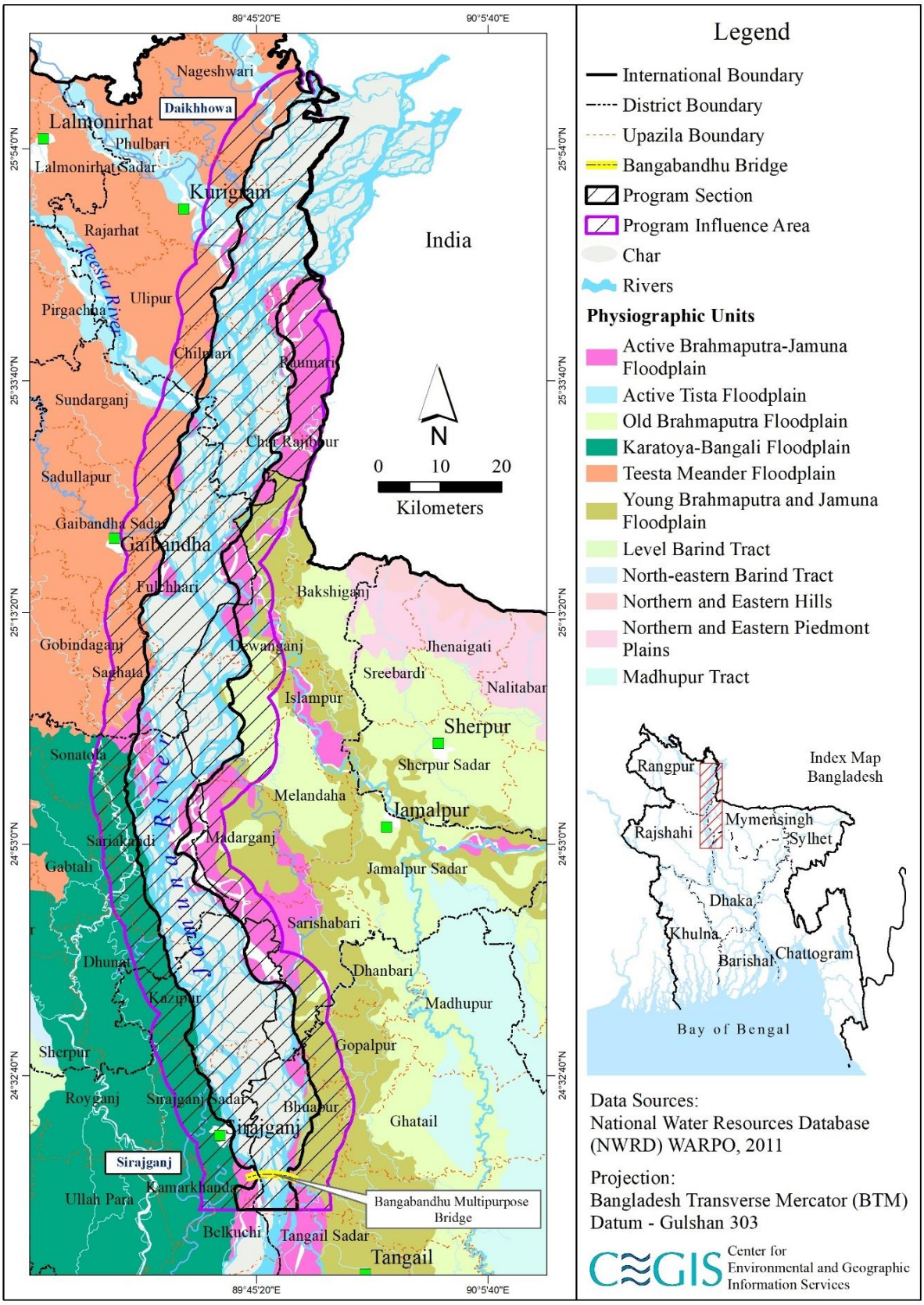


Figure 5.5: The Physiographic Units of the Program AOI and EBAA

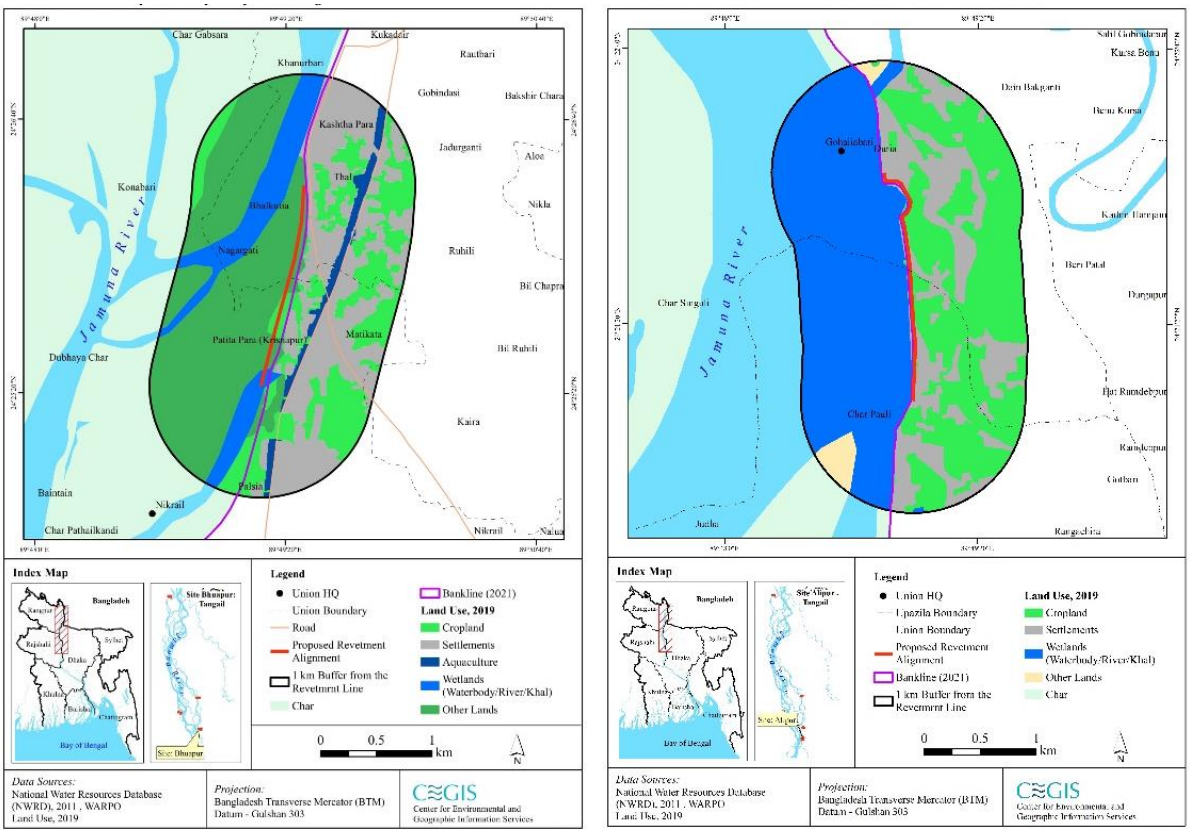


Figure 5.6: Landuse Patterns of the Project AOI of Two Sites

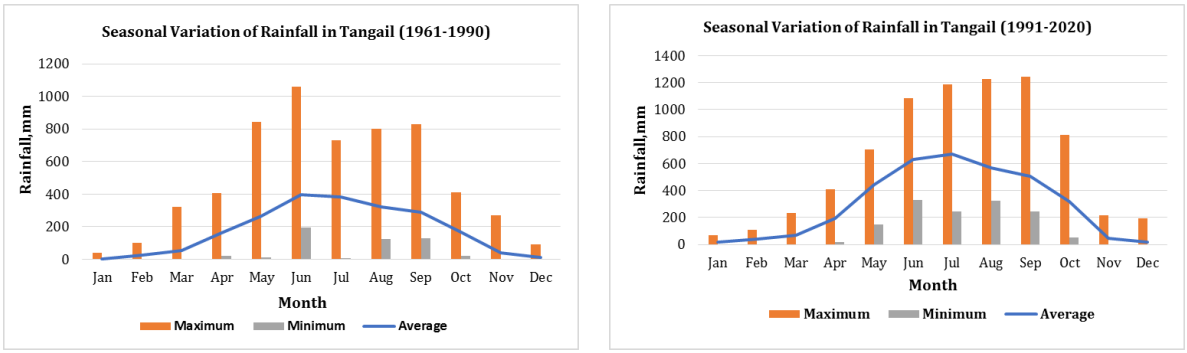
5.5 Climate and Meteorology

While the Program AOI mostly falls under the northern part of the northern region, north-western region and south-central region, the Project AOI falls under the south-western region. meteorological station for the project influence area.

Generally, the climate is sub-tropical with three seasons namely summer/pre-monsoon from March to May, monsoon from June to October, and winter season from November to February. Lower rainfall makes this area both atmospherically and pedagogically drier than the rest of the country. The rainy season is hot and humid with about 88 percent of the annual rainfall in the area. The winter is predominately cool and dry. The summer is hot and dry interrupted by occasional heavy rainfall, whereas monsoon comes in June and recedes in late October. Relevant meteorological data such as temperature, rainfall, and wind speed were collected from Tangail BMD station which is the nearest station to the project AOI.

5.5.1 Rainfall

The monthly maximum and average rainfall data of Tangail station for the last 59 years (1961-2020) was collected and analyzed, and is shown in Figure-5.7. During this period, the monthly maximum rainfall varied 10mm to 1200mm (Figure 5.7). There is a significant change in rainfall distribution pattern observed in last 30 years. Over the past decade, the maximum rainfall occurs in August and September, whereas August used to be the mostrainy month during 1961-1990 period (Figure 5.7). Over the past 59 years, the total annual rainfall varied from about 1000mm to nearly 5000mm (Figure 5.8). While the period 1961-1990 experienced increasing trend of rainfall, the 1991-2020 period has experienced a decreasing trend.



Source: Tangail BMD station

Figure 5.7: Monthly Maximum and Average Rainfall at Tangail BMD Station (1988-2017)

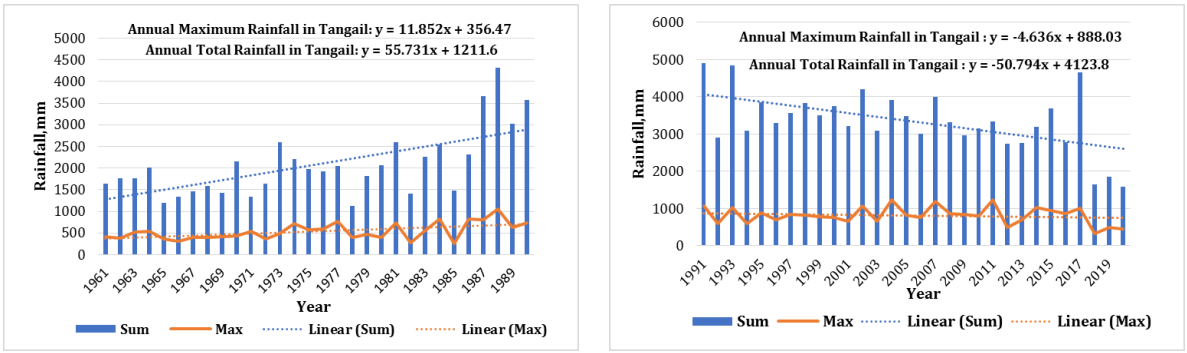
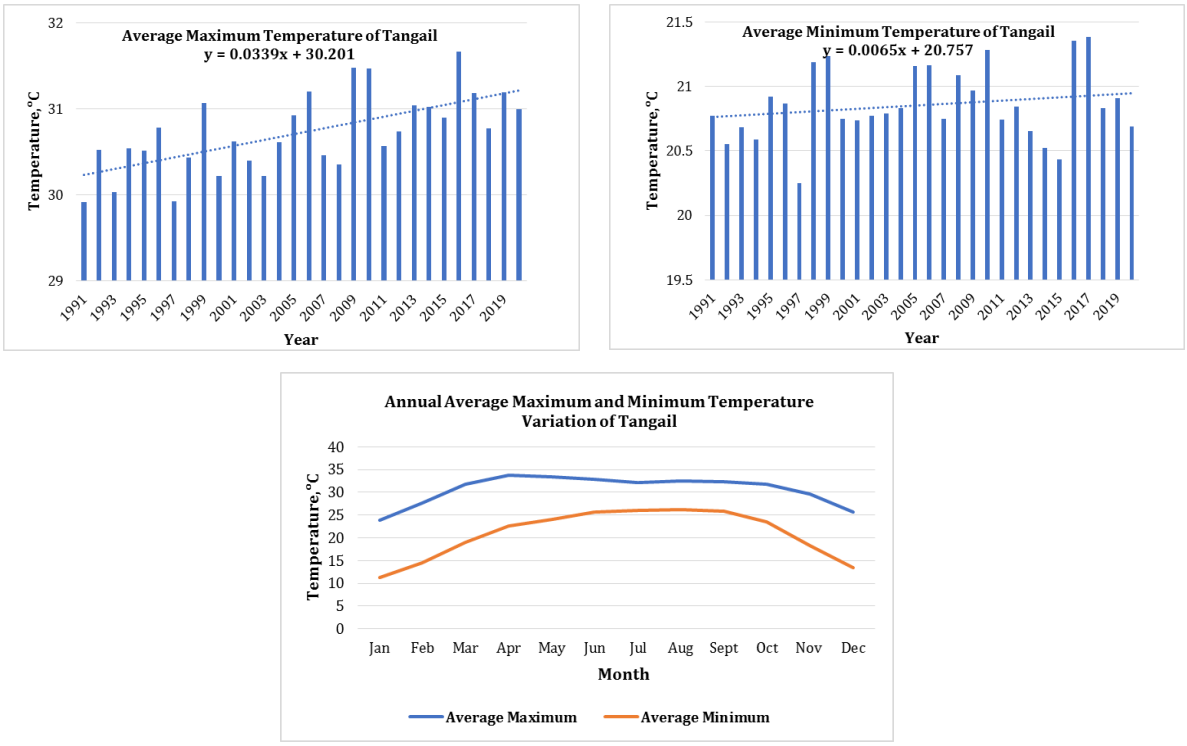


Figure 5.8: Annual Rainfall at Tangail BMD Station (1988-2017)

The extreme rainfall analysis shows that Tangail experienced more heavy and extreme rainfall than the other nearby BMD stations (i.e. Dhaka, Mymensingh, Faridpur and Cumilla). The record over the last 59 years shows that, at Tangail, there were 34 normal rainfall events with 100-200mm rain, 11 heavy rainfall events with 200-300mm rain and 7 extreme rainfall events with more than 300mm rain.

5.5.2 Temperature

The monthly average temperature data over the last 29 years (1991-2020) shows that the maximum temperature varies from 24.9°C to 34.9°C, with April being the warmest month, while the minimum temperature varies from 11°C to 25.1°C, with January being the coldest month. The monthly average of the maximum and minimum temperature of Tangail station are presented in Figure-5.9.

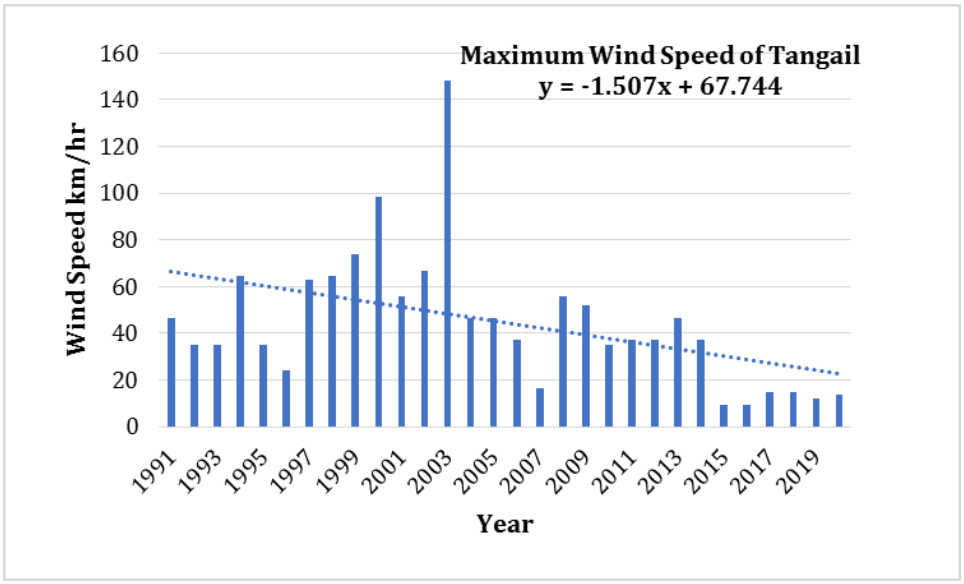


Source: Tangail BMD station (1991-2020)

Figure 5.9: Monthly Temperature at Tangail BMD Station (1991-2020)

5.5.3 Wind Speed

The data for maximum wind speed over the last 30 years (Figure 5.10 - 1991 to 2020) shows that the monthly maximum wind speed of 144 km/hr occurred in 2003.



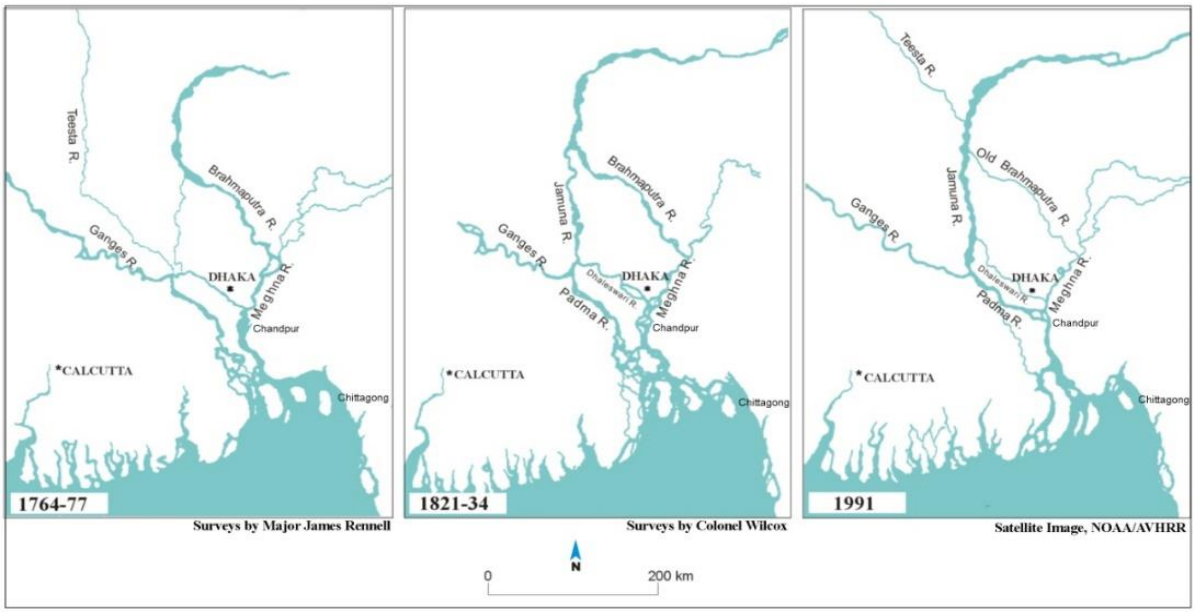
Source: Tangail BMD station (1991-2020)

Figure 5.10: Annual Maximum Wind Speed at Tangail BMD Station (1991-2020)

5.6 Jamuna River Morphology

5.6.1 Historical Development of Jamuna River

Historical development in the last 250 years indicates that the Brahmaputra River was flowing east of the Madhupur Tract along the present course of the Old Brahmaputra River as shown by Major Rennell in the eighteenth century. Subsequently, the main flow was diverted to the west of the Madhupur Tract, as surveyed by Colonel Wilcox in the nineteenth century as shown in **Figure 5.11**. The new course is named as Jamuna River and presently it is following the same course. This avulsion of the river is due to the tectonic tilting of the Madhupur Tract and addition of the flow from the Teesta River by its sudden shifting from west to east (Source: Morgan and McIntire, 1959). However, this avulsion is not a unique event as stated by Goodbred and Kuehl in 2000, as the series of periodic movements of the river occurred in the Holocene period (10,000 years before).



Source: Sarker, M. H., 2009

Figure 5.11: Historical Development of the Brahmaputra-Jamuna River

5.6.2 River Planform Development

The Jamuna River is one of the most dynamic rivers in Bangladesh. The Jamuna is a classic example of a braided river system. It has multiple channels separated by numerous small sand bars and Chars lands. **Figure 5.12** shows in plan view a portion of the Jamuna in the dry season satellite image of 2020. The widest portion is about 13.8 km. A small portion is enlarged in the index map, where numerous Char lands with vegetation and unstable sand bars can be seen.

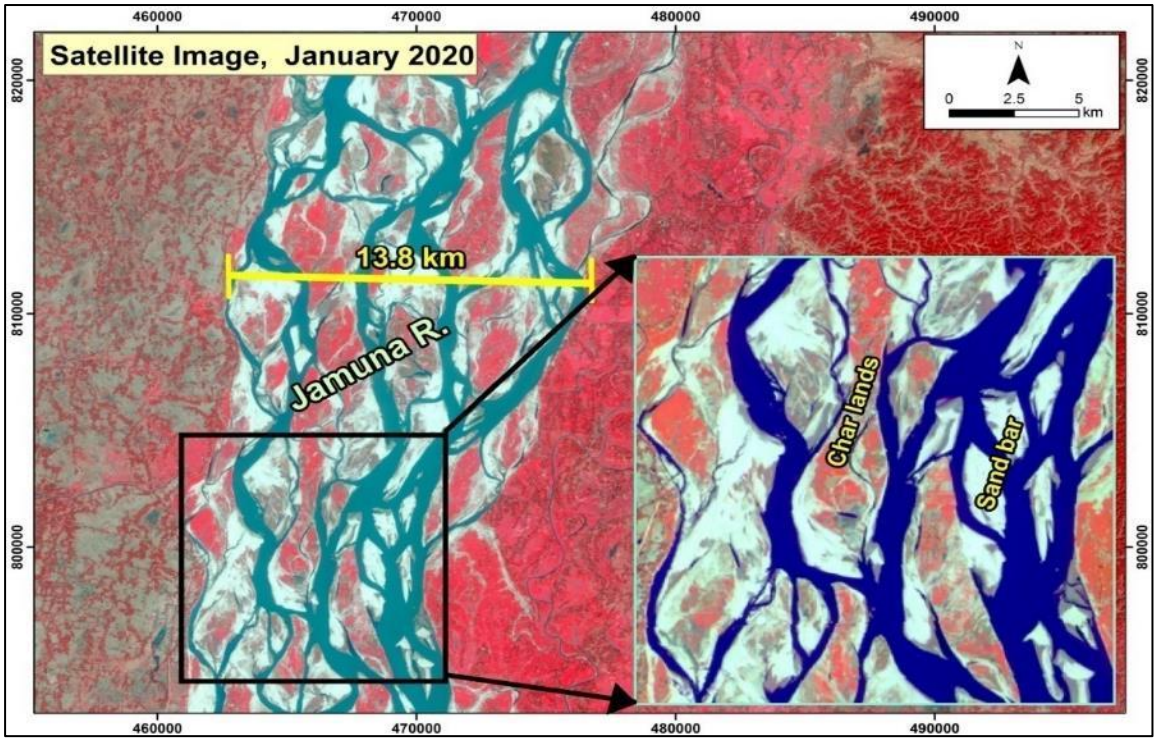


Figure 5.12: Planform of Jamuna River having Braided Characteristics

The Jamuna is a very dynamic river where migration of channels and shifting of banklines occur frequently. It is so dynamic that visible changes can be found even within a year. **Figure 5.13** shows in planview of a portion of Jamuna for four consecutive years. All the wide and narrow channels show changes in their courses each year which makes the system very complex. Also, the shape of Char lands changes with the change of channels. This illustrates the dynamic nature of the Jamuna River and how a channel may decline or develop within one season.

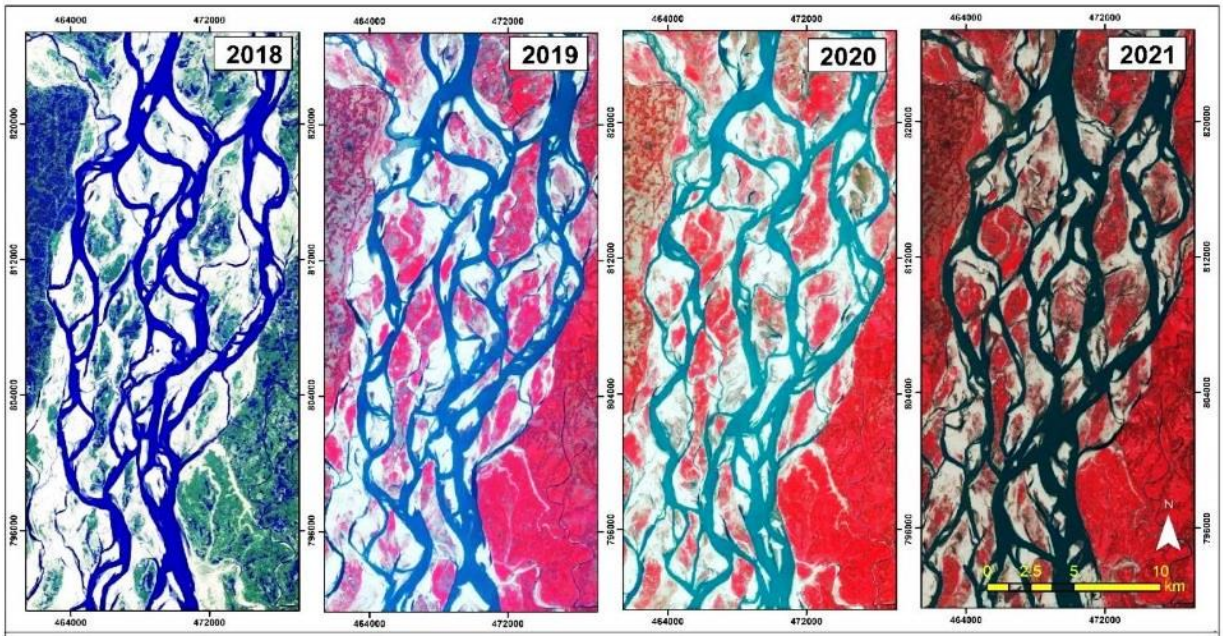


Figure 5.13: Changes in Planform of Jamuna for the Last 4 Years

5.6.3 Width of the Jamuna River

Widening of the river has been very significant over the last 46 years as the width has increased from 8.0 to 12.0 km on average (**Figure 5.14**). The 1950 Assam Earthquake had a massive impact in the planform changes of the Brahmaputra-Jamuna River as studied by Sarker and Thorne in 2006. Landslides due to the earthquake generated 50 billion m^3 of sediment which eventually added to changes in river planform of Jamuna and Meghna estuary. Mainly coarse sediment (sand portion) played a significant role to alter the morphology in the next 50 years from 1950 Assam earthquake which propagated gradually as a sand wave to the Bay of Bengal. This additional input of sediment made the river more dynamic and dissipated its energy by the process of the river widening.

Moreover, it has been observed that the river shows a trend of increased widening between 1970 and 2010. In the most recent decade, the average width of the river has remained stable.

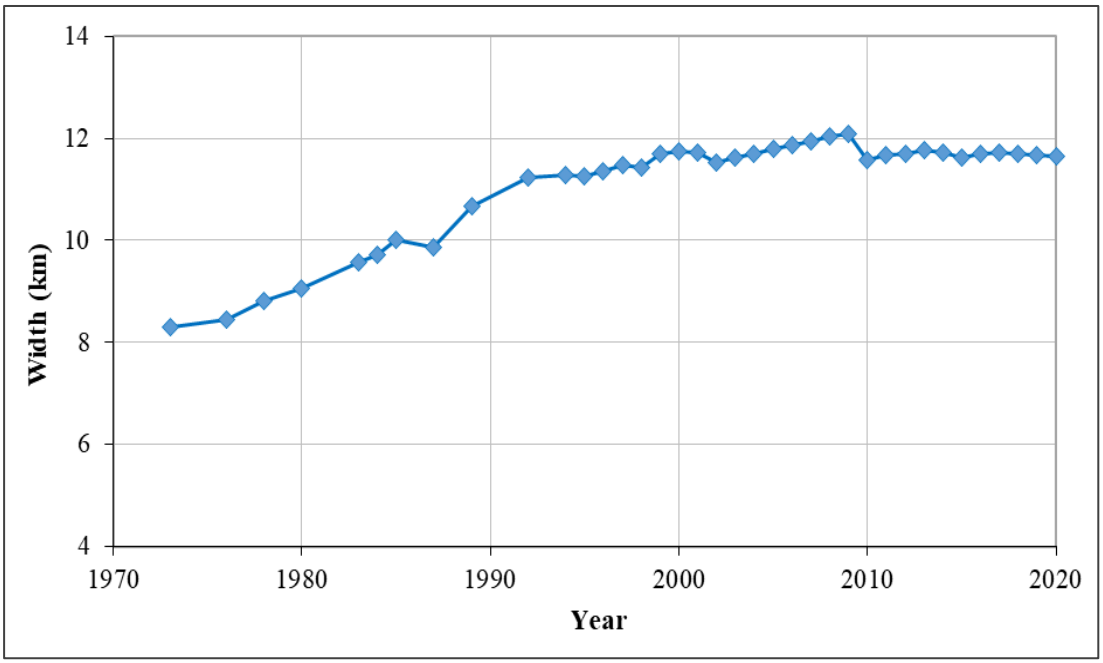


Figure 5.14: Average Width of the Brahmaputra-Jamuna River since 1970 Over Time

5.6.4 Char Dynamics

Char Dynamics in the Brahmaputra-Jamuna River is interrelated with the bank erosion processes, widening and narrowing of rivers. Development of Char within the riverbank affords land for settling of people and cultivation in the Char for maintaining their livelihoods. Widening of the river increases Char area. Char area has increased about 18% in 2016 compared to 1973 (about 76,000 ha) (**Figure 5.15**). Widening of the river caused increasing trend of the Char area. However, the widening process has slowed down recently. This does not mean the formation of Char will stop. Rather loss of Char in one area may compensate to other areas within the riverbank. Additionally, Char dynamics is directly related to livelihood and living standard of Char Dwellers in the Brahmaputra-Jamuna River. With the growing human population density in Bangladesh people have been forced to live in Char areas of the river. With the increase in Char areas since 1993 there has been an increase in the Charland population density in the recent time compared to early 1990's.

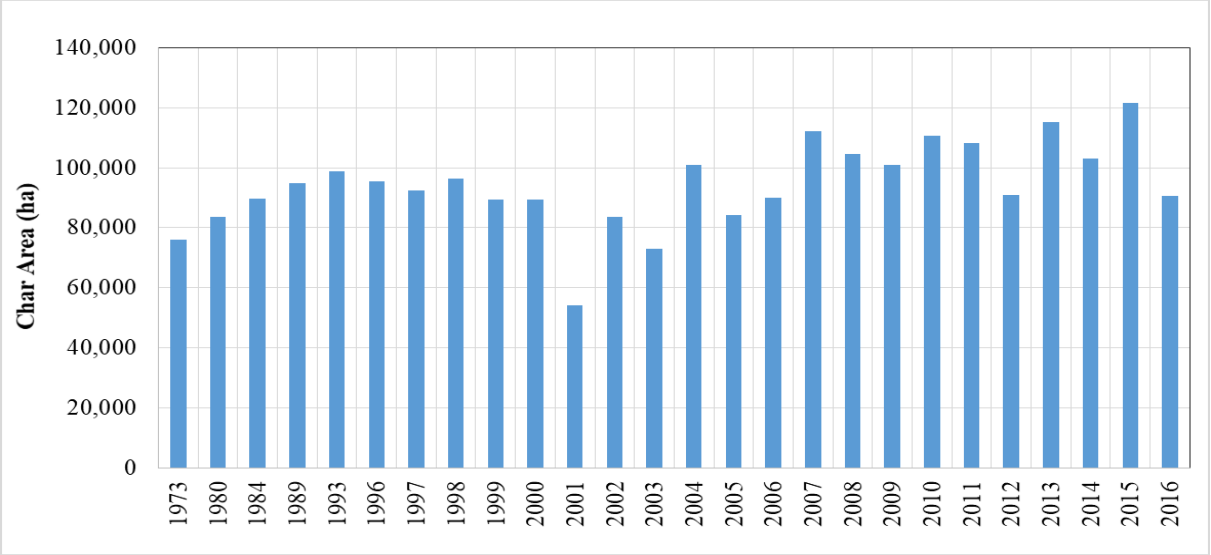
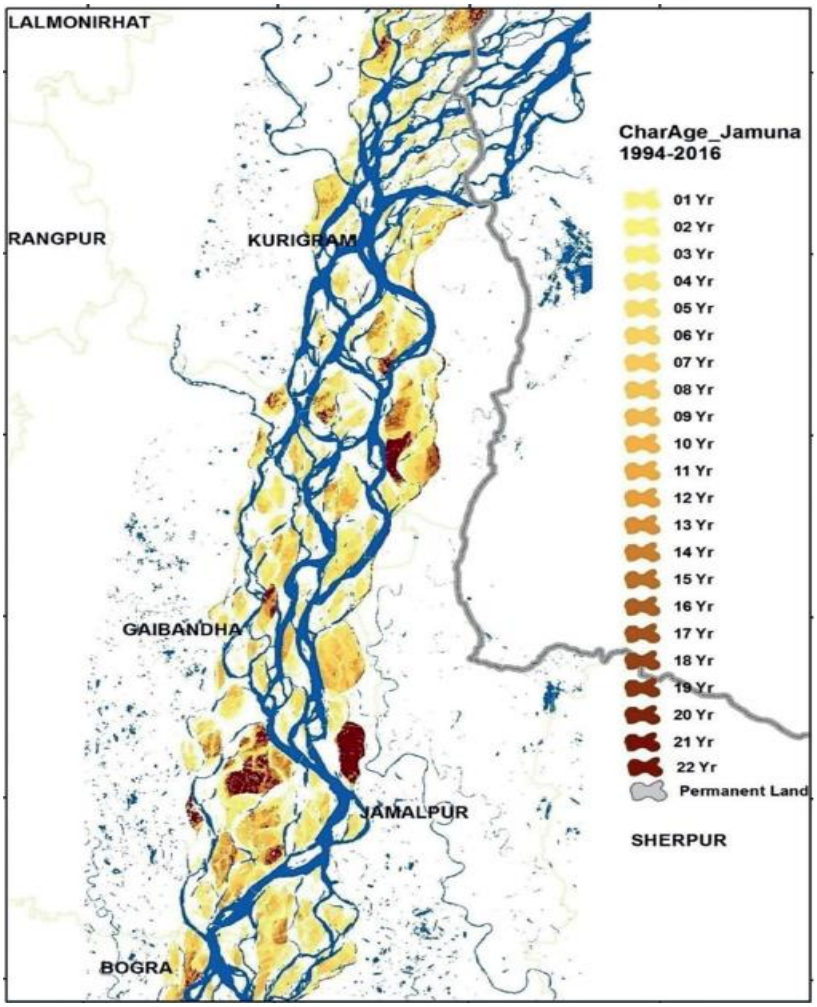


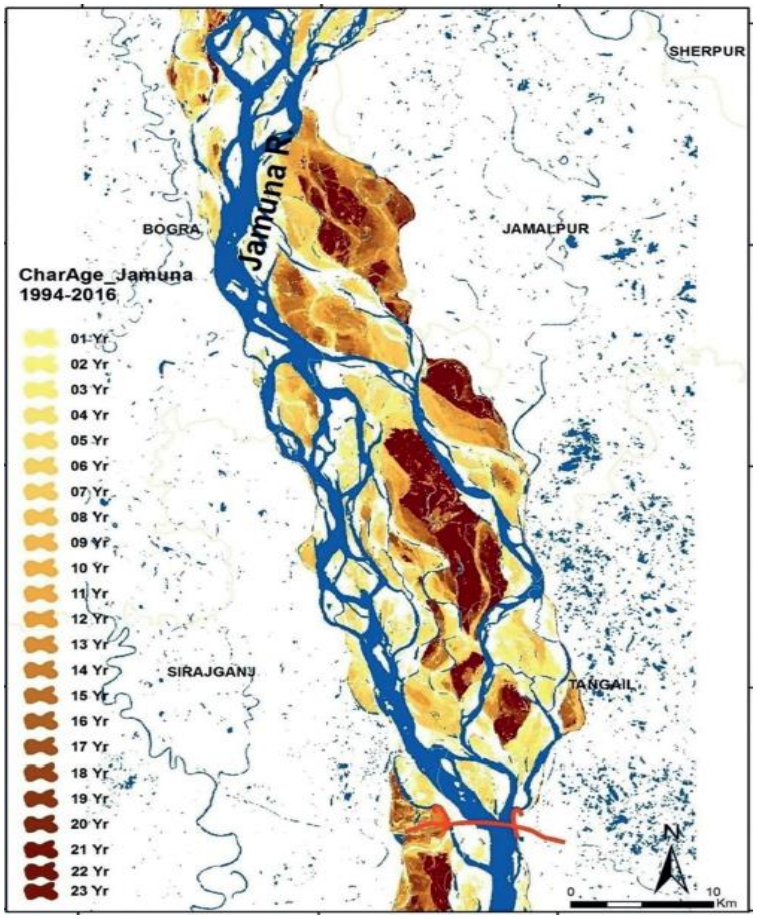
Figure 5.15: Char Area of the Brahmaputra-Jamuna River Over Time

The age of Chars of the JamunaRiver from its entry to Bangladesh to Bangabandhu Bridge was calculated by the FRERMIP study in 2019. Mainly Char age was calculated for the period 1994-2016 **(Figure 5.16 and Figure 5.17).**



Source: FRERMIP 2019

Figure 5.16: Char Age of the Jamuna River (Upstream)



Source: FRERMIP 2019

Figure 5.17: Char Age of the Jamuna River (Downstream)

5.6.5 Erosion and Accretion Analysis

Jamuna is a highly erosion-prone river. The average rate of bank erosion was assessed during the period from 1973 to 2020 at different time intervals for the study reach from the Bangladesh-India border to Sirajganj. This reach is about 160 km long. Both left and right banks are experiencing considerable erosion every year.

For the assessment of the erosion along both banks of the Jamuna River on a decadal basis, Landsat Satellite images of 1973, 1980, 1989, 2000, 2010 and 2020 were collected. After that, satellite images were geo-referenced. Afterward, images were co-registered with each other to avoid distortion from one image to another image.

Banklines were then delineated using satellite images from each year. Next, banklines were superimposed with each other to identify the locations of vulnerable areas along both banks of the river for different time periods from 1973 to 2020 (Figure-5.18). At the same time, erosion-accretion rates were calculated using Arc-GIS tool of Remote Sensing techniques. Table-5.1 and Table-5.2 show the amount of erosion and accretion for riverbanks on both sides of the river and the total rate of erosion and accretion for different time periods, respectively.

Table 5.1: Erosion of the Jamuna (from Bangladesh-India border to Sirajganj) during 1973-2020

Year	Erosion at Left Bank (ha)	Erosion at Right Bank (ha)	Total Erosion (ha)	Erosion rate (ha/year)
1973-1980	11,820	8,030	19,850	2,835
1980-1989	12,840	16,250	29,090	3,230

1989-2000	11,460	10,430	21,890	1,990
2000-2010	6,340	4,660	11,000	1,100
2010-2020	5,380	4,310	9,690	970

Table 5.2: Accretion of the Jamuna (from Bangladesh-India border to Sirajganj) during 1973-2020

Year	Accretion at Left Bank (ha)	Accretion at Right Bank (ha)	Total Accretion (ha)	Accretion rate (ha/year)
1973-1980	3,110	5,500	8,610	1,230
1980-1989	7,020	7,30	7,750	860
1989-2000	7,840	1,240	9,080	825
2000-2010	9,990	3,010	1,3000	1,300
2010-2020	3,020	1,050	4,070	405

It was observed that the left bank eroded more than the right bank for the observed time periods in this study reach. the highest erosion rate of 3230 ha/year was observed during 1980-1989. Since then, erosion decreased along both banks and was only 970 ha/year in the recent decade. This illustrates that the erosion rate of the Jamuna River from its entrance (inside Bangladesh) to Sirajganj reach shows a decreasing trend (**Figure 5.19**).

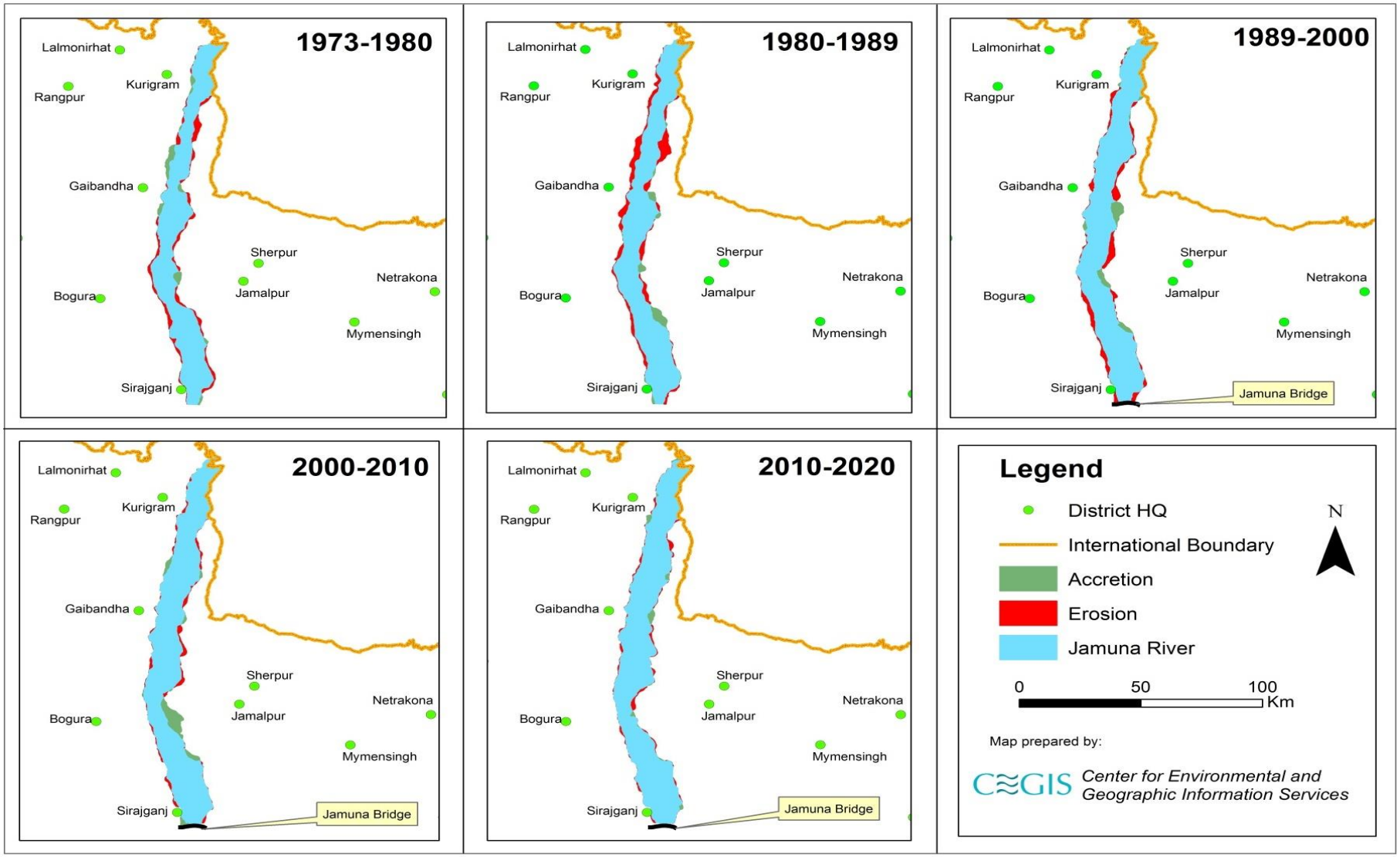


Figure 5.18: Erosion and Accretion of Jamuna River within Program AOI during 1973 to 2020

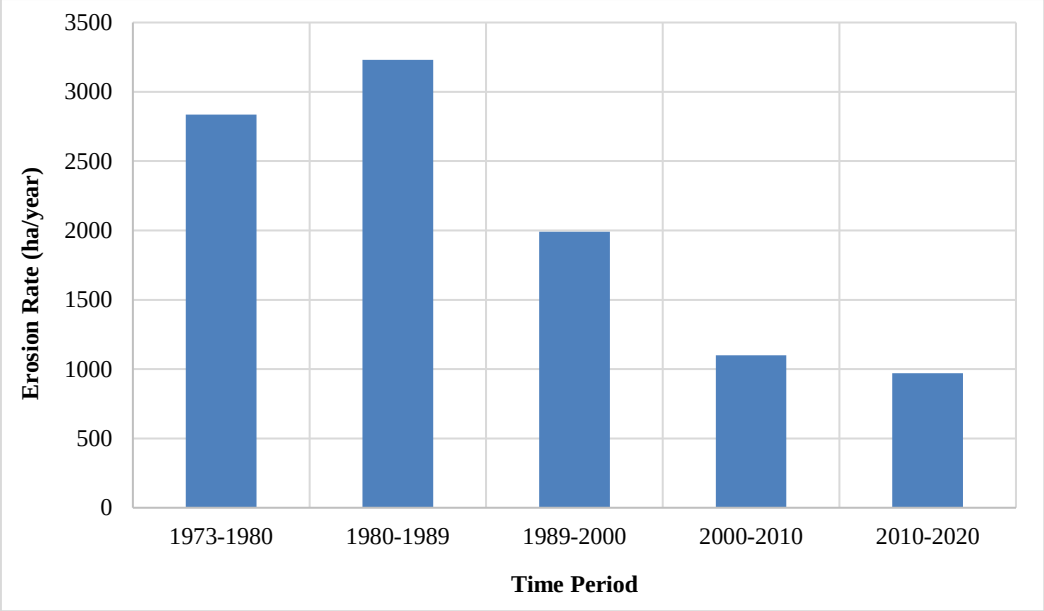


Figure 5.19: Historical Erosion Rate of the Study Reach of Jamuna River since 1973

Comparatively, more land was accreted on the left riverbank than on the right bank. The high rate of accretion has been observed for the 2000-2010 and 1973-1980 time periods and with rates of accretion at 1300 ha/year and 1230 ha/year, respectively.

5.7 River Morphology at C I Sites

5.7.1 Changes in Average Width

Jamuna River has increased in width over the last few decades. The increase of width can also be observed in the pilot sites. To assess the increase in width, 10 km reaches for every site have been considered, where 5km of upstream and 5km of downstream were counted from the location.

After delineation of banklines, a 10 km reach for each of the two pilot sites was marked separately by GIS tools. Then widths of a few sections from each reach were measured and finally the average of those widths was calculated. Thus, average widths were calculated for different years from 1973 to 2020. The average width of the sites for different years is provided in Table-5.3.

Table 5.3: Average Historical Width of 10 km Reaches at Two Pilot Sites

Pilot Site	Average Historical Width of Jamuna River at four Pilot Sites (km)					
	1973	1980	1989	2000	2010	2020
Bhuapur	8.1	8.5	8.4	11.1	10.2	9.9
Kalihati (Alipur)	4.8	4.8	5.8	8.9	7.7	7.6

5.7.2 Erosion and Accretion

For the assessment of erosion and accretion in pilot sites, 10 km reach (5 km upstream and 5 km downstream) has been considered for each site. The details of erosion-accretion analysis of all four sites are provided below.

Bhuapur

Table-5.4 and Table-5.5 show historical erosions and accretions of 10 km reach at Bhuapur, respectively. The left bank of the Jamuna (Bhuapur) is highly erosion prone here. The highest rate of erosion at 120 ha/year was observed during the period from 1989 to 2000 which reduced to 5 ha/year in the recent period of 2010-2020. While the amount of accretion is relatively less than erosion at Bhuapur, The highest

accretion rate at 60 ha/year was observed in the period from 1973 to 1980. **Figure 5.20** shows erosion and accretion of Bhuapur for different time spans. The Digital Shore line Analysis System run by the Feasibility Study Team has shown that within the dry period of 2018 to the recent post-monsoon period of 2021, the erosion-rate along the pilot reach has been approximately –minus 27 m/year while it was nearly – minus 32.4 m/year along the riverbank of Gobindashi and –minus 48.33 m/year near the Jamuna bridge guide bund.

Table 5.4: Erosion of 10 km Reach of the Jamuna River at Bhuapur

Year	Erosion at Bhuapur (Left Bank), ha	Erosion rate (ha/year)
1973-1980	720	100
1980-1989	930	100
1989-2000	1305	120
2000-2010	410	40
2010-2020	50	5

Table 5.5: Accretion of 10 km Reach of the Jamuna River at Bhuapur

Year	Accretion at Bhuapur(Left Bank) ha	Accretion rate (ha/year)
1973-1980	420	60
1980-1989	10	1
1989-2000	0	0
2000-2010	25	2
2010-2020	315	30

Alipur of Kalihati and Tangail Sadar

Table-5.6 and Table-5.7 show historical erosions and accretions of 10 km reach at Alipur, respectively. This site experienced highest erosion during 1989-2000 at a rate of 180 Ha/year. Figure 5.21 shows erosion and accretion of Alipur for different time spans after 2000, the rate of erosion decreased as the guide bund of Jamuna Bridge (1998) has protected some areas in this 10 km region. The highest accretion rate at 60 ha/year ocuured in 1973-1980 and there was no accretion from 1980 to 2010. An accretion rate of 7.5 ha/year was observed for the most recent decade.

Table 5.6: Erosion of 10 km Reach of the Jamuna River at Alipur, Kalihati

Year	Erosion at Alipur (Left Bank), ha	Erosion rate (ha/year)
1973-1980	230	30
1980-1989	1220	135
1989-2000	1960	180
2000-2010	250	25
2010-2020	110	10

Table 5.7: Accretion of 10 km Reach of the Jamuna River at Alipur, Kalihati

Year	Accretion at Alipur (Left Bank), ha	Accretion rate (ha/year)
1973-1980	430	60
1980-1989	0	0
1989-2000	0	0
2000-2010	0	0
2010-2020	75	7.5

This site has faced a high degree of riverbank erosion since 2016, especially at the downstream end of the new Dhaleshwari offtake due to the thalweg shifting towards the left bank-line, which resulted from the downstream movement of the right-bank Char system near the Jamuna River Multi-Purpose Bridge. DSAS analysis carried out by the Feasibility Study shows that while the average rate of erosion at the most erosion-prone reach (d/s of the new Dhaleshwari offtake) was nearly –minus 30.425 m/year from 2016 to 2019, it became approximately –minus 144.43 m/year from 2020 to 2021. Almost the entire reach was exposed to significant to severe degree of erosion along the bank-line, which expanded significantly during the last one and half years of analysis (From March 2020 to October 2021). Some existing bank protection works like revetments, CC block and geo-bag dumping works have been carried out, but several failure points have been observed here as well. Figure 5.22 illustrates the existing local conditions and protection works and erosion extent in the site at Alipur, Kalihati.

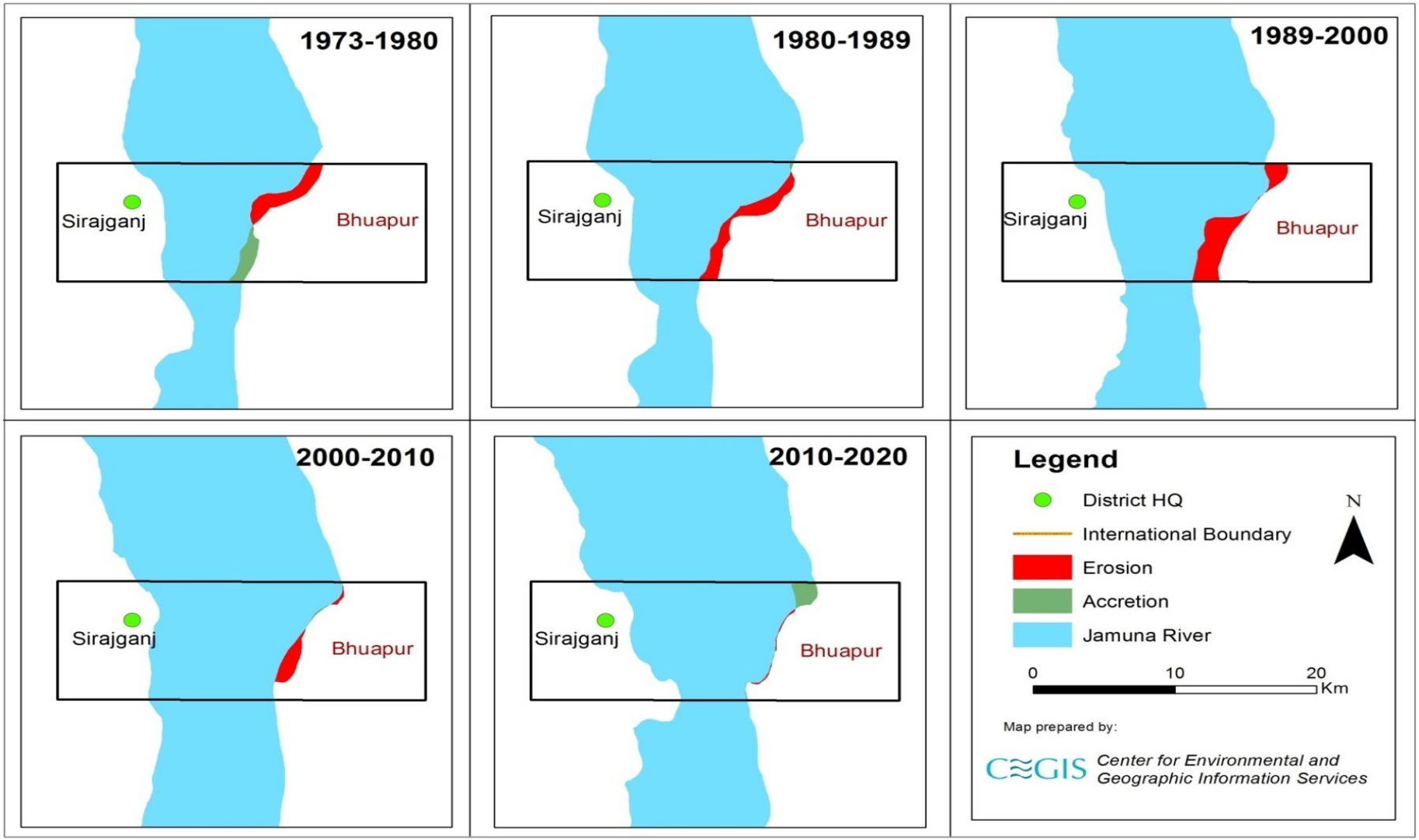


Figure 5.20: Erosion and Accretion of 10 km Reach of the Jamuna River at Bhuapur

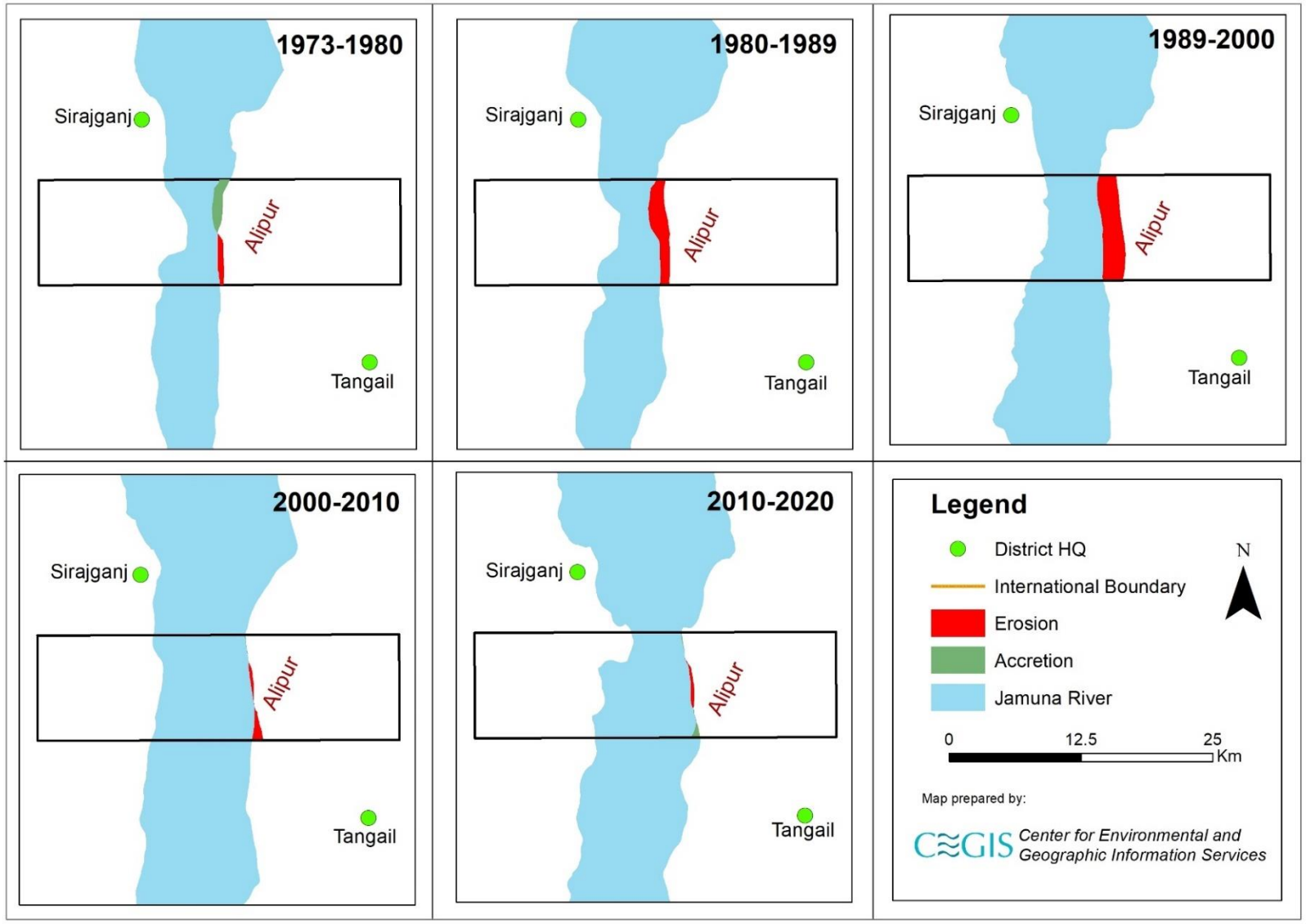
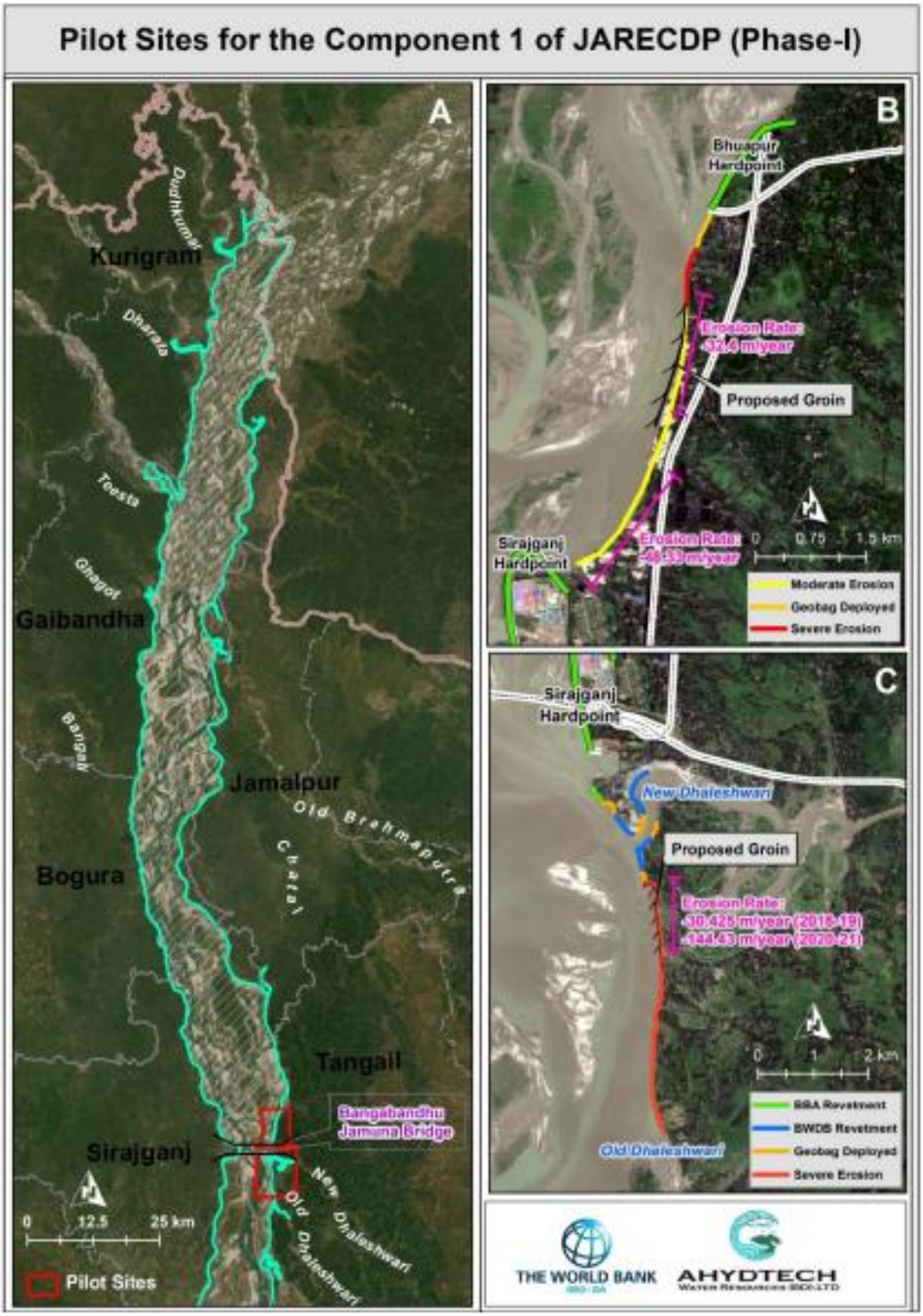


Figure 5.21: Erosion and Accretion of 10 km Reach of the Jamuna River at Alipur, Kalihati



Source: Feasibility Study Report

Figure 5.22: Existing Erosion Pattern at Two Piloting Sites

5.8 Riverbank Stabilization Practices along the Jamuna River

Riverbank protection or stabilization is a very expensive process. Hence, protective works are usually considered for very critical areas and areas with high land-use values. Bank protection structures along the Jamuna River were started in Bangladesh from 1963. Most of them involve groynes/spurs and revetment. The major large bank protection structures were constructed in the 1990s and included the Kamarjani permeable groynes, guide bunds for the Bangabandhu Bridge, Sirajganj Hard Point, hard points of Sariakandi and Mathurapara, Kalitola groyne, Bahadurabad revetment, and Bhuapur revetment. Table-5.8 and Table-5.9 show the overall condition of various structures along the right and left banks of the Jamuna River, respectively.

In the most recent decade, several major revetments were constructed along both banks of the Jamuna River for the management of the river and to reduce riverbank erosion. These include Koijuri Revetment, PIRDP Revetment, Chauhali Revetment, and Zafarganj Revetment.

Recently Bangladesh Water Development Board (BWDB) prepared a River Stabilization Plan of the Jamuna River under the project Flood and Riverbank Erosion Risk Management Investment Program (FRERMIP) where revetments were proposed including land reclamation (**Figure 5.23**). In addition to that, future embankment, dredge location, spill channel, alluvial and imposed floor corridor were suggested. It was projected that about 117,900 ha of land will be reclaimed if the proposed river stabilization works are implemented – creating land which could be used for development, settlement, commercial and other necessary purposes for the development of economic growth of the country.

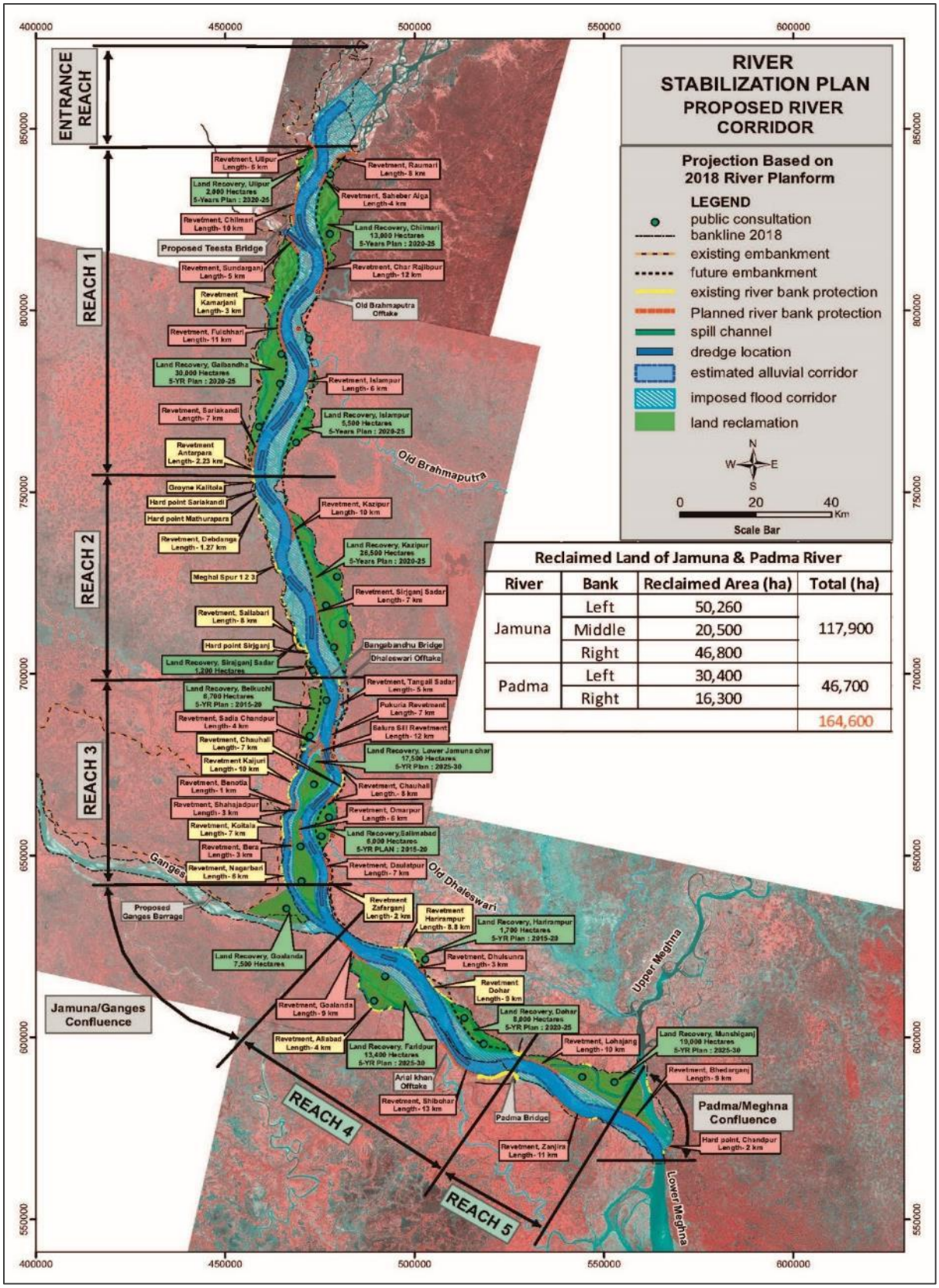


Figure 5.23: River Stabilization Plan by FRERMIP

Table 5.8: Bank Protection Structures along the Right Bank of the Jamuna River

Name of structure	Construction period	Exposed to the flow		Comments
		Minor Channel	Major channel	
Kamarjani permeable groyne	1994-95		1995	Major damages
Hasnapara Spur 1	2001-02	2002-03		Performance is not clear as it does not exposed to main channel
Hasnapara Spur 2	2001-02	2002-03		Performance is not clear as it does not exposed to main channel
Titparal Revetment	2005-06		2005-11	Minor damages but effective
Kalitola	1997-98		1997-11	Minor and major damages but effective
Sariakandi	1997-98		1997-11	Effective
Mathurapara	1997-98		1997-07	
Debdanga Revetment	2005-06		2005-08	Minor damages
Chandanbaisa (belmouth)	2001-02		2002-08	Damaged
Baniajan Spur	2001-02	2002-03		Erosion at the slope of the approach embankment in 2021
Meghai Spur 1	1999-00	2000-01	2004	Damaged in 2004
Meghai Spur 2	1999-00	2000-01		
Meghai Spur 3	1999-00	2000-01		
Singrabari Spur 1	1998-99		2002-03	Exposed for one year, damaged
Singrabari Spur 2	1998-99		2002-03	Damaged in 2002
Shuvagacha Spur 1	1999-00		2002-03	Damaged in 2002
Shuvagacha Spur 2	1999-00		2002-03	Damaged in 2003
Simla Spur 1	1999-01		2003	Damaged in 2003
Simla Spur 2	1999-01		2005	Exposed for one year
Simla Spur 3	1999-01		2002	Damaged in 2002
ShailabariGroyne	1980-81		1997-04	Damaged in 2004
Sirajganj Revetment	1997-98		1998-11	Minor damages, effective
Bangabandhu Bridge Right Guide Bund	1996-98		1996-11	Effective
Betil Spur	2000-02	2001-04		Damaged in 2004, after repairing damaged again 2007
Enayetpur Spur	2000-02	2001-04		Damaged in 2004, repaired in 2006
PIRDP, Geobag revetment	2004-06		2004-11	Effective
JMREMP Geo-bag revetment	2010			status is not available
FRERMIP, Project 1 (Koijuri)	2018-2020			recently completed

**Major channel: Perennial channel, Minor channel: Ephemeral channel; (Source: Sarker et al. 2011 and FRERMIP website)*

Table 5.9: Bank Protection Structures along the Left Bank of the Jamuna River

Name of structure	Construction period	Exposed to the flow		Comments
		Minor Channel	Major channel	
Bahadurabad Revetment	1996-97		1997-98 2008-11	Effective
Ghutail	1999-00		20003-04 2007-11	Major damage, Effective
Pingna	2005-06	2005-06		Exposed only to the minor channel
Nolin bazaar	2001-02	2002-03		Rate of erosion was small
Bhuapur Revetment	1996-97	1998-99		
Bangabandhu Bridge Left Guide Bund	1997-98		1998-11	Effective
Chauhali Revetment	2018-2020			still effective
Jafarganj Revetment	2018-2020			still effective
Harirampur Revetment	2018-2020			still effective

Source: Sarker et al. 2011, FRERMIP website, BWDB

5.9 Operation and Management of Navigation along the Jamuna

The Brahmaputra-Jamuna system was used for navigation popularly from Meghalaya-Assam to Bangladesh. Even before the Second World War, channels were continuously dredged using a dredger. There were several passenger and cargo berthing places along both banks of the Jamuna River. Sirajganj is an important station within the study reach. Chilmari was also an important inland port for the northern part of Bangladesh, but is no longer operational.

The Study reach of Jamuna is also included in the Routes under the Protocol on Inland Water Transit and Trade between Bangladesh and India. This portion is included in different routes, i.e., Kolkata-Raimangal-Mongla-Kawkhali-Barisal-Chandpur-Mawa-Aricha-Sirajganj-Chilmari-Daikhawa-Dhubri-Pandu-Silghat and back, and a second route – Karimganj-Ashuganj-Chandpur-Mawa-Aricha-Sirajganj-Chilmari-Daikhawa-Dhubri-Pandu-Silghat and back. To establish railway communication from Dhaka, the British Government introduced ferry service from Bahadurabad Ghat in Jamalpur to Teestamukh Ghat in Gaibandha in 1938. After the devastating flood of 1988, the station was relocated from Teestamukh Ghat to Balashi Ghat due to lack of navigability at the former station site. This popular ferry service has been inactive since 2004 due to heavy siltation and lack of navigability of the Jamuna River.

The annual average low flow of the Jamuna River is about 4,000 m^3/s which has the potential to keep the river fairly navigable even during the dry season. However, the braiding Characteristics make the channel very dynamic and shallow. The channel development/abandonment in a year is a very common process in this river. Reducing the navigability in one channel and developing the same in another channel may occur within a few weeks to a few months. Migration of bank lines and shifting of channels may be several hundred meters to a kilometer in a year. Moreover, the siltation rate is very high and may be more than 100% in some places. This results in the cost of maintenance dredging being higher than capital dredging. It is very difficult to fix one navigation route in the Jamuna River. These Characteristics make navigation uncertain and difficult.

During the last decades the braiding and width of the river have increased and, subsequently, depth and stability of the braided channels have decreased. Due to this phenomenon, regular maintenance dredging is required for smooth navigation. Though the recurrent maintenance dredging works well in the lower reaches, it could not yield effective results in upper reaches. For maintaining the Protocol Route, Bangladesh Inland Water Transport Authority (BIWTA) installs bundling at critical locations every year. But it has limitations on the extent of improving the depth and it has slowed process of improvement. It might be better to apply this to the smaller channels that have less flow velocity.

Although the formal navigation is limited, the informal navigation by country boats is immense in the Jamuna River. Several hundred thousand people are living in the Chars of the river. The only means of communication for these people and to transport their usable commodities is informal navigation. The informal navigation also connects the people living along both banks of the river. Navigation is also serving their trade and transportation of agricultural products. This informal navigation is very risky and causes many causalities every year.

Even with many challenges, the Jamuna River has tremendous potential for navigation. Comprehensive river management measures such as dredging, bank protection, and river training works may improve the existing navigation in the Jamuna River.

5.10 Hydrology of Brahmaputra-Jamuna River

5.10.1 Overview of River Network

The hydrology of the study area is mainly governed by the Brahmaputra-Jamuna River. The course of the Brahmaputra River from the international border between Bangladesh and India to the confluence with the Ganges near Aricha is referred to in Bangladesh as the Brahmaputra-Jamuna River. The Brahmaputra rises in the Great glacier in the Kailash range of the Himalayas in Tibet (China) at an elevation of 5150 meters. Locally named as Yaluzangbu, it flows eastward – parallel to the Himalayas – for about 1700 km, and along the northeastern corner of India, where it takes a sharp bend towards the south and southwest to enter Arunachal Pradesh (India) becoming the Siang or Dihang. After being joined by two tributaries – the Dibang and the Lohit – the river is known as the Brahmaputra and flows westward. During its course through Arunachal Pradesh and Assam, the Brahmaputra is joined by several tributaries including the Dhansiri, the Manas, the Sankosh from Bhutan and the Subansiri, the Kameng, and others from India along its right bank. It is also joined by several left bank tributaries including the Dihing, the Disang, and the Kopili, among others. After traversing about 700 km in a south-westerly direction in the Assam valley, the river turns south again to enter Bangladesh at Kurigram District. Thereafter it is joined by many tributaries flowing through the northern part of West Bengal (India) and northern Bangladesh – the principal ones among them are the Dudhkumar, the Dharla, and the Teesta. The Manas, Ghagot and Hurasagar rivers are also major tributaries of the Brahmaputra. Downstream of the Teesta, at Dewanganj, the Old Brahmaputra originates on the left bank of the Brahmaputra and the main channel flows as the Jamuna River until it reaches Aricha, where it combines with the Ganges to form the Padma River.

The total catchment area of the Brahmaputra is about 552,000 sq. km of which 195,000 sq. km lies in India (33.6%), 47,000 sq. km lies in Bhutan (7.8%), 270,900 sq. km lies in China (50.5%) and 39,100 sq. km lies in Bangladesh (8.1%).

In the EBAA, the water level in the Brahmaputra attains its peak in July-August and the lowest flow occurs in February. The Brahmaputra is a large braided and multi-channel river with an average width of over 12 km in the flood season. The length of the Brahmaputra-Jamuna River between the border and its confluence with the Ganges near Aricha is approximately 230 km.

The Jamuna River has a number of distributaries and tributaries. Dudhkumar, Dharla, Teesta, Ghagot, Badai, Kageshawari, Girai, Bangali are the tributaries of the Jamuna River while Manas is A distributary and Hurasagar is branch river of the Jamuna. All these rivers are interconnected by numerous channels (khals), tributaries and distributaries forming a hydrological network in the entire northwest region. For example, the Mahananda and Punorbhaba rivers, which are major rivers of the northwest region, are connected to the Atrai-Karatoya-Bengali system which drains to the lower Jamuna through the Hurasagar/Baral in the south east corner of the region. Figure 5.24 shows the water resource system within the Program Area while the **Figure 5.25** shows the River Network of Jamuna.

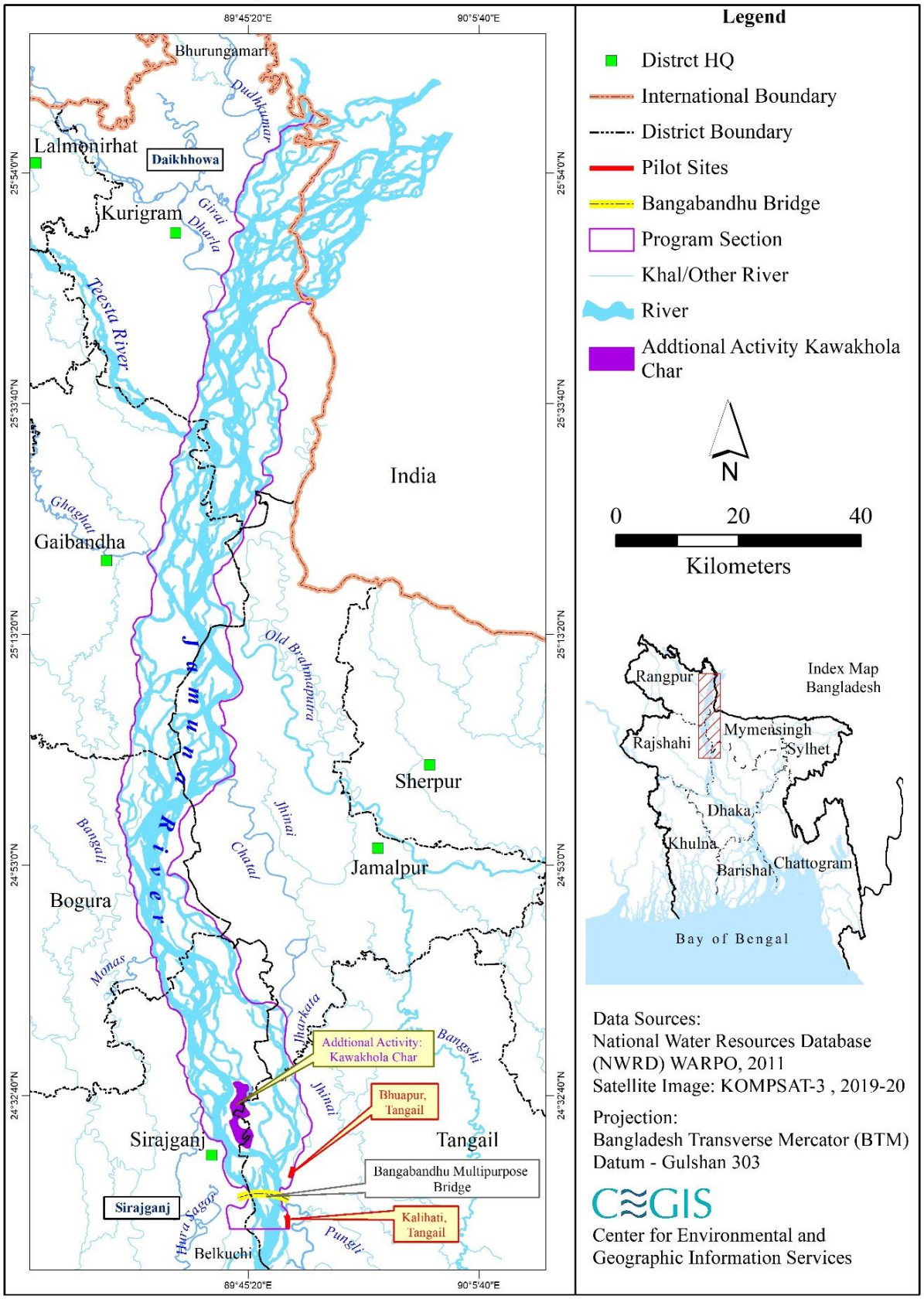
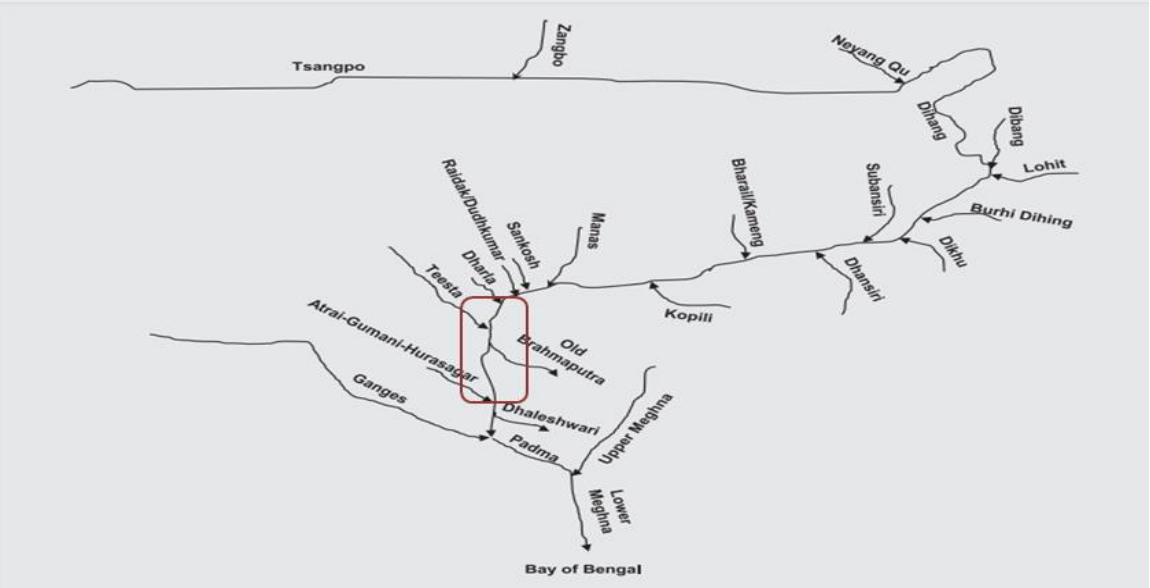


Figure 5.24: Water Resource System of the Study Area



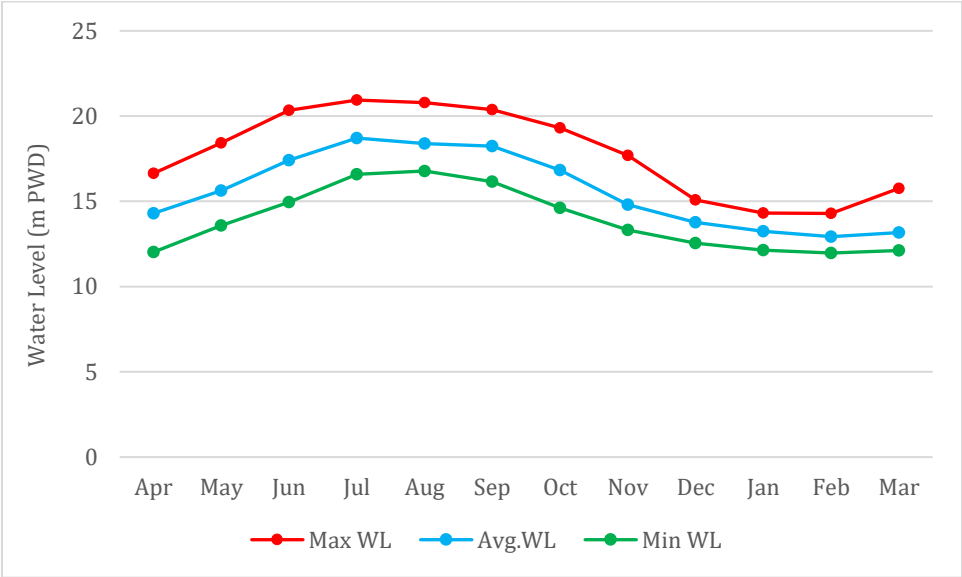
Source:(Mahanta et al., 2014)

Figure 5.25: Jamuna River Network (Brahmaputra River Basin)

5.10.2 River Water Level

Water Level at Bahadurabad Transit Station

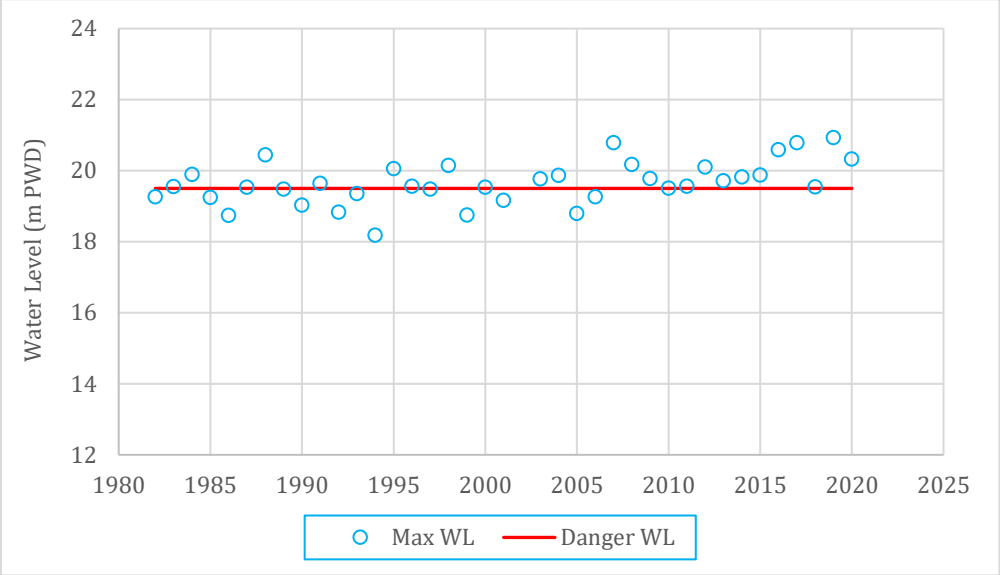
The water level data of the Bahadurabad Transit (Station No: 46.9L) of BWDB for the period from 1982 to 2020 (Figure 5.26) were collected and analyzed. The analysis shows that the maximum water level was 20.94 m PWD in July 2019 while the minimum water level was 11.97 m PWD in February 2015. The danger level of the river at Bahadurabad water level station is 19.50 m PWD. It is noted that whenever the river water rises above the danger level at this location, the flood may likely damage nearby crops and homesteads in the area.



Source: National Water Resources Database

Figure 5.26: Monthly Water Level Analysis for Bahadurabad Transit (1982-2020)

The historical annual maximum water level analysis was also carried out and is represented graphically in **Figure 5.27** which shows that the maximum flow of the Brahmaputra-Jamuna River is above the danger level, i.e. >19.50 m PWD in most of the years

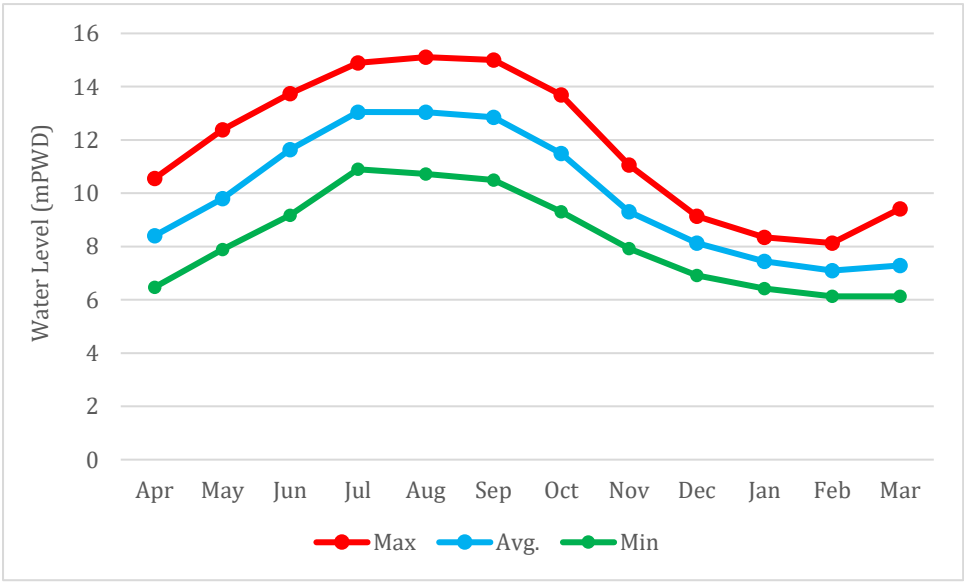


Source: National Water Resources Database

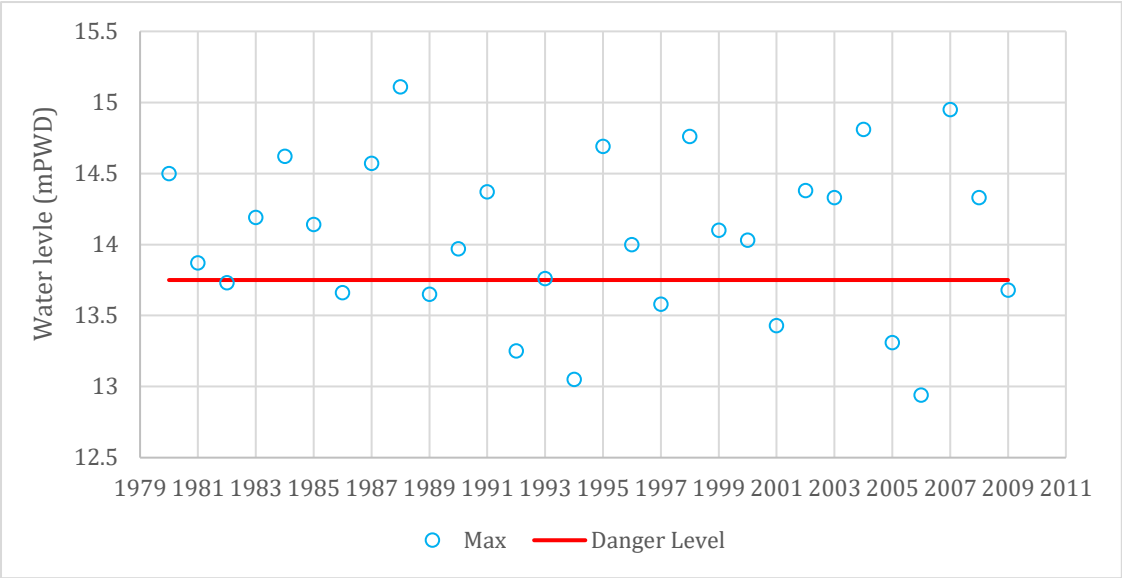
Figure 5.27: Annual Maximum Water Level Analysis at Bahadurabad Station (1982-2020)

Water Level at Sirajganj Station

The water level data of the Sirajganj (Station No: 49) of BWDB for the period from 1980 to 2009 were collected and analyzed. The analysis of the monthly variation of water level shows that the maximum water level is 15.11 m PWD in the month of August while the minimum water level is 6.13 m PWD in the months of February and March as presented in **Figure 5.28**. The danger level of the river at Sirajganj water level station is 13.75 m PWD.



Monthly water level of Jamuna River at Sirajganj



Annual maximum water level of Jamuna River at Sirajganj

Figure 5.28: Water Level of the Jamuna River at Sirajganj Station

5.10.3 River Discharge

Discharge at Bahadurabad Transit station

Figure 5.29 shows the monthly variation of maximum, average and minimum discharge of the Brahmaputra-Jamuna River from the data of 1980 to 2020 at Bahadurabad transit station. It reveals that discharge of the river is high in monsoon (June-October) and the maximum discharge was recorded as 103,129 m^3/sec in September, 1998. The disCharge reduces in the dry season (November-April) with the minimum discharge recorded as 2037 m^3/sec in March 2013.

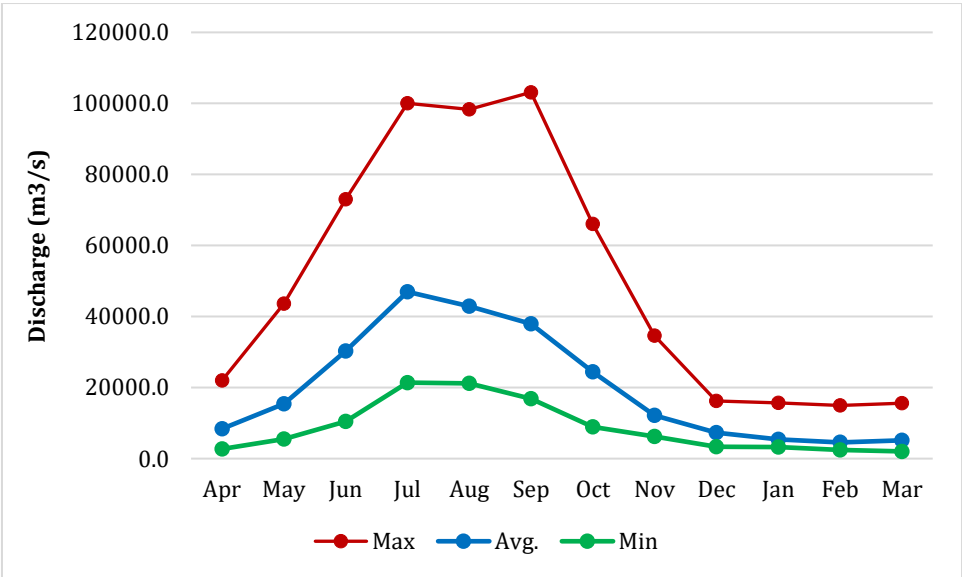


Figure 5.29: Discharge of the Jamuna River at Bahadurabad Transit Station (1980-2020)

The annual discharge data were analyzed for Bahadurabad Station for the period 1980 to 2020. The graph shown in **Figure 5.30** indicates that the maximum discharge fluctuates from 40,000 to 100,000 m^3/s. A range of the maximum discharge above 80,000 m^3/s was recorded in the years 1974, 1988, 1991, 1995, 1996,1998, 2004 and in 2016 where the maximum discharge of 103,129 m^3/s was observed in June, 1998.

A slightly increasing trend of discharge has been observed in the river and it might be followed in the future based on past fluctations as illustrated in the graph.

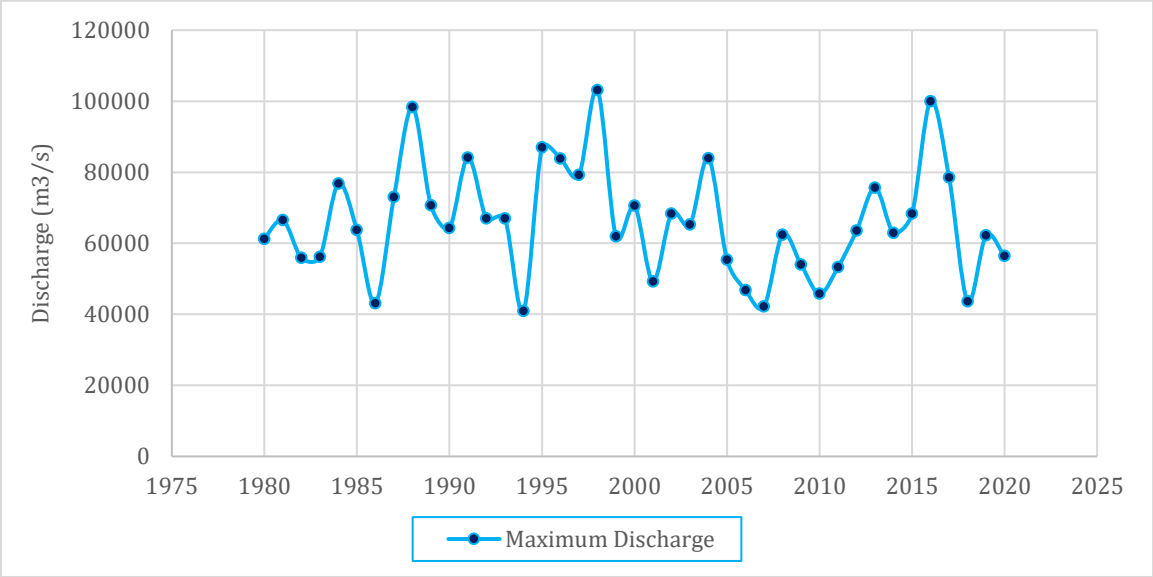


Figure 5.30: Annual Maximum Discharge at Bahadurabad Transit (1980-2020)

5.10.4 Sediment Load/Transport

Sedimentation is a key problem for the Brahmaputra-Jamuna River. From Assam (India), the Brahmaputra carries a huge load of sediment acquired from the rain-soaked Himalayan tributaries. In fact, with a suspended sediment load of 13 million tons per day during the flood season, the river is considered to be one of the most heavily sediment-laden large rivers in the world (Nishat, 2014). A part of this sediment is fine sand which is heavier than clay and silt and is deposited on the river banks as the floodwaters recede

5.11 Flood Frequency Analysis

Frequency analysis of the maximum water level at Bahadurabad station and Sirajganj station for the various return periods was carried out to assess the corresponding probable flood levels which are shown in Table-5.10. It appears from the analysis that the 50-year return period of flood levels is 20.95 mPWD and 15.27 m PWD at Bahadurabad and Sirajganj stations, respectively.

Table 5.10: Flood Return Period of Brahmaputra-Jamuna River

Return Period (Year)	Highest flood level (m PWD) at Bahadurabad station	Highest flood level (m PWD) at Sirajganj station
2	19.66	14.05
5	20.18	14.53
10	20.45	14.80
25	20.75	15.08
50	20.95	15.27
100	21.13	15.43

5.12 Water Management Infrastructure

During the last four to five decades, the Jamuna River has been undergoing strong metamorphosis in width, bank erosion, and braiding intensities. To cope with river related disasters, i.e., erosion and flooding, BWDB has constructed flood control embankments and various other kinds of infrastructure such as dykes, Groynes/spurs, revetments, guide bunds and other protective works along the bank of the Jamuna River. Recent surveys and estimations by CEGIS reveal that, there are 70 km of revetments, 21 Groynes, 3 hard points and a guide bunds on the right bank and 24 km of revetments, 4 hard points, and 1 guide bund along

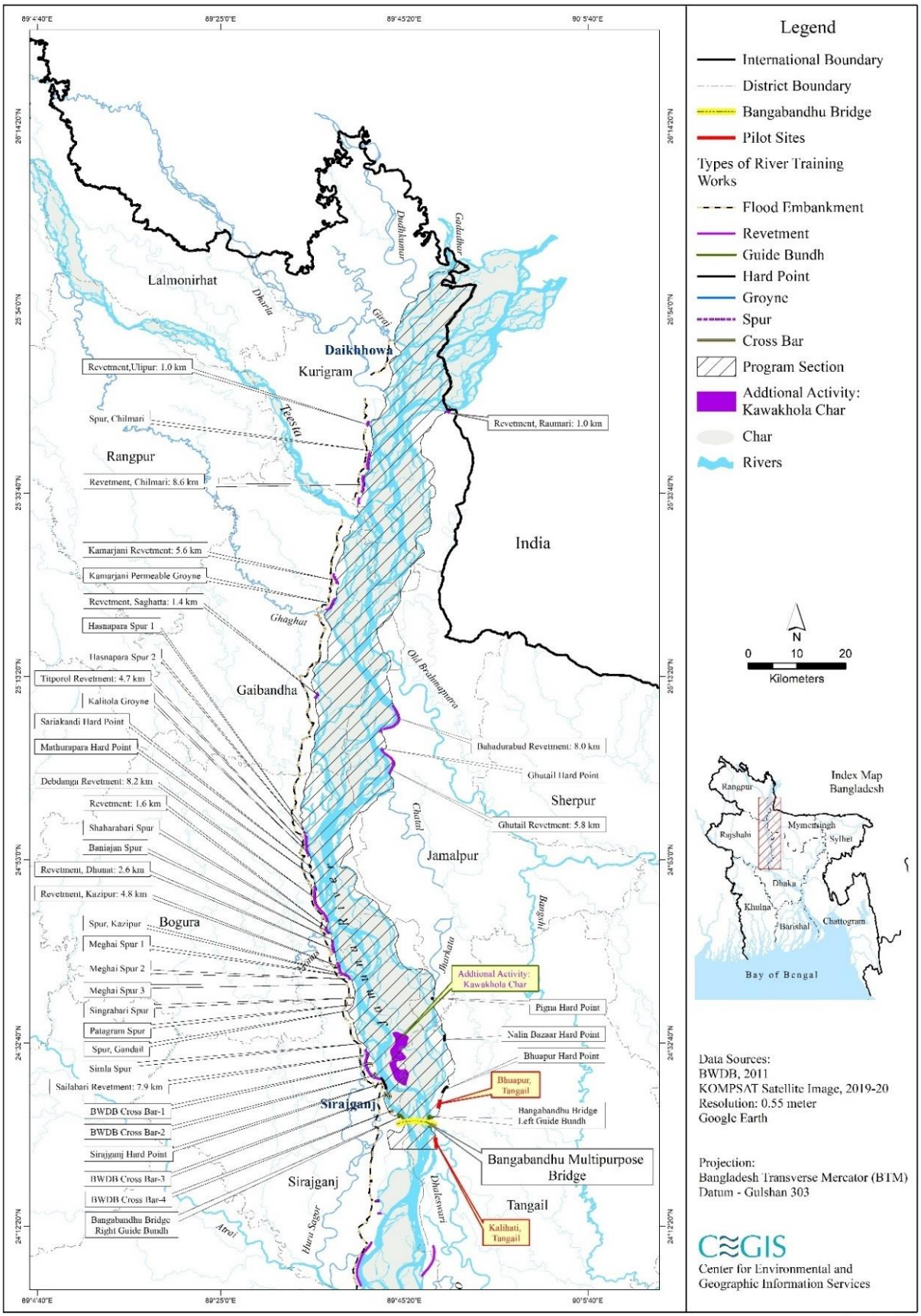
the left along of the Jamuna River (Figure 5.31)**.** According to a recent evaluation, the performance and stability of various structures vary in terms of reducing erosion rates and their influences on the overall morphology of the Jamuna River.[36] It was observed that most of the structures experienced considerable damage due to repeated undermining by scour. The main problems were associated with the deep scour due to outflanking and geotechnical stability problems associated with the launched slopes[37].

A 180-km long flood protection embankment, namely the Brahmaputra Right bank Embankment (BRE), was built with World Bank assistance in early 1960s for flood control purposes covering Pabna-Sirajganj, Bogura and Rangpur Districts.[38] The original BRE had a setback of about 1.50 km from the Brahmaputra's right bank. In the 1970s, the embankment started to fail under sporadic erosion attacks. During 1980s, the frequency of BRE breaches by erosion increased rapidly as longer sections came within the range of rapidly eroding river bends which would cause bank line erosion rates of several hundred meters per year in the early stage of bend formation. To prevent flooding, these breaches were typically closed by local retirements at about 200 m set-backs. As a result of this minimal set-back distance the BRE has been retired several times in many places. At present perhaps only 41 km of the original BRE has remained in place upstream of Jamuna bridge. Currently, many long stretches of BRE are very close to the river bank line. Consequently, security of the area protected by the BRE has been seriously threatened and large areas of land and Cities with large populations, such as Sirajganj, are exposed to flooding. Figure 5.31 shows the major Water Management Infrastructures along the Jamuna River

[36] Sarker, M.H. *et al.* 2011. Riverbank Protection Measures in the Brahmaputra-Jamuna River: Bangladesh Experience (https://www.researchgate.net/publication/263125674).

[37] Launched slope means the river bank slope (from the levee to the river bed) to be protected by the erosion protection work (by placing of geo-bag or CC block or gravel)

[38] Zaman, Mohammad *et al.* Flooding and Erosion Risk Management in the Brahmaputra-Jamuna Floodplain: Hope and Despair. In M. Zaman and H. Khatun (eds.) *Development-induced Displacement and Resettlement in Bangladesh: Case Studies and Practices.* New York: Nova Publishers, Second Edition, 2019.



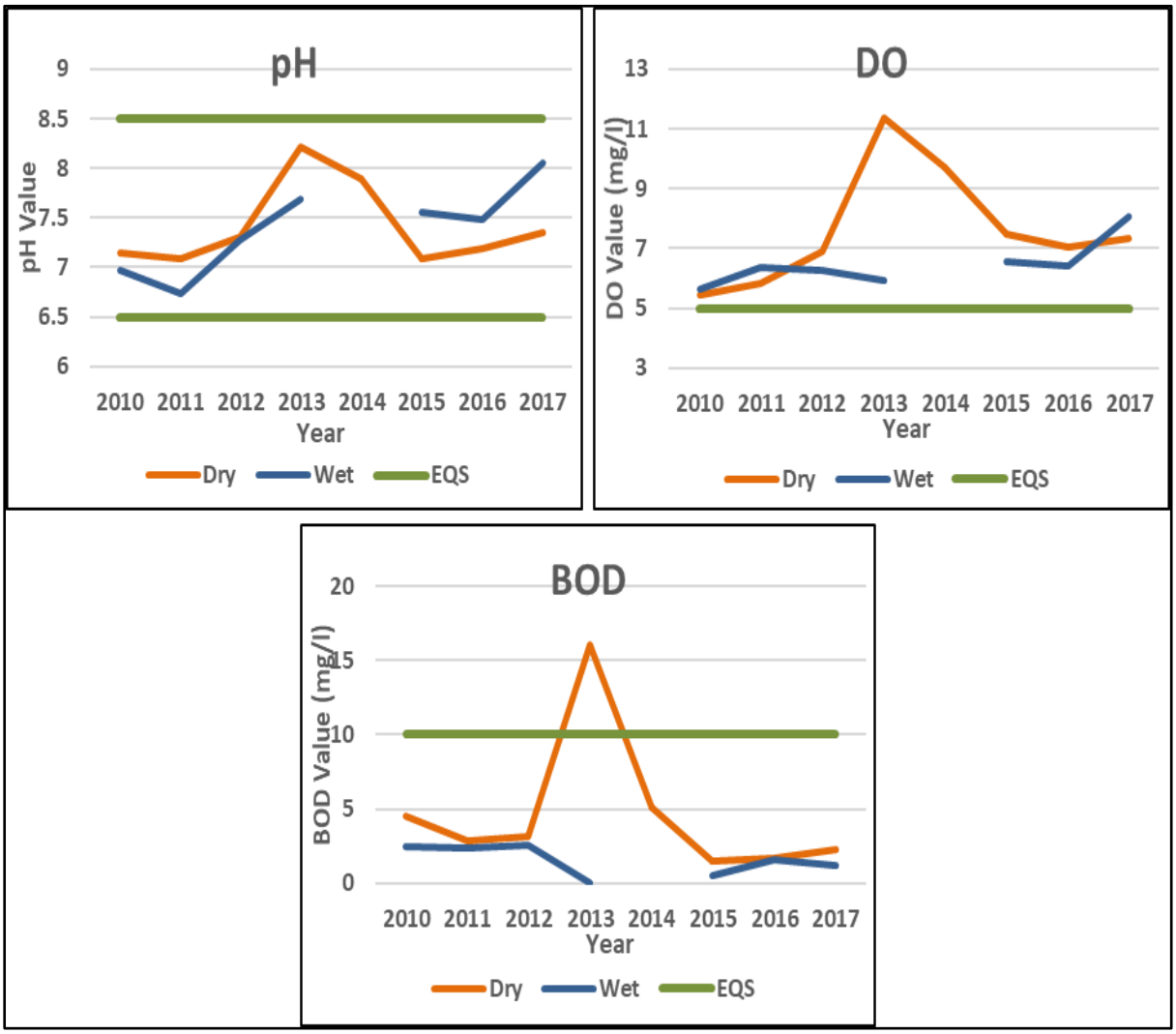
Source: CEGIS

Figure 5.31: Water Management Infrastructures along the Jamuna River

5.13 River Water Quality

Department of Environment monitored the water quality of Jamuna River from the existing monitoring locations. Their monitoring considered only three basic water quality parameters- pH, Dissolved Oxygen (DO), and Biochemical Oxygen Demand (BOD). Mean values for dry and wet periods were analyzed and compared with the Environmental Quality Standards (EQS) for inland freshwater (usage for fisheries, industries and irrigation) stated in Environmental Conservation Rules, 1997 of Bangladesh. **Figure 5.32** provides the trend over 2010 to 2017 of the three parameters. It could be observed that the pH of Jamuna River was within the standard limits, and slightly alkaline. pH values ranged between 6.74 to 8.22. Values of the wet season from 2010 to 2013 were lower than the dry season which could be expected because of low water flow in dry season but, from 2015, pH of wet seasons were higher.

The oxygen condition was also suitable for fisheries. All the values of Dissolved Oxygen (DO), both in wet and dry periods, were above the minimum acceptable limit (5 mg/l). The values ranged from 5.44 mg/l to 11.36 mg/l in dry seasons and 5.62 mg/l to 8.05 mg/l in wet seasons. BOD values ranged between 0 mg/l and 5.1 mg/l, except in the dry season of 2013 (16 mg/l), where the maximum standard limit for fisheries is 6 mg/l.



Source: Water Quality Reports of Department of Environment, 2010 - 2017

Figure 5.32: Trend of Water Quality of Jamuna-Brahmaputra River over 2010 to 2017

Anwar (Anwar et al., 2017) analyzed the water quality of Jamuna River at 5 stations located within 10 km upstream from Jamuna Bridge. Along with basic water parameters, the nutrients such as Nitrate (NO_3), Phosphate (PO_4), and Ammonium (NH_4) were also analyzed. pH, DO, BOD, Turbidity, and transparency

values were within the standard limits of water quality for fisheries and irrigation purposes. Nitrate values ranged between 0.118 mg/l to 0.186 mg/l, where the EQS of water for fisheries is 5 mg/l. Ammonium values were also within the standard limit (1.5 mg/l) and the values were between 0.16 mg/l to 0.50 mg/l. However, phosphate values were over the maximum acceptable range (0.5 mg/l). Phosphate values varied between 0.87 mg/l to 1.68 mg/l

Another recent study by CEGIS analyzed several parameters of Jamuna River water from two sampling locations. **Table 5.11** shows the monitored values and the EQS as well. All the values were found within the standard limits. For a few parameters such as calcium, sodium, and arsenic standards were not found for water used for fisheries and irrigation. Rather drinking water quality standards are mentioned for comparison and the values were found even lower than the drinking water standards.

Table 5.11: Water Quality of Jamuna-Brahmaputra River in 2019

Water Quality Parameter	Unit	Guide Bandh (Bhuapur)	Kakua (Kalihati)	Environmental Quality Standards[39]
Temperature	(°C)	24.9	25	20 – 30
Turbidity	NTU	1.85	8.9	10*
Total Dissolved Solids (TDS)	mg/l	152	101	1000
Electric Conductivity (EC)	µS/cm	312	214	-
Hardness as $CaCO_3$	mg/l	590	533	-
Calcium (Ca)	mg/l	12	19	75*
Sodium (Na)	mg/l	16	31	200*
Ammonia (NH_3)	mg/l	0.44	0.39	0.5*
Nitrate-Nitrogen (NO_3-N)	mg/l	1.62	0.81	5
Sulphate (SO_4)	mg/l	2	12	400*
Arsenic (As)	mg/l	0.003	0.002	0.05*
Lead (Pb)	mg/l	0.001	0.001	0.1
Faecal Coliform	Number/100 ml	308	240	-

Source: CEGIS, 2019. Environmental and Social Impacts Assessment of Technical Assistance Cooperation Project in Connection with Flood Management in Bangladesh, Yellow River Engineering Consulting Co Ltd.

From the water quality data of the Jamuna-Brahmaputra River, it can be stated that the water quality is good for aquatic life. However, it is difficult to express the overall river condition through a few monitoring points as the braided properties of Jamuna River makes it very wide. This is important because water quality may vary at different locations as well as width-wise due to different causes. The effects on the left bank may be completely different to those on the right bank and water quality may vary significantly. Accumulation of pollution and the effects may be localized and occur within limited areas of influence. In this regard, another study of Bangladesh Water Development Board in 2014 may be relevant. The report states that the overall water quality conditions of Jamuna was within the environmental standards, but the tributary rivers and canals had water quality below the standards (Bangladesh Water Development Board, 2015). Five locations, i) Banaijan canal (at Sirajganj), ii) Ichamoti River (at Sirajganj), iii) DeuliBeel (at Bogura), iv) Bangali River (at Bogura), and v) Ghagot River (at Gaibandha) were considered for the analysis. All the DO and BOD values were lower and higher than the acceptable minimum and maximum values, respectively, except in the Bangali River.

5.14 Water Pollution

5.14.1 Causes of Water Pollution

Water pollution is the condition where water becomes contaminated by the presence of physical, chemical, or biological substances at concentrations that impair water quality and make it harmful for human and animal consumption or other different purposes (WHO/UNEP, 1997; Schweitzer & Noblet, 2018). Pollution of river water is mostly caused by anthropogenic activities, which include discharge of harmful and waste materials, both in solid and liquid form, with no or minimum safe handling process. Release of pollutants in the open environment on the land or any wetland consequentially transports them into nearby rivers through natural or artificial drainage outlets. As the contaminants get loaded into the river, several mechanisms such as mixing (depending on stream velocity and direction), chemical decay (depending on atomic properties), aeration as a self-purification process of water (depending on water flow and available oxygen) take place. These complex processes continue along the river flow and the quality of water changes as the quality defining substances vary in concentrations.

Changes in river water quality impact the environment and human health. This causal relation can be demonstrated using D-P-S-I-R framework (Driver-Pressure-State-Impact-Response), developed by the European Environment Agency (EEA, 1999). Applying this model to river water pollution to identify the impacts shows that socio-economic drivers such as domestic, industrial and agricultural activities put pressure (release of wastewater and solid waste) on the environment that changes the condition from one state to another (increase of pollutants and change in water quality). Use of contaminated water causes ecological deterioration, human health problems, and other problems. Based on the impacts the responses change, which triggers the driver mechanism again.

Pollution of water can be identified by various indicators such as the concentrations of different substances, sediment quality of the river bed, distribution of pollution sources, and composition of microorganisms. In this study, the existing condition of the Jamuna River, in terms of water quality and the potential sources of water pollution, are analyzed.

5.14.2 Pollution Sources

Industrial pollution

In Bangladesh, many industries are situated along the banks of rivers for various benefits. The major polluting industries are fertilizer, cement and textile industries. However, unlike the rivers around Dhaka, there are not as many industries located along the banks of the Jamuna River. Also, the water quality data (table 5.11) does not indicate the effects from industrial wastewater.

Domestic pollution

Domestic pollution depends on the settlement density and the condition of waste management available. The river crosses five districts – Kurigram, Gaibandha, Sirajganj, Bogura, and Jamalpur. Human density around Jamuna River is more than 800 person/km^2. A large postion of the wastes from those settlements enter the Jamuna River. Chars are important features of the Jamuna River. There are a number of permanent and newly reclaimed Chars with more than 800 km^2 of area where there are settlements already present and are potential for economic developments. These areas do not have any sort of formal waste management system. As a result, solid, liquid and sewage waste generated in these Chars eventually end up in the river. However, the huge amount of river water and the seasonal flood dilute and transport these pollutants towards the downstream and ultimately to the bay of Bengal.

Agricultural pollution

Agricultural lands are pentiful adjacent to the Jamuna River. Specially, in the Char areas, agriculture is the main source of occupation among the inhabitants. Chemical fertilizers used in lands can cause water pollution after run-off events. The major fertilizers used in this area are Urea, TSP, MP, Gypsum and, in a few cases, Zn. Urea is widely used for production of Boro rice, potato, maize and other crops. The use of

pesticides depends on the degree of pest infestation. Local farmers and the Sub-Assistant Agricultural Officer (SAAO) reported that farmers are using different types (granular/powder and liquid) of pesticides, including: Virthako; Sumithion; Rovral; Basudin; Sumikron; Setara; Dupont Fartera; Cumulus; Thiovit; Ektara; and others (Table 5.12) to prevent pest infestation in rice and non-rice crop fields. The residue or breakdown product of these pesticides might remail in the river water and sediment.

Table 5.12: Use of Fertilizer and Pesticides in the Agriculture of the Project Influence Area

Name of crop	Farmers using fertilizer (Kg/ha)						Pesticide used by farmers		
	Compost	Urea	TSP	MP	Gypsum	Zn	No. of application	Liq. (ml/ha) apx.	Gran. (kg/ha)
HYV Aman	-	140	60	40	-	5	1-2	250	5
Lt. Boro	-	120	40	30	-	-	1-2	150	-
HYV Boro	3,000	200	80	60	40	7	2-3	400	7
Wheat	-	160	80	50	-	-	1	200	-
Summer maize	-	180	90	60	-	-	1	250	-
Winter maize	-	180	80	60	-	-	1-2	200	-
Millet (Kawon)	-	80	50	50	-	-	-	-	-
Lentil	-	100	50	20	-	-	-	-	-
Blackgram	-	100	50	20	-	-	-	-	-
Khesheri	-	100	50	20	-	-	-	-	-
Mustard	-	160	90	60	-	-	1-2	200	-
Ground nut	-	180	100	60	-	-	1-2	200	-
Sesame	-	120	100	80	-	-	1-2	200	-
Jute	-	160	80	-	-	-	-	-	-
Potato	1,500	180	90	80	40	-	2—3	400	7
Chili	-	180	100	80	30	-	2—3	400	6
Onion		150	80	100	60	2	1-3	100	-
Coriander		150	80	60	-	-	-	-	-
Summer vegetables	2,000	120	60	40	20	-	2-3	400	5
Winter vegetables	2,500	140	70	50	30		2-3	400	5
Sugarcane	-	200	120	100	-	-	1-2	250	6

Note: The study area includes the piloting sites and their 1km Buffer area

Source: CEGIS estimation based on DAE and field investigation, 2021

Plastic pollution

Plastic pollution can be examined from riverbed sediment. Being a wide and braided river, the water quality from the top surface of river may not precisely provide an indication of pollution and pollution sources. Tsering (Tsering et al., 2021) analyzed the riverbed sediment from 10 sampling locations of Brahmaputra River, including: 3 locations from Arunachal state in India; 5 from Assam in India; 1 from Jamuna River (near Jamuna Bridge); and 1 from Meghna River near the mouth of the Brahmaputra River into the Bay of Bengal. The study revealed a fluctuating trend of microplastic and plastics abundance over the river course where the maximum abundance was at the Jamuna River location. The study also mentioned that there are many industrial activities and domestic use of plastic bags in Assam in recent years with inadequate waste management practices which may flush wastes into Bangladesh in the wet periods. However, this plastic pollution does not have any relation with the SOP1 but for future SOPs a further study can be carried out to explore the pollution status in Bangladesh part of the Jamuna River.

5.15 Natural Disasters

5.15.1 Floods

Flooding is one of the most common and major natural disasters in the Project AOI. The upstream rush of water and excessive rainfalls in the hilly areas causes water levels to rise in the Brahmaputra-Jamuna River resulting in catastrophic floods. Breaching of the existing flood management embankments also causes disastrous floods in the study area. In the last 30 years, the most devastating floods occurred in 1988, 1998, and 2004. During these periods of flooding, almost the entire study area was severely affected and a significant amount of damage occurred. The 1998 flood has the highest published discharge (103,129 m^3/s) on the Jamuna River, at Bahadurabad, followed by the flood in 1988 (98,300 m^3/s). Both these catastrophic floods have resulted in extensive inundation for more than a couple of months, not only in the region but also over the country. Table 5.13 provides a picture of the extreme flood events in the Jamuna River area.

Table 5.13: Major Flood Impacts in the Jamuna River Area

Year	Flood Duration (Days)	Flooded Area		Flood Level (m)
		Total Flooded area km^2	Locations along the Jamuna River only	
1988	27	89,970 km^2	Kurigram, Gaibandha, Bogra, Sherpur, Jamalpur, Sirajganj, Pabna, Tangail, Manikganj	-
1998	66	100,250 km^2	All the upazilas along the Jamuna	20.37m
2004	16	56,000 km^2	Kurigram, Gaibandha, Bogra, Sirajganj	20.18 m
2008	10	59250 km^2	Kurigram, Gaibandha, Bogra, Sirajganj, Pabna	-
2017	20	Not available	Bogra, Brahamanbaria, Gaibandha, Jamalpur, Kurigram, Lalmonirhat, Rangpur, Sirajganj, Tangail	-
2019	28	Not available	Kurigram, Gaibandha, Lalmonirhat, Bogura, Nilphamari, Sirajganj, Jamalpur, Tangail,	-
2020	90	Not available	Jamalpur, Kurigram, Gaibandha, Tangail, Sirajganj, Bogura	-

Source: RMIP report, 2015 and EM-DAT data base

However, flood damage is mostly related to the accidental breaches that occur in the flood embankments along the Jamuna, rather than the severity of the flood event. Since flood embankments (BRE) along the Jamuna have been designed to protect the Project AOI from normal as well as extreme floods, flooding in the flood protected areas is primarily due to breaches in the embankments along the Jamuna which dominate the inundation cycle of the area. Table 5.14 shows the length and number of breaches in the BRE.

Table 5.14: Length and Number of Breaches in BRE

Year	Number of Locations	Length of Breaches (m)
1995	1	1,535
1996	2	4,830
1997	0	0
1998	1	876
1999	2	3,216
2000	0	0
2001	0	0
2002	0	0
2003	1	3,690
2004	1	990
2005	2	3,610

2006	2	2,350
2007	3	2,670
2008	1	487
2010	2	2,734
2011	0	0
2012	2	1,558
2013	2	5,250

Source: Fichtner/BWDB. 2014.

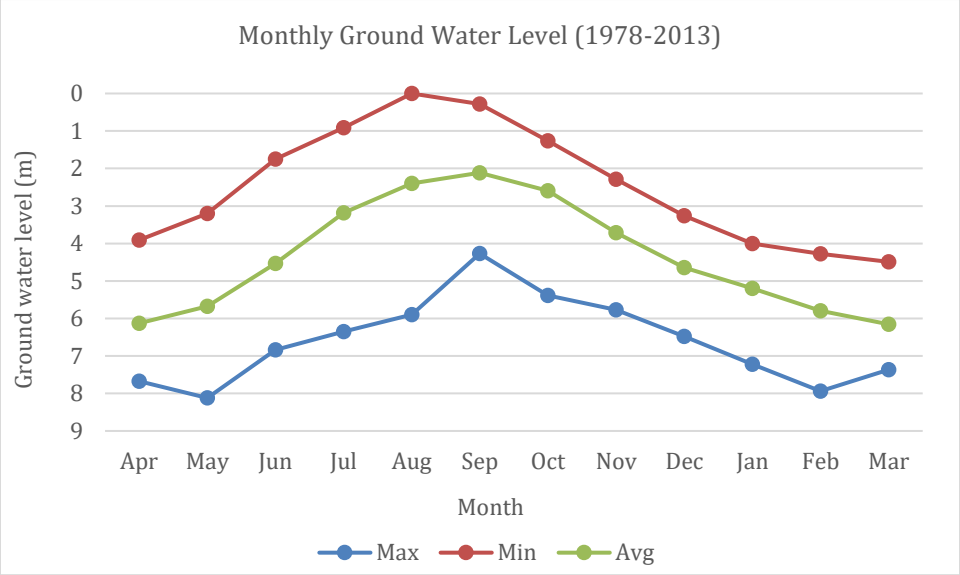
Over the years, due to continuous breaching, the integrity of the BRE is being threatened and large areas of rural and urban areas, such as Sirajganj, are being increasingly exposed to flooding.

5.15.2 Storms

There is limited evidence of local seasonal storms, popularly known as Nor'westers (Kalbaishakhi). Severe Nor'westers are generally associated with tornadoes. The frequency of Nor'westers usually reaches the maximum in April, whereas it is low in May and minimum in March. Nor'westers and Tornadoes are more frequent in the afternoon. Nor'westers may occur in late February due to the early withdrawal of winter from the Shillong Plateau of India. Bangladesh, including the study area, is witnessing unusual casualties from lightning strikes well ahead of the monsoon, which is in the pre-monsoon season comprised of the months of March through May. These lighting strikes are genrlly related to the Nor'westers storm. Considering the massive death toll due to lightning, in 2016, the Government of Bangladesh has declared it a natural disaster. A study conducted by save the Society and Thunderstorm Awareness Forum (SSTAF) shows that at least 177 people were killed and 47 others injured in lightning strikes in the country in four months from March to June in 2021. Among the deceased, 149 were male and 28 female. Most of the victims of lightning strikes were farmers who died while working in their fields. The study also reveals that Sirajganj is the lightning hotspot and eighteen people died in the district in June 2021. Conversely, hailstorms are not a common phenomenon in the study area but may significantly damage crops when they occur. Thunderstorms, which produce lightning, also occur can damage buildings, ignite fires and kill people by direct contact. According to the Ministry of Disaster Management and Relief, 2,164 people died in lighting strikes in the country from 2011 to 2020. At least 216 people die every year on average in lighting strikes, more than by floods cyclones and other natural calamities.

5.16 Groundwater

The groundwater data of BWDB observation well at Sirajganj station was collected from NWRD-CEGIS database archives for the period 1978 to 2013. The monthly maximum, average and minimum depth of groundwater from the ground surface are shown in **Figure 5.33.** It is observed from the analysis that the depth to groundwater from the ground surface decreases during the dry season, whereas the water table rises in the monsoon due to recharge by rain water and infiltration of peripheral river water. It is found that for Sirajganj station, the monthly maximum groundwater depth is 8.12 m which occurred in the month of May and minimum groundwater depth is 0 m which occurred in the month of August.



Source: NWRD, BWDB well station SIR001

Figure 5.33: Depth of Groundwater at Sirajganj Station

5.17 Ambient Air Quality and Noise

Ambient quality of air is mainly characterized by the presence of concentration of criteria pollutants, i.e., Particulate Matter (PM_{10} and $PM_{2.5}$), NOx, CO, SO_2 and Ozone (O_3) in the lower atmosphere. The Department of Environment (DoE) has set national ambient air quality standards for these pollutants in ECR, 1997 and subsequent amendment 2005 to protect human health and ecosystems. The proposed project is located along the Brahmaputra-Jamuna River where very few industries are recorded, except a few earthen/sand related businesses. However, the major sources of air pollution in the project airshed come from nearby municipalities, towns or scattered industries and transportation sectors. Figure 5.34 indicates the predominant wind directions relative to the Project AOI.

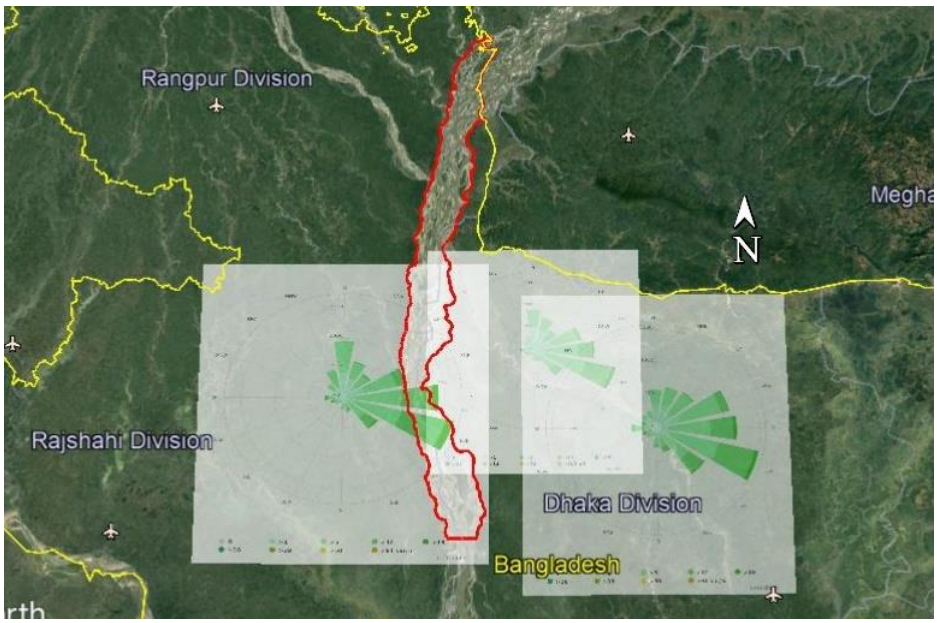


Figure 5.34: The Location of the Proposed Project along with Windrose Diagram

According to an study conducted by BWDB (BWDB, 2015), air quality in the project area was recorded in 2014. Ambient air quality monitoring was conducted at five locations (Jumarbari, Saghata, Gaibandha,

Sariakandi Hard Point, and Bogra) for 8hr continuous monitoring. **Table 5.15** shows the air quality monitoring data of the Project AOI along with national and international standards.

Table 5.15: Secondary Data of Air Quality in the EBAA

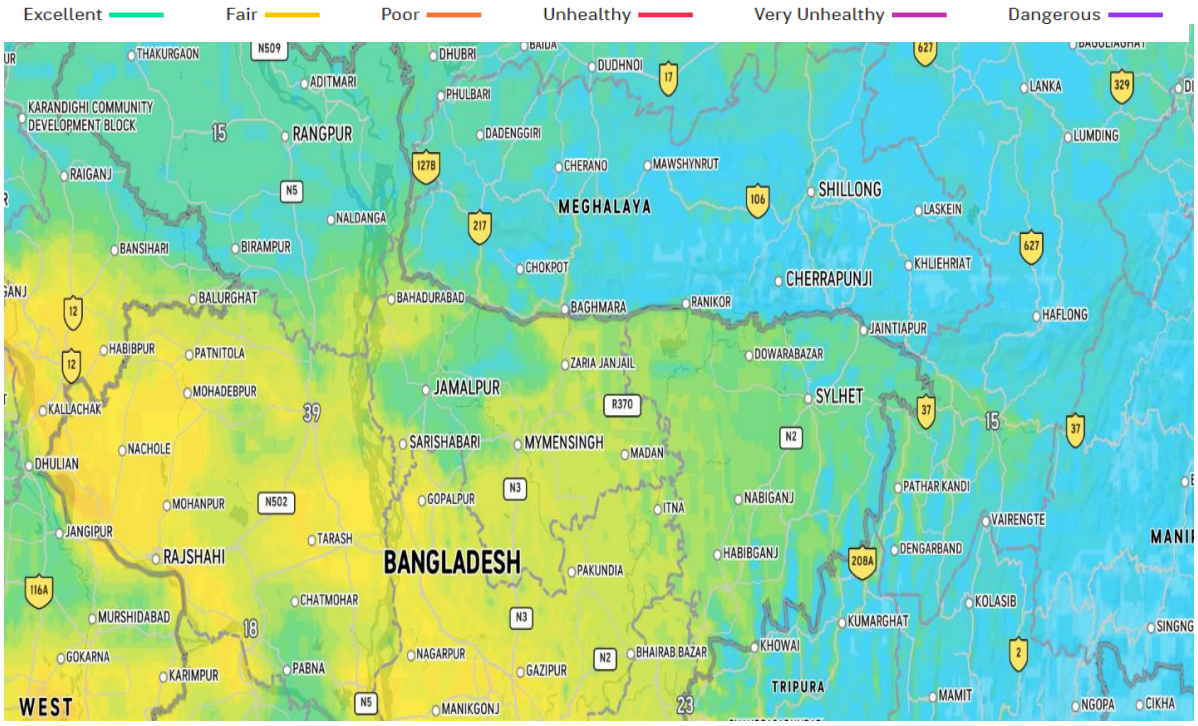
Sampling Location	Air Pollutants (µg/m3)		
	SPM (8hr)	NOx (8hr)	SO2 (8hr)
Jumarbari (market place), Saghata, Gaibandha	811	8.39	ND
Bharatkhali, Saghata, Gaibandha	260	6.54	ND
Baoitara, Saidabad, Sirajganj	593	11.9	ND
Ratankandi, Ratankandi, Sirajganj	298	7.14	ND
Singrabari, Kajipur, Sirajganj	261	6.35	ND
SariakandiHP,Sariakandi, Bogra	1,188	10.56	ND
Anantapur, Ulipur, Kurigram	375	7.56	ND
National Standard (ECR, 2005)	200 (8hr)	100 (Annual)	365 (24hr)
International Standard (IFC, 2007)	-	200 (1hr)	20 (24hr)

Note: ND-Not Detected

Source: BWDB, 2015

At that time, the main sources of pollution in Jumarbari (market place), Saghata, Gaibandha, Sariakandi, and Bogra include local vehicles, especially trucks, *karimons* and *nasimons* (locally manufactured small three-wheelers). However, suspended particulate matter exceeds the national standard limit. Therefore, human health or ecosystems are potentially vulnerable due to dust dispersion in the EBAA.

Air quality of the study area changes as the seasons change. During the monsoon, ambient air quality of the study area is relatively fair to excellent in the study area. **Figure 5.35** shows the Air quality index of the overall study area.



Source: (Rajshahi Division Air Quality Index (AQI) and Bangladesh Air Pollution | AirVisual, 2021)

Figure 5.35: Air Quality Indexing of the Proposed Project Airshed

5.18 Noise

The project area is located at the northern part of Bangladesh. Usually, the project area is calm and quiet as there are no noticeable noise generating sources. The main sources of local noise include rural vehicles, river vessels, diesel engine-based pumps, trucks and commercial activities. Based on a study conducted by BWDB in 2015 within the project area, the ambient noise levels are presented in **Table 5.16.**

Table 5.16: Noise Levels in the EBAA

Sampling Location	Classification of the Area as per ECR, 2006	Time of Noise Monitoring	Noise level, Leq (dBA)	ECR, 2006 Leq (dBA)	IFC 2007Leq (dBA)
Jumarbari(market place), Saghata, Gaibandha	Commercial and mixed	Day Time	34-36	60	70
		Night Time	30-32	50	70
Bharatkhali, Saghata, Gaibandha	Residential	Day Time	34-38	55	55
		Night Time	31-33	45	45
Baoitara, Saidabad, Sirajganj	Commercial and mixed	Day Time	36-38	60	70
		Night Time	32-34	50	70
Ratankandi, Ratankandi, Sirajganj	Commercial and mixed	Day Time	34-38	60	70
		Night Time	30-32	50	70
Singrabari, Kajipur, Sirajganj	Residential and rural	Day Time	36-38	55	55
		Night Time	31-34	45	45
SariakandiHP,Sariakandi, Bogra	Commercial and mixed	Day Time	46-51	60	70
		Night Time	46-48	50	70
Anantapur, Ulipur, Kurigram	Commercial and mixed	Day Time	34-37	60	70
		Night Time	30-33	50	70

Average noise levels were recorded as complying with both national and international standards. The rural commercial sites were denoted as mixed areas for fixing the standard limit. However, sudden peak noise or impulse noise of vehicles and loud speaker useds in festivals are the major noise sources in the study area.

5.19 Land Resources

This section has been prepared based on the land use analysis of the overal Program AOI and Project AOI.

5.19.1 Soil Characteristics

Thirty agro-ecological zones, 88 sub-regions and 536 units have been identified by adding successive layers of information on the physical environment which are relevant for land use and assessing agricultural potential in Bangladesh (FAO/UNDP, 1988 and BARC, 2018). In the study area, there are three Agro-Ecological Zones (AEZs) and some river areas have been found. These AEZ include: (i) Karatoya-Bangali Floodplain (AEZ-4); (ii) Active Brahmaputra-Jamuna Flood plain (AEZ-7); and (iii) Young Brahmaputra and Jamuna Floodplain (AEZ-8). The distribution of AEZs of the Jamuna River Economic corridor study area are presented in **Table 5.17** and shown **Figure 5.36.**

Table 5.17: Extent of AEZ in the Program AOI

AEZs Name and Number	Area(ha)	Percentage (%)
Karatoya-Bangali Floodplain (AEZ-4)	22,592	11.1
Active Brahmaputra-Jamuna Floodplain (AEZ-7)	160,591	78.9
Young Brahmaputra and Jamuna Floodplain (AEZ-8)	9,363	4.6
Old Brahmaputra Floodplain (AEZ-9)	10,380	5.1

Low Ganges River Floodplain (AEZ-12)	611	0.3
Ground Total	**203,537**	**100**

Source: CEGIS Estimation from AEZ database of FAO/UNDP, 1988

Note: the study area at each sites includes the bankline to be protected and 1km buffer area surrounding the bankline

Source: CEGIS Estimation from AEZ database of FAO/UNDP, 1988

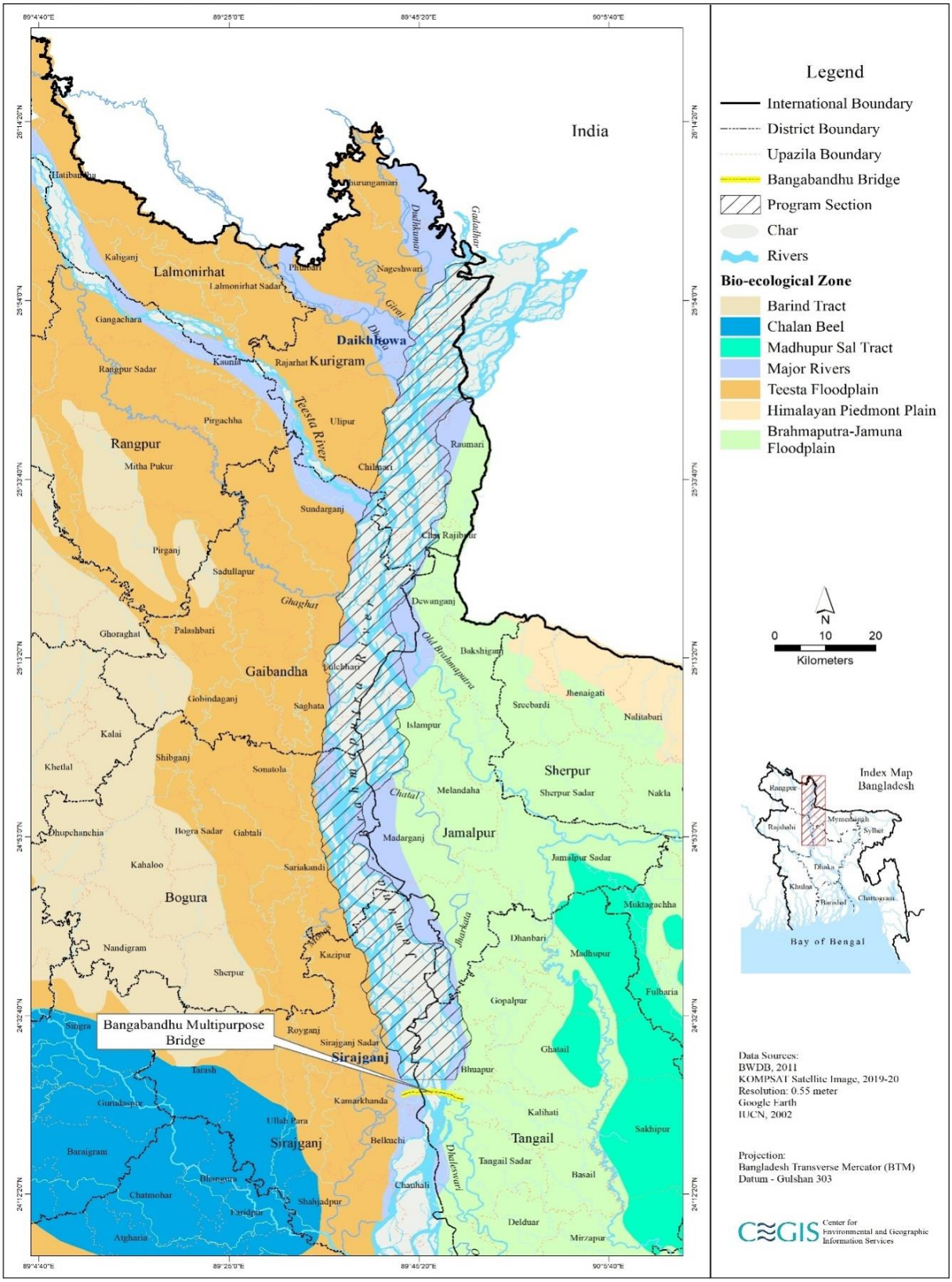


Figure 5.36: AEZs of the Jamuna River Economic Corridor Program Area

5.19.2 Land Use

Land use of the Program AOI were derived by analyzing Landsat Satellite Images dated 2019. In the study area, the image shows that the major land use category is agricultural land (27%) of the gross area. The rest (73%) of the areas are comprised of baor, built up non-linear, Herb Dominated Area (Terrestrial), Orchards & Other Plantations (Trees), Perennial Beels, Ponds, Rivers and Khals, Rural Settlement and Sand Bar. Detailed land use of the study area is presented in **Table 5.18**and **Figure 5.37.**

Table 5.18: Existing Land Use of the Program AOI

Land use class	Area(ha)	% of gross area
Baor	318	0.16
Built-up Non-Linear	30	0.02
Crop Land	66,887	32.86
Herb Dominated Area (Terrestrial)	5,255	2.58
Orchards & Other Plantations (Trees)	237	0.12
Perennial Beels	11	0.005
Ponds	1	0.0004
Rivers and Khals	52,169	25.63
Rural Settlement	7,057	3.47
Sand Bar	71,572	35.16
Grand Total	**203,537**	**100.0**

Source: LANDSAT Satellite Image, 2019

The land use at two Project AOI are presented in Figures 5.37 and 5.38 which shows that the crop lands varies from 21% to 42% and settlement varies from 13 % to 29%.

5.19.3 Land Type

Land type classification is based on depth of inundation during the monsoon season due to normal Flooding on agriculture land. In terms of depth of flooding, the five classes of land type are recognized by the Soil Resource Development Institute (SRDI), 1988. According to the table, the study area is dominated by medium high land 33% followed by high land 29%. Detailed land types of the Project AOI are presented in **Table 5.19.**

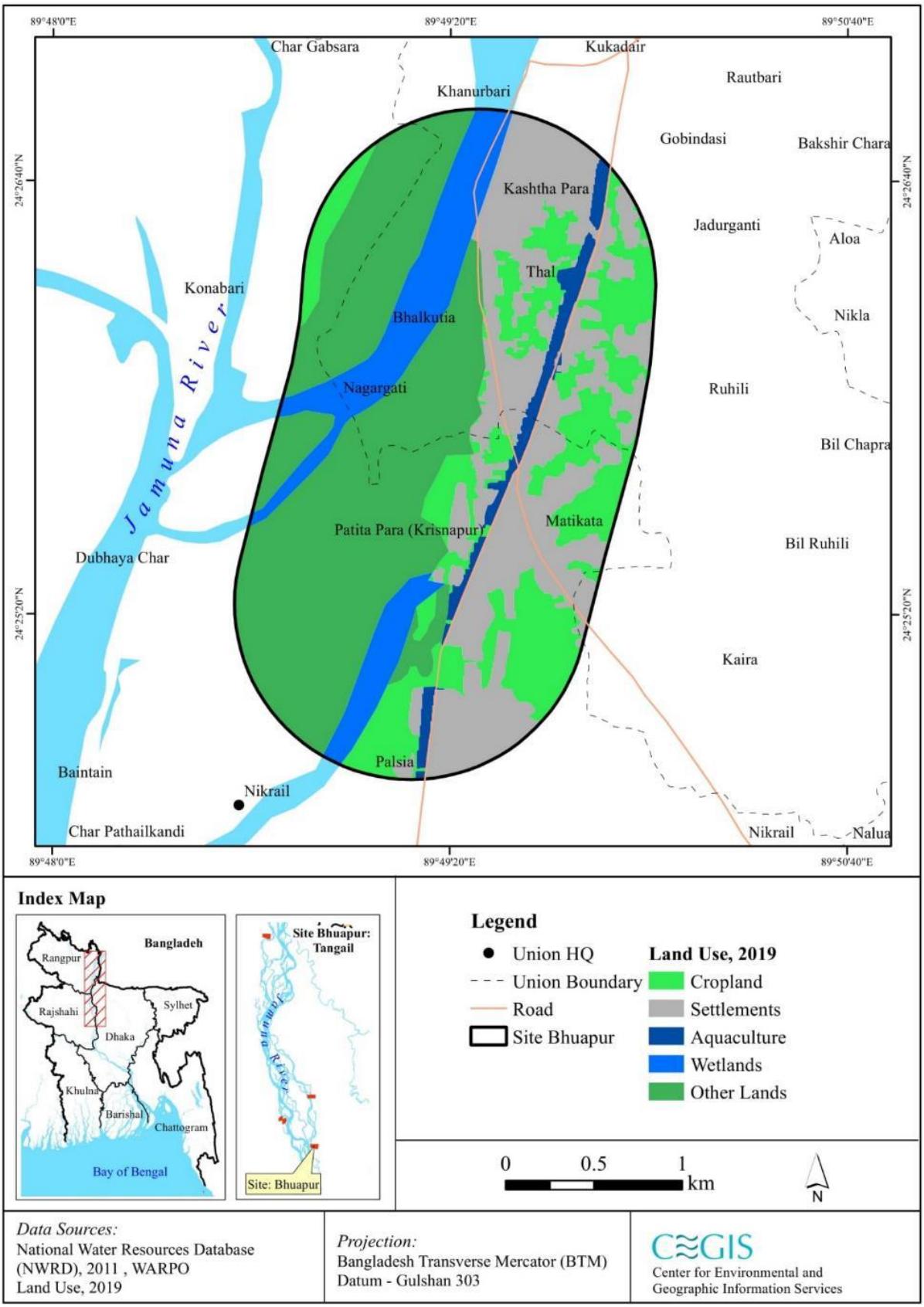


Figure 5.37: Land Use Map of the Piloting Site at Bhuapur and its 1km Buffer Area

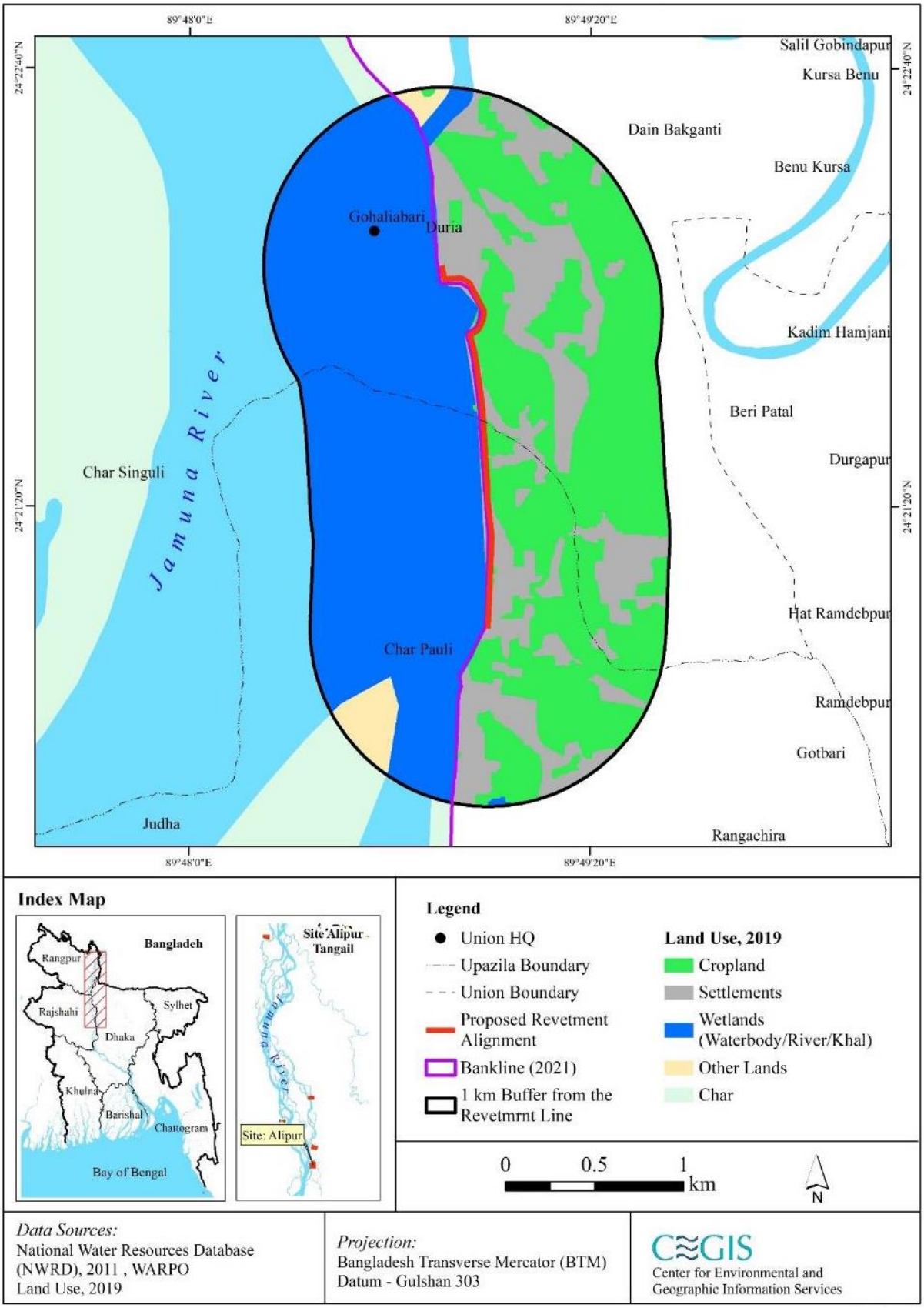


Figure 5.38: Land Use Map of the Piloting Site at Alipur, Kalihati site and its 1km Buffer Area

Table 5.19: Detailed Land Type of the Program AOI and Project AOI

Land Type	Program AOI (%of NCA)	Bhuapur Project AOI (% NCA)
Highland(F_0)	3.3	-
Medium Highland (F_1)	33.0	63
Medium Highland(F_1) /Medium Lowland(F_2)	0.2	37
Medium Lowland(F_2)	46.0	-
Lowland(F_3)	17.5	
Grand Total	**100**	**100**

Source: CEGIS estimation from SRDI, 1995

5.19.4 Soil Texture

Soil texture is the relative proportions of sand, silt and clay. It is very important for soil Characteristics that guide crop selection, crop production and also field management. The dominated soil texture of the lands in the program area is loam (64.7%), followed by sand (13.8%), clay loam (13.2%), clay (4.2%), loam/sandy loam (2.3%), sandy loam (1.0%), and Sandy Loam/Clay Loam/Loam (0.8%). Detailed distribution of soil texture is presented in **Table 5.20**. Similarly, clay and clay loam are dominating at the piloting sites as well (Table 5.20)**.**

Table 5.20: Soil Texture of the Program AOI and Project AOI

Soil Texture	Program AOI (%of NCA)	Bhuapur Project AOI (% NCA)
Clay	4.2	4
Clay Loam	13.2	13.99
Loam	64.7	
Loam/Sandy Loam	2.3	
Sand	13.8	
Sandy Loam	1.0	
Sandy Loam/Clay Loam/Loam	0.8	
Grand Total	**100.0**	**100.0**

Source: CEGIS estimation from SRDI, 1995

5.19.5 Irrigation

Both ground and surface water are the main source of irrigation. Deep Tube Wells, Shallow Tube Wells (STWs) and Low Lift Pumps (LLPs) are used for irrigation in the study area. The irrigation is being provided by withdrawal of groundwater which declines due to over exploitation during dry season. According to officials of local SAAO of DAE, crops are grown under rain-fed condition during Kharif-I and Kharif-II season. But supplementary irrigation is also provided to the fields of Potato, Wheat, Mustard, Maize, Chili, Onion, winter vegetables and Sugarcane cultivation. The cost of irrigation is high in the program and project influencing area. The local Upazila Agricultural Officer (UAO) reported that the irrigation cost increases during dry season due to lowering of groundwater Table. Detailed irrigation information is presented in **Table 5.21.**

Table 5.21: Irrigated Area by Crop in the Project Influence Area

Crop name	Irrigated Area		Cost (BDT/ha)		
	GW (% of NCA)	SW (% of NCA)	GW		SW
			DTW	STW	LLP
HYV Boro	95	5	10,000-12,000	14,000-14,500	9,500-10,000
Potato	100	-	2,000-2,200	2,000-2,500	1,800-2,000
Winter maize	100	-	3,000-3,500	5,000-5,500	2,000-2,200
Wheat	75	25	2,000-2,500	2,500-3,000	1,800-2,000
Winter vegetables	70	30	2,000-2,500	6,000-6,500	2,000-2,500
Mustard	80	20	2,200-2,500	2,200-2,500	1,800-2,000
Sugarcane	80	20	2,000-2,500	4,000-4,500	1,800-2,000
Chili	100	-	2,000-2,500	2,000-2,500	1,200-1,500
Onion	80	20	1,500-2,000	1,800-2,000	1,200-1500

Source: CEGIS estimation based on DAE and field investigation, 2021

6. Biodiversity and Living Natural Resources Baseline

This chapter presents a summary of the Biodiversity and Living Natural Resources baseline provided in Annex 6.1.

6.1 Study Area

The study area for biodiversity assessment was defined as the Biodiversity Area of Analysis (BAA) delineated through combining the Project AOI of both Pilot Site 1 and 2 and proposed dredging. The BAA was extended upstream and downstream to include indirect impact area and up to the floodplain of the opposite bank, and including a control area. Figure 6.1 shows the BAA map covers a total area of 17,584 ha. The following criteria were considered while delineating the BAA:

- Project Footprint (around 12 ha) and Project Influence Area (both direct and indirect, a total of 4645 ha)
- Impact of Noise from the Piling (piling will be the major activities)
- River area covering alluvial corridor, floodplain, and Chars between the banks etc.
- Physical boundary (e.g the countryside limit of the floodplain of the left-bank was considered up to an existing road)
- Possible hydrological Impacts of the intervention
- Control area (upstream area, downstream area and the habitats along the opposite bank of the river which are beyond the limit of project AOI)

The BAA extended to 1.5 km upstream from the proposed revetment of the Bhuapur pilot site, and 3 km downstream of the Tangail Pilot site (covering the offtake area of Dhaleswari river). The direct footprint area was along the left bank, but the BAA extended up to the right bank and its floodplain.

The BAA included (i) riverine habitat comprising the river and alluvial area, mudflats, sand-bars and submersible Chars, (i) floodplain zone consisting of terrestrial area, attached Chars (river island), Croplands, grasslands, homestead vegetation, planted forest area, freshwater, sand-mining & storage area, and built-up area are common landcover and land use occurring in these habitats.

Three types of major ecosystems observed in the study area namely Terrestrial, Freshwater and Charlands.

Terrestrial ecosystem: The terrestrial ecosystem in the BAA is dominated by the agricultural landscape and homestead areas, and heavily influenced by the water flow of the Brahmaputra-Jamuna River The terrestrial ecosystem includes Char lands that are covered by sun grass, reeds and other natural vegetation.

Freshwater ecosystem: Freshwater ecosystem in the BAA is mainly covered with river ecosystem and floodplain ecosystem. Lentic ecosystem is a body of standing water that includes ditches, seeps, ponds, seasonal pools, and basin marshes in the BAA.

Charland Ecosystem: The main channel of the Jamuna River is constantly shifting within its active floodplain, eroding and depositing large areas of new Charland in each flooding season.

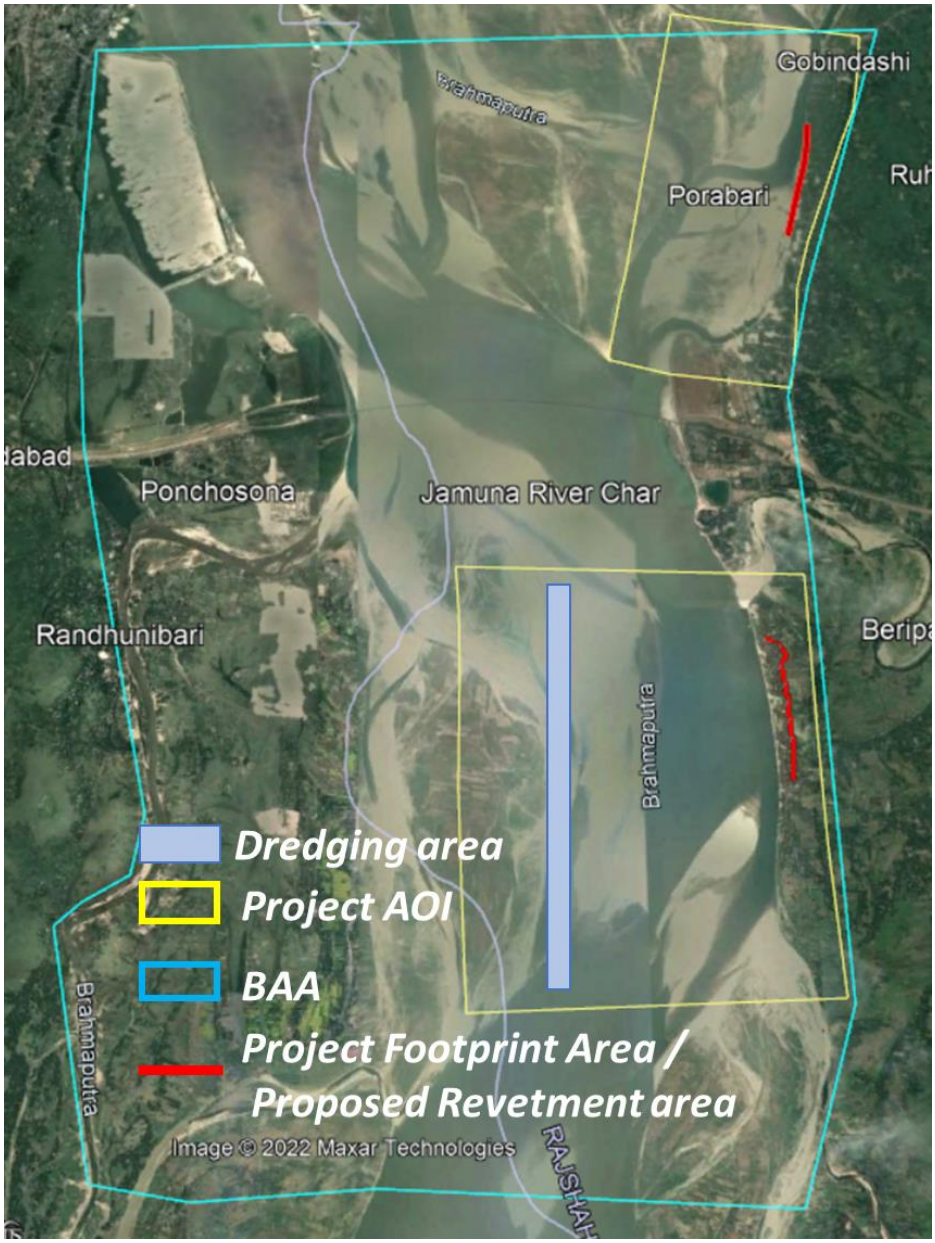


Figure 6.1: Map of the BAA

6.2 Legally Protected and Internationally Recognized Areas of High Biodiversity Value in and Around the BAA

The IBAT data lists several legally protected and internationally recognized areas with high biodiversity values. Many of them are out of range and irrelevant to the proposed project. The following table presents the IBAT list and screening results. There is 5 legally protected areas Internationally recognized Area of High Biodiversity Value around the project site (Table 6.1). But among them three are far away from the projet site (Figure 6.2).

Table 6.1: Legally Protected and Internationally Recognized Area of High Biodiversity Value In and Around the BAA

Area Name	Distance from BAA	Status and Designation	IUCN Category	Alignment with ESS 6	Screening Results
Silanda Nagdemra Dolphin Sanctuary	35.8 km	Legally protected area by GoB, listed in the IBAT	VI	Qualify as legally protected areas	Both sanctuaries are far from the site but relevant to the project site due to potential impacts to river dolphin, therefore included in the Biodiversity Risk Assessment
Nagarbari Mohonganj Dolphin Sanctuary	36.8 km				
Madhupur National Park Key Biodiversity Area	32.7 km	Legally protected area by GoB, and Important Bird Area, listed in the IBAT	IV	Qualifies as a legally protected area	Terrestrial National Park not connected with the Jamuna River hydrology. Not relevant to the proposed intervention and excluded from the risk assessment
Jamuna Brahmaputra River Key Biodiversity Area	0 km	Important Bird Area, listed in the IBAT Not legally protected	Not applicable	Qualifies as an internationally recognized area but is unmanaged	Relevant, included in the risk assessment
Bangabandhu Bridge Ecopark	7 km	GoB designated eco-park for scenic beauty, Legally Protected, not listed in the IBAT	Unknown	Qualifies as legally protected area.	Relevant, included in the risk assessment
Jamuna River Fish Sanctuary	0	GoB Designated Fish Sanctuary, not listed in the IBAT	Unknown	Relevance is not linked with ecosystem management	Has relevance to proposed mitigation and is therefore included in the Biodiversity Risk Assessment

6.3 Habitat Mapping

The habitat Characterization for the pilot sites was done by direct field survey, land use and Land Cover analysis. The terrestrial, aquatic and Charland ecosystem are further divided into distinct types of habitat which support diverse group of biodiversity (Figure 6.3, Table 6.2). A total of seven types of habitats were observed in the BAA and among them five were but mostly modified and two were modified (Table 6.2). Those habitats provide feeding, breeding, resting and rousting ground for different types of vertebrate and invertebrates (Detailed species list can be found in Annex 6.1).

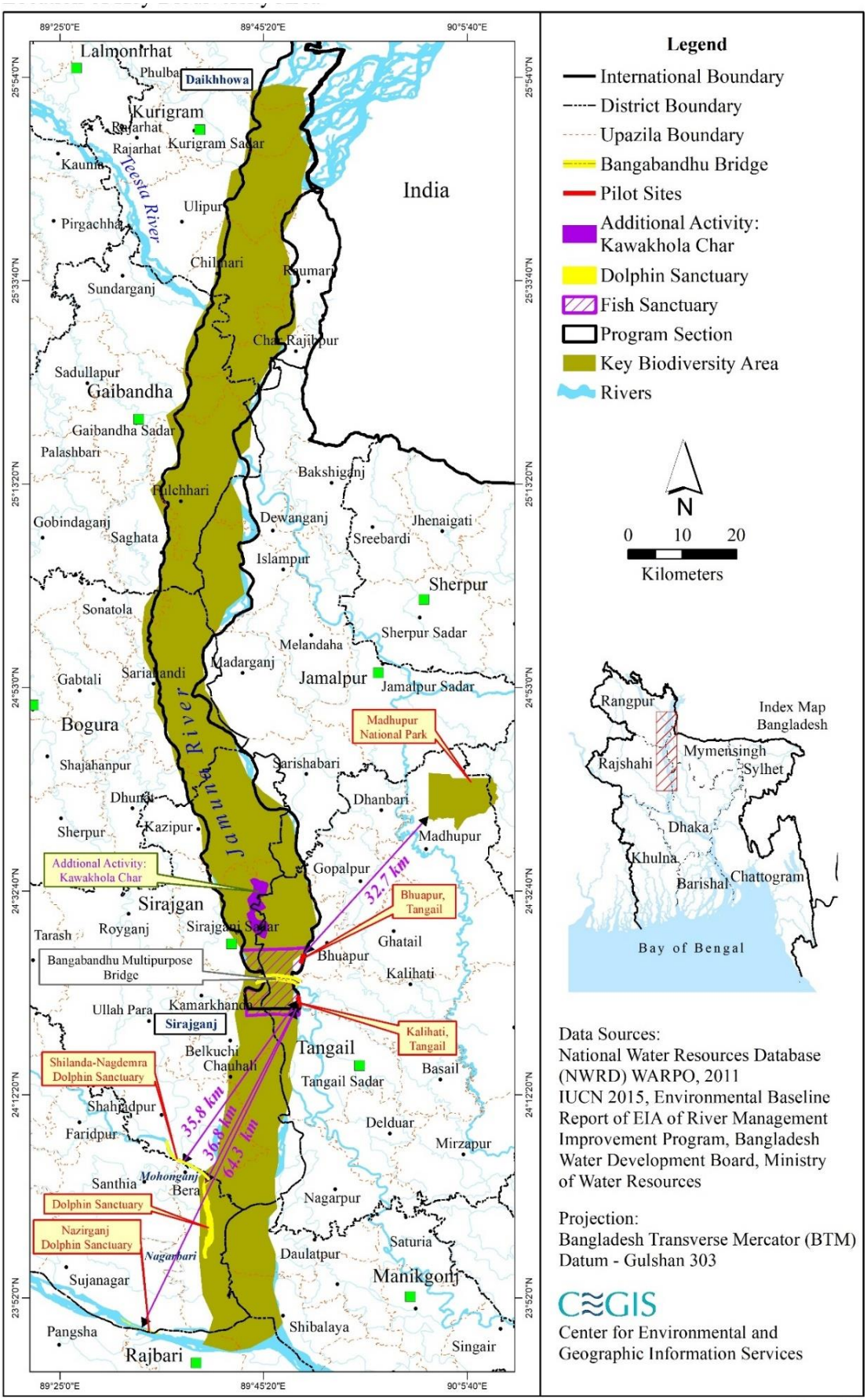


Figure 6.2: Location of Legally Protected Area and KBA around the BAA

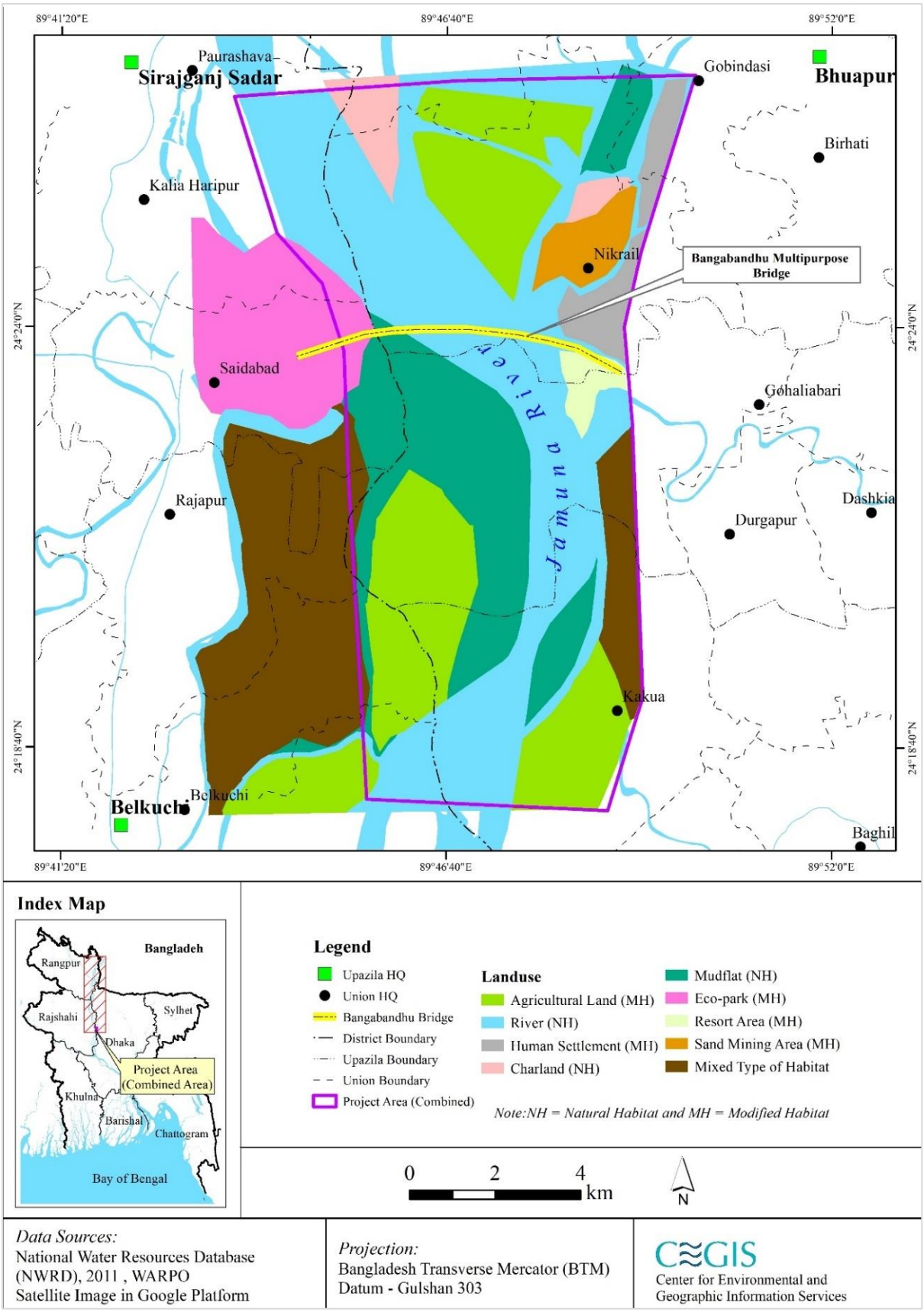
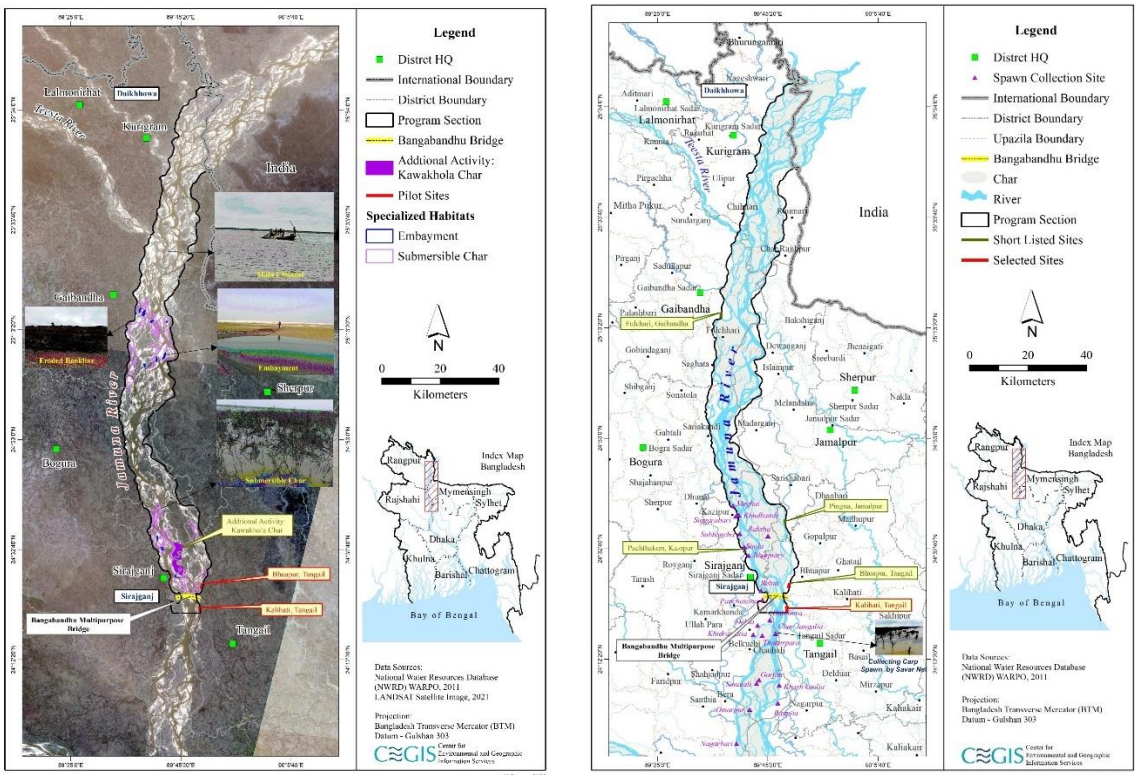


Figure 6.3: Habitat Mapping of the Project Area

Table 6.2: Names, Classification and Biodiversity Values of Habitats in the BAA

Habitat	Type	How do these habitats function?
Charlands (Newly emerged Charlands)	Natural	Charlands cover with sand, grasses, long reeds and agricultural lands which provide is the address of diverse bird species including rare species. This habitat harbors large number of invertebrates. Different types of grassland specialist bird species also found here (e.g., Olive-backed Pipit, Paddy-field Pipit)The habitats are mostly used by migratory ducks (e.g., Cotton Pygmy Goose) and common resident waterbirds (e.g., Little egret, Indian Pond Heron)
Riverbanks	Mixed but mostly modified	The habitat mostly river bank, mostly eroding in nature. The natural levee is often covered by grasses or bushes. Used by waders, wagtails, egrets, and herons. Good habitat for invertebrates (e.g., dragonfly) and amphibious species (frogs, toads).
Agriculture lands (on settled Charlands, and floodplain)	Modified	Major parts of the Charlands and floodplain are occupied by agricultural crops such as wheat, lentils, paddy, sesame, peanut and maize fields. This area is also ideal habitat for different group of insects (e.g., dragonflies, butterflies). Form the good community of insectivorous birds, and amphibians. It is suitable habitat for insectivorous and granivorous birds. Some species interact in these areas when it is located next to a natural habitat.
Mudflats, embayment area	Natural	Newly emerged Charlands and some of the submerged Char provide this type of habitats. Suitable habitat of water birds, water snakes, turtles, frogs, fish. Mudflats are suitable habitat for resting and breeding ground of wetland speciealist bird species (e.g., Jacanas, Snips, Wild ducks) The embayment area (Figure 6.4) near Char is also highly important for fisheries which serves grazing and nursing ground for small species of fish, including *Cabdio morar* (Piyali) *Ailia punctata* (Banshpata), *Ailia coila* (Kajuli), *Eutropiichthys vacha* (Bacha), *Mystus cavasius* (Golsha), C*lupisoma garua* (Gharua), *Glossogobius giuris* (Baila), *Salmostoma acinaces* (Chela), *Gudusia chapra* (Chapila)
Arboreal Habitat	Modified	There is an ecopark located within the EBAA. Basic habitat structure of the ecopark is arboreal. There is designated ecopark which is mostly a planted forest on the reclaimed land established during the construction of Bangabandhu Bridge. It serves habitat to a total of 89 species of wild animals. Among them 6 species were amphibians, 11 reptiles, 56 birds and 16 mammals.
River Water Area	Natural	This area is the core zone of river supported by deep waterbody. A diversity of fish, aquatic vegetation and crustaceans, reptiles and birds use the open water habitats. Kingfishers, Gulls, Terns, Cormorants, Herons, Egrets, and migratory birds collect their food from open water from river. 22 major carp spawn collection sites were identified in the Jamuna River (Figure 6.4).



A: Embayment and Submersible Char **B: Major Carp Spawn Collection Sites**

Figure 6.4: Important Habitats for Fish and Fisheries in Jamuna River In and Around the BAA

6.4 Biodiversity Features

The variation in habitat types and ecosystems sustains numerous flora and fauna species in the project influence area. The diversity in flora and fauna represents the species level status, distribution, and contribution in ecosystem in the Jamuna River.

6.4.1 Flora

A total of 76 plant species were identified in the area, among them 40 species are trees, 33 herbs and shrubs, and 3 bamboo species. These plant species divided into aquatic and terrestrial types (Table 5.1 in Annex 6.1). Terrestrial vegetation includes trees, herbs and shrubs which are generally found in the homesteads, settlements and along the embankment. The main purposes of planted trees are food, firewood, and timber production. In the open and uncultivated Charland areas, the plants that were seen are Binna Ghash, Kansh, Chhan, Ghagra, Ban Palang, Kolmietc. The two very common exotic tree species in the program influence area are Acacia and Eucalyptus. Common but invasive aquatic floras are Kachuripana (*Eichhornia crassipes*) which grow well in the stagnant aquatic environment where water flow is low or absent.

6.4.2 Fauna

The faunal diversity includes both the invertebrate and vertebrate groups. A total of 332 vertebrate species were identified in the field or retrieved from literatures which included 25 species of mammals, 223 birds, 36 reptiles, 15 amphibians. (Figure 6.5; Table 5.5 to5.9 in Annex 6.1). A total of 78 fish species were identified from literature and 33 fish species were recorded during catch assessment survey (Figure 6.5; Table 5.5 to5.9 in Annex 6.1). A total of 67 butterfly species was noted in existing literatures although detailed survey for invertebrates was not done in the program due to the limited availability of data and no significant impacts were expected.

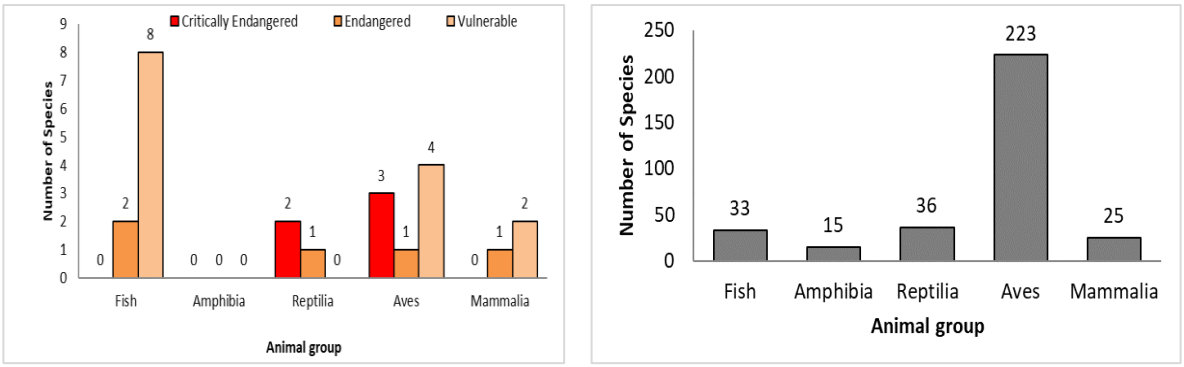


Figure 6.5: Diversity and Threatened Categories of Vertebrate Species in JRECDP Area

Mammalia

A total of 25 mammal species are known to occur in the program influence area. Ganges River Dolphin is the most prominent species (Figure 6.2; Table 5.5 in Annex 6.1). Another important mammal is the Fishing Cat which is endangered both nationally and globally.

Aves

A total of 223 species of birds are known to occur in the program influence area, of which 37.7% (84 species) are migratory winter visitors and rest are resident species (Figure 6.5: Table 5.6, 5.7 in Annex 6.1). Huge congregation of migratory winter birds including resident Lesser-whistling Ducks are sighted during November-March in the floodplains of Jamuna River (Source: transect data and Asian Waterbird Census 2014).

Reptilia

The number of reptilian species in the program influence area is 36 representing 21.7% of the reptile diversity of Bangladesh (Figure 6.5; Table 5.8 Annex 6.1). Gharial is the most significant species which is a nationally and globally critically endangered species (IUCN Bangladesh 2015).

Amphibia

The stagnant waterbodies and the riparian terrestrial areas offer important habitats for amphibians. Therefore, amphibians are fairly common in the project influence area harbouring 15 species (Figure 6.5; Table 5.9 in Annex 6.1). Some common species in the project area are Skipper Frog, Cricket Frog, Indian Bull Frog, and Common Toad (Hasan et al. 2014).

Fish

The present study observed 33 species of fishes and found 78 fish species in secondary literatures under 9 orders and 15 families in the Jamuna River. Among them, 2 are endangered, 7 vulnerable, 22 least concern and 1 data deficient according to IUCN Bangladesh 2015. List of observed fishes and their conservation status is shown in Table 9.5 in Annex 6.1. Nationally critically endangered Baghair, Endangered Gajar (*Channa marulius*), Rani (*Botia sp.*), pabda (*Ompok sp.*) are also found around the project area.

Invertebrates

A wide range of aquatic and terrestrial invertebrates is known to occur in the project influence area. But limited data is available on their diversity and abundance. The study area is similar to other areas of the country in terms of having diverse invertebrate communities. A number of species of dragonflies (e.g., Paddy-field Skimmer, Common Picture wing, River Skimmer), damselflies, spider, beetles, grasshoppers and earthworms (e.g., *Dendrobena* spp., *Apporectoda* spp., *Lumbricus* spp.) exist in the area. A checklist of butterflies in the program influence area is provided in Table 5.10 in Annex 6.1. Thirteen species are enlisted as vulnerable and one (Pointed Ciliate Blue) is categorized as endangered (IUCN Bangladesh 2015).

Threatened and Near Threatened vertebrate species

A total of forty-seven globally and nationally threatened and near threatened vertebrate species occurs in the program area. Among them, 6 species are mammals, 15 birds, 10 reptiles and 16 species are fishes (Table 5.2, 5.3, 5.4 in Annex 6.1). All these species have been assessed by IUCN Bangladesh (2015) and the global status has been retrieved from the IUCN Red List (www.iucnredlist.org). Among the critically endangered species three are birds, and two reptiles. Considering the endangered species, two are fish and one each were from reptile, bird and mammal each (Figure 6.5).

6.5 Bio-calendar of Wildlife

The bio-calendar of Jamuna River was made for the key species that inhabit the area. For constructing the calendar, field survey data and secondary information were considered. The water level data of Jamuna was also incorporated here to represent the relationship among biological activities of the species (Figure 6.6).

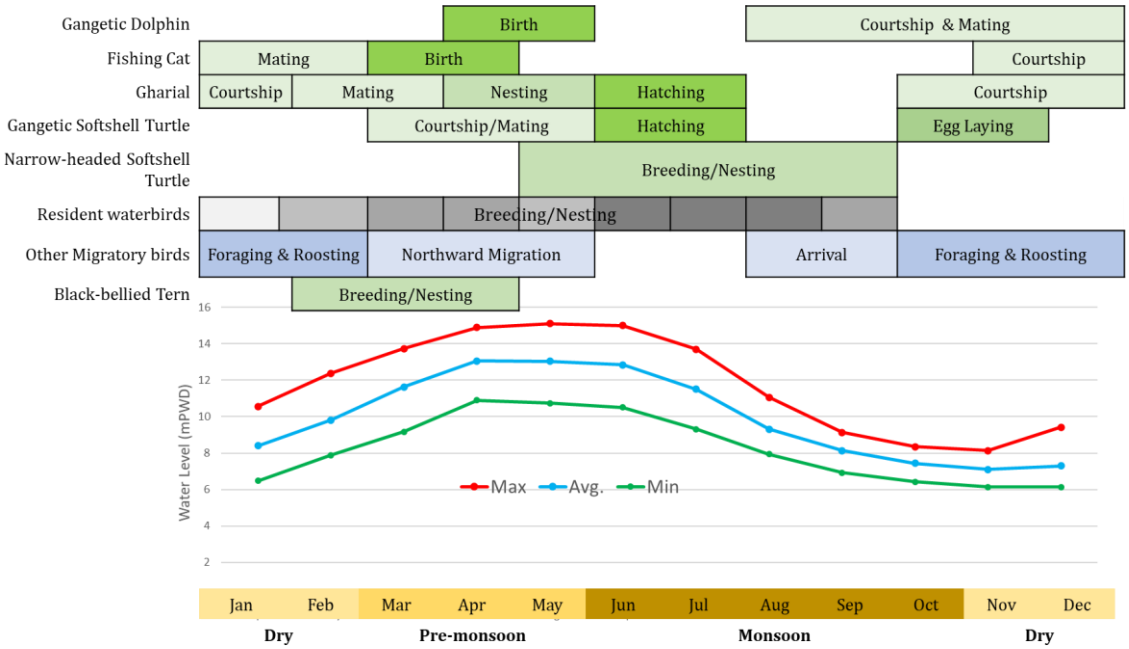
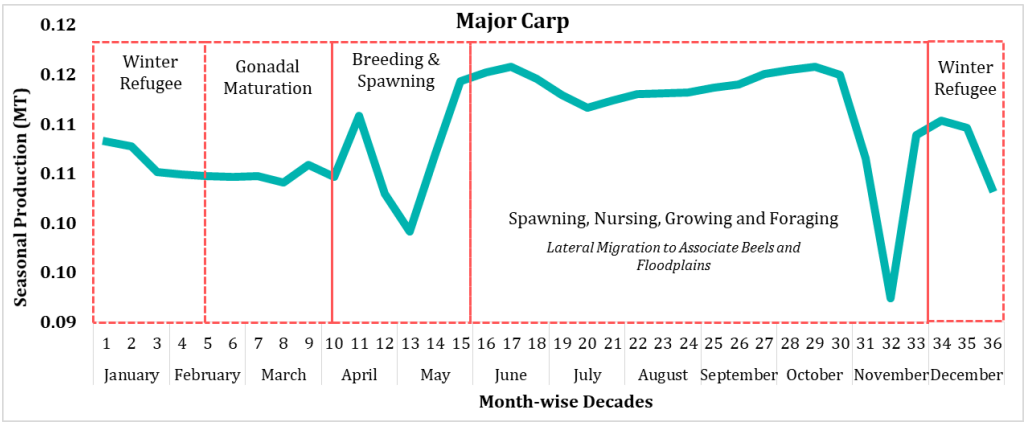
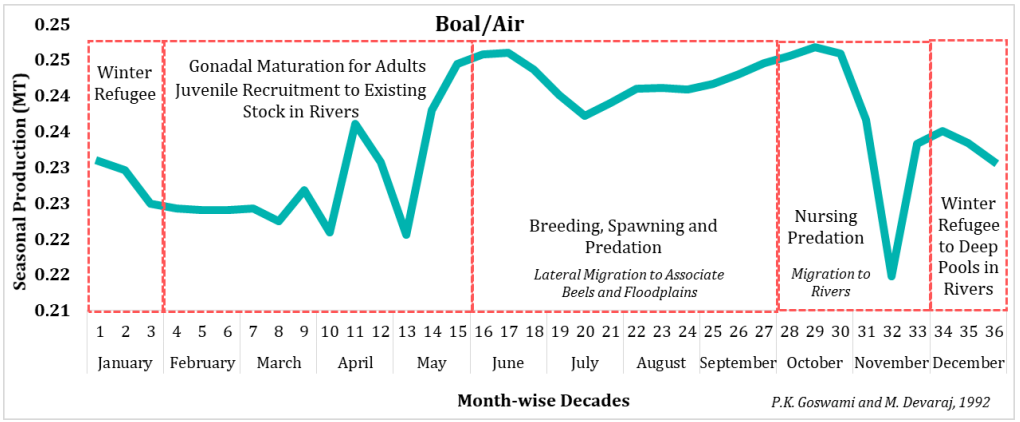
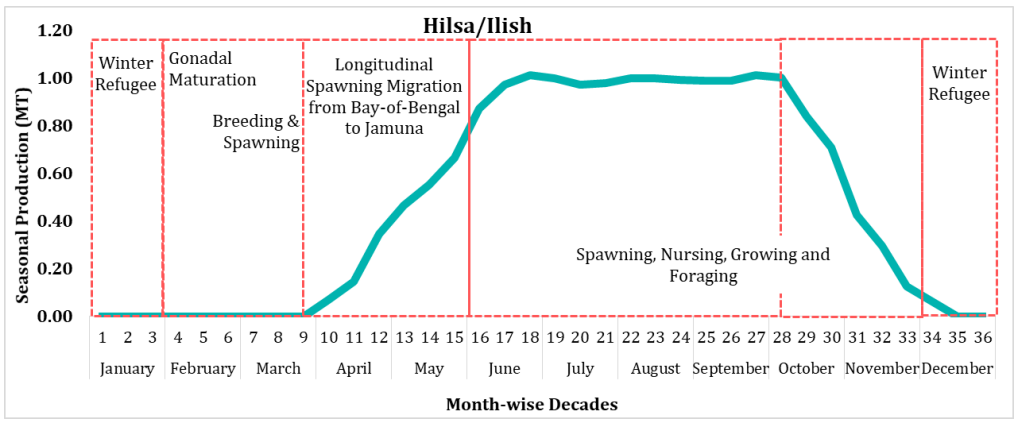


Figure 6.6: Bio-calendar of Important Wildlife Species in Jamuna River

Seasonal production calendars on Major Carp (Rui, Catla and Mrigel), Big Cat Fish (Boal and Air), Hilsha and other inland fishes were primarily developed based on the production probability. Fish production is influenced by water discharge and water depth, and seasonal life cycle, of these fish groups (Figure 6.7). These production calendars were validated from each data of these fishes and consultation with local commercial fishermen.







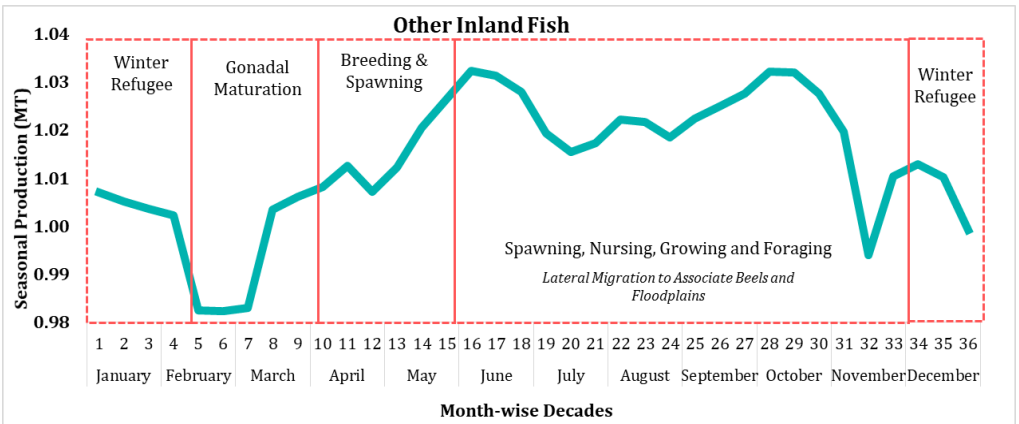


Figure 6.7: Seasonal Production of Major Carp, Big Catfish (Boal/Air), Hilsha and the Other Inland Fishes

6.6 Critical Habitat Assessment

6.6.1 Critical Habitat Criteria of the ESS6 of the World Bank

As per ESS6, Critical Habitats are defined as areas with high biodiversity importance or value including:

- habitat of significant importance to Critically Endangered or Endangered species, as listed in the IUCN Red List of threatened species or equivalent national approaches;
- habitat of significant importance to endemic or restricted-range species;
- habitat supporting globally or nationally significant concentrations of migratory or congregatory species;
- highly threatened or unique ecosystems;
- Ecological functions or Characteristics that are needed to maintain the viability of the biodiversity values described above in (A) to (D).

6.6.2 Methodology of Determining Critical Habitat

The approach to critical habitat assessment started with screening ESS6 criteria to preliminarily assess whether these criteria would be applicable or not. Thereafter, a species list obtained from the IBAT dataset of species for 50km radius of the project AOI. The IBAT listed a total of 903 species including 9 Critically Endangered (CR) and 18 Endangered (EN) species based on the global IUCN Red List of Threatened Species. The list of species was further updated with the data from IUCN Red List of Bangladesh (IUCN Bangladesh 2015). While determining the conservation status, priority was given to the national red list ratings over and global IUCN Red list status.

Species were screened through excluding the species which were not relevant to the BAA defined for biodiversity assessment and which were unlikely to occur within the BAA and its vicinity. The BAA included natural habitats like mudflats/sandflats, river area and newly emerged Chars. The modified habitats occuring within the BAA were agricultural lands, planted area, sand-mining & storage area, settlements and urban area like resorts.

Thereafter the relevance of critical habitat was assessed for each species based on expert judgment. The assessment of "significant importance" of the habitat was made through applying the following guidelines:

- Key Biodiversity Areas (KBA) including IBA and AZE sites, other protected areas and reasons for designation are important CH indicators but require appropriate justification against the ESS6 critical habitat criteria.
- ESS6 Criterion (a) requires an assessment against both global (IUCN) and national red list ratings. ESS6 footnote 13 states that where the threatened status of a species is listed differently between the two lists, assessment of the impact of net reduction should be based on the national/regional population. This is interpreted as a requirement to follow a precautionary approach and apply assessment of species reduction (project impact) to the smaller species population.
- CR species face an extremely high risk of extinction, and their survival is in a critical state. Therefore, if present in the BAA, consideration should be given towards ESS6 Criterion (a) being achieved, unless there are appropriate arguments for its exclusion.
- Where a significant proportion (± 1%) of the national or global population of a CR or EN species has a likely presence within the BAA, critical habitat can be achieved under ESS6 Criterion (a).
- ESS6 Criterion (b) can be achieved for restricted range species where the BAA overlaps a significant proportion (± 1%) of a species' distribution range.
- ESS6 Criterion (c) can be achieved for migratory and congregatory species where a significant proportion (± 1%) of a species' national or global population is exposed to the BAA of impact.

- ESS6 Criteria (d) and (e) are to be assessed on a case-by-case basis using reliable data sources and expert opinion, with consideration given to legally protected areas, KBAs, IBAs, AZE sites, Ramsar Sites, World Heritage Sites, other conservation initiatives and the reasons for which they are designated.

6.6.3 Determination of Critical Habitat Occurrence

A list of CR and EN species relevant to the BAA are presented in Annex 6.1. The screening assessment was based on the national database of Bangladesh's biodiversity, habitat preference of this species, and the Likelihood of Occurrence (LOO) of each species (within the BAA). The species that had not been recorded previously in the BAA, and which were unlikely to occur were excluded from the list. No endemic or restricted range species were found.

After the screening (Annex 6.1), the assessment was made to determine Critical Habitat Occurrence within the BAA as per the ESS6 criteria, and expert judgment on "habitat of Significant Importance" and "Significant Concentration of migratory species" (Table 6.3).

6.6.4 Screening of Critical Features against Potential Risk and Impacts

The potential critical habitat features (species which might trigger critical habitat criteria) were further evaluated on the basis of current threats and potential risk and impact due to the proposed interventions. The following table presents the final results. In total 5 species was detected and among them 2 were nationally critically endangered, 2 endangered and one vulnerable (Table 6.3).

Table 6.3: Final Screening of Critical Habitat Features against Potential Project Impacts

Species English and Scientific Name	Threat. Status		Documented Threats	Potential Project Risks and Impacts	Net Gain Requirements
	Nat.	IUCN			
Gharial *Gavialis gangeticus*	CR	CR	habitat destruction, upstream embankments and entanglement in fishing nets	There is a potential disturbance to Gharial through dredging, noise emissions associated with piling and the increased presence of workers associated with construction activities. However, a minimal population of Gharial is expected if any at all and mitigation to flush sensitive species away from construction works is considered sufficient to avoid any potential impacts.	Impacts can be avoided. Net gain is therefore not required
Ganges River Dolphin *Platanista gangetica*	VU	EN	Poaching, Collection of oil from dolphin	Dolphin might be disturbed by dredging operation and pile diving for Groyne construction.	Mitigation will be necessary and net gain will therefore be required. Engagement with specialists and nearby dolphin sanctuaries is needed to explore the option for net gain.
Prionailurus viverrinus Fishing Cat	EN	VU	Human wildlife conflict, Indiscriminate killing, Anthropogenic Threats	Was not found in survey period but the BAA does include suitable habitat for this species. Fishing cats will not be impacted by dredging activities but construction works on the river bank. The presence of workers	Mitigation is required and minimal net gain will be required.

Species English and Scientific Name	Threat. Status		Documented Threats	Potential Project Risks and Impacts	Net Gain Requirements
	Nat.	IUCN			
				may raise the levels of disturbance, although impacts will be minimal.	
Baghair *Bagarius bagarius*	CR	NT	Over fishing	Eroding river bank is the preferred foraging habitat. The proposed intervention would alter this habitat by preventing the erosion, filling the scoured area with sand-filled geobags although the overall impact of the pilot phase to these fish will be low.	There is no known reliable mitigation, however a residual impact assessment will be constrained by the lack of data on these species. The Department of Fisheries will be consulted to investigate opportunities for developing effective mitigation.
Chital *Chitala chitala*	EN	NT	Over fishing, loss of floodplain connectivity, loss of habitat		

6.7 Assessment of Species Triggering Critical Habitat Criteria and Other Important Species

6.7.1 Ganges River Dolphin (Platanista gangetica)

The Ganges River Dolphin is facing high risk throughout the distribution range due to anthropogenic threats. It is now restricted to a few larger channels of Ganges-Brahmaputra-Jamuna-Meghna river system, thus enlisted as vulnerable (VU) in IUCN Bangladesh Red list and endangered (EN) globally (Alom 2015). Three dolphin sanctuaries have been declared in the Padma-Jamuna River system of which two are in the Jamuna River. A field survey revealed a good number of Dolphins in the Jamuna River and in and around BAA. Generally, Dolphins are frequently sighted along the major channel of the Jamuna River. Similarly, within the BAA, the major channel of the Jamuna River seems most favourable for dolphins. During an IUCN survey in the dry season of 2014, 23 dolphins were encountered near the Kazipur reach of BAA. In another research, another research has revealed that dolphin counts in the Jamuna River varied significantly between dry and wet (monsoon) season.

Conservation action recommended by Bangladesh Dolphin Action Plan 2020-2030

The government has prepared a set of action plans[40] for conserving Dolphins in the Major rivers focusing on Jamuna and Padma. The plan sets a vision of securing river and coastal ecosystems of Bangladesh where dolphins flourish up to the carrying capacity. The overall goals of the action plan are:

- Reduce dolphin population decline in rivers and coastal waters of Bangladesh
- Ensure protection of existing dolphin habitats of Bangladesh

The strategic plan sets 26 action points (Annex 6.4) under the above two goals. These 26 action points have been planned under 8 strategic actions. Table 6.4 lists some of those actions that may have relevance to the project.

[40] Bangladesh Forest Department, 2019. CONSERVATION ACTION PLAN FOR GANGES RIVER DOLPHIN AND IRRAWADDY DOLPHIN OF BANGLADESH. Available at:

https://bforest.portal.gov.bd/sites/default/files/files/bforest.portal.gov.bd/notices/3c350df6_a887_4067_bf6c_6df09f3492e2/Bangladesh%20Dolphin%20Action%20Plan%202020-2030_Final%20report%20April%202019.pdf

Table 6.4: Strategic Actions of Bangladesh Dolphin Conservation Plan 2020-2030 Relevant to this Project

Strategies of Government for Dolphin conservation	How it is adopted in JRECDP Project 1
Goal 1: Reduce dolphin killing in rivers and coastal waters of Bangladesh	
Increase the baseline knowledge on dolphins and their habitats	Linked study has been proposed for understanding Dolphin population in the BAA.
Reduce incidental and intentional killing of dolphins	Mitigation measures are proposed for preventing accidental killing of Dolphin during dredging ensure no net loss as per the requirement of ESS6
Develop skill, capacity and governance for improved protection	Dolphin sanctuaries occur nearby, and there may be opportunities for improved governance and protection of those areas
Goal 2: Ensure protection of existing dolphin habitats of Bangladesh	
Increase knowledgebase on dolphin habitat and threats	The linked studies would contribute to current knodledge base
Engage all actors and stakeholders in protection of dolphin habitat	Stakeholder Consultation has been planned during project implementation

6.7.2 Gharial (Gavialis gangeticus)

The only large reptile in the area is the Gharial - *Gavialis gangeticus* which is a type of crocodile and is extremely rare. It is a globally and nationally threatened species. Several decades ago, this species had wide distribution in the Ganges-Brahmaputra River System, but the population sharply declined due to the lack of food (fish), accidental killing by fishing nets and destruction of eggs by domestic dogs (Khan 1982, Rashid et al. 1986). Today, it is one of the rarest species of wildlife in Bangladesh and there have been no report of its nesting since late-1980s. Gharials may have been moving between the two countries — Bangladesh and India — using the routes identified by Rashid et al. (2014).

6.7.3 Baghair (Bagarius bagarius)

One of the important catfishes found in the Jamuna River– and is an important food and game fish in Bangladesh, Bhutan, India and Nepal. It has been listed as CR in the IUCN Red List of Bangladesh (2015), however some studies indicated that the species occurs in many of the large rivers in Bangladesh and could be downlisted to vulnerable[41]. It is a carnivorous fish that feeds on small fishes, prawns, frogs, insects, etc. Therefore, *B. bagarius* is also important as a predator in top-down control of riverine food web.

The population has, however, steadily declined over the years. Yet sometimes large specimens are netted by the fishers. A 120 kg Baghair was captured in the Jamuna River near Dewanganj, Jamalpur on 27th February 2021 and another 48 kg Baghair was captured near the same site on 18th June 2021[42].

6.7.4 Fishing Cat (Prionailurus viverrinus)

A critically endangered small feline and most enigmatic predator - one of the largest among the 28 species of small cats found worldwide.

[41] Bijoya Paul, Md. Foijul Hasan, Md. Monirul Islam, Goutam Kumar, Kundu, Gouri Mondal, Samapti Saha, Md. Ghulam Mustafa. 2019. Evaluation of the status of threatened catfish *Bagarius bagarius* (Hamilton, 1822) from the Padma and Meghna river stretches of Bangladesh. Dhaka Univ. J. Biol. Sci. 28(1): 111-120, 2019 (January)

[42] https://www.risingbd.com/english/country/news/80330. 18 June 2021

Widely distributed in Bangladesh in different fragmented habitats. Habitat loss is one of the major threats particularly, transformation of wetlands remains high on the list facing the Fishing cat. In addition, indiscriminate killing whenever found exposed in different habitats; for consumption by some indigenous people – the Santals and Oraon in north Bangladesh; and road kills. The Char grassland of the Jamuna River makes an ideal habitat, but the extraction of grass and other human disturbances leaves them with little space for these cats to survive. The Santals go for traditional hunting early or late in the winter season in the Char lands of the Padma and Jamuna Rivers, adjacent area of their settlements, and nearest districts but sometimes, they travel further away to other districts to hunt wildlife particularly small mammals like mongoose, rabbit, jackal, fishing cat, civet, or whatever they can find.

7. Socio-economic Baseline Condition

7.1 Socio-economic Profile of The JRECD Program AOI

7.1.1 Overview

People living in the floodplain have historically adjusted by adapting their agricultural practices, cropping patterns, and settlements to annual flooding. But the high or abnormal floods (bonna), associated with widespread damage to standing crops, properties, and loss of human lives, are viewed as a calamity or disaster. As a result, those who are displaced migrate only a short distance and a large majority of the displaced adapt to their river-dependent lives and livelihoods.[43] However, the twin forces of erosion and flooding have a toll on the floodplain people, who lead a poverty-stricken life, particularly those who are displaced and live in Chars and along the embankments. Char dwellers are among the poorest and highly vulnerable to natural hazards of flood and erosions.

Historically, the Jamuna was once famous for its trade and navigational routes. Many markets and growth centers had flourished along the routes of the riverine country.[44] However, continuous shifting of the river interrupted navigation, and hence many market and growth centers lost their significance as trade centers. Aside from this, many large landowners living along the banklines had become landless due to continuing erosions and instability of the river, which is truly reflected in local ethos and stories: *Nodir ekul bhange, okul gore eito nodir khela, Sokal belar raja are bhai fakir sondha bela* (Breaking this bank and building the other is the river's lark, It makes the rich man of the morn a destitute by dark).[45] Thus, riverbank erosion caused by the shifting of river channels remains a perennial problem for Bangladesh.

It is, therefore, evident that many people in the Jamuna floodplain are perrenially at the risk of displacement. Therefore, the proposed bankline protection works and stabilization of the Jamuna River to a manageable navigation channel over the Program period will likely reduce the risks and bring about new opportunities and economic growth leading to social and economic transformation in the riverine regions.

7.1.2 Erosion Vulnerability, Displacement and Migration

The Jamuna is a multi-channel braided river changing its courses nearly every year at a noticeable rate. As a result, the width of the river has increased over time. Historical data indicate that the width of this river increased from 4.5 miles in 1830 to 7.5 miles by 1963, moving westward gradually. In the recent past, during 1984 and 1992, the width of the river Brahmaputra increased from 9.72 to 11.22 km. However, a declining rate is noticed in recent years. Although a detail analysis of erosion and accretion have been presented in Chapter 5, **Table 7.1** provides a gross information on erosion along the Jamuna River from 1973-2020 to give a glimpse of erosion severity.

[43] C. E. Haque and M. Q. Zaman, Human Responses to Riverine Hazards in Bangladesh: A Consideration for Sustainable Floodplain Development. *World Development*, Vol. 21(1), 1993.

[44] Radhakamal Mukerjee. *The Changing Face of Bengal: A Study in Riverine Economy*. University of Calcutta Press, 1938.

[45] M.Q. Zaman, The Social and Political Context of Adjustment to Riverbank Erosion Hazard and Population Resettlement in Bangladesh. *Human Organization*, Vol. 48(3), 1989.

Table 7.1: Erosion of the Jamuna (from Bangladesh-India border to Sirajganj) during 1973-2020

Year	Erosion at Left Bank (ha)	Erosion at Right Bank (ha)	Total Erosion (ha)	Erosion rate (ha/year)
1973-1980	11820	8030	19850	2835
1980-1989	12840	16250	29090	3230
1989-2000	11460	10430	21890	1990
2000-2010	6340	4660	11000	1100
2010-2020	5380	4310	9690	970

Source: Spatial assessment by CEGIS using Arc-GIS tool of Remote Sensing techniques, 2021

The river's shifting nature and monsoon flooding lead to various vulnerabilities, having tremendous impact on the life and livelihoods of the people in the floodplain. **Table 7.2** summarizes multiple types of risks and vulnerabilities and associated impacts on people and associated assets in the Program area.

Table 7.2: Vulnerability Types, Component, and Impacts

Type of Vulnerability	Immediate impacts	Socio-economic Impacts
Physical Vulnerability	• Loss of cultivable land • Eviction of homesteads • Infrastructural damage	• Decreasing household asset • Increasing number of landless people and increasing dependency on khas land (government owned land) • Increasing land rent for homestead construction • Dependency on the charity/relief for living • Interrupted service delivery
Economic Vulnerability	• Loss of agricultural production • Loss and damage assets and properties • Recurrent cost for household construction and maintenance	• Low income and unemployment; • Limited or no access to productive resources such as land; • Persistent poverty
Social Vulnerability	• Disruption of neighborhood and family ties due to displacement of settlement • Lose of political influences the due to displacement of community and disperse resettlement • Life risk for handicapped people	• Social helplessness and loss of support • Gendered based violence; • Poor health status and diseases; • Marginalization
Environmental Vulnerability	• Environmental degradation; • Poor drainage and relief; • Loss of vegetation and trees; • Increasing risk of hazards	• Crowded living on risk-prone zones; • Poor living environment; • Migration to inhabitable areas
Informational Vulnerability and Governance issues	Lack of relief system and/or limited opportunity of relief distribution due to poor/interrupted communication	Asset and life lose due to poor evacuation system and the lack of early warning system

Source: Adapted from Zaman, 2020[46]

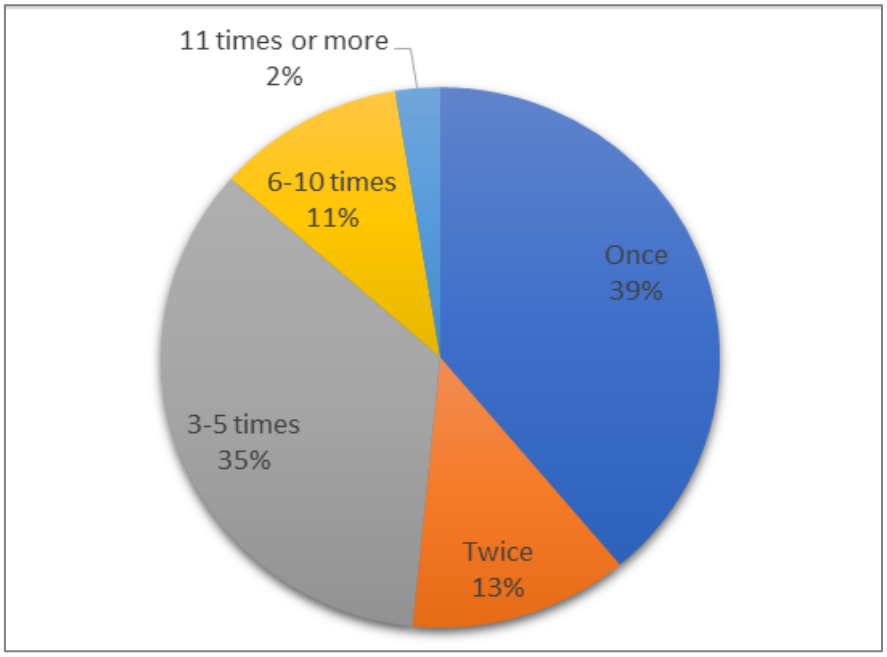
As evident, the vulnerability is multi-dimensional, from physical to economic to social and environmental and informational. The indicators of various types of vulnerability clearly show their interconnectedness.

[46] Mohammad Q. Zaman, Vulnerability, Disaster and Survival in Bangladesh. In Anthony Oliver-Smith and Susanna Hoffman (eds.) *The Angry Earth: Disaster in Anthropological Perspectives*, Second Edition, NY: Routledge 2020.

This is perhaps more so within the context of disaster and displacement in the Char/floodplain. For example, physical vulnerability, such as exposure to risk and settlement in the hazard-prone Chars, is a symptom of economic vulnerability. The economic vulnerability in turns shapes social and environmental vulnerability, pushing people into the most fragile and risk-prone areas, making them even more vulnerable.

There are various responses to these vulnerabilities.[47] From institutional side, local government institutions play a vital role, especially during high flood and support people by providing relief and cash-aid. However, in really, people displaced by erosion rarely receive any support or assistance from local administration. The erosion displaced families largely rely on kin and *samaj* (social unit based on kin and non-kin alliances) organizations for local adjustments and support in terms of relocation and rehabilitation. The people living along the bankline and/or Chars make such adjustments fairly regularly due to endemic displacement in the floodplain.

As reported in the 2014 RMIP Study[48] conducted among the people on the right bank of the Jamuna from Sirajganj to Gaibandha, 86% of those surveyed had experienced displacement caused by erosion. However, the frequency of displacement varies. About 39% of households experienced displacement once; another 35% were displaced 3 to 5 times, and 2% reported to have experienced displacement 11 times or more (see, **Figure 7.1**). The frequency and number indicate the precariousness and uncertainty that prevail in the floodplains due to erosion and displacement.[49]



Source: RMIP, Vol 2, 2014

Figure 7.1: Frequency of Displacement Experienced by Riverbank Residents

Thus, erosions by the Jamuna River have impoverished millions over the years. Box 1 illustrates the "story of the rich man in the morn a destitute by dark." This is too often told by people living with flood and

[47] C. E Haque and M.Q. Zaman. Coping with Riverbank Erosion Hazard and Displacement in Bangladesh: Survival Strategies and Adjustments. *Disasters*, Vol. 13(4) 1989.

[48] RMIP Vol. 2 cited earlier.

[49] Similar patterns have recently been reported from the Meghna Lower estuary. See Bimal K Paul et al. Coping Strategies of People Displaced by Riverbank Erosion. In M. Zaman and M. Alam (eds) *Living on the Edge,* cited earlier.

erosion; once a large landowner now landless and living on rented land and dependent on neighbors or relatives for livelihoods. This mutual support is a very common adaptive practice among people in the Jamuna floodplain.

Box 1: From Rich Landowner to Impoverished Landless

Alim ul Haque (pseudonym) was a rich landowner with some 500 *bighas*[50] of cultivable land in the 1970s. He accumulated the lands through inheritance and purchases. In his "original" village, he was a powerful social leader (*matabbar)* and used to help and support people in need affected by flood and erosion. Alim had eight children (four sons and four daughters). He never sent his children to school for education; land cultivation was their main economic stay and source of livelihood.

Like many of his villages, Alim experienced repeated displacement due to erosion by the Jamuna. However, he always moved back a short distance within the village, hoping that erosion will stop one day and be able to access his lands once they reappear as the dynamic process of erosion and accretion in the Jamuna system. He also did not want to migrate elsewhere because he feared losing his traditional social status and honor (*izzat*). Alim lost all his land to the Jamuna over the last 30 years and moved 20 times in and around his village. Finally, when all lost and gone to the river, Alim moved to a Char. He had to face displacement three times in the Char and then moved to the flood control embankment as informal settlers. The embankment was washed away the following year during the flood season. Alim finally moved inside the embankment and rented a piece of land for Taka 3,000 per year, a jump from Taka 2,000 in 2019 due to competitive land market caused by erosion.

Alim is now a helpless-tired elderly person who fought with the aggression of the mighty Jamuna River for the past 50 years. He now lives on his social safety net (SSN) allowance and occasional help from his sons and neighbors. Alim ul Haque's story reflects his resiliency and adaptation to the endemic erosion phenomenon and his ultimate pauperization caused by river erosion.

Source: Interview held at Kholabari Bazaar, Dewanganj, Jamalpur, in June 2021.

Alim ul Haque's displacement experience may appear high; however, it is not uncommon in the Jamuna floodplain and Char areas. Haque and Zaman[51] found that nearly 12% of those displaced (N=321) in Kazipur Upazila moved 13 times or more over 40 years. In Kazipur, 33% of those displaced moved between 1.5 to 8 km in their last reported displacement. These patterns are also reported in Char studies in the Padma River basin.[52] These patterns confirm that displacement is more common with short-distance migration despite unstable land and insecure lifestyles and the environment. Haque and Zaman[53] further observed that Charland people want to live and work within the Char environment.

7.1.3 The Social Tale of the Chars in the Program AOI

Char (or Charland, in plural Chars/Charlands) is the Bangla term of the riverine island and all types of bar[54]. The braided Jamuna has 56 large Chars and 226 small sandy and vegetated Chars[55]. The Jamuna Chars are of three types: the island Chars, attached Chars, and sand bars. Some island Chars are relatively stable and

[50] 1 bigha = 33 decimal

[51] Cited earlier (1989), Tables 3/4

[52] See, Shafi Noor Islam, Floods, Charlands Erosion and Settlement Displacement in the Ganges-Padma River Basin. In Mohammad Zaman and Mustafa Alam (eds), *Living on the Edge: Char Dwellers in Bangladesh*. Springer 2021.

[53] Cited above (1989).

[54] https://en.banglapedia.org/index.php/Char

[55] http://en.banglapedia.org/

settled; others are vegetated and good for year-round cultivation. In addition, there are others, such as sandbars, that are typically flooded; the sandbars are visible and used only during the winter/dry season. There are also Chars contiguous to riverbanks, called attached Chars, often indistinguishable from the floodplain. In general terms, Chars refer to all alluvial deposits – large or small, temporary or permanent – either in the river or close to the banklines.[56]

Char settlements are unique in Character and evolve over time. As soon as the new Chars emerge as sand bars during the dry seasons, the first step in establishing ownership rights in new Chars is to get "possession" that involve conflicting claims by people from both banks because there are enormous difficulties in determining ownerships of such alluvial formations; moreover, such sand bars often disappear during the following flood seasons. The *Bengal Alluvion and Diluvion Regulation* of 1825 and its subsequent amendments in 1950 (i.e., East Bengal Tenancy Act) and more recent post-independent amendments to 1994 are a complex set of rules that indeed provoke more conflicts than actually settling ownerships of such Charlands.[57] The new Chars are not surveyed for determining ownerships and titles by the Government of Bangladesh's Department of Land Records and Survey (DLRS) Department until these Chars are stabilized and are above the normal flood level that can typically take up to 30 years. The huge gap of 30 years in effect helps the locally powerful individuals/groups to grab newly emerged land before survey and settlement.[58] Thus, the alluvial Charlands remain subject to perennial dispute and protracted litigation among conflicting claimants due to difficulties identifying whether the land is an accretion or a reformation in situ.

An estimated 6 million people live in Jamuna Chars in the 200 km stretch from Kurigram to the Jamuna Bridge site in Sirajganj. Within this reach, some of the northern districts such as Kurigram, Rangpur and Gaibandha are relatively poorer with a large segment of Char population. Many NGO programs, including the Chars Livelihood Programme (CLP), funded by DFID and AusAID, and Practical Action (a British NGO), have worked in the northern districts for several years to improve livelihoods and reduce vulnerability among the poor, more particularly women in the Chars with some positive results.[59] However, the limited NGO interventions are inadequate to address the needs of Char people at large. Health, education, and other essential services are still major issues for Char dwellers due to isolation and lack of necessary infrastructure.

For settlement purposes, Char people usually select comparatively higher ground that are flood proofed to build their houses to reduce vulnerability and risks.[60] Typically, Char villages live in groups or clusters, coming from the mainland or other Chars after being displaced. This builds a sense of community through *samaj* organization as social capital to help each other in crisis. Box 2 provides an example of Char living and livelihood in one of the districts covered by the Program AOI.

Box 2: A Tale of Tiner Char in Jamalpur

Tiner Char is a large Char, located in Chukaibari Union Parishad (Smallest Rural Administrative and Local Government Unit), comprising a number of small Chars. It includes Char Projapoti, Munnia, Boral,

[56] Mohammad Zaman and Mustafa Alam (eds), *Living on the Edge: Char Dwellers in Bangladesh*. Springer 2021.

[57] Mohammad Zaman and Md. Akhtar Hossain, The Charland Administration and Governance: Need for a Paradigm Shift. In Mohammad Zaman and Mustafa Alam (eds), *Living on the Edge: Char Dwellers in Bangladesh*. Springer 2021.

[58] M. Q. Zaman, Social Structure and Process in Charland Settlement in the Brahmaputra-Jamuna Floodplain, *Man (*NS), Vol. 26(4), 1991.

[59] Suzanne Hanchett, Projects, Programs, and Services for Marginalized Groups: The Case of Women in Bangladesh River Island (*Chars*). Paper presented at the International Union of Anthropological and Ethnological Sciences (IUAES) meetings, Poznan, Poland, August 2019

[60] Ian Tod and Monzu Morshed, Flood Proofing to Reduce the Vulnerability of Char Communities: Experiences and Future Directions. In M. Zaman and M. Alam (eds) *Living on the Edge*, cited earlier.

Box 2: A Tale of Tiner Char in Jamalpur

Zigatola, and Char Holka Hawrabari. The study team visited Char Holka Hawrabari, administratively located under Ward no. 2 of Chukaibari UP. This Char is now inhabited by around one thousand families. Each family includes 7-8 members on average. Land of this Char was owned by the people of Chukaibari UP, who used to cultivate here. Due to erosion, they lost their land, moved to the mainland. This Char reappeared around 30 years ago and gradually became cultivable. At the beginning, landowners constructed temporary houses for staying with or without family during the planting and harvesting time. When the Jamuna River eroded their cultivable and homestead land on the mainland, they were forced to migrate to this Char permanently about 10 years ago. The dynamic processes of erosion, accretion, displacement, and migration are reflected in the tale of Tiner Char. People who call Tiner Char home have diverse occupations.

Agriculture and crop production is the dominant mode of livelihood. Many are also engaged in **livestock rearing** as a livelihood supportive option. Each house has cattle. Usually, Char dwellers take money from rich relatives or investors from the mainland for buying cattle. They rear and then sell the cattle after a year or two. Upon selling, the principal goes to the investor, and the profit is divided in half between investor and farmer. F**ishing** is also a source of income and livelihood. However, there are only limited number of professional fishers; many catch seasonally and/or for household consumption. Another significant source of employment and income is **wage** or **day laboring** by Char dwellers, especially during the off-season. They usually work in Chars, but mostly in the mainland for higher wages. Temporary inter-district migration is also common during the harvesting season. A new trend among the younger population is out-migration for employment. Several young men and women from Tiner Char are working in the **garments industry** in Dhaka and Gazipur.[61] The numbers are increasing over the years as currently employed workers take their people for work and opportunities offered by the city. Finally, very few educated persons from Tiner Char are in government jobs by police, army, and school teachers.

Tiner Char inhabitants visit Dewanganj, a sub-district, for all sorts of their needs, including healthcare. Currently, no NGO is working in Tiner Char. The Char Livelihoods Program (CLP) was active in the area until the CLP wind up its Phase II program.

Flooding and storm surges often hit them; during such time, affected households stay on a temporarily built elevated platform called '*macha'* (made of bamboo) as an adaptive strategy to floods.

Source: Interviews (June 2021)

7.1.4 Settlement Patterns

The bankline erosion victims and displaced households generally move to the countryside due to familiarity and social support, coupled with available alternative lands for settlement, either own and/or rented. Many without any choices or alternatives have been found to resettle beside the flood embankment. Indeed, thousands of families are currently living on embankments along the reach on both sides of the Jamuna River. Those who live on the embankment are typically absolute landless and destitute.

[61] This has also been reported in a recent study. See Hafiza Khatun et al. Out Migration as a Survival Strategy for Char Dwellers. In Mohammad Zaman and Mustafa Alam (eds), *Living on the Edge: Char Dwellers in Bangladesh*. Springer 2021.

Since the embankment is owned by BWDB, there is no need to pay and/or rent for reconstruction of houses on the embankment.[62] Typically, displaced families from local villages or neighborhoods resettle on the embankment in a cluster to maintain their close-nit social ties and relationship for personal security and thus "re-create" their lost village on the embankment, under their traditional samaj leadership. For example, in Kazipur-Sirajganj area, sections of embankment settled by people are known by names of those villages already lost to the river. This provides them a sense of "identity" and continuity of lives on the embankment.

Settlement in the Char land varies in terms of the age and stability of the Char. If the Char is older, people prefer to move there because of the higher stability of the land. On the other hand, if the Char is new, the settlements are typically limited to only few households and are dispersed. In contrast, older and stable Chars have large settlements and are usually clustered based on kinship and other social considerations (see Photo-1a that presents a cluster type settlement).

Photo-1a: Char settlement

Photo-1b: Settlement beside flood embankment

Figure 7.2: Typical Settlements in Chars and on the Flood Embankment in the Program AOI

In the Jamuna River area as well as in the project AOI, a considerable number of people who are functionally and absolute landless are living beside embankment (see photo-1b).

7.2 The Study Area for Socio-economic Baseline of the Project

The study area for socioeconomic analysis of the Project level baseline (Figure 7.3) has been defined as Socio-economic Area of Analysis (SAA) which covers the Project AOI (of the Component 1 of the Project 1 of the JRECDP SOP), and the Union[63] intersected by the project footprint (Table 7.3). It would thus cover the direct impact area, indirect area, and control area beyond the Project AOI. In addition to the SAA, socio-economic data collection and analysis were done for the Program AOI as well.

[62] Officially, BWDB is against such encroachment or settlement on the embankment that affect the long-term stability of the structure owing to cutting of slopes by the settlers and rat holes due to housing and settlement. Settlements on the embankment are allowed primarily on humanitarian grounds.

[63] *Union is the Smallest Rural Administrative and Local Government Unit in Bangladesh.*

Table 7.3: Administrative Boundary of the Socio-economic Area of Analysis for JRECDP Project 1

Name of the Pilot Site	District	Upazila (sub-district)	Unions intersected by the Project and therefore covered by the SAA
Bhuapur	Tangail	Bhuapur	Gobindasi
			Nikrail
Tangail-Kalihati		Kalihati	Gohaliabari
		Tangail Sadar	Kakua

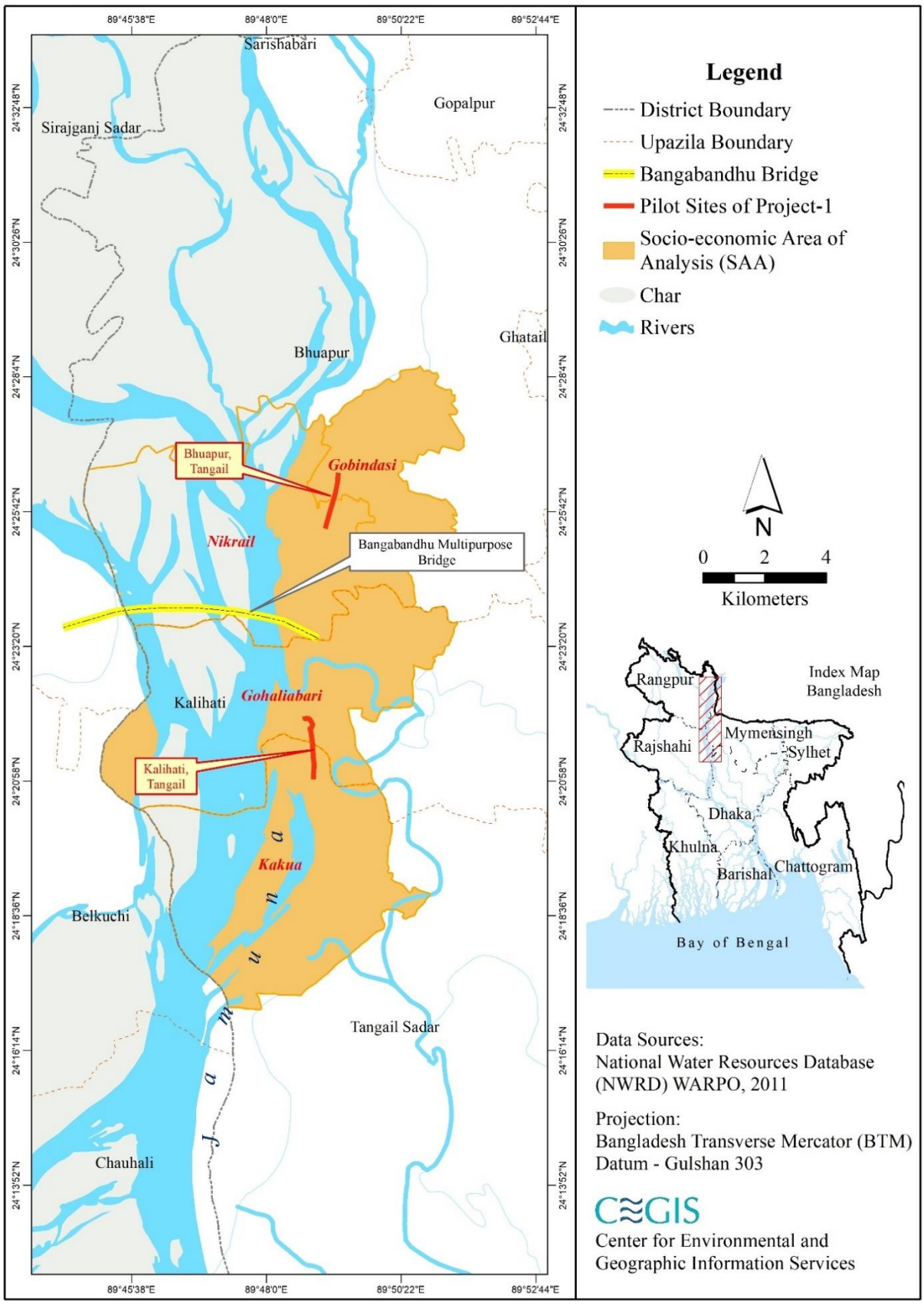


Figure 7.3: Map of the Socio-economic Area of Analysis

7.3 Data Collection Approaches

This socio-economic baseline section has been prepared with data from both primary and secondary sources. The scope and depth of primary data was restricted by the prolonged Covid lockdowns in the country. The primary data are thus complemented by secondary data where needed. The secondary sources include Housing and Population Census-2011 (published in 2012) by Bangladesh Bureau of Statistics, Social Assessment Report prepared for RMIP project,[64] and other published literature. The primary data was collected at two different times – first in June 2021 (in Bhuapur site) and the second in October 2021 (in Tangail-Kalihati site). For the Program AOI. Rapid Rural Appraisal (RRA) methods were used in the Program AOI and SAA, along with informal interviews, FGDs with occupational and multi-stakeholder groups, and group discussion at Union Parishad Level. Here, occupational groups refer to: famers, fishers, agriculture labourers, etc. Furthermore, FGDs with Char dwellers and displaced people have also been carried out. The Stakeholders Consultation and the Gender SEA-SH Team carried out separate consultation activities and interviews in the Program/Pilot areas, which are reported in the respective reports,[65] The Social Baseline Team conducted resource mapping exercises for qualitative data for the baseline assessment (see **Figure 7.4**).

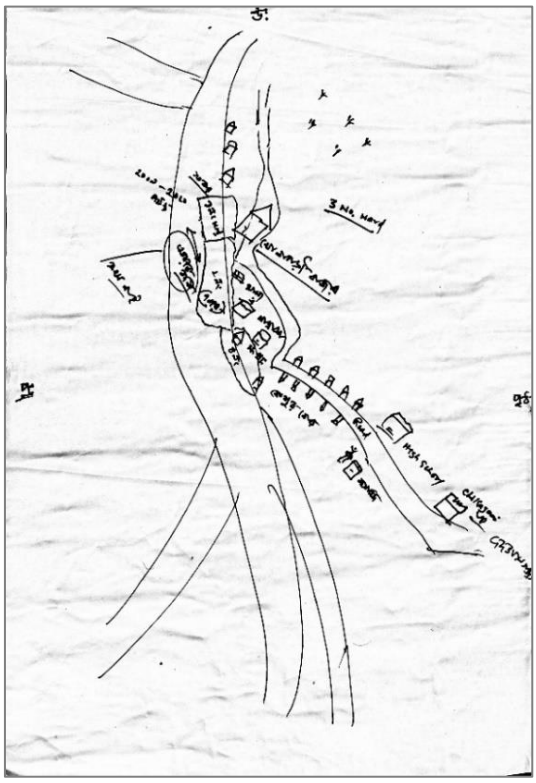


Photo: Resource mapping at Kholabari bazaar, Dewanganj Upazila

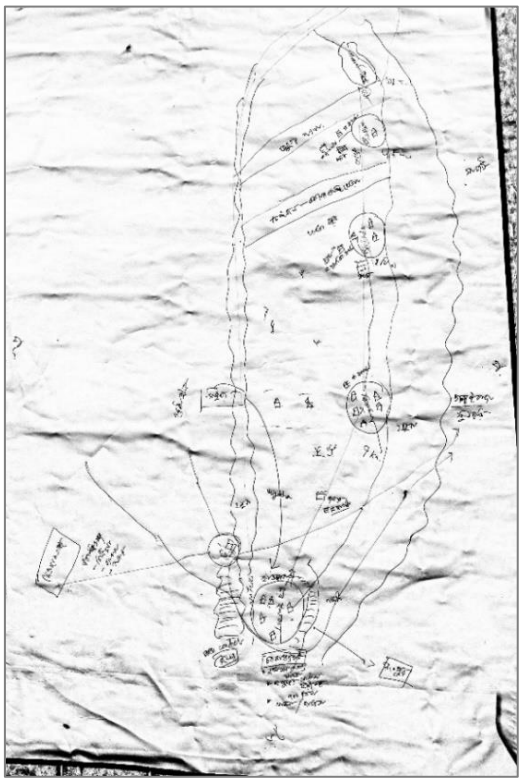


Photo: Resource mapping at Tiner Char

Figure 7.4: Field Interviews and Resource Mapping

[64] The River Management Improvement Program (RMIP) was prepared in 2014 for bankline protection and other measures to reduce erosion on the rightbank from the Jamuna Bridge site (Sirajganj) to Gaibandha. (The Project was later dropped). The Jamuna River Economic Corridor Development Project (JRECDP) has used the same reach (200 km) with multi-phase approaches for river stabilization and improved channel navigation and other activities. The RMIP data is a very useful secondary sources for this ESIA. Therefore, this ESIA has extensively used the RMIP data in preparing this report.

[65] JRECDP - Stakeholders Engagement Plan and Gender and SEA_SH Action Plan, November 2021.

7.4 Socio-economic Description of SAA

In this section, socio-economic profiles of both sites are presented – first using available Union level (lowest administration unit)[66] secondary data (see Table 7.4), followed by description of the two pilot sites. The population density of Tangial-Kalihati site is more than double that Bhuapur site. The rate of employed people is higher in Tangial-Kalihati site than Bhuapur. The involvement of people in the industrial sector is higher in Bhuapur than that of Tangial-Kalihati site. Bhuapur (*Upazila*/Subdistrict) shows negative growth rate whereas the rate in Tangail-Kalihati (i.e., Kalihati Upazila) area is 1.28, suggesting that a considerable number of people of Kalihati Upazila area have moved outside for employment in service sector.

Table 7.4: Comparative Profiles Selected Unions/Mouzas in the Pilot Sites

	Selected project sites	
	Bhuapur	**Tangail-Kalihati**
Administrative area included in the study	Two Unions	Two Unions
Population	58,986	57,464
Male	50.7	51.08
Female	49.3	49.20
Sex ratio	103	103
Household	13,955	12,352
Household size	4.2	4.7
Density per sq.km.	1509	715
Growth rate (Upazila)	-0.05	1.28
Literacy rate	44.2	35.99
Housing		
Pucca	1.1	0.39
Semi-pucca	9.8	1.51
Kutcha	85.4	97.12
Jhupri	3.7	1.02
Sanitation		
Sanitary (water-sealed)	11.3	2.57
Sanitary (non water-sealed)	48.7	24.52
Non-sanitary	35.7	58.25
None	4.3	14.65
Source of Drinking Water (%)		
Tap	0.5	0.46
Tube-Well	98	96.38
Other	1.5	3.2
Electricity Connection (%)	59.9	23.14
Housing Tenancy (%)		
Owned	94.4	88.61
Rented	2.2	9.8
Rent free	3.4	1.58

Source: BBS, 2012 (population was projected for 2020)

7.4.1 Socio-economic Condition of Bhuapur Pilot Site SAA

The Bhuapur site includes four Mauzas of two Unions located at Upazila under Tangail district. This is highly affected by flooding and siltation, which cause damages annually. Key features of this site are described briefly.

[66] Administratively, the two sites are located in four Unions covering six *mouzas* (revenue unit/village). The data presented relate to the administrative areas and not "footprint" of the pilot sites. The pilot sites are separately discussed.

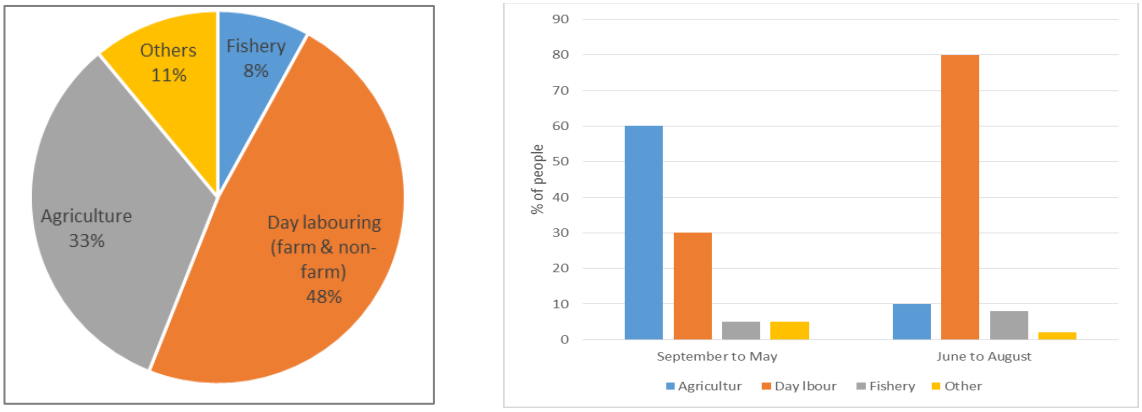
Flooding and siltation

Flooding is a very common and serious problem for the community living around the bankline of the proposed intervention area. Flood water overflows the bankline, inundates cultivable land, settlements and road networks. On average, flood waters remain for 15 to 20 days in agricultural plots, which causes crop damage. Sedimentation in distributaries is noticeable in this area. This also causes land accretion, some parts of which are now under cultivation. Also, people are involved in sand mining activities in accreted land.

Employment and livelihoods

People adopt various primary and secondary livelihood activities in the context opportunities available, seasonality ad impact of flood and erosion. In this area, a considerable number of people are involved in day laboring activity. Followed by daily wage labor, many people are also involved in agriculture activity, including cattle rearing. The non-farm activities are also growing.

Figure 7.5 shows the percentage of people involved in livelihood activities considering seasonal variation. Thus, according to this figure, the seasonality forces people to diversify their livelihood activities. However, the severe effect of flooding along with resource scarcity and socio-political deprivation, people mostly adopt day laboring activity during the lean period. Farmers, who cultivate corps from September to May, are forced to out-migrate to other districts and to earn an income from wage labor during June to August.

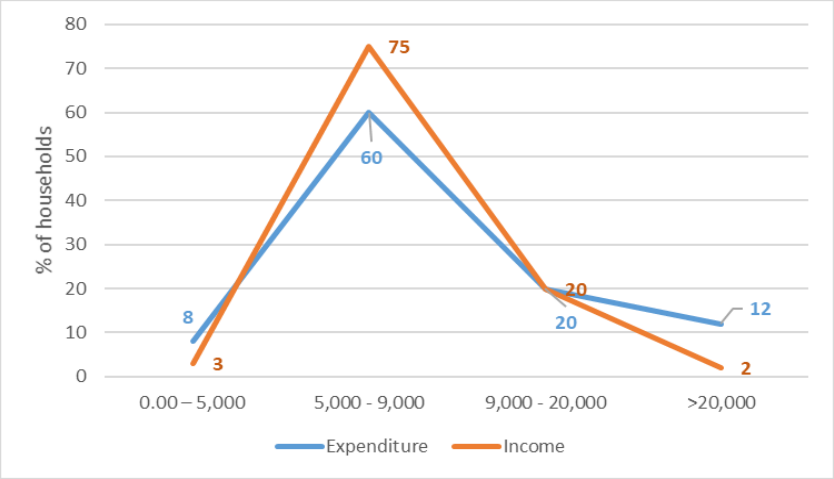


Source: Field Survey, 2021

Figure 7.5: Livelihood Activities at Bhuapur

Income and Expenditure

Household income and expenditure were assessed following the response of local people asked during group discussion and informal interviews. According to findings, most people belong to BDT 5000 to BDT 9000 category for both income and expenditure. However, some discrepancies between earning and expenditure, which could not be verified. Also, about 12% of households earn more than BDT 20000 per month (see figure 7.6).



Source: Field Study, 2021

Figure 7.6: Distribution of People according to Income and Expenditure

7.4.2 Socio-economic Condition of the Tangail-Kalihati Site SAA

This pilot site includes parts of two villages: Char Pauli and Alipur villages/mauzas. This area has been severely affected by riverbank erosion by the Jamuna River over the years. People tried to adapt to this disaster, migrated to urban area, changed occupation, etc. Key features of this site are described briefly.

Bankline Erosion and Impact

Figure 7.7 compares satellite images of 1995, 2001 and 2020 to illustrate the changes in river bankline and Charlands during this period which was triggered by construction of Bangabandhu bridge. According to local people, the erosion rate was negligible before the construction of Jamuna Bridge in 1998. After the construction of the Bridge, erosion started at a slower rate, which then accelerated since 2014. In the downstream of the bridge, the bankline migrated eastward causing rapid erosion in Kalihati and Tangail. According to local people, between 2014 and 2021, about 3,500 families have been displaced due to erosion. Of them, about 300 families have been displaced in 2021. Many of them have experienced 6-7 times displacement internally. Most of these displaced families have been forced to live on khas land because of their destitute condition driven by erosion. Some of them have taken a lease of private land and settled.

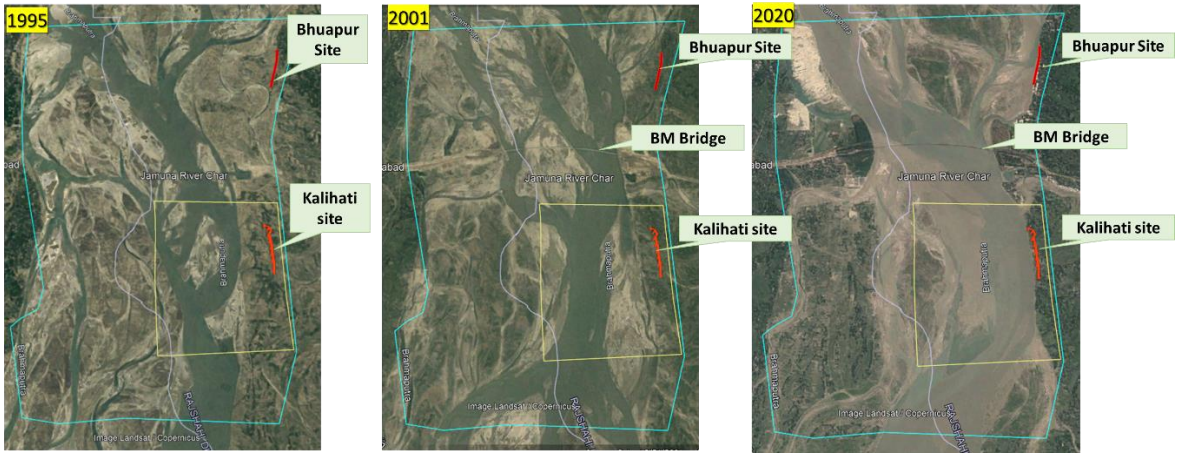
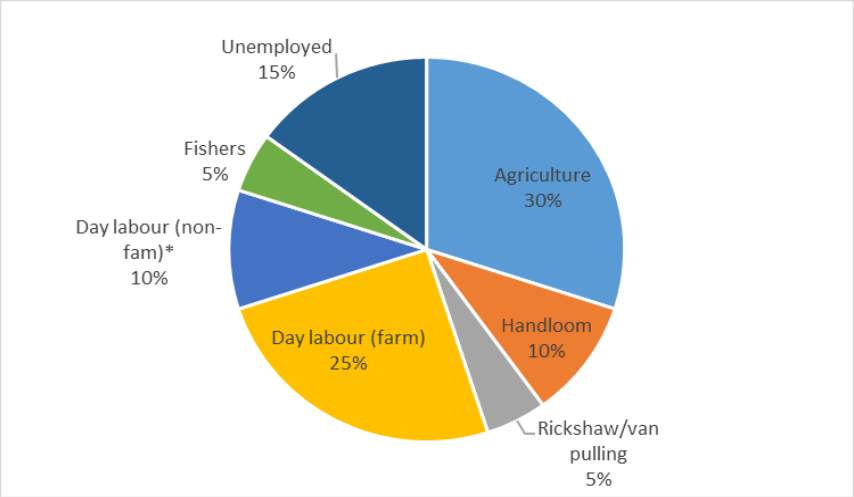


Figure 7.7: Abrupt Change in River Bankline and Charland after Construction of Bangabandhu Bridge

Employment and livelihoods

This area was known for handloom industries, which is now lost its significance due to erosion. The overall share of employment is shown in Figure 7.8.



** non-farm refers to manual labourer, mason, assistant mason, helper of truck driver, etc.*

Source: Field level assessment, 2021

Figure 7.8: Distribution of Population by Occupation

Agriculture is the dominant livelihood activity in this area. 30% people were reported to be involved in agriculture. Moreover, the number of farm labourers is 25%. The agriculture sector thus support 75% people in Kalihati. Although the handloom industry is declining, a considerable number of people (10%) remain involved in this sector. In Box 3, major livelihood groups are described briefly.

Box 3: Livelihood and Occupational Profiles of People in Tangail-Kalihati Site

Farming

Although agriculture is the dominant mode of livelihood, this practice is declining due to the erosion-driven land crisis in this area. Moreover, a significant cultivable land is now under lease and sold out for settlement of erosion victims. Most of the landowners produce crops by themselves with family labour and with the help of a few hired labour. The next cultivators are sharecropper, who produce crops following mutual terms and conditions of the landowners.

Handloom

Tangail handloom is famous for its unique weaving, patterns, and tradition. This industry was a successor of the famous Muslin, and thus was established in the nineteenth century in Tangail. This industry in this area is a 'cottage industry', and the looms are mostly installed in households. Most of the total installed looms has a unit size of five looms. Women are the main workforce of this industry, who can work easily at their home. Thus, handloom was a crucial livelihood source for local people before the recent aggressive river erosion (2014-2021), which caused about 3500 looms to disappear. Women became jobless and men have changed their occupation to manual labourers.

Van/Rickshaw puller

In the past, there were a very few people involved in the rickshaw/van pulling profession in this area. Presently, many of people are engaged in this profession being affected by river erosion. In fact, people who were heavily involved in agriculture or handloom have transformed into rickshaw-van pullers. Recently, a significant of them has moved to Dhaka because of: a) the increasing number of pullers, and b) lower income at the locality and hit by Covid-19 pandemics.

Labourers (farm and non-farm)

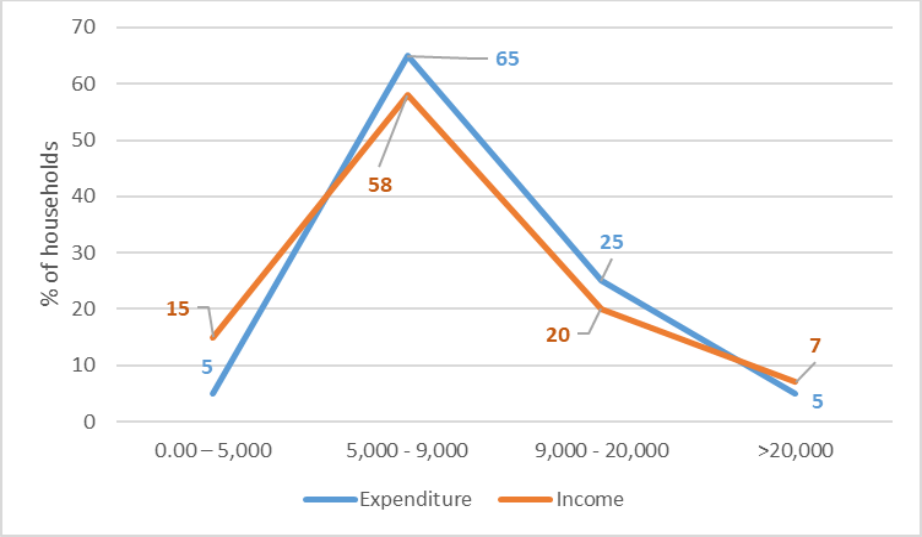
The large number of labourers are who lost their cultivable and homestead land due to river erosion. The farm labourer usually works within Tangail district, and often out-migrate to other district during the harvesting season. This group often involve in earth-working. Most of the non-farm workers are employed in Balumahal located at Bhuapur Upazila.

Fishes

The number of fishers is decreasing as the catch is gradually being lesser in the river. Because of the higher price of fishing gears and other related cost, fishing appears as a less economically viable option for survival in the competitive market. Therefore, many of them are changing this occupation and transforming into both farm and non-farm workers.

Income and Expenditure

Household income and expenditure were assessed following the response of local people asked during group discussion and informal interviews. According to findings, most people belong to BDT 5000 to BDT 9000 category for both income and expenditure (see Figure 7.9). There is a discrepancy between the number of earning and expending households in this group, suggesting indebtedness. Also, about 7% households have earning of more than BDT 20000 per month, whereas about 5% households expend this amount in a month.



Source: Field Survey, 2021

Figure 7.9: Distribution of People according to Income and Expenditure

7.5 Socio-economic Profiles of Households

7.5.1 Demography

Union level demographic features of three short-listed and two pilot sites are presented in Table 7.5. The discussion aims to present a broad overview of the entire Program AOI.

Table 7.5: Demographic Profiles of People in the Unions[67] of the SAA

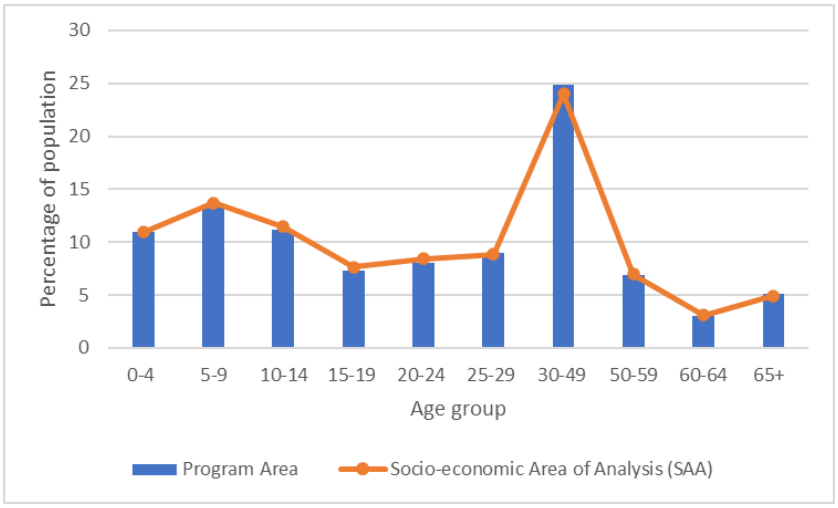
Name of Project site	Households	Population			Sex ratio	Population density [sq. km]
		Both (nos.)	Male (%)	Female (%)		
Bhuapur	13,955	58,986	50.7	49.3	103	1,509
Tangail-Kalihati	12,352	57,464	50.8	49.2	103	715
Total/Average	**26,307**	**116,450**	**50.7**	**49.3**	**103**	**1112**

The unions in the two pilot project areas have a total of 26,3.7 households with a population of 116,450. Of them, 50.7% are males, and 49.3% are females. The sex ratio is 103, which refers to 103 males per 100 female. The average density is 1,112per square kilometer. The average household size is 4.4, and most households comprise 3 to 4 members per household. (BBS, 2012; projected for 2020).[68]

The age composition shows that the age group 30 to 49 is the highest in the SAA of two project sites. (see **Figure 7.10).** Because of lower infant and under-five mortality (U5MR), the percentage of children is also noticeable.

[67] The Union is the lowest administrative unit in the country for which census data are available. The impact or project foot print will be on village/mouza (revenue unit) on a much smaller scale. Since proper field studies of pilot sites were not possible for covid restrictions and protocol, the union level data have been used to explain the general socio-economic profiles in the project area. The UPs of each piloting site are presented in the Table 7.3.

[68] The population projection for 2020 was estimated following 'simple linear method' by considering upazila wise growth rate estimated in Housing and Population census, 2011 (BBS, 2012). Thus, growth rate for Bhuapur, FulChari, Panchthakuri, and Pingna are respectively: -0.05, 1.81, 1.36 & 0.29. On the other hand, Tangail-Kalihati site spreads over two Upazilas and thus growth rate for Kalihati is 0.85 and for Tangail Sadar is 1.71.



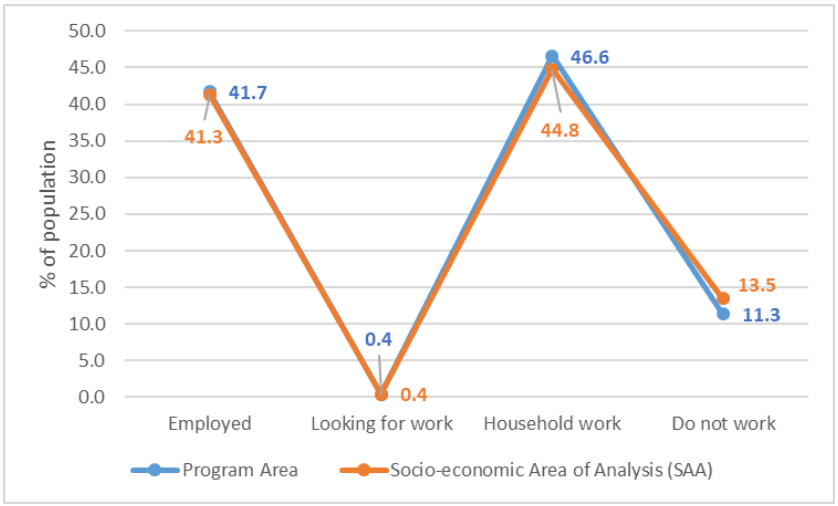
Source: BBS, 2012

Figure 7.10: Distribution of Population by Age

7.5.2 Employment Status

The BBS (2012) estimates employment status into four categories: employed, looking for work, household work, and not working (excluding school-age children up to 7 years old). The employment status shows that less than half of the population is employed. Here, employment includes earning people involved in any work, and therefore it discounts household work as employment.

Compared to the Program AOI, employment status in the SAA is slightly lower. On the other hand, the "do not work" category is marginally higher in the SAA (13.5%), referring to higher school dropout and unemployment. Since these people are not permanently employed, aged above seven years but not attending schools, the census did not include them into the used category, although many of them occasionally involved in income-earning work. (See **Figure 7.11)**.

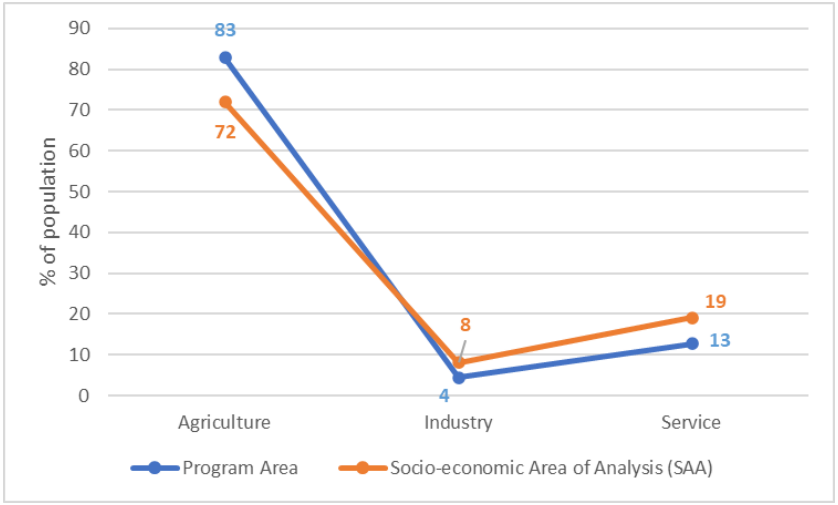


Source: BBS, 2012

Figure 7.11: Employment Status

In the following figure, the employed population has been distributed into three sectors: agriculture, service, and industry. Thus, according to data (BBS, 2012), agriculture is the dominant mode of livelihood in the Program AOI, estimated at 83%. This group includes farmers, including sharecroppers, fishers of both professional and seasonal, livestock and poultry farmers. The second-largest employment sector is service, which refers to salaried employees working in the office, teaching, etc., and people involved in transportation service. About 19% of people in the project area are engaged in the service section, which

is comparatively lower in the program AOI (13%). Also, involvement in commercial/industrial sector (including garment) is higher in the SAA (8%) than that of the program AOI (4%). (See **figure 7.12**).



Source: BBS, 2012

Figure 7.12: Sectoral Involvement of People in the Study Area

7.5.3 Diverse Employment Patterns in the Floodplain

The field study (FGDs, KII and consultations) conducted in June, September and November of 2021 and January and February of 2022 along the program corridor and C1 project sites found that the people are engaged in a diversity of activities for income sources and to earn their livings (Figure 7.13)). The available BBS data have limited value to understand the variety of economic activities in the floodplain. This section provides a summary of the field-level findings, further complemented with secondary sources. Overall, the employment and occupational patterns in the Jamuna River area can be divided into six broad categories: small farmers, laborers, fishers, involved in service, industrial workers, and businessperson/trader. People are not exclusively involved these groups, rather often change and/or are forced to chage their occupations due to riverbank erosion, flooding and other factors. The Figure 7.13 and the following occupational group-wise discussion highlights these occupational mobilities. Generally, most of the mobilities are found among small farmers and labourers. There is also an increasing trend among children of both groups, particularly girls, to be engaged in the garment industries.

Small farmers

The number of large farmers is too small in the riverine areas due to endemic erosions.[69] As a result, large landholders have gradually transformed into small landholders. Besides, many large, medium, and small landholders currently have no cultivable land of their own, and instead are cultivating as sharecroppers solely. Sharecropping practice is widely found around the Jamuna River. This practice is typical of two types: *Adha* (half) and *Tebhaga* (one-third) between the owners and cultivators. If the landowner provides inputs, the yield is distributed into *ada* or half; otherwise, total yield is divided into three (*Tebhaga*), and only one third is given to the landowner.

These small farmers combine their cultivation with rearing livestock at their homes, and usually both male and female members take care of these cattle. Moreover, livestock is commonly found in every household especially in Char areas due to ample grazing opportunities. Some small-scale farmers also reported seasonal fishing in Jamuna River as another option for income. So, multiple occupations are common

[69] There are, however, powerful persons (with political links with local administration and beyond) who have control over large area of Charlands without any ownership rights. The land is typically leased out annually through local informal systems and/or sharecropped under local arrangements.

practices. Therefore, erosion has forced the general population to change their occupation and to look for alternative sources of income for survival and sustenance. Short-distance migration was reported during the stakeholders' meetings and FGDs. Some displaced families migrated to nearby areas and purchased and/or rented land for homesteads. Most of the displaced families tend to remain within the vicinity with the hope that land will re-emerge. However, access and ownership remain uncertain in the riverine context

Wage Labor and Transportation

This includes both absolute and functionally landless people, in which absolute landless have no land either cultivable or homestead; whereas functionally landless only have homestead land. This group lost their land into Jamuna river, thus, being forced they opted for laboring activities. Generally, they are agricultural labourers, and mostly work locally. Some small farmers, especially their children, are involved in transportation services, such as powered country boats and other local transports to earn a livelihood. Others, particularly young family members moved to cities - Dhaka, Chattogram, Gazipur, etc. - for working in garment industry.

Temporary Migration for Work

Temporary seasonal migration to other districts was reported during the harvesting season, and also for earthwork. Although such migration is for agricultural work, some also work in urban centers as transport worker such as in rickshaw pulling, and construction work. The destination varies depending on personal contacts and network; however, the following were reported as typical destinations: Gazipur, Chattogram, Cox's Bazaar, Faridpur, Munshiganj, Shariatpur, Sunamjganj and Sylhet.

Fishers

The involvement in fishery sector is gradually declining because of scarce fish stock in Jamuna River, less catch with large-hole net, ban on certain gears, and ban on fishing during certain period. Some fishers who own a boat and nets, pick up fellow fishers as partner in fishing during fishing season. The income usually ranges from Taka 10,000 to Taka 15,000 per person/month for couple of months only.

Service Sectors

Literacy rate in the bankline villages are reportedly good. Erosion stricken people have very good motivation for educating their children; however, in Char areas the picture is different due to lack of ability and educational institutions. In Jamalpur District where field studies were carried out, many people have office jobs, both private and government. There are many in teaching occupation. Service sectors also include, transportation of both roadway and waterway. Many people are also involved in transportation sectors, with their own small vehicles. Waterway transportation is usually involved in goods carrying to the upazila market, and passenger carrying from mainland to isolated Chars.

Industrial workers

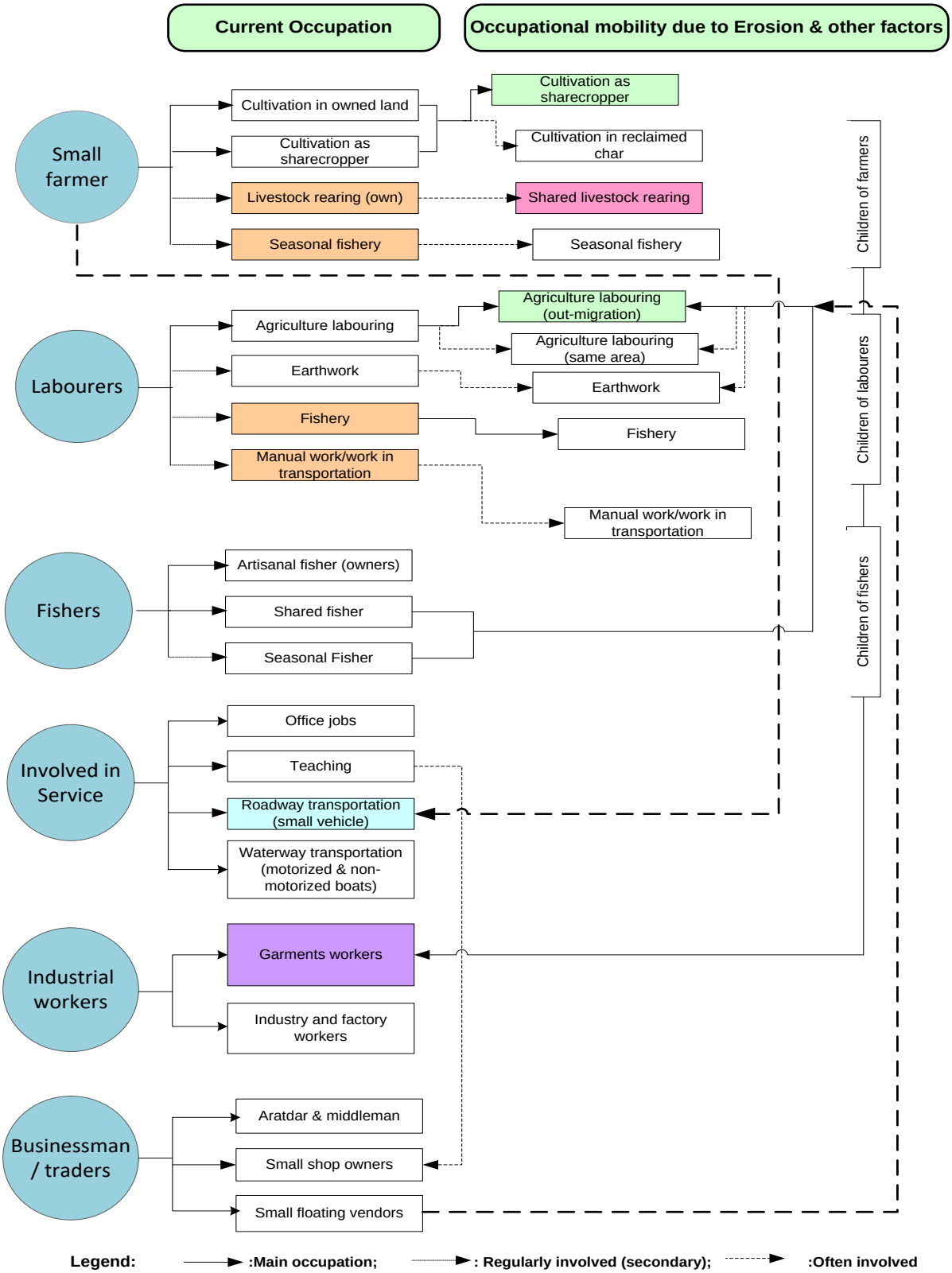
Industrial workers mostly refer to those in the garment sector. This trend is increasing, especially among the people living in isolated Chars. Both males and females from these families, move to city areas like Dhaka, Chattogram, and Gazipur for working in garment industries. Besides, a considerable number of people from the countryside are involved in local factories such as handloom factories. Also, a few moves to city area to work as industrial workers.

Traders and Businessmen

There are also significant local opportunities for local trades and businesses. Local traders deal with agricultural produce as a middleman to sell to the retailer or other intermediaries. The Char land is fertile

and can yield a few cash crops including maize. These traders buy from the local cultivators directly.[70] There are also small shop at village markets, who are professional retailers. On the other hand, some local level teachers or people with other major occupation often involve in retailing in their shops in village market. Furthermore, there are floating traders who visit rural areas and sell among others beautification items.

[70] See, M. Aminur Rahman et al. Crop Production Pattern s and Marketing in Char Areas: Adapting to Hazards and Vulnerability. In Mohammad Zaman and Mustafa Alam (eds), *Living on the Edge: Char Dwellers in Bangladesh*. Springer 2021.



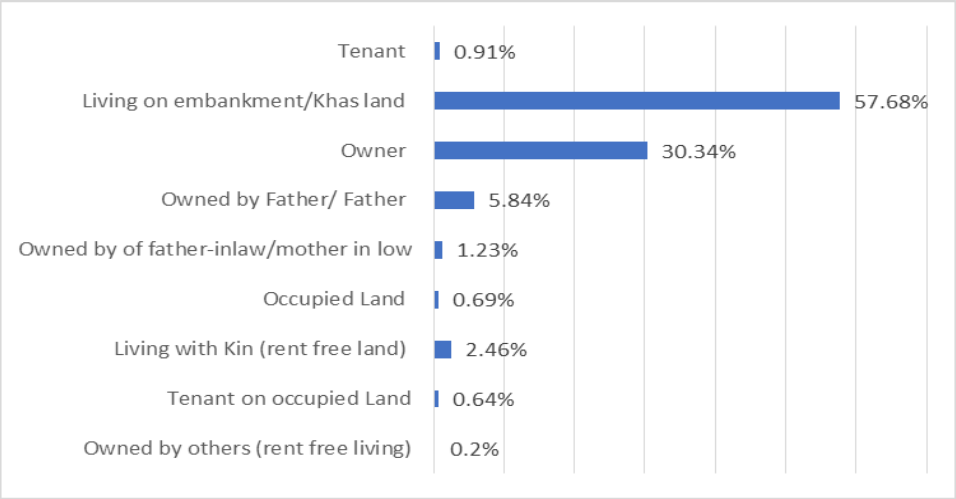
Source: Assessed and synergized by the writer based on findings, 2021

Figure 7.13: Mapping Livelihood and Occupational Patterns

7.6 Landholding/Land Tenure

Landownership in Kalihati and Bhuapur

Land ownership varies in terms of location of the area. About 95% people throughout the Program AOI have entitled homestead land. About 2% are living on rented land, and about 3% are living on rent-free land including khas land. In the Bhuapur and Kalihati site about 95% are also living on owned land. About 4% are living on rent-free land and about 1% on rented land (BBS, 2012, and priliminary field survey in 2021 and 2022). However, landownership at the closest vicinity of the river area shows a different picture, in which people living on the khas land or embankment is the highest. Fore example, according to the RMIP (2014) report, about 58% people close to the Jamuna River are living on embankment or khas land, whereas about 30% have entitlement to their lands. People who lost their all land including cultivable and homestead now live as tenants, and/or with their kin, or on occupied khas land (see, **Figure 7.14**).



Source, RMIP, 2014

Figure 7.14: Land Ownership Pattern

Landownership in Kaoakola Char

In Kaoakola Char, the third site of C1, the story of land ownership is completely different. The Kaoakola union has almost been eroded into the mighty Jamuna River due to severe erosion since the 1980s and it re-emerged in 1995. According to the national legislation, this reoccupation of lands needs to be settled through the local government office, in which the land office will do a survey and update the record and local DC office will initiate a legal procedure to determine the ownership. People who owned the land before disappearance of the Char has right to claim the ownership. Until the determination of the ownership, the land is attached to DC office.

Currently the land of Kaoakola is attached to DC office because such land survey and thereafter legal procedure to determine the ownership is yet to be initiated. However, people have reoccupyed and have beeb using the land as per the social recognization and consensus based on their earlier record of land ownership. People can not pay any taxes because the ownership of the land has not been legalized yet.

Out of total landholders in Kaoakola union, about 60% are absentee. This group left their village being displaced due to river erosion and settled in Sirajganj Sadar. They usually lease out their land in terms of annual rent and/or in a sharecropping system. Following the sharecropping system, landholders are given the share of crops and/or sale value of that crop.

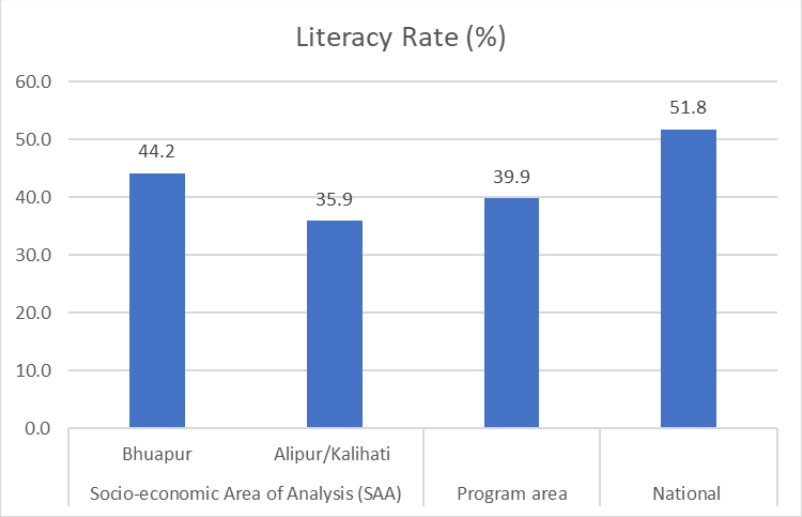
Since not all the land of the union re-appeared, many people are still landless and are living in the union. They live in two modes: renting the land from the 'original' owners and settling in the voluntarily donated land.

For any development work in Char which needs land acquisition, it involves a legal complexity because of – i) claims and counter-claims involved in land ownership, ii) reluctancy of the local government in initiating the legal procedure of reoccupation of lands in the re-emerged Chars. Although people are de-facto land controllers and entitled to the land (according to the previous record and social acceptance), the compensation process is complicated due to the absence of a new survey record. Apprehending this dynamic, landholders are often reluctant to transfer their land to the government whichout any compensation.

7.7 Infrastructures and Social Facilities

7.7.1 Education

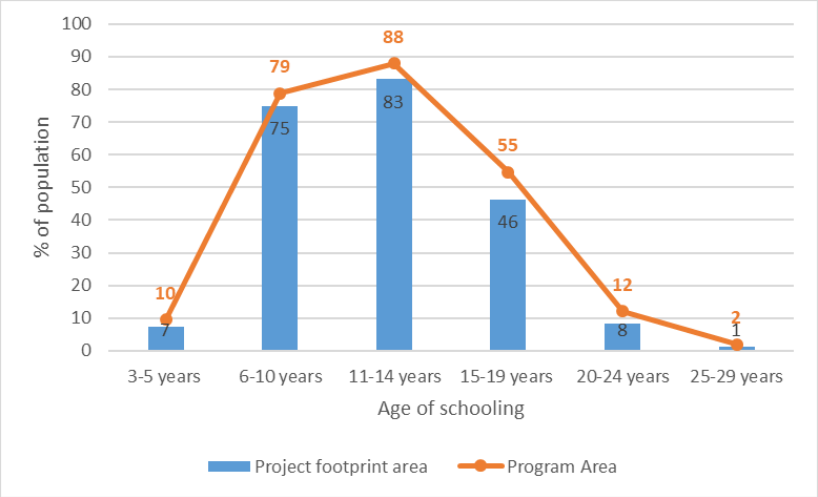
In the Program AOI, about 40% people can read and write, which is lower than the national average (52%). However, literacy rates vary around the project footprint sites. Tangail-Kalihati shows the lower literacy than that of Bhapur, in which only 33.9% people can read and write. (See **Figure 7.15**). (BBS, 2012).



Source: BBS, 2012

Figure 7.15: Literacy Rate

Figure 7.16 shows the school attendance rate by age in both Program AOI and SAA. Compared to both areas, attendance rate is higher in the Program AOI. However, the difference in attendance from the higher secondary onward is noticeable. In all age groups, attendance rate is lower in the SAA than that of Program AOI. (BBS, 2012). In Kaoakola Char the literacy rate is 30% which is little lower than the Bhuapur and Kalihati.

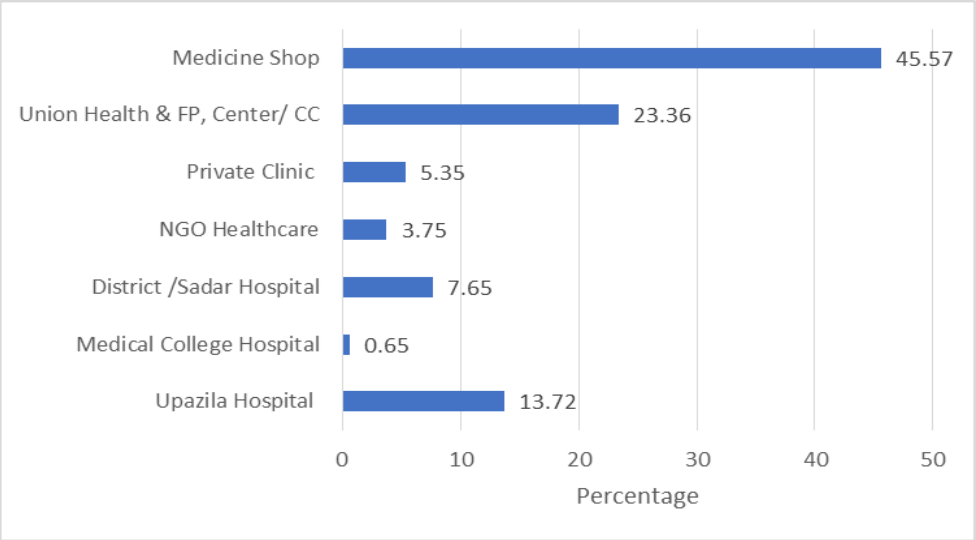


Source: BBS, 2012

Figure 7.16: School Attendance Rate

7.7.2 Health and Health Care

For common diseases, local people prefer to go the informal healthcare/workers such as medicine shops or village doctors. Besides, people most frequently accessed to the Union Health and Family Planning Centre and the Community Clinics. However, people accessed to the Upazila Health Complex and district hospital less frequently in the case of more severe health problems. This implies the preference of closer facilities rather than the distant ones, since it involves additional expense and troublesome journeys (see **Figure 7.17**). (RMIP, 2014).



Source: RMIP, 2014

Figure 7.17: Perception on Health Seeking by Service Providers

Bangladesh has a shortage of physicians, which problematizes the health care services. At present, the physicians per 1000 people is 0.63 (WB, 2022)[71]. There is a huge gap between sanctioned poistions of physcians and the number of available physicians that caused delayed health care, negligence, and improper treatment (DGHS, 2022)[72] .

The crude death rate (CDR) was estimated per 1000 population in districtes given below. By comparing among the following distrcits, the CDR is higher in Bogura and Sirajganj. The Infant Mortality Rate (IMR) and Under 5 years Mortality Rate (U5MR) are higher in Sirajganj district, accounted for 29 and 37.3 respectively. On the contrary, Jamalpur has the lowest IMR and U5MR (Table 7.6).

Table 7.6: Crude Death rate, infant mortality rate and under 5 mortality rate in the entire reach

Districts	Crude Death Rate (CDR)	Infant Mortality Rate (IMR)	Under 5 years Mortality Rate (U5MR)
Bogura	5.5	23.4	29.8

[71] World Bank (2022). World Health Organization's Global Health Workforce Statistics, OECD, supplemented by country data. Accessed from: https://data.worldbank.org/indicator/SH.MED.PHYS.ZS?locations=BD

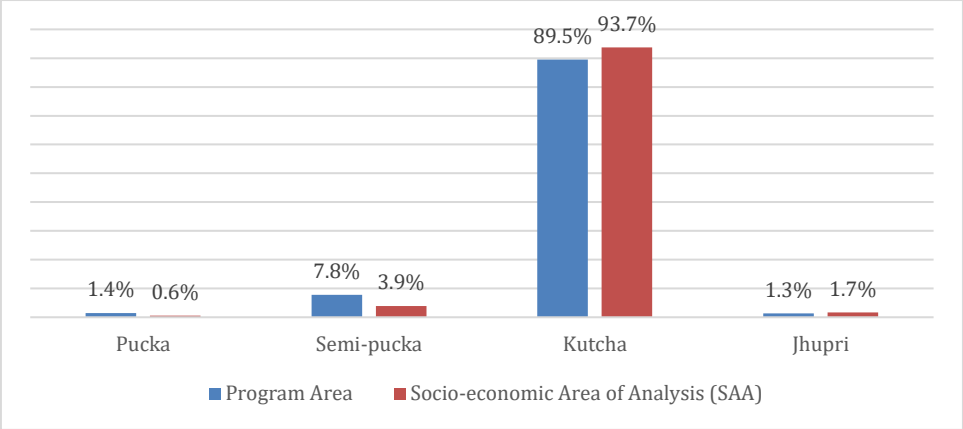
[72] DGHS (2022). Real time health information dashboard: Upazila wise physician distribution. Accessed from: http://103.247.238.81/webportal/pages/hw_hrm_upz_physician_distribution.php

Gaibandha	4.0	22.7	28.4
Jamalpur	4.2	18.4	25.7
Kurigram	4.7	12.4	19.8
Sirajganj	5.3	29.0	37.3
Tangail	4.8	20.1	27.6

(BBS: 2019[73])

7.7.3 Housing

According to BBS (2012), most of the houses are 'kutcha' in both the project footprint and Program AOI. The construction materials of these kutcha houses include: mud, tin, wood, etc. Although kutcha houses are higher in the SAA than that of Program AOI, semi-pucka houses are higher in Program AOI. (See **Figure 7.18**). (BBS, 2012).

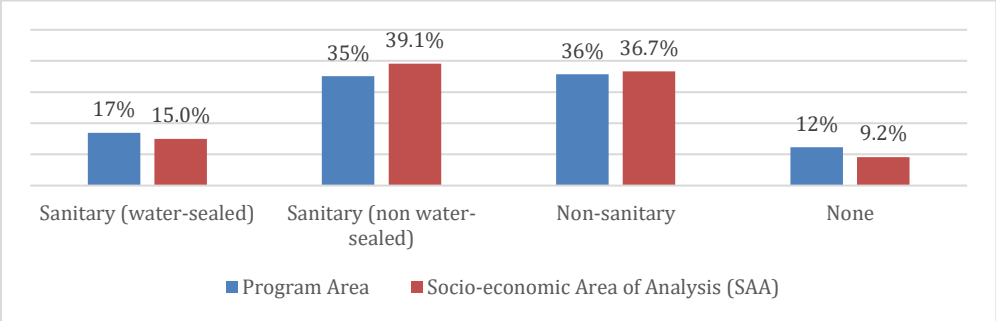


Source: BBS, 2012

Figure 7.18: Households by Construction Type/Materials

7.7.4 Sanitation

According to BBS (2012), about 12% and 10% households respectively in the program and SAA have no individual sanitation facility. They share toilets with their neighbours. These household are located at the riverside and on the embankment. Sanitary (non-water sealed) latrines is higher in the SAA, whereas sanitary (water-sealed) latrines is higher in the Program AOI. (See **Figure 7.19**). (BBS, 2012).



Source: BBS, 2012

[73] Bangladesh Bureau of Statistics (BBS) (2019), Report on Bangladesh Sample Vital Statistics 2018. Reproduction, Documentation & Publication Section (RDP). Statistics and Informatics Division (SID), Ministry of Planning, Government of the People's Republic of Bangladesh,Dhaka, Bangladesh

Figure 7.19: Sanitation Facilities by Type

7.7.5 Electricity

At present, about 33.3% households are enjoying electricity from gridline in the overall Program AOI, which is a bit higher in the SAA (40.7%) (BBS, 2012). The presence of solar electricity is increasingly found in the project area, especially in Char area.

7.7.6 Drinking Water

Tube wells are the main source of drinking water both in the program and the project footprint area, which covers about 96% households in both the program and the SAA. About 0.2% households in the SAA has supplied tap water, which slightly higher (1%) in the Program AOI. These households are located in urban area and are connected with the piped water supply. However, about 2 to 3% of households in this area is still use river or pond water for drinking (BBS, 2012).

7.7.7 Transportation Network

Communication through roadway networks is the most common in the entire Program AOI. Waterway is largely used for carrying agricultural produce from the Char area to the local market and *arotdar* (wholesale supplier). However, waterway is the main mode of communication for residents of isolated Chars. There are engine boats that are used to travel to different stations (ghats), which carry both residents and goods (see Figure 7.20).

Fragile road netwrok along the riverside

Boat *ghat* at the country side for communication to the Char area

Figure 7.20: Roadway and Waterway Transportation Network

The area of program AOI shows the availability of various types of communication networks. Thus, there are national highway that connect the entire north Bengal with Dhaka city. Also, there are regional highways and local roadway networks. A railway line that crosses the Jamuna river through Bangabandhu Bridge is an important communication route from Dhaka to the program area. The river also plays a crucial role for waterway communication that includes three classes of navigation routes: class-I, III and IV[74]. Also, the program AOI includes a protocol route between India and Bangladesh. (see Figure 7.21).

[74] The waterways of Bangladesh have been classified into four categories depending on least available depth (LAD) ranging from 3.90 m to 1.50m

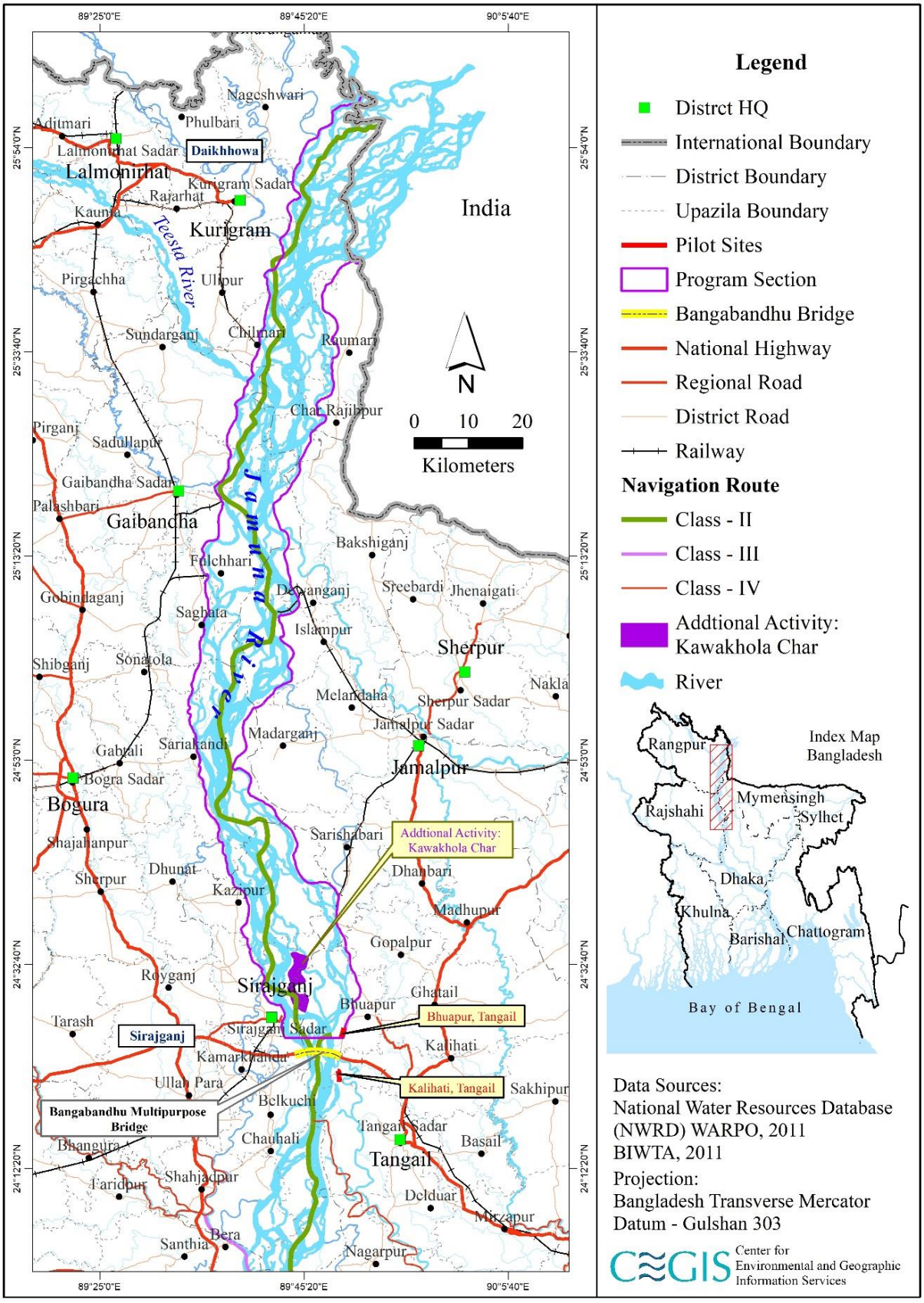


Figure 7.21: Map of the Road and Waterways Network in the Program AOI

7.8 Poverty

Figure 7.22 and 7.23 shows upper and lower poverty situation in the Program AOI. This refers to the poverty headcount ratio in the Program AOI, which has been presented for upazilas. Both upper and lower poverty line has been shown in separate maps (see below). According to data, Kurigram district is the highest poverty-stricken area. In this area, more than 60% people are poor following the upper poverty line, whereas about 50% are extreme poor (lower poverty line). Bogura has the lower poor people, estimate as less than 10% following lower poverty. Also, this area has the lower poverty headcount according to the upper poverty line.

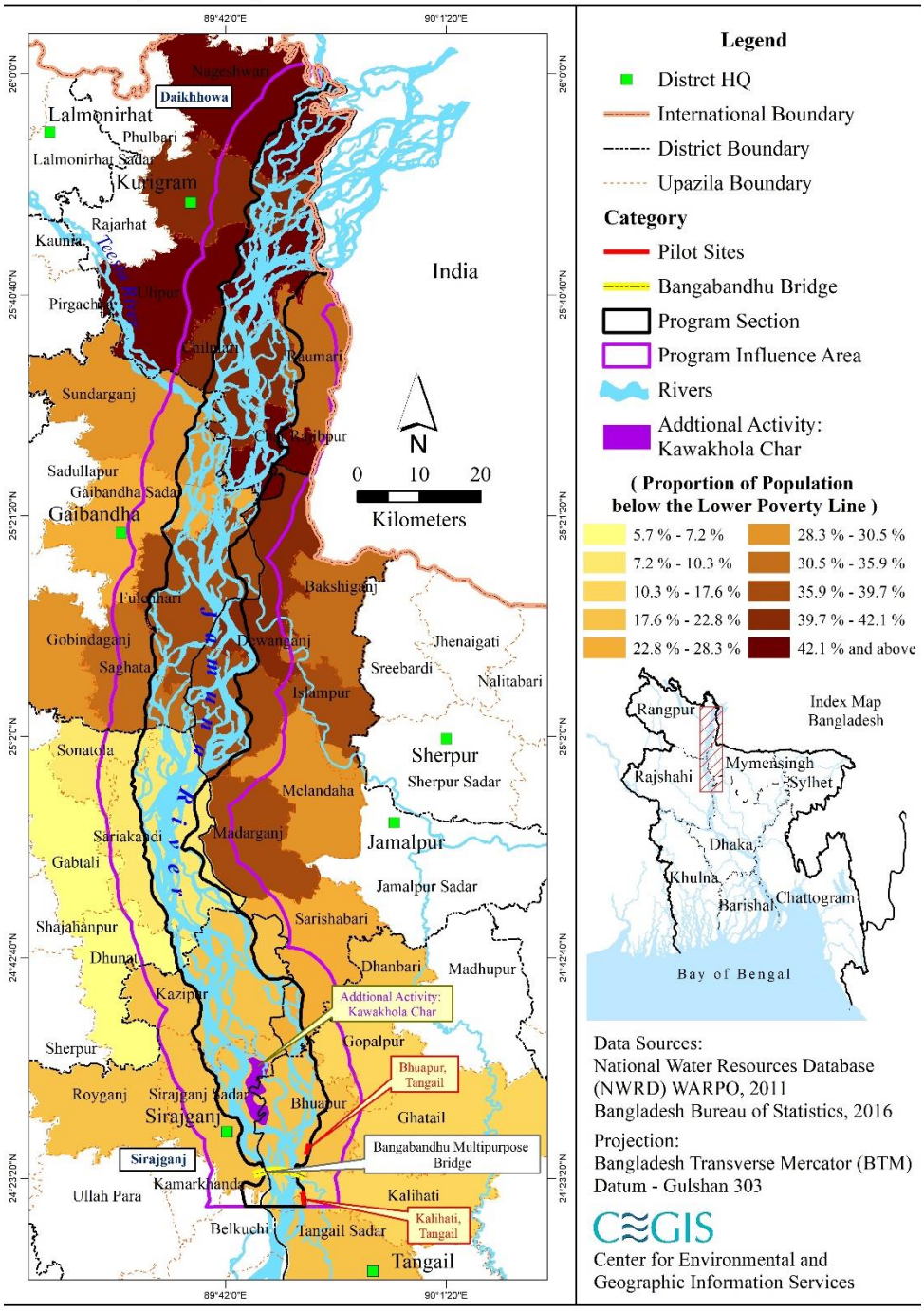


Figure 7.22: Map of the Below Lower Poverty Headcount Ratio in the Program AOI

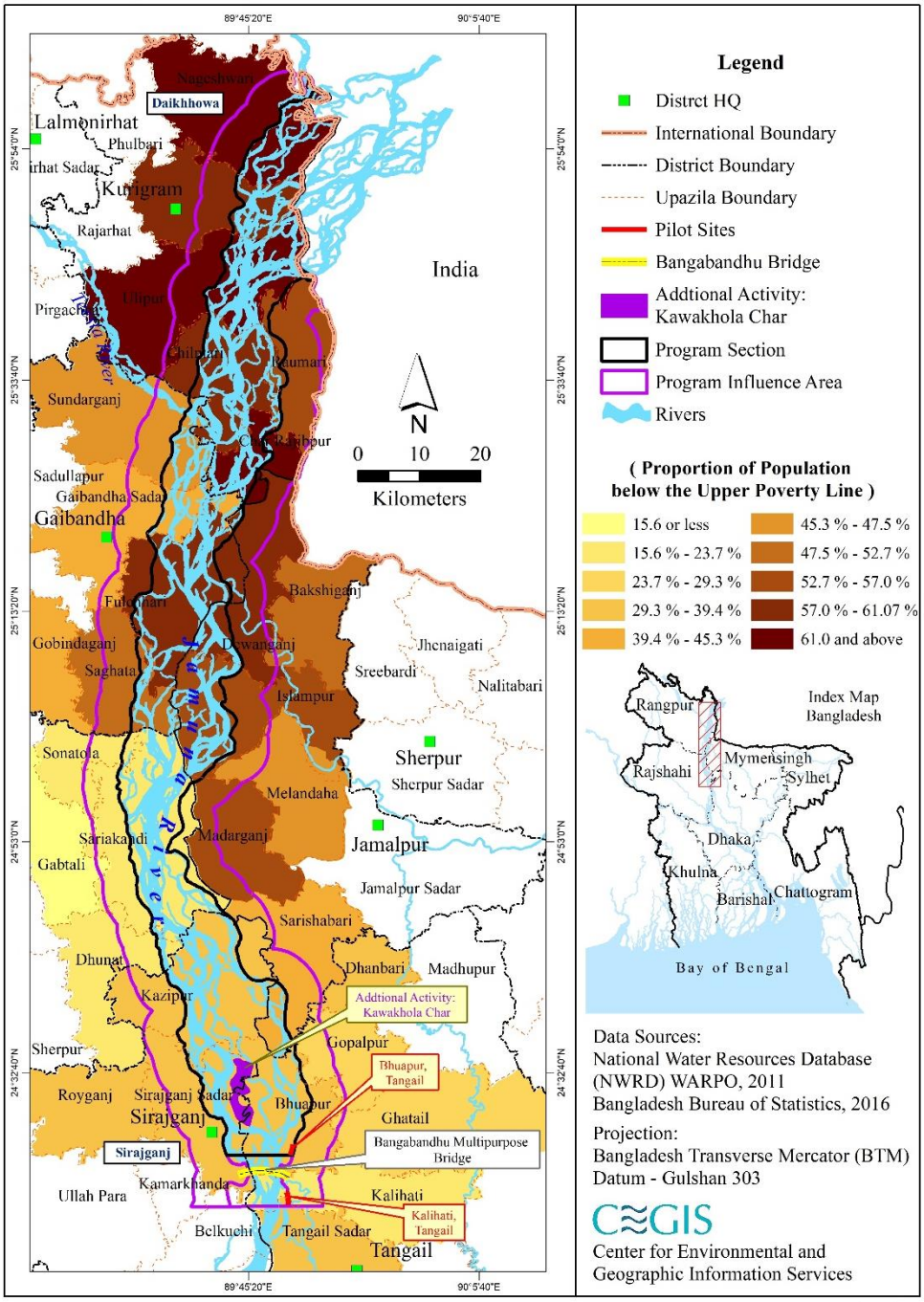


Figure 7.23: Map of the Below Upper Poverty Headcount Ratio in the Program AOI

7.9 Livelihood Vulnerability and Assessment

There is an overall precarity in life and living in the floodplain that needs to be recognized. Very broadly, as the social baseline conditions indicate, the population in the project/Program AOI has a low development status on (i) human (i.e., low literacy/education, skill levels); (ii) financial (i.e., 50-60% of the population belong to lower and/or upper poverty level); and (iii) physical capital (i.e., poor housing, little or no land; nearly two-thirds living on the old embankment and Chars are landless). However, the natural capital plays an important role for these floodplain communities that depend to a large degree on agricultural products, fruit trees, backyard poultry, and livestock. These are mostly grown or raised for own sustenance and only to a small degree for commercial purposes. In addition, local people are also involved in a variety of occupations such as fishing, trading (petty trade, transportation, shop keeping,

forias/beparis[75]), artisan/skilled labor – for example, carpenters, masons, electricians, rickshaw/van puller, tailoring, cobbler, barber, sweet maker, *chatai* (bamboo mat) maker, and wage employment in government and private sectors, including garments.[76] In sum, livelihood sources for the floodplain inhabitants are largely dependent on natural resources. Therefore, there are opportunities to improve livelihood mid and long-term through increasing the commercialization of agricultural products and the productivity of agricultural inputs as well as diversifying the livelihoods using existing natural/human resources.

7.10 Gender Analysis

Demographic composition

Out of total population in the pilot project sites (Bhuapur and Tangail-Kalihati), the sex ratio is 103 referring to 103 males per 100 females. This scenario is the same for both the pilot area. According to a study (RMIP, Vol 2, 2014), about 6% households are female-headed in the country side, which is relatively higher in Charlands. The primary reasons for female-headed households are: male migration, abandonment, divorce, and widowhood. The female-headed households are socially and economically disadvantaged. The majority of them have less earnings than that of the male-headed HHs.

Marriage

According to marital status, about 9% women are widowed at Bhuapur site, which is about 8.5% at Tangail-Kalihati (or Alipur) site (BBS, 2012). Divorce rate for women is higher in both sites than that of men.

Economic participation

According to Table 7.7, there is a considerable gap between male and female concerning gender segregated employment status. The rate of male employment is significantly higher both in Bhuapur (38.3%) and Tangail-Kalihati (20.95) sites, whereas only 3% women of Bhuapur and 0.9% women of Tangail-Kalihati are employed. In both areas, women are mostly involved in household work (BBS, 2012).

Table 7.7: Percentage of Gender Segregated Employment Status

	Bhuapur (%)		Tangail-Kalihati (%)	
	Male	**Female**	**Male**	**Female**
Employed	38.3	3.0	20.9	0.9
Looking for work	0.3	0.1	0.2	0.0
Household work	0.3	43.8	0.4	23.6
Do not work	6.9	7.4	25.4	28.6

Source: BBS, 2012

Table 7.8 shows the distribution of employed men and women in three large sectors. Thus, men are mostly involved in agriculture sector, whereas women in Bhapur site is largely involved in industrial sector (4%) and for Tangail-Kalihati site in service sector (3.4%). However, in all sectors the presence of men is predominant. According to the field findings, some women and young girls work in garment industry in Dhaka and regularly send money to families.

[75] Small/medium traders, who purchase various agricultural produces, are part of the value/market chain in the local and regional markets or bazaars. See M. Aminur Rahman et al, Crop Production Patterns and Marketing in Char Areas: Adapting to Hazards and Vulnerability. In M. Zaman and M. Alam (eds) *Living on the Edge: Char Dwellers in Bangladesh*, cited earlier.

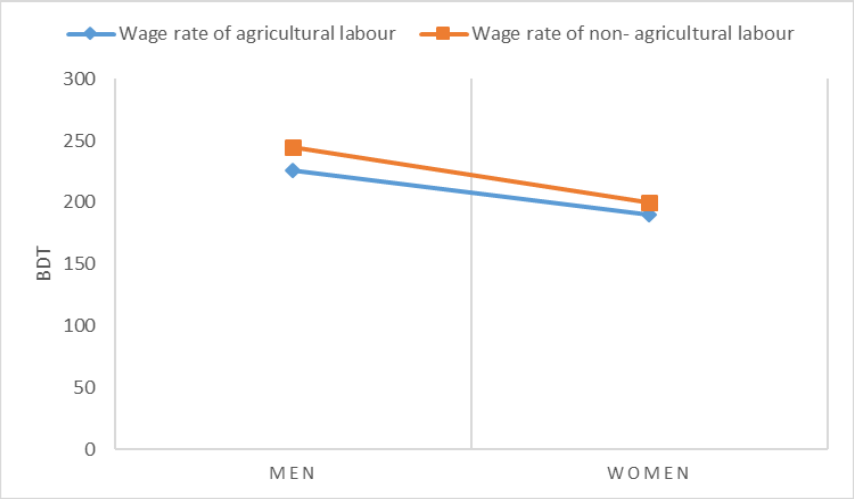
[76] Hafiza Khatun, et al, Out Migration as a Survival Strategy for Char Dwellers. In M. Zaman and M. Alam (eds) *Living on the Edge: Char Dwellers in Bangladesh*, cited earlier.

Table 7.8: Percentage of Gender Segregated Employed People

Sectors	Bhuapur (%)		Tangail-Kalihati (%)	
	Male	Female	Male	Female
Agriculture	51.6	0.8	54.7	0.6
Industry	14.2	4.0	4.6	0.2
Service	27.0	2.4	36.6	3.4

Source: BBS, 2012

There is a discrepancy of wage rate between men and women. The following figure shows the average wage differences (see figure 7.24).



Source: BBS, 2012

Figure 7.24: Gender Segregated Daily Average Wage Rate

The daily average rate also varies in terms of agricultural and non-agricultural work. Thus, in both project area, women have lesser wage rate than that of men (see Table 7.9).

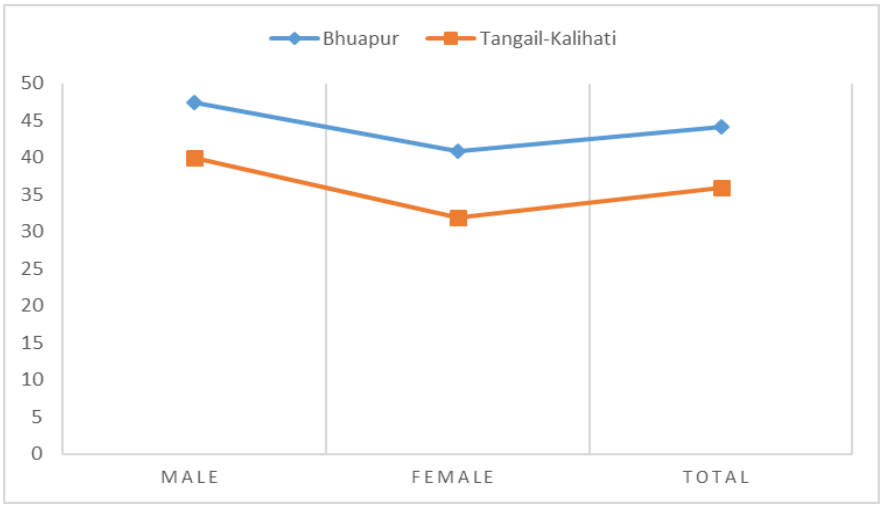
Table 7.9: Site-specific Gender Segregated Daily Wage Rate in BDT

Type of activities	Bhuapur		Tangail-Kalihati	
	Men	Women	Men	Women
Wage rate of agricultural labour (BDT)	211	175	240	205
Wage rate of non- agricultural labour (BDT)	250	200	240	200

Source: BBS, 2012

Education

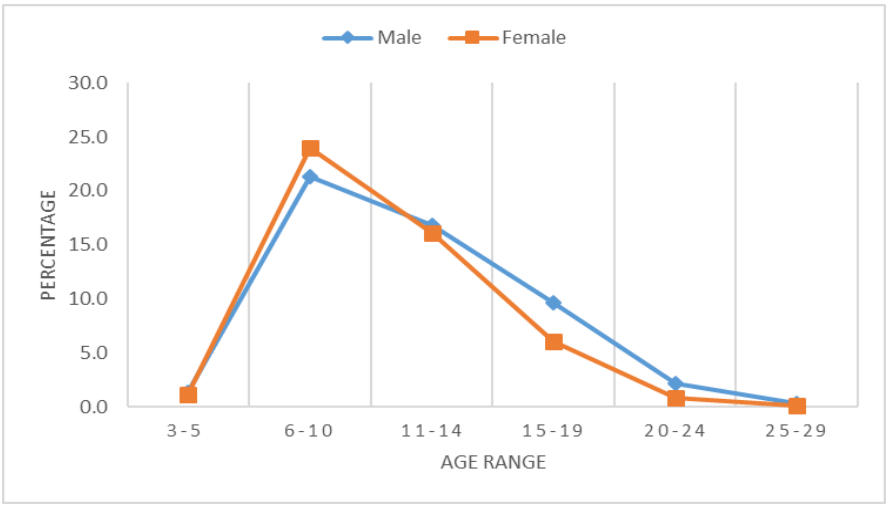
Following the gender segregated literacy rate (Figure 7.25), male literary rate is comparatively higher in both project sites than that of female, although literary rate for Bhuapur is higher than Tangail-Kalihati site (BBS, 2012).



Source: BBS, 2012

Figure 7.25: Gender Segregated Literary Rate

There is also a variation in enrolment between male and female. Although the enrolment rate is almost equal at the age of first schooling, this rate for female overtops the male at the primary and pre-secondary schooling. The secondary level enrolment then becomes a threshold, from which female enrolment starts gradual drop, and conversely, male enrolment increases (Figure 7.26).



Source: BBS, 2012

Figure 7.26: Gender Segregated Enrolment

Women empowerment

Ownership of land: In the case of the right to land, both women and men enjoy land ownership in the project. Conventionally, muslim families follow Muslim inheritance law while distributing land and other assets. Thus, a man receives twice than that of woman. However, there is a significant gap between convention and practice in the distribution of inherited land or asset. Thus, parents often prefer to distribute the majority share to a son while depriving a daughter, and the son often forces parents to do so. In many cases, the inherited land remains undistributed among children for a longer time, and if wish, a brother gives a very little amount of land or share a very insignificant amount of earning from the land to their sisters. Women, in fear of losing kinship ties, often overlook this improper distribution of land. The noticeable crisis emerges in the case of female-headed households, in which brother(s) ignores or denies land rights to sister-in-law in the case of the death of her husband. Although women can purchase land by her name, land is often registered for male members of families. The hindu families follow hindu

inheritance law. According to the he Hindu Law of Inheritance (Amendment) Act, 1929, a daughter is fifth in line to her father's property. In the absence of a son, son's son, son's son's son and widows the daughter inherits the property from her father.

Gender-based participation in public atmosphere: While males enjoy open participation at public or social sphere, women have very limited space. The religious bindings play a vital role in shaping this limited participation level. Women are remained 'invisible' socially and culturally because of the embedded social structure and men are considered the bread earner of a household. Women's earning is mostly considered as supplementary to the household income. Thus, the involvement in the economic sectors shapes the presence in the public sector. Since many women are involved in household work, which is private, women do not need to appear publicly.

Against this overall feature, a considerable number of women are increasingly involved in the public sphere such as in petty business, local government election, and NGO based associations. A large of number of females of Char area are also increasingly moving outside e.g. in Dhaka city for working in the garment industry, which contributes to household income significantly. Thus, the male-dominated relationship pattern is turning down slowly and leaving space for females. This is noticeably found in educated families who are involved in the service sector. More importantly, Char dwellers and other vulnerable families are gradually investing in educating their children, which is anticipated to derive positive gender relationships.

Gender-based decision-making role: Women can express their opinion in families within which both men and women are involved in income-generating activities. But women's opinion is hardly considered in important and critical issues like land, agriculture and livestock. Women can participate in decision-making process but in general, their opnion is given less importance.

Women have certain skills and social capital of their own. But this capital varies based on their age, economic status, and marital status. Generally, women from well-off families, married and middle-aged women enjoy more freedom than poor and unmarried women. But some aged and married women living on the embankment in Bhuapur (Tangail) informed that '*they used to work hard in their young age and in traditional agricultural system men had to depend on women for seed preservation, crop processing*'. During that time women had a certain level of control over household resource and was considered an important part of household'. On contrary, young and newly married women reported that 'they used to enjoy more freedom than that of their mothers and grandmothers.

For daily expenditure, their husbands give them money only when they have handsome income. The men only work outside of the home and do not participate in household works like cooking, cleaning or washing. As mentioned above, women are not allowed to go to the market for selling or buying products. If they want to do so, they need prior approval from their husbands or in-laws. When they go, it is to see a doctor and sometimes to tailor.

Sexual Exploitation and Abuse, and Sexual Harassment (SEA/SH): Although the situation is changing, domestic violence is still prevalent all across Bangladesh including the project areas. All the participants of the focus groups discussions (both men and women), admitted that women are beaten frequently by their husbands if they do not perform or act as 'expected'. This expectation comes from the gender roles such as performing household chores, serving food to the family member on time, taking care of children, helping the husband in agricultural activities, staying at home and limiting a woman's mobility to household premises except when there is a health issue involving the children. In addition, if a woman questions her husband's ability to feed the family or argue with him on a valid ground, this could be considered as unexpected behavior, which generally results in domestic violence. Also, women are often beaten even during pregnancy by their husbands and the reasons are mostly associated with less income by the husbands, not getting the food served by their wives on time, the women asking for money and the basic needs from their husbands. While they are beaten, the perception is that women depend on men so men have right to beat them, and for the same reason, Women do not go to their UP members to request punishment of their spouses through local arbitration. The women say that very few women will raise voice unless they have a well-off paternal family. Thus, gender-based violence is a big issue in the bankline communities and Chars. The reflection can be found in the response to the question asked to women at Chars- 'when do women feel safe or in what condition/environment do women feel safe,' - they replied that

women feel safe- when they are at home, even in the absence of their spouses and when they go out only with their husbands.

7.11 Vulnerable Groups/Communities

People living along the Bankline and in Chars are generally poor and vulnerable to risks of displacement. These include displaced communities now living on embankments, the poor and landless, female-headed households and those under the poverty line, the elderly, and the Char dwellers as tenant farmers, fishers, small landowners, etc. They face everyday vulnerability to disasters and a range of other causal factors, including access to land and limited livelihood sources.

The perception about Char dwellers and their living conditions are fundamentally different than those living in the mainland.[77] The Char dwellers are not helpless victims of disasters; instead they adopt active adaptive strategies to live with and manage the everyday catastrophe. But these groups may further be disproportionately impacted or disadvantaged by project interventions due to loss of land, displacement and loss of livelihood sources. The precarious bid for survival must be understood in its context. The first priority of these vulnerable people are to be protected from the riverbank erosion and seasonal flooding. Bank erosion turned them impoverished, as their economy, like traditional rural livelihood system, mostly depends on land. Thus, erosion caused their precarious situation. As this study found, many erosion victims who once controlled considerable amount of land, and eventually, the rural power are now powerless, poor people and depend on the Charity or the state allowance. Many of these people are now living on the state-owned khas land: no rights on the land and under the condition of easy eviction because of their helplessness. Further, although their eroded land re-emerged in the form of Char, many of them are unable to reoccupy and claim their ownership because of at least two reasons. First, local powerful actors grab the land as soon as its re-emergence. Second, the claim needs to be settled in the local land office subject other conditions, but the reluctance of the land office, and in some cases, the tendency to consider the land as khas delays and often denies their claim on the land. Thus, the land grabbing and the complexity of land administration also caused vulnerability.

7.12 Indigenous People

There are no known indigenous people or small ethnic minority groups or settlements. This will be further verified during project planning and implementation. Should any small ethnic minority groups be found, appropriate plans will be prepared.

7.13 Cultural Heritage and Historical Sites

There are no known cultural heritage or historical sites in the pilot areas. In case of any chance finds, proper management plans will be prepared in compliance with GOB archaeological regulations and ESF requirements.

7.14 Agriculture and Livestock

Agricultural land in the Project Influencing Area of Bhuapur site is 142 hectares and in Kalihait-Tangail site (Alipur) is 252 hectares. Major cropping pattern of the project influencing area Fallow-HYV Aman-HYV Boro which is practiced in 16% of the NCA followed by Fallow-Fallow-HYV Boro hich is practiced in 12% of the NCA. The single, double and triple cropped area is 28%, 62% and 10% of the NCA respectively. The cropping intensity of the project influencing areas is 161% which is less than national average cropping intensity (194%; BBS, 2018). Details are presented in Table 7.10.

[77] Mohammad Zaman and Mustafa Alam (eds), *Living on the Edge: Char Dwellers in Bangladesh,* cited earlier.

Table 7.10: Existing Cropping Patterns of the Bhuapur Project AOI

Land Type	Kharif-I (March-June)	Kharif-II (July-October)	Rabi (November-February)	Project AOI	
				Area (ha)	% of NCA
HL	Vegetables	Fallow	Vegetables	10	3
	Jute	Fallow	Onion	9	4
	Jute	HYV Aman	Lentil	8	5
	Fallow	HYV Aman	Maize	12	6
	Til	Fallow	Wheat	4	4
	Fallow	HYV Aman	HYV Boro	23	31
	Fallow	Fallow	Mustard-HYV Boro	17	5
	Til	Fallow	Chili	6	4
MLL	Fallow	Fallow	HYV Boro	14	13
	Jute	Fallow	Maize	7	3
	Fallow	Fallow	Ground nut	14	4
	Fallow	Fallow	Khesheri	4	2
	Fallow	Fallow	Millet	6	4
	Fallow	Fallow	LT Boro	8	11
Grand Total				142	12
Single Cropped Area				63	4
Duble Cropped Area				142	10
Triple Cropped Area				24	5
Total				229	10
Cropping intensity (%)				**161**	

Note: The study area is defined as the 1km buffer area of the proposed revetment / Bankline to be protected.

Sources: CEGIS estimation based on DAE and field investigation, 2021

7.14.1 Farming Practices

Crops are grown during two seasons: Kharif (March-October) and Rabi (November-February). During Kharif season mostly (HYV Aman) rice, maize, jute, sesame, Millet (Kawon) and vegetables are produced whereas during the rabi season crops such as (Lt and HYV Boro) rice, maize, Khesheri, wheat, ground nut, pulses, chili, onion, coriander, mustards, potato and other vegetables are grown. Main agricultural constraints include erosion, flood, drainage congestion, siltation of inland waters, and scarcity of water for irrigation. Livestock and poultry keeping play a significant role in the rural agro-based economy as well, however shrinking and degrading pastures, fodder shortages, disease, and lack of veterinary services are among key problems encountered.

7.14.2 Agricultural Labor

In the SAA, most of the crop production is being done manually. So, agricultural labor (seed sowing, intercultural operations, harvesting and post-harvest technologies) is considered as one of the essential inputs for crop production. The labor requirement is not uniform throughout the year and it varies from crop to crop and season to season. In the peak periods (November-January, April-May and July-August), the requirement is very high. The main activities carried out during the peak periods are (i) harvesting of HYV Aman and transplanting of Boro/ sowing of Rabi crops; (ii) harvesting of Boro and Rabi crops and sowing of Kharif-I crops and (iii) harvesting of Sesame, Jute and other Kharif-I crops and transplanting of HYV Aman (iv) Sowing and harvesting of annual crops, Onion, and pulses etc. During the peak period, laborers move from one region to another in search of work.

7.14.3 Crop Production and Damage

The yield level of different crops is closely associated with the supply level of input use and agricultural practices. In determining the yield level of four locations of Aman and Boro crops, the average yield value of High Yielding Variety (HYV) and local varieties has been considered. The yield rate of Kharif and Rabi crops includes average yield value of all crops are presented separate location. The crop yield rate has been estimated from the information collected from DAE offices. The details of the cropping pattern, production and damages are presented in 7.11.

Table 7.11: Existing Cropped Area, Annual Production and Damage in the Project Influencing Area of Bhuapur

Crop name	Cropped Area	Damage free		Damaged		Total production	Production loss
	(ha)	Area	Yield	Area	Yield	(Metric ton)	(Metric ton)
		(ha)	(Metric ton/ha)	(ha)	(Metric ton/ha)		
HYV Aman	43	41	3.1	2	1.8	127	3.6
LT Boro	8	7	1.8	1	1.1	13	1.1
HYV Boro	54	54	4.2	0	0	227	0
Total rice	105	102		3		367	5
Wheat	4	4	3.2	-	-	13	-
Winter maize	19	19	4.3	-	-	82	81.7
Millet (Kawon)	6	6	2	0	1.5	12	1.5
Lentil	8	7.5	1.4	0.5	0.5	10.5	0.25
Khesheri	4	4	1.1	0	0.8	4.4	0
Ground nut	14	13	1.6	1	1.1	21	1.1
Sesame	10	10	1.2	-		12.00	-
Jute	24	24	2.2	0	0	53	0
Chilli	6	6	2.8	-	-	16.8	-
Onion	9	8	12	1	1	96	1
Mustard	17	17	1.2	-	-	18.2	-
Summer vegetables	10	9	9	1	8.5	81	8.5
Winter vegetables	10	10	9.5	-		95	-
Total non-rice	141	138		4		514	94
Grand Total	246	240		7		881	99

Note: The study area is defined as the 1km buffer area of the proposed revetment / Bankline to be protected. Sources: CEGIS estimation based on DAE and field investigation, 2021

**cleaned/husked rice*

7.14.4 Livestock Resources

Livestock and poultry, being an essential element of integrated farming system, play an important role in the economy of the project area. The contribution of the livestock sector to overall GDP has been provisionally estimated at 1.78% for 2013-14. Its share of agricultural GDP in 2016-17 was 15% (provisionally estimated). Despite its modest share of overall GDP, livestock serves an essential role as a source of protein, employment generation, export earning, and provision of food security. Livestock resources play an important role in the sustenance of landless people, livelihood options for the rural poor families and are potentially important for poverty reduction. Livestock information's were collected from DoL of the study area. Figure 7.27 and 7.28 demonstrate the beef fattening and poultry farm respectively in the study area.

Figure 7.27: Beef Fattening in the Study Area

Figure 7.28: Poultry Farm Inside the Study Area

8. Environmental and Social Risks, Impacts and Mitigation Measures

8.1 Methodology of Risk Identification and Impact Assessment

First, Valued Environmental and Social Components (VESC) were identified based on team experience and through a brainstorming session among the team members. Later the preliminary list was revised in another working-session with external specialists of relevant fields. The VESC were validated with multi-level stakeholders during a multi-stakeholder meeting[78]. Thereafter, the negative impacts were identified against each VESC through a brainstorming session among the team members, taking the feedback from baseline survey. Project benefits and other positive benefits were excluded from the impact assessment. Once an impact is identified, it was further evaluated based on its degree of significance. The degree of significance of an impact or risk is defined by a five-point Likert Scale and evaluated by its magnitude and sensitivity. The details of the methodology for assessing magnitude, sensitivity and finally the significance are presented below.

8.1.1 Assessing the Magnitude of an Impact and Risk

The magnitude of each identified impact and risk is assessed based on five parameters including: i) duration of the impact (temporal aspect); ii) spatial extent of the potential impact, iii) reversibility of the impact; iv) likelihood of impact occurring; and v) compliance to national and international standards. A qualitative scoring technique of quantification is adopted to assess the magnitude of an impact assessing these five parameters. A Likert scale is developed (**Table 8.1**) to assess degree of each parameter. The scale had a maximum score "4" which is labelled as "High" and minimum score "1" which is labelled as "Low". A word scenario was also developed to guide quantification of each parameter. Once the assessment of each parameter is complete for an impact, a composite score for each impact is calculated summing scores of all five parameters. Depending on the composite score, the magnitude of the impact is assessed following the scale provided in **Table 8.2.**

Table 8.1: Definition of the Magnitude Classes and Parameters

Parameter	Qualitative Scale to Quantify the Parameter (corresponding score is in parenthesis)			
	High (4)	Substantial (3)	Moderate (2)	Low (1)
Duration of potential impact	Long term (More than 15 years)	Medium Term (5 to 15 years)	Limited to construction period	Temporary with no detectable potential impact
Spatial extent of the potential impact	Widespread far beyond project AOI	Beyond immediate project AOI	Within project AOI	Specific location within project component or site boundaries with no detectable potential impact
Reversibility of potential impacts	Potential impact is effectively permanent, requiring considerable intervention to return to baseline	Potential impact requires a year or so for recovering with some interventions to return to baseline	Baseline returns naturally or with limited intervention within a few months	Baseline remains almost constant
Compliance to Legal Standards	Breaches national standards and or	Complies with limits given in	Meets minimum national	Not applicable

[78] A national level multi-stakeholder meeting was arranged by the Ministry of Water Resources to share and review the technical details of the Project. The VESC were shared and validated during the meeting.

Parameter	Qualitative Scale to Quantify the Parameter (corresponding score is in parenthesis)			
	High (4)	Substantial (3)	Moderate (2)	Low (1)
before Mitigation Measures	international guidelines/ obligations	national standards but breaches international lender guidelines in one or more parameters	standard limits or international guidelines	
Likelihood of potential impacts occurring	Certain: Occurs under typical operating or construction conditions (Certain)	Likely: Occurs under worst case (negative impact) or best case (positive impact) operating conditions (Likely)	Occasional: Occurs under abnormal, exceptional or emergency conditions (Occasional)	Unlikely to occur

Table 8.2: Scoring Criteria for Magnitude Assessment

Magnitude of Impact	Composite score to define magnitude of an impact
High (H)	16 – 20
Substantial (S)	11 – 15
Moderate (M)	6 – 10
Low (L)	0 – 5

8.1.2 Assessing the Sensitivity of a Receptor

The sensitivity of a receptor for each impact is assessed based on the capacity or features (including proximity/numbers/vulnerability etc.) of the receptors to handle or tackle an impact. A four-level qualitative scale defining the sensitivity as "low", "moderate", "substantial" and "high" is developed to assess the sensitivity. The definitions of the sensitivity classes are outlined in **Table 8.3**.

In case of biodiversity risk assessment, the sensitivity has been defined following the ESS6 considering critical habitats or a species triggering CH criteria would have high sensitivity and the moderate habitat would have lower sensitivity.

Table 8.3: Definitions of the Sensitivity Classes

Sensitivity Class	Definition
High (H)	Vulnerable receptor with no capacity to absorb proposed changes or minimal opportunities for mitigation.
	Biodiversity Risk Assessment: If the receptor (species, or biodiversity feature or habitat) is triggering Critical Habitat Criteria
Substantial (S)	Vulnerable receptor with little capacity to absorb proposed changes or limited opportunities for mitigation.
	Biodiversity Risk Assessment: If the receptor (habitat) is categorized as natural habitat and provides supports to vulnerable species (EN and CR)
Moderate (M)	Vulnerable receptor with some capacity to absorb proposed changes or moderate opportunities for mitigation
	Natural or modified habitats with anthropogenic pressure and decreasing trend of habitats (or population) with biodiversity value
Low (L)	Vulnerable receptor with good capacity to absorb proposed changes and/or good opportunities for mitigation
	Modified habitats with occurrence of no important species

8.1.3 Assessing Significance of an Impact

The significance of an impact (without mitigation) was assessed by its magnitude and sensitivity. A cross-tabular matrix is developed to assess the magnitude qualitatively.

The significance of an impact was evaluated following a four-level scale which is determined by a cross tabular matrix between magnitude and sensitivity **Table 8.4 and 8.5.**

Table 8.4: Cross-tabular Matrix for Assessing Significance of an Impact

Magnitude of Impact	Sensitivity of Receptors			
	High (H)	Substantial (S)	Moderate (M)	Low (L)
High (H)	High (H)	Substantial (S)	Substantial (S)	Moderate (M)
Substantial (S)	High (H)	Substantial (S)	Moderate (M)	Low (L)
Moderate (M)	Substantial (S)	Moderate (M)	Moderate (M)	Low (L)
Low (L)	Moderate (M)	Low (L)	Low (L)	Low (L)

Table 8.5: Significance of the Impact

Significance Class	Word Description
High (H)	The resource/receptor are highly sensitive to the impacts/risk and would likely experience a high magnitude impact that would endure for a long time, extend over a large area, exceed national/international standards, endangers public health and safety, threatens a species or habitat of national or international significance, and/or exceeds a community's resilience and ability to adapt to change. The Project may have difficulty in complying with the applicable ESF requirement, and significant mitigation would likely be required.
Substantial (S)	The resource/receptor would experience a clearly evident change from baseline conditions and would approach but not exceed applicable standards. The Project would comply with the applicable ESF requirement, but mitigation would be required.
Moderate (M)	The resource/receptor would experience a noticeable effect, but the magnitude of the impact is sufficiently small (with or without mitigation) that the overall effect would remain well within applicable standards. The Project would comply with the applicable ESF requirement, but mitigation may be required.
Low (L)	The resource/receptor would experience a noticeable effect, but the magnitude of the impact is sufficiently small (with or without mitigation) that the overall effect would remain well within applicable standards. The Project would comply with the applicable ESF requirement, but mitigation may be required.

8.1.4 Mitigation Hierarchy

The World Bank's ESF recommended under ESS1 a mitigation hierarchy, which consists of four steps to manage an impact:

(1) Avoidance is the most preferred form of mitigation where technical options are proposed to be adopted within the project design to completely avoid the impact.

(2) Where avoidance is not possible, specific actions to minimize or reduce risks and impacts to acceptable level.

(3) Once risks and impacts have been minimized or reduced, mitigate; and

(4) Lastly, where avoidance, minimization, and mitigation are not adequate to manage the potential risks, significant residual impacts remain, compensate for or offset them, where technically and financially feasible.

8.2 Impacts on Water Resources and Mitigation Measures

8.2.1 Potential Impacts and their Evaluation

The project includes several activities such as construction of riverbank protection, limited dredging to manage river bank erosion, installation of navigational aids, etc. which might involve hydro-morphological impact and/or risk. After the civil works and mechanical activities are finished, the project forecasts an increase of inland cargo and passenger transport (additional 2 million tons cargo and 5 million passengers annually in 2030). The additional activities of C1 components include 6.15 km of Bank protection work by sand-filled geobags, 6.3km of canal re-excavation and constructing a bund across a canal for erosion prevention. Potential risk and impacts **(Tab 8.6)** on water resources are identified and assessed in the following sections. Also based on the significance of the impacts, specific mitigation measures are discussed following the mitigation hierarchy.

Table 8.6: Summary of Impact on Water Resources

Potential Impacts	Temporal Aspects	Spatial Aspects	Reversibility	Compliance	Likelihood	Magnitude	Sensitivity	Significance without mitigation	Residual Impact after mitigation
Changes on River Planform beyond the Project AOI	3	1	1	1	1	M	M	M	L
Changes in River Bankline (upstream and downstream of proposed structures)	3	2	2	1	2	M	M	M	L
Reduction of floodplain and alluvial corridor within the Project AOI	4	2	2	1	1	M	M	M	L
Increase of erosion risk downstream of the Project AOI	3	3	3	2	2	S	M	M	L
Increase of erosion in Mechra union due to canal re-excavation	1	2	2	2	2	M	M	M	L
Changes in River Hydrology (flow regime, water level)	3	1	1	1	1	M	M	M	L

8.2.2 Description of Impacts and Possible Mitigation Measures

Changes in river Planform and Bankline

Jamuna is a braided river with several channels including lots of Char lands and sand bars. During Project 1, Component 1 (River Training) would be piloted only at two sites, 1.71 km long at Bhuapur and 2.23 km long at Kalihati site. The proposed dredging of around 7.065km (length 7.065km, width 100m, depth 6m) longitudinally traverses a mid-channel Char-land. All of these interventions will change the overall river planform at the reach of the proposed intervention and there is a chance of readjustment of the river planform at the downstream of the intervened reach. However, the river planform of the Jamuna is always changing. The mid-channel Char-land where the proposed dredging has been proposed is gradually disappearing and migrating towards downstream for a couple of year which will be stimulated by the proposed dredging. The proposed dredging might cause either disappearance or downward migration of the mudflats/submersible sand-bars currently at downstream (Figure 8.1). These mudflats/sandbars are in trend of shifting which is natural in Jamuna River. Therefore, the impacts of the proposed intervention on the river planform from the environmental perspective is assumed to be moderate. However, in long-term, the proposed intervention might contribute to stabilize the channel by reducing its braiding behavior at the proposed intervened reach.

The proposed Groynes are expected to prevent the bank erosion at the intervened sites thus stabilize the bank. Moreover, in long run, the Groynes would attract sedimentation along the bank and thus gradually shift the current Bankline towards the river (gradual narrowing down). Relevant mitigation measures are presented in the Table 8.7.

The dredging alignment has been fixed following the current trend of morphological changes to minimize the impacts. The arrangement of the Groynes (position with respect to the flow direction) has also been placed to minimize the impacts of the flow deflection towards the opposite banks/Chars.

The installations of navigational aids, would have no impact on the river planform and bankline.

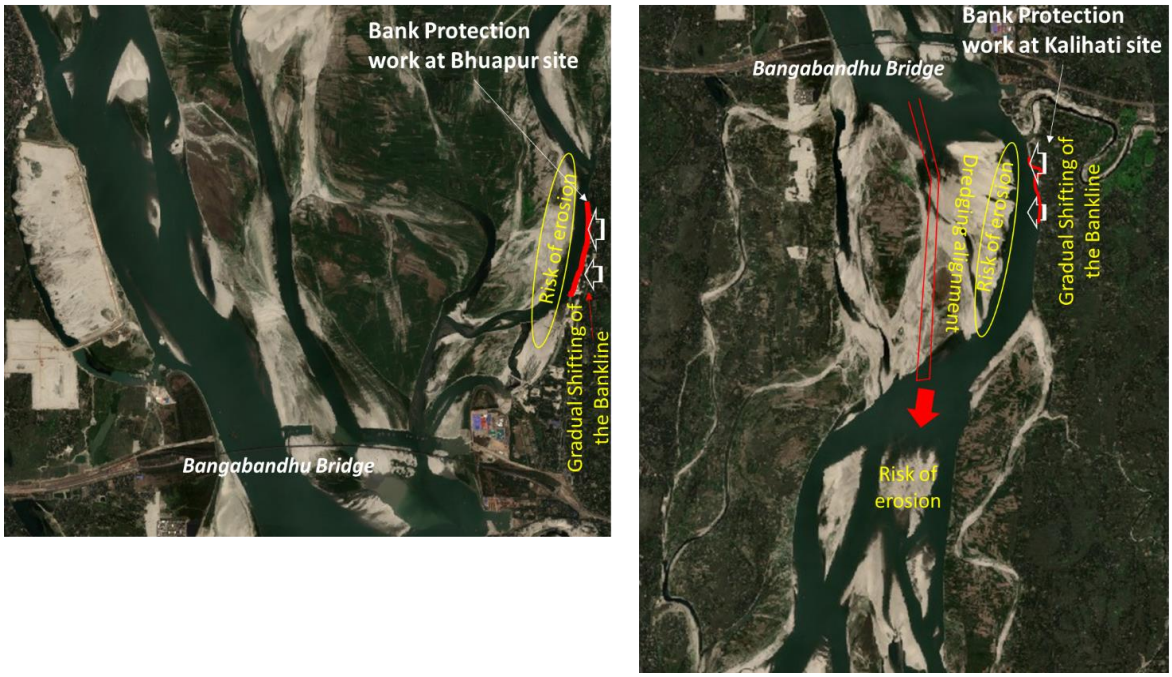


Figure 8.1: Impacts of the Component 1 Work on River Planform

Table 8.7: Mitigation Measures to Mitigate Impacts on River Planform

Mitigation Hierarchy (ESS1)	Measures
Avoid	• The dredging alignment has been fixed avoiding the risk of increasing erosion along the right bank (in Belkuchi upazila). The alternative alignment which was close to the right bank of the river and which would increase downstream erosion risk were avoided
Minimize	• The angle of the Groynes (with respect to the flow direction), has been minimized to ensure minimization of the flow deflection towards the opposite bank (Char) • The technology for bank protection i.e. Top Blocked Permeable Groyne (TBPG), has been preferred to minimize the drastic changes on river planform, Bankline. TBPG results gradual changes taking advantages of natural process.
Mitigate	• Guiding the morphological process (by structural intervention/ dredging) based on morphological trend analysis and hydrodynamic modeling • Chars with high biodiversity importance will be protected by nature-based solutions (further research is needed to explore appropriate solutions). Soft measures like temporary TBPG (i.e. bandaling), vegetative protection, etc. are alternative options as well.
Compensate/ Offset	N/A

Reduction of Floodplain and Alluvial Corridor within Project AOI

Groynes will be constructed at each pilot site. Local scouring may occur around the apex of the Groynes. Also, Groyne will reduce flow velocity near bank and will help to settle down the sediment particles. Thus, it may deflect the flow to the mid-channel. The proposed intervention might lead to contraction of the alluvial corridor near the piloting sites and change the floodplain area (Figure 8.1). The sedimentation attracted by the Groynes might result in closing of any anabranch or secondary channel flowing adjacent to the proposed revetment lines (specially at Bhuapur site). However, it is difficult to determine whether the Project 1 activities will maintain a navigation channel in the complex channel system like the Jamuna River. It is also difficult to determine without any hydrodynamic modeling whether the potential changes in floodplain and alluvial corridor will increase flooding risk downstream. Mitigation measures for changes in floodplain and alluvial corridor are presented in Table 8.8.

Table 8.8: Mitigation Measures for Changes in Floodplain and Alluvial Corridor

Mitigation Hierarchy (ESS1)	Measures
Avoid	Primary objective of the Project is to maintain a stabilized channel and train the river to prevent erosion. The placement of the Groynes, engineering design etc. were thus decided to lead the changes to alluvial and flood corridor as per the design.
Minimize	The TBPG will be designed (especially the length towards the river and the alignment with respect to the bankline) in a way it would avoid any aggressive change in the alluvial and flood corridor.
Mitigate	CC block/geobag will be provided around the apex of the Groynes to prevent potential scouring so the Groyne structures sustain the scouring effects.
Compensate/Offset	N/A

Increase of Erosion Risk to the Downstream Areas

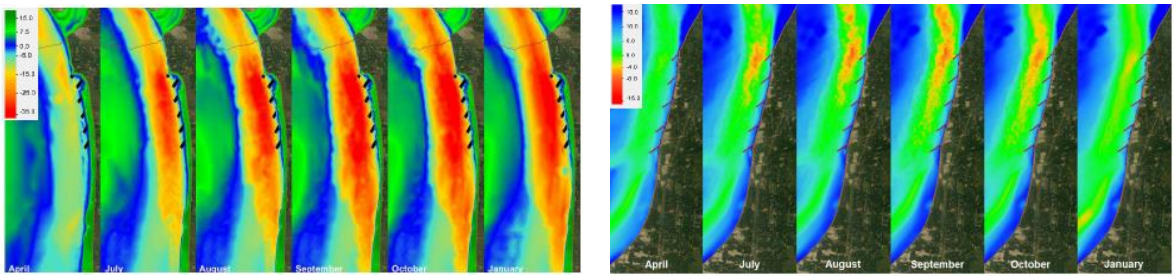
Erosion-rate along the Bhuapur pilot reach is approximately -27 m/year while it was nearly -32.4 m/year along the riverbank of Gobindashi and -48.33 m/year near the Jamuna bridge guide bund during dry period of 2018 to the recent post-monsoon period of 2021. On the other hand, average rate of erosion of Kalihati site at the most erosion-prone reach (d/s of the new Dhaleshwari offtake) was nearly -30.425 m/year during 2016-19, approximately -144.43 m/year during 2020-21. Almost the entire reach was exposed to significant to severe degree of erosion along the bank-line, which deteriorated significantly during the last one and half years (March 2020 to October 2021). The proposed bank protection works target to prevent current bank erosion at two pilot sites and enhance the accretion process along the bank and sedimentation at Dhaleshwari offtake. It is expected that 2,667 people in 2026 and 6,076 people in 2031 will be protected and 367.73 ha in 2026 and 743.82 ha in 2031 of land area will be protected by the implementation of both sites. These are the expected impact as per the modeling outcome.

The scouring often takes place at the toe of the Groyne and the place between two Groynes. In this case, the design has been prepared based on hydro-dynamic modeling to minimize the risk and also some mitigation measures have been adopted to mitigate. **Table 8.9** demonstrates the mitigation measures for erosion risks at downstream and on the opposite bank.

However, generally, erosion risk increases downstream on the riverbank opposite to the bank protection works. The feasibility study concluded based on hydro-dynamic modeling that the erosion risk downstream is minimum because of their selection of technology and design.

The overall impacts of the TBPG series are presented in Figure 8.2 for both sites based on the simulation of temporal variation of the site bed level with TBPG series (case 4). The hydrodynamic model results have confirmed that there will be velocity reduction near the riverbank for the TBPG series installation. The sedimentation occurs near the bank due to decreased velocity. Figure 8.2 illustrate how the velocity near the bankline is reduced in between two Groynes and downstream of the Groyne-in-series respectively. The Groyne scenarios show not only bank erosion protection but also sedimentation along the bankline. In both

locations, substantial velocity reduction can be noticed near the bankside with Groyne series installation. Mitigation measures for increasing risk of erosion are presented in Table 8.9.



(a) Kalihati Site (b) Bhuapur Site

Figure 8.2: Temporal Variation of Bedlevel (mMSL) at both Pilot Sites with Groyne Series

Increase of erosion risk in Mechra due to Canal Re-excavation

The Re-excavation of the canal in Kaoakola Char might increase the erosion along the canal bank especially in Mechra union. The re-excavation would increase flow in the canal which might cause erosion in some places. However, to mitigate this risk a crossbar/bund will be constructed at the off-take of the canal to reduce the flow as well as to reduce the risk of erosion.

Table 8.9: Mitigation Measures for Increasing Risk of Erosion at Downstream and at Opposite Chars

Mitigation Hierarchy (ESS1)	Measures
Avoid	• The dredging alignment has been fixed avoiding the risk of increasing erosion along the right bank (in Belkuchi upazila). The alternative alignment which was close to the right bank of the river was avoided • The alignment of the canal to be re-excavated in Kaoakola has been designed avoiding the internal canals, agricultural lands, and valued lands in Kaoakola.
Minimize	• The placement/arrangement of the Groynes (with respect to the flow direction), has been decided to ensure minimization of the flow deflection towards the opposite bank (Char) • The technology for bank protection i.e. Top Blocked Permeable Groyne (TBPG), has been preferred to minimize the risk of erosion beyond the project AOI. • Designing the protection work on the basis of hydro-dynamic modeling. • In case of Kaoakola canal re-excavation a crossbar will be constructed at the off-take of the canal to prevent the bank erosion.
Mitigate	• Innovative river-guiding structures like combination of permeable Groyne-in-series, TBPG, brush wood and other river training structures to be constructed for bank protection works at erosion prone areas. • Combination of interventions will deflect the river thalweg away from the vulnerable left bank. This will provide land protection and may enhance navigability at the vicinity of the site to some degree. • Reduce sediment load at the old Dhaleshwari offtake at downstream by increasing sedimentation at Groyne locations and hence, improving the flow regime at Dhaleshwari offtake. • CC block and sand filled geo bag will be kept ready at project site specially during monsoon and will be dumped immediately when erosion appears. • Regular inspection and maintenance of bank protection works and Groynes e.g. maintenance of structure, protection from scouring, emergency maintenance, etc. • Any sign of structural failure will be addressed immediately to prevent further deterioration. • Maintenance budget will be allocated for emergency repair • Implement erosion forecasting and dissemination of information to BWDB field offices for necessary action. Currently erosion forecast are being done by MoWR and BWDB (with support from CEGIS) for a collaboration with this initiative might bring further enhancement.
Compensate /Offset	• N/A

Changes in River Hydrology

The proposed structures will be implemented only at two sites, 1.71 km at Bhuapur site and 2.23 km river reach at Kalihati site. Therefore, any noticeable change in river hydrology due to the proposed intervention is very unlikely. There might be some local changes at pilot sites as the proposed Groyne will deflect the flow towards mid-channel. However, the proposed intervention would not change the river discharge, water level, etc.

The flow regime shall be shifted. The protective work would deflect the flow from bankline to mid-channel. The dredging would also drive a portion of the flow towards downstream through the new channel across a Char.

The impact of the proposed intervention on water level would be negligible because of the scale of intervention. Such risk has been minimized by adopting the TBPG technology which makes the changes gradually giving the river more time to adjust by itself.

8.3 Impacts on Water Quality and Mitigation Measures

8.3.1 Potential Impacts and Ttheir Evaluation

Potential impacts on the water quality of river and groundwater (Table 8.10) are mostly related with the construction related interventions of the project. If proper approaches based on available best practices are not taken, the water quality might be contaminated as listed below:

- **Contamination of water bodies by construction waste:** Waste from construction sites which might include construction materials (cement, sand, bricks, etc.), scrap metal, scrap wood, paper, kitchen waste from construction camp, spilled-oils from equipment or vehicles, etc. might end up into river if not properly managed. Also, open discharge of solid and liquid wastes from the labor shed and dredger and houseboat can contaminate the surface water with nutrients, heavy metals, organic pollutants, etc. The wastewater might also include spillage of hydraulic fluid from leaking hydraulic connections or blown hydraulic hoses on hydraulically powered equipment.
- **Increase of turbidity in river-water column**: The bank protection work at two site will involve dumping and placement of 262,584 nos of sand-filled Geobag (250 kg each) and 87,170 numbers of CC block (40cm x 40cm x 20cm) in both sites. Besides, there will be around 906 piles (cast-in-situ-bored piles) to be installed (366 at Bhuapur site and 540 at Kalihati site). Disposal of sand-filled geobags, piling, preparing slope for bank protection work, and dredging might cause increased turbidity in the river-water column nearby. Besides, as an additional sub-component of C1, around 6.15km of river bank will be protected by Sand-filled geobags and around 6.3km canal will be re-excavated which will contribute to change in water quality in place of bank protection and re-excavation.
- **Risk of oil spillage from dredger**: There is a risk of spillage of oil, lubricant and bilge water during dredging, hydrographic surveys, refueling, loose or broken hydraulic fittings and transport/storage, if not properly maintained or not carried out following the GIIP.
- **Risk of Spilling concrete or concrete slurry during construction**: : The construction activities involve installation of 906 cast-in-situ-bored piles which involve a risk of spilling raw concrete or concrete slurry during construction.
- **Risk of Ship Pollution:** The project forecasts a nominal increase in inland cargo and passenger transports (additional 2 million tons cargo and 5 million passengers annually by 2030). Although the project aims for environmentally efficient vessels, there is a risk of ship pollution.

A summary of the impact on water quality is presented in Table 8.10.

Table 8.10: Summary of Impact Assessment on Water Quality

Potential Impacts	Temporal Aspects	Spatial Aspects	Reversibility	Compliance	Likelihood	Magnitude	Sensitivity	Significance	Residual impacts after mitigation
Impacts during construction									
Contamination of water bodies by construction and dredging waste	2	2	2	2	3	S	M	M	L
Increase of turbidity in river-water column due to dredging and re-excavation	2	2	2	2	3	S	M	M	L
Risk of oil spillage from dredger	2	2	2	2	3	S	M	M	L
Risk of Spilling concrete or concrete slurry during construction	2	2	2	2	3	S	M	M	L
Risk & Impacts during operation (additional 2 million tons cargo and 5 million passengers annually by 2030*)*									
Risk of Degradation of water quality due to spillage of bilge water, oil, lubricant from the vessels (mostly nearby a terminal)	3	2	3	4	2	S	M	M	L
Risk of Water pollution from improper waste management by the vessels and careless actions by the passengers (mostly nearby a terminal)	3	2	3	4	3	S	M	M	L

8.3.2 Description of Mitigation Measures

Available mitigation measures to tackle water pollution from solid and liquid wastes are included but not limited to the measures mentioned in Table 8.11, 8.12 and 8.13.

Table 8.11: Mitigation Measures for Water Pollution from Construction and Dredging Waste

Mitigation Hierarchy (ESS1)	Measures
Avoiding	No mixing concrete onsite and use concrete premix.
Minimizing	• Maximize the use of materials for construction and hence, minimizing the disposal and runoff of construction waste. • Hire unskilled local labor to minimize the size of construction cam
Mitigation	• ESCOP 1: Waste Management • ESCOP 3: Water Resources Management; ESCOP 6: Erosion and Sediment Control • Adoption of GIIP for construction of bored in-situ cast piles for TBPG.
Compensate/Offset	N/A

Table 8.12: Mitigation Measures for Water Pollution during Dredging

Mitigation Hierarchy (ESS1)	Measures
Avoiding	No dumping of any bilge water and any ship waste and wastewater into the river.
Minimizing	• Optimize use of resources (oil, fuel, water etc.) • Minimize stationing of dredger nearby any sensitive receptors. Maintain a minimum setback distances from the sensitive habitats (natural habitats like mudflats, fish spawning area, any area where a large assemblage of migratory birds is seen, area with high dolphin activity, etc.) • Optimize the dredging requirement to minimize the water pollution risk.
Mitigation	• The fueling equipment will be equipped with automatic shut-off nozzles. • International standards for refueling of dredger will be followed. • Emergency oil spill kits will be present at places of refueling. • Make bilge water pumping a requirement for all dredgers and vessels for internal transfers and transfer to shore reception facility. Waste and bilge water from dredgers and vessels will be collected and further discharged at a designated discharge point at port/terminal/anchorage area equipped with appropriate facilities. With long-term vision, some river ports can establish these facilities to collect sludge and safe disposal of them. Budget for establishing these facilities are considered in the ESMP. • Dredging Management plan will be followed accordingly by the dredging contractors. • Accidental spills will be managed through the preparation and implementation of an emergency response plan to be prepared by the contractors as part of the OHS Plan (Chapter 9). • The contractor should develop an incident reporting and monitoring mechanism. • Monitoring of implementation of environmental management plan will be done by engaging monitoring agency. • Introduce penalty for enforcing national environmental law. Any illegal dumping by the dredgers and vessels will be penalized monetarily and the amount will be sufficient to rectify harm caused by the disposal. • Further mitigation measures are detailed out in the ESCOP 1, 2.
Compensate/Offset	N/A

Table 8.13: Mitigation Measures for Water Pollution during Operation and Maintenance Period from Passenger and Cargo Traffics

Mitigation Hierarchy (ESS1)	Measures
Avoiding	• No dumping of any type of solid waste and wastewater into open water. • Restrict passengers and ship operators to throw any sort of waste material into the water by communication, awareness building, legal enforcement.
Minimizing	• Install waste disposal containers within vessels and then organize a collection and disposal system to an approved landfill location • An awareness/communication practice/system will be established in vessel to aware the passengers
Mitigation	• Shore reception facilities will be established at four ports and jetties to collect solid waste, wastewater and bilge water from the incoming vessels and develop a procedure for safe disposal of them. The cost of waste and bilge water treatment system has been included in the ESMP. o Wastewater and solid wastes will be accumulated inside the vessel and discharge at shore reception facilities. • Knowledge regarding impacts of water pollution and measures to control along with rules and regulation will be disseminated among the vessel owners, operators and port authorities.

Mitigation Hierarchy (ESS1)	Measures
	• Monitoring of implementation of environmental management plan will be done by responsible agencies such as BIWTA, port authorities, DoE, etc. Introducing penalty/fine for littering or non-observance of waste management procedure would help enforcement of law.
Compensate/Offset	N/A
Water pollution from spillage of oil, lubricant	
Avoiding	• No refueling nearby any sensitive area • No stationing of any vessel nearby any sensitive receptors.
Minimizing	Optimize use of resources (oil, water, etc.)
Mitigation	• The fueling equipment will be equipped with automatic shut-off nozzles. • Fueling will be done only at the ports and jetty areas, and no refuelling will be done from smaller boats and ships while moving through the river route. • International standards for refueling will be followed. • Emergency Spill Kit will be present at places of refueling. • Bilge water related to fuel and lubricants will be discharged at the shore reception facilities at the ports/Jetties. • Monitoring of implementation of environmental management plan will be done by responsible agencies such as BIWTA, port authorities, DoE, etc. • Accidental discharge of oil will be managed by the Emergency Response Operation Facilities of the Port, which is being covered by the SOP Emergency Response Plan, laid out in the Chapter 9: OHS.
Compensate/Offset	N/A

8.4 Impacts on Noise and Vibrations and Mitigation Measures

8.4.1 Potential Impacts and Evaluation

Various construction activities, such as installation of the Groynes, the pile driving, dredging and excavation work, and operation of heavy equipment will cause noise and vibration and can affect receptors near the construction sites. Earth work requiring the movement of 126,522.5 m^3 of earth at the Kalihati site and 122,591 m^3 at the Bhuapur site by truck/boat or any other means will cause noise and vibration along the transportation routes. The vibration may affect the stability of nearby structures. Operation of construction equipment causes ground vibrations which spread through the ground and diminish in strength with the distance. Buildings founded on the dry land in the vicinity of the construction site respond to these vibrations, with varying results ranging from no perceptible effects at the lowest levels, low rumbling sounds and fellable vibrations at moderate levels and slight damage at the highest levels. Ground vibrations due to piling activities very rarely reach the levels that can damage structures, but can achieve the audible and fillable ranges in buildings and in the waterbodies close to the site, which might affect the communities and aquatic species.

Table 8.14 shows the noise sources and Table 8.15 shows impacts respectively. The noise during the construction phase depends on the stage of construction work and equipment used at the site.

Table 8.14: Sources of Noise

Sl. No.	Sources of Noise	Activities
1	Construction activities	• Site clearing and preparation; • Excavation and concrete placement • Erection of structures. • Concrete mixing and aggregate production systems; • Construction Camps / Ancillary Facilities • Pile driving or drilling activities; • Haulage and general vehicle movements;
2	Mobile sources (Mostly vehicles involved in construction activities)	• Engine running • Hydraulic horns • Loading and unloading activities

Table 8.15: Summary of the Noise Impacts

Potential Impacts	Temporal Aspects	Spatial Aspects	Reversibility	Compliance	Likelihood	Magnitude	Sensitivity	Significance	Residual impacts after mitigation
Construction of Groynes at Pilot Sites									
Noise from Site clearing and preparation;	1	1	1	1	1	L	M	M	L
Noise from Excavation and concrete placement	2	2	2	2	2	M	M	M	L
Noise from Erection of structures.	2	2	2	2	2	M	M	M	L
Noise from Concrete mixing and aggregate production systems;	2	2	2	2	2	M	M	M	L
Noise from Construction Camps / Ancillary Facilities	2	1	1	2	1	M	M	M	L
Noise from Pile driving (cast insitu bored pile, vibratory hammer)	2	4	2	3	4	S	S	S	M
Noise from Haulage and general vehicle movements;	2	3	2	2	2	S	M	M	L
Noise from Engine running	2	3	2	2	2	S	M	M	L
Noise from Hydraulic horns	2	3	2	2	2	S	M	M	L
Noise from Loading and unloading activities	2	3	2	2	2	S	M	M	L
Disturbance to Dolphin, fishing cat and Gharial due to noise of construction activities such as pile driving	2	1	2	2	3	M	H	S	L
River Dredging									
Noise from Haulage and general vehicle/Vessel movements;	2	3	2	2	2	S	M	M	L
Noise from Engine running	2	3	2	2	2	S	M	M	L
Noise from Hydraulic horns	2	3	2	2	2	S	M	M	L
Noise from Loading and unloading activities	2	3	2	2	2	S	M	M	L
Installing Navigation Aids									

Potential Impacts	Temporal Aspects	Spatial Aspects	Reversibility	Compliance	Likelihood	Magnitude	Sensitivity	Significance	Residual impacts after mitigation
Noise from Haulage and general Vessel movements;	2	3	2	2	2	S	M	M	L
Noise from Engine running	2	3	2	2	2	S	M	M	L
Noise from Hydraulic horns	2	3	2	2	2	S	M	M	L
Installation of Floating and Movable Jetty									
Noise from Haulage and general Vessel movements;	2	3	2	2	2	S	M	M	L
Noise from Engine running	2	3	2	2	2	S	M	M	L
Noise from Hydraulic horns	2	3	2	2	2	S	M	M	L
Commencing of Hydrographic Survey (by Ship)									
Noise from Haulage and general Vessel movements;	2	3	2	2	2	S	M	M	L
Noise from Engine running	2	3	2	2	2	S	M	M	L
Noise from Hydraulic horns	2	3	2	2	2	S	M	M	L
Increase of River Traffic									
Noise from Haulage and general Vessel movements;	2	3	2	2	2	S	M	M	L
Noise from Engine running	2	3	2	2	2	S	M	M	L
Noise from Hydraulic horns	2	3	2	2	2	S	M	M	L

8.4.2 Description of Impacts and Mitigation Measures

Increased Noise level during construction period

The project involves civil and mechanical interventions to install groyines, and river bank protections. Specially, the 0.9 m diameter of 366 in Bhuapur Site (45-50 m length in 2 rows) and 0.75 m diameter of 540 piles in Kalihati site (45-50m length, 3 rows) will be driven using vibratory hammers. Pile driving of 17,185.53 m in Bhuapur and 28,568.7 m in Kalihati sites will increase the ambient noise level up to a harmful level for local communities' close proximity of the pilot sites. Pile driving can also generate high underwater and air noise levels that can affect hilsa migration, dolphins' vocalization and migratory birds' habitat. However, these impacts due to noise are limited to the construction period, the spatial extent is also not very wide, and sensitivity is high for dolphin and communities' close proximity of the pilot sites.

Sound levels from various pile driving activities were compiled by the CALTRANS (2015). Sound levels from 2.4 m (96 inches) steel pile driven through hydraulic hammer measured at various distances is shown in Figure 8.3. The relationship between the measured sound levels from the pile and distance from the pile is also shown in Figure 8.3. Three metrics are commonly used in evaluating hydroacoustic impacts on fish and they are, (a) Peak sound pressure level (Peak), (b) Root mean square (RMS), and (c) Sound exposure level (SEL). In Figure 8.3 red data points represent Peak, black points indicate RMS, and blue points denote SEL sound pressure level.

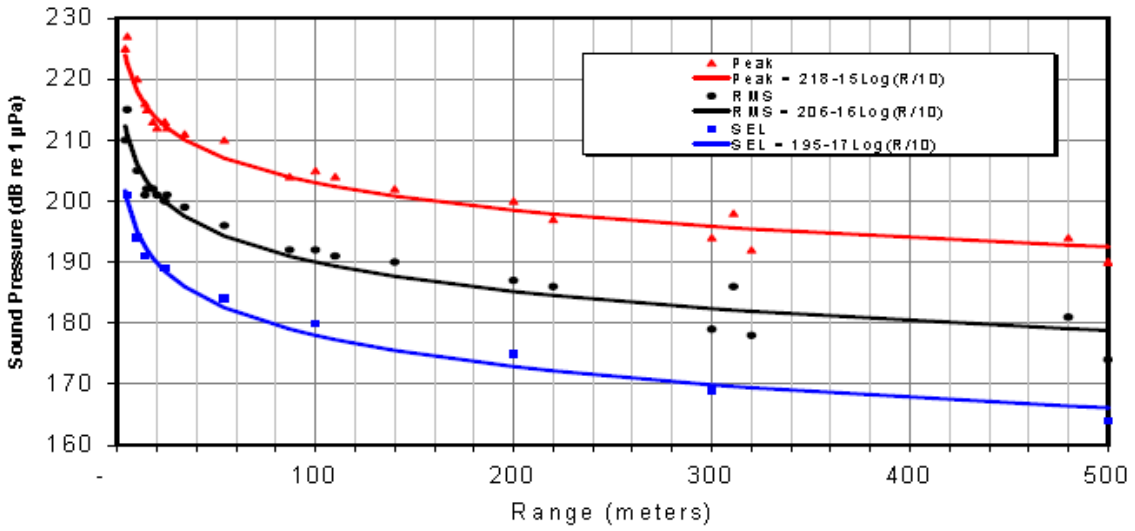


Figure 8.3: Relationship between Measured Sound Level and Distance from Pile

Figure 8.3 indicates that noise levels reduce with distance due to transmission losses. Noise levels from piling operations primarily depend on the type of the pile and type of the hammer. Noise levels generated by both vibratory and impact drivers are given in Table 8.16 to compare the noise levels from both the impact and vibratory hammers. As shown in Table 8.15, vibratory hammers produce less noise levels than the impact drivers.

Table 8.16: Comparison of Noise Levels from Pile Driving Steel Pipes through Different Methods

Driver	Location	Diameter	Water Depth	Distance from source	Peak	RMS	SEL
Vibratory	Bangor, WA	0.9 m (36 inches)	4.6-21.9 m	6-29m 64-98m 100-315m 836-2,290m 2,200-2,281m 2,800-2,937m		169 152 150 135 132 133	
Hydraulic Impact	Humboldt Bay Bridges	0.9 m (36 inches)	4 m	10 m 20 m 40 m	197 192 190	185 181 178	- 169 164
Diesel Impact	San Rafeal, CA	0.75 m (30 in)	~ 4 to 5m	10m 20m 30m 40m 60m	205 200 199 194 195	190 185 181 178 169	170

Source: CALTRANS (2015)[Error! Bookmark not defined.]

Gangetic dolphin and winter birds (migratory) were identified during the biodiversity surveys in relatively close to the project site and are the most likely taxa to be affected by pile driving. In the following section, impacts of pile driving on dolphin and migratory birds are discussed in greater detail.

Impact on Ganges River Dolphin

For all cetaceans, including dolphins, sound serves three main functions: (i) it provides information about their environment, (ii) it is used for communication, and (iii) it enables the remote detection of prey. The sounds generated by these animals often extend beyond the range audible to the human ear. Vocalizations of Dolphins will be in range of 125-173 dB (at 1m) for whistles and 218-228 dB (at 1m) for clicks.

U.S. Department of Commerce, National Oceanic and Atmospheric Administration (NOAA) has published Underwater Acoustic Thresholds for Onset of Permanent (PTS) and Temporary Threshold Shifts (TTS) for mammals.[79] This technical guidance presented sound exposure level (SEL) and peak sound pressure level (SPL) for high frequency (HF) cetaceans (Ganges/Indus Dolphins) and are presented in **Table 8.17a.**

Table 8.17a: Sound Exposure Level and Peak Sound Pressure Level for High Frequency Cetaceans

Group of Cetacean	Impulsive Hammer				Non-Impulsive	
	TTS Threshold		PTS Threshold		TTS	PTS
	SEL (weighted)	Peak SPL (unweighted)	SEL (weighted)	Peak SPL (unweighted)	SEL (weighted)	SEL (weighted)
	(dB re 1 µPa²s)	(dB re 1 µPa)	(dB re 1 µPa²s)	(dB re 1 µPa)	(dB re 1 µPa²s)	(dB re 1 µPa²s)
HF	140	196	155	202	153	173

Pile drive generated noise has the potential to impact dolphin populations as this noise is capable of masking dolphin's vocalization. The threshold peak impulse source pressure for direct physical trauma in aquatic mammals and reptiles is generally considered to be >200 dB[80] and hence dolphins and Gharial would not be expected to experience permanent hearing impairment from sound pressures generated by pile driving using vibratory hammers. A vibratory pile-driving hammer has a set of jaws that clamp onto the top of the pile. The pile is held steady while the hammer vibrates the pile to the desired depth. Because vibratory hammers are not impact tools, noise levels are typically not as high as with impact pile drivers. However, piles installed with a vibratory hammer must often be proofed, which involves striking the pile with an impact hammer to determine its load-bearing capacity, possibly with multiple impacts.

Effects on behavior are more likely. Behavioural studies indicate a temporary displacement from the area where pile drivers are operating. No overt behavioural changes were observed in response to the pile-driving activities, but the animals' speed of travel increased and some dolphins remained within the vicinity while others temporarily abandoned the area. Field experience during the Padma Bridge construction indicates that dolphin numbers returned close to normal once pile driving had ceased.

Occurrence of dolphin in the project area was observed during the field surveys, the courtship and mating period of dolphin is in August through December and birth period in April through June. Dolphin emerges to water surface for breathing from time to time.[81] In addition, breeding period for most of the fishes in Jamuna coincides with Hilsa migration period. Since, most of the pile driving will take place in the bankline and conducted during dry season, noise generated from pile driving will not affect the migration patterns of the major fishes. The potential Gharial habitat within the BAA is also far away from the pile driving area to have an impact on Gharial behavior.

[79] NOAA (2016) Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing, http://www.nmfs.noaa.gov/pr/acoustics/Acoustic%20Guidance%20Files/opr-55_acoustic_guidance_tech_memo.pdf

[80] JA David Mciwem (2006), Likely sensitivity of bottlenose dolphins to pile-driving noise, Water and Environmental Journal 20, pp48-54 (http://www.marineconnection.org/docs/Dolphins at Risk-piledriving.pdf)

[81] Wakid, A. and Braulik, G. (2009): Protection of endangered Gangetic dolphin in Brahmaputra River, Assam, India. Final report to IUCN-Sir Peter Scott Fund. Pp 44.

Pile driving during other season (August-February), mitigation measures recommended by the Joint Nature Conservation Committee[82] (JNCC) will be adopted to minimize the impacts on dolphins. JNCC guidelines recommend the following:

- ***Mitigation Zone:*** A mitigation zone of at least 500m radius willbe established,
- ***Piling at night or poor visibility:*** Piling will not be commenced during periods of darkness or poor visibility (such as fog), or during periods when the river/sea state is not conducive to visual mitigation, as there is a greater risk of failing to detect the presence of aquatic mammals and reptiles,
- ***Pre-Piling Search:*** The mitigation zone will be monitored visually and/or acoustically using Passive Acoustic Monitoring (PAM) for a minimum of 30 minutes prior to the commencement of piling.[83]
- *Delay if any aquatic mammals (especially Dolphin), Fishing Cat* and reptiles (especially Gharial) *are detected within mitigation zone:* Piling will not be commenced if aquatic mammals and reptiles[84] after the last visual or acoustic detection. The Contractor will track the movements of any aquatic mammals and reptiles detected and ensure they are satisfied the animals have left the mitigation zone before they advise the technician to commence piling activities.
- ***Soft-Start of Pile Driver:*** JNCC guidelines also recommend the adoption of a 'soft start', a period of not less than 20 minutes; using a low energy start to the operations would give any aquatic mammals and reptiles an opportunity to leave the area. It is believed that by initiating piling at a lower power this will allow for any aquatic mammals and reptiles to move away from the noise source, and reduce the likelihood of exposing the animal to sounds which can cause injury. If an aquatic mammal enters the mitigation zone during the soft-start then, whenever possible, the piling operation will cease, or at the least the power will not be further increased until the aquatic mammal and reptiles exits the mitigation zone, and there is no further detection for 20 minutes.
- ***Break in piling activity:*** If there is a pause in the piling operations for a period of greater than 10 minutes, then the pre-piling search and soft-start procedure will be repeated before piling recommences. If a watch has been kept during the piling operation, the Contractor will be able to confirm the presence or absence of aquatic mammals and reptiles, and it may be possible to commence the soft-start immediately. However, if there has been no watch, the complete pre-piling search and soft-start procedure will be undertaken.
- ***Acoustic Deterrent Devices (ADDs):*** The use of devices that have the potential to exclude animals from the piling area will be considered. Acoustic Deterrent Devices (ADDs) will only be used in conjunction with visual and / or acoustic monitoring. Use of "scammers" or "pingers" upstream and downstream to chase away dolphins and other aquatic mammals and reptiles. When planning to use ADDs, the potential effectiveness of candidate devices on the key aquatic mammal and reptile species likely to be present in the area will be assessed by the Contractor.

Impact of Air Noise on Communities and Migratory/Winter Birds

[82] Joint Nature Conservation Committee. (2010) Statutory nature conservation agency protocol for minimising the risk of injury to marine mammals from piling noise Joint Nature Conservation Committee, Aberdeen, UK. (https://data.jncc.gov.uk/data/31662b6a-19ed-4918-9fab-8fbcff752046/JNCC-CNCB-Piling-protocol-August2010-Web.pdf)

[83] This 30 minute period is used in the JNCC seismic survey guidance

[84] A 20 minute period is adopted by the JNCC seismic survey guidance. Issues of swimming speed and noise dosage are considered in the Thame Developer report - it is considered that twenty minutes is a sufficient period of time to allow individuals to be at a distance where risk of injury or death is minor.

Charland with their mudflats and sandy beaches are the major staging grounds for migratory birds. Although it is possible that critical and endangered migratory birds (e.g. Yellow breasted Bunting, Indian Skimmer, Black-bellied Tern, Painted Stork) can occur in the Project AOI, there is no recent record of sighting in the Project AOI. During the construction period if construction activities coincide with the migratory birds that utilize this habitat, potential disturbance will occur. Construction activities, such as pilling, dredging and human traffic in the Charland has the potential to negatively affect Charland dwelling animals, including migratory birds. A major impact will be on the sensitive receptors in close proximity of the pilot sites and on the winter birds. As some uncommon and rare winter visitors (Black-bellied Tern, Black Stork, Painted Stork, River Lapwing, Lesser Adjutant, Greater Spotted Eagle, Spot-billed Duck, Cotton-pygmy Goose, and Gray-headed Fish Eagle) are possible to be sighted in the BAA, air noise from pile driving activities, construction equipment, vehicles, and human traffic has the potential to disturb migratory birds, compelling them to leave these areas. Noise and the movement of workers may also disturb the migratory birds, which may leave or change their flight route until the activities are over. Staging grounds of birds have been identified during the field investigations. Air noises from pile driving activities are estimated using the empirical formula shown in equation 1 recommended by NRC (2012)[85]:

$$L_{max} at\ D_1 = Construction\ L_{max}\ at\ D_0 - 25 * Log(\frac{D_1}{D_0})$$

where,

L_{max} at D_1=Maximum air sound level at a desired distance,

Construction L_{max} at D_0 = 98 dB (for 0.75 diameter pile driving using a vibratory hammer),

D_0 = 15 m.

Equation 1: Estimation of Air Noise Levels in Sensitive Receptors

Table 8.17b presents estimated noise levels at sensitive receptors close to the pilot sites. To reduce air noise levels, mitigation measures such as acoustic enclosure, cofferdam can be placed to cover the hammer and the exposed pile to reduce the air noise level. A minimum reduction of 10 dB air noise levels can be set for one single noise mitigation measures to minimize potential impacts on the communities and birds.[86]

[85] NRC (2012) Construction Noise Impact Assessment. Biological Assessment Preparation, Advanced Training Manual Version 02-2012. US Nuclear Regulatory Commission, https://www.nrc.gov/docs/ML1225/ML12250A723.pdf

[86] Bellmann, M. A. (2014) Overview of existing Noise Mitigation Systems for reducing Pile Driving Noise, Inter.noise 2014, Melbourne, Australia, 16-19 November 2014, https://www.acoustics.asn.au/conference_proceedings/INTERNOISE2014/papers/p358.pdf.

Table 8.17b: Estimated Noise Levels at Nearby Sensitive Receptor

Site Name	Sensitive Receptors	Northing	Easting	Distance	Lmax
	Settlements			50	84.93
				100	77.40
				500	59.93
				1000	52.40
				2000	44.88
				3000	40.47
				4000	37.35
				5000	34.93
Kalihati	Madrasha 1	19927550.05	503457.0385	144	73.44
	Settlement 1	19926762.46	503504.694	517	59.57
	madrasha 2	19927440.79	503470.4498	494	60.06
	Mosque 1	19927299.38	503480.4305	730	55.82
	Settlement 2	19925865.76	503550.0624	568	58.54
	Settlement 3	19925902.97	503542.7705	152	72.86
	Settlement 4	19926400.25	503520.4769	296	65.62
Bhuapur	Mosque 1	19935215.65	503097.11	463	60.76
	Settlement 1	19935017.59	503104.3829	279	66.26
	Settlement 2	19934759.78	503115.1712	155	72.64
	Mosque 2	19934750.88	503117.4252	319	64.81
	Mosque 3	19934671.29	503121.6179	358	63.56
	Settlement 3	19933796.04	503167.621	825	54.49
	Graveyard	19934182.8	503145.9134	523	59.44
	Mosque 4	19934227.24	503140.1815	186	70.66
	Settlement 4	19933650.85	503170.234	477	60.44
	Settlement 5	19934420.51	503130.2862	106	76.77

Impact on Fishing cat and Aquatic Life: Based on the above discussion (Noise and Vibration Impacts due to Pile Driving), noise levels from vibratory pile driving are limited to near the source and are not expected to have any large-scale or long term impact on aquatic habitats. Interim thresholds[87] for fish are presented below:

- 206 dB peak
- 187 dB cumulative SEL for fish ≥ 2 gm
- 183 dB cumulative SEL for fish < 2 gm

Aquatic species close to the pile drivers may exhibit avoidance response and move away from the piling areas. However, mitigation measures presented in Table 8-18 will be taken to avoid impacts on aquatic species.

[87] Popper, Arthur N., Thomas J. Carlson, Brandon L. Southall, and Roger L. Gentry. 2006. Interim Criteria for Injury of Fish Exposed to Pile Driving Operations: A White Paper.

Table 8.18: Mitigation Measures for Increased Noise Risk

Mitigation Hierarchy (ESS1)	Measures
Avoid	• No construction activities at night. • No positioning of stationary noise sources such as generators and compressors as far away as possible from noise sensitive areas. • Forbidding horns in populated areas. • No the use of impact hammer for unconsolidated substrates (e.g., sand, mud, gravel). • No operations during monsoon seasons • No time periods when effective impact mitigation is not possible, • No night time pile driving activities to eliminate vibration in nearby homes during the nighttime hours
Minimize	• Careful construction (adopitng the mitigation measures mentioned here along with frequent wildlife monitoring, ESMP monitoring) during October to December and April to June, because this period is very sensitive for Dolphin and Gharial. November to February is also critical for migratory birds (forging and roosting) and therefore careful construction is needed • Minimize the duration over which the sound-producing activity is intended to take place; • No pile driving during high water level to avoid impact on aquatic species. • Minimize the individual and cumulative sound pressure and exposure levels delivered into the environment by the activity. If necessary, the use of alternative, lower impact equipment and methods could be explored (e.g., vibratory hammer, gravity base piles). • Use muffler systems to control engine noise • Use shields that are physically attached to the particular piece of equipment, particularly for stationary equipment and where considerable noise reduction is required. • Movable noise attenuation measures would be erected around pumps, trucks, and other noisy equipment when operating in close proximity to residential areas. • Use a smaller hammer to reduce the sound pressure. The sound produced in pile driving has a direct relationship to the force used to drive the pile • For minimizing vibrations, route heavily loaded trucks away from the residential streets, if possible, select streets with fewest homes, if no alternatives are available. • Operating of earth moving equipment on the construction lot as far away from vibration sensitive sites as possible • Take action to scare off dolphins and Gharial away from the construction areas using pingers prior to start of high noise activities.
Mitigate	• Require contractors to prepare and submit to the PIU a "Pile Driving Plan" following JNCC Guidelines to be approved before commencing any works at the pilot sites. The PIU will scrutinize the Pile Driving Plan to ensure it is effective for reducing impacts, is thorough and the contractor has the appropriate capacity available to implement it. • Subsequent implementation of works will be appropriately supervised to ensure they are implemented correctly to avoid having to be redone and duplicate adverse impacts. • Source control requirements may have the added benefits of promoting technological advances in the development of quieter equipment. • Equipment modifications, such as dampening of metal surfaces, are effective in reducing noise due to vibration. Another possibility is the redesign of a particular piece of equipment to achieve quieter noise levels • Sound aprons are useful when the shielding must be frequently removed or if only partial covering is possible. • Enclosures for stationary work may be constructed of wood or any other suitable material and typically surround the specific operation area and equipment. • The use of electric powered equipment is typically quieter than diesel, and hydraulic powered equipment is quieter than pneumatic power • Using vehicles and equipment in good conditions

Mitigation Hierarchy (ESS1)	Measures
	• Use vibratory hammer. Under those conditions where impact hammers are required for reasons of seismic stability or substrate type, it is recommended that the pile be driven as deep as possible with a vibratory hammer prior to the use of the impact hammer. • Monitor sound levels (under water and air) during pile driving at various distances within the mitigation zone to ensure that noise levels do not exceed the DoE, WB or any other international recognized criteria. • Incorporate the use of clear "ramp-up" (i.e., "soft-start") procedures, whereby sound energy input to the marine environment is gradually or incrementally increased from levels unlikely to cause significant behavioral impact on aquatic mammals to the full output necessary for completion of the activity. • Implement measures to attenuate the sound when sound pressure levels exceed the DoE, WB or any other internationally recognized criteria. Methods to reduce the sound pressure levels include, but are not limited to: • Incorporate the use of fully enclosing or confined bubble curtains, encircling absorptive barriers (e.g., isolation casings, cofferdams) or other demonstrably effective noise reduction methods at the immediate works site, in order to reduce underwater sound propagation from on-site operations. Studies have shown that such methods can provide a significant reduction in sound input to the wider aquatic environment in the order of 10-30 dB.**Error! Bookmark not defined.** • Use a hydraulic hammer if impact driving cannot be avoided. The force of the hammer blow can be controlled with hydraulic hammers, and reducing the impact force will reduce the intensity of the resulting sound • Further mitigation measures are described in the ESCOP 11.
Compensate/ Offset	N/A

8.5 Impacts on Air Quality and Mitigation Measures

8.5.1 Potential Impacts and their Evaluation

During the construction phase fugitive dust will be emitted on a longer-term basis from stationary sources such as quarries, borrow pits, especially during dry season. The likely sources and their impacts (Table 8.19) of air pollutants are as follows:

- **Mobile sources (Mostly vehicles involved in construction activities)**
  - Exhaust emissions from the operation of construction machinery (e.g., Nitrogen Oxides (NOx), Sulfur Oxides (SOx) and Carbon Monoxide (CO)). PM10
  - Dust generated by movement of vehicle. PM 2.5
  - Dust emission while transporting construction materials, e.g., sand, gravel, rock, cement, etc., on local earth roads
- **Fixed sources (Generator sets, construction equipment e.g., compressors and excavation/ grading activities):**
  - Rock crushing, mixing of construction materials.
  - Open burning of waste materials
  - Dust generated by quarries, borrow pits, haul roads, unpaved roads
  - Dust generated from soils and material stock-piles.

Table 8.19: Summary of the Impacts on Air Quality

Potential Impacts	Temporal Aspects	Spatial Aspects	Reversibility	Compliance	Likelihood	Magnitude	Sensitivity	Significance	Residual impact after mitigation
Construction activities and dredging & dredged material disposal									
Exhaust emissions from the operation of construction machinery (e.g., Nitrogen Oxides (NO_x), Sulfur Oxides (SO_x) and Carbon Monoxide (CO)).	2	2	1	2	3	M	S	M	L
Dust generated by movement of vehicles/vessels.	2	2	2	2	2	M	S	M	L
Dust dispersion while carrying the construction materials e.g., sand, gravel, rock, cement, etc. and disposal of dredging materials	2	3	2	2	2	S	S	S	L
Rock crushing, mixing of construction materials, soils and material stock-piles, dredged material disposed sites	2	2	2	2	2	S	S	S	L
Increase of River Traffic after construction and installation of navigation aids									
Exhaust emissions from the ships (e.g., Nitrogen Oxides (NOx), Sulfur Oxides (SOx), Particulate matters, and Carbon Monoxide (CO)).	3	4	2	2	2	S	S	S	L

8.5.2 Description of Impacts and Mitigation Measures

Exhaust emissions from the operation of construction machinery

Construction works which are very significant parts of the project tasks, involve operation of different types of fuel burning machineries. Exhaust emissions from the engines consist of harmful and toxic gases such as Nitrogen Oxides (NO_x), Sulfur Oxides (SO_x) and Carbon Monoxide (CO), and particulate matter (PM_{10}, $PM_{2.5}$). Continuous emission of these pollutants can cause air pollution which may travel further the project boundary following the wind. River banks are common shared places for different species to live and wade especially, birds and turtles. Using of poor-quality fuel and technical faults of any equipment may cause greater emission. TO tackle air pollution from exhaust emissions, the following mitigation approach will be followed. **Table 8.20** proposes some possible mitigation measures to control or reduce the exhaust emission.

Table 8.20: Mitigation Measures for Air Quality Deterioration

Mitigation Hierarchy (ESS1)	Measures
Avoid	• No earthen roads for transporting the construction materials • No locations for borrow pits, rock crushing facilities, concrete batching yards near the water bodies and community area. • No storing the Construction materials from nearby waterbodies and community area. • No spoil storing on the river bank/slope • Place the DG sets and other powered equipment away from sensitive receptors to avoid complaints
Minimize	• Fencing of project area by drum sheet or mesh nets • Limiting site clearance and base stripping activities within the project boundary • Stocking of construction materials and machinery must be within a limited area

Mitigation Hierarchy (ESS1)	Measures
	• Stock piles of construction materials be required to cover in order to protect them from wind and weathering action • Use of low-sulfur diesel in all vehicle, and equipment • Construction wastes must be reused or recycled as and where possible • Burning of waste material will be restricted • Limiting activities for producing fugitive dust particle e.g., excavating earth, handling of the construction materials etc. • Vegetation clearance and base stripping at riverside and country side slopes of the bank protection works will be minimized • Ensure all machinery is maintained in good operating condition • Regular maintenance of water vessels, vehicles, generator and construction machinery in accordance with manufacturer's specifications. • Transport vehicles must not be overloaded. • Avoid queuing of vehicles in areas adjacent to site, particularly near sensitive receptors including housing. • Switch off / throttle down all site vehicles, water vessels, generator and machinery when not in use. • Concreate batching and mixing plant will be located downwind of and minimum 500m away from residential areas as well as sensitive receptors and be fitted with high stack (30m) to allow adequate dispersion of emissions;
Mitigate	• Vehicle speed restriction (e.g., 20 km/h) must be enforced to control dust generation • Construction materials must be covered to protect from wind action • Spray water regularly for suppressing fugitive dust • Dump trucks carrying sand or other fines containing materials have their loads covered when under way to mitigate dust generation from the loads • An appropriate freeboard must be maintained in trucks hauling construction materials • Introducing pollution free/new technology in construction activities • Approved pollution control devices to be fitted in equipment and machinery • Establish grass carpeting in the unpaved area where possible • Regular air monitoring will be carried out near the sensitive receptors to ensure ambient air quality remains within the limits defined by national standards • The contractor must adopt the ESCOP 7, 9, and 10
Compensate/Offset	N/A

8.6 Impacts on Biodiversity and Mitigation Measures

8.6.1 Potential Impacts and their Evaluation

The impacts of the Project 1 activities of the Program would be mostly low to moderate due to scale of the intervention that are summarized in Table 8.21. On site disturbance includes impacts on sensitive species of biodiversity significance and poorly known species like frogs and snakes. Generally, the construction activities, like pile driving, excavation, concreting operation may affect these species, along with several threatened bird species.

The site-specific impacts on biodiversity include disturbance on aquatic and terrestrial ecosystem, displacement of individuals and populations of species, alteration of habitats, alteration in population dynamics, changes in species composition and isolation or fragmentation of habitats.

Noise from pile driving and light generated during Groyne construction, installation of navigation aids and vessel movement during operation may harm individual animals consequently affecting the feeding and breeding behaviors on long term population levels. Among the important species of Jamuna River and its adjacent areas, Dolphin, Fishing Cat, Gharial, Narrow-headed Soft-shell Turtle, Ganges Soft-shell Turtle,

Painted Stork, Black-bellied Tern and migratory birds are worth mentioning, as identified in the baseline chapter. The project activities might take place in the area of occupancy and extent of occurrence that may have impact on these important species. The summary of the impacts is presented in Table 8.21

Table 8.21: Summary of Impacts on Biodiversity

Potential Impacts	Temporal Aspects	Spatial Aspects	Reversibility	Compliance	Likelihood	Magnitude	Sensitivity	Significance	Residual Impact after mitigation
Construction of Groynes at Pilot Sites and dredging									
Disturbance to Brahmaputra-Jamuna River KBA	2	2	3	2	3	S	S	S	L
Contraction of mudflats, river area (alluvial zone), Charlands like natural habitat at site	3	2	2	2	1	M	S	M	L
Loss of mixed but mostly modified habitats along the bank	3	1	3	2	3	S	M	M	L
Risk of increasing disturbance and reduction of suitability in the natural habitats (river area, mudflats, Chars) due to pollution (Noise, water pollution, etc.) from construction activities including dredging	2	3	3	2	3	S	S	S	L
Loss/Turmoil of benthic and riverbed due to dredging	2	1	2	2	3	M	S	M	L
Impacts of Navigation Aids and Movable Jetty									
Disturbance of nocturnal wildlife due to installation of navigational materials and devices	1	1	3	2	2	M	S	M	L
Impacts on Species and biodiversity features triggering critical habitat criteria									
Risk of physical injury to Dolphin, and Gharial through collision	2	1	3	2	1	M	H	S	L
Disturbance to Dolphin, fishing cat and Gharial due to noise of construction activities such as pile driving	2	1	2	2	3	M	H	S	L
Temporal loss of habitat of Baghair fish (*Bagarius bagarius*) and Chital (*Chitala chitala*)	2	1	2	2	3	M	H	S	L
Risk of disturbance to dolphins, and Gharial due to increased light and sound due to increased navigation post construction	2	2	2	2	2	M	H	S	L
Increase of River Traffic									
Risk of disturbance to aquatic wildlife in river and Chars (frogs, turtles, fishes, reptile) due to increased light and sound	2	2	2	2	2	M	S	M	L
Risk of disturbance to wildlife in floodplain and Chars due to increased light and sound	2	2	2	2	2	M	S	M	L
Risk biodiversity loss due to accidental oil spillage	2	2	3	2	1	M	S	M	L

8.6.2 Description of Impacts and Mitigation Measures

Impacts on Legally Protected and Internationally Recognized areas of High Biodiversity value. The possible mitigation measures have been listed in the T**able 8.22**

Dolphin Sanctuary

- There are two Dolphin Sanctuaries nearby the Project AOI. The Silanda-Nagdemra sanctuary is in a tributary of Jamuna River (Boral River) located at 35.8km downstream of the Project site. The other one (Nagarbari-Mohanganj) is at 36.8km downstream of the project site and located at along the right bank.
- The Silanda-Nagdemra is located in a tributary, at around 36.8 km from Project site which will not be affected (either directly or indirectly) by the proposed intervention
- The Nagarbari-Mohonganj is along the Jamuna, it is far enough away (36.8km from project site) to not be impacted by the proposed intervention. The hydrodynamic modeling study predicted no hydro-morphological alteration that could impact the sanctuary.
- Therefore, no impact is expected on the Dolphin sanctuary

Madhupur National Park

- The Madhupur National Park is a deciduous forest and is the largest Shal forest in Bangladesh, but is 32.7km away from the project site. The park is not connected with the Jamuna River and impacts associated with the Project are not expected to reach to the national park.

Jamuna-Brahmaputra KBA

- This KBA is around 250 km long and covers around 200,000 ha area. Within this entire region, there is not defined, specific or demarked area or sites.
- Our baseline survey and review suggest that the upper part of the Jamuna which is the most braided part, and the isolated islands where agriculture has not been started provides the most suitable habitats for birds, however the critical habitat assessment found no bird species potentially qualifying the CH criteria.
- The proposed intervention would only alter the flow regime locally, which might not make any significant impacts on the hydro-morphology of the entire Jamuna to affect the suitable habitats.
- Erosion along the Charlands close to the Kalihati site might be increased due to reflection of the flow from the bank to be protected. The morphological study shows that the Chars is eroding and gradually migrating towards downstream over the last couple of years. The proposed intervention and dredging would speed up this natural process.
- The construction activities especially the dredging operation and pile driving would cause temporary disturbance to the birds if they assemble in the Char near the construction site.

Ecopark

- The Bangabandhu Bridge Ecopark is around 7km away and located at the opposite bank of the project sites. It is a planted forest of 50 ha established on a reclaimed land and preserved for its scenic beauty.
- The proposed intervention would not cause any impacts to the Ecopark.

Contraction of mudflats, river area (alluvial zone), Charlands like natural habitat at site

The proposed Groyne would ultimately increase sedimentation processes along the protected bank and gradually contract the river width at site by reclaiming lands (discussed in section 8.2). The dredging longitudinally across the Charland near the Kalihati site would also result in loss of mudflats which is

currently potential for habitats for winter-visiting migratory birds. The dredging and the resultant change in the flow might increase erosion at the Chars & mudflats which are also potentially habitats with high biodiversity values. However, the net loss can be assumed to be zero as the proposed Groyne would result gradual land reclamation and bank protection would also protect natural habitats and mixed but mostly modified habitats along the bank.

Loss of mixed but mostly modified habitats along the bank

The proposed bank protection and embankment construction might require a total of around 29 acres land located in mostly modified habitats. But the proposed protection work is also expected to prevent rest of the habitats along the riverbank from erosion.

Risk of increasing disturbance and reduction of suitability in the natural habitats (river area, mudflats, Chars) due to pollution from construction activities

There is a risk of water pollution and noise from construction activities especially from pile driving, dredging, transportation of primary supply, etc. (discussed in section 8.3, 8.4 above). The construction activities and dredging thus risk the reduction of suitability. The noise, waste, and pollution from construction activities and dredging also increases disturbance to the wildlife present or likely to be present in those habitats.

Uncontrolled and accidental contaminant (e.g. concrete slurry, oils, etc.) release may cause severe biomass reduction of zooplankton and phytoplankton and adverse genetic effects. Fish communities will be disturbed and their fertility rate may reduce and they will leave natural habitats as well as change their behavioral states. Some mollusks and crustaceans are resistant to low level of contamination but higher aquatic vertebrates (e.g., reptiles, aquatic mammals) and sensitive species (e.g., frogs) can be affected by low-level contamination.

However, given the scale of the activities and enormous size of the Jamuna River, such disturbance would not be significant.

Risk and Impact on Critical Habitats

Physical injury of large aquatic animals (Dolphin, turtles, Gharial) through collision

The risk of collision with river vessels is a key potential impact for large aquatic animals due to dredging, and increased river traffic. Turtles and other aquatic reptiles are generally slow moving with a relatively low degree of maneuverability which make them potentially atrisk of collision with ships. Conversely, Dolphins are highly mobile underwater, and they have the capacity to avoid collision. But underwater noise might create disturbance to Dolphins and reduce their ability to detect moving objects, ships, etc.

Disturbance of nocturnal wildlife and cetaceans (dolphin), fishing cat and reptiles due to noise of construction activities, pile driving

The impacts of noise have been discussed in detail in section 8.3 above. There is a substantial risk of disturbance to nocturnal wildlife, dolphins, reptiles by noise, especially the pile driving noise.

There is no risk of aquatic trauma. However, the noise may lead to alteration in feeding and breeding patterns. Noise has intense impacts on the physiology and behavior of birds, mammals (especially dolphins) and aquatic reptiles. This includes masking signals used for communication, mating and predation. It may result in a temporary decrease in local population density with the increase in noise levels. Since construction noise is limited to the pilot sites and the temporal pattern is limited, the affected populations are expected to return to the affected areas soon after the activities. However, impacts will be reduced, and occupation of habitats will recover rapidly where noise dampening measures are applied (by bubble curtain, or mitigation measures proposed in section 8.3).

Temporal loss of Baghair habitat along the eroding river bank

The riverbank protection by concrete blocks and Geobags at the eroded sides would need sloping and leveling of the intervened bank. The deep pools on the riverbed created by scouring are known resting habitat for Baghair. Those pools (a few might exist along the eroding riverbank) might be filled by geobags or leveled during construction. During the construction period, such habitat might be disturbed of lost. However, assorted concrete blocks will create gaps between geobags placed under water which can serve as suitable resting places for cat fishes like Air, Baghair. After completion of the project, it is expected that the proposed bank protection works and Groyne would shift the flow condition which causes formation of such pools gradually towards mid-channel. Therefore, it can be assumed the net loss of the habitat would be zero.

Disturbance to wildlife (frogs, turtles, dolphins, fishes) due to increased light and sound

Behavioral responses of animals are highly variable to light and sound effects, especially on breeding behavior. The responses associated with breeding behavior of sensitive species include individual hearing sensitivity, activity pattern, and motivational and behavioral state. Behavioral alteration in breeding will vary on the species demographic factors (e.g., age, sex); presence of dependent offspring, past exposure of the animal to the light and noise; individual light and noise tolerance; environmental factors that influence sound and light transmission; and habitat Characteristics (e.g., being in confined location). The increase of river traffic will certainly cause changes according to the above scenario. However, Project 1 is not expected to result in a major increase in river traffic.

The mitigation measures are presented in Table 8.22, 8.23 and 8.24 below.

Table 8.22: Mitigation Measures for Risk and Impacts on Biodiversity

Mitigation Hierarchy (ESS1)	Measures
Avoid	• No construction activities during wet season covering July to October to avoid impacts to Dolphins. • No working at night to reduce disturbances for nocturnal animals. • No placement of Jetty in areas where threatened terrestrial fauna can be found
Minimize	• Removing vegetation will be minimized to the full extent possible • Preparation of slope for bank protection work will be as minimum as possible • Measures described in Table 8.8, 8.10, 8.11, 8.12, 8.17 and 8.19 will minimize impacts on biodiversity
Mitigate	• Carefull construction (ensuring mitigation measures are in place, monitoring in place) in rest of the time. Because August to December is Courtship and Mating season of Dolphin; January-march is matting season of fishing cat; January-April is courtship and mating seasons of Gharial; March to June is mating season of turtle; and migratory birds arrives and stays in August to March. • Conduct continuous inspection for leaks prior to and during each construction activity (e.g., concrete pouring) • Gradually ramp up the sound levels (pile diving) to scare the dolphins, gharial and other important reptiles away before piling commences. Use pingers upstream and downstream to chase away dolphins and aquatic reptiles. Monitor area for these creatures to ensure they are well away from the piling site – scare them away using pingers if they are within the high noise emission zone prior to noisy construction activities. • Assorted concrete blocks and geobags will be placed below the water surface in a manner that creates small caves and hide-away locations for catfish and other small to medium sized aquatic fauna. • Measures described in Table 8.8, 8.10, 8.11, 8.12, 8.17 and 8.19 will mitigate the impact • Adopt ESCOP 1, 2, 7, 9, 10, 11, 12, 13 and 19
Compensate/Offset	Compensation mitigation and offset are described in Table 8.23

Table 8.23: Mitigation Measures against the Impacts on Critical Habitats

Mitigation Hierarchy (ESS1)	Measures
Avoid	• No construction activities during wet season due to technical difficulties would benefits Dolphin, Gharial, Baghair and other species triggering CH. Monsoon is birth period for Dolphin, nesting & hatching period for Gharial, breeding period of resident birds, breeding and nesting period of turtle (partial). • No placement of Jetty in areas where threatened terrestrial fauna can be found • Measures described in Table 8.8, 8.10, 8.11, 8.12, 8.17 and 8.19
Minimize	• Halting of Geobag dumping and pile driving when pods of Dolphin is present nearby • Preparation of slope for bank protection work will be as minimum as possible • The length of the Groyne (towards river) has been reduced to avoid the deep scouring area (potentially deep pool area which is a known habitat of Baghair) of the channel. • Measures described in Tables 8.8, 8.10, 8.11, 8.12, 8.17 and 8.19 will minimize the impacts
Mitigate	• Require contractors to prepare and submit to the PIU a "Pile Driving Plan" that incorporates measure to minimize impacts following JNCC Guidelines to be approved before commencing any works at the pilot sites. The PIU will scrutinize the Pile Driving Plan to ensure it is effective for reducing impacts, is thorough and the contractor has the appropriate capacity available to implement it. • Subsequent implementation of works will be appropriately supervised to ensure they are implemented correctly to avoid having to be redone and duplicate adverse impacts. • Placement of assorted CC blocks and geobags at the toe of the revetments and Groynes to create small caves and crevasses to favour Baghair and other catfish habits. • Implement a strict prohibition of any disturbance/killing/trading of Dolphin, Fishing Cat, Baghair, and other species triggering critical habitat criteria • Measures described in Table 8.8, 8.10, 8.11, 8.12, 8.17 and 8.19 will mitigate the impacts • Adopt ESCOP 1, 2, 7, 9, 10, 11, 12, 13 and 19
Compensate/Offset for net gain as per ESS6	• Develop a "net gain" plan for Dolphin that is proportional to the low impact as an action of the BMP. This plan is to be developed through engagement with specialists and collaboration with management authorities of the Jamuna River Dolphin Sanctuaries. Establishing a collaboration on dolphin conservation is especially relevant towards pioneering mitigation approaches for future phases of the project when larger impacts are expected. • Awareness creation among the community to prevent killing of fishing cat • In such collaboration, local NGOs working on Dolphin conservation can be included. • Coordinate with the Department of Fisheries to complement their activities in the nearby fish sanctuary areas in Jamuna River (Char Pouli of Tangail to Durga Temple of Bhuapur and Belkuchi to China Badh of Sirajganj) • No fishing by workers is to be permitted in the fish sanctuary

Table 8.24: Mitigation Measures against the Impacts on Ecosystem and Biodiversity Increased River Traffic

Mitigation Hierarchy (ESS1)	Measures
Avoid	• Do not permit ships/boats to enter the construction site that do not follow the ECR 1997 and other river traffic rules. • Do not permit ships to enter the construction site that do not meet the criteria of Department of Shipping • Introduce speed limits for boats (max 10 knots) near sensitive receptor, area with conservation importance, sanctuaries, etc.
Minimize	• Regulated/slow speed shipping to avoid collision with animals • Provision of propeller guards to prevent injuries to dolphins • Nesting grounds, breeding and spawning grounds shall be identified (in Stage 2) and ship operation will be minimized • If Dolphin/Gharial spotted, then the measures will be taken to push them away using Pingers
Mitigate	• Vehicles must be refueled off-site where possible and all fueling of machinery must be undertaken at least 10 m from the river • Fueling of vessels must be undertaken in bunded areas and all fueling equipment must be regularly (yearly) inspected and serviced • Enhancement of fishing in the area by boosting and funding fish nurseries and provision of better fishing aids and training of fishermen • Caution signs shall be placed to prevent hunting of animals • Instruction will be given to all vessels and all employees and staffs that no dolphin or any other endangered species shall be harmed due to any reason • Awareness creation on natural resources among ship/vehicle employees
Compensate/ Offset	Compensation mitigation and offset are described in Table 8.23

8.7 Impacts on Fisheries and Mitigation Measures

8.7.1 Potential Impacts and their Evaluation

In the construction phase, impacts on fisheries are expected due to the change in water quality due to materials wash water at the construction site, mixing of suspended sediment and substrates in water column etc. The underwater noise might also disturb the fish. In the post construction phase, the expected impact are disappearance of existing habitat and appearance of new habitat at the revetment sites, disappearance of channel and the submersible Chars including the embankments. The impacts of the project on fisheries resources have been assessed based on the following assumptions:

- Materials wash water from the construction sites as well as from ready mixed concrete machinery may contaminate and cause the river water turbid locally;
- Sloping and leveling the eroded bank of the river for setting up CC blocks may disappear the scour habitats;
- Bank protection work by CC blocks may alter muddy bank habitat to concrete bank habitat, which may cause appearance of new habitats in the aftermath;
- Throwing of plastic bottles, plastic bags and food packaging waste by passengers to the river at Jetty site may degrade aquatic condition of the river locally.
- Construction of Groynes may deflect the flow, which may hit the opposite bank of the channel and erode the bank as well. In this project, the structure of the Groynes has been designed in such a way that the deflected flow would not affect the opposite bank of the channel and the submergible Chars along with the embankments as well. Therefore, the Groynes would not affect the bio-periods of fishes.

The detailed description of the impacts and evaluations are provided in table 8.25.

Table 8.25: Summary of Impacts on Fisheries

Potential Impact	Temporal Aspect	Spatial Aspect	Reversibility	Compliance	Likelihood	Magnitude	Sensitivity	Significance	Residual Impacts after Mitigation
Bank protection work by CC blocks and Geobags and construction of top-blocked permeable Groynes									
Disappearance of scour habitats at the river bank side due to bank protection work.	2	1	2	2	3	M	H	**S**	**L**
Materials wash water from construction site may contaminate river water quality locally which may cause loss of fish habitat suitability.	2	2	2	2	2	M	S	M	L
Change in fish habitats (embayment area, mudflats, alluvial area, etc.)	3	3	2	2	3	S	S	S	L
Construction of Floating and Movable Jetty									
Degradation of fish habitat condition at the Jetty site due to throwing of plastic bottle, polythene and food packaging waste by the passengers	4	2	3	2	2	S	S	S	L

8.7.2 Description of Impacts and Mitigation Measures

Disappearance of scour habitats at the river bank side due to bank protection work

The riverbank protection by concrete blocks at the eroded sides would need sloping and leveling of the intervened bank. The bank side may have scour holes which function as resting places for various species of fish like Eels (Boro Baim- *Mastacembelus armatus*), catfishes (Air- *Sperata aor,* Rita- *Rita rita,* Boal- *Wallago attu*) and other small fishes (Punti- *Puntius sophore,* Gulsha- *Mystus cavasius,* Baila- *Glossogobius giuris*). Sloping and leveling the riverbank may cause disappearance of scour holes of the riverbank in the project site. The mitigation measures are described in Table 8.26.

Impacts on Fish Habitats

Following the impacts of the proposed interventions on river hydro-morphology, it can be assumed that fish habitats in the intervened reach would be gradually contracted by the proposed Groynes. The mudflats and floodplain area (e.g. Chars) would be reduced. However, the total alluvial area (river area excluding Char and mudflats) might be increased if Chars are eroded. At this stage it is difficult to quantitatively assess the loss because the hydro-dynamic modeling results are not available and these expected changes will not take place immediately but rather will occur gradually.

Formation and disappearance of embayment area which is considered as local important fish habitat is a natural trend in Jamuna River. The dredging might open a current embayment area in the Char and might turn it into a channel. However, similar habitat might form naturally in nearby areas.

The mitigation measures are described in Table 8.26 which are expected to create safe and secluded spaces that improve the habitat for some fish species. In addition, a fisheries management plan has been proposed in the ESMP to ensure net loss as per the ESS6 requirement for natural habitat.

Materials washed water from construction site may contaminate river water quality locally which cause loss of fish habitat suitability

The construction materials such as gravels, sand, iron, brick, stone etc. will be placed in the construction site. The wash water of these construction materials may contaminate water and can affect the aquatic biodiversity including fish in the local context. In addition, storm water runoff from the construction site

and thus oil and grease mixed waste water would also reduce river water quality which may affect survival of fishes. Further, ready mixed concrete machinery and other equipment may be used during construction of Groynes. Wash water of the ready mixed concrete machinery may cause contamination to the river water by increasing turbidity locally. It is expected that the nature of the impact is temporary and localized. The mitigation measures are described in Table 8.26.

Change in fish composition at the bank protection site

The bank protection work under this project will be implemented at four (04) locations along the river reach. The banks may have several scour holes where various species of fish, such as eels (*Baim*), catfish (*Air, Rita, Boal, Bacha*), and small fishes (*Punti, Tengra, Gulsha, Gutum*) take shelter there in the wet season. Implementation of the bank protection work by setting up concrete blocks will transform the muddy bank habitat to a concrete habitat. Therefore, the fish species take shelter and graze in the muddy bank may be shifted who would not be able to adapt to the changed habitat. However, the CC blocks used for bank protection may serve a special habitat for certain fish species such as eels (Baim) and large catfish (Air, Rita, Boal) and carp (Kalibaush). In addition, establishing geo-bag may create special fish habitat, as algae, phytoplankton and other microphytes may grow on their surface. Therefore, fish species who prefer algae and microphytes would aggregate in the altered habitat. Hence, changes in fish composition at the bank protection sites may have insignificant impact on fisheries resources. The mitigation measures are described in Table 8.26

Packaging waste from the passengers

Establishment of Jetty resulting in increased movement of passengers may throw different types of waste like plastic bottles, plastic bags, food packaging etc. to the river which may degrade riverine aquatic condition at the Jetty sites. Therefore, fish species which are supposed to be foraging around the Jetty sites may be compelled to avoid the area. Moreover, construction of Jetty and thus increased number of water vessels like passenger/cargo vessels, fishing trawler, speed boat or other engine boat may discharge bilge water into the river water, which would deteriorate river water quality. The mitigation measures are described in Table 8.26

Table 8.26: Mitigation Measures against Impact and Risk on Fish and Fish Habitat

Mitigation Hierarchy	Measures
Avoid	• Measures described in Table 8.8, 8.10, 8.11, 8.12, 8.17 and 8.19 will avoid some impacts • No Construction activities in wet season (breeding, spawning, nursing and growing season of major fishes like carp, Air, Baghair, Hilsha and other inland fishes)
Minimize	• The extent of river wide construction must be minimized giving importance to fish and biodiversity • Measures described in Table 8.8, 8.10, 8.11, 8.12, 8.17 and 8.19 will minimize the impacts
Mitigate	• Measures described in Table 8.8, 8.10, 8.11, 8.12, 8.17 and 8.19 are relevant here as well. • Further measures will be detailed out in ESCOP 1, 2, 3, 9, 10, 11, 13, 15 • Prohibit fishing by the project worker in the declared fish sanctuary area (including the project AOI) • Placement of assorted CC blocks and geobags at the toe of the revetments and Groynes to create small caves and crevices that favour Baghair and other fish habitats
Offset	• Consultation with the Dept of Fisheries to investigate opportunities for developing effective mitigation plan. The plan needs to be proportional to the low expected impact. • Establishing a collaboration on Baghair and other fish conservation is especially relevant towards pioneering mitigation approaches for future phases of the project when larger impacts are expected

8.8 Impacts on Agriculture and Mitigation Measures

The construction of proposed embankment and revetment in Kalihati and Bhuapur would require acquisition of around 29 acres land including around 27.6 acre of agricultural lands. Besides, some standing crops might be damaged during construction activities, transportation of primary supply. Construction of crossbar/bund in Mechra of Kaoakola Char would require around 15 acre land and construction of flood shelter (Killa) would require around 160 acre lands. These lands include agricultural area as well. Impacts are presented in the Table 8.27 and mitigation measures are discussed in Table 8.28.

Table 8.27: Summary of Impacts on Agriculture

Potential Impacts	Temporal Aspects	Spatial Aspects	Reversibility	Compliance	Likelihood	Magnitude	Sensitivity	Significance	Residual Impact after Mitigation
Impact During Construction									
Loss of Standing Crop/Crop Production due to land reacquisition (for labor camp, construction sites, etc.)	2	2	2	2	3	S	S	S	L
Damage to standing crop on nearby agricultural land due to waste and water disposal from construction activities, transportation of construction material, labor movement, transportation of dredged material, etc.	2	2	2	2	2	M	S	M	L

Table 8.28: Mitigation Measures for Loss of Crop Production

Mitigation Hierarchy	Measures
Avoid	N/A
Minimize	• Start construction after crop harvesting • Reduce construction period • The notice of activities would be circulated to the affected farmers before starting of farming activities
Mitigate	N/A
Compensate/ Offset	• Crop Compensation will be provided to the land owner/farmers as per market price of the crop. • Meet the requirement of ESS5

Table 8.29: Mitigation Measures for Damage to Standing Crop

Mitigation Hierarchy	Measures
Avoid	N/A
Minimize	Construction activities, storage of materials, etc. must be limited to the designated areas
Mitigate	• The construction site must have waste management facilities • No solid waste and wastewater will be dumped/discharged to nearby area • Adopt effective traffic management plan for mitigating impacts of traffic on nearby agricultural land • Adopt ESCOP 1, ESCOP 4, ESCOP 5, and ESCOP 7
Compensate /Offset	• Compensation must be provided for every cropping season to the farmer/land owner for the whole construction activities in line with ESS5 • Compensation will be provided to the farmers for loss of standing crop (if any) for direct impact area in line with ESS5 • In case of land requisition, the land must be returned to the farmer with its original condition

8.9 Impacts on Society and Mitigation Measures

8.9.1 Socio-economic Impact and Mitigation

The summary of the socio-economic impacts is presented in Table 8.30.

Table 8.30: Socio-economic Impacts and their Evaluation

Potential Impacts	Temporal Aspects	Spatial Aspects	Reversibility	Compliance	Likelihood	Magnitude	Sensitivity	Significance	Residual Impacts after Mitigation
Land acquisition									
Dispossession due to land acquisition and resettlement	4	1	4	1	4	S	M	M	L
Land acquisition induced poverty may increase vulnerability of women and girls to SEA/SH	4	1	3	3	2	S	M	M	L
Land acquisition induced poverty may increase the risk of child marriage and other SEA/SH due to displacement by land acquisition	4	1	3	3	3	S	M	M	L
Land acquisition induced poverty may lead abandonment by spouse and intimate partner violence	4	1	3	3	2	S	M	M	L
Impacts and Risk During Construction									
Socio-cultural shock due to labour influx	2	2	3	3	3	S	M	M	L
Disturbance of water users to access to river water	2	1	2	1	3	M	M	M	L
Income loss due to the acquisition and disturbance of cultivable land	4	2	3	1	4	S	M	M	L
Health hazard with the outside labourers and their movement in the community	3	2	3	3	2	S	M	M	L
Public nuisance and disturbance due to construction activities and pollution from construction activities	2	2	3	1	4	S	M	M	L
Risk of exclusion of vulnerable group in stakeholder engagement and project benefits	4	2	4	3	2	S	M	M	L
Risk of exclusion of E&S Risk Management during planning and construction due to lack of E&S Risk Management Capacity of IAs	4	2	3	3	3	S	M	M	L
Increased demand of outsider (employees & visitors) may enhance the risk of SEA/SH	3	2	3	3	2	S	M	M	L
Additional stress on existing SE facilities local health, sanitation, road network, etc.	2	2	2	2	4	S	M	M	L
After project construction									
Risk of rising False Sense of Security and therefore rising the risk of livelihood, asset and service loss due to bank failure from the failure of the Groynes	4	2	3	1	2	**S**	M	M	L

8.9.2 Description of Impacts and Proposal of Mitigation Measures

Dispossession due to land acquisition and resettlement

This Implementation requires land acquisition, land take by negotiated settlement and relocation of households. The land take will dispossess landowners, and relocate households. The displaced households, therefore, will need to be resettled. Below, in Table 8.31, mitigation measures against this impact are described.

Table 8.31: Mitigation Measures for Dispossession of Land due to Acquisition and Resettlement

Mitigation Hierarchy (ESS1)	Measures
Avoid	The design has considered intervention foot-print avoiding the inland and maximize the use of bank-line
Minimize	• Engineering design has optimized the use of land • Minimize the number of people to be relocated
Mitigate	• Replacement value based on current market price plus 10% stamp duty fee and compensation for standing crops as per ESS5 • Relocation Sites will be constructed with civic facilities. • Cash compensation will be provided for self-relocation; provisions of civic amenities in host villages. • Severely affected HHs will receive additional cash compensation; laborers will receive cash compensation and job opportunity during construction period. Training on poultry, fish-farming and new skill development will be provided.
Compensate/Offset	• Take enhancement measures through livelihood program. • Female HH receives additional compensation and training on income generation activities.

Socio-cultural impact due to labour influx

The project implementation requires both local and outsider laborers, who are anticipated to work until the implementation period is over. The outsider laborers (which is relatively small) will, therefore, need to stay in the project area for a long time and to interact with the local community. The socio-cultural life in the project area, like rural areas of Bangladesh, is homogenous in terms of their common cultural practices, beliefs, social structures, etc. Because of this homogeneity, any outsiders can encounter socio-cultural shock in the host communities. Thus, the stay of outside laborers may also bring shock for both themselves and for the host communities. Eventually, social tensions may arise in the project area. Below, mitigation measures against this impact are described. However, the labor influx is expected to be low due to the scale of the project and expected labor requirement which is around 300. A maximum of 200 non-local workers is estimated. However, the maximum possible number of non-local labor in place at a time would not be more than 100, which might be at the time of geobag disposal, the most labor-intensive activity. A detail Labor Management Procedure has been prepared alongside this ESIA. Table 8.32 bellow describes the mitigation measures against the impacts of labor influx to complement the LMP.

Table 8.32: Mitigation Measures for Managing Labor related Risk and Impacts

Mitigation Hierarchy (ESS1)	Measures
Avoid	N/A
Minimize	• Unskilled workers who will comprise the majority of the workers will be hired locally/from the host/local communities • If required labors are not found in the local area, laborers from the closest villages will be recruited. • Build a good relation with local community or community leader by Contractors and head of the laborers • Inform and train up labors on the etiquettes of intermixing with local community
Mitigate	• Proper accommodation for laborers at the project site with civic facilities • Meeting with community leaders to discuss their issues / concerns • Develop a grievance redress mechanism to register and resolve related complaints • Develop a guideline for training up labors on the Worker's Code of Conduct of community mixing • All workers must sign and abide by a code of conduct compliant with all project E&S conditions. • Further measures will be implemented according to ESCOP 1, 15, 17, 18
Compensate/Offset	• Financial contribution to common property resources such as local mosque, temple, etc. under CSR

Income loss due to the acquisition and disturbance of cultivable land

Usually, land is scarce in erosion-prone areas. Agriculture is the major means of livelihoods. Furthermore, most of the landholdings are small and marginal, and many are involved in sharecropping and cultivation in rented land. Therefore, land acquisition will not only dispossess but also impacts household incomes. Below, Mitigation measures are described in Table 8.33.

Table 8.33: Mitigation Measures against the Impact Loss due to Land Acquisition

Mitigation Hierarchy (ESS1)	Measures
Avoid	• Avoid major cultivable land for acquisition • Maximize the use of bank-line
Minimize	Optimize the use of land
Mitigate	• Provide adequate compensation considering the future loss of income and livelihoods as per ESS5 • Offer kind (land) as compensation • Recruit family members in the intervention work • Provide income-generating training
Compensate/Offset	Take enhancement measures through livelihood program.

Health hazard with the outside laborers and their movement in the community

As communicable diseases- like Covid-19- spread rapidly through human interactions, the outside labors may spread diseases unknown to the community because of their unawareness, reluctance to follow health protocol, and intermixing with local communities. Eventually, the entire community might be affected. Mitigation measures against this impact are presented in Table 8.34.

Table 8.34: Mitigation Measures against the Health Hazard due to Labor Influx

Mitigation Hierarchy (ESS1)	Measures
Avoid	• Strong control of the movement of laborers • Regular health checkup
Minimize	• Strong monitoring on the monitoring of laborers • Arrange medical units for emergency treatment and health guidelines • Training up laborers regarding health and hygiene
Mitigate	• Provide health-related equipment such as masks, sanitizers, etc. • Follow the health-related protocol in the working sites as well as in accommodation place • Provide medicine and consultation • Collaborate with the government to ensure all workers are COVID vaccinated • Further measures will be implemented according to ESCOP 1, 15, 17, 18
Compensate/Offset	• Health insurance for laborers • Provision of Medical or Sick leave • Provide health-related equipment to the community as well.

Public nuisance and disturbance due to construction activities and pollution from construction activities

Pollution, especially from noise, dust, waste and wastewater and visual obstruction due to construction activities, causes community disturbance and nuisance. The mitigation measures for such impacts are described in Table 8.35.

Table 8.35: Mitigation Measures against Community Disturbance due to Construction Activities

Mitigation Hierarchy (ESS1)	Measures
Avoid	• Use low sound and low polluting construction equipment • Set up workstation at a designated place
Minimize	• Transportation of construction materials at night to minimize pressure on roads • Setup construction site at a location away from the settlement and major road • Construction camps will be established in brownfield sites or areas of minimal impact in consultation with local communities • Consultation with the communities to inform them of construction works before they occur.
Mitigate	• Setup a grievance redress committee involving community leaders • Spraying water around the construction site • Regular meeting with local people and community leaders • Adopt mitigation measures proposed against noise, air quality, waste, etc. • Any other mitigation measures will be described in ESCOP 1, 3, 9, 10, 11, 14, 18
Compensate/Offset	N/A

Risk of exclusion of vulnerable group in stakeholder engagement and project benefits

The vulnerable groups especially the people living in the Charlands, displaced communities now living on embankments, the poor and landless, female-headed households and those under the poverty line, the elderly, and the Char dwellers as tenant farmers, fishers, small landowners, etc. have very limited capacity and power to get involved in the stakeholder engagement process which is always led by the implementing agencies and local elites. A Stakeholder Engagement Plan has been prepared and included in this ESIA in chapter 12. In line with the SEP, mitigation measures are proposed and presented in Table 8.36.

Table 8.36: Mitigation Measures against the Risk of Exclusion of Vulnerable Community

Mitigation Hierarchy (ESS1)	Measures
Avoid	• Identify socially underprivileged groups and ensure their inclusion and active presence in the planning, implementation and operation process • Carry out separate meetings for women and vulnerable groups • Provision of transportation or transportation costs particularly for the disabled, marginalized and the elderly ones including women • Engagement of local NGO's and CBO's who work with vulnerable people at the community level to help disseminate information and organize consultations
Minimize	• Consult vulnerable groups, reflect their concern in the project design, planning and implementation • Influence local level implementers to treat all affected people equally while recruiting in project activities regardless of their administrative attachment (voter area), sex, religious identity, and political alignment
Mitigate	• Prepare a labor engagement plan by addressing equity and justice • Prepare a roadmap to involve vulnerable groups in various stages of the project • Ensure a women-friendly workspace • ESCOP 8, 9, 16 will address after this issue further
Compensate/ Offset	• Compensation to displaced people due to land acquisition/intake as per ESS5 • Provide livelihood training • Provide additional compensation and livelihood restoration targeting vulnerable and disadvantaged groups identified. The process should be different than the livelihood restoration of other groups

Risk of exclusion of E&S Risk Management during planning and construction due to lack of E&S Risk Management Capacity of IAs

Integration of the E&S Risk management in the project planning, implementation and operation largely depends on the capacity of the implementing agency. Currently, E&S risk management capacity of both Implementing agencies are inadequate. Ad hoc capacities are only available at the project level only during the project implementation period. Therefore, the E&S risk during the operation remains high. The ESIA includes an institutional assessment and proposals for building long-term E&S risk management capacity which has been described in Chapter 13. In line with Chapter 13, specific mitigation measures are elaborated in Table 8.37.

Table 8.37: Mitigation Measures against the Risk of Exclusion of E&S Risk Management in Project Planning, Implementation and Operation

Mitigation Hierarchy (ESS1)	Measures
Avoid	• Establish an E&S unit dedicated to the Project • Provide overall Capacity Enhancement Training and training on ESF • Implement E&S Safeguard Requirements • Allocate separate budget for E&S risk management in the DPP
Minimize	• Include of Environmental and Social Experts in Project Management Units • Provide a guideline for E&S implementation to the management unit • Issuance an instruction to the department from the responsible government agency for seriously taking care of E&S issues • Regular monitoring E&S issues, and seriously take in agenda • Further measures will be implemented according to ESCOP 1, 2, 10, 11, 12, 13
Mitigate	• Establish regular capacity development and training program for E&S professionals • Monitoring of E&S risk during operation of the project/program after completion (post-construction period)
Compensate/Offset	N/A

Risk of rising flood in downstream areas and Charlands

Although Project 1 activities are very limited in their ability to cause flooding downstream of the pilot sites, the risk of increased flooding cannot be eliminated. The hydrodynamic modeling might be available before implementation of the project which will help to quantify the exact risk. But theoretically there is a risk of increased flooding at downstream area due to contraction of floodplain and alluvial corridor. However, given the scale of the project, and low human settlement/activity in the Char areas that could be subject to the flood risk, the risk is very low. Mitigation measures are described in Table 8.38.

Table 8.38: Mitigation Measures against the Risk rising Flood in the Downstream Area due to Groynes and Revetments

Mitigation Hierarchy (ESS1)	Measures
Avoid	The TBPG has been adopted to avoid any aggressive change of the alluvial and floodplain zone
Minimize	The design can be optimized considering adequate room for the rivers especially for flood flow.
Mitigate	• Organize Char living people, form an overseeing committee to communicate with operation level GRC • If the hydrodynamic modeling determines any risk of flooding in the downstream area, that area needs to be covered under flood management program • Establish flood early warning and risk communication mechanism in place. • ESCOP 3, 6, 9 will be applicable for further measures
Compensate/ Offset	• Implement disaster risk financing solutions e.g. flood insurance, Shock Responsive Social Protection System, etc. • Livelihood restoration and enhancement program • Engaging Char people to the project related activities

Risk of False Sense of Security from the River Protection Work

There is a tendency of rapid development in the areas where erosion protection works are implemented assuming that the land and assets will be protected by the protection works. People and the disaster managers often start avoiding disaster preparedness in those areas assuming that the area is protected from the disaster. However, we often see failure of erosion protection work. Especially in Jamuna, there is a long history of failure of spurs, Groynes and revetment work. Therefore, development grown depending on revetment, Groynes, or erosion protection work in general increases risk. Furthermore, Project 1 is considered as a testing case of a new technology which has limited application beyond the laboratory environment which further increases the risk. The mitigation measures which are proposed against such risk are listed in Table 8.39.

Table 8.39: Mitigation Measures against the False Scene of Security from the Erosion Protection Work

Mitigation Hierarchy (ESS1)	Measures
Avoid	N/A
Minimize	• In case of adoption of new technology, partnership with academic institutions, scientific organizations will be made for performance monitoring. • Critical infrastructures (railroad, national highway, pipeline, water supply network, etc.), high value infrastructures (academic institutes, government office, etc.) will not be constructed on the land considered to be protected by the protection work until the Groynes and protection works are found to be successful in preventing bank erosion.
Mitigate	• Local community must be aware about the possible chance of technological failure or natural phenomenon to discourage them establishing high value assets (e.g. heavy

Mitigation Hierarchy (ESS1)	Measures
	industry, high rise buildings, etc.) near the Bank considering the lad will be protected by the structure forever.
Compensate/ Offset	• Introduce Disaster Risk Financing Solution to cover the community risk. • The existing critical infrastructure e.g. embankment can be brought under financial protection • The Proposed revetment work, Groynes will also be covered under DRF solution to ensure quick disbursement of fund in case of emergency for emergency O&M and recovery.

8.10 SEA/SH Risk

- The Environmental and Social Impact Assessment Identified several SEA / SH risks associated with Project 1 activities. These risks are mostly related to the land acquisition, labor influx, and induced development. The details of the Gender and SEASH risk and impact assessment are provided in Annex 3 of this report. Most of the risks and impacts are low and moderate. The highlights of the SEA / SH risk assessment are:
- The project will involve construction work under Component-1. Most of the labor demand will be met locally. However, it may require hiring some skilled labor from outside of the program area. This labor influx may increase the demand for sex work, including the risk of trafficking of women for sex work, forced early marriage with construction workers as a livelihood strategy, and increase the demand for transactional sex.
- The project will involve land acquisition and dredging under Component-1, which may lead to displacement, loss of residential and agricultural land, loss of assets or access to assets altogether, resulting in loss of income and livelihood. This increased poverty and marginalization can lead to child marriage, abandonment by spouse and family and intimate partner violence.
- Community-women use the river for bathing and daily household chores. So, any sort of river management work will expose them to the workers and officials. Besides, the construction work of the program may occur near school routes or pedestrians that are frequently accessed by local women and girls which may increase their exposure to project workers and as a result, may increase the risk of SEASH. Women and girls in the community may experience eve-teasing, sexual abuse and harassment.
- The Jamuna Chars are one of the most remote areas of Bangladesh where legal and medical support barely reaches. Besides, low density of population and weak communication facility make Char settlements favorable for different types of criminal offence including women trafficking and rape. If river management work includes Chars, it may increase the risk of trafficking for women and adolescents of that area and adjacent areas.
- The Program may employ women as laborers. If they work along with male laborers without proper labor management and gender strategy, they may face sexual abuse, harassment and violence.

Bangladesh government has an agency/cell under the Ministry of Women's and Children Affairs responsible to addressing SEA / SH related cases with aid and assistance from the police. Besides, different national and international organizations work to mitigate SEASH. But most of these facilities are available in urban areas.

All the identified risks and impacts have been evaluated based ons their significance. The significance has been determined based on magnitude and sensitivity of the risk or impact. The methodological details of this evaluation have been described in Annex 3. Table 8.40 lists the identified risks and impacts and their significance. Table 8.41 identifies proposed mitigation measures.

Table 8.40: Summary of the SEASH Risk

Potential Impacts	Temporal Aspects	Spatial Aspects	Reversibility	Compliance	Likelihood	Magnitude	Sensitivity	Significance	Residual Impacts after Mitigation
Labor Influx									
Demand for sex by migrant workers will increase SEASH	2	3	2	4	2	**S**	M	M	L
Sexual harassment within the labour camp and nearby community	2	3	2	4	4	**S**	M	M	L
Force and early marriage by construction workers	2	3	2	2	2	**S**	M	M	L
Displacement by Land Acquisition									
Land acquisition induced poverty may lead the sexual activities by the poor girls and women with project employees	4	1	3	3	2	**S**	M	M	L
Land acquisition induced poverty may increase the risk of child marriage and other SEA/SH due to displacement by land acquisition	4	1	3	3	3	**S**	M	M	L
Land acquisition induced poverty may lead abandonment by spouse and intimate partner violence	4	1	3	3	2	**S**	M	M	L
Risk due to the presence of outsider									
Community school or college girls may be harassed or sexually abused by the project workers	2	3	2	3	3	**S**	M	M	L
Presence of outsiders in the community and interaction with them may create stigmatization for women which may result in early marriage for adolescent girls and intimate partner violence/divorce/abandonment for married women.	2	2	1	1	2	M	M	M	L
Sexual Exploitation and Abuse/Sexual Harassment (SEA/SH) in Charland									
Women trafficking and rape may increase due to low density of population and weak communication facility	3	3	3	4	2	**S**	H	S	L
Project workers may tempt the community women and girls to achieve a job in exchange of sexual activity	2	2	3	4	3	S	M	M	L
Salary discrimination of the female workers	2	2	2	4	3	S	M	M	L
COVID-19 Risk									
Increase of COVID-19 spreading risk in the women due to labor influx	3	3	2	3	3	S	H	S	L
Increase of COVID-19 spreading risk in the women due to visit of outsider	3	3	2	3	3	S	H	S	L
Increase of COVID-19 spreading risk in the project-related women staffs	3	2	2	3	3	S	H	S	L

Table 8.41: Mitigation Measures to Manage Risk of SEA SH due to Project Activities

Mitigation Hierarchy	Mitigation measures
Rising Risk of SEA and SH of the local women due to Labor Influx	
Avoid	N/A
Minimize	• The Project 1 will ensure a working environment where there is zero tolerance to SEA/SH. There will be an effective GRM which is well equipped to address SEA/SH complaints • Minimize the number of external labor • Ensure Codes of Conduct signed and understood by the contractor, labors and other project workers.officials.

Mitigation Hierarchy	Mitigation measures
	• Training on the zero tolerance of SEA/SH and other forms of GBV under the project.
Mitigate	• Awareness raising and sensitization on GBV for all stakeholders including the community and vulnerable populations, • GBV service provider mapping to refer incidents of GBV from the GRM or any other reporting mechanism that may be established through the project. • Establish an effective grievance redress mechanism (GRM) with multiple channels to complaints about SEA/SH and establish SEA/SH allegations reporting channels • Receive and refer SEA/SH complaints to SEA/SH service providers and check if the case is closed and/or follow up on action taken by the contractor against any worker who has violated the codes of conduct. • Take direct sanctions against perpetrator by the contractor and/or law enforcement agency • Refer victim/ survivor will to medical and legal service providers • Follow up registered cases and ensure safety of client • ESCOP 15, 17, 18 will mitigate the impact
Compensate/Offset	N/A
Increase the Risk of Child Marriage, Abandonment and GBV due to Displacement by Land Acquisition	
Avoid	Establish good financial management choices with the compensation money by the recipients through orientation and workshops
Minimize	• Engineering design has optimized the use of land • Minimize the number of people to be relocated • Design has considered bank protection foot-print avoiding the inland and maximize the use of bank-line • If possible, propose alternative sites to avoid major agriculture land and resettlement of people • Engage local stakeholders (political, cultural, religious, health teams, local councils, social workers) in awareness rising activities
Mitigate	• Relocation Sites will be constructed with civic facilities • Cash compensation will be provided for self-relocation; provisions of civic amenities in host villages. • Severely affected HHs will receive additional cash compensation; laborers will receive cash compensation and job opportunity during construction period. • Training in poultry, fish farming and new skill development training will be provided. • If SEA/SH occurs, then complaints will be received and processed accordingly through the GRM
Compensate/Offset	• Take enhancement measures through livelihood program. • Female HH will receive additional compensation and training on income generation activities.
Rising the Risk of GBV, Child Marriage and Abandonment due to Presence of outsiders	
Avoid	N/A
Minimize	• Ensure Codes of Conduct in local languages are signed and understood by the contractor and construction workers • Awareness raising for workers on zero tolerance to any form of SEA/SH including these mentioned forms of SEA/SH • Engage local stakeholders (political, cultural, religious, health teams, local councils, social workers) in awareness raising activities
Mitigate	• Establish an effective grievance redress mechanism (GRM) with multiple channels to complaint about SEA/SH and establish SEA/SH allegations reporting channels • GBV complaints will be received and processed • Direct sanctions against perpetrator will be taken • Follow up the registered cases and ensure anomality of clients • Include registered cases and actions in program reports • Awareness raising and sensitization on SEA/SH for all stakeholders

Mitigation Hierarchy	Mitigation measures
	• Create separate pathway and space for community people
Compensate/Offset	Not available
Risk of SEA-SH at project related work	
Avoid	N/A
Minimize	• The Project 1 will ensure a working environment where there is zero tolerance to SEASH. There will be an effective GRM which is well equipped to address SEA/SH complaints • Ensure Codes of Conduct signed and understood by the contractor and construction workers • Preparation of gender inclusive labor management policy • Build separate toilet and resting space for female labors which are further away from male toilets, have proper lighting and are properly constructed.
Mitigate	• SEA/SH complaints will be received and processed • Direct sanctions against perpetrator will be taken • If gender inclusive labor standards can't be maintained, cash compensation will be provided for affected female community members • AIGAs could be introduced to affected female workers • Include gender desegregated data in M&E system and ensure regular reporting
Compensate/Offset	Not available
Access to SEA-SH Service Providers	
Avoid	Avoid exposing women to construction/work place
Minimize	• Mapping SEA/SH prevention and response actors at national and local levels • Develop a referral process to response SEA-SH cases • Disseminate information, in collaboration with SRA-SH service providers, on SEA/SH referral pathway and the importance of timely seeking services
Mitigate	• Support clients/ survivor/victim to access medical and legal support • Work with local health clinic and administration to facilitate support and services • Regular follow up of registered cases
Compensate/Offset	Not available

9. Occupational Health and Safety Framework

9.1 Overview

This Chapter will guide Project 1 contractors to prepare site and contract specific occupational health and safety (OHS) plan based on the information on design, construction program, and work forces for both BWDB and BIWTA components.

9.1.1 Purpose

The Occupational Health and Safety Plan (OHSP) is the key tool to manage occupational health and safety (OHS) risks associated with the Project. Its core purpose is to ensure that all activities are planned, carried out, controlled and directed with consistent, approved, health and safety management practices, procedures or standards.

This document is a framework for the Contractor to a practical approach to manage OHS risks as per ESS2 requirements, World Bank Group as Environmental Health and Safety Guidelines (EHSGs), Good International Industry Practices, specific international standards such as US OSHA, AUS/NZ, UK, etc. and Bangladesh's regulatory framework, and requirements will be stated in the contract, such as:

- Bangladesh Labor Act, 2006 (as amended through July 22, 2013)
    - Chapter VII of the Labor Act 2006, Special Provisions Relating to Health Hygiene and Safety
    - Chapter VI of the Labor Act 2006, Safety, Sections 61 to 78 addresses all construction related safety
    - The 2013 amendment on the Labor Act, makes a large number of revisions to the 2006 Act in terms of compensation due to death (s19), termination of employment (s 23, s24 and s27), resolving dispute over a child's age (s36), dangerous work for children (s39), emergency exits (s62); access to gangways, stairs etc. for workers (s72), adding a new section 78a concerning mandatory use of personal safety equipment, notification of competent authority in case of incident (s80), establishment of a health center in companies employing more than 5000 workers (s89), adding a new section on formation of a safety committee (s90a), compulsory group insurance (s99), adding a new section 124a entitled 'Payment of dues including wages through conciliation, and prohibition on deducting money to survivors of a worker who has died (s155).
- ESS2 – Labor and Working Conditions
    - The Borrower will develop and implement Labour Management Procedures applicable to the Project.
    - Measures relating to occupational health and safety will be applied to the project. The OHS measures will include the requirements of ESS2 and will consider the General Environmental Health and Safety Guidelines (EHSGs) and, as appropriate, the industry-specific EHSGs and other GIIP.
    - The OHS measures will be designed and implemented to address, (a) identification of hazards, (b) provision of preventive and protective measures, (c) training of project workers, (d) documentation, reporting, and remedies of occupational incidents, (e) emergency prevention and preparedness and response arrangements to emergency situations, and (f) remedies for adverse impacts such as occupational injuries, deaths, disability and disease.

- All parties who employ or engage project workers will develop and implement procedures to establish and maintain a safe working environment, including that workplaces, machinery, equipment and processes under their control are safe and without risk to health, including by use of appropriate measures relating to chemical, physical and biological substances and agents. Such parties will actively collaborate and consult with project workers in promoting understanding, and methods for, implementation of OHS requirements, as well as in providing information to project workers, training on occupational safety and health, and provision of personal protective equipment without expense to the project workers.
- Workplace processes will be put in place for project workers to report work situations that they believe are not safe or healthy, and to remove themselves from a work situation which they have reasonable justification to believe presents an imminent and serious danger to their life or health. Project workers will not be retaliated against or otherwise subject to reprisal or negative action for such reporting or removal.
- Project workers will be provided with facilities appropriate to the circumstances of their work, including access to canteens, hygiene facilities, and appropriate areas for rest.
- A system for regular review of occupational safety and health performance and the working environment will be put in place and include identification of safety and health hazards and risks, implementation of effective methods for responding to identified hazards and risks, setting priorities for implementation, and evaluation of results.

- World Bank Group Environmental Health and Safety Guidelines (EHSGs), 2007.
- ILO Code of Practice. 1992, Safety and Health in Construction Industry ISBN 92-2-107104-9
- Safety and Health in Building and Civil Engineering Work, ILO Codes of Practices
- American National Standard Institute (ANSI) for Personal Protective Equipment (PPE). As for example, Eye and Face Protection (ANSI Z87.1-1989), Head Protection (ANSI Z89.1-1986), Foot Protection (ANSI Z41.1-1991) or equivalent acceptable to the Engineer.
- Good International Industry Practices (e.g., OSHA)
- ESF/Safeguards Interim Note: COVID 19 Considerations in Construction/Civil Works Projects, April 7, 2020.

9.1.2 Scope

OHS framework is applicable to all activities related to the JRECDP Project 1 construction.

Some of the key high-risk activities may involve the following:

- Vehicles and driving;
- Ground control and support structures;
- Construction of a coffer dam at pile site (e.g., Groyne construction);
- Excavation work;
- Pile driving
- Operation of mobile equipment on site and on community roads including passenger vehicles, truck dumpers, excavators, graders, loaders etc.;
- Work at height and dropped objects;
- Work in confined space;
- Work over or near water;
- Material haulage;

- Manual handling;
- Lifting and crainage;
- Welding work;
- Concrete batching;
- Maintenance and operation of the vessels and other water transports;
- Maintenance and operation of the site camp and other facilities like workshop and first aid center; and
- Dredging operation and associated risk to workers and community members.

9.1.3 Objectives and Targets

Following are the objectives of developing the OHS framework:

- Safe operation with Zero harm to community members and Contractor's Staff
- Meet or exceed the contractual safety obligations

The Contractor will establish project specific measurable targets to achieve above mentioned objectives. The determination of these targets is based upon Contractor's continual improvement philosophy, external peer group benchmarking and stakeholders' input. The Contractor will establish targets for each Project for every fiscal year and can make targets as the following:

- Total Recordable Injury Rate of 1.5 or less (or based on the Contractor previous yearly trend)
- Lost Time Injury Frequency Rate of 0.5 or less (or based on the Contractor previous yearly trend)

Project Senior Leadership, Project Manager, Construction Manager and Technical Director are fully committed to achieve the above-mentioned targets. Leading and lagging indicators should be established by the Contractor to drive performance to meet these targets. Following are some leading indicators showing senior management commitment. Complete details of all Key Performance Indicators (KPIs) should be presented in "PR13: Measurement" Process of Contractor's project specific OHS framework.

- All Project Manager complete 1 Walk-through Inspection per month.
- All Construction Managers complete 2 Walk-through Inspections per month with their assigned Health and Safety Officer.
- All OHS supervisors complete 1 site inspection weekly.

9.1.4 Working Together for Success

The responsibility for safety cannot be "delegated" to "OHS Officers or HSE Managers". The OHS staff of the Contractor support line management by assisting in jobsite training, serving as trained and knowledgeable observers, providing administrative assistance, monitoring and evaluating the success of the safety program and acting to continuously improve this plan. While this role is important, commitment and active participation by everyone, every day, on every task, is necessary if the Contractor is to achieve the level of safety excellence that the Borrower expects.

The Contractor follows a hierarchy of OHS implementation. Mandatory requirements are established by the HSE policy, followed by the agreed OHS Management system standard, linked to other OHS system controls such as; standards, codes of practices, safe job procedures, safe work practices and facility / site specific safety instructions and any other safe systems of work that fosters a safe environment at the work execution level (refer to diagram in **Figure 9.1**).

Figure 9.1: OHS Management System

Requirements at any level must meet and support the requirements at higher levels. The HSE policy and OHS management system standard apply to all activities covered in the scope of this OHS framework.

All relevant OHS documents and tools are available and held by the OHS Officer of the project.

9.1.5 OHS Framework Review and Revision

This document provides a comprehensive framework to meet the contractual obligations to achieve safe work. The OHS Plan will be a set of living documents that will undergo routine review and updates when any of the following happens:

- There is a change in the scope of the project, or
- A yearly periodic review, or
- There is a change in construction methodology/technique based on site condition, or
- Following a significant OHS hazard or a major accident, and instructed by the Engineer, or
- At the end of the Project (to allow for improvements in subsequent projects).

The Contractor's OHS Officers are responsible for the review and update.

In addition, the Contractor can also prepare, submit and implement OHS sub plans and Standard Operating Procedures (SOPs) to address specific construction hazards either as a separate document or as part of the Method Statement.

9.1.6 OHS Management System Expectations

The Contractor management should believe in Zero harm to community and all individuals while carrying operational activities. To ensure that the Contractor has prepared the OHS Plan in accordance with the following minimum expectations in line with the policies stated above:

- Safety requirement mentioned in the contract document;
- National regulations and district level by laws (if any);
- ESS2 – Labor and Working Conditions and associated Guidance Note
- World Bank Group Environmental, Health and Safety, General Guidelines-2007;
- ESF/Safeguards Interim Note: COVID 19 Considerations in Construction/Civil Works Projects, April 7, 2020.

- International Labour Organization Code of Practice in Health and Safety in Construction, 1992; and
- Good International Industry Practices (e.g., OSHA, ANSI).

Given above, all resources of standards and guidelines have been described. Following principles further elaborates on this.

- Wherever there is a conflict in guidance of the above, the more stringent safety requirement shall be applied. The Contractor will make sure that all applicable local regulations are always complied with.
- In this document 'Shall' and 'must' signifies a mandatory requirement whereas 'Should' will be used to mention a recommended practice that the Contractor management will strive to accomplish.

9.2 Hazard Risk Assessment

A hazard risk assessment is a critical examination of health and safety hazards at a construction site and operation and maintenance (O/M) work. Performing regular hazard risks assessments can help construction and O/M stakeholders comply with OHS regulations. Hazard risks assessments can help OHS and technical teams implement corrective measures to protect workers from health and safety threats during construction and operation stages.

9.2.1 Hazard Risks Assessment Codes

The principle behind the Hazard Risks Assessment System and the assignment of Hazard Risks Assessment Codes (HRACs) is to identify and control workplace hazards. HRACs are based on the hazard severity, probability of occurrence, and number of people exposed or potentially adversely affected in the event of an accident. While all hazards should be resolved as soon as possible, the Hazard Risks Assessment System is a safety risk ranking method to assist in making informed decisions concerning hazard control while providing decision makers with a consistent and defensible approach for prioritizing safety hazard abatement efforts based on available resources and with consideration towards competing demands and priorities.

9.2.2 Likelihood and Consequence of Hazards

HRACs require assigning values for likelihood or probability of an outcome occurring, and the consequence or severity of a potential outcome. Based on these assigned values, a matrix format is used to place the specific hazard within a specific location of the matrix. This location can then be used to determine an HRAC number for that hazard activity.

The Likelihood or probability Code is considered numerical (1 through 5). These are presented in **Table 9.1.**

Table 9.1: Likelihood Ratings

Sl.	Likelihood	Definition
1	Remote (1)	Unlikely to occur but known in the sector; probability 0.1%-1%
2	Possible (2)	Likely to occur once or more during construction/ organization; probability 1%-10%
3	Occasional (3)	Likely to occur once every two years or more; probability 10%-50%
4	Likely (4)	Occurs more than once or twice per year, is continuous or certain to occur; probability 50%-80%
5	Frequent (5)	Multiple occurrences have happened frequently in the industry; probability >80% and above

Next is the Consequence or severity Code, varies from 1 to 5 and is presented in **Table 9.2.**

Table 9.2: Consequence Ratings

Sl.	Consequence	Definition
1	Incidental (1)	No impact or minor First Aid injury
2	Minor (2)	First aid injury (e.g., minor cuts and bruises, eye irritation from dust) or very minor health effect
3	Moderate (3)	Lost Time/ Non-Lost Time injury (e.g., sprains, fracture, cut, lacerations, burns or bruises) or health effect (i.e., deafness or dermatitis)
4	Serious (4)	Major injuries: amputations, major fractures, multiple injuries, or health effects: severely life shortening disease, occupational illness, Single Fatality (drowning)
5	Catastrophic (5)	Multiple fatalities or Multiple permanent disabilities

9.2.3 Risks Assessment Matrix

The hazard risks assessment matrix is presented in **Table 9.3**. This matrix helps OHS team to prioritize workplace hazards by identifying them as high, warning, medium, and low. Those hazards identified as high will require the most stringent controls available as well as immediate attention. They may even demand that such activities be cancelled from the Project. Specific workplace controls can be applied so that the associated hazards are more effectively controlled and therefore, result in a revised assessment category to a more acceptable level. Note that the box at the bottom indicates that if we can eliminate the hazard (such as eliminating the task that subjects the worker to the hazard or allowing an outside specialized contractor to complete the task for the worker), the hazard no longer exists and therefore can be removed from a project's control process – this is the ultimate hazard control.

Table 9.3: Risk Matrix

Likelihood / Severity	Remote (1)	Possible (2)	Occasional (3)	Likely (4)	Frequent (5)
Incidental (1)	Low (1)	Low (2)	Low (3)	Low (4)	Low (5)
Minor (2)	Low (2)	Low (4)	Low (6)	Medium (8)	Medium (10)
Moderate (3)	Low (3)	Low (6)	Medium (9)	Warning (12)	Warning (15)
Serious (4)	Low (4)	Medium (8)	Warning (12)	High (16)	High (20)
Catastrophic (5)	Low (5)	Medium (10)	Warning (15)	High (20)	High (25)

9.2.4 Summary of Assessed Hazard Risks

The project's potential risks and their significance have been assessed using the methodology described in Section 9.2.1 and 9.2.2. A summary of these risks and their significance along with the control measures are presented in **Annex 9-1**. The risk matrix will be revisited once construction details are available from C1 Consultant. OHS Plan Documents Structure hierarchy is shown in Figure 9.2.

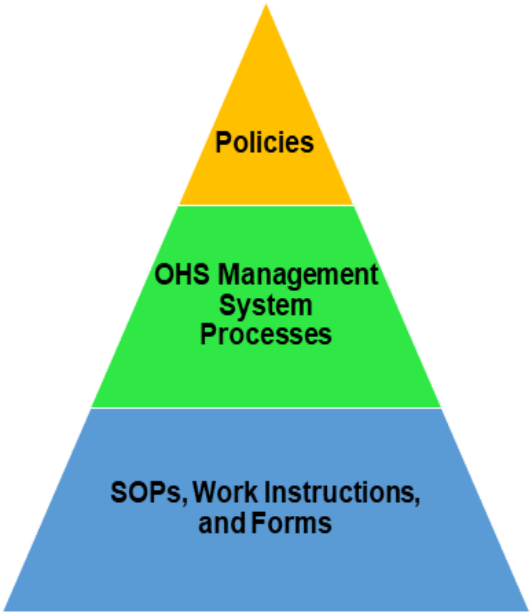


Figure 9.2: Document Hierarchy of the OHS Plan

9.2.5 Policies

Contractor's operating policies are the highest-level document. They provide with direction when the Contractor operates in different geographies of the world. These are based on the Contractor's senior management commitments and they guide in day-to-day operations.

9.2.6 Human Resources Policy

Contractor's human resources policies should focus on the responsibility to respect human rights and play a positive role in the communities where they operate. To this end, Contractor should commit to respecting human rights as set out in the United Nations Universal Declaration of Human Rights and the International Labour Organization (ILO) Declaration on Fundamental Principles and Rights at Work, as well as adhere to the United Nations Guiding Principles on Business and Human Rights, the Voluntary Principles on Security and Human Rights and the World Bank Environmental and Social Standards 2: Labor and Working Conditions.

The Contractor must continually assess the human rights context of their activities, including impacts that they may cause and those to which they may contribute or be directly linked. This determines the prevention, mitigation and control measures required, including using leverage from their business relationships.

Contractors should recognize, respect and abide by all project workers, community worker, and employment laws and expect their subcontractors and other third-party companies to meet the same standards. No child or forced labor is allowed under the project/program – by the contractors or sub-contractors or primary suppliers. These include prohibitions on child labor, forced labor and discriminatory behavior.

Contractors should value and respect the traditions and the culture of the many different communities in the project area where they do business.

Contractors should believe their business activities contribute to the economic well-being and quality of life. Contractors should recognize the effect that their activities may have on local communities, and they value and strive to engage in a meaningful way with the communities where they do business to help ensure that they positively contribute to the welfare of the local communities.

Contractors should endeavor to conduct business with communities who share their values and business principles.

9.2.7 Contractor's Health and Safety Policies

Safety and Environmental Sustainability is not a choice, it's a lifestyle. Contractors should support a safe work environment and ensuring the safety of all employees and the clients. They should recognize Safety as a Core Value of their business. Contractors will be responsible for the compliance of OHS/CHS including the compliance for their respective sub-contractors.

Safety and Environmental Sustainability are non-negotiable. Contractors should prevent occupational injury or illness always takes precedent, even over operating productivity. Compliance with National land Local legislation, as well as client and industry safety and environmental standards must be maintained at all times.

Everyone has a role to play. Contractors' Occupational Health and Safety Plan should be built on best practices and industry leading safety management systems. To be successful, such a plan must start with proper attitudes toward injury and illness prevention on the part of all employees. It also requires cooperation on all Health and Safety matters, not only between management and employees, but also between each employee and his or her co-workers.

Recognize the responsibilities of Health, Safety and Environment are shared:

- Contractors accept responsibility in leading the Health and Safety program and for its effectiveness and improvement.
- Supervisors, Officers, and Managers should be responsible for developing positive attitudes towards Health and Safety in themselves and those they supervise and ensuring that all activities are performed with the utmost regard for the Safety and Health of those involved.
- Employees are responsible for wholehearted, genuine cooperation with all aspects of the health and safety program.
- Provide education to participating personnel, thus enabling them to understand and share in the responsibility for monitoring and protecting the environment.
- Maintain an effective reporting and communication system, and develop a project action plan commensurate with company standards and regulatory/client requirements.

Contractors should make responsible decisions and should believe in environmental sustainability by applying the core values and upholding the code of conduct. They should protect their employees, the public and the environment.

9.2.8 Alcohol and Drug Policy

The use of alcohol and illegal drugs shall be strictly forbidden on all project sites.

All project workers on the project shall comply with the following.

- No project worker shall distribute, possess, consume, or use alcohol or illegal drugs on the work site or in any vehicle or any other equipment.
- No project worker shall report to work or be at work under the influence of any drug, or substance that may cause impairment and/or will affect their ability to work safely.
- No project worker shall misuse prescription or non-prescription drugs while at work. If a project worker is taking a prescription or non-prescription drug for which there is a potential unsafe side effect, he has an obligation to report such potential to the supervisor.
- Management reserves the right to conduct searches of premises and worksites where there are reasonable grounds to conclude there is or has been use or possession of substances prohibited under this Policy.
- Any person taking medication that can affect or restrict their ability to do their job safely must advise and must discuss with his/her direct supervisor.

- Smoking at work places should be banned except in designated smoking areas which are equipped with fire extinguisher, " smoking permitted here" signs and trash cans, and possession of lighters and matches should be prohibited before entering work areas
- Management at their discretion may conduct 'Reasonable Cause Suspicion Testing' if there are evident reasons to believe that the person in question is impaired.
- Management may also conduct Post Incident Alcohol & Drug testing to rule out if this may be a contributory factor in the incident.

9.2.9 Business Conduct and Ethics Code

Each Contractor's Business Conduct and Ethics Code should be built on the core values and highlights the principles that guide their business conduct. Use it for guidance about their ethical standards and where to take worker's questions or concerns

Ethical decision making

Ethical decision making is essential to the success of each Contractor. Some decisions are obvious and easy to make; others are not. By asking questions below can help to make the right ethical decisions.

Four yes answers are required to qualify an action as ethical.

1. Is it legal?
2. Is it consistent with company policies? If the proposed action does not comply with company policy, you should not do it.
3. Is it in the best interests of my co-workers, the company, and the community?
4. If it were made public, would I be comfortable?

   If the answer to any of these questions is "No": STOP. If you're not sure: speak to the Project Manager.

9.2.10 Organization Values

Diversity and Inclusion

The Contractor should learn from and respect the cultures in which they operate. They should have an inclusive work environment that values the uniqueness and diversity of individual talents, experiences and ideas. They should provide equal opportunity and to treat personnel without illegal bias. Contractors will not discriminate based on race, religion, color, national origin, age, sex, gender identity, disability, political preference, membership or non-membership in any lawful organization

Integrity and Trust

Contractors should be honest with themselves and others and honour the company commitments. They should trust, respect and support each other. All employees should earn the trust of their colleagues and partners by operating with the highest ethical standards in all they do.

Partnership

Build trusting and mutually beneficial relationships by collaborating with the communities, customers, suppliers and other business partners. Objective should be in succeeding with partners.

Protect People and the Environment

Contractors should place the highest priority on the health and safety of the employees, communities and protection of the assets. Deliver world-class performance with a focus on preventing high-consequence incidents.

9.2.11 OHS Management System Processes

The OHS Management System Process forms a framework of each Contractor's OHS management plan (OHS Plan) and these are the Contractors' second-tier documents after policies. Contractors for both Components 1 and 2 should develop the following OHS Management System Processes based on the project and site requirements:

- PR01: Induction Process
- PR02: Job Hazard Analysis
- PR03: Meetings
- PR04: Personnel Competency and Training
- PR05: Short Service Worker Program (with tools for assessment)
- PR06: Reward and Recognition
- PR07: Disciplinary Process
- PR08: Permit to Work Process
- PR09: Work Observation Process
- PR10: Critical Risk Protocols
- PR11: Personal Protective Equipment (PPE)
- PR12: Incident Investigation
- PR13: Measurement - Leading and Lagging Indicators
- PR14: Pandemic Action Plan (COVID-19)
- PR15: OHS Compliance Audit
- PR16: Inspections
- PR17: Personal Risk Assessment
- PR18: Risk Management
- PR19: Document Control

9.2.12 Standard Operating Procedures (SOP), Work Instructions and Forms

Standard Operating Procedures and Work Instructions are mostly technical in nature and are third-tier documents in overall risk management approach. Forms and checklists provide support for implementing the controls mentioned in these SOPs. Table 9-4 presents a list of SOPs, which will be developed by the Components 1 and 2 contractors of Project 1 based on project specific risk assessment matrix and be part of their OHS Plan.

Table 9.4: List of Standard Operating Procedures

Component 1	Component 2
SOP 01: Dredging	
SOP 02: Work at Height	
SOP 03: Excavation	SOP 03: Excavation
SOP 04: Mobile Equipment	SOP 04: Mobile Equipment
SOP 05: Barricading and signs	SOP 05: Barricading and signs
SOP 06: Cell Phone Use	SOP 06: Cell Phone Use
SOP 07: Safe Driving	SOP 07: Safe Driving
SOP 08: COVID19 Guidance	SOP 08: COVID19 Guidance
SOP 09: Material Haulage (Loading and Unloading)	

Component 1	Component 2
SOP 10: Traffic Interface Planning	SOP 10: Traffic Interface Planning
SOP11: Severe Weather	SOP11: Severe Weather
SOP 12: Lifting and Hoisting	SOP 12: Lifting and Hoisting
SOP 13: Scaffold Erection	
SOP 14: Working Near or Over Water	SOP 14: Working Near or Over Water
SOP 15: Illumination	SOP 15: Illumination
SOP 16: Ground Support	
SOP 17: Water Management	
SOP 18: Ventilation	
SOP 19: Fire	SOP 19: Fire
SOP 20: Electrical Systems	
SOP 21: Hazardous Material Management	SOP 21: Hazardous Material Management
SOP 22: Equipment Inspection & Maintenance	SOP 22: Equipment Inspection & Maintenance
SOP 23: First Aid	SOP 23: First Aid
SOP 24: Project Worker Welfare Facilities	SOP 24: Project Worker Welfare Facilities
SOP 25: Camp Management	
SOP 26: Emergency Response Plan	SOP 26: Emergency Response Plan
SOP 27: Operation of Crushing and Batching Plants	
SOP 28: Contractor Security Management	
SOP 29: Cofferdam Construction	
SOP 30: Work in Confined Space	
Others	

The specific direction of Contractors is shown through the health and safety policy and the responses to Contractual/applicable laws, regulations, guidelines, and standards as above. These considerations together assist Contractors' continuing contention to provide/develop/apply and review OHS provision and their consistent applications at site.

9.3 Project Organization

9.3.1 Contractor Organogram

A typical Contractor's organogram is presented in **Figure 9.3.**

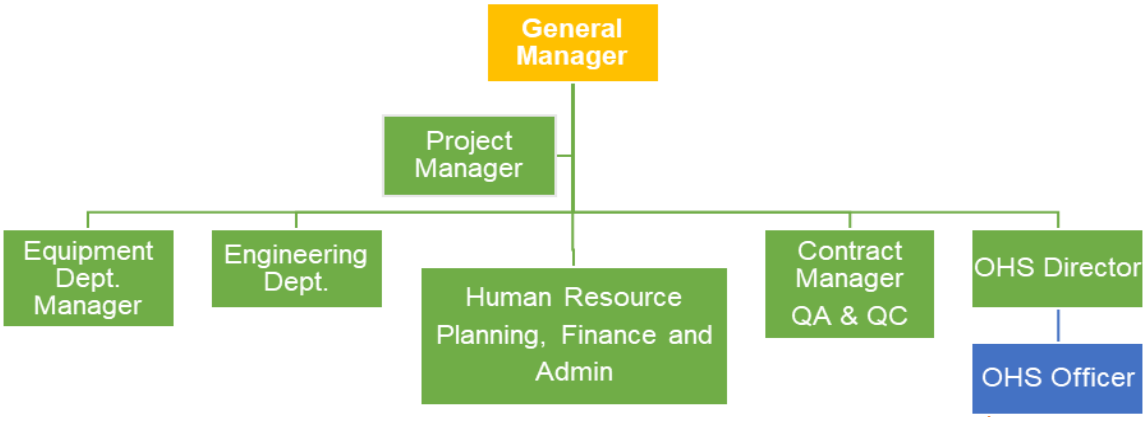


Figure 9.3: Contractor Organogram

9.3.2 OHS Organogram

A Contractor's typical OHS organization should resemble that shown in **Figure 9.4.**

Figure 9.4: Contractor's OHS Organization

9.3.3 Roles and Responsibilities

These roles and responsibilities give a holistic understanding pertaining to implementation of the OHS Plan which comprises multiple processes and SOPs. However, each process and SOP may also have additional specific requirements pertaining to a specific role.

General Project Manager

- Overall accountability for the development, implementation and maintenance of the OHS Plan.
- Accountable for allocation of sufficient resources for the execution of the plan.
- Ensure that empowered and competent personnel are available for the execution of the plan
- Make sure that Sr. Leadership (all directors, Construction Managers and other line management personnel) are fully aware of their responsibilities as per the Processes and SOPs of the OHS Plan.
- Discourage achievement of operational results at the cost of safety violations
- Develop a culture where it is safe to speak up and provide the time, people and resources to respond to OHS concerns identified by their workers
- Review Executive Summary of incidents, ensure that Root Causes are being identified and resources are provided for the closure of Preventive and Corrective Actions

Project Manager

- Overall accountability for the development, implementation and maintenance of the OHS Plan.
- Accountable for allocation of sufficient resources for the execution of the plan.
- Ensure that empowered and competent personnel are available for the execution of this plan

- Make sure that Sr. Leadership (all directors, Construction Managers and other line management personnel) are fully aware of their responsibilities as per the Processes and SOPs of the OHS Plan.
- Demonstrate visible leadership, walk to talk behavior to reinforce the implementation of the OHS Plan
- Attend monthly OHS Committee/Progress Review Meeting and monitor the performance through leading and lagging indicators.
- Discourage achievement of operational results at the cost of safety violations
- Develop a conducive culture where Personnel are authorized to *STOP unsafe work without fear of retribution
- Develop a culture where it is safe to speak up and provide the time, people and resources to respond to OHS concerns identified by their workers.
- Ensure that Work Observation program is utilized, and all incidents are fully investigated
- Review Executive Summary of incidents, ensure that Root Causes are being identified and resources are provided for the closure of Preventive and Corrective Actions
- Encourage reward and recognition where personnel demonstrate safe behavior or identify hazards and fairly apply disciplinary process when personnel cut short.

**ILO COP 2.2.12. Where there is an imminent danger to the safety of workers, the employer should take immediate steps to stop the operation.*

OHS Director

- Be a Subject Matter Expert of the OHS Plan. Provide training and awareness regarding the implementation of the OHS Plan that includes multiple Processes and SOPs.
- Convene monthly OHS Committee/Progress Review meeting and share implementation progress, points of concern.
- Be familiar with all local, national, and international laws that are applicable to the operations.
- Establish and maintain a professional relationship with Company /Contractor and subcontractor representatives.
- Establish an audit system that measures the effectiveness of the OHS Plan.

OHS Officer

- Be a Subject Matter Expert of the OHS Plan. Provide training and awareness regarding the implementation of the OHS Plan that includes multiple Processes and SOPs.
- To be familiar with all local, national, and international laws that are applicable to Operations.
- Raise concern in the monthly OHS Committee/Progress Review meeting regarding implementation of controls stipulated in the OHS Plan.
- Provide training to staffs on the OHS Plan. Conduct regular sessions for all project team members to inculcate the requirements of the OHS Plan.
- To report to the Contractor's Management Team on implementation progress, monthly KPIs.
- To ensure that sufficient training and induction of all personnel is being provided and maintained.
- To ensure that visit induction is given to all visitors before they are allowed to visit the site.
- To develop the OHS awareness of all personnel employed on the project and ensures their participation in all aspects of the health and OHS program
- Provide guidance for the purchase of personal protective equipment
- Regular inspection of construction safety and security as per PR09: Work Observation Process

- Provide guidance to employees regarding their emergency response responsibilities.
- Decide whether a potential rescue service or team is adequately trained and equipped to perform permit space rescues of the kind needed at the facility and whether such rescuers can respond in a timely manner, and organize drills
- Review of OHS management plan annually.

OHS Staff/ Supervisor

- Perform the assigned inspections and discuss the findings with OHS Officer
- Ensure communication procedure and system to communicate emergency events to site technical supervisor and emergency authorities (e.g., Incident Response Center (IRC) and/or Police, health centers)
- Communicate with construction site personnel to help them understand the hazards of the site and understand the demands of the operating personnel about OHS matters.

Site Technical Supervisors (part of the technical team)

- They allocate tasks and check that the project workers are implementing OHS requirements to standard. They provide feedback and guidance on OHS implementation.
- Ensure that the controls stipulated in PTW (Permit to Work) are implemented and STOP the work when critical controls are missing or compromised
- Discuss Job Hazard Analysis (JHA) and conduct effective Tool Box Talk with all project workers. Ask questions to ensure that they have a good understanding.
- Ensure that all new employees receive training as per PR01: Induction Process and PR05: Short Service Worker Process
- Conduct worksite observations, discuss safety concerns with project workers
- Develop a culture where it is safe to speak up and provide the time, people and resources to respond to OHS concerns identified by their workers. They are also responsible for escalating issues that can't be resolved by the project workers or at the supervision level to OHS Team or senior management.
- Responsible for making an incident scene safe and secure and for ensuring that hazards, near misses and incidents are entered into the reporting system.
- Ensure all project workers use appropriate PPEs and train them how to use PPEs.

Workers

- Conduct Personal Risk Assessment Take 5 (Stop, Look, Assess, Control, and Monitor) and do not proceed to work if unsafe to do.
- Use authority to STOP work if observe an unsafe work by fellow worker or SSW.
- Report hazards and at-risk behavior as and help the Contractor management to develop a conducive safety culture.
- Use PPE as provided.
- Conduct a visual inspection of equipment at the beginning of the operation and ensure that equipment is de-energized before working on a piece of equipment.
- Ensuring that they wear appropriate PPE for the activity that they undertake.
- Be aware and mindful of hazards related to any work activity; do not undertake a job or task if physically or mentally not fit.
- Seek clarification for uncertainty relating to a task with the Supervisor.

- Do not undertake a job if not competent to do so.
- Raise improvement opportunities.
- Report near misses and actual incidents.

9.4 Incident Reporting

The Contractor is required to notify IA and PIU of all incidents including near misses. All incidents must be reported to the site superintendent immediately. All incidents that require medical attention, or have the potential for medical attention require the immediate notification of the project management team.

9.5 Investigations

An investigation must be conducted by the contractor supervisors for all incidents involving their workers. The preliminary investigation report must be submitted to the project management team within twenty-four hours of occurrence. These reports must be completed to the satisfaction of the PIU.

9.6 Audits, Inspections and Corrective Action

Contractors shall inspect their work areas and their subcontractors' work areas on an on-going basis to verify compliance with OHSE regulations. Contractors are expected to conduct formal inspections on their job sites and provide copies of the inspections to PIU. If non-compliance items are observed, the contractor must rectify any unsafe acts and/or conditions without delay. Work which is not in compliance with applicable OHSE standards will be stopped until corrective action is implemented.

Inspections on their job sites and provide copies of the inspections to PIU. If non-compliance items are observed, the contractor must rectify any unsafe acts and/or conditions without delay. Work which is not in compliance with applicable OHSE standards will be stopped until corrective action is implemented.

10. Community Health and Safety Plan

10.1 Introduction

The Community Health and Safety (CHS) plan recognizes that project activities, equipment, and infrastructure can increase community exposure to risks and impacts. In addition, communities that are already subjected to impacts from climate change may also experience an acceleration or intensification of impacts due to the project activities. The preparation of this CHS Plan is a mandate as per the World Bank's ESS-4 and included with the ESIA report of the JRECDP. This CHS plan addresses the health, safety, and security risks and impacts on project-affected communities and the corresponding responsibility of Borrowers to avoid or minimize such risks and impacts, with particular attention to people who, because of their particular circumstances, may be vulnerable.

10.1.1 Objectives

The objectives of the CHS Plan are to:

- Describe actions required to implement the construction-related management and preventive measures outlined in the Environment Assessment document and required by the World Bank's ESS4, Community Health and Safety and Guidance Note 4 (Community Health and Safety).
- Describe the processes and standard operating procedures required to conduct the tasks related to a specific project implementation.
- Describe additional measures required to implement Good International Industry Practice (GIIP).
- Facilitate the addition and/or modification of control measures as new data become available via monitoring activities, health centers and community-based sources.
- Outline the roles and responsibilities of the positions in charge of implementing the CHS Plan, including monitoring and evaluation.
- Devise a training plan for all workforces and community members who are directly exposed to the health and safety hazards of the Project.
- Describe the processes for recording and reporting non-conformances, as well as measurement and reporting of key performance indicators (KPI).

10.1.2 Scope

The scope of the CHS Plan addresses the commitment to:

- Mitigate potential impacts and hazard risks of Project related activities that may affect the health and safety of communities within the areas of influences of four pilot sites under Component 1 and along the transportation route.
- Maintain a healthy workforce and labor pool in the community; and
- Contribute to the improved health, safety and wellbeing of the local community in the areas of influence.

In many respects, the programs within the scope of CHS Plan will inform the Social Management Plan. The plan will be implemented at the beginning of the construction phase and continue to the end of the Project life. The plan has been informed by the provisions of the World Bank's ESS4: Community Health and Safety and Guidance Note 4 (Community Health and Safety), World Bank Group's (WBG's) Environmental Health and Safety Guidelines (EHSGs), Good International Industry Practices (GIIP), and the Project's ESIA.

This Plan applies to Project construction and operational stage and the associated risks and potential impacts that these activities may have on community health, safety, and security. The geographical scope is described by the Project Area of Influence which comprises two parts:

- The physical footprint of the project, comprising the area occupied by direct components, such as two pilot sites, along the navigation route, and Associated Facilities (Area of Direct Influence).
- The area directly and indirectly affected outside the physical footprint, as determined by the presence and interaction of Project aspects with the environmental and social characteristics of the surrounding area (Area of Indirect Influence). The Area of Indirect Influence encompasses the 'Project Affected Communities'.

The risks and potential project impacts to community health, safety, and security can emanate from both within and outside the so-called "project fence." For this reason, the scope of this plan focuses on the management of aspects associated with the interaction of construction activities, the workforce, and the community.

The central element of the CHS Plan is a set of control measures designed to avoid or mitigate the adverse effects of project activities on the health, safety, and security of the community, while at the same time, enhancing the beneficial effects and capitalize on opportunities that may contribute to improving overall community well-being.

Implementation Agency's staffs involved in the Community Relations, Environment Health and Safety staffs of the Contractors and the Engineer will be responsible for the Community Health and Safety Plan with input from the Social Team.

This OHS Plan is currently preliminary draft and dynamic in nature and will continue to be developed and modified in consultation with all relevant stakeholders, including but not limited to BWDB, BIWTA and community, throughout the lifecycle of the Project, especially, after the detailed design where site specific information and community interaction path will be determined.

10.1.3 Relation of the Community Health and Safety Plan with Other Management Plans

The Community Health and Safety Plan is related to, overlaps, shares objectives or can supplement strategies with the following management plans of the Contractor:

- Occupational Health and Safety Plan;
- Community Development Plan;
- Stakeholder Engagement Plan;
- Biodiversity Management Plan;
- Procurement Plan;
- Security Management Plan;
- Traffic Management Plan;
- Emergency Preparedness and Response Plan;
- SEA/SH Action Plan
- Water Management Plan; and
- Air Quality Management Plan.
- Adoption of ESCOPs

Some plans named above are related to disciplines where no significant impact on communities is expected, because of small scale construction. However, these disciplines remain related to this Plan for monitoring and follow-up purposes.

10.1.4 General Strategy for Mitigation/Control

In terms of community health and safety, the Contractor's strategy will be to implement programs that contribute to the maintenance of a healthy workforce and local community and protect against potential negative health effects of the Project within the Project AOI. As such the following programs have been identified for implementation and must be committed by the contractor in bid document:

- Health Services Program;
- Disease Prevention Program;
- Subcontractor Integrity Program;
- External Emergency Response and Preparedness;
- Security with Integrity Program;
- Community Health and Safety Awareness Program;
- Safety of Services Program by maintaining quality Management Systems;
- Potential Risks and Impacts on Ecosystem Services Program; and
- Positive Lifestyles Program.

The underlying principles that guide the approach and implementation of the Community Health and Safety programs are:

- Accountability and transparency – understanding that confidentially of health data overrides any need to demonstrate vulnerability in a population, sub-population or individual. Planning and implementation of social management is conducted in an environment of accountability and transparency, with the disclosure of agreements, general monitoring results, and processes to relevant stakeholders;
- Confidentiality – Handling and monitoring of health data is conducted in an environment of confidentiality to an international standard of medical ethics;
- Equity assurance – administering actions to benefit all members of a vulnerable sub-population, avoiding discrimination, and avoiding personal identification of any individual who may be at risk;
- Leveraging – as disenfranchised communities are identified, the Contractor will consider leveraging or focusing other programs to these sub-populations to assure some equity in Project impacts;
- Cultural context – Action Plans are culturally appropriate and based on clear understanding of affected people's expectations, basic needs and vulnerabilities;
- Evidence-based health management planning – The Community Health and Safety Management Plan is developed from a clear understanding of Project impacts and risks and affected communities at all stages of the Project lifecycle;
- Participatory planning for development and implementation of detailed action plans – where possible, planning, implementation and monitoring of health management actions are undertaken in partnership with affected people, organizations from government and civil society that can provide insights to identify possible causal pathways;
- Flexibility in implementation – health management implementation is recognized as necessarily flexible and subject to change, in response to on-going engagement, data collection and monitoring results, and emerging challenges; and
- Balanced internal responsibility for implementation – responsibility for the implementation of the Community Health and Safety Management Plan will be shared between the Project's Community Relations Department, the Environment, Health, and Safety Department; and all other departments and staff whose activities may affect or impact local communities.

10.2 Evaluation of Risks and Impacts and Mitigation

This section identified the possible hazards and its impact/risks with ratings (Table 10.5) on the local community due to the construction and operational activities of this project. Annex 10-1 presents impacts and risks with likelihood, consequence, risks and propose mitigation/control measures to avoid or reduce the magnitude of the risks to the nearby communities. Since, detail design of pilot sites and construction activities are yet to finalize, the control measures are generic in nature, site and construction specific controls will be provided when additional details are available from the technical team of both Components 1 and 2 of Project 1.

The assessment process involved the following steps

- Identification of potential hazards
- Assess Risks/Impacts on the local communities
- Impacts on the projects by the affected communities
- Estimated risks before mitigation
- Control Measures
- Residual risks
- Responsible person to implement the control measures.

Table 10.1: Risk Ratings

Risk Matrix				Likelihood				
				Unlikely to occur but known in the sector; probability 1%-1%	**Likely to occur once or more during construction/ organization; probability 1%-10%**	**Likely to occur once every two years or more; probability 10%-50%**	**Occurs more than once or twice per year, is continuous or certain to occur; probability 50%-80%**	**Multiple occurrences have happened frequently in the industry; probability > 80% & above**
				Remote (1)	**Possible (2)**	**Occasional (3)**	**Likely (4)**	**Frequent (5)**
				1	**2**	**3**	**4**	**5**
Severity	No impact or minor First Aid illness	Incidental	**1**	1	2	3	4	5
	First aid illness (e.g., minor fever, pain) or very minor health effect; one incidence during the construction	Minor	**2**	2	4	6	8	10
	Medical treatment cases (e.g., infections, high fever, cough), destruction of crops, 2-3 one incidences during the construction	Moderate	**3**	3	6	9	12	15
	Major health issues, hospitalization, bank failures, or threat to structures: Single Fatality (drowning)	Serious	**4**	4	8	12	16	20
	Multiple fatalities or erosion of Multiple houses	Catastrophic	**5**	5	10	15	20	25

Color coding		
Color	**Risk**	**Score**
Light Blue	Low	1-6
Blue	Medium	8-10
Yellow	Warning	12-15
Red	High	16-25

10.3 Community Health and Safety Management Framework

10.3.1 Health Services Program

The health services program will enhance and monitor effective change in access to health, and any linkage to health status in general and in terms of the area of influence and specific communities and subpopulations (e.g., women, girls, children, in-migrants, visible minority) within the project area. The health services program will use environmental, social, economic and health data to continually track and evaluate the changing vulnerability of communities within the area of influence so that action can be focused on the most vulnerable communities at any given time.

Contractors will work with local government to identify any necessary follow-up actions if health status is negatively affected by the Project in areas of influence. Possible actions will include supporting provision of affordable health services, including mobile health outreach clinics within the areas of influence.

The Contractor understands the potential consequences of breaches of medical ethics, including the potential for direct and indirect discrimination of, and violence against, affected persons. Health data must be confidential to the individual and health professionals only. To minimize breaches of confidentiality, the Contractor will identify opportunities for collaboration with local governments and communities to develop or share in third party health data collection and reporting for the communities in the areas of influence. In any case, the Contractor will set clear expectations and protocols for the management of medical data to prevent access to, and disclosure of medical data to, non-medical employees, managers or others. The Contractor will carry out a continuous risk assessment of the procedures in place, monitor its medical staff, and identify any necessary corrective or preventive actions for continuing operations.

At closure of the construction, the Contractor will work to maximise likelihood of continued improvement to general health and wellbeing. Under the Social Management Framework, the Contractor will work with local government to identify options to protect and enhance the health of communities in the areas of influence post-closure. During the closure phase, the Contractor will transfer knowledge of general health status, trends in health status over the life of the Project, and predictions for changes in health status for different post-closure scenarios to the government.

10.3.2 Disease Prevention Program

The Disease Prevention Program will focus on methods to reduce of community exposure of water related disease. The program will be delivered through active mitigation (e.g., limiting bodies of stagnant water), development support in nearby communities, and community awareness. The program will be informed by health monitoring.

10.3.3 Pandemic Action Plan Program (COVID-19)

To protect the health and safety of workers, as well as surrounding communities from pandemic, it is strongly recommended to conduct a workplace review and risk assessment for exposure to COVID-19 and other infectious disease where the nature of works, stage of implementation, project activities, and status of the project must be taken into consideration. In addition, vulnerable groups such as migrant workers as well as women, older workers, at-risk workers including those with underlying health conditions, or those with combined vulnerability factors who will also be disproportionately impacted, should also be considered.

Contractors will setup COVID-19 screening, testing and quarantine management as it applies to new workers, existing workers returning to site, and visitors to site. Project contractor/Management must need to engage local Governments, community leader, businesses, and healthcare providers contributing to an overall community mitigation strategy to minimize illness and death rates as well as the social and economic impact of COVID-19. Project management should put emphasis on community mitigation measures and choose which ones to put in place to prepare for and respond to community transmission of COVID-19. Implementation of community mitigation measures of COVID-19 is based on:

- Detection of confirmed cases of COVID-19 with no epidemiologic link to known cases.
- COVID-19 Response Plan will be developed which will be monitored and progress is reported regularly to Senior Management (and the Board) for review and improvement.
- The project will dedicate community outreach / community relations staffs who will establish channels of communication with local communities. These channels will be used to communicate the Project's response to COVID-19, and to provide COVID-19 prevention information to communities in a culturally appropriate way
- Contractors should establish proper channels of communication and collaboration with local/regional health institutions in their jurisdiction.
    - These channels will be used to communicate and coordinate with the COVID-19 response, for reporting cases and contact tracing.
    - The project will be following health protocols from local health authorities regarding the management of cases and fatalities
- The project authority will develop a Grievance procedure in place that will be adapted for COVID-19 Grievances.
    - Both workers and community members have an immediate way to contact the Project (e.g., by phone) regarding any potential grievance linked to COVID-19.
    - There is evidence that grievances received linked to COVID-19 are being prioritized and resolved promptly.
- Frequent meetings with community authorities either through seminar or FGDs should be conducted to make the community aware of the severity and fatality of COVID-19 and also inspire them to follow the WHO recommended precautions. In addition, awareness campaign should be taken place among the community by putting up poster or leaflet distribution in Bengali language.

10.3.4 Chikungunya and Dengue

Chikungunya, dengue and other vector borne disease reduction campaigns will be applied consistently throughout the Project duration and will include awareness of linkages between stagnant water and dengue, including through poor sanitation conditions. Open water sources are created and/or enlarged, as a result of construction activities and storage of plant, materials and equipment, with the potential for increased mosquito breeding sites. Increased burden of disease in workforce, results in increased demand on Project health services and reduce productivity.

Perform a baseline entomological study to define the most predominant vector species in the Project area, as well as determining the susceptibility of mosquitoes to the different classes of insecticides. The Contractor will encourage good sanitation practices, and the use of mosquito nets throughout the area of influence. The Contractor will support development of local knowledge and on the exposure pathways and determinants of exposure in vulnerable communities. The Health Services Program will inform the Disease Prevention Program of the most vulnerable communities (with highest dengue incidence) for prioritized action. Provide information for training of workers in Chikungunya and Dengue awareness so they can take knowledge back to communities. Actions and lessons learned in the areas of influence will regularly inform Occupational Health and Safety training.

10.3.5 Sanitation and Water Supply

Contractors will support the development of improved sanitation and improved water facilities. Through stakeholder engagement, the Contractor will encourage people to construct, adopt and effectively use improved sanitation and water facilities. Focus groups with local government, existing communities and in-migrants may be implemented to help knowledge exchange and establish common expectations for sanitary conditions in the areas of influence.

The facilitation and dissemination of information on the linkages between improved water sources, sanitation conditions and human health, and on good hygiene practices, will promote use of the improved facilities and minimize the increased incidence of water related disease and food-borne illness in the areas of influence.

On-going monitoring of health and health impact pathways (e.g., number of bodies of stagnant water, number of people with access to improved sanitation facilities) will be implemented by the Contractor with regular feedback to those affected.

10.3.6 Sexually Transmitted Diseases

Stakeholder engagement activities will include culturally specific and gender specific awareness education about incidence of sexually transmitted diseases in the areas of influence, information on pathways of exposure, and any local evidence to aid acceptance of this information and dispel current myths about causes of HIV/AIDS. Contractors will assist communities in developing education materials such as those using anecdotal epidemiology that would aid increasing acceptance of evidence-based research and facts regarding HIV/AIDS.

10.3.7 Subcontractor Integrity Program

Contractors will be clear about its expectations of subcontractors during all phases. Contractors will continually monitor and evaluate companies' performance, including performing spot checks on-site, to ensure that the expected level of safety culture is being adhered to. The subcontractor integrity program will be far reaching and include, but not be limited to the performance regarding the following:

- General traffic safety;
- Hazardous materials management;
- Community health and safety;
- Occupational health and safety; and
- Adherence to construction standards stated in the general and specific conditions of the main contract.

10.3.8 Emergency Preparedness and Response Planning

Contractors will develop an emergency preparedness and response plan (EPRP) to contain emergencies. A risk assessment will be conducted during the Stage 2 E&S study covering major emergencies and corresponding management measures for the project. Contractors will work with local authorities to strengthen the national emergency response network in the areas of influence and to ensure implementation of the project specific emergencies and make arrangements with external emergency services (Fire, ambulance, etc.), if the resources available with a given Contractor is not sufficient to contain the emergency.

If an external emergency arises not due to the Project but something where collaboration from the Contractor is needed for both labor and emergency equipment, Contractors can extend collaboration to work with local authorities and communities. Contractors will develop procedures in the EPRP on actions that need to be taken when an external emergency event is triggered. The EPRP prepared by the contractor will cover both project-specific and emergencies in the communities. The Contractor will conduct capacity building and train local communities as needed to make sure the communities know what to do during an emergency. Contractors will work with local authorities to make sure they are aware of it and if needed strengthen the emergency response network to be able to coordinate with the Project.

During each Project phase, the Contractor will communicate potential hazards, potential emergency scenarios, and health risks associated with emergency scenarios. Consultations will be held with communities and community leaders in the areas of influence and along the transportation route, and specific emergency response and preparedness measures will be determined and incorporated in the

emergency response plan. Trainings and awareness for the communities on the emergency response plan will be carried out by contractors.

The following aspects of the Emergency Preparedness and Response Plan will be jointly addressed by Contractors, the community and government representatives:

- Definition of information and notification chain(s) within government/regulatory agencies (who needs to be informed, who has which responsibility and access to/control over resources), following notification of the authorities by the Contractor that an emergency situation has occurred;
- Media information chain (local radio) – such as warnings of embankment failure in up and downstream areas;
- Evacuation procedures for the local affected population;
- Awareness of operations and their risks and preparedness to respond (e.g., sufficient capacity of beds in local hospital);
- Preparedness of state/community emergency response teams (fire brigade) and awareness of risks and potential emergency scenarios, availability of PPE adequate for specific risks such as respirators, full-body harness etc.;
- Knowledge of site plan by ambulance teams (fastest access to critical points such as embankment, explosive storage);
- Training requirements of key people (police, hospitals and local health centres) and alignment of their training plans with the Contractor training plans;
- Commitment to coordinated emergency drills between the Contractor and police, fire fighters, national disaster management authority, etc., and aligned plans for drills; and
- Nomination of community representatives in the preparation of the external plan, and in the planning of and participation in, drills.
- Designated coordinator for EPRP implementation and
- Measures for restoration and cleanup of the environment following any major accident.

10.3.9 Security with Integrity Program

The operations and selection of the Project's security personnel will be guided by the relevant provisions of ESS 2 (Labor conditions) and ESS4 (Community Health, Safety and Security) and the associated GN4: Guidance Notes:

- Security will be provided in a manner that does not jeopardize the community's safety and security, or the client's relationship with the community;
- All secuity personnel must read, sign and adopt the Code of Conduct in line with ESS4;
- Security personnel may not be used to force or extract work from workers;
- Contractors will carry out a continuous risk assessment of the security arrangements in place, monitor its security personnel, and identify any necessary corrective or preventive actions for continuing security operations;
- Security arrangements will follow the principle of proportionality, respect for human rights, and good international practice;
- Contractors will ensure that those providing security are not implicated in past abuses;
- Contractors will provide adequate training in the use of force and appropriate conduct toward workers and communities;
- Contractors will ensure that security personnel act within the applicable legislation of the country;

- Contractors will not sanction any use of force except when used for preventive and defensive purposes in proportion to the nature and extent of the threat;
- Contractors will provide a grievance mechanism to express concerns about the security arrangements and acts of security personnel;
- If security personnel are permitted to use force, instructions must be clear on when and how force may be used, specifying that security personnel are permitted to use force only as a matter of last resort and only for preventive and defensive purposes in proportion to the nature and extent of the threat, and in a manner that respects human rights;
- Security personnel will be instructed to exercise restraint and caution, clearly prioritizing prevention of injuries or fatalities and peaceful resolution of disputes. The use of physical force will be reported to and investigated by the Contractor;
- Any persons injured because of the action of security personnel will be transported to medical facilities;
- The instructions for security personnel will make clear that arbitrary or abusive use of force is prohibited; and
- Unlawful acts of any security personnel will be reported to the appropriate authorities.
- The contractor will require them to act within the applicable law and any requirements set out in the Environmental and Social Commitment Plan (ESCP)

Contractors may seek support from government authorities and appropriate non-governmental organizations (NGOs) to aid preventative planning, evaluation, monitoring and follow-up to ensure security services providers meet Project expectations. Support may include strategies to identify and manage presence of ex-combatants and ex-military personnel within the community and within the Project security services.

Contractors' security services' responsibilities will include preventing hazardous materials or waste from leaving the Project site or the hazardous waste disposal site for the Project.

Contractor will endeavor to monitor in-migration trends and vulnerability indicators through interaction with the community, including incidence of sexual violence and perceived security. Recording good social and health performances in the project area is key to protecting community security and lowering the potential for conflicts and acts of violence in the Direct Area of Influence and Indirect Area of Influence.

Contractors will need to establish mitigation measures in relations to engaging and partnering with local stakeholders, such as supporting the extension of policing services to prevent the intensification of violent conflicts.

10.3.10 Community Health and Safety Awareness Program

Awareness on Community Health and Disease Prevention

Where an assessment identifies risks, for example communicable diseases, which may arise from the interaction of project workers with local communities, the ESIA for the project describe such risks and measures to address them. Such measures can include, more generally, the use of skilled trainers to raise awareness among project workers of the risks, expected behaviors, and consequences of violations, communicated through training, and publicized codes of conduct. It is also important to raise awareness of the risks among community members and local health authorities and inform them about available grievance mechanisms. In addition, Contractors will create awareness of linkages between stagnant water and dengue, including through poor sanitation conditions in the communities close proximity to the Project. Provide information for training of community representatives in Chikungunya and Dengue awareness so they can take the knowledge back to their respective communities.

Community health and disease prevention awareness campaigns will be applied consistently throughout the Project duration and will include awareness of:

- Linkages between improved water sources, sanitation conditions and human health;
- Common water related disease and food borne illness rates in the areas of influence;
- Good hygiene practices;
- Benefits to properly using the improved facilities; and
- Evidence of improvement in target communities to encourage adoption in other communities.

Traffic and Road Safety Awareness

Stakeholder engagement activities, an effective communication strategy, as well as monitoring and management plans will help the Contractor prevent potential negative impacts resulting from a poor in-country safety culture. These actions include the following:

- Clear expectations regarding road safety culture, road safety behavior and road safety training, provided to workers and contractors;
- On-going monitoring of traffic and Pedestrian Interface in the project area (e.g., near misses, reports from communities, reports from project traffic) with regular feedback to those affected; and
- Knowledge transfer to workers and affected communities regarding road user awareness with advice on strategies for interacting with project traffic.

In addition, Contractors will promote traffic safety awareness in communities in the Direct Area of Influence and along the transportation route.

Hazardous Materials Management and Safety Awareness

Contractors will provide hazardous materials management safety communications to communities in the areas of influence to deter workers, their families and others from collecting, reusing, recycling or reselling Project waste. Communications will include examples of hazardous materials used in Project construction, operation and rehabilitation, the risks to human health, and appropriate methods of use and disposal.

During the closure phase, the Contractor will disseminate information on residual site hazards, including the hazardous materials waste disposal site (landfill). Awareness training will include dissemination of information relating to, as for example, the sand mining and the potential impacts of damaging the slope and soil cover, which would jeopardise the rehabilitation success and expose the communities in the areas of influence to unnecessary and preventable health and environmental risk.

Use of Security Personnel

Contractors will engage with communities about the project's impacts on community safety and security, create awareness concerning the Code of Conduct commitment and project grievance mechanism, as outlined in the Stakeholder Engagement Plan (SEP), LMP and SEA/SH action Plan.

Contractors will avoid internal operational silos by ensuring that their Security staff coordinate regularly with other departments, such as Community Relations and Human Resources. Through its Community Relations function, Contractors will share information with communities about security arrangements, the Contractors' security policies, and the expected conduct of security personnel. Dialogue with communities about security issues can also help Contractors to identify potential risks and local concerns, and can serve as an early warning system.

Community members will be informed through the awareness program, where to go with complaints about the conduct of security personnel. Can they lodge such complaints through the company's general community grievance mechanism or is there one specifically for security concerns—or even an alternative complaint mechanism (for example, as part of the local justice system)? Contractors will maintain a clear process and communicate it. The awareness will also provide information on the community members' ability to make complaints without fear of intimidation or reprisal.

Gender considerations are also important, as women often have different experiences and interactions with security personnel. For example, the potential for sexual harassment or sexual violence against women can increase from an expanded presence of private or public security forces in a project area. Contractors should consider consulting and creating awareness separately for women's group, which may offer important perspectives and may help Contractors to identify a fuller range of potential risks and community concerns. At the same time, security personnel's awareness of and respect for culturally specific gender issues may help the local population accept their presence. Contractors might consider recruiting female security guards to improve cultural acceptance and reducing tensions, particularly in situations where there are frequent interactions between guards and women from the community.

Positive Lifestyles Program

Through the Community Development Plan, the Contractor will encourage culturally appropriate positive lifestyle choices to:

- Establish good financial management choices;
- Deter an increase in alcohol use, substance abuse and tobacco use;
- Avoid violence against women, including sexual violence;
- Avoid ethnic- or religious- based violence;
- Adopt good hygiene practices and sanitation; and
- Reduce the potential for STDs.

Awareness campaigns may be conducted within the workplace and at religious institutions, local governments, schools, and health clinics.

SEA/SH awareness program

Apart from the reasons of this hazard indicated in the Risk matrix (Table 10.2), other examples of SEA/SH need to be considered but are not limited to:

- A project worker tells women in the community that he can get them jobs related to the work site (cooking and cleaning) in exchange for sex
- A worker that is connecting electricity input to households says that he can connect women headed households to the grid in exchange for sex.
- A project worker gets drunk after being paid and rapes a local woman.
- A project worker denies passage of a woman through the site that he is working on unless she performs a sexual favor.
- A manager tells a woman applying for a job that he will only hire her if she has sex with him.
- Male staff comment on female staffs' appearances (both positive and negative) and sexual desirability.
- When a female staff member complains about comments male staff are making about her appearance, they say she is "asking for it" because of how she dresses.
- A male staff touches female staff members' buttocks wither in project or in community when she passes her destination.
- School or college girls might be get seduced or tempted by the project staff by offering gifts or other benefits

To protect and prevent community SEA/SH Strengthen community engagement and awareness-raising is essential. Critical awareness activities need to be conducted which will include training and awareness-raising sessions with women, girls, boys and men in communities of concern as well as with other stakeholders (including implementing and operational partners, government officials, civil society organizations, and companies in the private sector). To prevent SEA effectively, all staff and project workers

must make sure that project Persons of Concern (PoC) are aware of their rights and entitlements. On the other hand, PoC from contractor and project management side should know that they are entitled to assistance that they should never be expected to provide any form of sexual favor, and that demands for such favors are strictly prohibited. Community and project victims should also know how and where to report SEA incidents safely and confidentially when they occur. As part of prevention, trainings and information campaigns should be put in place for all project personnel and PoC. Training and information campaigns may include the distribution of information sheets, posters and videos, or community meetings, focus group discussions, etc.

Beside that the project will include a general Code of Conduct (CoC) as well as a Labor Code of Conduct, covering the GBV/SEA/SH related risks for the contractors, sub-contractors, and laborers who will be employed under the project.

10.4 Other Measures to Manage CHS Risks

10.4.1 Safety of Services by Maintaining Quality Management Systems

The Contractor will establish and implement appropriate quality management systems to anticipate and minimize risks and impacts. Projects may provide many kinds of services to communities, such as those relating to education and health, social security and social protection, transport, and utilities, such as electricity and gas, water and sanitation, and waste disposal. Management systems that address the safety of such services are important because without adequate protection measures the provision of such services can present dangers for communities. Such systems address the community health and safety risks posed by project services, for example, risks associated with:

- Infrastructure construction and heavy equipment movement, such as, struck by moving vehicle;
- Water or irrigation canals, such as drowning, flooding, or water-related diseases;
- Waste disposal, such as toxicity, waste dump collapse, or air pollution;
- Quarries or excavation works, such as rock falls or hazardous equipment;
- Water and sanitation services, such as contaminated water or spread of disease;
- Electricity supply, which may result in electric shock from electrical cabinets or cables;
- Service providers, which may use their service for the purpose of financial, sexual, or other exploitation, particularly of vulnerable groups such as women, children, and the elderly.

In such circumstances, the Contractor will apply hierarchy of controls, such as, eliminate/substitute, and engineering control of hazards and if hazards are low risk, then introduce administrative controls and as a final resort provide appropriate personal protective equipment.

10.5 Potential Risks and Impacts on Ecosystem Services

The project's direct impacts on ecosystem services may result in adverse health and safety risks to and impacts on affected communities. With respect to ESS4, ecosystem services are limited to provisioning and regulating services as defined in ESS1. Where appropriate and feasible, the Contractor will identify the project's potential risks and impacts on ecosystem services that may be exacerbated by climate change. Adverse impacts will be avoided, and if they are unavoidable, the Contractor will implement appropriate mitigation measures.

As indicated in ESS1, ecosystem services are the benefits that people derive from ecosystems. The provisioning services that ecosystems provide include the products people obtain from the ecosystems, such as food, freshwater, timbers, fibers, and medicinal plants. Regulating services of ecosystems are the benefits people obtain from the regulation of ecosystem processes, such as surface water purification, carbon storage and sequestration, climate regulation, and protection from natural hazards. Ecosystems and ecosystem services affected by the project need to be part of the environmental and social assessment as

required by ESS1 and mitigation and preventive measures should be identified in the ESIA and accordingly field implement them to preserve the ecosystem.

10.6 Organization, Roles, and Responsibilities

The requirements of this CHS Plan will be stewarded and implemented by the Project. The Environment, Health and Safety (EHS) Officer will own this Plan.

The following roles and responsibilities are examples of the type of roles that will apply during the construction phase. As the needs of the Project change over time, some roles may be replaced and or combined with others that are more appropriate to the Project's needs at the time.

10.6.1 Environment, Health and Safety (EHS) Officer

- Responsible for overall implementation including coordination with government and community representatives
- Responsible for ensuring safe behaviors by Project personnel such that community safety is protected
- Investigates and analyses community safety events when/if they occur and escalates findings and required remedial actions to Management as required
- Responsible for notification of community safety incidents, as described in the Environmental and Social Management Plan.

10.6.2 Medical Doctor/Coordinator

- Responsible for health support coordination, delivery and implementation of health services to the workforces
- Ensure health specifications and programs/procedures meets Country health regulatory requirements
- Develops and coordinates the implementation of health inspection and audit programs to monitor compliance with health requirements
- Provides review of disease prevalence data and recommends changes to address disease prevalence and severity.

10.6.3 Security and Community Health Representative

- In consultation with Medical Doctor/Coordinator, identifies and evaluates community health risks
- Identifies mitigation steps to address community health issues affected by project activities
- Conducts inspections and audits for effective implementation of community health programs
- Management and coordination of security guards employed by the Project
- Management of security incidents which occur both on the Project site and outside the site
- Collects, analyses data, reports on and provides recommendations on initiatives for continuous improvement in the community health program performance and compliance.

10.7 Training and Competency

Contractors will ensure that personnel responsible for the execution of tasks and requirements in this Plan are competent based on education, training, and experience.

This CHS Plan requires training be provided to workers who may be exposed to hazards (health, safety or security) associated with Project activities. This training is part of the mitigation framework to be developed based on specific project activities and implemented by the Contractor, so it is not addressed in detail within this document. The training and increase in Project worker awareness associated with health,

hygiene and sanitation, communicable disease, sexually transmitted infection (STI) and HIV/AIDS education campaigns are a key component in minimizing health risks to the community posed by activities of the Project.

This Plan requires workforce awareness program/training be provided as part of camp initiation as well as incorporated into ongoing and regular training commitments, particularly with regard to the management of communicable diseases. This training is applicable to all Government, Contractor, sub-contractor, and Engineering personnel and will be developed and implemented by Contractors in association with the Engineer following the Government review and approval. Training will include, but not be limited to:

- Voluntary Principles for Security and Human Rights training for all Project security guards and security management, including the appropriate use of force and protection of human rights
- STI and HIV/AIDS prevention and awareness training for all workforces
- Driver training to improve driver and vehicle safety, as well as systems for monitoring and enforcement
- Road and traffic safety awareness for school children and the community leaders
- Sanitation and nutrition awareness and education for all workforces, with a focus on messages which can be taken home to families to encourage good sanitation and nutrition practices in rural settings
- Respiratory illness and infectious disease management, including TB
- Vector-borne disease awareness including Chikungunya and Dengue
- Speed restrictions in populated areas, safe driving in rural areas, safe driving in dusty environments, defensive driving and basic first aid
- Guidance for all workforces with potential occupational exposures and prevention to SARS-CoV-2
- Benefits of vaccinations and disease prevention
- Adverse impacts of Drug and Alcohol usage.

10.8 Performance Indicators

The Borrower will review and endorse indicators which will be monitored to determine the effectiveness of the Community Health, Safety, and Security impact and risk mitigation measures.

Examples of indicators may include, but should not be limited to:

- Rates of communicable disease in the Project workforce
- Rates of communicable disease in the community
- Project related safety and security incidents in the community
- Number of grievances or claims of Project related impacts on the community.

The development of risk and impact management strategies will include specific performance indicators. Indicators will be included in the monthly report of any given Contractor and the Engineer, with the aim that regular reviews for effectiveness and achievement of desired outcomes are part of the report development process. This will ensure that improvements and additional preventions can be implemented as and when required.

Project environmental assessment report should include provisions for specific community health monitoring which may be undertaken in partnership with government, NGOs, or third parties with the intent to share the data with Government or appropriate health planning and consideration by the Government.

Community health indicators may include, but not be limited to:

- Rates of Chikungunya and Dengue, and other vector-borne diseases
- Community health aspects, i.e., rate of STI's, TB, HIV/AIDS.

The Borrower may, at its discretion, audit any contractors, subcontractors, or suppliers to assess compliance with this Plan. The Borrower may also, at its discretion, undertake audits of other third-party facilities and providers associated with the Project, as relevant to the ESMP.

10.9 Monitoring and Maintenance

10.9.1 Confidentiality Requirements

Contractors will ensure health data are handled to an international standard of medical ethics. Health data is confidential to the individual and health professionals only. Contractors will assure that data is stripped of all personal identifiers before dissemination to other (non-medical) company employees or external bodies, reducing the potential for any internal or external discrimination of employees or community members. Sample size and relative risk of personal identification will need to be considered before combined health data is published internally and externally. Contractors understands that confidentiality of health data overrides any need to demonstrate vulnerability in a population, sub-population or individual.

10.9.2 Community Health Monitoring

Community health monitoring will include monitoring of exposure pathways as well as disease. Regular feedback to local communities will be important to provide evidence and encouragement for long-term adoption of positive health related behaviours.

Contractors will identify opportunities for collaboration with local governments and communities to develop or share in health data collection and reporting for the communities within the areas of influence. Data would preferably be collected and analyzed by community and gender, age and socio-economic or other health-associated status if data size allowed and is protective against confidentiality breaches.

10.9.3 Audit

Contractors will conduct an annual internal community health and safety audit to evaluate the ethical compliance, comprehensiveness and effectiveness of the Community Health and Safety Plan. Periodically the plan may be audited by qualified external auditors to verify the internal auditing.

10.10 Review and Update

The Plan shall be regularly updated, considering the following aspects, as applicable:

- Updated Project design;
- Change in project phase;
- Operational experience;
- Ongoing stakeholder consultation;
- New regulatory requirements and changed legislative framework; and
- Emerging social change and community health issues such as new communicable or non-communicable diseases.

There is no authoritative guidance on the frequency of the updates, however, in line with international best practice, yearly update would be advisable, and more often if major changes have occurred.

Responsibility for the update lies with the Environment, Health and Safety Officer, in cooperation with other departments such as the Security and Community Health Representative, and following the feedback from the GRM.

11. Rapid Cumulative Impact Assessment

11.1 Background

This Chapter presents the rapid cumulative impact assessment (R-CIA) of the proposed Jamuna River Economic Corridor Development Program, Project 1. The major interventions of Project 1 are:

- Piloting of river training with TBPG at two sites along with a total length of 3.9 km of revetment along the left banks of the Jamuna River;
  - at Bhuapur: 2.3 km of revetment (by CC Block) and five Groynes (150m~185 m each)
  - at Kalihait-Tangail: 1.6 km revetment (by CC Block) and six Groynes (80m~190m each) and 6 km dredging longitudinally traversing a sandbar/mudflat nearby
  - placement of geo-bags underwater along the protected bank and Groynes
- Erosion protection (around 6 km) of Kaoakola Char by placing sand-filled geobags on the river bank.
- Re-excavation of a 6.2 km canal in Kaoakola and construction of a crossbar across an offtake of the canal
- Installation of Navigation Aids, piloting of prototype navigation facility, institutional strengthening for improving navigation with an expectation of additional 2 million tons cargo and 5 million passengers annually by 2030

The R-CIA was conducted in compliance with ESS1 of the World Bank's ESF following the "Six-step" methodology (Figure 11.1) of R-CIA developed by IFC[88]. This R-CIA will set the scope of the CIA and a high-level guidance on preparation of the subsequent SOPs of the JRECDP. This R-CIA shall be further updated and a detailed CIA shall be conducted during the Implementation of SOP-1 when the detailed design and additional information on included projects and hydro-dynamic modelling outcome will be available.

11.2 Assumptions in the R-CIA

While preparing this R-CIA there were a number of limiting factors that restricted this R-CIA to be based on the reconnaissance survey, ESIA outputs, and desktop analysis:

- The detailed information on SOP 1 of the JRECDP was yet to be known;
- The concept of the subsequent SOP of the JRECDP was known but activity plan and detail information/design were yet to be known;
- Similarly, the detailed information on past and ongoing projects were not available. Therefore, the study mostly depends on published reports, and interviews with relevant project authorities conducted during ESIA;
- Future projects were identified by reviewing national plans and newspaper articles, and interview of officials of IAs conducted during ESIA. No detailed information, project timeline, etc. were available. Therefore, the cumulative impacts were assumed mostly based on a credible scenario of the future projects on the basis of the available project concepts, information collected from relevant implementing agencies and expert judgment.

[88] IFC, 2013. Good Practice Handbook on Cumulative Impact Assessment and Management: Guidance for the Private Sector in Emerging Markets. Available at:

https://openknowledge.worldbank.org/bitstream/handle/10986/17842/864920WP0IFC0G0IC00Department0CESPQ.pdf?sequence=1&isAllowed=y

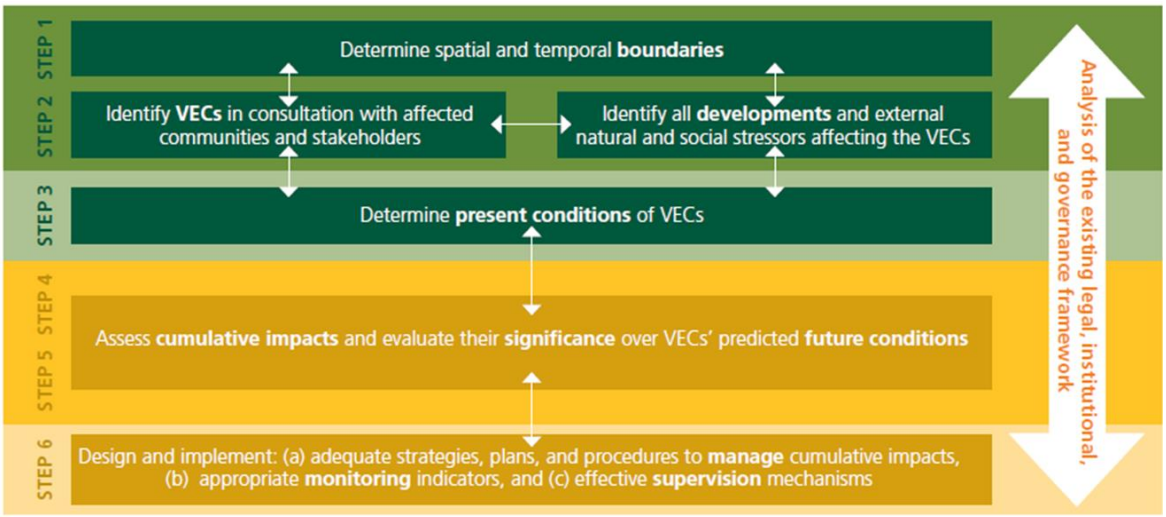
COVID-19 restricted extensive stakeholder consultation. However, an in-person workshop was organized involving relevant subject matter experts to validate the findings of the R-CIA. The discussion and feedback of stakeholder consultations conducted during ESIA were also provided important inputs for R-CIA.

11.3 R-CIA Methodology

The objectives of the RCIA are to determine:

- If the combined impacts of the project, other projects and activities, and natural environmental drivers will result in a change in VEC condition that may put the sustainability of a VEC at risk (i.e., exceed a threshold for VEC condition which is an unacceptable outcome); and
- What management measures could be implemented to prevent unacceptable VEC condition. This may include additional mitigation of the project being assessed, additional mitigation of other existing or predictable future projects, or other regional management strategies that could maintain VEC condition within acceptable limits.

The overall methodology of the R-CIA is illustrated in the Figure 11.1 that includes six steps involved in a R-CIA/CIA. This R-CIA was largely a desktop-based analysis however, the reconnaissance survey, preliminary survey and the overall ESIA provided valuable inputs to the desktop analysis. A workshop was arranged to validate the VECs and the R-CIA results with relevant experts (the list is in Annex 11.1) in November 2021. A series of stakeholder consultations (Chapter 13) were carried out for the purpose of ESIA, those findings were also very helpful for the R-CIA. Also, a standalone E&S audit was conducted with the ESIA to explore the E&S risk, E&S risk management capacity of the ongoing development programs in the Jamuna River with objectives similar to JRECDP which contributed to the desktop analysis for R-CIA. Moreover, a series of interviews were conducted with officials of IAs for the purpose of assessing the E&S risk management capacity of IA under this ESIA (Chapter 14) which helped to identify the management actions to mitigate cumulative impacts on the selected VECs.



Source: IFC, 2013. Good Practice Handbook on Cumulative Impact Assessment and Management: Guidance for the Private Sector in Emerging Markets

Figure 11.1: Six-Step Methodology of R-CIA

11.3.1 Scoping and Selection of Valued Environmental Components (VEC)

Based on the desktop analysis of Government's Plans, relevant project documents, earlier studies (e.g. ESIA and CIA of the RMIP which was a predecessor of the JRECDP but the project was not approved) , SESA reports of the ongoing largescale interventions in the Jamuna river (i.e. FRERMIP), several VECs were preliminary identified. Stakeholder consultations conducted under this ESIA (discussed in section 11.2 above) also helped preliminary identification of several VECs. The list was then screened as per the expert judgment of the R-CIA team and was validated by a transparent and meaningful consultation (workshop)

with external subject matter experts (the list of external experts is in Annex 11.1) on 29 November 2021. During the screening process, the VEC which would be negatively impacted were considered only. The Table 11.1 below lists the preliminary VECs and result of screening.

Table 11.1: Preliminary Selection and Screening of VEC

Preliminary selected VEC	Screening with relevance to JRECDP SOP 1 and cumulative implication	Conclusion
River Discharge and Environmental Flow	There are a number of external stressor that might be responsible for reducing river flow and E-flow but this VEC is not to be impacted by the SOP 1. This VEC is not relevant.	Screened out
River Flood and Erosion	"River flood and Erosion" is most important issue for Jamuna River from the perspective of hydrology, morphology and socio-economy as well. Any project which is planned for flood and erosion risk in Jamuna might bring hydro-morphological changes that might increase flood and erosion in Charlands and downstream area. The river stabilization and narrowing down by river training work is the major aim of the JRECDP and some other ongoing initiatives in Jamuna River. The SOP1 is also contributing to the preparation of the JRECDP. Such river narrowing down must be systematically planned considering the cumulative impacts of the interventions on overall flood risk and erosion risk in Charlands, downstream area and confluence area which are not generally within the Program of Project footprint area.	Screened to the R-CIA. Further rationale are discussed below the table
Water Quality	The SOP-1 might impact the VEC but the VEC is not attributed to other ongoing initiatives. Therefore, we assumed water quality will not be cumulatively impacted in this case. Furthermore, currently the water quality of the Jamuna River is not an issue like other rivers of Bangladesh, because the river basin is still mostly rural.	Screened out
Air Quality	The SOP-1 might impact the VEC but the VEC is not attributed to other ongoing initiatives. Therefore, we assumed air quality will not be cumulatively impacted in this case.	Screened out
Terrestrial Habitat and Biodiversity	The SOP-1 might impact the VEC locally, temporarily. The other ongoing and future initiatives might impact the locally. There is potential that the terrestrial habitat will be benefited by SOP-1 and other initiatives by protecting it from erosion and by reclaiming new land. The positive impacts are excluded from the scope of R-CIA at this stage.	Screened out
Aquatic Habitat and Biodiversity	The SOP -1 and the other subsequent SOPs will impact the VEC. The other initiatives are also attributed with it. The VEC is also very important because it covers KBAs, legally protected areas, and biodiversity features triggering critical habitats.	Screened to the R-CIA. Further rationale are discussed below the table
KBAs and Legally Protected areas	It can be considered as an indicator to be covered by the aquatic biodiversity VEC.	Screened out
Socio-economy	This is a very broad VEC. The Aim of current SOP1 and other SOP2 as well as other development activities is to improve the socio-economic condition. Conversely there are several E&S risks and impacts which might downgrade the overall benefits. It would be better to select more specific VEC.	Screened out
Urbanization	This VEC will be positively impacted by the SOP-1 and other development activities.	Screened out
Rural/Char Livelihoods	This VEC covers the vulnerable and disadvantageous groups. This VEC might be negatively impacted (without mitigation) by the SOP-1 and other subsequent SOPs. The other development activities also threaten the VEC.	Screened to the R-CIA. Further rationale are discussed below the table

Preliminary selected VEC	Screening with relevance to JRECDP SOP 1 and cumulative implication	Conclusion
Industrialization	This VEC will be positively impacted by the JRECDP and other development activities. The positive impacts are excluded from the scope of R-CIA at this stage.	Screened out
Regional Connectivity	The VEC will be positively impacted because the SOP-1 and other SOPs of the JRECDP are aiming for improving this VEC. The positive impacts are excluded from the scope of R-CIA at this stage.	Screened out

Three VECs were finally selected, which are – i) River Flood and Erosion, ii) Aquatic biodiversity, iii) Rural and Char Livelihoods.

- **River Flood and Erosion:** The Jamuna River flood corridor includes Alluvial Corridor, Charland, and Floodplain. All the present river management plans of Brahmaputra-Jamuna river i.e., FAP 1, BWDB 2015[89], BUET-BWDB 2019[90], IWM 2019[91] and FRERMIP[92], consider narrowing down of the river significantly (either drastically or gradually) by systematic river training work. The narrowing down by river training would reduce the riverbank erosion risk and flood risk in the mainland (within the program area), increase the depth of the river and navigability. Such narrowing down would significantly reduce the flood corridor by reducing floodplain area which might increase the risk of flooding in the downstream areas, Charlands and in the existing floodplain area. Although the current SOP 1 activities might not result any significant narrowing down of the river but it aims exploring the performance of TBPG in gradual narrowing down to inform the subsequent SOPs.
- **Aquatic Biodiversity**: Experience from other countries (People's Republic of China: Yellow River, USA: Mississippi) and in Bangladesh shows that cumulative impacts of river stabilization work on aquatic biodiversity will generally be negative (e.g., fish assemblage changes over half a century in the Yellow River). Mitigation measures (e.g., regulators, fish-passes, buoys, sanctuaries), if properly designed, constructed and operated, may diminish/reduce the extent and intensity of these impacts. Production losses from capture fisheries may be compensated by aquaculture practices, although this may not benefit fisherfolk who lose capture fisheries resources, and it does not replace biodiversity losses. Establishing additional fish- or wildlife reserves and restoring connectivity with the floodplain may mitigate biodiversity loss to some degree.
- **Rural and Char Livelihoods**: The Program Area belongs to a highly active flood plain which experiences flooding every year, sometimes multiple times. Secondary data indicates problems of under-nutrition, residual poverty, and annual livelihood shocks are dominant in Char area. Interviews during the preliminary surveys found a complex livelihood system in which the intrinsic knowledge of river flooding plays a foremost part in the decision-making processes regarding cropping, livestock rearing and the search for labor. River stabilization may improve bank erosion and flooding one hand and may erode some of the stabilized Char and reduced floodplains. People who are dependent on the floodplains and Char resources will be negatively affected, which demand a holistic approach on livelihood restoration.

[89] Feasibility Study of Capital Dredging and Sustainable River Management in Bangladesh, (BWDB, September 2015).

[90] Concept Paper on Managing Brahmaputra-Jamuna River System

[91] Brahmaputra-Jamuna Corridor Development Program

[92] River Stabilization And Development: Jamuna-Padma And Dependent Areas

11.3.2 Assessing the Cumulative Impacts and their Significance

Cumulative impacts on the three VECs were identified mostly by desktop analysis reviewing the available, ESIA reports of the project, examples of similar projects elsewhere (in a case when ESIA was not available), expert judgment and brainstorming sessions among the team members. Once the impacts were identified, the determination of impact significance was made evaluated considering the magnitude of the cumulative impact and the sensitivity of each VEC (Figure 11.2).

Magnitude of Impact	Sensitivity of Receptors			
	High (H)	Substantial (S)	Moderate (M)	Low (L)
High (H)	High **(H)**	Substantial **(S)**	Substantial **(S)**	Moderate **(M)**
Substantial (S)	High **(H)**	Substantial **(S)**	Moderate **(M)**	Low **(L)**
Moderate (M)	Substantial **(S)**	Moderate **(M)**	Moderate **(M)**	Low **(L)**
Low (L)	Moderate **(M)**	Low **(L)**	Low **(L)**	Low **(L)**

Figure 11.2: Cross-Tabular Matrix of Assessing Significance of an Impact

11.4 Valued Environmental Component 1: Flood and Erosion Risk

11.4.1 Spatial and Temporal Boundary

The spatial boundary (Figure 11.3) of the R-CIA analysis was extended to:

- Entire Jamuna River starting from Indian Border upto the confluence of Padma River (236 km)
- Section of Padma River upto the confluence of Meghna River (120 km)
- Section of Meghna River upto the estuary (115 km)

The proposed spatial boundary consists of 'Rivers, floodplains, Confluences, hotspot, and Charlands. The total length is around 471 km to cover both JRECDP AOI, the FRERMIP AOI (Figure 11.3) which are the two major investment programs in progress. Furthermore, the boundary was extended to cover the confluence of two other major river of the country which are to be affected if the entire Jamuna River would be narrowed down. In addition, a 5 km buffer was considered from each bankline to cover the floodplains. The same boundary was followed for other RCIA of other VEC as well. This boundary needs to be further updated once the hydro-dynamic modelling outcome is available.

The temporal boundary was selected as 2015 to 2038 The past temporal boundary of Flood Corridor VEC was considered as 2015 based on the trend of the river widening (Figure 5.14, Chapter 5). The river widening is highly related with the flood corridor. The analysis of river width during (1970-2020) showed that the average width of the river (equivalent to flood corridor) had been widening up to 2010 then it appeared to be stable during 2010-2020. The year 2015 was selected because, the FRERMIP program which is a large-scale development activity in Jamuna River started its implementation in 2015.

The future temporal boundary was selected considering the time horizon of the JRECDP SOP. The SOP3, the last project of the SOP, would be completed by 2037-2038. The major intervention of narrowing down would take place in 2025-2031 in SOP2, therefore, the future boundary 2038 would be reasonable to capture the impacts of SOP2.

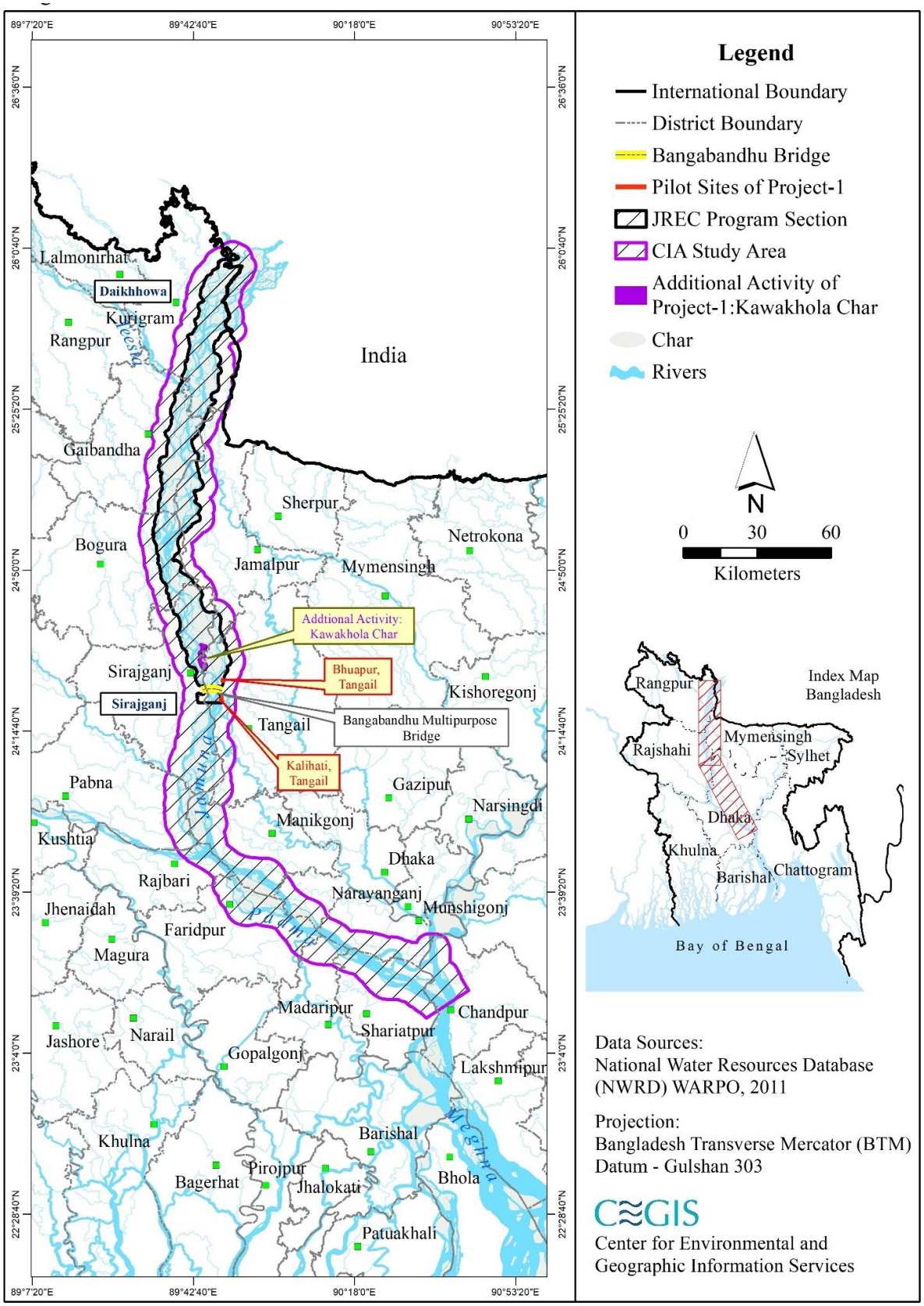


Figure 11.3: Spatial Boundary Flood Corridor VEC of R-CIA

11.4.2 Relevant Projects

There are currently seven technical assistance and investment projects worth about USD6 billion, focusing on improvement into river management. The largest is the River Stabilization and Development: Jamuna-Padma and Dependent Chars Project under Flood and Riverbank Erosion Risk Management Investment Program (FRERMIP) worth about USD3.7 billion. This is followed by the River Bank Improvement Program worth USD1.8 billion, which aims at strengthening and extending embankments on the rivers around Dhaka, focusing on flood protection, improving drainage and transportation. Bangabandhu Railway Bridge is another investment to improve capacity and safety of railway transportation by constructing a dual-gauge, double-track dedicated railway bridge worth about USD1.9 billion. Bank protection of the existing river training works of Bangabandhu Bridge (consisting of guide bunds at each abutment, approximately 3 km long and two hard points upstream- at Bhuapur on the left bank and at Sirajganj on the right bank) will be utilized. Restoration of Buriganga River by augmentation of flow in New-Dhaleswari-Pungli River from Jamuna is another project which shares the project boundary with the Kalihati pilot site. All these projects are considered in this R-CIA study. A brief description of each is provided below:

FRERMIP

BWDB has been implementing a program called Flood and Riverbank Erosion Risk Management Investment Program (FRERMIP) in partnership with Department of Disaster Management with the funding support from the Asian Development Bank and Government of Netherlands. FREMIP falls with the Project AoI (Kalihati Site).

The FRERMIP has three components –

1. Flood and River bank Erosion Risk Management (17.8 km riverbank revetment has been constructed, and further construction of 34.8 km has been planned. 21.3 km embankment has been constructed and further construction of 68.3 km has been planned)
2. Strengthened Institutional System for Flood and Erosion Risk Management: It includes institutional capacity building by training, establishing scheme inventory and mapping system, Smart Project Monitoring and Management System, and conduction of several studies for knowledge development
3. Project Management which covers the cost for technical, and logistic support to Project Implementation Unit.

Currently, the DPP of the Project 2 is at ECNEC[93] for approval. The loan (around 157 million USD) and grant (around 18 million USD) have already been approved by the competent authorities. A further description of FRERMIP is available in Chapter 3. The overall concept of the FRERMIP is illustrated in the Figure 11.4 below.

[93] Executive Committee of the National Economic Council (ECNEC) is the highest authority headed by the Honorable Prime Minister to approval the DPP of a project.

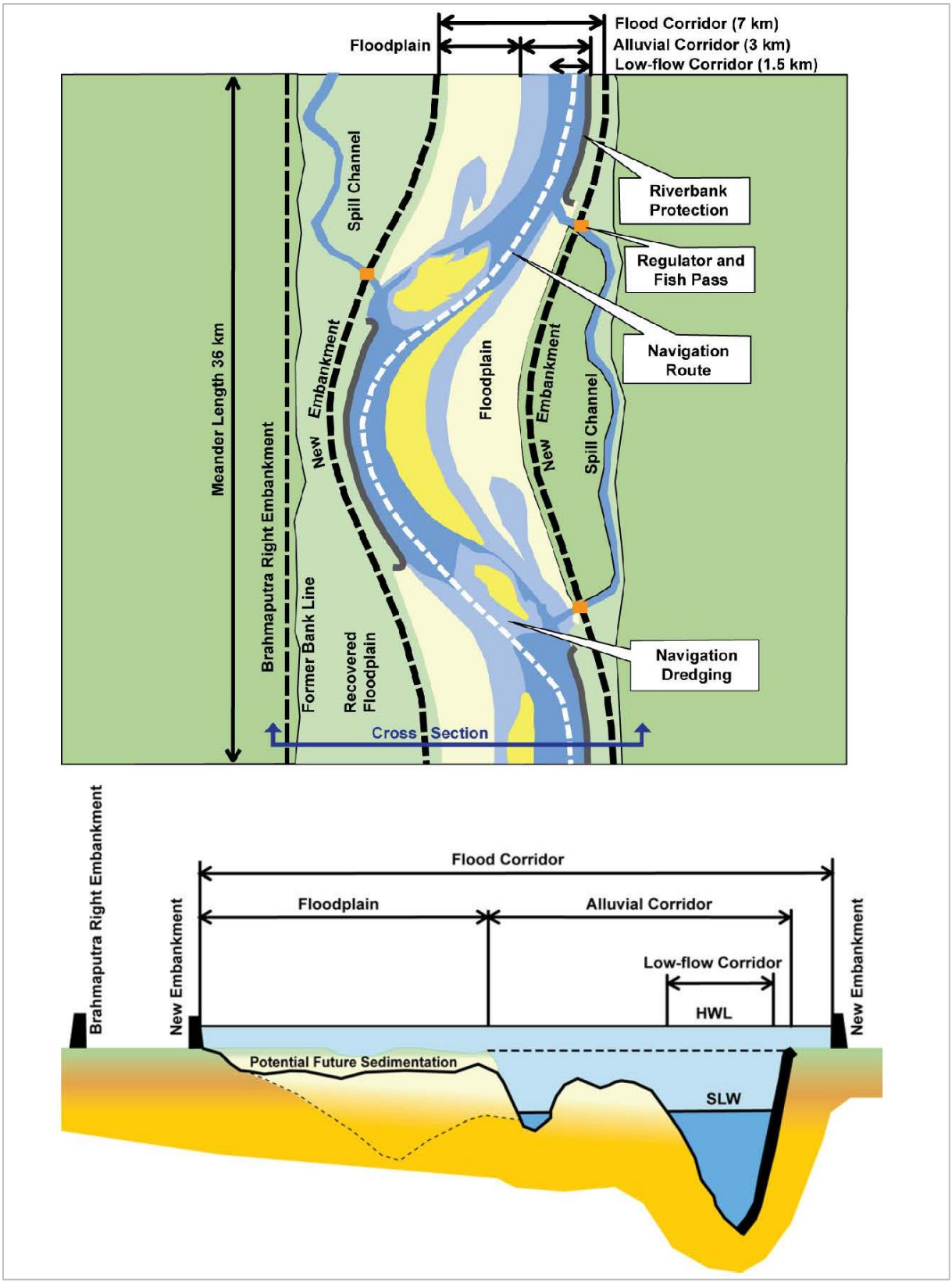


Figure 11.4: Overall Concept of the River Stabilization Plan of the FRERMIP

Augmentation of Buriganga flow by silted uplinks with Jamuna

BWDB had originally prepared a DPP entitled "Augmentation of Buriganga flow by silted uplinks with Jamuna" on the basis of a study "Feasibility & Mathematical Model Study of Approaching and Investigating

for strategy for Rehabilitating the Buriganga-Turag-Shitalakhya River System and Augmentation of Dry Season flow in the Buriganga River" in 2006 which was not approved by the Government because no financial resource was found. Later in April 2010, the government approved the revised DPP with the budget of BDT 9,440.9 million. The aim of this project is to receive 245 cumec water from Jamuna to Pungli during dry season and ultimately discharge 141 cumc flow to the Buriganga. BWDB has been implementing the project since 2010. The construction of the project is still in progress with several revision due to field condition and inadequate planning. As per the latest revision, the project budget stands at BDT11, 255, 93 million94. With the recent changes in the project components, which include: i) construction of sediment basin and guide bank at the off-take of new alignment of Dhaleswari-Pungli river; ii) dredging of new alignment of Dhaleswari – Pungli river and iii) foundation treatment of bridges on the dredging alignment, etc. Currently, BWDB is implementing a dredging operation at offtake area, and completed revetment work (guide bank) near the off-take area. The project implementation period has been extended to 173% and the budget has been increased by around 181% as per the monitoring report of the IMED. Inadequacy in planning, preparing the DPP based on older mathematical modelling study, selection of options without adequate investigations and their impacts, shifting of the river, high sedimentation, etc. were the major reasons of the long-delay of the projects. BWDB later conducted a detail feasibility study by the AVIC-ENG and CHWE and accordingly, the DPP has been revised by including several project components considering the impacts of the project on fisheries, existing bridges, sustainability, etc., which are –

- Dropping the idea of constructing regulation and fish-pass at the off-take of New Dhaleswari-Pungli river and adding the construction of sediment basin in the off-take area;
- Including the foundation treatment of the existing bridges considering the impacts of dredging on the existing bridges;

IMED has also recommend to change the location of the off-take area to further upstream to allow more flow towards the Pungli River. The physical progress (as per the monitoring of IMED) of the project is as follows:-

- 20% progress completion of river dredging by dredger,
- 7.5% progress of constructing sediment basins
- 36 % progress in protection & conservation of sediment basin
- 21 % progress in foundation treatment of bridges
- 23 % progress in operation and maintenance dredging
- 68% progress in land acquisition

Enhancement of Agricultural Productivity towards Food Security in Char Lands

The program targets ensuring food security, improving nutritional status and reducing the poverty of marginal and small farmers and their families living in the Charlands through boosting agricultural production and improving income generation.

Integrated Jamuna-Padma Rivers Stabilization and Land Reclamation Project

The concept includes stabilization of the Jamuna-Padma River corridor, reclaiming land; reducing flood risk, restoring distributaries, restoring navigation; increasing land-based productivity, and protecting the environment.

[94] IMED 2019. Final Report of the In-depth Monitoring of Buriganga River Restoration Project (New Dhaleswari-Pungli-Bongshai-Turag-Buriganga River System) (in Bangla), Implementation Monitoring and Evaluation Division, Ministry of Planning

Sustainable Restoration of Connectivity of Major Navigation Routes

The project includes improving the navigability of 24 river routes by dredging, opening up around 2,500 km of waterways for smooth and year-round plying of waterways, increasing the water flow of the respective rivers.

Bangabandhu Railway Bridge

This is an investment project under implementation. The railway bridge is about 4.8 km long, double-track, three-span continuous truss Girder Bridge located in 300m upstream of the existing Bangabandhu Bridge.

Upstream Water Diversion and Hydro-Projects

About 39 dams are constructed in Brahmaputra[95] and ten dams are currently under construction (total installing capacity is about six gigawatts: (a) Two dams in China: Pangduo and Zangmu, (b) Four dams in Bhutan: Dagachhu, Mangdechhu, Punatsangchhu-I and Punatsangchhu-II, and Four dams in India: Subansiri Lower, Lower Teesta III, Lower Teesta IV and Teesta Barrage. The stress of these upstream intervention on the Jamuna River are

- Reduction of dry season flow: The term reduces implies here that there is not sufficient water available during dry season for socio-economic activities which is an impediment to economic development of the country.
- Bangladesh perceives India's river-linking project (RLP) as the greatest potential danger to its own water security in the Brahmaputra/ Jamuna.
- A statistical analysis of data from 1997 to 2016 indicates that for 65% of the time Bangladesh did not receive its guaranteed share during the critical dry periods with high water demand.[96]
- West Bengal, India is diverting large amounts of Teesta water through its Gazaldoba Barrage during the dry season for agricultural purposes. Northwest Bangladesh has been seeing the detrimental effects of low river flow on agriculture, fisheries, and water transport in the Teesta region. In 2020, Bangladesh received roughly 300 cusecs on the Teesta in the dry season, compared with 5,500 cusecs only a few years ago.
- Poor management of upstream water resources by China, without regard to the ecosystem and water diversion in the Indian side for their own use, are seen in Bangladesh as harmful to the entire Brahmaputra basin.

Sudden release of water in the rainy season from upstream structures worsen the flood of Bangladesh.

Sandmining by indiscriminate dredging in the river

Like other major rivers in Bangladesh, the Jamuna River has become one of the major sources of construction sand. Each year local government gives permits for mining sand by dredging without any assessment of resources availability, their impacts, and sand mining technology. Such dredging does not consider the river hydro-morphology therefore, in many places such dredging increases river erosion and results embankment-failure induced flooding. Such dredging also alters the natural flow regime and Char migration.

[95]BWDB (2015); Environmental Impact Assessment Report, River Management Improvement Program, Phase I, Ministry of Water Resources, Government of Bangladesh.

[96] Rahman, Kazi & Islam, Zahidul & Navera, Umme & Ludwig, Fulco. (2019). A Critical Review of the Ganges Water Sharing Arrangement. Water Policy. 21. 10.2166/wp.2019.164.

11.4.3 External Stressor

Climate Change

The BDP 2100 baseline study on Climate change concluded that the total rainfall would potentially increase throughout the GBM basins. In the North East the rainfall increases up to 800 mm/year. The higher future rainfall is mainly caused by an increase in intensity because the number of rain days are not expected to increase. This increased rainfall would have impact on river flow. The modelling study carried out under BDP2100 indicated that the peak discharges and monsoon flow of the Brahmaputra River would increase. Therefore, there is a clear indication that in future flood will be severe.

11.4.4 Present Condition of VEC1

At present the average width of the Jamuna River (Bank to Bank) is around 12 km which includes Charlands, alluvial corridor and floodplains along the right bank of the river. The flood plain along the left bank has already been cut-off by the Brahmaputra Right Embankment. The alluvial corridor and Charlands are very dynamic due to erosion and accretion. The Brahmaputra Basin as well as the GBM basin is at high risk of flood. Each year, the monsoon water level of the river inundates a majority of the Charlands and thus these Charlands serves flood corridor services. The detail baseline condition of the river hydrology and morphology have been discussed in the Chapter 5 of this report.

11.4.5 Assessment of Cumulative Impacts

Impacts on Flooding

The SOP 1 activities alone might not result in any noticeable change in flooding in the Charlands and downstream areas. The upcoming phases of JRECDP and FRERMIP interventions are considering stabilization, channelization, eventual narrowing down of river by significantly reducing the floodplain areas which might result increase of flooding in the Charlands and the downstream stretches if the flood risk mitigation measures, adjustment of the river depth (by dredging) are not comprehensively planned and implemented. Channelization can typically reduce flooding in upstream reaches of a river system; meanwhile, lower reaches usually experience an increase in peak flood levels and have a higher frequency of flooding, unless river protection measures are in place. Since, the narrowing down would be a gradual process and the river might find its balance by deepening itself, the risk of flooding might not be increased in upstream stretches. This process would largely depend on the discharges from the upstream, the type of river training interventions in place, and the synchronization with the Outfall Rivers (i.e., Padma and Meghna). The narrowing down of Jamuna would increase the velocity which might cause early and more intense flood in the outfall areas, especially the –Jamuna-Padma confluences and the Meghna River. However, these risks are arguable and can neither be ascertained or discarded without knowing the detail master plans, strategic interventions, regional hydrological modeling results, synchronization among Jamuna, Padma and Meghna River management plans. The uncertainty postulates that there is a profound need for comprehensive study, formulation of a masterplan and basin-wide and regional hydrologic and morphological modeling study covering the Padma-Jamuna confluence and Meghna estuary.

Impacts on Erosion and Accretion

The historical morphological changes in Jamuna have led to the significant erosion of floodplain and Char land areas impacting floodplain coverages and Char dwellers. During last 47 years (1973 to 2020), about 91,520 ha of floodplain land was eroded on Jamuna due to its westward migration and widening. On the other hand, total accretion was 42,510 ha. The total area of the river has increased from 170,000 ha in 1973 to 219,010 ha in 2020. Erosion of 9,205 ha land will be prevented due to the implementation of piloting work. Through stabilization of river bank of Jamuna, Padma, and Brahmaputra a total of 170,178 ha of land

can be prevented from erosion (CEGIS 2019).[97] Therefore, cumulative impacts of all river stabilization and bank protection works will reduce the risk of flooding due to embankment failure in the protected sections of the Program area. However, bank erosion might increase in the Jamuna outfall area if no mitigation measures are implemented in the downstream stretches of Padma and Meghna. Furthermore, sedimentation might increase in the Padma River area (Jamuna-Padma confluence area) when the sediment enriched water from the narrowed down Jamuna River outfalls into the Padma River. Similarly, erosion-accession pattern in the Meghna River estuary might also be changed due to the implementation of FRERMIP. Therefore, it is deemed necessary to conduct a comprehensive assessment taking Padma and Meghna rivers and estuarine area into the considerations during the preparation of the SOP2.

If the interventions near the off-take area (e.g. New Dhaleswari-Pungli River off take) are not carefully designed, the C1 piloting and subsequent program interventions work might conflict with the Restoration of Buriganga River by enhancing the sedimentation in the off-take area. Such risk calls for detail mathematical modeling to predict the impacts of the proposed C1 piloting and subsequent interventions on the – i) new Dhaleshwari-Pungli river off take area which is located around 500 m upstream of the piloting site, ii) Dhaleswari river off-take area which is located around 2km downstream of the pilot site, and iii) off-take and confluences in the downstream stretches of the CIA boundary.

11.4.6 Significance of Cumulative Impacts

The impacts identified and discussed above were further evaluated to determine the significance. In case of the risk of rising erosion in the Jamuna River, sensitivity (of the population living along the river bank site) was considered substantial. These areas are mostly agricultural lands and settlements. The same judgment was followed while determining the sensitivity of the people towards increase of flooding. Sensitivity of the people living in the Charlands was also considered high because most of the people living in Chars are disadvantageous and vulnerable. The magnitudes of the risk of rising flooding and erosion were assumed to be moderate because of uncertainty involved in the assumption. Housing in case of risk of rising flooding in Charlands was considered substantial because of higher likelihoods. Finally, the two cumulative impacts were estimated as moderate and one as high. It is to be noted here that the contribution of the SOP-1 to these risk/impacts are insignificant because the scale of the intervention is very small.

Table 11.2: Significance of Cumulative Impacts on River Flood and Erosion

Cumulative Impacts	Magnitude	Sensitivity	Significance
Risk of rising erosion in the downstream of Jamuna River, at confluence area	M	S	M
Increase of rising flood risk in the Charlands	S	H	H
Increase of rising flood risk at the at the outfall of Jamuna – Padma confluence	M	S	M

11.4.7 Strategic and Management Action

In line with the significance of the impacts, these high-level management actions were identified which should be further assessed and evaluated during the detailed CIA when further detail information of the SOP1 and other subsequent SOPs will be available. The high-level management action can be:

- A Master Plan on the Brahmaputra-Jamuna River Management Plan should be developed which would be the basis of JRECDP. Such master plan should suggest a sustainable approach of river stabilization integrating the biodiversity management plans. Such master plan can be jointly prepared by the riparian countries, or at least jointly by Bangladesh and India. because

[97] CEGIS (2019). Prediction of Riverbank Erosion.

there should be a synchronization between river stabilization and management including dredging plan of both countries, and an agreement on E-flow

- The design of the final width of the Jamuna River should not be based on hydraulic behaviour of the River, but its ecological services and functions, its morphological dynamics and environmental requirements should also be considered.
- The design depth of the river should be synchronized with the downstream and upstream rivers. An integrated dredging plan covering Brahmaputra-Jamuna, Padma and Meghna River should be formulated. The objective of the dredging should not be only navigation. Reducing the flood risk due to narrowing down of the river should also be considered while formulating the dredging plan. Commencing physical and numerical modeling can help the overall planning and designing.
- The selection of technology for river training should be based on an alternative analysis of the current practices with the real-life experiences, results of other piloting cases, further comprehensive physical and numerical modeling. The alternative assessment should consider the technology robustness, constructability, maintenance, cost, social and resettlement, and environmental considerations.
- The government of Bangladesh should also explore opportunities of constructing reservoirs on the tributaries and distributaries of Brahmaputra-Ganges-Meghna catchment and dependent area for optimum use of water, restoring the ecosystem and biodiversity. However, in such case, careful consideration of environmental flow should be given highest priority.

11.5 Valued Environmental Component 2: Aquatic Biodiversity

11.5.1 Spatial and Temporal Boundary

The Spatial and temporal boundary of VEC 1 (River Flood and Erosion, section 11.1) were followed for R-CIA of VEC2 (Aquatic Biodiversity). The aquatic habitats and biodiversity are highly linked with the river hydro-morphology. The river area, flood plains, Charlands, mudflats, etc. are important habitats with high biodiversity values in the Jamuna River. These habitats and their ecological functions are linked with the overall hydrology. Since the boundary of VEC1 was designed based on river hydro-morphology, the same boundary is appropriate for VEC2.

11.5.2 Relevant Projects

The development activities/projects identified for R-CIA of VEC1 (section 11.4.2) are relevant for VEC2 as well, the projects were:

- Augmentation of Buriganga flow by silted uplinks with Jamuna
- Enhancement of Agricultural Productivity towards Food Security in Char Lands
- Integrated Jamuna-Padma Rivers Stabilization and Land Reclamation Project
- Sustainable Restoration of Connectivity of Major Navigation Routes
- Bangabandhu Railway Bridge
- Upstream Water Diversion and Hydro-Projects

Apart from these projects, there are several initiatives for overall management of the aquatic biodiversity which includes Dolphin Sanctuary management, Fish Sanctuary establishment, migratory birds' conservation activities, floodplain fish conservation activities, etc. These will have cumulative impacts on the overall aquatic biodiversity of the Jamuna River. Projects likely to have positive cumulative impacts were excluded from R-CIA. However, while outlining the high-level management actions, the activities of these projects were considered to ensure synchronization.

11.5.3 External Stressor

The Climate Change and Sandmining from the rive bed are two most important external stressors for aquatic biodiversity which have already been described in section 11.4.3.

11.5.4 Present Condition of VEC 2

The river section to be intervened by the project is a part of the Jamuna-Brahmaputra IBA and a government declared fish sanctuary (fishing prohibited area). There is a national park (Madhupur National Park) at 32.7 km away and two Dolphin sanctuaries at 35.8 km and 36.8 km away from the Project site. Newly emerged Charland (Sandbar), mudflats, embayment area, and the river area are the natural habitats. The braided river is a well-known habitat for Gharial. The mudflats and Charlands are also very important habitats for a number of migratory birds and water birds. The entire Jamuna River is a KBA due to its high biodiversity value. The critical habitat assessment found Gharial, Ganges River Dolphin, Fishing cat, and two fishes (*Bagarius bagarius and Chitala chitala) are triggering critical habitat criteria.* The ecosystem is highly connected with the river hydrology and morphology. Currently the biodiversity is threatened by unplanned water management infrastructures, dredging, sandmining, growth of the settlement and agricultural activities. The detailed description of the biodiversity is presented in the Annex 6.1 and Chapter 6 of the ESIA

11.5.5 Assessment of Cumulative Impacts

Fish Migration

The Jamuna is connected with many rivers and khals (canals) of which important ones are the Bangali River, the Ichamati River, the Hurasagar River, the Ghagot River, the Manosh River, the Alai River, the Dudhkumar River and the Teesta River. These rivers are connected either directly or through different khals. Many of such rivers are located beyond the study area though they might have contribution in fisheries. There are many seasonal and perennial beels which are connected with the rivers through the internal khals. This interlinked water system act as movement network for fishes and other aquatic fauna in the entire area.

The riverine fishes particularly the Beel breeders generally migrate from the river to Beel through the connected Khals or to the floodplain when floodwater overtops the river and inundate the adjacent area during monsoon. Some species of fish remain confined in the river, while some species migrate upstream of the river and some species migrate to Beels/floodplains during monsoon season.

The Jamuna River act as a longitudinal migration route for many riverine fishes. The major migratory fishes include Carps, Cat fishes and Hilsa. Hilsa (Jhatka) migrates into the Jamuna during March-May and August -September from Bay of Bengal through the Meghna and the Padma rivers (Maunsell, 2011).[98] Carp fishes migrate longitudinally to the upstream of the river and laterally to the inundated floodplains in the late dry season or early rainy season. Pile driving affects significantly the migration process of the major fish like Hilsa. During Padma Bridge construction during 2017-2018, changes in migration pattern observed during pile driving. Hilsa used other rivers to migrate to upstream due to the significant underwater noise during pile driving operation. Drifting migration of eggs and larvae occurs to the downstream or enter to floodplain with the floodwater. At the end of the rainy season, the adults and young migrate to the main river channel in order to avoid the harsh conditions of the floodplain during the dry season. Connecting canals between main rivers and other water bodies act as vital role for maintaining successful fish migration.

The bank protection works in BRE, Jamuna, Padma and Meghna rivers have historically blocked the fish migration routes between the rivers and its floodplains. The proposed bank protection works under

[98] Maunsell (2011). Environmental Impact Assessment Report, Padma Multi-purpose Bridge Design Project, Bangladesh Bridge Authority, Government of Bangladesh.

JRECDP along with other planned and future works in the Project AoI has the potential to cause barriers for the lateral migration of fish and other species. The upstream dams and barrages can prevent longitudinal migration of the fish species.

Fish Habitats

The Jamuna is a braided and multi-channel river evolving sand bars (Chars) in the mid-channel and also on the bank sides. There is a much interaction of sand bars/Chars with fisheries. Char dynamics and its development is closely related to the river bank erosion processes and linked to the trends of widening and narrowing of rivers. Deep water area, shallow water areas, submergible Chars and embayment are important fish habitats. Among them, the embayments and the submergible Chars function as grazing and nursing ground for small indigenous species (SIS) of fish including *Ailia punctata* (Banshpata), *Ailia coila* (Kajuli), *Eutropiichthysvacha* (Bacha), *Mystuscavasius* (Golsha), *Clupisomagarua* (Gharua), *Glossogobiusgiuris* (Baila), *Salmostomaacinaces* (Chela), *Gudusiachapra* (Chapila) etc.

The proposed JRECDP SOPs and the ongoing FRERMIP, both have the long-term goal of narrowing down of the Brahmaputra -Jamuna River which would provide bank protection measures with innovative technologies and ultimately result in reduction of floodplain areas, especially the submergible Chars, embayment areas and shallow water zone. In addition, the natural habitats in close proximity to the bankline, floodplains and Chars will be modified due to the bed and slope preparation with geobag and concrete block placements, flow reflection, and eventual erosion of the Chars. The existing habitats are suitable for specific fish species, like *Ailia punctata* (Banshpata), *Ailia coila* (Kajuli), *Eutropiichthysvacha* (Bacha), *Mystuscavasius* (Golsha), *Clupisomagarua* (Gharua), *Glossogobiusgiuris* (Baila), *Aspidoparia Morar* (Piyali) *Salmostomaacinaces* (Chela), *Gudusiachapra* (Chapila), such reduction of floodplains and habitat modifications might lead to disappearance of these species. These of these small fishes serve an important ecological functionand rheir decline might impact the fishes and other species located in the upper level of the food chain.

Fish Spawning

In 2018-19, Department of Fisheries (DoF, 2019) identified 24 major carp spawn collection sites in Jamuna River. Among the sites, 22 sites fall in Sirajganj District and 02 sites fall in Pabna District as presented in Figure 11.5 and Table 11.3. Presence of the spawn collection activities denote the existence of major carp, catfish and chital breeding grounds in Jamuna River. In 2018-19, a total of 952 kg spawn was collected from different spawn collection spots. There might be cumulative impacts of the FRERMIP, JRECDP and other ongoing river management activities on these spawning habitats. The river narrowing down might reduce these areas suitable for spawning area of major carp.

Table 11.3: Carp Spawn/Fertilized Egg Collected from Jamuna River in 2020

District	Upazila	Collection Centre	Collection Period	Frequency of Spawning Time	Spawn Collected (kg)
Sirajganj	Sirajganj sadar	Vatpiary, Panchasona, Hatboyra, Shimla, Soyasekha	May to June	2	177
	Shahjadpur	Sonatali, Belotia, Tarotia.	June to July	3	36
	Chauhali	Khashkaolia, Basotia, Gorjan, Omarpur	June to July	2	400
	Belkuchi	Khiramatia, Delua, Thakurpara, Jangalia	June to July	3	157
	Kazirpur	Magai, Khudbandi, Shingrabari, Shuvagacha	May to June	3	179
Pabna	Bera	Raksha, Nagarbari	May to June	2	138
				Jamuna Total	**1087**

Source: DoF, 2020 (FRSS, 2019-20)

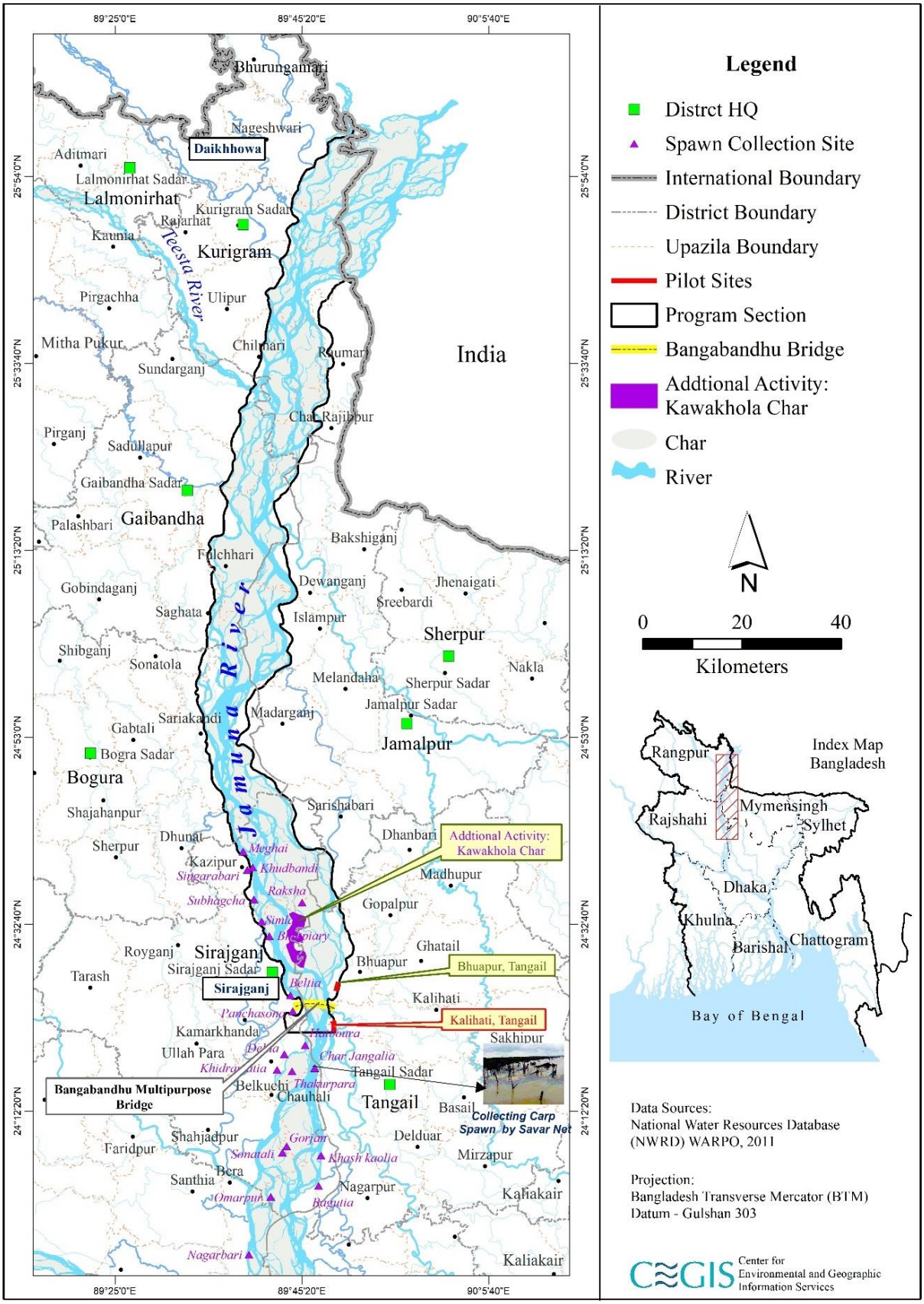


Figure 11.5**: Spawn Collection Sites in Jamuna Near the Pilot Sites**

Wildlife Habitats and Biodiversity

The diversified habitats of the Brahmaputra-Jamuna River are the key to the occurrence of a rich biodiversity. There are scientific evidences of occurring Ganges River Dolphin (VU), Gharial (CR), Dolphin, Narrow-headed Soft-shell Turtle (CR), Black-bellied Tern (CR), Painted Stork (CR), Indian Spotted Eagle (EN), Ganges Softshell Turtle (EN), and Fishing Cat (EN) in Jamuna River which make the Jamuna River including its Chars, floodplain, submergible Chars, alluvial zone, mudflats and grasslands, incredibly important national and global biodiversity.

The cumulative impacts of the proposed interventions along with the upcoming phases, FRERMIP, other ongoing development activities and the current threats to the ecosystem would be very significant if those programs are not carefully planned and giving due diligence to the biodiversity management. Although the proposed phase 1 activities are minimal, the upcoming phases of the JRECDP and the FRERMIP would result gradual narrowing down of the Jamuna River by reducing the floodplain areas including the submergible Chars, and mudflats areas which are important habitats for biodiversity. Improvement in navigation will attract more inland water transport traffic and heavy construction may impact aquatic mammals. There is also a future plan of developing economic zones in the reclaimed lands which might have further impacts on the biodiversity. The increase of construction activities and the induced development would increase the anthropogenic pressures and threats on biodiversity as well if the mitigation measures and biodiversity management plans are not carefully designed and implemented. This calls for further study for developing mitigation plans and biodiversity management plans during the subsequent JRECDP SOP activities.

11.5.6 Assessment of Significance

The significance of the cumulative impacts was evaluated based on expert judgment and was driven by concepts, and preliminary plans of the development activities. The assessment indicated substantial to moderate impacts on the VEC2. However, the contribution of the SOP1 to this impact is low because the scale of the project is only to support the upcoming SOPs.

Table 11.4: Significance of the Cumulative Impacts on VEC: Aquatic Biodiversity

Cumulative Impacts	Magnitude	Sensitivity	Significance
Reduction of Fish Habitats and Spawning area (e.g. mudflats, embayment, shallow water zone, floodplain)	M	S	M
Impacts on Fish Migration (longitudinal and lateral)	S	S	S
Loss of aquatic biodiversity (especially Turtle, Dolphin, Reptiles, etc.) due to reduction of mudflats, embayment, shallow water zone, floodplain area	M	H	S
Disturbance to migratory birds	M	S	M

11.5.7 Strategic and Management Action

To address the cumulative impacts associated with the future activities, like, pile driving, slope and bed preparation, geobag placements and other construction activities, and the upcoming projects of the JRECDP it is recommended that future ESIA conduct more comprehensive assessments on the impacts on biodiversity for the entire CIA area. Mitigation included in the ESIA requires contact to be made with authorities of the Jamuna River dolphin sanctuaries and fisheries authorities to address expected impacts. Establishing appropriate contact presents an important step towards understanding future impacts and identifying solutions to upcoming projects of the JRECDP.

Currently, selective studies are available for specific locations only in Jamuna-Brahmaputra River System. Lack of comprehensive data and continuous monitoring to track important species population is a bottleneck for any fruitful recommendations. Therefore, the following recommendations are made for further assessment:

- Conduct an encounter, abundance and habitat survey for important species in the entire program area during implementation of the SOP 1 to support the SOP 2 ESIA so that biodiversity offset can be planned if necessary. These important species include: (a) Ganges River Dolphin (*Platanista gangetica*), globally Endangered; (b) Gharial (*Gavialis gangeticus*), globally and nationally threatened species; and (c) Gangetic Softshell Turtle (*Nilssonia gangetica*), nationally endangered; (d) Narrow Headed Shoftshell Turtle (*Chitra indica*) nationally criticlcal and globally Endangered. (e) Black-bellied Tern (*Sterna acuticauda*), nationally critical and globally Endangered. The species list is indicative only.
- The Biodiversity Management Plan (BMP) for the SOP 2 of the JRECDP should consider proposal for establishing wildlife sanctuaries in several Charlands and selective areas within the program area suitable for the specific species. The ESIA of FRERMIP similarly proposed establishment of wildlife sanctuaries (aquatic), fish sanctuaries, etc. Therefore, while preparing such BMP during the SOP 2 ESIA, synchronization with FRERMIP and similar conservation activities in the upstream countries, institutional integration for efficient and effective management of the sanctuaries and protected area should be considered. Such institutional arrangement also calls for permanent capacity development of E&S risk management of Implementing Agencies.
- The engineering design of bank protection work, off-take and out-fall structures should consider fish ladders and passes to facilitate lateral fish migration between rivers and floodplains, to maintain the same productivity of floodplain fisheries. This will be further studied during SOP 2 ESIA.
- Since Dolphin abundance was observed in the main channel of Jamuna River, pile driving activities for Groyne construction in the pilot sites and scale-up activities in Project 2 should be scheduled in such a way, so that piling does not affect the courtship and mating periods of August to December.
- Provide technical and financial support to the existing fish sanctuaries (Char Pouli, Tangail to Durga Temple; Mukundi, Sirajganj to China Dam-03; Char Pouli, Tangail to Mukundi; and Durga Temple Tangail to Kalia) and fish catch prohibition initiatives of the government[99] in the Program area and establish more fish and dolphin sanctuaries in Jamuna. Conduct a detailed biodiversity study in the entire CIA study area in Project 2 to identify suitable areas of sanctuaries and their management.
- The FRERMIP is considering to establish a number of wildlife sanctuary in some Chars and river area. Further study is needed to explore the opportunity of synchronization and to explore how such sanctuary can benefit aquatic biodiversity of the entire Jamuna. The SOP 2 and 3 should consider establishment of sanctuary in synchronization with the FREMIP.
- A comprehensive fishery development program can be studied during Phase 2 ESIA for the restoration of floodplain habitat through re-excavation of khals and beels, artificial stocking of fingerlings and capacity building of fishers for sustainable harvesting and developing marketing facilities. All these activities are expected to increase the fish production in the Jamuna and restore the fish habitats.
- Fulchari area, Gaibandha has been an important area for several recent (2019, 2020, 2021) captures of gharials. The area needs intensive study to look for any nesting sites for gharials. Transmitters may be fixed or implanted on the captured gharials for long-term study on their movement. The location can be ascertained once the baseline survey is done and duration can be determined after the assessment in Project 2.

[99] Fish catch is prohibited during the entire year in these fish sanctuaries, Rule 19, Protection and Conservation of Fish Rules, 1985 (amended in 2021)

- Freshwater softshell turtles nest on the sandy river banks and Char banks. Intensive survey and monitoring needed to search and identify freshwater turtle nesting sites.
- Adequate intervals between engineering structures (gryones, etc.) along the river banks allowing the aquatic animals (fishes, turtles, terrestrials animals using river banks like fishing cats, otters, etc.) use the river fore-shore and bank area.
- Ecological niche modeling (ENM) can be a useful tool in Cumulative Environmental Impact Assessment (CEIA) studies for conservation planning of threatened biodiversity. This will allow to estimate the species potential environmental niche and distribution areas by overlaying the impacts and drawing a potential impact map that will indicate that project activities and other threats might deteriorate the habitats thereby affecting the population of the species.

11.6 Valued Environmental Component 3: Char Livelihood

11.6.1 Spatial and Temporal Boundary

Since flood and erosion risk is the major socio-economic issue directly linked with the livelihood of the people living in the Jamuna as well as the GBM basin, the R-CIA followed the same boundary defined for the VEC-1 (Flood and erosion risk).

11.6.2 Identification of Relevant Projects

The projects identified for RCIA of VEC-1 are also relevant to VEC-3.

11.6.3 Identification of External Stressor

Climate change is an external stressor for VEC3, see Section 11.4.3

11.6.4 Present Condition

People living in the Jamuna River flood plain are highly vulnerable to flooding and erosion. The region is also recognized as an area with high poverty. Historically they have been adjusting and adapting their lives and livelihoods in response to flooding. The annual monsoon flood is considered as a blessing to make their land cultivable but the extreme floods also cause widespread damage. The livelihoods of the people living in Jamuna River floodplain are highly vulnerable to river erosion as well. River bank erosion and flood make their livelihood at continuous risk of displacement. As reported in the 2014 RMIP Study[100] conducted among the people on the right bank of the Jamuna River from Sirajganj to Gaibandha, 86% of those surveyed had experienced displacement caused by erosion. Since 1964, the government is taking several structural interventions to manage the flood and erosion risk. The lives and livelihood and overall socio-economic condition of the people living in the mainland and Chars of Jamuna were discussed in the Chapter 7 of this report.

11.6.5 Assessment of Cumulative Impacts

There is a strong correlation between the flood and erosion vulnerability and the current livelihood status. The frequent displacement, migration and resettlement contribute to poverty among the Char people. Poverty rates are very high in Char areas in the country, particularly in the northern part of the Teesta-Brahmaputra reach. The major objectives of the JRECDP, FRERMIP and other ongoing development includes enhancing disaster resilience and thereby enhancing prospects for economic development with a better and more secured future. However, the main focus of these program is on the livelihoods' development in the mainland with limited or no attention to the Chars. The Charlands are generally

[100] RMIP Vol. 2 cited earlier.

excluded from flood management and erosion protection plans. The major aim of the JRECDP and FRERMIP is also on bank stabilization to protecting the river banks. Increased flood risk in Charlands area is often considered as acceptable risk. Thus, there is a high risk of exclusion of Charland inhabitants from the benefits of the programs. Although the FRERMIP considered flood and erosion management infrastructures for a limited number of Chars, but those are less prioritized. The Charlands in general are more susceptible to changing course of the river. Unless Chars are protected, their inhabitants will be at a greater risk due to the implementation of the programs, hence, livelihood may be seriously impacted. However, at this stage it is not possible to assess which Char will be affected and their extent. This will be available once hydrodynamic modelling is completed.

The landownership of the people living in the Chars is another complex issue. In most of the Chars the land rights have not been settled by the government. Therefore, any kind of land acquisition in the Charlands area for the purpose of the development activities is considered to be of high social risk.

11.6.6 Assessment of Significant of the Cumulative Impacts

As indicated in Table 11.5, the overall significance of the cumulative impacts on the VEC3 is assumed to be substantial. However, the contribution of the SOP1 to this cumulative impact is low because of it's scale of the project footprint.

Table 11.5: Significance of the Cumulative Impacts on VEC: Aquatic Biodiversity

Cumulative Impacts	Magnitude	Sensitivity	Significance
Risk displacement of people living in the Chars due to increased risk of flood and erosion	M	H	S
Risk of exclusion of People Living in the Chars from Benefits of the Programs	M	H	S
Risk of displacement due to land acquisition	M	H	S

11.6.7 Strategic and Management Action

The following high-level management actions have been outlined which should be considered during the preparation of the SOP2 and future subsequent project.

- **The master plan of Jamuna River stabilization** needs to take into account the disaster risk of the Charlands area into the consideration. The gradual river narrowing down should be planned and designed in a way which would not increase the disaster risk in the Charland areas. The overall master plan should also consider the relocation and resettlement of the population living in the Chars subject to increased disaster risk. There should be a land zoning and regulation to guide the induced development, to prevent the growth of settlement in the vulnerable area, and to facilitate sustainable growth of settlement in the planned area. Such land zoning and regulation are also needed for protecting the agricultural and settlement area from unplanned industrial and infrastructural development.
- **A comprehensive Disaster Management Strategy** should be adopted including designing and implementation of shock responsive social protection system, disaster insurance system for the people living in the vulnerable area and the area to be vulnerable due to the proposed programs. A combination of infrastructure support and resilience enhancing initiatives/programs can ensure sustainable riverbank erosion management.
- **The financial protection of Critical Infrastructures** (embankment, revetment and Groyne in this case) should be in place. The design benefits outcome of the program and largely depend on the sustainability and functioning of the proposed interventions. Sustainability and effective functioning of these infrastructure depend on the effective emergency operation and maintenance and quick rehabilitation if damaged by flood or erosion. Inadequate maintenance, delayed recovery from disaster damage are common scenario in Bangladesh.

Therefore, these infrastructures should be financially protected by either insurance or emergency repair and disaster recovery fund or any other form of Disaster Financing Solution.

- **Institutional Strengthening for E&S Risk Management** must be in place which should consider a permanent capacity of E&S Risk Management for Implementing Agencies. The achievement of social resilience by the proposed program requires careful consideration of E&S risk management in planning, implementation and operation.
- **A Livelihood Restoration and Development Program** should be in place. Char Livelihood Program (CLP) funded by DFID, supported 133,026 extreme poor families in ten districts through eighteen partner NGOs in two consecutive phases: Phase one: 2004–2010 and Phase two: 2010–2016. The program achieved a good deal of success and generated useful learning experience for future work in reducing poverty in such remote areas in Bangladesh. Another example of a very practical and innovative program called "sandbar cropping" in the Chars in the north-western/Gaibandha area is helping poor farmers displaced by river erosion in producing food crops like pumpkin on transitional river beds or Chars.[101] Over two-thirds of the beneficiaries of the sandbar cropping are women in the Chars. Further, the pumpkin cultivation has led to empowerment of women/stakeholders in the Chars in Gaibandha area. Similar programs can be taken in JRECDP. Considering the impacts stated above, the objectives of the **livelihood program** should be two-fold: (a) short-term to mitigate any adverse impacts due to project interventions (e.g., compensation for loss of income, wages and/or access to work) and enhanced employment opportunities in project civil work and/or supporting activities; and (b) mid- to long-term plan focusing on increasing income and livelihoods through improved productivity of existing crops and livestock, skill building to diversify livelihoods, and better marketing and linkages of products to market. Several NGOs, including Chars Livelihood Program (CLP), have successfully addressed livelihood programs in Char villages in the program reach area using agriculture and skill training as with their main strategies.[102]
- **Annex 12.2** Includes a ToR for contracting NGO/Social Consulting Firm to design a Livelihood Restoration Plan for SOP1. Such LRP can be upscaled during the subsequent SOPs which would have substantial contribution to the cumulative impacts on the VEC 3.

[101] AZM Nazmul Islam Chowdhury, Sandbar Agricultural Technology and Innovation in Chars. In M. Zaman and M. Alam (eds) *Living on the Edge: Char Dwellers in Bangladesh*, Springer 2021.

[102] Muhammad Lokman Hossain, the Chars Livelihoods Programme: Experience and Learnings. In M. Zaman and M. Alam (eds) *Living on the Edge: Char Dwellers in Bangladesh*, cited earlier.

12. Environmental and Social Management Plan

This chapter describes the environmental, health, safety, and social management plan (ESMP) of the Project. This Chapter is prepared based on ESMP implementation practices in other World Bank funded projects in the region and other good international industry practices. The ESMP will be updated and finalized when the detailed design of the pilot river trainings and navigational aid components are conducted or completed.

12.1 Objectives of ESMP

The basic objective of the ESMP is to manage adverse risks and impacts of proposed project interventions by applying a mitigation hierarchy that would avoid, minimize and mitigate these risks and impacts on the environment, workers, and community during construction and operation stages of project. Where significant residual risks and impacts remain, compensation/offset will be applied. The specific objectives of the ESMP are to:

- Facilitate the identification and implementation of the mitigation measures following the mitigation hierarchy.
- Maximize potential project benefits, mitigate negative impacts and control risks;
- Address occupational and community health and safety hazards and corresponding control measures during construction and operation stages;
- Identify responsibilities for implementing agencies (BWDB and BIWTA), contractors, consultants, and other members of the project team for the environmental, health, safety, and social management of the Project; and
- Define a monitoring and supervision mechanism and identify monitoring and inspection parameters to:
    - Ensure the complete implementation of all mitigation and control measures,
    - Ensure the effectiveness of the mitigation and control measures;

12.2 Contractors Certifications

All contractors procured under the Project shall be compliant with ISO 9001 Quality Management, ISO 14001 Environmental Management and ISO45001 Occupational Health and Safety Management certifications. This will be done imposing the requirements of ISO certifications during prequalification or technical evaluation of contractors. In addition, all subcontractors under the major contractors will also be subject to ISO 14001 and ISO45001 audit provisions by the main Contractor(s) during the the Project.

12.3 Various Mitigation and Control Measures

The ESMP includes different types of mitigation and control measures and subplans for significant impacts and risks: (i) general and non-site-specific measures in the form of environmental and social codes of practices (ESCOPs) presented in Annex 9-1 to address general construction and operation matters identified as medium and minor/low in significance prior to mitigation and prevention in Table 7.5 and Table 7.10; (ii) project specific and to the extent possible, site-specific mitigation measures discussed in Chapter 7 and summarized in Table 7-4; (iii) construction environmental and social action plan (CESAP) with site-specific and contract-specific management plans to be prepared by the Contractors; (iv) OHS Management System Processes and Standard Operating Procedures to be prepared by the Contractors; and (v) proposed ESMP Sub-plans to address significant project level and cumulative impacts.

12.3.1 Environmental and Social Code of Practices for Construction

The environmental and social codes of practice (ESCOPs) are generic, non-site-specific guidelines for the construction phase. The ESCOPs consist of environmental and social management guidelines and OHS practices to be followed by the contractors for sustainable management of all environmental, social, health and safety issues. The ESCOPs are listed below and details are presented in **Annex 12.1**.

- ESCOP 1: Waste Management
- ESCOP 2: Fuels and Hazardous Goods Management
- ESCOP 3: Water Resources Management
- ESCOP 4: Drainage Management
- ESCOP 5: Soil Quality Management
- ESCOP 6: Erosion and Sediment Control
- ESCOP 7: Topsoil Management
- ESCOP 8: Topography and Landscaping
- ESCOP 9: Quarry Areas Development and Operation
- ESCOP 10: Air Quality Management
- ESCOP 11: Noise and Vibration Management
- ESCOP 12: Protection of Flora
- ESCOP 13: Protection of Fauna
- ESCOP 14: Road Transport and Road Traffic Management
- ESCOP 15: Construction Camp Management
- ESCOP 16: Cultural and Religious Issues
- ESCOP 17: Workers Health and Safety
- ESCOP 18: Construction and Operation Phase Security
- ESCOP 19: Operation of Heavy Equipment Management
- ESCOP 20: Excavation
- ESCOP 21: Lifting and Material handling
- ESCOP 22: Dredging and Disposal

12.3.2 Construction Environmental and Social Action Plan

The Contractor will prepare a 'Construction Environmental and Social Action Plan' (CESAP) demonstrating the manner in which they will comply with the requirements of site specific management plans, ESCOPs and the mitigation measures proposed in the ESMP of this ESIA Report. The CESAP will be submitted within 90 days of Contractor's mobilization but before commencing any works and will be approved by the Engineer. The CESAP will form the part of the contract documents and will be used as monitoring tool for compliance. Violation of the compliance requirements will be treated as non-compliance leading to corrective actions or otherwise imposing a penalty on the contractor.

12.3.3 Occupational Health and Safety Plan

Contractors will also prepare an occupational health and safety plan devising the general guidelines for the identified hazards and control measures along with the OHS Management Processes and Standard Operating Procedures presented in Chapter 9 of this ESIA. World Bank General Environmental Health and Safety Guidelines, Chapter 2: Occupational Health and Safety, 2007; Bangladesh Labour Act 2006 and as amended in 2013; and ILO Code of Practices 1992, Safety and Health in Construction Industry; and Safety and Health in Building and Civil Engineering Work, ILO Codes of Practices. If the guidelines stated before

cannot address a specific OHS management in the project, Good International Industry Practices will be applied, as for example, OSHA, etc. Review and update of the OHS plan will be done (a) when there is a change in the scope of the project, (b) there is a change in construction methodology/technique based on site condition, (c) following significant OHS hazard or a major accident, and (d) at the end of the Project (to allow for improvements in subsequent projects).

The OHS Plan should contain general guidance for all identified hazards under each work activities. It also contains management system processes and standard operating practices. Processes and SOPs should be presented in three discrete headings, (a) Contractor's Standards on the identified hazard management, (b) Expected Site specific OHS hazard and risks during construction, and (c) Control Measures proposed by the Contractor.

12.4 Job Hazard Analysis

Job hazard analysis (JHA) will be conducted for each construction component focusing on job tasks to identify hazards before they occur. It will focus on the relationship between the worker, the task, the tools, and the work environment. Ideally, after identifying uncontrolled hazards, steps should be taken to utilize hierarchy of control: elimination, substitution, engineering controls, administrative controls and personal protective equipment, to minimize them to an acceptable risk level. Many workers are injured and killed at the worksite every day. The JHA should be one of the major components of the larger commitment of the Contractor's health and safety management system. The JHA should be conducted on many jobs in the worksite. Priority should be given to the following types of jobs:

- Jobs with the highest injury or illness rates;
- Jobs with the potential to cause severe or disabling injuries or illness, even if there is no history of previous accidents;
- Jobs in which one simple human error could lead to a severe accident or injury;
- Jobs that are new or complex to the construction or have undergone changes in construction processes and procedures; and
- Jobs complex enough to require written instructions.

12.5 EHS in Method Statement

The Contractor will include an EHS Chapter in each Method Statement. This EHS section will be based on the JHA and environmental and social issues of the site and specific to construction methods to be followed by the Contractor. This section will be reviewed by the EHS Specialists of the Engineer/Construction Supervision Consultant (CSC) and confer approval along with other technical parameters to be reviewed by the engineering team of the CSC. Each revision of the method statement should also be reviewed by the EHS Specialists and their concurrence will be required to get them approved.

12.6 Request for Inspection

Poor temporary structures such as scaffold, stairs, and ladders are one of the major causes of the accidents in construction industry. For technical verifications of the temporary structures, specifications in the bidding documents define the material, stability, strength and deflections of each temporary structure. However, this clause is often ignored in construction industry as the main focus is the permanent structures. Therefore, a Request for Inspection (RFI) for temporary structures will be required, as a pre-requisite for the readiness of site. Along with the technical requirements (e.g., complete drawings, calculations relating to stability, strength, and deflections), health and safety parameters will also be inspected for all temporary structures. During these RFI, both technical and EHS personnel of the CSC will inspect the requirements and certify the technical quality and the readiness of the site to commence the work.

12.7 Field Engineer's EHS Oversight

There will be limited supervision staff available in EHS to cover all project sites and project shifts in the project. Therefore, it will become impossible to supervise and monitor EHS parameters in every site in a continuous basis. Therefore, site engineers can be delegated certain EHS oversight. Engineers monitoring forms including RFI and Daily Monitoring Forms (DMF) and checklists will be designed to include EHS aspects. EHS should be made also a key responsibility of site engineers.

A training program will be devised by CSC on engineers' oversight in EHS and will be offered by EHS specialists of CSC to address EHS immediately when identified and raise it to EHS specialists if further action is required. The training on engineers' oversight should convey the following messages:

- Engineers will assume greater responsibility for overseeing the EHS as part of their daily routine work,
- Engineers would review and approve each site's readiness to commence the work as per the design specifications, certifying whether Contractors are meeting the requirements of the Method Statements, and withholding funds from them that are not complied with.
- Engineers would impose financial penalties on the Contractor with nonexistent or non-compliant EHS matters; and
- Engineers will assist workers in recognizing environment friendly and safe work measures and procedures necessary to protect the natural environment and occupational health and safety of workers and prevent illnesses, injuries and fatalities during construction.
- Engineers will maintain the safety statistic and performance and report to higher authority/PIU regularly

12.8 Inclusion of Relevant Components of ESMP in Contract Documents

The relevant measures in the ESMP of the Project along with the ESCOPs and occupational hazards and risks will be included in the contractors' bid documents. The technical specifications of the bid documents will clearly state that contractor will need to comply with the mitigation and control measures provided in the ESMP, ESCOPs, OHS Plan, World Bank Group EHS General Guidelines and NEQS.

12.8.1 BOQs in Bidding Documents

The following items will be included in the bills of quantities (BOQs) of bidding documents

- After the award of any given contract and before mobilization, the Contractor awarded the work will prepare and submit two separate plans, CESAP and OHS Plan in compliance with ESMP, WBG EHS Guidelines and NEQS and in accordance with international best practice. The preparation and their revisions and updates will also be quantified and presented as line items in the Contract.
- Quantities of personal protective equipment (PPE), first-aid boxes, ambulance, and health care facility with Bangladesh Medical Association licensed doctors and nurses.
- Provision of Environmental and OHS Staffs for the entire construction period. Detailed staff requirements are presented in Chapter 14.
- Providing and maintenance of Dust Measurement Meters for spot measurements (5 number).
- Quarterly 24-hour Air Quality Monitoring PM10, PM2.5, NO2, SO2, CO2, CO.
- 15 minutes continuous noise monitoring at 2 pilot sites close proximity of settlements and nearby biodiversity sensitive area (i.e, Dolphin habitat, migratory birds habitat) during the construction work.
- Pile Driving Plan that would be river dolphin-sensitive and other aquatic mammals-sensitive following JNCC Guidelines

12.8.2 Payment Milestones

Payments to contractors will be linked to environmental, health and safety performance, measured by completion of the prescribed environmental and social mitigation measures in the CESAP and control measures described in the OHS plan. In addition, for any non-compliance causing damages or material harm to the natural environment, workers, public or private property or resources, the contractor will be required to either remediate / rectify any such damages in a timeframe specified by and agreed with the engineer (CSC), or pay IAs for the cost (as assessed by Ias) of contracting a third party to carry out the remediation work. For repeated non-compliance the Contractor will be penalized. The penalty of non-compliance of the requirements of the CESAP and OHS Plan will be 3% of the total Civil Works in the Instruction of Payment Certificate (IPC). The penalty will be imposed after all contractual instruments are applied and a Non-compliance Report (NCR) is issued by the Engineer.

12.9 Environmental Management Plan

The impact assessment predicted environmental impacts and risks during the construction and operation/post-construction period ESMP is covered by ESCOP described in the Annex 12.1. To support the ESMP implementation, a Mitigation Plan for construction and operation period has also been developed and presented in Table 12.3 and 12.4. The Environmental and Social Management Framework of the Additional Activities are provided in Appendix 1.

12.9.1 River and Floodplain Management

The proposed TBPG and dredging at Kalihati site would contribute to dynamism of the river planform especially at Tangail-Kalihati reach and its downstream. The following strategic and management measures should be considered for managing the risk of any drastic change in the river planform:

- The PIU should develop a detailed plan and design of the TBPG and dredging alignment based on hydro-dynamic modeling and morphological study.
- The length, angle, and flow-bandling part should be designed carefully to avoid any abrupt change or drastic narrowing down of the river.
- The dredging alignment, and requirement should be fixed based on historical morphological analysis of the river reach and possible impacts on bar migration in downstream areas.
- While deciding the dredging requirement, sustainability of dredging, its purpose, and minimum risk of erosion in downstream areas should be studied and ensured.
- Effective monitoring of river morphology, erosion-accretion, hydrological parameters is therefore needed during pre-construction, construction and operation phases. A robust monitoring system/arrangement must be deployed for the pre-construction stage.
- There is an opportunity of involving local people in the Operation and Maintenance of the embankment and revetment. As per the Participatory Water Management Rules 2014, the implementing agency must transfer the ownership of the project to the local community through a process of participatory water management.
- Participatory water management approach will help to manage any residual flood and erosion risk, risk of false sense of security[103], and to improve sustainability of the proposed water management infrastructure.
- In general, the river stabilization plan should be prepared taking the "Room for River concept" into consideration.

[103] It has been detailed out in the Chapter 8, section 8.9.2.

12.9.2 Ship Pollution Management during Operation Phase

The ESMP for managing the Noise and Pollution from ships (increased river traffic) includes the following:

- Establishing a Permanent E&S Risk Management Unit in BIWTA with adequate workforce, logistics and other resources
    - The E&S risk management unit shall develop standard ship operation procedure and practices, standard refueling practices
    - The E&S risk management unit of BIWTA will develop standard ship operation procedure and practices for hazardous and dangerous goods e.g., petroleum products, LPG, Chemicals, Coals, etc.
    - The E&S risk management unit shall enforce and monitor the environmental regulations and standards.
    - The E&S will also operate the standard environmental inspection procedure
    - The E&S will also develop and enforce environmental auditing of Ships (cargo vessels)
- Regular Inspection and Monitoring of Ships Condition, emission, noise, and environmental management activities
- Strict enforcement of national environmental regulations
- Enforce energy efficient, emission efficient and noise efficient ship design
- Enforce waste and wastewater management on ship and at ports.
    - Ships must be equipped with waste and wastewater management facilities
    - No waste and waste water dumping in River
    - The port and terminals must have waste and waste water collection and management facilities
- Promotion of Environmentally Friendly Cargo and Pontoon
- The long-lasting loud noise at night from these slow-moving boats can be significantly reduced through appropriate muffler systems. Proper enforcement and monitoring system is necessary for ensuring ship operators do not remove the muffler system from the engine
- Establish Emergency Response Facilities at Major Terminals and Anchorage Areas
    - The BIWTA should also establish Emergency Response Facilities for sunken Oil Tanker, LPG Carrier and other dangerous cargos.
    - Emergency Response Facilities for Oil Spillage

12.9.3 Fisheries Management Plan

The project sites are within the boundary of Jamuna River Fish Sanctuary. The critical habitat assessment indicates two fish species Baghair and Chital triggering CH criteria of ESS6 and proposes the Department of Fisheries is engaged to explore opportunities for development of mitigation to improve the protection of these fish The overall risk on Fisheries is Moderate to Substantial and accordingly a set of mitigation measures has been proposed. To meet the ESS 6 requirement for natural and critical habitat the following management plan has been proposed.

Here the fisheries management plan has been developed with the aim of achieving “no net loss” of fisheries habitat and “net gain” of Baghair and Chital. The overall significant loss of fish biodiversity and degradation of riverine habitat condition of the Jamuna River for sustaining fisheries resources. The following should be considered for fisheries management but not limited to:

- The bio-periods like breeding, spawning, nursing, recruitment and grow-out time of dominant fish species need to be identified and calendared so that their respective grounds can be looked after with due care;
- The fish grazing, breeding, spawning, nursery and grow-out grounds of the river needs to be identified and protected as well.
- Care will be taken to avoid locations of significance and bio-periods for major construction and dredging works-;
- Identifying the ecologically rich river reaches and places like "Kole" (Embankment in the young Char land) and fishing restrictions in those reaches or places, for improving the fish resources of the river;
- Fishing should be banned near those bank protection works and navigation aid sides which by modifying riverine environment attract the fishes near structure. Introduction of eco-friendly river training works such as bandal should be preferred where heavy engineering work is not necessary;
- Change in design of riverine structures should be considered to allow lateral migration of fish during flood season and to make the structures more fish friendly.

Fish Diversity Management: Creation of Artificial Fish Habitats

The fish diversity management plan aims to improve fisheries by concentrating fish, providing cover, and/or creating additional resting and spawning habitat. These objectives can result in increased fish recruitment and growth, periphyton production. Generally, habitat structures attract fish. There are many considerations and information need prior to implementing fish diversity management plan. One key consideration is which type of structure will be most effective to attract the target species. A recent study carried out by Institute of Water and Flood Management [104] indicated rise of cat fish like Air, Boal, and Baghair in the area protected by hard structures and areas where assorted CC blocked were placed. The assorted CC block at lunching apron and toe of a bank protection work provides shelter and spawning habitat to some catfishes.

Fish Habitat Structure Types

CC Block, Wooden Purcumine Crib, tetrapods, wooden piles, reef balls/tripods, four pallet stacks are a few known artificial fish habitat structures. The appropriate structure for target fish species (Baghair, Chital, and Kajuli) are to be decided with Department of Fisheries. Such structures can be places under water along with the Groynes and protected slopes to favor fish assemblages, shelter. Photographs of some typical artificial fish habitats are provided in Figure 12.1.

[104] IWFM (2011). Hydraulic profiling of important fish habitats of the Jamuna River. Draft final report. IWFM, BUET.

Assorted CC block placed on the bank-slope and low water

Wooden Porcupine Crib

Concrete Tetrapods

Four pallet stacks

Reef balls

Concrete Triangle blocks

Concrete structure

Figure 12.1: Pictures or Some Typical Fish Habitat Structures

In addition to placing artificial structures, vegetative planting especially along the embayment area, river bank might attract fishes.

Fish Habitat Management and cooperation with Department of Fisheries

- Both of the pilot sites are located within a government declared fish sanctuary. The PIU should collaborate with the Department of Fisheries (DoF) to prepare and implement the fisheries management plan including identification of appropriate measures.
- Fishing is already prohibited by the declaration of the sanctuary. There is a general tendency of rise of fishing activities near protected area. The PIU should collaborate with DoF and raise community awareness to ensure no fishing in the project sites.
- Fish diversity monitoring must be included in the monitoring plan during project construction and operation period.

12.10 Biodiversity Management Plan

12.10.1 Future Research and Study Plan

Encounter, Abundance and Habitat Survey

It is proposed to conduct an encounter, abundance and habitat survey for species triggering CH criteria of ESS6 (Dolphin, Gharial, Baghair, Fishing cat, Chital, see Table 6.4) to support the biodiversity off-set plan to achieve the net gain. Such survey should include identification of current threats, habitat suitability, possible conservation measures, and potential area for future establishment of sanctuary.

Wildlife and Biodiversity Survey

Wildlife survey in the program influence area is proposed to be done to monitor the changes in their status, composition, distribution and diversity. Especially, survey for sensitive species (e.g. fishing cat) and groups (herpetofauna) is recommended to know the changes or alteration in their ecology and behavior. The survey can be done in the project area through employing a set of methods such as- transect line, plot count, point count, focal animal sampling, setting camera traps etc and include consultation. The appropriate survey method should be selected by the specialist to be appointed by the PIU.

12.10.2 No Net Loss / Net Gain Strategy

Residual impacts

This would be a temporal loss of natural habitats (mudflats, embayment area, newly emerged Charland at downstream of the dredging area). This is a natural and ongoing process but the additional impact resulting from Project 1 is expected to be low. It would be temporal because the emergence, disappearance and reappearance of those habitats is a part of the known dynamic Characteristic of Jamuna River. The proposed intervention might accelerate the process at a few places. Therefore, it can be assumed the net loss of the natural habitat approximate zero which satisfies World Bank ESF ESS 6 requirements for No Net Loss. However, a detailed hydrodynamic modeling study should confirm it because no quantitative data is available now. Currently the Feasibility Team is conducting such modelling study and the result will be available before implementation of the project.

The residual impact on Dolphin, Gharial, Fishing cat and two fish species (Baghair and Chital) after mitigation would be Low (See table 12.1). The risks are:

- Disturbance to Dolphin, fishing cat and Gharial reptiles due to noise of construction activities, pile driving
- Temporal loss/shifting of habitat of Baghair fish (*Bagarius bagarius*). The Baghair prefers high velocity zone. The proposed interventions is expected to deflect the current high velocity flow regime towards mid channel.

Table 12.1: Net Gain Requirements for Critical Habitats

Species Name	Net Gain Requirements
Gharial *Gavialis gangeticus*	A minimal population of Gharial is expected in the project AOI and BAA, if any and mitigation to ensure there are no sensitive species prior to construction works is considered sufficient to avoid impacts. **Therefore, Net gain is not required**
Ganges River Dolphin *Platanista gangetica*	Mitigation will be necessary and net gain may therefore be required. Consultation with specialists and management of Jamuna River Dolphin Sanctuaries is needed to explore the option for net gain.
Prionailurus viverrinus Fishing Cat	Mitigation is required to discourage construction workers from disturbing this species, indiscriminate killing and engaging in illegal wildlife trade. A residual impact needs to be determined, and minimal **net gain may be required.**
Baghair *Bagarius bagarius*	There is no known mitigation, however a residual impact assessment will be constrained by the lack of data on these species**.** A tentative Fisheries Management plan has been presented in the 12.9.3 section above. **Consultation with the Dept. of Fisheries will be required to investigate opportunities for effective mitigation.**
Chital *Chitala chitala*	

Biodiversity Offset Strategy for Dolphin

The government has prepared a set of action plans[105] for conserving Dolphins in the Major rivers focusing on Jamuna and Padma. The plan sets a vision of securing river and coastal ecosystems of Bangladesh where dolphins flourish up to the carrying capacity. The overall goals of the action plan are:

- Reduce dolphin population decline in rivers and coastal waters of Bangladesh
- Ensure protection of existing dolphin habitats of Bangladesh

The strategic plan sets 26 action points (Annex 6.4) under the above two goals. These 26 action points have been planned under 8 strategic actions (Table 12.2).

Table 12.2: Strategic Actions of Bangladesh Dolphin Conservation Plan 2020-2030

Strategies	Relevance to JRECDP Project 1
Goal 1: Reduce dolphin killing in rivers and coastal waters of Bangladesh	
Increase knowledgebase on dolphins and their habitats	Measures can be adapted to ensure net gain requirement of ESS6. Linked study has been proposed for understanding Dolphin population in the BAA.
Reduce incidental and intentional killing of dolphins	Mitigation measures are proposed for preventing accidental killing of Dolphin during dredging ensure no net loss as per the requirement of ESS6
Develop skill, capacity and governance for improved protection	Dolphin sanctuaries occur nearby, and there may be opportunities for improved governance and protection of those areas
Understand socio- economic dimensions about dolphins	This action would lead to improved community awareness of dolphin conservation
Goal 2: Ensure protection of existing dolphin habitats of Bangladesh	
Increase knowledgebase on dolphin habitat and threats	Linked study has been proposed for understanding Dolphin population in the BAA

[105] Bangladesh Forest Department, 2019. CONSERVATION ACTION PLAN FOR GANGES RIVER DOLPHIN AND IRRAWADDY DOLPHIN OF BANGLADESH. Available at:

https://bforest.portal.gov.bd/sites/default/files/files/bforest.portal.gov.bd/notices/3c350df6_a887_4067_bf6c_6df09f3492e2/Bangladesh%20Dolphin%20Action%20Plan%202020-2030_Final%20report%20April%202019.pdf

Strategies	Relevance to JRECDP Project 1
Increase protected area network for dolphins	N/A
Engage all actors and stakeholders in protection of dolphin habitat	JRECDP PIU will cooperate with the Forest Department while enforcing relevant law and implementing any protection measures
Understand and reduce dependency of local communities on dolphin habitats	N/A

12.11 Dredged Material Management Plan

12.11.1 Dredging Plan

Small scale dredging activities will be carried out in two different sites named Kalihati and Kaoakola Char as an additional works under JRECDP SOP 1.

Kalihati site dredging alignment is located in the middle of Jamuna River (Alternative 1 in Figure 12.2). The dredging area will be 7km long, 100 wide and 6m depth where the excavated canal will have slope of 5cm in 1 km. The rationale of this dredging is to increase the sediment carrying capacity, ease navigation and to regain the channel alignment along the proposed site. This canal dredging through the Chars/Island has been systematically assessed and finalized to ensure minimum dredging, and minimum impacts on the downstream area.

Another dredging activity will be implemented in Kaoakola Char. A canal (Figure 12.3) will be re-excavated to improve local navigation and water storage capacity. During monsoon this canal gets inundated and thereafter sedimented during post monsoon season. Therefore, the canal needs to be dredged to maintain the water flow during dry season to increase its drainage capacity, retention capacity, navigability, and transportability as well. The estimated canal excavation will be about 6,265 m long, 30 m width and cross-section will have side slope of 1:3.

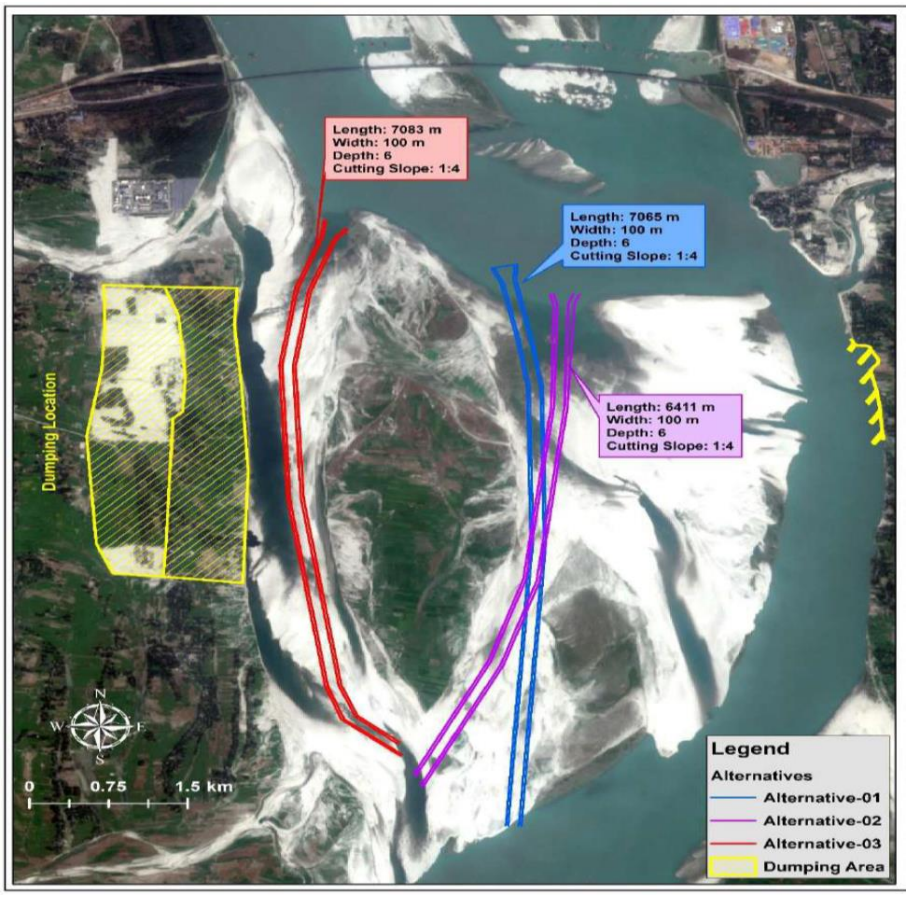
12.11.2 Dredging Operations and Dredged Material Volume

Dredging activities at kalihati site will generate about 5.51 M m^3 and from Kaoakola about 1.5 M m^3 Dredged material will be generated. Hence the total quantity of dredge materials from both sites will be 7 M m^3.

Dredging work at Kaoakola canal excavation will be conducted by operating 18" dredger with necessary arrangement by Tug boat/Work boat disposing dredged earth up to 1.5 km, positioning the cutter of dredger at designed level while the Kalihati dredging work will be conducted by 26" dredger.

The dredging activities will generate local turbidity around the cutter heads of the dredges, but this turbidity will not significantly spread beyond the dredging trenches or channels because the bulk of the dredging takes place below the surrounding river bed. Generally, the turbidity plumes often subside at a rather rapid rate, within a few hours, especially where currents are strong, so that turbidity is often temporary and of short duration. The settling rate is primarily dependent on the density of the suspension and the grain size distribution of the suspended material, assuming a two-layer fluid system around the dredger or fill area outflow: an upper layer of water and a lower layer of suspension (water plus sediment). Sand-size particles may settle within the hour, but clay-size particles (<2 micron) may take many hours (sometimes even days), if the density of the suspension is high.

Turbidity due to dredging is not considered problematic as the dredging quantities are very small compared to the total sediment load of the Jamuna River. Hence dredging has no major short-term impact on the river morphology and any long-term impact would be masked by natural changes depending on the annually changing flood Characteristics.



Note: Alternative 1 is the selected dredging alignment

Figure 12.2: Dredging and Use of Dredged Material at Kalihati Site

12.11.3 Dredged Material Management

Dredging at Kalihati site

The proposed dredged material will be dumped at Sirajganj Economic Zone (SEZ). Figure 12.2 demonstrates the SEZ which is a private economic zone for industrial investors located just along the Jamuna River right bank. The associated authority of SEZ is eager to buy this dredged sand from this project for their land filling. SEZ possesses about 415 acre of land that needs to be filled up-to 3.5m height of land. The 5.51 M m3 dredged volume would be accommodated by 389 acres of land of the SEZ. Another Government owned Economic Zone at Sirajganj (next to the private SEZ) is also showing interest to use the dredged material for their land development. BWDB is also in communication with local government and EZ authority for preparing final agreement of dredged material use.

Canal Re-excavation in Kaoakola Char

There are several possible scopes to manage the dredged material in a proper and sustainable way. Most of the dredged material can be used for the Char development works through CDD works. The following interventions will be required to use the dredged materials:

- There will be a 1500 m protective work at the downstream of the canal where a boat ghat and a rest house is present. It is planned that the dredged material from the re-excavation process will be used to support the proposed 1.5 km protective work at the boat ghat.
- A closure of 800 m length using cross-dam will be constructed at the upstream of the canal where dredged material from the re-excavation process will be used for the cross-dam.

- Construction of a total ten elevated platforms (Killa) will be required approximately 160 acres of land to be developed and elevated by using the dredged material. These platforms can be used for potential flood shelter, school, medical clinic, farm, and other commercial utilities.
- During the Public Consultation Meeting (PCM) some existing flood-prone village facilities like households, schools, mosques bazars etc., were identified whose level needs to be raised above the local flood level (about 16m PWD). Through the CDD work the dredged material will be used to elevate these facilities

Figure 12.3: Canal Dredging and Use of Dreged Material in Kaoakola Char

12.11.4 Environmental Management and Institutional Arrangement

Contractors are normally responsible for design, construction and maintenance of areas and primary environmental monitoring. Environmental specialists of Construction and Supervision Consultant (CSC) are responsible for supervision or auditing of monitoring of turbidity levels of river near dredging and reclamation areas, and outflow from reclamation areas. PIU from the BWDB will setup a 'Dredge Material Disposal Committee' with representatives of local government, nearby community, Char-dwellers contractor and CSC to effectively dispose the dredge materials from reclamation areas to the local community, private and public organizations. The committee will setup procedures for receiving and approving requests from the public. The committee is responsible for providing facilities at reclamation areas to allow the public to carry the materials and fixing of any nominal tariff to cover these expenses. The committee is also responsible for setup and monitoring of procedures for transport of material from

reclamation areas to the designated disposal areas by boats and trucks without causing any environmental degradation. The procedures shall include

- Boats and tractors/trucks cannot carry materials more than their capacity. Only suitably dry materials are allowed to be transported.
- Materials can be filled in the boats/trucks and are to be carried in the boats/trucks in such a way that there will not be any spills in the river or on the road
- Materials should be covered with tarpaulins during high winds and rains. Trucks carrying materials should be always covered.
- Carriage of dredged material by Bulkhead/cargo/boat or any other means should be within 1 km along the river
- As there are no industries situated to the close proximity of dredging site the material ingredients should be suitable for safe dumping but further chemical testing of the dredged material needs to be done to confirm it is not contaminated.
- The reclamation areas should be maintained properly to protect Soil contamination

12.12 Social Management Plan

12.12.1 Compensation Plan to be Covered by RAP

A Resetlement Policy Framework alongside this ESIA has been prepared to guide the RAP which will be prepared before implementation of the project. The RAP would detail out the compensation plan. National regulations and World Bank ESF will be applied for compensation. Following Project Affected People (PAPs) are eligible for compensation:

- Persons who have formal legal rights to land or assets;
- Persons who do not have formal legal rights to land or assets, but have a claim to land or assets that is recognized or recognizable under national law; or
- Persons who have no recognizable legal right or claim to the land or assets they occupy or use.

In other words, the compensation plan will be inclusive; all affected persons will be covered, compensated for lost assets, and assisted in relocation and resettlement, following the Resettlement Policy Framework (RPF). The non-titled persons will be provided resettlement assistance in lieu of compensation for the land they occupy and other assistance, if they occupy the project area before the cut-off date established by the project authority.

Furthermore, all persons of the above categories (a, b, and c) will be compensated for loss of any assets such as crops, structures, trees and/or business losses. Thus, PAPs include all categories, irrespective of their status or whether they have formal titles, legal rights or not, squatters or otherwise encroaching illegally on land, are eligible for assistance if they occupied the land or had used of it, before the entitlement cut-off date. All PAPs, thus, will receive (i) compensation (as required, to match replacement value), and/or (ii) replacement land, structures, seedlings, other resettlement assistance such as shifting allowance, assistance with rebuilding structures, compensation for loss of workdays/income.

Land owners, as identified by the DC office, will be eligible for Compensation Under Law (CCL) and additional benefit to reach the replacement value to be determined by the PVAC and paid by the DC Office (however, indirectly by the Project) to the entitled persons/family. Structures located on GoB land, if displaced, will be entitled for compensation under the policy of the Project as determined in the entitlement matrix of PRF. Vulnerable PAPs will qualify for additional assistance to facilitate them relocation and restoration of their livelihoods. Non-vulnerable households with land and/or structures affected will be entitled to compensation for lost assets at replacement costs and assistance for shifting and reconstruction of the structure. Any structure not directly used by a non-vulnerable household i.e., rented-out for income will also qualify for additional resettlement assistance.

The PAPs who are entitled to compensation under the project include:

- Persons whose structures are in part, or in total, affected temporarily or permanently by the Project;
- Persons whose residential or commercial premises and/or agricultural land (or other productive land) is in part, or in total, affected (permanently or temporarily) by the Project;
- Persons whose businesses are affected in part, or in total, (temporarily or permanently) by the Project;
- Persons whose employment or hired labor or share-cropping agreement is affected, temporarily or permanently, by the Project;
- Persons whose crops (annual and perennial) and/or trees are affected in part, or in total, by the Project; and
- Persons whose access to community resources or property is affected in part, or in total, by the Project.

Other than PAPs, such as if any Common Property Resources (CPR) are affected the compensation must be paid and ensure that affected CPRs are reconstructed before dismantling or damaged by the Executing Agency on their own.

12.12.2 Resettlement/Relocation Plan to be Covered by the RAP

The proposed pilot/subproject locations have homesteads and other structure. These homesteads need to be resettled or relocated. Since the relocation process requires cost for shifting, this also needs to be compensated. The detail plan for resettlement and relocation will be prepared in the Resettlement Action Plan in accordance with the RPF.

- Replacement value of the structure as determined by PVAC and PMU in consultation with affected HHs.
- Transfer Grant at actual cost which will include labor cost and transportation cost.
- Reconstruction Grant in actual cost which will include land development, labor cost and transportation cost.
- PIU, in collaboration with local government and Resettlement Assessment Committee (RAC), will make best efforts to identify alternative residential or commercial sites for the affected HHs.
- Dismantling cost for non-shiftable structure will be determined by the PVAC and PIU based on the actual price and consultation with affected households (HHs).
- Project will construct a new community property in consultation with the community and / or managing committee.
- No community property can be demolished until a new one is constructed.

12.12.3 Livelihood Restoration and Development Plan

In the program area, the livelihood situation for those at risk is relatively homogenous largely due to similarities in the socio-demographics such as high poverty levels, everyday vulnerability to erosion and displacement, poor communication as well as lack of civic infrastructure and amenities. The potential adverse impacts of the Project 1/pilot interventions are likely to be temporary and limited due to linear acquisition of land for bankline protection works. As such, the immediate negative impacts of project interventions are temporary and short-term loss of income due to disruption of livelihood and social capital caused by displacement and resettlement. However, given the endemic nature of bankline erosion, flooding and forced migration due to land and homestead losses, a livelihood restoration and social development plan will be required for the local communities to benefit from the project/program implementation. The

livelihood program, to be prepared before implementation[106] of the project should cover not only those immediately affected but also include vulnerable households near the subproject/pilot sites, particularly those living on the old embankments and adjacent Chars as well as host communities.

Assessments

Very broadly, as the social baseline conditions indicate, the population in the project/program area has a low development status on (i) human (i.e., low literacy/education, skill levels); (ii) financial (i.e., 50-60% of the population belong to lower and/or upper poverty level); and (iii) physical capital (i.e., poor housing, little or no land; nearly two-thirds living on the old embankment and Chars are landless). However, the natural capital plays an important role for these floodplain communities that depend to a large degree on agricultural products, fruit trees, backyard poultry, and livestock. These are mostly grown or raised for own sustenance and only to a small degree for commercial purposes.

In addition, local people are also involved in a variety of occupations such as fishing, trading (petty trade, transportation, shop keeping, *forias/beparis*[107]), artisan/skilled labor – for example, carpenters, masons, electricians, rickshaw/van puller, tailoring, cobbler, barber, sweet maker, *chatai* (bamboo mat) maker, and wage employment in government and private sectors, including garments.[108] In sum, livelihood sources for the floodplain inhabitants are largely dependent on natural resources. Therefore, there are opportunities to improve livelihood mid and long-term through increasing the commercialization of agricultural products and the productivity of agricultural inputs as well as diversifying the livelihoods using existing natural/human resources.

Objectives

Given the above, the objectives of the livelihood program should then be two-fold: (a) short-term to mitigate any adverse impacts due to project interventions (e.g., compensation for loss of income, wages and/or access to work, increase risk of flooding/erosion) and enhanced employment opportunities in project civil work and/or supporting activities; and (b) mid- to long-term plan focusing on increasing income and livelihoods through improved productivity of existing crops and livestock, skill building to diversify livelihoods, and better marketing and linkages of products to market. Several NGOs, including Chars Livelihood Programme (CLP), have successfully addressed livelihood programs in Char villages in the program reach area using agriculture and skill training as with their main strategies.[109]

Framework, Strategies and Guidelines

During implementation of the Phase 1, an initial assessment of livelihood development needs along the five livelihood asset dimensions – human, natural, physical, financial, social assets – will be conducted among the beneficiary communities (i.e., project-affected, embankment settlers, and adjacent Chars). The beneficiary communities will be consulted and engaged in the design and implementation of the livelihood programs. The bottom line of the livelihood program should be poverty alleviation, particularly among the

[106] Annex 12.2 provides a ToR for Developing Livelihood Restoration Plan

[107] Small/medium traders, who purchase various agricultural produces, are part of the value/market chain in the local and regional markets or bazaars. See M. Aminur Rahman et al, Crop Production Patterns and Marketing in Char Areas: Adapting to Hazards and Vulnerability. In M. Zaman and M. Alam (eds) *Living on the Edge: Char Dwellers in Bangladesh*, cited earlier.

[108] Hafiza Khatun, et al, Out Migration as a Survival Strategy for Char Dwellers. In M. Zaman and M. Alam (eds) *Living on the Edge: Char Dwellers in Bangladesh*, cited earlier.

[109] Muhammad Lokman Hossain, The Chars Livelihoods Programme: Experience and Learnings. In M. Zaman and M. Alam (eds) *Living on the Edge: Char Dwellers in Bangladesh*, cited earlier.

most vulnerable groups (e.g., female-headed households, the elderly, and the very poor) and sustainable social development over the course of the program period.

Livelihood restoration for project-affected households and beneficiary groups is the primary mandate for this bank protection and infrastructure development program. Based on the objectives of the livelihood plan as well as impact assessment, two major strategies will be pursued: (1) restoration of income and livelihood of the directly project-affected population in short-term, and (2) sustainable mid- and long-term livelihood improvements, (3) Enhance Livelihood Resilience by Implementing Shock Responsive Social Protection Program. Several interventions may be undertaken under each strategy.

As said, the livelihood program would be two-fold: 'short-term' and 'medium to long-term'. The potential interventions as 'short-term' have been presented below under Strategy-1.

Strategy 1 – Income and Livelihood Restoration

cash assistance to support lost income;

(i) assistance to re-establish businesses, employment in construction site and construction-supported sector; and

(ii) Special assistance for vulnerable groups in the form of additional support.

On the other hand, the potential interventions as 'medium to long-term' have been presented below under Strategy-2.

Strategy 2 – Livelihood Development

community participation in plantation and social forestry on embankment sides;

(i) technical support for fostering the cultivation of high-value vegetables;

(ii) improving the productivity of the livestock sector;

(iii) enhancing the productivity of the poultry sector;

(iv) improving the fisheries and fish production;

(v) need-based training of skilled labor;

(vi) installation of solar home systems for electricity and enhanced quality of life; and

(vii) Grants to support livelihood enhancing projects, particularly for poor and vulnerable women/groups.

Strategy 3 – Shock Responsive Social Protection Program

Design a new Shock Responsive Social Protection System (SRSPS) or modify an existing one to make it Shock Responsive; (EGPP+ of Ministry of Disaster Management and Relief or existing SP of Ministry Social Welfare can be good candidates)

(i) Implement the SRSPS, flood and erosion can be the target shock which would trigger the SRSPS

(ii) Strengthen the Local Government and the Line Agencies towards Implementation of the SRSPS

The IA (Implementing agency) will hire an experienced NGO to design and implement the Livelihood Restoration and Development Plan. The NGO will coordinate with RAP implementation agency for short-term livelihood restoration as per the RAP matrix. The NGO will conduct stakeholder workshops to verify and refine the livelihood development plan prior to implementation. The IA will monitor the implementation and make necessary adjustments, based on implementation experience and feedback from the beneficiaries.

Sexual Exploitation and Abuse and Sexual Harassment Risk Mitigation Action Plan

Along with the ESIA a standalone Sexual Exploitation and Abuse and Sexual Harassment Risk Mitigation Action Plan has been prepared. The SEASH Risk Mitigation Action Plan includes the Following:

- Gender Action Plan

- Sensitizing the BWDB and BIWTA and Integrating the SEA-SH into the DPP and PAD
- Integrating SEA/SH into the Bidding Documents
- Create awareness on SEA-SH and GBV
- Addressing GBV-related risk in program
- Stakeholder consultations and Disclosure on SEA-SH action plan in the project area SRA-SH prevention and response service mapping
- SEA/SH sensitive channels for reporting in the Grievance Redress Mechanism (GRM)
- Operating Procedures and Response Protocol
- Enforcement of a Code of Conduct

In any project implementation, Sexual Exploitation and Abuse and Sexual Harassment (SEA/SH) are crucial. To protect and prevent community from SEA/SH, strengthen community engagement and awareness-raising is essential. Critical awareness activities need to be conducted which will include training and awareness-raising sessions with women, girls, boys and men in communities of concern as well as with other stakeholders (including implementing and operational partners, government officials, civil society organizations, and companies in the private sector). To prevent SEA effectively, all staff and project workers must make sure that project Persons of Concern (PoC) are aware of their rights and entitlements. On the other hand, PoC from contractor and project management side should know that they are entitled to assistance that they should never be expected to provide any form of sexual favor, and that demands for such favors are strictly prohibited. Community and project victims should also know how and where to report SEA incidents safely and confidentially when they occur. As part of prevention, trainings and information campaigns should be put in place for all project personnel and PoC. Training and information campaigns may include the distribution of information sheets, posters and videos, or community meetings, focus group discussions, etc.

Beside that the project will include a general Code of Conduct (CoC) as well as a Labor Code of Conduct, covering the GBV/SEA/SH related risks for the contractors, sub-contractors, and all project workers/officials who will be employed under the project.

12.13 Transboundary Management of River

Although the impact assessment predicted no impacts to be take place in the upstream countries due to the Phase 1 activities, however, considering the coming phases of the SOP, interventions which are taking place in the upstream countries, a basin-wise approach of river management is suggested. The basin-wise approach of flood management, erosion and accretion management, navigation management and the overall river management are advocated by both national and international scientific communities as well as the policy makers of Bangladesh. A further study should be conducted to explore the scope of basin-wise management approach. Such basin-wise approach should include:

- Integrated Environmental, hydrological and morphological monitoring and database development, (jointly/collectively by the riparian countries). The online database must be developed, operated, and maintained by riparian countries and the database must be accessible by the implementing agencies, research organizations and relevant agencies of the riparian countries.
- Joint formulation a comprehensive master plan covering the Brahmaputra-Jamuna River from source to its downfall at Meghna River. However, formulation of the master plan for the river reach between India and Bangladesh can be initiated immediately.
- Establishing institutional mechanism/framework for basin-wise management of the river. In this case, the current Joint River Commission can take the lead and create a special unit/wing for preparing the master plan.
- Another alternative might be, establishing Brahmaputra River Commission, an international body to be jointly created, operated and maintained with the responsibility of policy and plan

formulation, integrated monitoring of river hydrology and morphology, general policy/plan preparation for flood management, erosion & accretion management, environmental risk management, etc. In that case there should be another international mechanism among the Joint River Commission, Brahmaputra River Commission and the Joint Management Committee of the Protocol Routes.

- The institutional arrangement and scope of work of the Joint River Commission/ proposed Brahmaputra River Commission should be extended to include environmental risk management e.g., joint inspection and monitoring international ships, establishing E&S Risk management standards, Ship Design and Operation Standards, sharing of Emergency Response Logistics, monitoring of pollution from ships, etc.
- Establish a common approach for flood monitoring and forecasting based on the jointly developed integrated monitoring and database system (accessible by all the riparian countries).

12.13.1 Implementation of Mitigation Plan

The mitigation plan is the key element of ESMP to be prepared based on the impact and risk assessment described in Chapter 8. The Plan describes the potentially negative impacts and risk of each construction activity, lists mitigation measures as per the mitigation hierarchy to address the negative impacts and risks, and assigns responsibilities for implementation, prevention and monitoring and inspecting of these measures. The Mitigation Plan is given in Tables 12.3 and 12.4. Contractors will make sure they present the implementation status of mitigation measures identified in this Table in every monthly report, with quantifiable information.

Table 12.3: Mitigation Measures, Relevant ESCOP and Responsible Agencies for Implementation

Component	Impacts	Mitigation Measure	Relevant ESCOP	Responsibility
Construction Stage				
Hydro-morphology of River and Floodplain	• Changes on River Planform beyond the Project AOI • Changes in River Bankline (upstream and downstream of proposed structures) • Reduction of floodplain and alluvial corridor within the Project AOI • Changes in River Hydrology (flow regime, water level) • Increase of erosion risk downstream of the Project AOI	Chapter 8: Table 8.7, 8.8. 8.9	• ESCOP 3 • ESCOP 6 • ESCOP 12 • ESCOP 13 • ESCOP 19 • ESCOP 22	Contractor, CSC, PIU
Water Quality	• Contamination of water bodies by construction and dredging waste • Increase of turbidity in river-water column • Risk of oil spillage from dredger • Risk of Spilling concrete or concrete slurry during construction • Risk of Degradation of water quality due to spillage of bilge water, oil, lubricant from the vessels (mostly nearby a terminal) • Risk of Water pollution from improper waste management by the vessels and careless actions by the passengers (mostly nearby a terminal)	Chapter 8: Table 8.11, Table 8.12 Table 8.13	• ESCOP 1 • ESCOP 2 • ESCOP 3 • ESCOP 4 • ESCOP 5 • ESCOP 6 • ESCOP 7 • ESCOP 12 • ESCOP 13 • ESCOP 17 • ESCOP 19 • ESCOP 22	Contractor, CSC, PIU
Noise Level	• Site clearing and preparation; • Excavation and concrete placement; • Erection of structures; • Concrete mixing and aggregate production systems; • Construction Camps / Ancillary Facilities; • Pile driving (cast insitu bored pile, vibratory hammer); • Haulage and general vehicle movements; • Engine running; • Hydraulic horns;	Chapter 8: Table 8.18	• ESCOP 11 • ESCOP 15	Contractor, CSC, PIU

Component	Impacts	Mitigation Measure	Relevant ESCOP	Responsibility
	• Loading and unloading activities;			
Air Quality	• Exhaust emissions from the operation of construction machinery (e.g., Nitrogen Oxides (NOx), Sulfur Oxides (SOx) and Carbon Monoxide (CO)); • Dust generated by movement of vehicles/vessels; • Dust dispersion while carrying the construction materials e.g., sand, gravel, rock, cement, etc. and disposal of dredging materials; • Rock crushing, mixing of construction materials, soils and material stock-piles, dredged material disposed sites; • Exhaust emissions from the ships (e.g., Nitrogen Oxides (NOx), Sulfur Oxides (SOx), Particulate matters, and Carbon Monoxide (CO).	Chapter 8, Table 8.20	• ESCOP 1, ESCOP 10, ESCOP 14, ESCOP 18	Contractor, CSC, PIU, DoF, Local Government Bodies
Biodiversity and Ecosystem	• Disturbance to Brahmaputra-Jamuna River IBA • Contraction of mudflats, river area (alluvial zone), Charlands like natural habitat at site • Loss of mixed but mostly modified habitats along the bank • Risk of increasing disturbance and reduction of suitability in the natural habitats (river area, mudflats, Chars) due to pollution (Noise, water pollution, etc.) from construction activities including dredging • Loss/Turmoil of benthic and riverbed due to dredging • Disturbance of nocturnal wildlife due to installation of navigational materials and devices • Risk of physical injury to Dolphin, and Gharial through collision • Disturbance to Dolphin, fishing cat and Gharial reptiles due to noise of construction activities, pile driving • Temporal loss of habitat of Baghair fish (Bagarius bagarius) • Risk of disturbance to dolphins, and Gharial due to increased light and sound (after construction period due to increased navigation) • Risk of disturbance to aquatic wildlife in river and Chars (frogs, turtles, fishes, reptile) due to increased light and sound • Risk of disturbance to wildlife in floodplain and Chars due to increased light and sound • Risk biodiversity loss due to accidental oil spillage or contamination	Chapter 8, Table 8.22, 8.23, 8.24	• ESCOP 1 • ESCOP 2 • ESCOP 5 • ESCOP 10 • ESCOP 11 • ESCOP 12 • ESCOP 13 • ESCOP 19 • ESCOP 22	Contractor, CSC, PIU
Fisheries	• Disappearance of scour habitats at the river bank side due to bank protection work. • Materials wash water from construction site may contaminate river water quality locally which may cause loss of fish habitat suitability. • Change in fish habitats (embayment area, mudflats, alluvial area, etc.)	Chapter 8, Table 8.26	• ESCOP 1 • ESCOP 3 • ESCOP 4	Contractor, CSC, PIU

Component	Impacts	Mitigation Measure	Relevant ESCOP	Responsibility
	• Degradation of fish habitat condition at the Jetty site due to throwing of plastic bottle, polythene and food packaging waste by the passengers		• ESCOP 5 • ESCOP 13 • ESCOP 22	
Agriculture	• Loss of Standing Crop/Crop Production due to land reacquisition (for labor camp, construction sites, etc.) • Damage to standing crop on nearby agricultural land due to waste and water disposal from construction activities, transportation of construction material, labor movement, etc.	Chapter 8, Table 8.28, 8.29	• ESCOP 1 • ESCOP 3 • ESCOP 4 • ESCOP 5 • ESCOP 6 • ESCOP 7	Contractor, PIU
Socio-economic including Labor and working condition,	• Dispossession due to land acquisition and resettlement • Land acquisition induced poverty may lead the sexual activities by the poor girls and women with project employees • Land acquisition induced poverty may increase the risk of child marriage and other SEA/SH due to displacement by land acquisition • Land acquisition induced poverty may lead abandonment by spouse and intimate partner violence • Socio-cultural shock due to labor influx • Disturbance of water users to access to river water • Income loss due to the acquisition and disturbance of cultivable land • Health hazard with the outside laborers and their movement in the community • Public nuisance and disturbance due to construction activities and pollution from construction activities • Risk of exclusion of vulnerable group in stakeholder engagement and project benefits • Risk of exclusion of E&S Risk Management during planning and construction due to lack of E&S Risk Management Capacity of IAs • Increased demand of outsider (employees & visitors) may enhance the risk of SEA/SH • Additional stress on existing SE facilities local health, sanitation, road network, etc. • Risk of rising False Sense of Security and therefore rising the risk of livelihood, asset and service loss due to bank failure from the failure of the Groynes	Chapter 8, Table 8.31~8.39	• ESCOP 1 • ESCOP 2 • ESCOP 4 • ESCOP 5 • ESCOP 6 • ESCOP 7 • ESCOP 8 • ESCOP 9 • ESCOP 10 • ESCOP 11 • ESCOP 14 • ESCOP 15 • ESCOP 16 • ESCOP 17 • ESCOP 18 • ESCOP 19 • ESCOP 22	Contractor, PIU, CSC
SEA/SH Risk	• Demand for sex by migratory workers will increase SEA/SH • Sexual harassment within the labour camp and nearby community.	Chapter 8: Table 8.41	• ESCOP 15 • ESCOP 16	Contractor, PIU, CSC

Component	Impacts	Mitigation Measure	Relevant ESCOP	Responsibility
	• Force and early marriage by construction workers. • Land acquisition induced poverty may lead the sexual activities by the poor girls and women with project employees. • Land acquisition induced poverty may increase the risk of child marriage and other SEA/SH due to displacement by land acquisition. • Land acquisition induced poverty may lead abandonment by spouse and intimate partner violence. • Community school or college girls may be harassed or sexually abused by the project workers. • Salary discrimination among the female workers. • Increase of COVID-19 spreading risk			

Table 12.4: Mitigation Plan during Operation and Maintenance

Component	Impacts	Mitigation Measure	Responsibility
Water Quality	• Water pollution due to improper waste management of the increased inland water transports • Water pollution from accidental spillage of oil and lubricant from ships • Contamination of water bodies by dredging waste • Pollution by passengers	• No dumping of any type of solid waste and wastewater into open water. • Restrict passengers and ship operators to throw any sort of waste material into the water. • No refueling nearby any sensitive area • No stationing of any vessel nearby any sensitive receptors. • Building awareness • Wastewater and solid wastes should be accumulated inside the vessel and discharged at designated locations near the ports, jetty or anchor Facilities should be installed at the ports and jetties to collect solid waste, wastewater and bilge water from the incoming vessels. • The fueling equipment should be equipped with breakaway" hose connections that provide emergency shutdown of flow in case of failure of connection. • Fueling should be done only at the ports and jetty areas, and no instant refueling should be done by smaller boats and ships while moving through the river route. • International standards for refueling should be followed. • Absorbents should be present at places of refueling. • Bilge water related to fuel and lubricants should be discharged at the designated sites near the ports/Jetties. • Monitoring of implementation of environmental management plan should be done by responsible agencies such as BIWTA, port authorities, DoE, etc.	BIWTA, BIWTC, Vessel operators, DoE
Hydro-morphology of River and Floodplain	Increase of erosion risk downstream of the Project AOI	• Monitoring of river planform changes • Implement erosion forecasting and dissemination of information to BWDB field offices for necessary action. Currently erosion forecasting is being done by MoWR and BWDB (with support from CEGIS) for a collaboration with this initiative might bring further enhancement.	MoWR, BWDB, CEGIS
Noise Level	• Sound pollution from tourism • Sound pollution from vehicles	• Enforcement of ECR 1997 and Noise Control Rules 2006 • Regular Inspection and Checking of Ship health	BIWTA, BIWTC, DoE
Air Quality	Ship Pollution	• Use of low-sulfur diesel in all vehicle, and equipment • Enforcement of ECR 1997 • Regular Inspection and Checking of Ship health	BIWTA, BIWTC, DoE
Biodiversity and Ecosystem	• Disturbance to Brahmaputra-Jamuna River IBA	• Do not permit ships/boats that do not follow the guidelines of river traffic • Avoid allowing more vehicles/devices than the capacity	MoEFCC, Dept. of Forest, Dept

Component	Impacts	Mitigation Measure	Responsibility
	• Risk of increasing disturbance and reduction of suitability in the natural habitats • Disturbance of nocturnal wildlife due to night navigation • Risk of physical injury to Dolphin, and Gharial through collision • Disturbance to Dolphin, fishing cat and Gharial reptiles due to noise of construction activities, pile driving • Risk of losing fish diversity	• Nesting grounds, breeding and spawning grounds shall be identified (in Stage 2) and ship operation in these areas should be minimized • Regulated/slow speed shipping to avoid collision with animals • Provision of propeller guards to prevent injuries to dolphins • Awareness creation among local people and relevant Govt. agencies • Engagement and collaboration with management authorities of nearby established Dolphin sanctuaries to explore opportunities for current and future mitigation of impacts to guide development of upcoming phases of the JRECDP. • Design and deploy effective management of fish sanctuary • Community involvement in management of fish sanctuary • Enforce Pollution Control rules (ECR 1997, Noise Pollution Control Rules 2006, etc.)	of Fisheries, BIWTA, BIWTC, DoE
Socio-economic	• Risk of erosion downstream of Project AOI • Risk of rising False Sense of Security and therefore rising the risk of livelihood, asset and service loss due to bank failure from the failure of the Groynes • Risk of land acquisition due to induced development • Risk of shrinking agricultural land due to induced development • SEA/SH Risk	• Public awareness creation. • Proper monitoring of flood and erosion risk and deploy effective warning system • Extend Disaster Financial Solution to mitigation any future risk of flood/erosion • Extend the Shock Response Social Protection System to mitigate future risk and resilience building • Preparation of Land regulation and rural development plan to guide induced development • Proper compensation and resettlement in case of any future land acquisition by a development project. • Awareness creation among local people and project workers. • Regular monitoring • Arranging workshop with school going girls for self-defense in any case of SEA/SH incident	Local Government, MoWR, BWDB, MoDMR, DDM, LGED

12.13.2 Environmental Monitoring Plan

Implementation of the ESMP and related subplans s required monitoring be conducted throughout each phase of the Project. Some of the measures in the ESMP are straight-forward to monitor while some needs specific parameters and indicators to be measured for monitoring at certain frequencies. Regular monitoring of different indicators will be able to evaluate the impacts. The monitoring plan is presented in Table 12.5.

Table 12.5: Environmental and Social Monitoring Plan

Components Monitoring	Monitoring Indicators	Locations	Frequency	Type/Duration of Sampling	Implemented by	
					Monitoring	Supervision
Pre-construction phase monitoring						
Compensation amount	Compensation received or not	Project site	Half yearly	Consultation with the land and structure owners, squatters, other affected people, and relevant authority	Third party Monitoring and submit report to the project authority.	PIU
Livelihood Condition and Employment Status	Occupational change In employment Household income and expenditure	Project area and adjacent project area (within 2 km)	-	Household survey and FGD	Third party Monitoring and submit report to the project authority.	PIU
Grievance Mechanism	Establishment of GRM Operation, Procedures, Records and Documents	At work site	Monthly	visual inspection and enquiry to know the Grievance Mechanism	Third party Monitoring	PIU
Construction phase monitoring						
Air Quality	SPM, PM2.5, PM10	Construction site	Quarterly	24-hour	Third party Monitoring	PIU
Water Quality	Total alkalinity, Ammonium Nitrogen, BOD5, COD, EC, Oil and Grease, Turbidity, TSS, TDS, TS, etc.	Construction site, 1km upstream and 1km downstream of each site	Monthly	Grab Sampling	Third party Monitoring	PIU
Noise	Day time (6:00 – 21:00) and Night time (21:00 – 6:00) L_{10}, L_{90}	Construction Site Construction Camp Nearby Sensitive Locations	Monthly	Three Sample during day time and one sample during night, 15 min sampling each time.	Third party Monitoring	PIU
Disaster Risk	Flood level, Flood Duration, Flooding depth, erosion and accretion, Disaster Risk Awareness,	Construction sites, upstream area, especially Charlands area nearby the construction sites	Seasonally	Survey, Satellite Image Analysis, FGD, KII	Third party Monitoring	PIU

Components Monitoring	Monitoring Indicators	Locations	Frequency	Type/Duration of Sampling	Implemented by	
					Monitoring	Supervision
River Plan Form	Bankline, Flood zone, Alluvial zone,	River reach along the proposed revetment line	Annually	Survey, Satellite Image Analysis	Third party Monitoring	PIU
Livelihood and Employment	Labor Engagement for project activity		Quarterly	Household survey and FGD	Third party Monitoring and submit report to the project authority.	Project Authority
Gender SEA-SH	Implementation of SEA-SH action plan	Pilot/ Subproject sites	Quarterly	Both quantitative and qualitative assessment	Independent third-party monitoring	CSC and PIU
Occupational Health and Safety	First-aid Cases Medical Treatment Cases Lost Time Injury Number of near misses Number of Walk-through Inspections by Project Managers, Construction Managers, Health and Safety Officer and OHS supervisors	Construction site, Construction Camp	In various frequencies	Walkthrough, inspections, and incident reporting	Contractor	CSC, PIU
Community Health, Safety and Security	Rates of COVID-19 and other communicable disease (Chikungunya and Dengue, and other vector-borne diseases), Project related safety and security incidents, Number of grievances or claims of Project related impacts on the community.	Worksites and community close proximity of the project	In various frequencies	Inspection and interview of labor, project personnel and community members followed by a checklist	Contractor	CSC and PIU
Health and Sanitation	Availability of Potable Water, Drinking water quality, Availability of Hygienic Toilet	Construction/labor camps	Monthly	Inspection and interview of labor, project personnel	Third party Monitoring	PIU
Grievance Mechanism	Operation, Procedures, Records and Documents	At work site	Monthly	Visual inspection and enquiry to know the	Third party Monitoring	PIU

Components Monitoring	Monitoring Indicators	Locations	Frequency	Type/Duration of Sampling	Implemented by	
					Monitoring	Supervision
				Grievance Mechanism		
Fish biodiversity	Fish Habitat, Fish Composition and population structure	4 revetment construction sites in Kaoakola, 3 sites along the canal to be reexcavated 2 locations along the each of the piloting sites 2 sites along the dredging area Pontoon sites	Six-monthly upto 1 years after the construction	In-situ investigation and Test	Third party Monitoring	PIU
River Dolphin and large aquatic species	Number of individuals	Noise impact zone	Weekly for 3 months post pile driving activities	Count numbers of dolphins surfacing.	Third party Monitoring	PIU
Operation/Post-Construction						
Air Quality	SPM, PM2.5, PM10	Near the Pontoon to be constructed Piloted sites	Monthly upto two years of construction	24 hour	E&SRM wing of BWDB	BWDB and DoE
Water Quality	Total alkalinity, Ammonium Nitrogen, BOD5, COD, EC, Oil and Grease, Turbidity, TSS, TDS, TS, etc.	3 sites along the re-excaveted canals 3 sites in Kaoakola revetment 2 locations in each C1 piloting sites	Monthly up two years of construction	Grab Sampling	E&SRM wing of BWDB	BWDB and DoE
		Sensitive receptors along the Navigational Routes, Terminal areas	Monthly up two years of construction After that, querterly	Grab Sampling	E&SRM wing of BWDB and BIWTA	BWDB, BIWTA and DoE
Noise	Day time (6:00 – 21:00) and Night time (21:00 – 6:00) L_{10}, L_{90}	Sensitive receptors along the Navigational Routes, Terminal areas	Monthly up two years of construction	Three Sample during day time and one sample during night, 15 min sampling each time.	E&SRM wing of BIWTA	BIWTA and DoE
Disaster Risk	Flood level, Flood Duration, Flooding depth, erosion and accretion, Disaster Risk Awareness,	Piloted sites, upstream area, especially Charlands area nearby the piloted sites	Bi-annually	Survey, Satellite Image Analysis, FGD, KII	E&SRM wing of BWDB	BWDB and DoE
Operation and Maintenance of Embankment,	Hydraulic condition, anthropogenic activities,	Piloting sites	Bi-annually	Survey, KII, Interview of BWDB officials	E&SRM wing of BWDB	BWDB and DoE

Components Monitoring	Monitoring Indicators	Locations	Frequency	Type/Duration of Sampling	Implemented by	
					Monitoring	Supervision
Revetment and TBPG	performance, embankment failure, O&M activities, etc.					
River Plan Form	Bankline, Flood zone, Alluvial zone,	River reach along the proposed revetment line	Annually	Survey, Satellite Image Analysis	E&SRM wing of BWDB	BWDB and DoE
Ship Pollution	Emission from Ships Incidents of waste and wastewater discharge, oil spillage from ship, etc.	Terminal areas, Sensitive areas along the navigational routes	Quarterly up to two years after construction	Exhaust monitoring (randomly selected sample ships)	E&SRM wing of BIWTA	BIWTA and DoE
Ship Inspection.	Ship Conditions Waste Management Facilities Waste Water Management Facilities Emission, energy efficiency, OHS, etc.	At Ship	At every 2 years of obtaining licensee from BIWTA	Inspection and Auditing	E&SRM wing of BIWTA	BIWTA and DoE
Ship Terminals E&S risk	Site Condition Operation efficiency of Ship waste collection and management facilities Operation efficiency of Ship waste and wastewater collection and management facilities	Ship Terminals	Quarterly up to two years after construction afterthat Bi-annually	Inspection and Auditing	E&SRM wing of BIWTA	BIWTA and DoE
Social Development and Disaster Resilience	Disaster Awareness, Social development, climate migration, Income equity, livelihood condition, WATSAN condition, disaster damage, perception on piloted works, etc.	Villages protected by proposed piloting activities and vulnerable villages near the piloting sites	Biannually	Survey, Document checking, Institutional survey, KII, Household Survey, FGD	E&SRM wing of BWDB	BWDB and DoE
Disaster Risk Financing (Community	Insurance (or other DRF solution) coverage, enrolment, insurance (or other				E&SRM wing of BWDB	BWDB and DoE

Components Monitoring	Monitoring Indicators	Locations	Frequency	Type/Duration of Sampling	Implemented by	
					Monitoring	Supervision
	DRF solution) benefits, etc.					

12.14 ESMP Implementation Cost

Detailed cost estimates for implementation of mitigation measures and preventive actions presented in ESMP are presented in **Table 12.6**. The total cost of ESMP implementation is USD 9,955,088

Table 12.6: Budget for Implementation of ESMP

Sl.	Items	Unit	Site	Quantity	Unit Rate ($)	Amount ($)	Amount (Lac BDT)
1	**Civil Works (will be part of Contractor's Budget)**						-
(a)	Camp Construction and Management	year	2	3	75,000.00	450,000	*387.000*
(b)	Preparation and Submission of CESAP	No	3	1	20,000.00	60,000	*51.600*
(c)	Revision of CESAP	No	3	2	3,250.00	19,500	*16.770*
(d)	Preparation and Submission of OHS Plan	No	3	1	30,000.00	90,000	*77.400*
(e)	Revision of OHS Plan	No	3	2	5,000.00	30,000	*25.800*
(f)	Dust Management by Water Spraying	veh-d	3	180	200.00	108,000	*92.880*
(g)	Top Soil Stripping, Storage and Reuse	m^3	3	1,950	2.00	11,700	*10.062*
(h)	EHS Staffs of Contractors (C1)	MM	3			446,512	*384.000*
(i)	Environmental Quality Monitoring	No	3	8	10,200.00	244,800	*210.528*
(j)	Personal Protective Equipment	No				306,900	*263.934*
(k)	Waste Management and Watewater Treatment plant at Shore Reception of BIWTA	No	1			120,000	*1,395.349*
					Subtotal	*1,887,412*	*1,623.174*
2	**DoE Approval**						
(a)	Phase 1 (BWDB)					*6,047*	*5.200*
(b)	Phase 2 (BWDB)					*8,721*	*7.500*
(a)	Phase 1 (BIWTA)					*6,047*	*5.200*
(b)	Phase 2 (BIWTA)					*8,721*	*7.500*
					sub-total	*29,535*	*25.400*
3	**Biodiversity Management**						
(a)	Biodiversity Management Plan (Consultancy)					*200,000*	*172.000*
(b)	Piloting of Fisheries Management Plan (by NGO)					*67,000*	*57.620*
					Subtotal	*267,000*	*229.620*
4	**Institutional Strengthening and Capacity Building**						-
(a)	PIU Budget (BWDB)					1,239,535	1,066.000
(b)	PIU Budget (BIWTA)					1,454,118	1,250.541
(c)	Panel of Experts					208,000	178.880
(d)	Consultancy Services for Updating E&S Documents of Phase 1					617,372	530.940
(e)	Consultancy services for E&S of Phase 2					1,339,093	1,151.620
(f)	E&S Consultancy Services for Construction Monitoring and Supervision					733,023	630.400
(g)	PIU Budget (BIWTA)					1,454,118	1,250.541
(h)	E&S Consultancy Services for Construction Monitoring and Supervision (BIWTA)					1,051,765	904.518
					Subtotal	*5,591,141*	4,808.381
5	**Resettlement Policy Framework (includes Staffing and Operational Costs, e.g., Hiring INGO for RAP Implementation, Independent M&E Monitor, IAs Capacity Building etc.)**						
	Land Acquisition/Resettlement						-
	Pilot Site 1 – Bhuapur					213,300	*183.438*
	Pilot Site 2- Kalihati					265,503	*228.333*
	Pilot Site 3- Kawakhola					1,323,542	*1,138.246*
	Livelihood Restoration and Development by NGO					45,118	
	Monitoring of LAP/RAP/LR&D					94,118	
	Workshop/Training					5,859	
					Subtotal	*1,947,439*	*1,674.797*
6	**Gender and SEA/SH Risk Mitigaiton Action Plan (Training and workshop)**					*100,000*	*86.000*
7	**Stakeholder Consultation and GRP**					86,050.00	*74.003*
8	**Additional Studies (Consultancy)**						-
(a)	Disaster and Climate Change Impact (DIA) Assessment					23,256	*20.000*
(b)	Exploring the Transboundary Issues of JRECDP, assessing sector-wise transboundary water demands, etc.					23,256	*20.000*
					Subtotal	*46,512*	*40.000*
					Total	**9,955,088**	***8,561.376***

13. Stakeholders Engagement, Consultation and Disclosure

13.1 Introduction

Stakeholder engagement is an inclusive process that involves stakeholders into meaningful consultations throughout the project life cycle. The Environmental and Social Standard (ESS) 10 emphasizes open and transparent engagement. According to ESS10, an "effective stakeholder engagement can improve the environmental and social sustainability of projects, enhance project acceptance, and make a significant contribution to successful project design and implementation". The GoB also place great importance on involving stakeholders for determining the environmental and social impacts associated with project implementation.

To gather local knowledge for baseline conditions, understand perceptions of the community regarding impact significance, and propose meaningful mitigation measures, attempts were made to consult with stakeholders. However, due to the Covid-19 outbreak around the country and nation-wide lockdown adequate on-site and in-person consultations were limited. The gaps were minimized using alternative approaches such as Zoom, WhatsApp, tele-consultant, remote interviews were undertaken for data collection. Additional stakeholder consultation will be held prior to project implementation.

13.2 Past Stakeholder Engagement Activities

In 2014, BWDB conducted extensive stakeholder consultation meetings for the River bank Improvement Program within the same project reach.[110] The local stakeholders extended full support to the Project[111] and still wait bankline protection to get relief from the curse of the river bank erosion in the project area. Under JRECDP Project 1, two pilot sites have been selected for river training and protection works. The C1 Consultants responsible for the technical design of the subproject conducted public consultation meetings at each site, giving due attention to social and environmental considerations. In addition, the ESIA team members for social baseline, gender/SEA-SH, stakeholders' consultation, and resettlement conducted weeklong consultation meetings in June- 2021 in the program/project area. Further consultation meetings were held on site in September and November 2021 and in January 2022. The detail outcomes of the consultation are presented in the main SEP report. The team as noted earlier conducted some virtual meetings through video conference, using zoom and other platforms, particularly with IA officials. In summary, for the ESIA, public consultations were conducted with six distinct types of local stakeholders including local community people, occupational group (agriculture, fishers) womens' group, Char people, vulnerable group (displaced due to river erosion), local government officials, relevant government agencies and other interested persons as per the ESS10.

To make the consultation effective and measningful, the targetted communities were informed earlier and a schedule was fixed. Further, some project-related information such as project background, objectives and the proposed activities of the project were distrubuted for broadbased discussion, comments and feedback. The consultations were conducted following the SEP prepared alongside this ESIA.

13.3 Summary of the Feedback from the Stakeholders

Table 13.1 presents a summary of the stakeholder consultation meetings held in the program areas in June, September, November 2021 and January and February 2022. Meetings were held along the Program AOI

[110] The RMIP was later dropped by the Government of Bangladesh due to lack of, among others, adequate dredging program for improving the navigability of the Jamuna channels.

[111] RMIP/*Social Action Plan Vol. 3 Public Consultation and Participation Plan*, Nov 2014.

and Project AOI, in adjacent Char settlements, and in the Project Footprint area of Bhuapur, Kalihati and Kaoakola.

In all, 26 consultation meetings were held in which a total of 530 persons (488 male and 42 females)[112] attended. Later in January and February 2020, further consultation was carried out in Kaoakola Char in connection with the additional activities of C1. Key concerns raised during the meetings are (i) continued erosion and loss of land; (ii) lack of appropriate measures for bank protection and river stabilization; (iii) lack of support and/or policy to assist those who are displaced by the erosion processes; (iv) loss of livelihood and limited alternative sources for support and survival; and (v) poverty and marginalization among the displaced and vulnerable groups. The details of the consultations along with photographs, participants lists are reported in the Annex 13.1. The key finding of consultation meetings are presented in Table 13.1 below.

Table 13.1: Summary of Key Concerns and Action Taken in Responses to the Suggestions

Stakeholder Group	Key Concerns of Stakeholders	Action taken
Land owners/Farmers	• Protection from any further erosion; • proper and market price for land; • compensation for structures and other assets	• River training work has been designed by the project; • Separate RPF and LMP has been developed to address the resettlement issues;
Local Laborers	• Employment opportunity in the project; • Training for alternative income and small businesses	• Separate LMP has been developed to address the labor management issues. • A livelihood restoration plan has developed under social management plan.
Vulnerable Groups/Displaced Households Due to Erosion/Char Land People	• Protection from riverbank erosion; • If any land reclaimed from the project, give priority the displaced people to distribute; • Prepare resettlement site for the displaced people living in the embankment; and • training for income and small business	• River training work has been designed by the project to protect the bank erosion; • Separate RPF has developed to resolve the land acquisition and resettlement issues as per the WB guideline and national law • A livelihood restoration plan has developed under social management plan.
Fishers	• livelihood assistance during river dredging; • training for alternative livelihood	A livelihood restoration plan has developed under social management plan.
Small Business Owners	• Compensation for loss of business; • compensation for loss of business structures	A livelihood restoration plan has developed under social management plan.
Hand Loom Owners and Laborers of Char Mouli Bazar of Kakua Union	• The hand loom owners have lost their structures and households and most of them are now unemployed • Protection from riverbank erosion	• Separate LMP has been developed to address the labor management issues.

[112] Separate meeting with women's groups were held by the gender specialist. The standalone document on GAP and SEA/SH Action Plan reported that consultation.

Stakeholder Group	Key Concerns of Stakeholders	Action taken
	• Provide appropriate training for alternative livelihood	• A livelihood restoration plan has developed under social management plan
Community Leaders/Local Government Bodies	• Take immediate action to protect river erosion and save community people; • Proper compensation to affected persons, including resettlement of the embankment dwellers; • Engage the local Govt. bodies in to the project work so that they can monitoring the quality of work; and • Regular basis dredging of the river and Char protection work to stabilize the Char; • Protection work needed through piling from river bed. • Enable early warning system for river erosion	• River training work has been designed by the project to protect the bank erosion; • Separate RPF has developed to resolve the land acquisition and resettlement issues as per the WB guideline and national law • For developing the navigation channel regular basis dredging has been considered under the project design. • To engage the community in the project a new component has added for the project named Community Engagement and Project Management
Char Dweller	• The ownership of the land has not been settled by the government. Currently all lands are attached to DC office and people have right to claim ownership. • There are several erosion vulnerable places which need to be protected. • Canal re-excavation might increase erosion risk • Flood Shelter would be highly beneficial but compensation must be paid for land intake	• Negotiated Settlement would be followed in case of any land intake. • Those locations have been considered in the project. • The Canal to be re-excavated and the alignment has been decided and agreed in a PCM. THe new alignment would not increase erosion risk. Besides, a crossbar/canal closure will be constructed to prevent erosion risk. • Compensation cost has been considered in the DPP

14. Institutional Assessment for Managing Environmental and Social Risk

14.1 Background

As per the Concept Note of the JRECDP, and the Feasibility reports, it is understood that the Bangladesh Water Development Board (BWDB) under the Ministry of Water Resources of Bangladesh, and the Bangladesh Inland Water Transport Authority (BIWTA) under the Ministry of Shipping will be the major implementing agencies (IAs) of the JRECDP. The component 1 of the proposed JRECDP, which is mostly the erosion protection work (embankment, revetment and Groynes) will be implemented by the BWDB. The Component 2 of the JRECDP which is mostly oriented to the development of navigation channel and facilities will be implemented by the BIWTA.

14.2 Approach of Institutional Assessment

The Consultant conducted a preliminary assessment of the capacity of the implementing agencies to manage environmental and social risk in line with the Environmental and Social Framework of the World Bank. The assessment has been conducted based on existing capacity of the organizations, their current practices, Environmental and Social Audit of two of their current projects (BWDB/FRERMIP[113] funded by ADB; and BIWTA/Bangladesh-India Line of Credit financed dredging in Jamuna[114]). Several key officials from BWDB and BIWTA (Table 14.1), were interviewed. In addition, a number experts and consultants who worked in different implementation projects of these organizations and ex-senior officials (top management) were interviewed to further explore the capacity from the perspective of the implementation. The questionnaire for conducting the meetings were designed following the MOTA framework[115] of Implement ability Assessment.

[113] Flood and River Bank Erosion Risk Management Investment Program (FRERMIP), an ADB funded project, is being currently implemented jointly by BWDB and Department of Disaster Management. The program area covers the stretch of Jamuna starting from the downstream of Bangabandhu Bridge.

[114] The dredging was planned as a part of the Development of fairway in the stretches of Ashuganj-Zakiganj and Sirajganj-Daikhhowa of Indo-Bangladesh Inland Water Transit and Trade Protocol Route. However, In Jamuna River only a few kms of dredging were commenced.

[115] MOTA-Motivation and Ability Framework, was first developed by Professor Phi (Phi et al 2015) to conduct Implementability which helps to systematically explore the institutional feasibility and Societal Feasibility of a, infrastructural development plan. Later, Sadik et al., (2021) has further extended the framework to make it appropriate and applicable in the field of water resources management of Bangladesh.

Table 14.1: List of the Stakeholders Interviewed for Institutional Assessment

SL. No	Name	Designation and Affiliation	Interview Date and Method
1.	Md. Rafiqul Islam Choubey	Superintending Engineer (Civil), BWDB Project Director, FRERMIP	16 June 2021, Face-to-face
2.	Mr. Md Mizanur Rahman Bhuiyan	Superintending Engineer (Civil), BIWTA	June 10 to June 17, 2021 (several conversions over email, and telephone)
3.	Mr. Md. Rahmat Ali	Deputy Chief, Fishery, BWDB	10 August, 2021, Online Meeting using Zoom
4.	Mrs. Shahnaz Parvin	Asstt. Chief (Sociology), BWDB PMU, Irrigation Management Improvement Project (Muhuri Irrigation Project)	9 August, 2021, Online Meeting using Zoom
5.	Belal Uddin Biswas	DC (E&F) Chief Planning Office DC (Agriculture) additional charge	12 August, 2021, Online Meeting using Zoom
6.	Mrs Salma Begum	DCE (Sociology), Planning 3 Chief WM	12 August, 2021, Online Meeting using Zoom
7.	Muhammad Monirul Alam Sarker*	Deputy Chief Extension Officer (DCEO), Central Zone and Addl charge Barishal and Mymensingh	July 14, 2021, Online Meeting using Zoom
8.	Mr. Hafizur Rahman*	DCEO, Jessore (additional charge)	19 July, 2021, Online Meeting using Zoom
9.	Mr. Mominul Islam*	DCEO, Jessore	19 July, 2021, Online Meeting using Zoom
10.	Mr Md Jahangir Alam	Deputy Chief	7 September and 8 September, 2021, telephone conversation
11.	Mr. K.M. Saki Ingil	Assistant Engineer (Civil), PMO, FRERMIP, BWDB	16 June 2021, Face-to-face meeting
12.	Dr Mohammad Mahfuzur Rahman	Chairman, Jashore University of Science and Technology. Ex-Research Officer (E&F), BWDB	10 August, 2021 31 August, 2021 (Conversation on Mobile)
13.	Mr. Sayed Monwar Hossain	Ex-Director, BIWTA	July 4, 2021, (conversation on Mobile)

**Interviews were conducted as a part of an ongoing research on Institutional Analysis of BWDB following the same questionnaire designed using the MOTA framework*

14.3 Profile of the Relevant Line Agencies

14.3.1 Bangladesh Water Development Board

BWDB is the mandated organization (by the Water Development Board Act, 2000) for development and efficient management of water resources of the country. The board has the power of regulating flow of surface and ground water without interfering private right. To that end, it can take (construct or establish) necessary structural (flood management infrastructure, irrigation infrastructure, dredging, water storage infrastructure, erosion protection structure, etc.) and non-structural measures (flood early warning, erosion early warning, drought early warning, research, formulation of guidelines, people' participation, etc.). The Director General is the head of the management of the Board while there is a Governing Council chaired by the Minister of the Ministry of the Water Resources and the DG of BWDB is the Secretary of the Governing Council.

The board went through several initiatives of institutional reform (1985 and 1998) that ended up in downsizing its workforce (24,368 number of posts downsized to 18,032 posts in 1984 and further downsized to 8,935 posts in 1998) which ultimately limited efficiency at the field level, especially for monitoring post-project operation. Realizing its need to expand its workforce, in 2010 the government planned a new need-based setup of a total of 13,220 workforces which is still in the approval process. The recent annual report of the BWDB (2019-2020[116]) flagged the gaps in the existing workforce.

BWDB has a very limited workforce to manage environment and social (E&S) risks since 2005 to ensure integration of environmental and social risks into the project planning. Their involvement in project implementation is very limited unless they are attached to a particular project. In post-project monitoring, their involvement is subject to their involvement in any technical committee formed by the head office which is also a very irregular practice.

14.3.2 Bangladesh Inland Water Transport Authority

Bangladesh Inland Water Transport Authority is a successor of the East Pakistan Inland Water Transport Authority which was established in 1958. BIWTA is the mandated organization for conservancy works including river training works for navigational purposes and for provision of aids to navigation. Therefore, the autonomous organization has been developing, operating and managing inland water ways and navigational aids including ports and terminal facilities; providing pilotage services and salvage operation to inland water transports; maintaining navigational routes, etc. It also serves the regulatory services to ensure vessel safety and design standards, ensures conservancy of navigation routes, surveys and publishes hydrographic information, etc. BIWTA is also the competent authority of Bangladesh for the protocol route between India and Bangladesh.

The authority consists of chairperson and three members appointed by the Government. BIWTA has 19 divisions, each run by either a director or a chief.

Currently BIWTA does not have any workforce to manage Environmental and Social risks.

14.4 Current Institutional Arrangement of BWDB for E&S Risk Management

A focused institutional arrangement for managing E&S Risk and ensuring integration of E&S risk management into operation is yet to be planned and established. Although, there are a few officials recruited to integrate Environmental and Social risks into the project planning. The interviewed officials clarified that responsibility of E&S risk management is embedded in the general responsibilities of O&M circles and Executive offices. For almost all foreign aided ongoing projects, the project management unit

[116] https://bwdb.gov.bd/en/archive/pdf/6820.pdf

(PMU) has institutional arrangement for E&S setup. The capacity of BWDB for managing E&S risk can be illustrated and described in two ways – i) permanent capacity and ii) project based ad hoc capacity.

14.4.1 Permanent Capacity of BWDB in Managing E&S Risk

BWDB created several positions in the field of Environment and Social Development in 2003 and the first recruitment was made in 2005. The positions were Research Officer, Assistant Chief, and Deputy Chief for each of the three disciplines – Environment and Forest, Social Development and Fisheries. Table 14.2 shows the current number of positions in the current organogram of BWDB where lack of recruitment and position has clearly identified. This gap has imposed an ultimate burden to other staff and hinders the E&S related works. A close look at Table 14.2shows that there are 4 Assistant Chiefs (Sociology) and 3 Assistant Chief (Environment & Forest (E&F)), 1 Assistant Chief (fisheries). In the same way we found that there are Deputy Chief (DC) position for Sociology and Fisheries but no DC position for E&F. This discrepancy has revealed a silent dissatisfaction among the current workforce.

Table 14.2: Nos of Position in the Current BWDB Organogram and Actual Recruitment

Position Name	Current No. of Positions	Positions Filled	Positions Vacant
Nos of Research Officer (E&F)	4	3	1
Nos of Research Officer (Sociology)	4	2	2
Nos of Research Officer (Fisheries)	3	2	1
Nos of Assistant Chief (E&F)	3	1	2
Nos of Assistant Chief (Sociology)	4	4	0
Nos of Assistant Chief (Fisheries)	1	1	0
Nos of DC (E&F)	0	0	0
Nos of DC (Sociology)	1	1	0
Nos of DC (Fisheries)	1	1	0

In addition, such positions were created without clear placement in the organogram and they were attached/posted in different departments like Planning Directorate, Monitoring and Evaluation and some large-scale projects. Since there was no definite career path for the recruits and the positions were not designed for promotion to excel, frustration grew among these staffs which resulted leaving the job for other opportunity. Later, in 2010 (Gazetted in 2013 as BWDB Service Rules 2013) the BWDB prepared a Need-Based Organogram merging the professionals in the field of Environment and Social into the Water Management Sub-Cadre under the Chief, Water Management. The Chief Water Management was already suffering from workforce shortages and career path issues, with this merger the promotion became more competitive. Besides, the roles and responsibilities of Water Management Cadre and Environmental and Social Cadres (including Fisheries) are completely different which created another issue of effectiveness. After the merger, the Deputy Chiefs of Environmental and Social Cadre could become Principal Extension Officers whose roles and responsible is completely different that E&S risk management. Such complexity created problem in implementation of the merger. During the assessment process, cadres from both lines suggested establishment of independent unit/wings/department for Water Management and E&S Risk Management.

The systematic assessment clearly indicates that there is a need of establishing a separate unit for E&S Risk Management with adequate workforces. The unit or wing to be established should also be extended to at least Zonal Officer of BWDB at this stage and up to the field level in future. The findings of the systematic institutional assessment have been presented in Table 14.3 .

Table 14.3: Current E&S Risk Management Capacity of BWDB

Sl no	Component	Current Capacity and Gap	Remarks/ Suggestion
1.	Financial	• Financial capacity of an implementing project depends on consideration of cost items considered in the DPP. Often,	An independent E&S risk management unit headed by Chief E&S Risk

Sl no	Component	Current Capacity and Gap	Remarks/ Suggestion
		adequate budget for ESMP implementation is not adequately considered in the DPP. • There is no annual budgeting system of E&S risk management. However, it is understood to be embedded into the regular O&M activities. However, such O&M budget is not adequate to effectively address the E&S risk. • Currently the Chief Water Management Office only prepare the annual budget for training and social mobilization of Water Management Groups. There are some Environmental Issues discussed in such training as well. However, such budget is inadequate to cover efficient training of WMOs to manage local E&S risk. • The training budget for BWDB staffs including the E&S staffs is prepared by the training department.	Management with sufficient annual budget allocation and financial power to spend on E&S risk monitoring and management is necessary.
2.	Institutional	• The BWDB does not have its own policy on E&S Risk management. However, the National Policies, and Laws of the Governments apply to BWDB as well. • The MoWR and WARPO have developed a guideline on EIA for Water Resources Project in 2003 (published in 2005) which is very old and focused on only EIA methodology which is outdated as well. • Currently BWDB has some professionals related to Environmental and Social Development Aspects. But there is no unit or wing responsible for E&S risk management. The current E&S professionals are posted to planning directorate, monitoring and evaluation, Chief Water Management Office, and different projects. • Recently, the E&S professionals are merged into Water Management wing/cadre which created opportunity of promotion to upper position for the E&S professionals but it created more competition for the existing professionals of WM cadre. • There is no position above the Deputy Chief focused on E&S risk. After the promotion when the current Deputy Chiefs of E&S field will be the Principal Extension Officers whose responsibility is implementing Participatory Water Management. • Until the merger, those E&S positions were appeared to be blocked post which resulted leaving of job of a number of E&S recruits. • There is the issue of accessibility to policy and decision making as well. Currently, the highest position of an E&S professional is Deputy Chief which is equivalent to Executive Engineer (5th Grade). Therefore, they do not have any access to policy level meetings, Ministry level meetings where a certain level of hierarchy are maintained and only the officials higher than 5th grades are allowed. • The current workforce on E&S issues and institutional mandates of the workforce are limited to their involvement in planning with an open clause that they are to be involved as per the direction of the top management. Currently, they are not involved in project implementation (unless they are posted to any project) and post-project monitoring (unless they are not nominated as a member of a technical committee).	A separate unit/ wing/ department should be established focused on E&S risk management. The unit should have its own mandates, budgets and financial spending power. Besides, BWDB should have its own policy on E&S risk. The EIA guideline published in 2005 should be revised.

Sl no	Component	Current Capacity and Gap	Remarks/ Suggestion
3.	Social	• In general, the BWDB has a good network and relationship with Development partners and other government agencies. • However, at local level, there is an issue of coordination. Since the E&S officials are mostly based in Dhaka, they are not connected with local government agencies, local NGOs and local community as well. Although the Water Management offices maintain communication and relation with local community and local government agencies directly and through the water management groups, their concern is more towards participatory water management and local O&M issues. • During project planning, and implementation, local level stakeholder meetings are conducted to explore the E&S issues. But the scope and practice of organizing E&S focused workshop or meeting with community and other stakeholder at local level in post-project time is very limited.	A separate unit/wing on E&S risk management extended up to zonal level can take the responsibility of local level coordination and communication from E&S perspective.
4.	Technical	• There is no established practice of training the current E&F officials on E&S issues especially on E&S compliance, World Bank's ESF, etc. • However, recently the training department of the BWDB has started keeping one or two lectures focused on environmental issues, ESIA or E&S compliance for the new recruits and whenever any long training course is designed. • Each year, officials have access to several trainings but those are mostly from external sources. • None of the E&S officials have received training on World Banks new ESF. • There is no regular training program designed for the E&S officials. • The responsibility of ESMP implementation and ensuring E&S safeguard in project implementation go to field level executive engineer. In most of the cases, field engineers are not completely equipped with E&S compliance training. • In case of foreign aided projects, such limitation is covered by recruiting E&S staffs in the Project Management Unit and hiring consultants. But no permanent capacity has been developed.	The technical knowledge is linked with permanent capacity. If a separate unit is established, they can arrange regular training and skill development including staffs certifications on E&S risk management (e.g., OHS certificates like, NEBOSH, IOSH, Safety Professional, etc.).
5.	Perceived Opportunities (advantages) of Adopting World bank's ESF	**It ensures:** • Environmental Sustainability • Environmental and Social Safeguard. • ESIA/EIA/SIA often help us to take best decision • ESF and other national international safeguard requirements are to help project implementing in sustainable manner, not to halt a project	Staffs can obtain Certificates free of cost on Environmental and Social Framework - ESF Fundamentals, The Open Learning Campus of the World Bank Group.
6.	Perceived Threats (disadvantages) of Adopting World bank's ESF	There are some administrative and practical difficulties implementing ESF, e.g., as per WB requirement illegal settler should also get compensation which is against the government practices.	

14.4.2 Ad hoc Capacity in Managing E&S Risk at Project Level

In case of foreign aided projects, the project management unit often have Environmental and Social Experts to monitor the E&S risk and compliance. The PMU then engage several consultants to take care of the E&S risk management issues. For example, FREMIP, the Blue Gold Program, the World Bank Funded Coastal Embankment Improvement Project (CEIP), etc. have dedicated unit/s for managing E&S risk and monitoring E&S performance. However, their involvement is focused on providing technical support. The local implementation unit (Executive Office of the BWDB) still suffers the absence of E&S specialists which sometime lead to having gaps or inefficiency in implementing E&S risks. Since the function and operation of PMU are limited to the project period, post-project operation and monitoring of ESMPs or management of E&S risk fall under the responsibility of relevant O&M circle. Due to the lack of workforce and no provision of dedicated E&S unit, post-project management of E&S risk including operation and monitoring ESMPs are often overlooked. Organizational arrangements for foreign funded projects are presented in Figure 14.1: Project Level Institutional Arrangement of BWDB (Foreign Aided Project)

In case of a government funded project, an E&S unit like that in foreign aided projects are not common. The PMU or the Chief Engineer office hires a consulting firm for E&S risk assessments (IEE, EIA) and environmental monitoring during project construction. The post project operation and monitoring of ESMP fall under the responsibility of relevant O&M circle.

The Chief Monitoring office is responsible for overall monitoring of ongoing projects but its focus is always on physical and economic progress of a project/s. The DG, BWDB also frequently forms taskforces for monitoring ongoing and completed projects but they also focus on engineering standards. The environmental and social management and monitoring are thus overlooked. Sometime, the committee adopts any Assistant Chief or Deputy Chief (E&F/Fisheries/Social Development) as a member, but their scope of work is very limited. Organization Chart for government funded project is presented in Figure 14.2.

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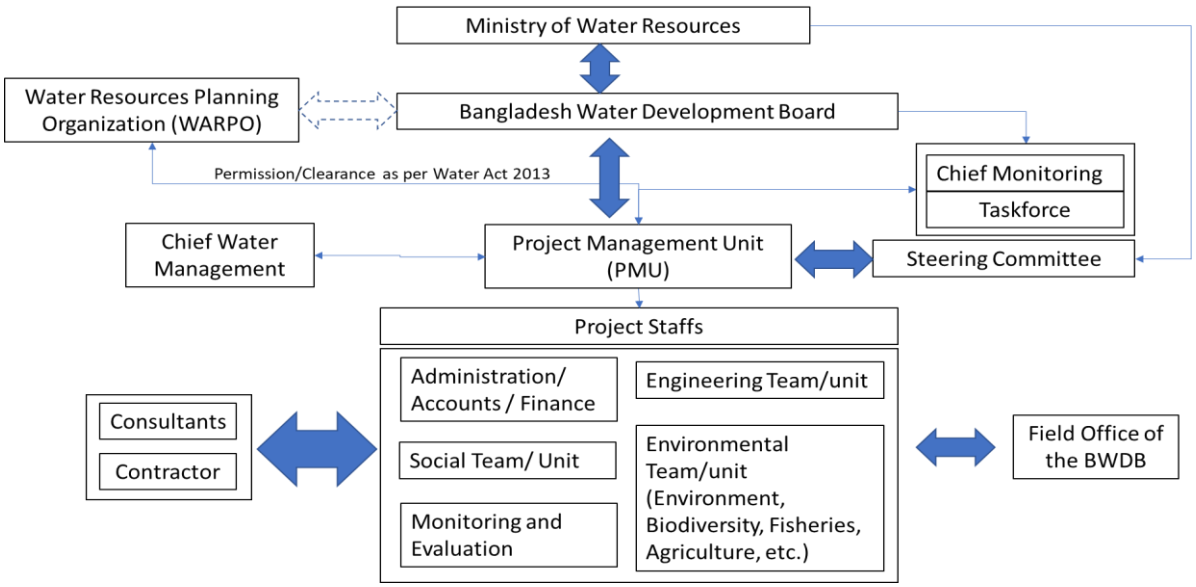

Figure 14.1: Project Level Institutional Arrangement of BWDB (Foreign Aided Project)

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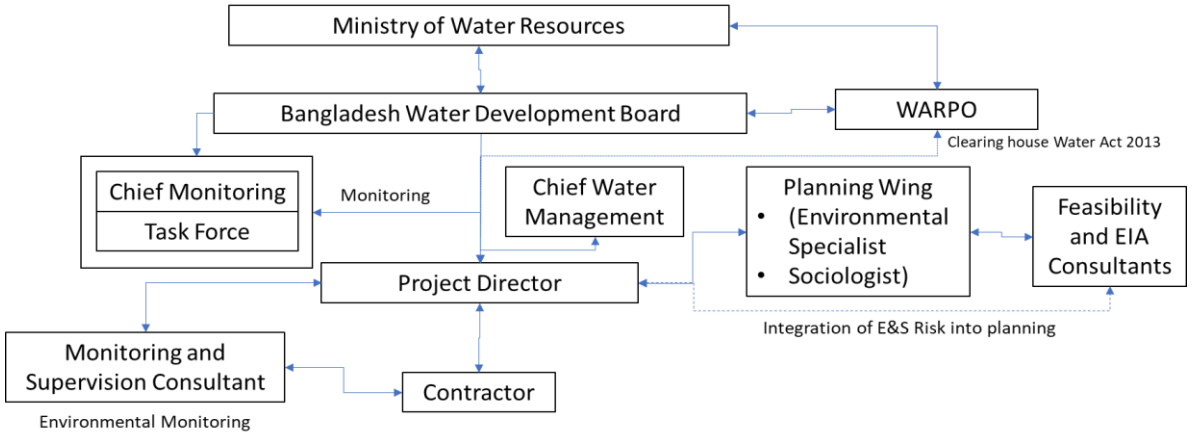

Figure 14.2: Project Level Institutional Arrangement of BWDB (GoB Funded Project)

The E&S officials (Research Officer/Assistant Chief/Deputy Chief in the field of Environment and Forest, Fisheries and Social Development) posted in the Planning Directorate/Wing support incorporating the environmental and social risk management into the project planning. They often prepare pre-feasibility report and IEE of comparatively smaller project with low budget. But they are not directly involved in project implementation and operation.

14.5 Current Institutional Arrangement of BIWTA for E&S Risk Management

Unlike to BWDB, BIWTA have neither a dedicated unit nor a dedicated workforce for managing E&S risk. BIWTA manages the E&S risk of an ongoing project by the setup of Project Implementation Unit (PIU). The PIU generally appoints consultants for conducting feasibility study, environmental studies (IEE, EIA, ESIA whichever appropriate) and for monitoring and supervision including the task of environmental monitoring. The E&S consultants involved in different BIWTA project, stressed the lack of experience and workforce of BIWTA in handling E&S risk. The BIWTA officials also stressed the need of long-term capacity for managing E&S risk.

The ESIA reports of some recent large-scale projects of BIWTA recommended setting up a dedicated unit for E&S safeguarding/compliance[117] which has not been followed yet. While interviewing the relevant officials of the dredging department of BIWTA, it has been understood that strengthening the planning department with additional workforce for handling E&S compliance had been proposed. There is a similar discussion taking place for strengthening the capacity of the dredging department.

[117] ESIA and ESMP of Bangladesh Regional Water Transport Project, available at

http://biwta.portal.gov.bd/sites/default/files/files/biwta.portal.gov.bd/page/4e97b481_943e_4ca4_ae8a_a325b0aac1b9/Final%20Report_Main%20Text.pdf

http://documents1.worldbank.org/curated/es/976801468014656634/pdf/SFG1546-REVISED-EA-P154511-Box396264B-PUBLIC-Disclosed-6-2-2016.pdf

14.6 Women in the Implementing Agencies

Currently women employment in both implementing agencies is not as encouraging as it should be. The BWDB has 11.67% women staffs. However, there is no women in the top management (i.e., Director General to Additional Chief Engineer). Among the Superintending Engineers and equivalent other officials, women officials are only 2.9% (3 out of 101). Among the assistant engineers and equivalent officials 10.2% are women which is showing a sign of improvement.

In case of BIWTA only 5.7% women staffs. However, among the technical and managerial staff women are 10.05% and among the support staff they are 5.37%.

14.7 Strengthening Capacity of E&S Risk Management for BWDB

The BDP2100 sets out USD38 billion worth of physical and institutional investments,[118] which are projected to increase economic growth by 8 percent per year. A major portion of these investments are to be led by the Ministry of the Water Resources and thereby the BWDB. Since the BDP 2100 has received a huge attention from the major Development Partners including Netherlands, Japan, Germany, United Kingdom, France, Canada, the United Nations Development Programme, the Food and Agriculture Organization, the Asia Infrastructure Investment Bank (AIIB), the Asian Development Bank (ADB) and the World Bank.

Therefore, it is expected that a significant number of large-scale projects will be soon planned and implemented by the BWDB. It is out of subject to mention that, management of E&S risk will become vital for these development projects, which will require a long-term vision and capacity development of the BWDB in E&S Risk Management.

Besides, the Government has established the Perspective Plan 2021-2041 realizing the Vision 2041 with a reachable vision of being a developed nation by 2041. The Perspective Plan sets its pathway on four pillars: (i) governance; (ii) democratization; (iii) decentralization and (iv) capacity building. To this end, one of the key targets is improving the "Global Environmental Performance Index" of Bangladesh from the "bottom 5%" to "top 30%". Such improvement can only be possible when the government agencies will increase its E&S Risk management capacity.

14.7.1 Proposed Long-term Capacity for Managing E&S Risk

In line with the policy requirements as mentioned above, and the requirement of the ESF of the World Bank, This E&S study proposes establishment of a new Wing/Unit to be entitled as "Environment and Social Risk Management (E&SRM)" headed by a Chief (equivalent to a chief Engineer, Grade 2) under the Director General of BWDB. The wing will have offices at – i) Head Quarter, ii) Central Office, and iii) nine zonal offices (Figure 14.3). This proposal will be further reviewed at the Project 1 implementation stage, based on detailed consultation with Implementing Agencies. The detail organogram is illustrated in the Figure 14.4. The E&SRM will oversee managing E&S risk of a project and thereby support to the planning, implementation, operation and maintenance of Water Management Project of BWDB. They will closely work with the field offices of BWDB ensuring E&S compliance requirements are fulfilled, the WM projects are operated ensuring E&S safeguards. The details job description of the E&SRM Wing/Unit during the project life cycle are described in the Table 14.4 below.

[118] The World Bank, under the Bangladesh Water Platform 3.0 (see paragraph 29), plans to develop a financing strategy with the Government for the majority of the BDP2100 infrastructure investments. This strategy, and an accompanying implementation road map, are scheduled to be completed in April 2021.

Table 14.4: Job Description of the E&SRM Wing/Unit

Planning and Pre-Construction	Construction	Operation and Maintenance
• The E&SRM Wing/Unit will be responsible for integrating E&S Risk Management and Planning into the Water Resources Management Planning and Practice of BWDB, • The Wing/Unit will be responsible for E&S Risk Planning, • The Wing/Unit will be in charge-of Preparing terms-of-reference of the SEA, SESA, ESIA, IEE, EIA, LARP, RAP, LMP or other environmental and social assessment works, and Support the Project Director while Engaging the E&S Consultants, • The Wing/Unit will provide necessary E&S Risk Management related inputs to the DPP, • The Wing/Unit will monitor the activities of the E&S Consultants and review, make comment and approve (Internal) the SEA, SESA, ESIA, IEE, EIA, LARP, RAP, LMP or other environmental and social assessment related reports submitted by the consultant, • The Wing/Unit will coordinate with the Department of Environment and will be in charge of obtaining and renewing Environmental Clearance Certificate from the DoE,	• The Wing/Unit will be responsible for E&S Risk related Support to Implementation • The Wing/Unit will also be co-responsible for implementing the ESMP, RAP and other E&S Risk management plans along with the O&M division/Project Director in concern. The Wing/Unit will maintain close cooperation, collaboration and coordination with the O&M divisions in implementing ESMP and vice-versa. • Responsible for assisting Project Directors in reviewing bid documents for inclusion of ESMP measures, overseeing and monitoring construction activities, producing periodic monitoring reports and submit them to DOE and funding agencies, • Ensuring inclusion of ESMP including OHS and CHS aspects, ESCPs, and ESMP budget with detailed BoQ in bidding documents, • Advising on ESMP principles and requirements to CSC, contractors, and providing training to BWDB field staffs, and others as needed to ensure effective implementation of the ESMP, • Supervising CSC for the implementation of ESMP, • Closely coordinate with other concerned agencies, local governments and communities to support implementation of ESMP and RAP, • Preparation of progress reports on implementation of ESMP and RAP. • Will be jointly responsible for Implementing E&S Monitoring Plan along with the PD or the O&D division in concern	• The Wing/Unit will be responsible for E&S Risk related Support During O&M • The Wing will be responsible for coordinating with DoE for Renewing Environmental Clearance Certificate. • Prepare Necessary E&S Monitoring report for the purpose of renewal of Environmental Clearance Certificate • Will be jointly responsible for Implementing E&S Monitoring Plan along with the PD or the O&D division in concern • Plan and propose training and skill developments of staffs in emerging fields, such as OHS, wildlife conservation, disaster risks and climate change, and • The Wing/Unit will also inform the O&M Division in Concern when any E&S risk management/mitigation measures are needed to ensure E&S safety of a project during O&M • The Wing will also coordinate with the Chief Water Management office and work closely with the Water User Groups to enable them taking care of regular E&S Risk Management Measures and to enable them taking E&S risk management related decision.

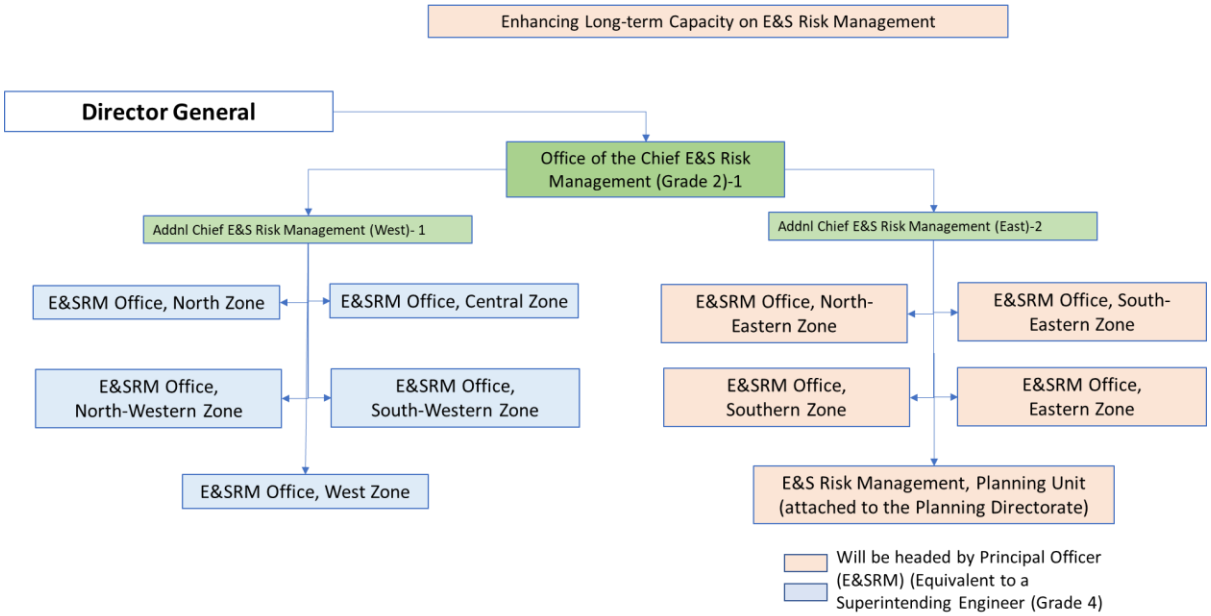

Figure 14.3: Proposed Institutional Set-up of Environmental and Social Risk Management Wing of BWDB

BWDB has an old laboratory, which has very limited resources. It is recommended that BWDB establish a central Laboratory focusing on Environmental and Ecological Health of the River and Floodplain. In addition to environmental and ecological health monitoring equipment (e.g., water quality parameter testing equipment, benthos and plankton examination equipment, dredged material testing equipment, etc.) the laboratory should be equipped with online monitoring facilities at major rivers, data management and reporting, storage of data in a central server, etc. Additional study will be needed whether the existing laboratory will be refurbished or a new central laboratory will be established. If new then the requirement of workforce and equipment will be assessed and will be proposed later.

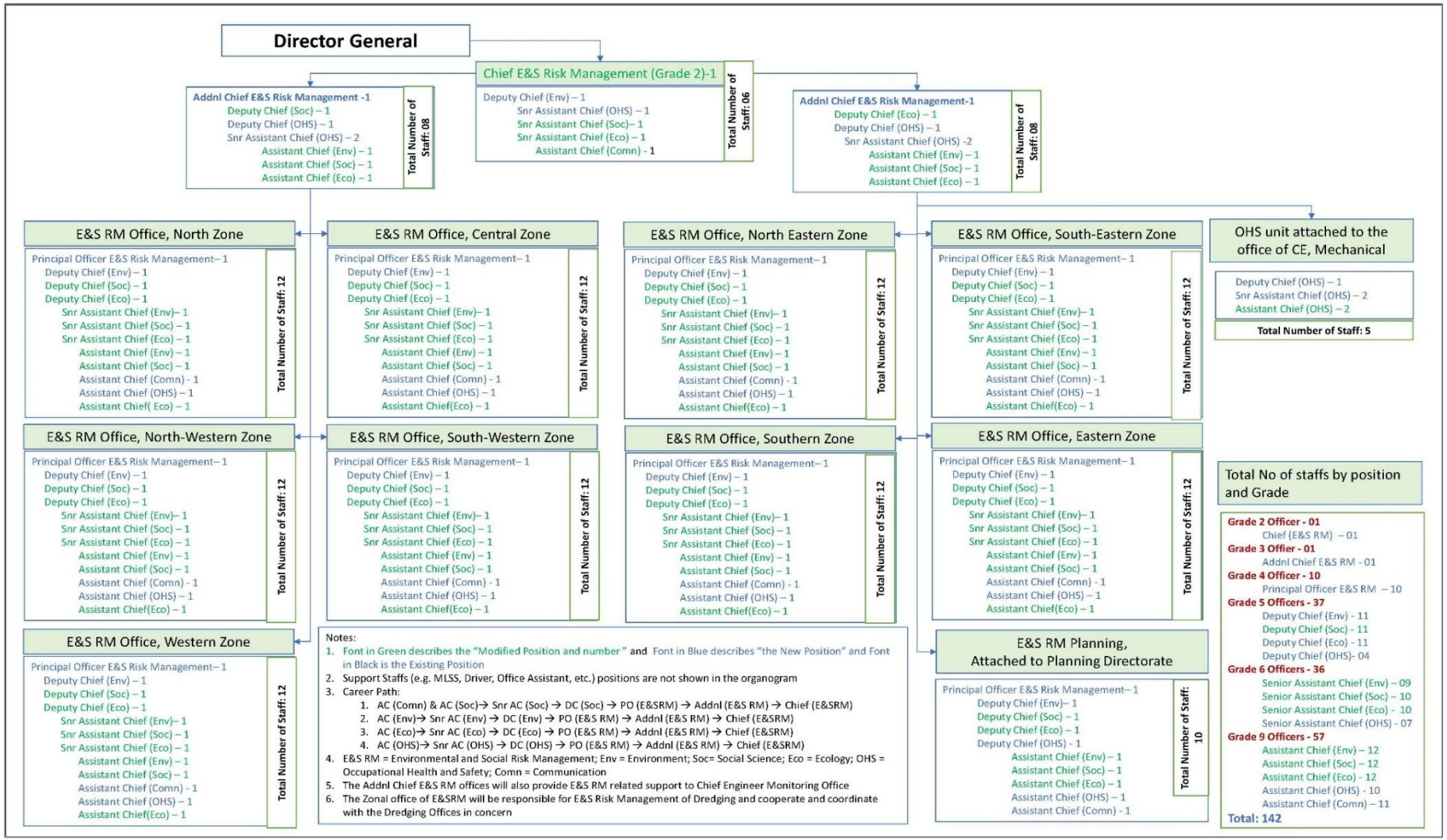

Figure 14.4: Organogram of the Proposed E&S Risk Management Wings of BWD

14.7.2 Proposals for Strengthening Project Level Capacity to Support the Implementation of JRECDP Project 1

For strengthening the project level capacity to support implementation of the JRECDP Project 1, a number of E&S experts are proposed to be recruited for the Project Implementation Unit/Project Management Unit (Table 14.5). Besides, a third-party consulting firm should be recruited for supervision and monitoring of ESMP implementation. E&S consulting teams will be required for updating the E&S Documents of S1 and E&S Documents of P2.

Table 14.5: E&S Individual Consultants for the PIU

Sl.	Position	Person-months
1	Deputy Chief (ESHS)	42
2	Environmental Specialist	42
3	OHS and labour Specialist	42
4	Resettlement Specialist	42
5	Gender and SEA/SH Specialist	42
6	Communication & GRM Expert	42
7	Training Coordinator	42

14.7.3 Support from Field Level Offices of BWDB

The PMU/PIU can obtain field level support from field offices. Such supports might include the following:

- Maintain liaison and interaction with the PAPs and local communities to address their concerns;
- Provide proper guidance to PAPs for the submission of their requests for compensation as per eligibility and entitlement;
- Help the PAPs to forward their complaints, if any, to the GRC;
- Maintain close liaison with PMU, E&SRM Unit/Wing, contractor, and relevant government departments for RAP implementation;
- Distribute the notices to the entitled PAPs regarding payment of compensation; and
- Facilitate the PAPs for completing the necessary documentation to receive their entitled payments; and
- Maintain close liaison with PMU, E&SRM Unit/Wing, contractor, and relevant government departments for RAP implementation and traffic management.

14.7.4 Construction Supervision Consultant

CSC will be responsible for the following tasks:

- Responsible for the supervision of RAP and ESMP implementation
- Updating the RAP before start of RAP implementation;
- Supervise civil works, ensuring compliance with all design parameters including quality requirements
- Ensure Contractors include EHS parameters based on Job Hazard Analysis in their Method Statement
- Supervising contractors for ESMP implementation and issuance of noncompliance reports
- Conduct EHS and ESCOP trainings
- Provide input, advice and approval on activity specific method statements relating to ESMP
- Prepare monthly reports and submit to PMU

The E&S staffs of CSC with estimated person-month person-months are presented in Table 14-8.

Table 14.6: Consultancy Service for Construction Supervision and Monitoring

Position Name	No. of Position	Person-months
Environmental Specialist	1	30
Biodiversity and Wildlife Specialist	1	26
Socio-economic Specialist	1	22
Gender and SEA/SH Specialist	1	20
Land Tenure & Resettlement Specialist	1	20
Stakeholder Engagement & Communication Specialist	1	30
Community and Occupational Health & Safety Specialist	1	26
Labor Laws Specialist	1	16
EHS Inspectors	8	304

14.7.5 Contractor

Contractors will be responsible for the following:

- Preparation of CESAP with site and issue specific mitigation and management plans for approval of CSC before mobilization.
- Preparation of Occupational Health and Safety Plan based on risk assessment, construction methods, site specific hazards. Revise OHS Plan (a) when there is a change in the scope of the project, (b) there is a change in construction methodology/technique based on site condition, and (c) following significant OHS hazard or a major accident.
- Responsible for implementation of mitigation and monitoring measures and controls (OHS Processes and SOPs) proposed in the ESMP
- Prepare separate monthly reports for addressing environmental and social impacts and OHS issues

The following personnel presented in Table 14-9, are required in the contractor's environmental, social, health and safety team:

Table 14.7: EHS Staffs of Contractors

Position Name	No. of Positions	Person-months
Environmental Specialist/Manager	4	24
OHS Specialist/OHSO	4	24
Communication Specialists	4	24
Licensed Medical Doctor (MBBS)	2	24
Medical Technician	2	24
EHS Inspectors	8	24

14.7.6 Panel of Experts

The Panel-of-Experts (POEs) will provide independent guidance to implementing agencies and the Consultants will be recruited by the IAs. They will guide the Program's preparation and implementation as part of the E&S risk mitigation and management. Table 14-10 presents the POE members and their estimated person-days.

Table 14.8: Panel of Experts

Position Name	No. of Positions	Person-day
River Training & Hydro-morphology Expert	1	40
Navigation Expert	1	40
Rural Livelihood Expert	1	40

Bio-diversity Expert	1	40

14.8 Strengthening Capacity of E&S Risk Management for BIWTA

In line with the policy requirements described in section 14.6.1 and the requirement of the World Bank's ESF, this E&S Study proposes a dedicated directorate on E&S Risk Management in BIWTA to be headed by a director. The directorate is proposed to be established under the office of the Chairman of BIWTA. Figure 14-5 presents the proposed human resources required under the proposed E&S Risk Management Directorate.

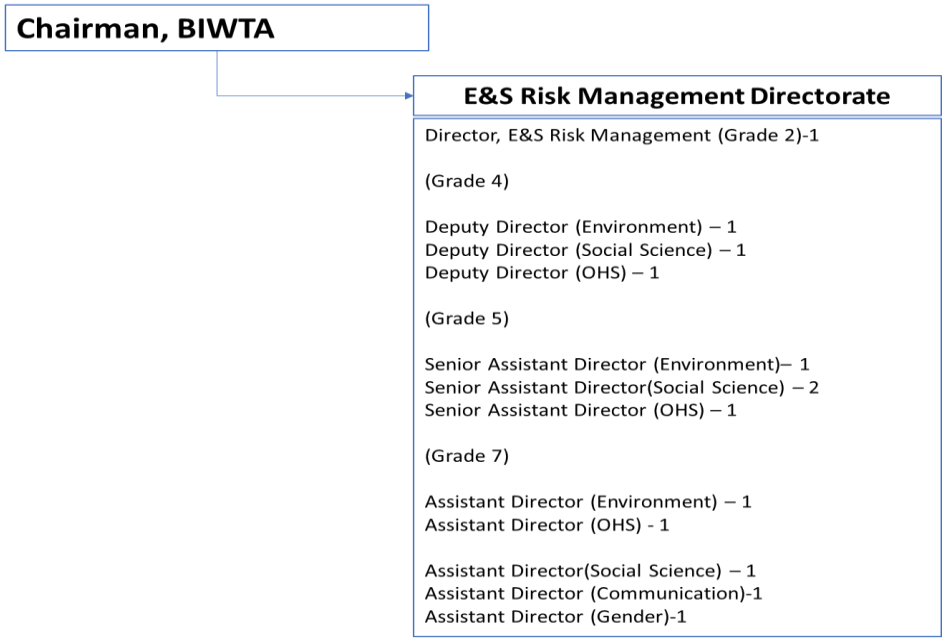

Figure 14.5: Organogram of the Proposed E&S Risk Management Directorate of BIWTA

14.8.1 Proposals for Strengthening Project Level Capacity to Support the Implementation of JRECDP Project 1

For strengthening the project level capacity to support implementation of the JRECDP Project 1several E&S specialists are proposed for the Project Implementation Unit (Table 14.11). Besides, a third-party consulting firm needs to be recruited for supervision and monitoring of ESMP implementation (Table 14-12).

Table 14.9: E&S Individual Consultants for the BIWTA PIU

Sl	Position Name	No of Positions	Person-month
1	Environmental Specialist	1	42
2	Resettlement Specialist	1	42
3	Gender and SEA/SH Specialist	1	42
4	Communication & GRM Specialist	1	42
5	Biodiversity Specialist (Aquatic Ecology)	1	42
6	OHS Specialist	1	42
7	Training Coordinator	1	42

Table 14.10: Consultancy Service for Construction Supervision, Monitoring (BIWTA)

Sl	Position Name	No of Positions	Person-months
1	Environmental Specialist	1	26
2	Biodiversity and Wildlife Specialist	1	26
3	Socio-economic Specialist	1	20

Sl	Position Name	No of Positions	Person-months
4	Gender and SEA/SH Specialist	1	14
5	Land Tenure & Resettlement Specialist	1	12
6	Stakeholder Engagement & Communication Specialist	1	26
7	Community and OHS Specialist	1	26
8	Labor Laws Specialist	1	14
9	EHS Inspectors	6	156

14.8.2 Consultant for the Preparation of Phase 2

Consulting services will be required to prepare E&S documents for Phase 2 interventions and Navigation Master Plan under the Program. Table 14-13 presents the human-resources required and an estimated person-months for the services.

Table 14.11: Required Resources for the Phase 2 Preparation

Sl	Position Name	No of Positions	Person-months
1	Environmental Specialist (International)	1	2
2	Environmental Specialist	1	4
3	Ecologist	1	4
4	Social Development Specialist	1	4
5	Gender & SEA/SH Expert	1	4
6	Occupational Health & Safety Expert	1	4
7	Consultation and Communication Expert	1	4
8	Field Surveyors	4	12

14.9 Requirements of National Policy

The Government of Bangladesh has already introduced the 2021-2041 Perspective Plan (PP2041) which is a continuation of vision 2021, has been embraced by the government and aims to carry the country to the path of development. Out of the major priority areas of this road map GOB has placed a special emphasis on "BLUE ECONOMY", which has focused to increase the economic growth keeping the natural environment protected and aquatic and terrestrial resources safe.

There is no shortage of environmental rules, regulations and plans in Bangladesh. Many laws and regulations have been enacted over the years to protect and mitigate the environmental risk/impact and programs and policies are in place to adapt and minimize the adverse effects of climate change. However, the results on the ground are less than satisfactory causing much weaker performance of Bangladesh in environmental management relative to other countries. The main constraints are skilled and trained human resource and administrative capacity.

In line with the achievement of Vision 2041 the BWDB and BIWTA under the Ministry of Water Resources and Ministry of Shipping (MoS) is currently playing a vital role by implementing the Jamuna River Economic Corridor Development Program which is funded by World Bank and Asian Infrastructure Investment Bank (AIIB). In the recent years most of the donor agencies including World Bank has mandated all borrower to manage and mitigate substantial Environmental and social risk that is associated with the development project. Albeit both of those IAs has the experiences to work with Bank funded project under old Operation Policies/Bank Policies. However, World Bank has initiated new Environmental and Social Framework (ESF) with ten Environmental and Social Standards (ESS) in October 2018. JRECDP will be the first ESF compliant project for both IAs, involving substantial E&S risks management. Therefore, the proposed program demands more dedicated and skilled workforce to manage E&S impacts and risks.

Based on the gaps of current Organogram and opinion of the employees from BWDB E&S unit, the Consultant has prepared and proposed an updated Organogram for BWDB, with the following changes and addition to strengthen the E&S Risk Management unit:

- Some positions are increased by number and some are modified by their position names with specific roles and responsibilities.
- New Position has added to strengthening the capacity of E&S unit to cope with ESF.
- Entry level positions RO (Social Science) and RO (Communication) will be promoted to Assist ant Chief (Social Science). Similarly, RO (Environment) and RO (OHS) will be promoted to Assistant Chief (Ecology).
- Principal Officer (E&S RM) positions are the promotional position for Deputy Chiefs.
- Similarly, Additional Chief (E&SRM) is the promotional position for PO (E&SRM) and Chief (E&SRM) is the promotional position for Additional Chief (E&SRM)

It can be assumed that the proposed Organogram for both BWDB and BIWTA will not only enhance their capacity of the E&S unit but to form an individual strong platform with environmental and social expertise where there will be a specific carrier path to develop the young professional.

14.10 Capacity Building and Training

Capacity building for effective implementation of the E&S Risk Management is a key element of the ESMP and will require to be carried out at all tiers of the project, including BWDB head office and zonal offices, BIWTA, CSC, and contractors. At the construction site, CSC will take the lead in implementing the capacity building plan, though the contractors will also be responsible to conduct trainings for their own staff and workers. The various aspects that are covered under the capacity building will include general environmental and social awareness, key environmental and social sensitivities of the area, key environmental and social impacts of the project, ESMP and ESCOP requirements, OHS aspects, and waste disposal. **Table 14-14** provides a summary of various aspects of the environmental, OHS, and social trainings to be conducted at the construction site. The plan along with the budget should be further reviewed by Project 1, implementation consultant and may revise as needed in consultations with IAs.

During the O&M phase of the project, these trainings will continue to be conducted by the staffs of IAs for all relevant O&M personnel.

Table 14.12: Environmental and Social Training

Contents	Participants	Responsibility	Schedule
• General environmental and socioeconomic awareness; • Environmental and social sensitivity of the project influence area; • ESCOP Mitigation measures; • Community issues and workers' code of conduct; • Grievance Mechanism; • ESMP • Awareness of transmissible diseases • Social and cultural values.	PMU; CSC; selected contractors' crew	CSC	Prior to the start of the field activities. (To be repeated as needed.)
• Certificates on Environmental and Social Framework - ESF Fundamentals, the Open Learning Campus of the World Bank Group.	E&S Risk Management Staffs	Proposed E&S Risk Management Unit or Directorate	Online participation
• OHS Plan • Job Hazard Analysis • Incorporation of EHS in Method Statement	Construction Workers	Contractors	Prior to the start of the construction activities. (To be repeated as needed.)
• Road safety; • Defensive driving/; Waste disposal; • Cultural values and social sensitivity.	Drivers;	Contractors	Before and during the field operations.

Contents	Participants	Responsibility	Schedule
			(To be repeated as needed.)
• Importance and use of PPEs and emergency communication • Excavation, Cranes and Rigging, Working at heights, scaffolding,	Workers	Contractors	Before and during the field operations. (To be repeated as needed.)
Application of Contractual Instruments during OHS violations Excavation and trenching OHS in handling and transportation of mechanical equipment	Contractor, CSC, E&S Risk Management Staffs	CSC	During construction.
Overseas training on EHS for E&S Risk Management Staffs	E&S Risk Management Staffs	CSC	During Construction

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