Environmental Impact Assessment (draft)

Project No.: 44167-015
August 2020

(1 of 2)

Bangladesh: Flood and Riverbank Erosion Risk Management Investment Program – Project 2

Prepared by the Bangladesh Water Development Board for the Asian Development Bank.

Government of the People's Republic of Bangladesh

Bangladesh Water Development Board

Asian Development Bank

Prepared for Project Loan No TBC and Grant No TBC

Flood and Riverbank Erosion Risk Management Investment Program (FRERMIP)-Project-2

Draft Environmental Impact Assessment

August 2020

Prepared by:
Bangladesh Water Development Board (BWDB)
Financial support: Asian Development Bank (ADB)
Technical Support: ISPMC (NHC-EMM JV)

Flood and Riverbank Erosion Risk Management Investment Program Project-2

Institutional Strengthening and Project Management Consultant (ISPMC)

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Issue and revision record

Revi-sion	Date	Originator	Checker	Approver		Description
				Name	Signature	
A	26 Jan 2017	Md. Amir Faisal	Wandert Benthem	Knut Oberhagemann		Initial draft
B	16 Nov 2017	Md. Amir Faisal	Wandert Benthem	Knut Oberhagemann		Updated in accordance with latest designs and river situation
C	13 Dec 2017	Md. Amir Faisal	Wandert Benthem	Knut Oberhagemann		Updated in accordance with latest designs and river situation
D	22 Feb 2018	Md. Amir Faisal	Wandert Benthem	Knut Oberhagemann		ADB comments of 8 and 13/2/2018 Incorporated and addressed including referencing IUCN status of animals
E	20 April 2020	Zinat Naznin, Wim Giesen	Md Amir Faisal	Knut Oberhagemann		Updated as per latest design as of 5th April 2020 including the removal of Harirampur embankment and in accordance with comments from PMO on 05/11/2019 with updates to data series where available
F	02 Jun 2020	Wim Giesen	Hiba Khan	Knut Oberhagemann		Updated on basis of comments matrix provided by ADB on 18 May 2020.
G	30 June 2020	Wim Giesen	Hiba Khan	Knut Oberhagemann		Update on basis of comments matrix provided by ADB (Sumit Pokhrel) on 26 June 2020.

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Flood and Riverbank Erosion Risk Management Investment Program Project 2
ADB Loan No. TBC and GRANT No. TBC
Institutional Strengthening and Project Management Consultant (ISPMC)

Key Data

Name of Project:	**Flood and Riverbank Erosion Risk Management Investment Program**
Borrower, Executing Agency and Implementing Agency:	Government of Bangladesh (GoB) Bangladesh Water Development Board (BWDB) Department of Disaster Management (DDM)
Financing (Project 2):	Asian Development Bank (US$ 197 million). ADB Loan No. TBC. Government of Bangladesh (US$ 178 million)
Consultant:	Joint Venture of Northwest Hydraulic Consultants Ltd. (Canada) and Euroconsult Mott MacDonald Ltd. (UK) in association with Deltares (Germany), Resource Planning and Management Consultants (Bangladesh) and CEGIS (Bangladesh). Contract Signed: 8th September 2015
Contracting Authority:	PD, FREMIP, BWDB, Dhaka
Start/ End Dates:	ADB Loan Agreement: 27 June 2014 (approved), 14 August 2014 (signed), 17 September 2014 (effective) Multi-tranche financing facility (10 years): August 2014 to August 2024 Dates for FRERMIP: - Tranche 1/ Project 1[1]: August 2014 to June 2021 (6.9 years) - Project-2: September 2020 to June 2024 (3.8 years)
Beneficiaries:	Local stakeholders directly and indirectly benefitting from river flood protection works and land reclamation and development
Subproject Sites/ Location/ Areas	Focus of works are along the Jamuna-Padma river corridor, from Bangabandhu (Jamuna) bridge to confluence with Meghna River at Chandpur; i.e. Reaches 3, 4 and 5. FRERMIP Project 2 comprises the three priority subprojects, JRB-1, JLB-2 and PLB-1 which extend over (part of) the following districts: Sirajganj, Tangail, Pabna and Manikganj.

	km²	ha
Total Area of all Sub Projects	9,292.3	929,230
FRERMIP SPs (JRB1, JLB2): Total Area	1,794.1	179,409
FRERMIP SPs: Agricultural Benefit Area	317.8	31,779
FRERMIP SPs: Population		2.6 million
FRERMIP SPs: Population Density		690/ km²
FRERMIP SPs: No. of Households		2.03 million
FRERMIP SPs: Average HH Size		5.2
Master Plan Total Area	15,950.0	1,595,000
Master Plan Agricultural Benefit Area (flood risk mitigated)	5,000.0	500,000
Land Reclamation Area in River Corridor, Total	1,500.0	150,000
Land Reclamation Area in River Corridor, FRERMIP	660.0	66,000

[1] These were originally referred to as Tranches and later Projects. The words Tranche or Project should be read interchangeably within this document

EXECUTIVE SUMMARY

Introduction	This report presents the findings of an Environmental Impact Assessment (EIA) study that was carried out as part of the ongoing ADB-financed *Flood and Riverbank Erosion Risk Management Investment Program (FRERMIP)*. FRERMIP is a multitranche financing facility (MFF) [2] with the Bangladesh Water Development Board (BWDB) as the Executing Agency and the Department of Disaster Management (DDM) as Implementing Agency for community-based flood risk management measures. The program is implemented in two tranches/ projects: Tranche-1 (2014-2021), Project-2 (2020-2024). The proposed Project 2 combines the Tranches 2 and 3 as per MFF design. For the Tranche-1 works an EIA study was conducted in 2013-2014. in connection with that study, this EIA report formulated for FRERMIP (Project-2) project. FRERMIP outputs are (i) strengthening the flood and riverbank erosion management system, and (ii) establishing, at priority erosion sites, sustainable, integrated non-structural and structural risk management measures. The MFF provides a loaned amount of approximately $250 million; further financing of the program is provided by the Government of Bangladesh and the Government of the Netherlands ($28.7 million). **CONTEXT** FRERMIP aims to sustain incomes and livelihoods of people living along selected reaches of Jamuna, Ganges and Padma Rivers by enhancing resilience to flooding and to riverbank erosion through a mix of structural and non-structural measures. After initially protecting critically eroding riverbanks at priority areas, the program moves to more systematic riverbank stabilization, potentially leading towards river-reach stabilization during later tranches. The stabilization approach is making use of the currently ongoing consolidation of the river morphology developing towards a more accentuated channel pattern like the one observed in the 1970s, before the dramatic widening (from the 1970s to 2000s) took place (FAP -24) In parallel existing, degraded or eroded embankment lines will be restored and extended to arrive at reliable flood protection for the large population living on the floodplain along the main rivers. The community-based flood risk management component aims to increase resilience and preparedness of the population for the residual risk, for example if existing embankments unexpectedly breach. FRERMIP as whole aims to reduce the flood risk at three priority subprojects by providing new and rehabilitated embankments, leaving distributaries open, along selected reaches of the Jamuna and Padma Rivers. To protect these embankments, riverbanks will be progressively stabilized, starting at critically eroding reaches. Over time, and in conjunction with other government programs, this approach may lead to a general river stabilization with less channels

[2] The MFF FRERMIP consists of three individual loans for three individual projects, however systematically developing phases (called tranches in ADB's terminology) of interventions at three priority sites along the Lower Jamuna and Upper Padma Rivers. The cascading loans are packaged into a Program with a duration of 9 years, while the three tranches (phases) overlap and are scheduled for typically 4-years duration. Each tranche or loan is called Project with interventions at different Sub-project sites.

	potentially having some similarity to the river system before the passing of the sediment wave of the Great Assam Earthquake. In parallel to this study, Government investigates other river restoration alternatives[3]. Siting of physical works for FRERMIP is being planned by using an innovative dynamic methodology that responds to evolving river behaviour ("adaptive approach"). The anticipated benefits are considerable: (i) reduced loss of agricultural and other land to river erosion, (ii) reduced flood damage to agriculture (and so on) and (iii) increased agricultural production on less-flooded agricultural land. **THE ASSESSED PROJECT** The assessed Project is the proposed Project-2 of the MFF. The proposed Project 2 combines the Tranches 2 and 3 as per MFF design. The Tranche-1 works were also located in the same three sub-reaches and are similar in nature to the Project-2 works. The Project-2 physical works consist of riverbank-erosion protection works along critically eroding areas in JRB-1 and JLB-2, construction and rehabilitation of an existing embankment in JRB-1, and embankment construction plus wave protection works near Harirampur at PLB-1. Assessment of the resettlement and compensation requirements of all Project-2 works are dealt with in a separate study and report. Total ADB investment for the Project-2 works is estimated at $ 197 million.
Environmental categorization	The required environmental safeguards for FRERMIP were first set in an Environmental Assessment and Review Framework (EARF) document of May 2014 (updated May 2020), and in a Strategic Environmental and Social Assessment (SESA) for the main River Stabilization Plan that was first drafted in 2016 and has been updated and expanded various times since then. During the second phase of the scoping process, the Project-2 EIA study team conducted compliance monitoring of the Environmental Management Plan (EMP) implementation of Tranche-1 construction works which yielded important insight in which impacts were/were not significant. This team also conducted the SESA of the wider long-term River Stabilization Plan (RSP) that identified significant impacts. Schedule 1 of Government of Bangladesh's (GoB) Environmental Conservation Rules act of 1997 lists 69 types of projects listed as Red category, including: i) Engineering works where the capital investment is more than 1 million Taka; and ii) Construction/reconstruction/expansion of flood control embankment, polder, dike, and so on. Hence, according to GoB regulations the project is a Red category project requiring an IEE, EIA and EMP, and environmental clearance from the Bangladesh DoE. As identified in the SESA and the RSP, potential or likely **significant** negative impacts of the RSP interventions, including those of Project-2, are expected to

[3] The River Stabilization Plan (2020) investigated one single and one multiple-channel option for Jamuna and Padma as a first step towards the development of a river stabilization plan. Morphological assessment of potential future channel patterns is conducted as part of FRERMIP implementation which will deliver a comprehensive River Stabilization Plan that identifies potential stabilization solutions, to be implemented in an adaptive and phased manner, with minimal impacts on the river and char environment.

include the following:

1. Temporary disruption of social coherence in already vulnerable char land communities due to loss of chars and resettlement to large-scale, lower land quality land recovery sites, elite land grab and increased regional social disparity; in addition to temporary, also expected to be limited in area and number of affected persons.

2. Reduced river connectivity between the river and the (current) floodplain, affecting surface and groundwaters and fisheries resources.

3. Loss of natural terrestrial, aquatic and wildlife habitat, affecting biodiversity and fisheries production.

4. Alteration of the main river channel from a wide, braiding river to a less braided, narrower course, resulting in permanent loss of river associated habitats.

The temporary disruption of social coherence in char land communities and resettlement was recognized during the scoping phase, and as this meets the standards of significant according to ADB standards[4], Project-2 is categorized as Category A under Involuntary Resettlement, and a resettlement plan, including an assessment of social impacts is required and has been produced.

In terms of environmental category, according to SESA and RSP the impacts on fish, fisheries and wildlife (habitat) are expected to be significant and lasting and are only partly mitigable. Based on this alone, the project is to be listed as **environment Category A**, as "it is likely to have significant adverse environmental impacts that are irreversible, diverse, or unprecedented. These impacts may affect an area larger than the sites or facilities subject to physical works. "

ADB's policy on Environment Safeguards (2012)[5] states that "A project's category is determined by the category of its most environmentally sensitive component, including direct, indirect, cumulative, and induced impacts in the project's area of influence" and the policy requires that "environmental impact assessments evaluate transboundary and cumulative impacts of ADB projects or programs". Cumulative impacts on fish, fisheries and wildlife habitat, are expected to be even greater over time and only partially mitigable, hence further triggering classification as Category A, requiring a full EIA and EMP.

[4] Asian Development Bank (2013) Operations Manual Bank Policies (BP), OM Section F1/BP, 21 pp. October 2013.

[5] Asian Development Bank (2012) Environment safeguards. A good practice sourcebook, draft working document December 2012.

Impacts	**RIVERBANK PROTECTION INTERVENTIONS AND IMPACTS – GENERAL** The Brahmaputra System (including the braided Brahmaputra in Assam and the Jamuna in Bangladesh as well as the Padma and Lower Meghna) is a dynamic system that is characterized by continuous, unpredictable changes. In addition, the system was strongly influenced by the passing sediment wave triggered by the 1950 Great Assam Earthquake. The river belt has developed from a more stable single or double channel pattern in the late 1960s to a vastly expanded braided belt with numerous main, medium, and minor channels in the early 2000. The reach downstream of Bangabandhu (Jamuna) Bridge still exhibited a largely single channel characteristic in the early 1970s, being 6 km wide. By 2000 the width exceeded 11 km. During this period of expansion densely populated fertile floodplain land converted into mostly low-lying sand bars and chars. This process has changed the river environment, characterized by one or two pronounced deep channels to a multitude of shallower channels, many falling dry during the dry season. More recently the Brahmaputra exhibits much less lateral erosion and slowly turns back to a more stable, natural channel pattern. This development has triggered Government's initiative to study different options for "river restoration" supporting the natural process of consolidation and regaining some of the lost, densely populated floodplain land. The environmental consequences of the transformation of the river environment from few deep channels into a vastly expanded, shallow braided belt, were not systematically studied. Therefore, its environmental impact is non-quantifiable and in addition it is superimposed by dramatic population growth (from around 70 million to 150 million) with increasingly intensifying land use on the flood plains but also systematic river use such as fishing. Riverbank protection works at the sub-project sites have the purpose of protecting the existing floodplain habitat from continuous and systematic erosion. These works have numerous primary intended *direct* beneficial impacts. Along the erosion-protected sections, they reduce the risk that erosion of agricultural land will destroy livelihoods, impoverish vulnerable families, and result in displaced persons lacking options other than squatting on public lands or migrating to the Dhaka slums. Another intended direct benefit along erosion-protected sections is reduced risk of erosion damage to existing infrastructure (roads, settlements, bridges and so on), including flood embankment breaches. An additional benefit of erosion protection and channel stabilization works is achieved when such works are in front of an existing or prospective flood embankment and allow the stabilization of that embankment. Erosion protection works decrease risks to the economic benefits of embankment flood protection, and thereby justify the costs. This erosion protection impact is considered indirect or conditional because its value depends on the impacts of the associated flood protection embankment. River changes associated with FRERMIP riverbank protection work have been and are being assessed through specific morphology studies (TN-B1-5 2019, TN-C1-6 2019), which conclude among others that the initial (Tranche-1) riverbank protection works have little impact on the overall morphology of the Jamuna, including the immediate downstream areas. In all cases the work results in deeper channels along the protected bank but with expected little impact on downstream areas.

	The morphology study also assessed the relevance of the built protection work on future potential channel options, part of larger-scale river stabilization plans. The non-symmetric Jamuna Bridge has substantially changed the lower part of the Jamuna River, creating a large attached char at the right bank from the western bridge abutment to about Enayetpur, and resulted in a single channel in this reach. The bank protection proposed at Enayetpur is expected to help stabilise the bifurcation long term. Downstream, the river exhibits two channels, enclosing a large char. The morphological assessment indicates that this currently existing channel pattern is likely the most desirable for the future, meaning that the overall natural river pattern will not be altered by the proposed interventions nor being in conflict with likely future stabilization options, rendering the present work redundant. The same holds true for the situation in the upper Padma River, where a two-channel solution with variable flow appears to be a viable alternative in the long run. The reason for this is that the river stabilization plan proposes a meandering single channel solution here as final outcome of the morphological work. First studies on the interaction of riverbank protection works with the environment have been conducted in 2007 and 2016. The JMREMP, 2007 study found that there were more fish species and higher population numbers at protected banks, as opposed to unprotected banks. The size of the fish depends on the size of the voids in the protection, which means that large voids in concrete blocks tend to attract larger fish, specifically carnivores, but fewer numbers, while geotextile bags ('geobags'), having more but smaller voids, attract smaller fish in larger numbers. The Center for Environmental and Geographic Information Services (CEGIS, 2011) identified overall positive impacts of geotextile bag revetments on water resources, fisheries, the algae community, the ecosystem and the socio-economy. Important findings are that there is no change in water quality, the terrestrial habitat is protected, and the socio-economic conditions are improved for the local population, including employment opportunities during construction, health and sanitation conditions, fishing opportunities, and especially the situation of women. Geotextile bag revetments might change the composition of fish species, alter the habitat of the benthic community, as well as cause local shifting of the migratory routes of the dolphins[7] during construction. However, these effects are reversible, and the constructed revetments do not impact on the free movement of dolphins and the benthic habitat is quickly restored over geotextile bag revetments. With respect to the overall use of the recommended riverbank protection technology, CEGIS 2011 concludes: "Considering all environmental, social and technical consequences of the geotextile bag use under water, it might be concluded that compared with CC block use alone, geotextile bag use under water with CC block used above water is more environmentally sustainable, socially acceptable, technically feasible and economically cost effective if the quality requirements and design requirements are assured and monitored." Dolphins utilizing riverine habitats potentially affected by the FRERMIP works are part of a trans-boundary (Bangladesh-India) population. Most international migration of dolphins occurs within peri-border areas as short-range tributary-to-mainstem trips, but longer-range movements of individuals outside the FRERMIP influence area cannot be ruled out. Localized stable and deeper channels in front

[6] JMREMP; 2007. Bank Protection and Fisheries at JMREMP two Sub-projects. Dr. Munir Ahmed, Special Report 24, May. CEGIS, 2011: Final Report on Environment Impact Assessment (EIA) for Use of Sand-filled Geo-Bags Under Water; earlier the JMREMP design include an EIA and obtained environmental clearance from Government before starting the construction of geotextile bag revetments.

[7] Dolphins normally chose the thalweg, i.e. the deeper part of the river for migration

of the FRERMIP protective works are more attractive for dolphins as they provide preferred migration routes. First studies indicate that the proposed riverbank protection increases the amount of small fish, the main food for dolphins. The construction season lies outside of the migration season of the dolphins (during the rising and falling of flood waters) and does not overlap much with the surfacing time of the juvenile and neonate dolphins in the morning and afternoon-evening hours.

SPECIFIC JRB-1 INTERVENTIONS AND IMPACTS

Riverbank protection work will be placed alongside the riverbank in the same manner as earlier works without impacting much on land and water habitat. Land acquisition and resettlement activities are less than during Tranche-1. On average one can assume that a strip of approximately 20 to 40 m width will be acquired alongside the whole length of the riverbank protection works. The potential acquisition of land for embankment work on the char will be discussed with local stakeholders, as char ownership and delineation of plots is different from the ownership on the floodplains, which can be well defined geographically.

For the flood embankment a full land-acquisition and resettlement process will be conducted. However, the flood embankment alignment has been chosen to reduce the impact on existing settlements.

In terms of environmental enhancement, different measures are planned:

- BWDB/MoWR will request the Bangladesh Inland Water Transport Authority (BIWTA, under the Ministry of Shipping (MOS) to place navigation buoys along all protected riverbanks with kilometre spacing, to protect fish habitats from systematic overfishing with floating nets. In this regard, BWDB will provide the data of riverbank protection works, dredging works and other related works.
- The countryside slopes of the embankment shall be used for tree plantation of local resilient varieties to help re-establishing a diverse vegetation cover.
- The riverside slope of the embankments shall be planted with resilient grass suitable to provide limited wave protection, where no full wave protection shall be required. Especially Vetiver, Katkin and Dhoincha are recommended.
- Two (2) regulators with fish passes will be constructed to assure connectivity between the main river and the floodplain.
- It is proposed that bird, dolphin and/or fish sanctuaries be established at appropriate locations.

Impacts expected from JRB-1 interventions include:

- Loss of riverside habitat; some of this is temporary, as vegetation on banks will be replanted; however, as the river morphology will change (the river may become narrower), some loss will also be permanent.
- Loss of connectivity between river and floodplain, as new works including embankments will serve to protect against flooding and erosion; this in turn affects fish migration and floodplain biota, which can only partly be mitigated with fish-passes and regulators.
- Persons will need to be moved from proposed construction areas and may (temporarily) lose livelihoods. These impacts are mitigable and largely temporary; the chosen alignment has reduced the need for land acquisition and affectees are compensated by implementing the resettlement action plan.

Specific JLB-2 Interventions and Impacts

The land acquisition and resettlement alongside riverbank protection works follows established principles and is summarized under subproject JRB-1.

The potential acquisition of land for embankment work on the char may be discussed with local stakeholders, as char ownership and delineation of plots is different from the ownership on the floodplains, which can be well defined geographically.

In other locations no land acquisition and resettlement impact is expected as most work takes place in the river channel and in flood spill channels on the char.

Environmental mitigation and enhancement measures follow the same principles as applied to the upstream works at JRB-1. In addition to the typical works alongside the floodplains, the around 100 m wide strip between the protected riverbank and the embankment on the char shall be planted with dhoincha, katkin, vetiver or any other helpful plant for land reclamation to combine a technical function with income generation and environmental enhancement. The thick layer of reeds provides habitat while dampening the wave impact on the embankment. In addition, 10 regulators with fish-passes will be constructed.

Impacts and mitigation measures are the same as for JRB-1, although perhaps of a different magnitude.

Specific PLB-1 Interventions and Impacts

Riverbank Protection will only require a comparatively small strip of some 30 m alongside the existing riverbank protection works. Around 27 ha of land will be required for riverbank protection construction.

The embankment has an estimated average width of some 50 m, which translates into a total land acquisition of some 90 ha of land. About 7 km of the alignment (40%) will be placed on newly reclaimed charland. The alignment may avoid dense settlements and culturally important establishments to minimize resettlement. A very initial assessment indicates resettlement of around 500 households.

Impacts and mitigation measures are the same as for JRB-1 and JLB-2, although perhaps of a different magnitude.

Environmental mitigation and enhancement measures will be like the ones described for JRB-1; in total 2 regulators with fish passes including one boatpass are foreseen to connect the distributary with Baral/Hurasagar River.

Land Acquisition, Resettlement and Construction Impacts

The land acquisition and resettlement required by the implementation of the Project-2 physical works will be managed through the Resettlement Plan process.

Routine impacts of construction-phase activities will be managed through the inclusion of standard environmental safeguard clauses in construction contract

	bidding packages, Contractor's Environmental Management Plans (CEMPs) and BWDB construction supervision. **STAKEHOLDER COMMENTS AND CONCERNS** Three rounds of public consultation were undertaken during preparation of Tranhce-1 and Project-2 EIA. The first two rounds (2013-2014) presented the proposed project and EIA terms of reference to stakeholders for their review and suggestions and presented the draft EIA results to stakeholders for their comments. Stakeholder concerns are at most moderate, and are resolvable through continued dialogue and accommodation during design and implementation. During the third round (2016-2017) stakeholders in JRB-1 and JLB-2 were revisited and the proposed Project-2 works were presented and responses on these were sought and incorporated in the subproject designs. **RECOMMENDED ACTIONS** Mitigation of the impacts is complex and challenging. It will not result in all residual impacts being reduced to insignificance, but mitigaton (as indicated in the EMP, and following SOPs) will reduce them to levels considered acceptable by government (e.g. MoE) and society at large. To the extent possible, impacts will be mitigated through measures purpose-designed to the impact and setting. Many mitigation measures have been mainstreamed into the engineering designs, which also incorporate significant impact avoidance features e.g. leaving distributaries open and embankment afforestation. It is important to recognize potential cumulative effects when moving from emergency type riverbank protection (that target initial perceived risks and are reactive) during the initial project towards more systematic river stabilization in the priority reaches during following tranches. The first tranche incorporated a comprehensive river stabilization study to develop and assess potential future stabilization options as well as impacts and mitigation measures. In addition, this study accounts for the potential cumulative and trans-boundary impacts from potential other programs and projects by covering the whole Brahmaputra System from the upstream areas at Kurigram in Bangladesh to the Bay of Bengal.
Environmental Management Plan	The Environmental Management Plan (EMP) sets for the mitigation and monitoring to be undertaken. Four mitigation packages address: • *Construction-phase impacts.* Management will be through the inclusion of standard environmental safeguard clauses in construction contract bidding packages, Contractor's Environmental Management Plans (CEMPs) and BWDB construction supervision. • *Impacts on critical habitats and trans-boundary/internationally migrating/threatened species:* The proposed mitigation measures are modelled after the Wetland Biodiversity Rehabilitation Project of GIZ /Department of Fisheries/BWDB, recently concluded in areas of Padma adjacent to the JRB-1 project area. • *Impacts on open water fish biodiversity and production.* Measures to mitigate these impacts (i) include open water fisheries-related measures (such as fish-passes and buoys to curb use of nets) and (ii) expansion of aquaculture, particularly in areas benefitting from Project-led reductions in flood and erosion risk. • *Land acquisition and resettlement impacts.* Management measures will

	be documented in the Resettlement Action Plan for Project-2. The EMP will be implemented by the Project Management Unit supported by the Institutional Strengthening and Project Management Consultant (ISPMC) team that includes environment specialists. There will be kept provision for appointing an NGO and a separately hired specialist environmental management organization to expand the biodiversity database for the study area and outline the establishment of one or more fisheries sanctuaries in line with gradually increasing river stabilization during the program. Implementation of EMP mitigation and monitoring activities will be scheduled to ensure that each type of safeguards measure is in place and operating effectively by the time each corresponding impact (construction- or implementation-phase) is triggered. A significant EMP item for the Project-2 works is the construction 2 regulators plus fish-passes at JRB-1 and 8-10 (TBC) regulators plus fish-passes at JLB-2, all designed to maintain connectivity between the river and the floodplain. At about USD 1 million per regulator, this is a significant EMP investment; other key EMP investmentis installing buoys by BIWTA/MoS in consultation with BWDB/FRERMIP at 1 km intervals along 60 km of the left bank of the Jamuna River with the dual purpose to indicate the navigation channel and prevent indiscriminate fishing practice with drift nets. Most of the mitigation and environmental enhancement measures in the EMP however, are the responsibility of the contractors, or are the responsibility of BWDB staff, or other parties, and these are thus mostly cost items that are paid from other budget lines. As total costs of the Project-2 works are estimated to be around $ 375 million, the total EMP implementation costs are currently estimated at some $ 10-15 million, or 4% of the total project costs for Project-2.
Design- and Implementation -Phase Public Consultation	Stakeholder consultation will continue during subproject implementation to provide information to stakeholders about the project and to receive their input and concerns. Meetings will include households and persons affected by resettlement (AHs and APs) and other adverse environmental and social impacts. At these meetings, information about designs, impacts, and mitigation and monitoring measures, including specific resettlement entitlements, will be disclosed verbally and in Bangla-language information handouts.
Grievance Redress Mechanism (GRM)	During Tranche-1, three local Grievance Redress Committees (GRCs) were formed, one in each sub-project area. While these may continue for implementation of Project 2 works, they require strengthening to allow effective functioning. To boost the capacity, it is proposed to assign two national GRM specialists (male and female) to facilitate the (re)- establishment and operation of the GRCs at each site. A Joint Verification Team (JVT) consisting of 3 members (Representatives from BWDB, DC, INGO) will visit the site before planning and construction for investigation of land and resettlements or other related assets. Then a Property Valuation Advisory Team (PVAT) consist of 4 members (Representative from BWDB, DC, INGO) will assess the costing of the identified assets in the alignment of the intervention. The concerned office will pay the Affected Person (AP)s CCL and Resettlement Grants as per PVAT's decision. If any AP has any complaint against any decision, then he can submit his complaint to the GRC. Each GRC consists of 5 members (Representatives from BWDB, UP, AP, INGO). Aggrieved persons are free to access the country's legal system regardless of GRC involvement.

Reporting and Monitoring	Reports will be prepared according to ADB's and GoB agency (BWDB, MoWR, ERD, PC and others) requirements. These include Quarterly Progress Reports (QPR), semi-annual Environmental Monitoring Reports, Work Completion Reports, Training Reports, IMED Reports, Project/Work Completion Reports and any other reports on the basis of ADB/GoB's requirement. The reports will be disclosed on ADB, BWDB and the project's website. Environmental Monitoring Reports will be prepared by the PMO with close consultation with the Environmental Focal Point (EFP), the Gender Progress Report will be prepared by the PMO with close consultation with the Gender Focal Point (GFP) and the Resettlement Plan Implementation Progress Report will be prepared by the PMO with close consultation with the Resettlement Focal Point (RFP). Monitoring will be undertaken for timely detection of conditions requiring remedial measures; to provide information on mitigation and institutional strengthening progress; and to assess compliance with required safeguards. Overall implementation progress including EMP implementation will be reviewed during periodic review missions involving ADB, the Implementing Agency and the Executing Agency.

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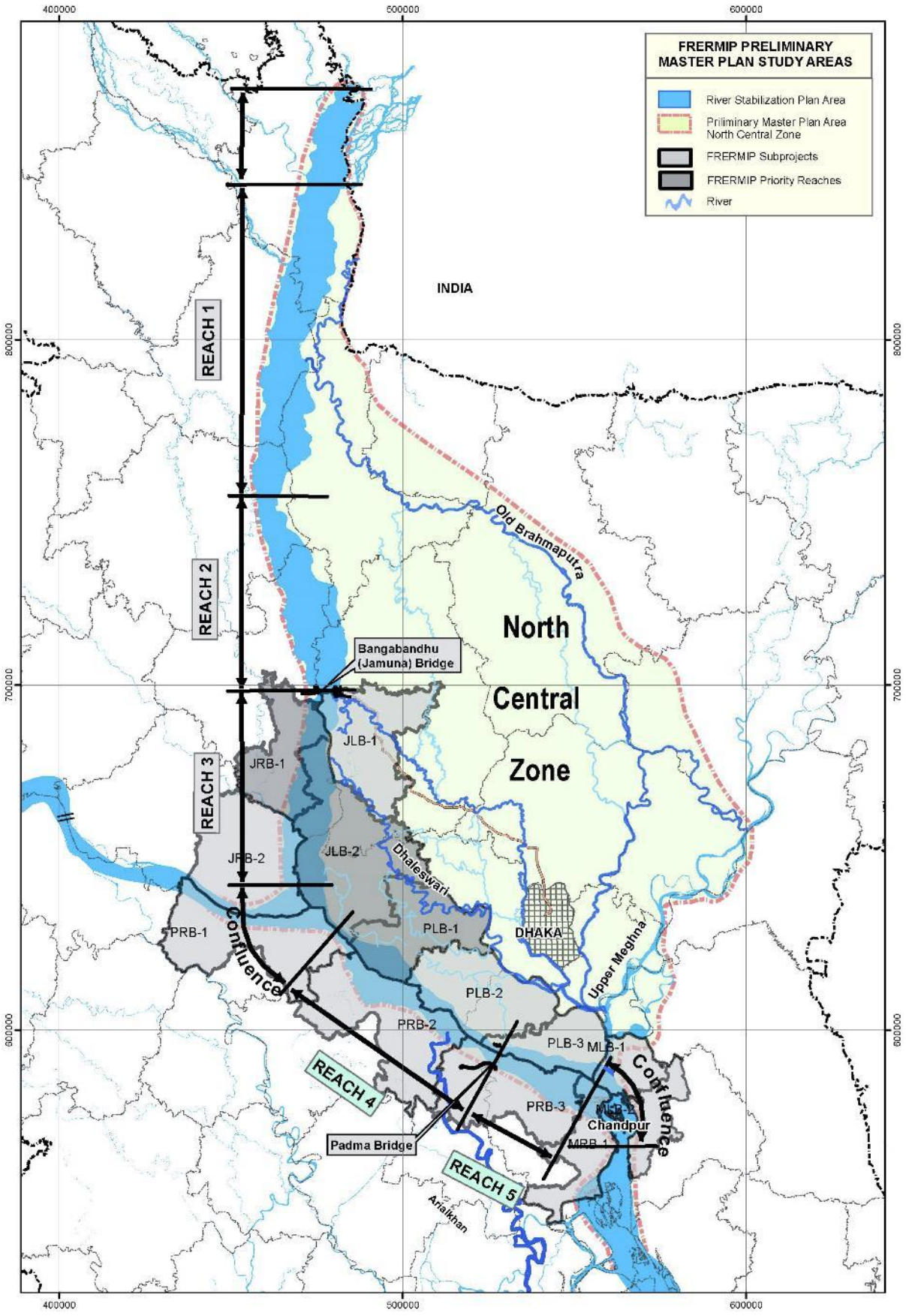
ACRONYMS

ADB	Asian Development Bank
AIFRERMIP	Assam Integrated Flood and Riverbank Erosion Risk Management Investment Program
BBA	Bangladesh Bridge Authority
BBS	Bangladesh Bureau of Statistics
BCCSAP	Bangladesh Climate Change Strategy and Action Plan
BDT	Bangladesh Taka
BMD	Bangladesh Meteorology Department
BWDB	Bangladesh Water Development Board
CAS	Catch Assessment Survey
CC	Cement concrete
CEGIS	Centre for Environmental and Geographic Information Services
CEMP	Contractor's Environmental Management Plan
CIA	Cumulative Impact Assessment
DAE	Department of Agricultural Extension
DDM	Department of Disaster Management
DOE	Department of Environment
DOF	Department of Fisheries
EAP	Environmental Action Plan
EARF	Environmental Assessment Review Framework
ECA	Environment Conservation Act
ECA	Ecologically Critical Area
EIA	Environmental Impact Statement
EMM	Euroconsult Mott MacDonald Ltd. (UK)
EMP	Environmental Management Plan
EOP	Environment-on-project
F0	Area flooded to a maximum of 0-30 cm, either (i) MPO land type, remains flooded for three days or more to this depth in the 1:2 year return flood event; or (ii) hydrologic model area, instantaneously flooded to this depth in the modeled event (any return period)
F1	Area flooded 30-90 cm maximum (see F0)
F2	Area flooded 90-180 cm maximum (see F0)
F3	Area flooded 180-300 cm maximum (see F0)
F4	MPO land type, over 300 cm maximum 3-day flood depth, 1:2 event
FAO	Food Agriculture Organization
FAP	Flood Action Plan
FES	Fishing Effort Survey
FGD	Focus Group Discussion
FRA	Feeder Road Type A
FRB	Feeder Road B
FRERMIP	Flood and Riverbank Erosion Risk Management Investment Program

FS	Feasibility Study / Frame Survey
FWIP	Future-with-project
FWOP	Future-without-project
GoB	Government of Bangladesh
GRC	Grievance Redress Committee
GRM	Grievance Redress Mechanism
GPA	Guidelines for Project Assessment
IEE	Initial Environmental Examination
IESC	Important Environmental and Social Component
IFC	International Finance Corporation
ISPMC	Institutional Strengthening and Project Management Consultant
IUCN	International Union for Conservation of Nature
JMREMP	Jamuna Meghna River Erosion Mitigation Project
JLB	Jamuna Left Bank
JRB	Jamuna Right Bank
JVT	Joint Verification Team
KII	Key Informant Interview
MFF	Multi-tranche Financing Facility
MLB	Meghna Left Bank
MPO	Master Planning Organization
NGO	Non-governmental organization
NHC	Northwest Hydraulic Consultants Ltd. (Canada)
NWRD	National Water Resources Database
PC	Public consultation
PCR	Public Cultural Resources
PLB	Padma Left Bank
PMBP	Padma Multipurpose Bridge Project
PMO	Project Management Office
PPTA	Project Preparation Technical Assistance
PWD	Public Works Department
RCC	Reinforced Cement concrete
RBIP	Riverbank Improvement Project
RRA	Rapid Rural Appraisal
SRDI	Soil Resource Development Institute
UFO	Upazila Fisheries Office
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
WARPO	Water Resources Planning Organization



Subprojects of FRERMIP Program Area 2014-2024

1 INTRODUCTION

1.1 Overview

1. The project area of the Flood and Riverbank Erosion Risk Management Investment Program (FRERMIP) comprises about 244,316 ha of which approximately 15% consists of water bodies and the remainder consists of terrestrial habitats including charland. 13% (up to 37% during the monsoon season, with rivers 30,783 ha and floodplain 59,782 ha) is occupied by rivers and a minor percentage (less than 2%; khal 312 ha, beels 1258 ha, kol 605 ha, fish ponds 1,235 ha) is occupied by other water bodies. The hydrology of the area is dominated by the three major rivers: Jamuna, Ganges and Padma. FRERMIP is an Asian Development Bank (ADB) multi-tranche financing facility (MFF) prepared and being implemented in partnership with the Government of Bangladesh (GoB). It aims at sustaining incomes and livelihoods of people living along the fore-mentioned three main rivers by enhancing resilience to flood and riverbank erosion. Project outputs from Project-2 will (i) strengthen the flood and riverbank erosion management system, and (ii) establish, at priority erosion sites, sustainable, integrated non-structural and structural risk management measures. Total project costs are currently estimated at $ 375 million ($197 m loan from ADBand $178 million by GoB funding).

2. An Environmental Assessment Review Framework (EARF) and an Environmental Impact Assessment (EIA) report, both of May 2014, were prepared as part of the Tranche-1 feasibility studies under the ADB project preparation technical assistance project Main River Flood and Bank Erosion Risk Management Program (PPTA No. 8054 BAN). The EARF has since been updated, the latest version being that of May 2020.

3. The EARF sets forth (i) the safeguards procedures to be followed during subsequent tranches/ projects, (ii) safeguards-related criteria to be considered in the selection of subprojects for subsequent tranches, and, regarding Executing Agency safeguards capacity, (iii) an assessment and recommendations for appropriate institutional strengthening – and is still regarded as sufficient for the current stage of contract implementation.

4. The 2014 EIA for Tranche-1 was made for three (3) sub-reaches: Jamuna Right Bank 1 (JRB-1), Jamuna Left Bank 2 (JLB-2), and Padma Left Bank 1 (PLB-1). Tranche-1 construction interventions comprised riverbank protection works through application of sandbags and concrete blocks, rehabilitation and construction of new embankments and drainage structures. The draft EIA report was reviewed by the Netherlands Commission for Environmental Assessment (NCEA) and comments were to the extent possible at that stage incorporated in the version of May 2014 of the report (Annex 11).

5. The present 2020 EIA report is for three (3) Project-2 sub-reaches, i.e. Jamuna Right Bank 1 (JRB-1), Jamuna Left Bank 2 (JLB-2) and Padma Left Bank 1 (PLB-1). Construction interventions for Project-2 are mostly like those of Tranche-1 and are conducted in the same or similar environments as the ones of Tranche-1. The EIA Report for proposed Project-2 project is formulated in connection with the approved EIA report for the Tranche-1 project.

1.2 Objectives

6. FRERMIP aims to provide security and sustain incomes and livelihoods of people living along the three main rivers of Bangladesh through establishing integrated non-structural and structural risk management measures at priority erosion sites and addressing their sustainability.

1.3 Project Area *versus* Study Area

7. The project area of the proposed investment encompasses the river reach of the Jamuna River from south of the Jamuna Bridge and the proposed Ganges Barrage site to Chandpur on the Lower Meghna. The Jamuna and Ganges river courses downstream of these two major river works are somewhat independent of upstream river developments. These upstream areas are expected to be included in the Ganges Barrage project and the World Bank-supported Riverbank Improvement Project (RBIP). The total project area supports a total population of 10.5 million in 40 upazilas and 431 unions, with an average population density of nearly 1,600 persons per km² of floodplain land.

8. The EIA study area has focused on three sub-reaches, i.e. JRB-1, JLB-2 and PLB-1. These three sub-reaches were selected from 13 sub-reaches into which the Main River Project (MRP) area was divided based on discussions among BWDB, ADB and the PPTA consultant. Sub-reaches are divided at Upazilas boundaries, most of which follow main river tributaries and distributaries and have not changed since 1961, facilitating the calculation of long-term trends from Upazilas-wise datasets. Each sub-reach covers three to four upazilas and has a population of approximately 1 million. Six sub-reaches were selected for pre-feasibility level investigation using a multi-criteria assessment approach, and works were implemented in JRB-1, JLB-2 and PLB-1 in Tranche 1. These three sub-reaches were retained for the feasibility study of Project-2.

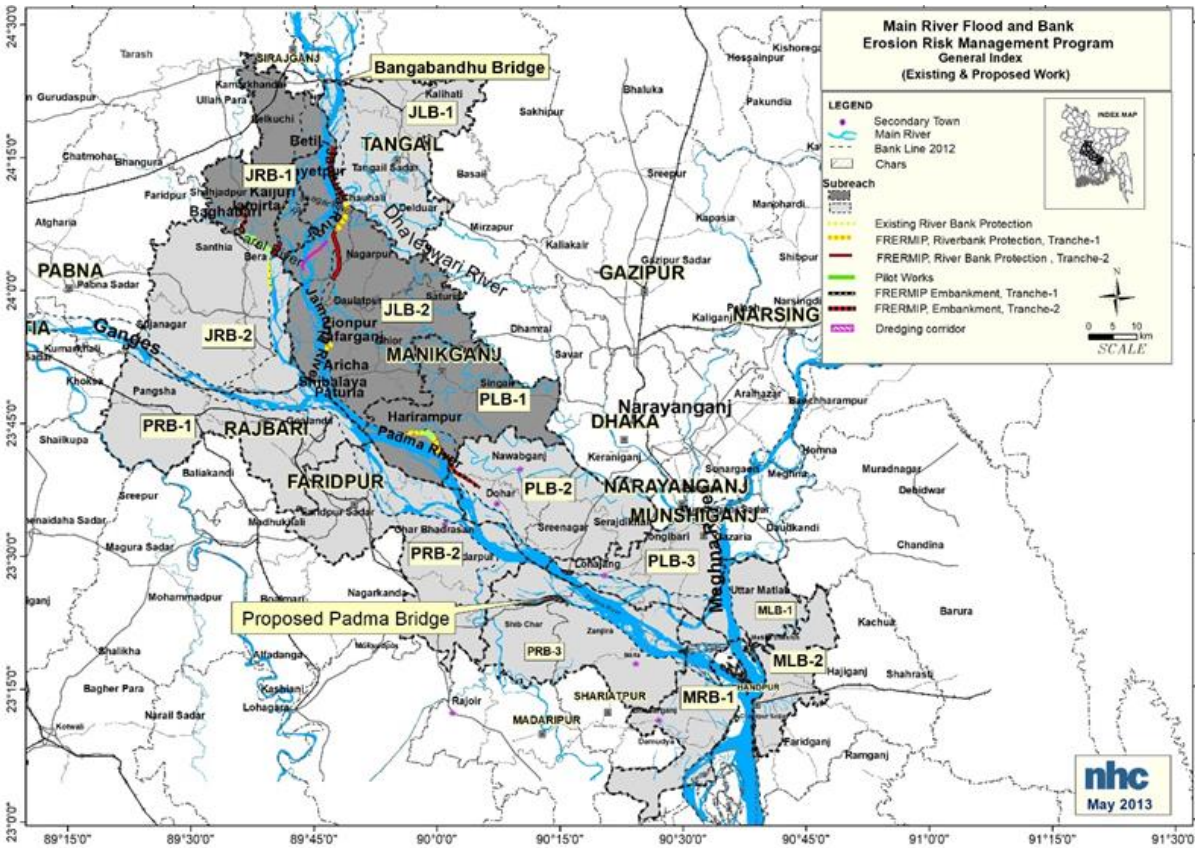


Figure 1-1. Project area with sub-reaches

1.4 EIA Team Members

The EIA for Tranche-1 was prepared by the following specialists:

- Dr Sara Bennett, International Environmental Specialist
- Mr Mujibul Huq, Environmental Adviser, CEGIS
- Dr Anil Chandra Aich, Soil and Agriculture Specialist, CEGIS
- Dr Dilruba Ahmed, Senior Sociologist, CEGIS
- Mr Ashok Kumar Das, Senior Fisheries Biologist, CEGIS
- Mr Kazi Kamrull Hassan, Senior Water Resources Planner, CEGIS
- Mr Amanat Ullah, Senior Ecologist, CEGIS
- Mr Fahad Khan Khadim, Junior Water Resources Engineer, CEGIS
- Mr Roland Nathan Mondol, Junior Fisheries Biologist
- Mr Mobashir Bin Ansari, Junior Sociologist
- Mr Saifuddin Mahmud, Junior Sociologist
- Mr Zahid Hasan Dhali, Junior Agriculturist

The present updated EIA for Project-2 was prepared by the following specialists:

- Mr Wandert Benthem, International Environmental Specialist
- Mr Md. Amir Faisal, National Environmental Specialist
- Dr Md. Shahjahan Howlader, National Fisheries Specialist

1.5 Report Format

This EIA report has the following 12 (twelve) chapters:

Chapter 1: Background, study area, objectives, scope of work in addition to presenting the list of the multi-disciplinary EIA study team members

Chapter 2: The policy, legal and administrative framework

Chapter 3: Approach and methodology followed for conducting the EIA study

Chapter 4: Description of the project including the present status of the infrastructure and the proposed interventions

Chapter 5: Environmental and social baseline conditions in respect of meteorology, seismicity, water resources, land resources, agriculture, livestock, ecological resources and socio-economic condition

Chapter 6: Public consultation and disclosure

Chapter 7: Important environmental and social components likely to be impacted by the proposed river stabilization works

Chapter 8: Assessment of the impacts of the proposed works on the environmental and social components pertaining to water resources, land resources, agriculture, livestock, ecological resources and socio-economic condition

Chapter 9: Grievance Redress Mechanism

Chapter 10: Analysis of alternatives

Chapter 11: Environmental Management Plan

Chapter 12: Conclusions and recommendations

2 POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

2.1 Introduction

9. This Chapter summarizes the policies, laws, regulations, guidelines and international environmental agreements to which Bangladesh is a party that are relevant to this

environmental assessment, including all environmental safeguards and environmental management guidance relevant to the assessed project.

2.1.1 Environmental Protection Policies and Legislation

NATIONAL CONSERVATION STRATEGY (NCS, 1992)

10. The NCS was drafted in late 1991, submitted to Government in early 1992, and then approved in 1993. After Bangladesh endorsed 1980's World Conservation Strategy, the government (with assistance from IUCN) started working on developing the NCS document for Bangladesh. The objectives of the NCS are to: i) Provide guidance for future resource use and for conservation of resources; and ii) Suggest actions to be adopted by the government to ensure conservation of resources while keeping up the current pace of resource utilisation and economic development.

NATIONAL ENVIRONMENTAL POLICY (NEP, 1992)

11. The Bangladesh NEP sets out the basic framework for environmental action, together with a set of broad sectoral action guidelines. The Environment Policy provides the broader framework of sustainable development in the country. It also states that all major undertakings which will have a bearing on the environment (including setting up of an industrial establishment) must undertake an Initial Environmental Examination (IEE) and Environmental Impact assessment (EIA) before they initiate the project. The Environmental Policy designates the Department of Environment (DoE) as the approving agency for all such IEEs/EIAs to be undertaken in the country.

NATIONAL ENVIRONMENTAL MANAGEMENT ACTION PLAN (NEMAP, 1995)

12. The NEMAP is a wide ranging and multi-faceted plan building on and extending the statements set out in the National Environmental Policy. NEMAP was developed to address issues and management requirements for the period 1995 to 2005 and sets out the framework within which the recommendations of the National Conservation Strategy are to be implemented. NEMAP provides the framework for implementing the NCS.

13. NEMAP has the following broad objectives:

(i) Identification of key environmental issues affecting Bangladesh;
(ii) Identification of actions necessary to halt or reduce rate of environmental degradation;
(iii) Improvement of the natural and built environment;
(iv) Conservation of habitats and biodiversity;
(v) Promotion of sustainable development; and
(vi) Improvement in the quality of life of the people.

BANGLADESH CLIMATE CHANGE STRATEGY AND ACTION PLAN (BCCSAP, 2009)

14. The BCCSAP was formulated in 2008 to coordinate the country's response to climate change, and be presented as a coordinated effort at the UNFCCC 2009 COP in Bali. The BCCSAP demonstrates the government's commitment to low carbon development and ensuring that infrastructure is climate proof, both of which are of direct relevance to Project 2 design and implementation.

15. The BCCSAP is built on the following six pillars:

(i) Food security, social protection and health to ensure that the poorest and most vulnerable in society, including women and children, are protected from climate change and that all programs focus on the needs of this group for food security, safe housing, employment and access to basic services including health;

(ii) Comprehensive disaster management to further strengthen the country's already proven disaster management system to deal with increasingly frequent and severe natural calamities;

(iii) Infrastructure to ensure that existing assets are well maintained and fit-for-purpose and that urgently needed infrastructure is put in place to deal with the likely impact of climate change;

(iv) Research and knowledge management to predict the likely scale and timing of climate change impacts on different sectors of the economy and socio-economic groups, to underpin future investment strategies and to ensure that Bangladesh is networked with the latest global thinking on science and best practices of climate change management;

(v) Mitigation and low carbon development to ensure low carbon development options and implement these as the country's economy grows over the coming decades and the demand for energy increases; and

(vi) Capacity building and institutional strengthening to enhance the capacity of government ministries and agency, civil society and the private sector to meet the challenges of climate change and mainstream them as part of development action.

2.1.2 Environmental Conservation Act (ECA, 1995) and Amendments

ECA '95

16. The Bangladesh Environment Conservation Act of 1995 (ECA '95), with its 2000 and 2002 amendments (see below), is currently the main legislation for environment protection in Bangladesh. The Act addresses environment conservation, environmental standards development and environment pollution control and abatement. It replaced the earlier Environment Pollution Control Ordinance of 1977 that is now repealed.

(I) The main objectives of ECA '95 are:
   a. conservation and improvement of the environment; and
   b. control and mitigation of pollution of the environment.

(II) The main strategies of ECA '95 can be summarized as:
   a. Declaration of ecologically critical areas and restriction on the operations and processes, which can or cannot be carried out/initiated in the ecologically critical areas (by 2015, 13 Ecologically Critical Areas had been declared in Bangladesh, none of which are in the project area);
   b. Regulations in respect of vehicles emitting smoke harmful for the environment; Environmental clearance;
   c. Regulation of the industries and other development activities' discharge permits; Promulgation of standards for quality of air, water, noise and soil for different areas for different purposes;
   d. Promulgation of a standard limit for discharging and emitting waste; and
   e. Formulation and declaration of environmental guidelines.

17. ECA (1995) requires environmental clearance from DoE of industrial units and projects. Under Section 12 of the Act, "no industrial unit or project shall be established or undertaken without obtaining environmental clearance from the Director General in the

manner prescribed by the Rules." The Act requires project proponents to obtain Environmental Clearance from the Director General (DG) DoE prior to construction.

18. A schedule attached to the Environment Conservation Rules 1997 categorizes projects as Green, Orange A, Orange B, and Red, with green having least impact and red having major environmental impacts and identifies for each category the level of environmental impact assessment required and other clearance application procedures and information.

19. An appeal procedure is available for proponents who fail to obtain clearance. Failure to comply with any part of this Act may result in punishment to a maximum of ten years imprisonment or a maximum fine of BDT1,000,000 or both. The Department of Environment (DOE) executes the Act under the leadership of the DG.

ECA AMENDMENT 2000

20. This amendment focuses on (i) ascertaining responsibility for compensation in cases of damage to ecosystems, (ii) increased provision of punitive measures, both fines and imprisonment, and (iii) fixing authority on cognizance of offences.

ECA AMENDMENT 2002

21. This amendment sets forth: (i) restrictions on polluting automobiles; (ii) restrictions on the sale and production of environmentally harmful items like polythene bags; (iii) assistance from law enforcement agencies for environmental actions; (iv) punitive measures; and (v) authority for trials of environmental cases.

ECA AMENDMENT 2010

22. This amendment of the Act deals with: (i) declaration of ecologically critical areas (ECAs); (ii) prohibition of harmful work and processes from being begun or continued in such areas; (iii) management systems for ECAs; (iv) restriction of hill cutting and razing; (v) restriction of hazardous waste production, import, collection, transportation, etc; (vi) prohibition of pollution created by ship breaking or cutting; (vii) prohibition of infilling of demarcated wetlands and waterbodies; (viii) determination of responsibility for compensation in cases of ecosystem damage; and (ix) restrictions on various industries and projects in various locations. This amendment empowered the government to enforce more penalties than before. Moreover, affected persons were given provision for putting objections or taking legal actions against the polluters or any entity creating nuisance to affected person.

ENVIRONMENT COURT ACT (ECA, 2010)

23. This act provides for the establishment of environment courts and amends the prevailing act to accelerate punishment of environment-related crime. This act defines: the jurisdiction of the environment court; the penalty for violating the court's order; the trial procedure in the special magistrate's court; the appeal and investigation procedures; and it gives the environment court authority to enter, search and inspect. This act allows government to take necessary legal action against any parties who creates environmental hazards/damage to environmentally sensitive areas as well as human society. According to this act, government can take legal actions if any environmental problem occurs due to FRERMIP interventions.

ENVIRONMENTAL CONSERVATION RULES (ECR, 1997)

24. The ECR were issued by the Government of Bangladesh in exercise of the power conferred under the Environment Conservation Act (Section 20), 1995. Under these Rules, the following aspects, among others, are covered:

(i) Declaration of ecologically critical areas
(ii) Classification of industries and projects into four categories
(iii) Procedures for issuing the Environmental Clearance Certificate (ECC)
(iv) Determination of environmental standards.

25. Rule 3 defines the factors to be considered in declaring an area 'ecologically critical area' (ECA) as per Section 5 of ECA 95. It empowers the Government to declare an area 'ECA' if it is satisfied that the ecosystem of the area has reached or is threatened to reach a critical state or condition due to environmental degradation. The Government is also empowered to specify which of the operations or processes shall not be carried out or shall not be initiated in the ecologically critical area.

26. Rule 7 classifies industrial units and projects into four categories depending on environmental impact and location for issuance of ECC. These categories are: Green, Orange A, Orange B, and Red.

27. All existing industrial units and projects and proposed industrial units and projects that are low polluting are categorized under "Green" and shall be granted Environmental Clearance. For proposed industrial units and projects falling in the Orange-A, Orange-B and Red Categories, firstly a site clearance certificate and thereafter an environmental clearance certificate will be required. A detailed description of these four categories of industries has been given in Schedule-1 of ECR '97. Apart from the general requirement for every Red category proposed industrial unit or project the application must be accompanied with a feasibility report, Initial Environmental Examination (IEE), Environmental Impact Assessment (EIA) based on approved terms of reference (ToR) by DoE, and Environmental Management Plan (EMP). As per ECR '97, water resources development projects fall under the 'Red' category project, as do engineering works where the capital investment is more than 1 million Taka. Therefore, the FRERMIP project is a 'Red' category project which requires IEE, EIA. And EMP for environmental clearance from DoE.

28. The ECR '97 describes the procedures for obtaining Environmental Clearance Certificates (ECC) from the Department of Environment for different types of proposed units or projects. Any person or organization wishing to establish an industrial unit or project must obtain ECC from the Director General. The application for such certificate must be in the prescribed form together with the prescribed fees laid down in Schedule 13, through the deposit of a Treasury Challan in favor of the Director General. The fees for clearance certificates have been revised in 2010. Rule 8 prescribes the duration of validity of such certificate (three years for green category and one year for other categories) and compulsory requirement for renewal of certificate at least 30 days before expiry of its validity.

EIA GUIDELINES FOR INDUSTRIES (1997)

29. Sets forth IEE and EIA requirements for various industrial sectors and activities.

ENVIRONMENTAL CLEARANCE PROCEDURE FOR RED CATEGORY PROJECTS

30. Figure 2-1 shows the application procedure for obtaining site / environmental clearance. To obtain an environmental clearance certificate for category Red projects (i.e. the Project documented here), the following documents and materials must be submitted with the application to DoE:

(i) Project feasibility report, where applicable

(ii) Environmental impact assessment report
(iii) Environmental management plan
(iv) No Objection Certificate from relevant local authority (where applicable)
(v) Other necessary information, where applicable

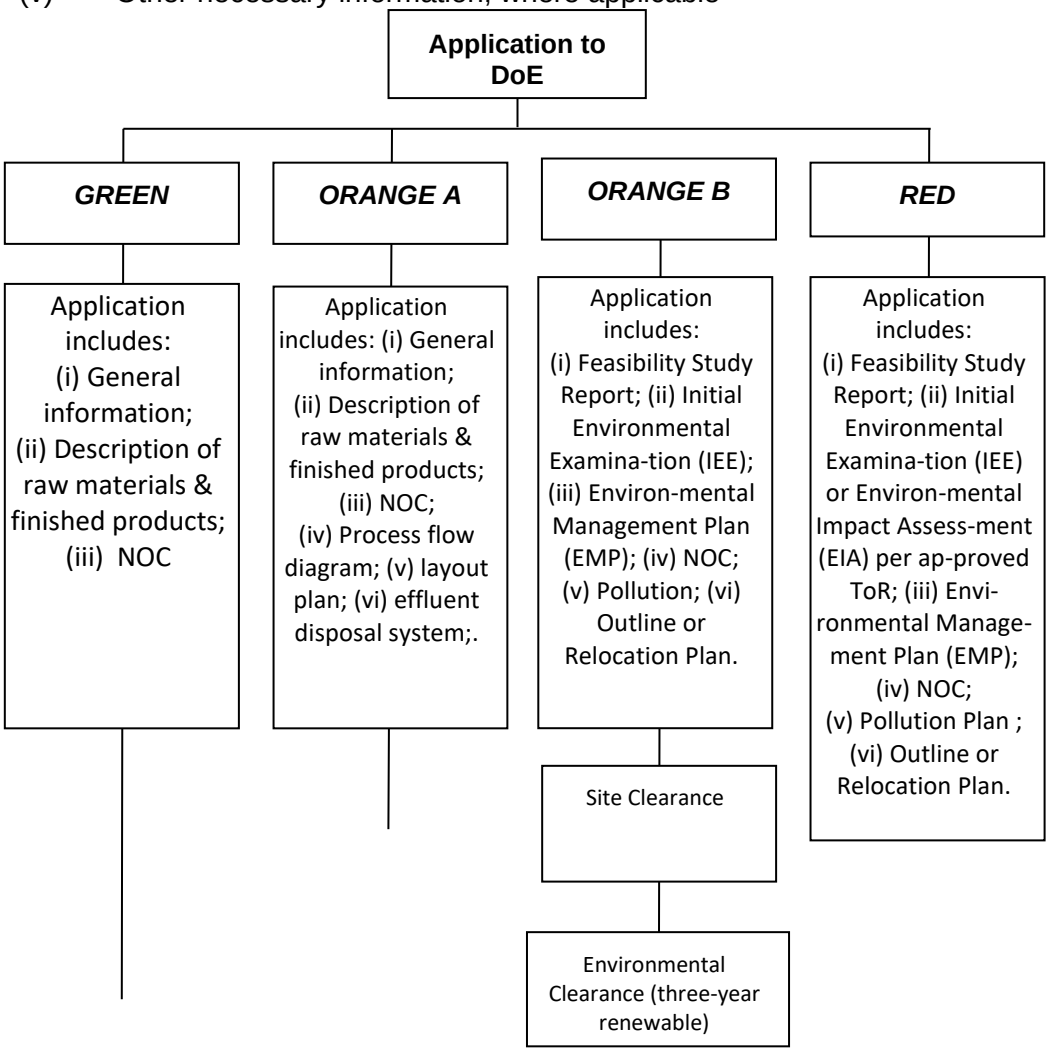


Figure 2-1. Application procedure for obtaining site and environmental clearance

2.1.3 Water Policies, Plans, and Legislation

NATIONAL WATER POLICY (1999)

31. Endorsed by the GoB in 1999, the National Water Policy (NWP) aims to provide guidance to the major players in water sector for ensuring optimal development and management of water. According to the policy, all agencies and departments entrusted with water resource management responsibilities (regulation, planning, construction, operation, and maintenance) are required to enhance environmental amenities and ensure that environmental resources are protected and restored in executing their tasks.

32. The policy has several clauses related to water resource development projects for ensuring environmental protection. Some of the relevant clauses are:

(i) Clause 4.5b: Planning and feasibility studies of all projects will follow the Guidelines for Project Assessment, the Guidelines for People's Participation (GPP), the Guidelines for Environmental Impact Assessment, and all other instructions that may be issued from time to time by the Government.

(ii) Clause 4.9b: Measures will be taken to minimize disruption to the natural aquatic environment in streams and water channels.

(iii) Clause 4.9e: Water development plans will not interrupt fish movement and will make adequate provisions in control structures for allowing fish migration and breeding.

(iv) Clause 4.10a: Water development projects should cause minimal disruption to navigation and, where necessary, adequate mitigation measures should be taken.

(v) Clause 4.12a: Consider environmental protection, restoration and enhancement measures consistent with National Environmental Management Action Plan (NEMAP) and the National Water Management Plan (NWMP).

(vi) Clause 4.12b: Adhere to a formal environment impact assessment (EIA) process, as set out in EIA guidelines and manuals for water sector projects, in each water resources development project or rehabilitation program of size and scope specified by the Government from time to time.

(vii) Clause 4.13b: Only those water related projects will be taken up for execution that will not interfere with aquatic characteristics of those water bodies.

33. Most of the above clauses are applicable to the FRERMIP.

NATIONAL WATER MANAGEMENT PLAN (2001, APPROVED 2004)

34. The National Water Management Plan (NWMP) 2001, approved by the National Water Resources Council in 2004, envisions to establish an integrated development, management and use of water resources in Bangladesh over a period of 25 years. Water Resources Planning Organization (WARPO) has been assigned to monitor the national water management plan. The major programs in the Plan have been organized under eight sub-sectoral clusters: i) Institutional Development, ii) Enabling Environment, iii) Main River, iv) Towns and Rural Areas, v) Major Cities; vi) Disaster Management; vii) Agriculture and Water Management, and viii) Environment and Aquatic Resources. Each cluster comprises of several individual programs, and a total of 84 sub-sectoral programs have been identified and presented in the investment portfolio.

GUIDELINES FOR ENVIRONMENTAL ASSESSMENT OF WATER MANAGEMENT (FLOOD CONTROL, DRAINAGE AND IRRIGATION) PROJECTS (APPROVED 2003, PUBLISHED 2005)

35. The 2005/2003 guidelines are an update of 1992 guidelines issued by Flood Plan Coordination Organisation (FPCO) to govern assessment of Flood Action Plan (FAP) projects and programmes. The document sets out the framework for environmental assessment of flood control, drainage, and irrigation projects in Bangladesh; it aims both to educate and to guide project planning. It primarily addresses project planning (project identification, pre-feasibility, feasibility), but does include information on the preparation of management recommendations for later project stages (design, construction, operation, monitoring, decommissioning). The guidelines emphasize the need for wider knowledge of measures and procedures such as EIA to prevent future environmental damage, considering the “widespread and serious environmental damage done in the past by physical interventions affecting the water sector (largely before formal assessment procedures were developed).” The stated purpose is “not to prevent development, but to ensure that it proceeds with due regard for the environment.”

THE NATIONAL DRINKING WATER SUPPLY AND SANITATION POLICY (1998)

36. The goal of the National Drinking Water Supply and Sanitation Policy (1998) is access to all of water and sanitation services within the shortest possible time at a price that is affordable to all. The Policy will be achieved through strategies formulated at various levels in consultation with the Ministry of Planning. Policy objectives are (i) to improve the

standard of public health and (ii) to ensure an improved environment. Policies for rural and urban areas are presented separately as they differ in institutional aspects, content and magnitude.

THE NATIONAL POLICY FOR ARSENIC MITIGATION (2004)

37. The National Policy for Arsenic Mitigation (2004) provides a guideline for mitigating the effect of arsenic on people and environment in a realistic and sustainable way. It supplements the National Water Policy (1998) and the National Policy for Safe Water Supply and Sanitation (1998) in fulfilling national goals related to poverty alleviation, public health, and food security.

38. The Policy states that access to safe water for drinking and cooking shall be ensured through implementation of alternative water supply options in all arsenic-affected areas. Arsenic mitigation activities under the Policy will focus on public awareness, alternative arsenic safe water supply, diagnoses and management of patients and capacity building. The national arsenic programme is to encourage and promote research and development on the impact of arsenic on water supplies, health, food and agriculture. Any resettlement on Project 2 should bear in mind the issues related to arsenic in drinking water.

INLAND WATER TRANSPORT AUTHORITY ORDINANCE (1958)

39. This ordinance sets up an authority for the development, maintenance and control of inland water transport and certain inland navigable waterways. The authority is mandated to perform functions including carrying out river conservancy work; river training for navigation purposes and aiding navigation; drawing up dredging program requirements and priorities for efficient navigable waterway maintenance, reviving dead or dying rivers, channels, and canals, and development of new navigation waterways.

2.1.4 Wildlife, Fisheries, Forestry, and Biodiversity Policies and Legislation

BANGLADESH WILDLIFE (PROTECTION AND SAFETY) ACT 2012

40. The 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; I Act:

(i) Protects 1,307 species of plants and animals, including 32 species of amphibian, 154 species of reptile, 113 species of mammal, 52 species of fish, 32 species of coral, 137 species of mollusc, 22 species of crustacean, 24 species of insect, 41 species of plant and 13 species of orchid. Of these, 8 amphibian-, 58 reptile-, 41 bird-, and 40 mammal species are listed as endangered in the Bangladesh IUCN Red Data Book (2000).

(ii) Mandates one to three years imprisonment, a fine of BDT 50,000 to 200,000, or both, for wildlife poaching, capturing, trapping, and trading, and for the purchase of wild animals, parts of wild animals, trophies, meat or other products without licence

(iii) Mandates two to seven years imprisonment and BDT 100,000 to 1 million fine or both, for killing an elephant or tiger; and 12 years plus BDT 1.5 million for repeat offenders.

(iv) Mandates five years imprisonment and BDT 200,000 fine for killing a cheetah, clouded cheetah, gibbon, sambar deer, crocodile, gavial, whale and dolphin.

(v) Mandates two years imprisonment and BDT 200,000 fine for killing a wild or migratory bird.

(vi) Empowers the Government to create an eco-park, safari park, botanical garden, or breeding ground on any state-owned forest land, land or waterbody.
(vii) Mandates two years imprisonment for farming, woodcutting, burning, and construction on such reserves.

BANGLADESH WILDLIFE (PRESERVATION) ORDER (1973) AND ACT (1974)

41. The Bangladesh Wildlife Preservation (Amendment) Act 1974 regulates the hunting, killing, capture, trade and export of wildlife and wildlife products. It provides a list of protected species and game animals, and empowers the Government to declare areas as game reserves, wildlife sanctuaries, and national parks to protect the country's wildlife and provides the following legal definitions:

(i) *Game Reserve* is defined as an area declared by Government wherein the capture of wild animals is unlawful, to protect wildlife and increase the population of important species;
(ii) *National Park* is defined as an area declared by Government comprising a comparatively large area of outstanding scenic and natural beauty with the primary objective of protection and preservation of scenery, flora, and fauna in their natural state, to which access for public recreation and education, and for scientific research, may be allowed;
(iii) *Wildlife Sanctuary* is defined as an area declared by Government that is closed to hunting, shooting, or trapping of wild animals as an undisturbed breeding ground, primarily for protecting natural resources, including wildlife vegetation, soil, and water.

42. The Act allows Government to relax any or all specified prohibitions for scientific purposes, for aesthetic enjoyment, or betterment of scenery.

PROTECTION AND CONSERVATION OF FISH ACT (1950)

43. This Act provides power to the government to:

(i) Make and apply rules to protect fisheries.
(ii) Prohibit or regulate erection and use of fixed engines; and construction of temporary or permanent weirs, dams, bunds, embankments and other structures.
(iii) Prohibit the destruction of fish by explosives, guns, and bows in inland or coastal areas.
(iv) Prohibit the destruction of fish by poisoning, pollution, or effluents.
(v) Prescribe the seasons during which fishing is allowed.
(vi) Prohibit fishing during spawning periods.
(vii) Specify officials having authority to detect breaches of this Act.

EAST-BENGAL PROTECTION AND FISH CONSERVATION ACT (1950) AND AMENDMENTS

44. East-Bengal Protection and Fish Conservation Act (1950) and Amendments The East-Bengal Protection and Fish Conservation Act (1950), as amended by the Protection and Conservation of Fish (Amendment) Ordinance (1982) and the Protection and Conservation of Fish (Amendment) Act (1995), provides for the protection and conservation of fish in inland waters of Bangladesh. These instruments define a relatively non-specific framework that simply provides a means for Government to introduce rules to protect inland waters not in private ownership. Among other things, they sanction rulemaking regarding destruction of, or any attempt to destroy, fish by poisoning of water or depletion of fisheries by pollution, industrial effluent, or otherwise.

PROTECTION AND CONSERVATION OF FISH RULES (1985)

45. These Rules are in line with the overall objectives of the Fisheries Act and its amendments. Section 5 of the Rules states that, “No person shall destroy or make any attempt to destroy any fish by explosives, gun, bow and arrow in inland waters or within coastal waters”. Section 6 states, “No person shall destroy or make any attempt to destroy any fish by poisoning of water or the depletion of fisheries by pollution, by trade effluents or otherwise in inland waters.”

THE NATIONAL FORESTRY POLICY (1994)

46. The National Forestry Policy (1994) is a revision of the National Forest Policy (1977) in light of the National Forestry Master Plan. The major targets of the Policy are to conserve existing forest areas; bring approximately 20 per cent of the country’s land area under the afforestation program; and increase reserve forest land by 10 per cent by the year 2015, through coordinated efforts of Government and non-governmental agencies, and active participation of the people.

47. The need of amendments of the existing forestry sector related laws and adoption of new laws for sectoral activities have been recognized as important conditions for achieving the policy goals and objectives. The Forest Policy also recognizes the importance of fulfilling the responsibilities and commitments under international multilateral environmental agreements.

THE BIODIVERSITY CONSERVATION STRATEGY AND ACTION PLAN 2004

48. The Biodiversity Conservation Strategy and Action Plan 2004 (BCSAP) is a wide-ranging multi-faceted plan closely related to the National Environment Policy. BCSAP has the following broad objectives:

(i) Identification of key environmental issues affecting Bangladesh;
(ii) Identification of actions necessary to halt or reduce the rate of environmental degradation;
(iii) Improvement of the natural and built environment;
(iv) Conservation of habitats and biodiversity;
(v) Promotion of sustainable development; and
(vi) Improvement in the quality of life of the people.

2.1.5 Agriculture and Land Use Policies and Legislation

NATIONAL AGRICULTURE POLICY (1999)

49. The goal of the National Agriculture Policy (1999) is to facilitate and accelerate technological transformation with a view to achieving self-sufficiency in food production and improving the nutritional status of the population. The overall objective of the Policy is to achieve food self-sufficiency through increasing production of all crops including cereals and a dependable food security system for all. It aims to ensure, inter-alia, a sustainable agricultural production system; preservation and development of land productivity; and preservation of crop diversity. The Policy also aims to develop a contingency management system to combat natural disasters. The Policy provides 38 upazila-level programs to address soil erosion in Madhupur Tract, Barind Tract, and the piedmont.

NEW AGRICULTURAL EXTENSION POLICY (1996)

50. The goal of the New Agricultural Extension Policy 1996 is to encourage national agricultural extension system agencies and partners to provide efficient and effective

services that complement and reinforce each other, to increase the efficiency and productivity of Bangladesh agriculture. To achieve this goal, the Policy includes the following key components: (i) extension support to all categories of farmer; (ii) efficient extension services; (iii) decentralization; (iv) demand-led extension; (v) working with groups of all kinds; (vi) strengthened extension-research linkage; (vii) training of extension personnel; (viii) appropriate extension methodology; (ix) integrated extension support to farmers; (x) coordinated extension activities; and (xi) integrated environmental support.

51. The broad objective of the Policy is to facilitate and accelerate technological transformation with a view to achieving food self-sufficiency and improving the nutritional status of the population. The long-term objective is to ensure sustainable agricultural development maintaining the ecological balance in the natural environment. The National Task Force responsible for preparation of this Policy has also been charged with development of an Implementation Strategy that will establish: (i) clear definitions of the roles for the various extension agencies; (ii) effective mechanisms for collaboration and information exchange among extension agencies and among farmers; (iii) effective mechanisms for the supply, management, and monitoring of resources to support the extension agency activities; (iv) mechanisms to provide extension agents at all levels with skills and training appropriate to their job requirements; and (v) effective linkages to support three-way information flow between farmers, extension agents, and research institute staff.

NATIONAL LAND USE POLICY (2001)

52. The Land-Use Policy aims to ensure land use in harmony with the natural environment. The Policy introduced a zoning system to ensure the best use of land in different parts of the country considering local geological differences, to rationalize the currently unplanned expansion of residential, industrial, and commercial construction.

NATIONAL ENVIRONMENTAL POLICY

53. Bangladesh National Environmental Policy of 1992 is one of the key policy documents of the Government and sets out the basic framework for environmental action. The Environment Policy delineates the Department of Environment (DoE) as the approving agency for all such IEE/EIAs to be undertaken in the country. The objectives of Environmental Policy are to i) Maintain ecological balance and overall development through protection and improvement of the environment; ii) Protect the country against natural disaster; iii) Identify and regulate activities which pollute and degrade the environment; iv) Ensure environmentally sound development in all sector; v) Ensure sustainable, long term and environmentally sound use of all national resources, and vi) Actively remain associated with all international environmental initiatives to the maximum possible extent. The Policy covered all geographical regions and 15 development sector like Agriculture, Industry, Health & Sanitation, Energy and Fuel, Water Development, Flood Control and Irrigation, Land, Forest, Wildlife and Bio-diversity, Fisheries and Livestock, Food, Coastal and Marine Environment, Transport and Communication, Housing and Urbanization, Population, Education and Public awareness.

THE BANGLADESH BIODIVERSITY ACT, 2017

54. The Act was passed in line with Bangladesh's constitutional mandate under Article 18A and international mandates under Convention on Biodiversity. This Act regulates the Biodiversity conservation and sustainable use of its resources. The Bangladesh Biodiversity act includes National Fisheries Policy, 1988, National Livestock Development policy 2007, National Forest Policy 1994, Bangladesh Wildlife (Protection and Safety) Act, 2012. It delegates the duties for granting permission to such access on the National Biodiversity Committee, who shall also determine the equitable sharing of benefits accrued from biodiversity, biological resources and traditional knowledge.

JALMAHAL MANAGEMENT POLICY, 2009

55. Government of Bangladesh set out "Government Jalmahal management Policy, 2009" in order to conserve Biodiversity of fisheries and income generating of fish farmer and fisherman. The Policy stipulates specific rules for leasing out of lands and water bodies owned by Government (khas land) to the fish farmer and fisherman. The policy provides formation of committees in different levels of the Government to lease out Jalmahal up to 20 acres and above.

BALUMAHAL AND SOIL MANAGEMENT ACT, 2010

56. Balumahal and Soil Management Act, 2010 provides to overcome the hazards faced and extraction of sand/soil in a planned manner during leasing out of Balumahal. The act imposes the restriction of extraction of sand from specified area on certain conditions. This act includes the illegal extraction of sand as offence and subject to trail for penalty of such activities.

2.1.6 Environmental Quality Standards

57. Environmental quality standards relevant to the Project, for air quality, noise, and sewage discharge, are provided in Table 2-1, Table 2-2 and Table 2-3.

Table 2-1. Bangladesh Standards for Ambient Air Quality

No.	Area	Suspended Particulate Matter	SO_2	Co_2	NOs
		(mg/m^3)			
Ka	Industrial and mixed	500	120	5000	100
Kha	Commercial and mixed	400	100	5000	100
Ga	Residential and rural	200	80	2000	80
Gha	Sensitive	100	30	1000	30

Source: Schedule-2, Rule 12, Environment Conservation Rules of 1997 (Translated from Bengali)

Notes:

1. Sensitive area includes national monuments, health resorts, hospitals, archaeological sites, educational institutions
2. Any industrial unit located not at a designated industrial area will not discharge such pollutants, which may contribute to exceed the ambient air quality above in the surrounding areas of category 'Ga' and 'Gha'.
3. Suspended particulate matters mean airborne particles of diameter of 10 micron or less.

Table 2-2. Bangladesh Standards for Noise

No.	Area Category	Standard Values (dBA)	
		Day	Night
Ka	Silent Zone	45	35
Kha	Residential area	50	40
Ga	Mixed area (basically residential and together used for commercial and industrial purposes)	60	50
Gha	Commercial area	70	60
Umma	Industrial area	75	70

Source: Schedule 4, Rule-12, Environment Conservation Rules, 1997 (Page 3127, Bangladesh Gazette, 28 August 1997, trans. from original Bengali).

Notes:

1. Daytime is defined as the time between 6 Am. to 9 pm.
2. Night-time is defined as the time between 9 pm to 6 am.
3. Silent zones are areas up to a radius of 100 m around hospitals, educational institutes, and Government-declared special establishments. Use of vehicular horns, other signals, and loudspeakers are prohibited in silent zones.

Table 2-3. Bangladesh Standards for Sewage Discharge

Parameters	Unit	Values
BOD	mg/L	40
Nitrate	mg/L	06-Sep
Phosphate	mg/L	25
Suspended Solid (SS)	mg/L	100
Temperature	^oC	30
Coliforms	number/100ml	1000

Source: Schedule-8, Rule-I3, Environment Conservation Rules, 1997. (Page 3131, Bangladesh Gazette, 28 August 199, trans. from Bengali].

Notes: i) These standards are applicable for discharge into surface and inland water bodies; ii) Chlorination is to be done before final discharge.

2.2 Project-Relevant International Environmental Agreements in Force in Bangladesh

58. Of the international environmental agreements to which Bangladesh is a party,[8] those potentially relevant to the Project are:

(i) Convention on Wetlands of International Importance (also known as the Ramsar Convention, 1971; Bangladesh 1992) – promotes conservation and wise use of all wetlands.
(ii) Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES Convention, 1975, Bangladesh 1981) – aims to ensure that international trade in specimens of wild animals and plants does not threaten their survival.
(iii) Convention on Biological Diversity (1993, Bangladesh 1994) – addresses: a. sustainable use of biological diversity components,
(iv) fair and equitable sharing of genetic resources utilization benefits.
(v) Convention on the Conservation of Migratory Species of Wild Animals (also known as CMS or Bonn Convention) (1983; Bangladesh 2005) – addresses conservation of terrestrial, marine, and avian migratory species throughout their ranges, including conservation of migratory species habitats.
(vi) Convention on Climate Changes (Known as Kyoto Protocol, Japan, 1997) International treaty on climate change and emission of greenhouse gases.
(vii) Convention on Occupational Health services (Geneva, 1985) To promote a safe and healthy working environment.

59. These instruments document the GOB commitment to biodiversity conservation, climate change and disaster risk management generally, at all levels (global-national-regional-local and ecosystem-habitat-species), and specifically to the provisions of these agreements.

2.2.1 ADB Safeguards: Policy and Guidelines/Guidance Documents

60. At the time of this report, current versions of Project-relevant ADB safeguards policy and guidelines/guidance documents included:

ENVIRONMENT AND SOCIAL

2009 Safeguard Policy Statement.
2010 Multitranche Financing Facility, Section D14/BP, Operations Manual
2011 Complaint Handling in Development Projects - Grievance Mechanisms: A Critical Component of Project Management
2011 Complaint Handling in Development Projects - Building Capacity for Grievance Redress Mechanisms
2012 Guidelines for Climate Proofing Investment in Agriculture, Rural Development, and Food Security

ENVIRONMENT

2003 Environmental Assessment Guidelines
2012 Environment Safeguards, A Good Practice Sourcebook—Draft Working Document.

SOCIAL

[8] Department of Environment.n.d. "Multilateral Environmental Agreements in Force in Bangladesh". Government of Bangladesh.http://www.doe-bd.org/agreement.html

2003 [Policy on] Gender and Development
2006 Gender Checklist: Agriculture
2009 Project Gender Action Plans, Lessons for Achieving Gender Equality and Poverty Reduction Results. Briefing Note
2012 Involuntary Resettlement Safeguards, A Planning and Implementation Good Practice Sourcebook – Draft Working Document.
2012 Indigenous Peoples Safeguards, A Planning and Implementation Good Practice Sourcebook - Draft Working Document.
2012 Handbook on Poverty and Social Analysis A Working Document.
2012 Guidelines for Gender Mainstreaming Categories of ADB Projects.

3 APPROACH AND METHODOLOGY

61. This Chapter presents the detailed approach and procedure employed to conduct the EIA study. Also described in the Chapter are data sources and methodology of data collection, processing and impact assessment.

3.1 Overall Approach

62. The EIA study for the project interventions under Project-2 has been carried out following the DoE and WARPO guidelines for water resources projects. The overall approach of the study is shown in Figure 3 1.

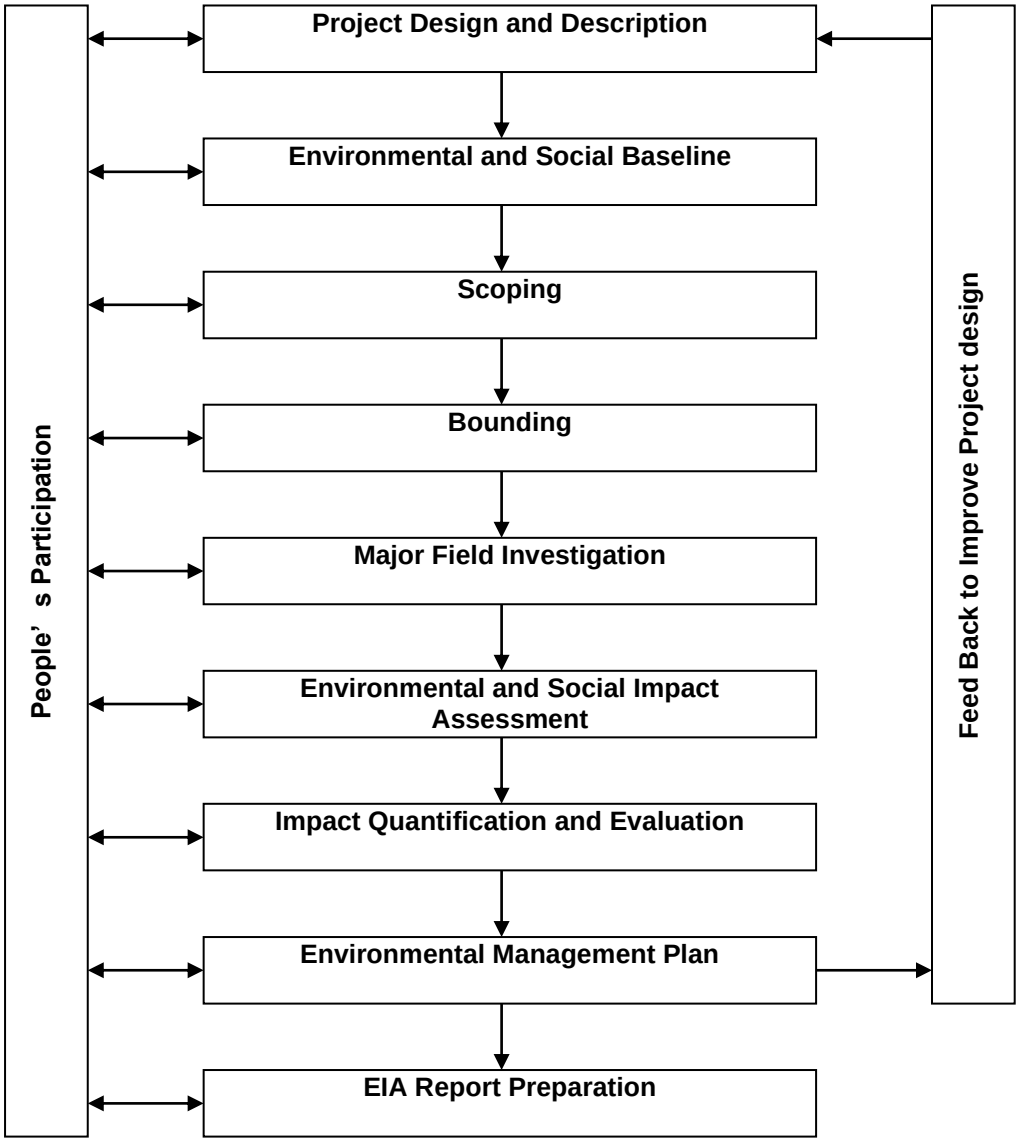


Figure 3-1: Overall approach of the EIA study

3.2 Methodology

63. The step-wise, detailed methodology followed for the EIA study is briefly described below.

3.2.1 Project Design and Description

64. Interventions proposed for Project-2 were the basis of this EIA study. Initial information and specifications of the proposed interventions was obtained from the FRERMIP consultant team. This was followed by development of a base map using the images and data available with CEGIS in GIS data layers. Thereafter the EIA study team met the concerned Executive Engineer of BWDB from whom detailed and specific information was collected and marked in the base map. The EIA study team also observed, to the extent possible, the present condition of the existing infrastructure during field visits. Opinions of the local people on the performance of the existing infrastructure and their perception about the proposed interventions were also obtained.

3.2.2 Baseline Data Collection and Analysis

65. Baseline data collection was conducted as a pre-requisite for the EIA study. The baseline conditions in the project area were assessed according to information collected from secondary and primary data sources through literature review, field investigations and consultation with stakeholders. The baseline condition was established with respect of water resources, land resources, agriculture, infrastructure (including roads and waterways), livestock, fisheries, ecosystems and socio-economic conditions including identification of problems in the proposed project sites and adjoining areas.

WATER RESOURCES

66. Water resource data under the heading river hydrology, river morphology, groundwater availability, drainage pattern, ground and surface water quality and water use were collected from secondary sources and primary observation by the professional of the multi-disciplinary team members backed up by feedback from the local people during field visits for baseline preparation and impact assessment in this study. Major river systems were identified for hydrological and morphological investigation through historical and current data collection and analysis. Specific areas or points of interest were selected for collecting data on special hydrological and morphological events such as river-khal-beel network, water availability, drainage pattern, water quality (surface and ground water), flash flood, risk of erosion or sedimentation, and so on.

67. Field visits were made to the study area and primary data on water resources components were collected through discussion with stakeholders. A checklist was used to obtain the information on different resources. Local knowledgeable persons and community representatives were also interviewed. During the field visits, the multidisciplinary EIA team members made professional observations pertaining to their individual areas of expertise. The impact of the project was assessed by analyzing collected data, community knowledge analysis and professional justification of water resource managers. The management plan for water resources components was incorporated to assess impact risk and water resources status using stakeholders' requirement and expert judgment.

68. The specific data on different events of water resources were gathered and analyzed using the methodology presented in Table 3-1.

Table 3-1. Data collection for the EIA study

Parameter	Data Sources	Methodology
Surface Water hydrology		
Dry and wet season water level and discharge	BWDB	Mean monthly water level was collected from BWDB database
Drainage system	CEGIS	Data was gathered through image analysis and physical observations were used for ground trothing
River hydro-morphology		
Sedimentation	CEGIS	Data was collected through satellite image, secondary sources and physical observations.
Flooding	SRDI, CEGIS	Land type based on different inundation depth was collected from SRDI and verified in field
Ground water hydrology		
Water table	BWDB and field investigation	Data was collected from source organizations at different locations in the total study and project area.
Water quality and use		
Surface and ground water quality.	BWDB, DPHE and field investigation	Water quality was analyzed on the basis of data from BWDB and verified at field level through physical observation as well as in consultation with local people.
Surface and ground water use (availability)	Local community and authority	Sources and different sector of water use was identified from field investigation and local authority
Ecology		
Birds, dolphins, fish	Bangladesh Bird Club, IUCN, DoF, DoE	Meetings, collection of reports, field visits
Vegetation	Various	Reports, field visits

69. Meteorological data such as rainfall, evapo-transpiration, temperature, sunshine hours, humidity and wind speed were collected and analyzed for assessing local climate that are directly related to water resources of the study area. Meteorological data for selected stations was collected from the National Water Resources Database (NWRD) of WARPO, which contains long time series of temporal data showing daily values for meteorological stations maintained by the Bangladesh Meteorological Department (BMD).

70. The general geological features and the seismicity of the project and its surrounding areas were collected from available secondary literature and Geological Survey of Bangladesh. The topographical data was collected from Geological Survey of Bangladesh

and National Water Resources database (NWRD) of Water Resources Planning organization (WARPO).

LAND RESOURCES

71. The Agro-ecological Region of the proposed study area has been identified using secondary sources (FAO/UNDP). The land use, land type, soil texture data have also been collected from Upazila Land and Soil Resources Utilization Guide (Upazila Nirdeshika) of Soil Resource Development Institute (SRDI). The secondary data of these parameters have been verified at field level through physical observations as well as in consultation with the local people and officials of the Department of Agricultural Extension (DAE) during field visits.

AGRICULTURE RESOURCES

72. Data on agricultural resources included farming practices, crop production, constraints, existing cropping patterns, crop variety, crop yield, crop damage and agricultural inputs were used. Agriculture data was collected from primary sources through extensive field survey by developing questionnaires and in consultation with local people and concerned agricultural officials. Agricultural resources data were also collected from secondary sources from Upazila Agriculture Extension office (DAE). Crop production was determined using the formula: Total crop production = damage free area × normal yield + damaged area × damaged yield. The crop damage (production loss) was calculated using the formula: Crop production loss = Total cropped area × normal yield- (damaged area × damaged yield + damage free area × normal yield). The crop damage data were collected from the field.

LIVESTOCK RESOURCES

73. The present status of livestock (cattle/bullock, buffalo, goat and sheep) and poultry (duck and chicken) in the study area have been evaluated at field level survey in consultation with the local people through PRA, RRA and KII. Livestock resources data was also collected from secondary sources from the Upazila Livestock office.

FISHERIES RESOURCES

74. **Data collection methods:** The fisheries data was collected for the EIA study by considering the seasonal variance of dry and wet seasons. Prior to data collection, a checklist/ questionnaire was developed. The checklist included all kinds of information which should be looked at in the context of existing and potential structures of the project. A combination of survey techniques was used for data collection including sampling site selection, data collection, data analysis and reporting. The sequential interpretation of the methodological approach is described below.

75. **Sampling Site Selection:** Existing and proposed intervention wise sites were selected for data collection. Sampling sites varied depending on the proposed intervention sites. During site selection concentration was given on the areas with interventions and areas without interventions to find the difference between them in terms of fisheries impact.

76. **Data Collection:** Data was collected in multiple ways which can be broadly as (i) primary data collection and (ii) secondary data collection. Primary data was collected from the fishermen community, fisher households and local key informants and secondary data were collected from Upazila Fisheries Offices during field visits.

77. **Habitat Identification:** Fish habitat classification was done based on physical existence and were categorized into capture and culture fish habitats. The capture fish habitats included river, khal, floodplain, burrow pit and beel. The culture fish habitats included homestead culture fish-pond, commercial fish farm, and so on.

78. **Capture & Culture Fish habitats:** Capture fish habitat assessments were done through Fishing Effort Surveys (FES), Frame Surveys (FS), micro scale Catch Assessment Surveys (CAS), habitat based species diversity and composition, identification of species of conservation significance, identification of potential fish habitat prescribing to restore for fish conservation, fish migration surveys and habitat identification for fish conservation. Culture fish habitat assessment was done through homestead culture fish-pond surveys and commercial fish farm surveys.

79. **Associated Information:** Information on post harvest activities, forward and backward linkages, fisher livelihood information, fisheries management issues, potential fish recruitment, fish infrastructure and fisher vulnerability, and so on, were also collected.

80. **Secondary Data Collection:** Relevant secondary data was collected from the Upazila Fisheries Office (UFO) from their annual report and from various literature/studies.

81. **Data Analysis and Output:** Fish productions for individual habitats were obtained through a series of calculation procedures using the collected information of FES, FS, CAS and Habitat area. Aggregating the fish production from all habitat types, total fish production of the study area was estimated basin wise and then holistically. Secondary information that was collected from the UFOs and literatures were used to supplement primary data in production estimation.

ECOLOGY

82. Information on bio-ecological zones and their characteristics has been collected from publications of Bangladesh office of the International Union for Conservation of Nature (IUCN). The ecological component of the EIA study focused on terrestrial and riverine ecology including flora, birds, reptiles, amphibians, mammals, and migratory birds. The field activities included collecting ecosystem and habitat information, sensitive habitat identification, identifying ecological changes and potential ecological impact. The land use information on different ecosystem was generated through analysis of recent satellite images. Field investigation methods included physical observation; transect walks, habitat surveys and consultations with local people. Field visits were carried out in delineating the ecological baseline condition. Public consultation was carried out through Focus Group Discussions (FGD) and Key Informant Interview (KII) methods. An inventory of common flora and fauna was developed based on field surveys and the data base of IUCN Bangladesh.

SOCIO-ECONOMIC RESOURCES

83. The socio-economic baseline information including the study area, demographic information, occupation and employment, literacy rate, drinking water, sanitation, electricity facilities etc. were collected form secondary sources, i.e. BBS, 2011 and other relevant literatures included data obtained from BWDB. The income expenditure, land ownership pattern, self assessed poverty status, migration, social overhead capitals and quality of life, disasters, conflicts of the study area, information on NGOs, cultural and heritage features of the project area were collected mainly from primary sources through PRA and FGDs and public consultations.

84. The steps taken for collecting socio-economic data were as follows:

(i) Data was collected from BBS, 2011 and reviewed relevant literatures from BWDB;
(ii) Reconnaissance field visit and discussion with BWDB officials and local stakeholders for primary data collection;
(iii) PRA /RRA, FGDs, KII for primary data collection;

(iv) Institutional Survey (IS) for primary data collection in district and Upazila level offices which included DC office, LGED office, Civil Surgeon office, Social Service office etc.

3.2.3 Scoping and Bounding

85. A scoping process was followed for selecting Important Environmental and Social Components (IESCs) which are likely to be impacted by the proposed interventions under Project-2. Scoping was done in two stages. The Tranche-1 EIA study team made a preliminary list of the components pertaining to their disciplines, which could be impacted by the project. This included village scoping sessions where stakeholder perceptions were obtained about those environmental and social components. Professional judgment of the EIA team members as well as the stakeholder opinion obtained in the scoping sessions was considered in selecting the IESCs.

86. During the second phase of the scoping process the Project-2 EIA study team conducted compliance monitoring of Environmental Management Plan (EMP) implementation of Tranche-1 construction works, which yielded important insight in which impacts where significant, and which were not. This team also conducted the Strategic Environmental and Social Assessment (SESA) of long term River Stabilization Plan (RSP) that identified significant impacts. Finally, this team prepared the required Initial Environmental Examination (IEE) and ToR for the EIA study of Project-2, which was then reviewed by the DoE and ADB, commented upon and approved for implementation.

87. The area likely to be impacted by the project interventions under Project-2 was delineated in consultation with the BWDB in addition to feedback received from the local people during baseline consultation. The processed RS tools were used for this purpose but there were some errors due to unavailability of high-resolution images of the proposed project area in CEGIS archive. The entire area influenced by existing sub-projects and the proposed projects were considered as the potential area to be impacted.

3.2.4 Major Field Investigation

88. The EIA study team members collected intensive data on possible impacts of the project after procuring the project plan. Data on the IESCs were collected from the field. In this case, information on the IESCs were gathered through a mixed method including RRA, PRA and KII using checklists for water resources, land resources, agriculture, livestock, fisheries, ecosystem and socio-economic components. Intensive consultation with the local people was carried out in each case for securing people's participation. The multidisciplinary EIA study team members also made observations and justification during the field visits. This time the concentration was on the historical status and public responses for the IESCs and the possible condition of the same against the proposed interventions.

3.2.5 Impact Assessment

89. Environmental and social impacts of the proposed interventions in the project on the IESCs have been assessed through several sets of activities. Impacts are caused because of interaction of specific project activities with the existing environmental settings. The impacts of proposed interventions were estimated based on difference between the future-without-project (FWOP) condition and the future-with-project (FWIP) condition. The FWOP conditions were generated through trend analysis and consultation with the local people. This reflected the conditions of IESCs in the absence of the proposed interventions. Changes expected to be brought about due to the proposed interventions were assessed to generate the FWIP condition. Comparison and projection methods were used for impact prediction. This included both positive and negative impacts which were considered in the preparation of the environmental management plan.

90. The sequence of assessment of environmental and social impact was as follows:

(i) Changes in IESC status pertaining to water resources;
(ii) Changes in IESC status pertaining to land resources, agriculture, livestock and poultry;
(iii) Changes in IESC status pertaining to fisheries;
(iv) Changes in IESC status pertaining to ecological resources; and
(v) Changes in IESC status pertaining to socio-economic condition.

3.2.6 Impact Evaluation

91. At this stage, attempts were made to quantify the impacts of the proposed interventions on the IESCs. But it was not possible to quantify all impacts, especially the impacts on some of the environmental and social components. In those cases, qualitative impacts were assessed, and scores were assigned with (+) sign for positive impacts and (-) sign for negative impacts. The magnitude of both positive and negative impacts was indicated in a scale of 1 to 10 on extent, magnitude, reversibility, duration and sustainability considerations.

3.2.7 Preparation of Environmental Management and Monitoring Plan

92. An environmental management plan (EMP) for the proposed project was prepared comprising the mitigation/ enhancement measures with institutional responsibilities, environmental monitoring plan, training and capacity building plan, and reporting and documentation protocols.

3.2.8 EIA Report Preparation

93. At the end of the process, the present report was prepared incorporating all the findings of the EIA study. The EIA for the Tranche-1 works formed the base and this was updated to the extent needed for Project-2 works.

4 PROJECT DESCRIPTION

4.1 Project-2 Civil Works

94. Project-2 consists of:

(i) Around 40.50 km of riverbank protection – including:
  (a) JRB-1: 10.50 km (3.50 km at Benotia and 7 km at Enayetpur);
  (b) JLB-2: 15.50 km upstream of Chauhali and 10.5km precautionary work with intelligent dredging;
  (c) PLB-1: 4km at Harirampur
(ii) Around 8.5 km of wave protection to complete underwater protection built under Tranche 1 at PLB-1 (Harirampur);
(iii) Around 47.9 km of embankments including:
  (a) JRB-1: 7.9 km at Kaijuri/ Shahjadpur to complete the 21.3km of embankment constructed under Tranche 1 including 2 regulators with fish passes;
  (b) JLB-2: 40km of climate-smart[9] embankment between Aricha and Chauhali including over the reclaimed Solimabad channel including 8-10 (TBC) regulators with fish passes;
(iv) Around 40 km of adaptation works and 10km allowance for emergency works;

95. Road construction was included in the original DMF of the MFF, but was not carried out in Tranche-1 and has been dropped from Project-2 for the following reasons:

(i) Insufficient funds in Tranche-1 to expand works to include road construction, and
(ii) The BWDB is not strictly mandated to build roads and RHD as well as LGED have already indicated strong interest to build the roads.

Figure 4-1 provides a map of FRERMIP Tranche-1 and Project-2 works.

[9] Climate smart embankments have a crest that can be raised as necessary based on increased flood / wave levels due to climate change without changes to the main embankment level/ roadway level behind. They have slopes that can be planted with trees and make use of natural reeds to protect against wave loading where suitable

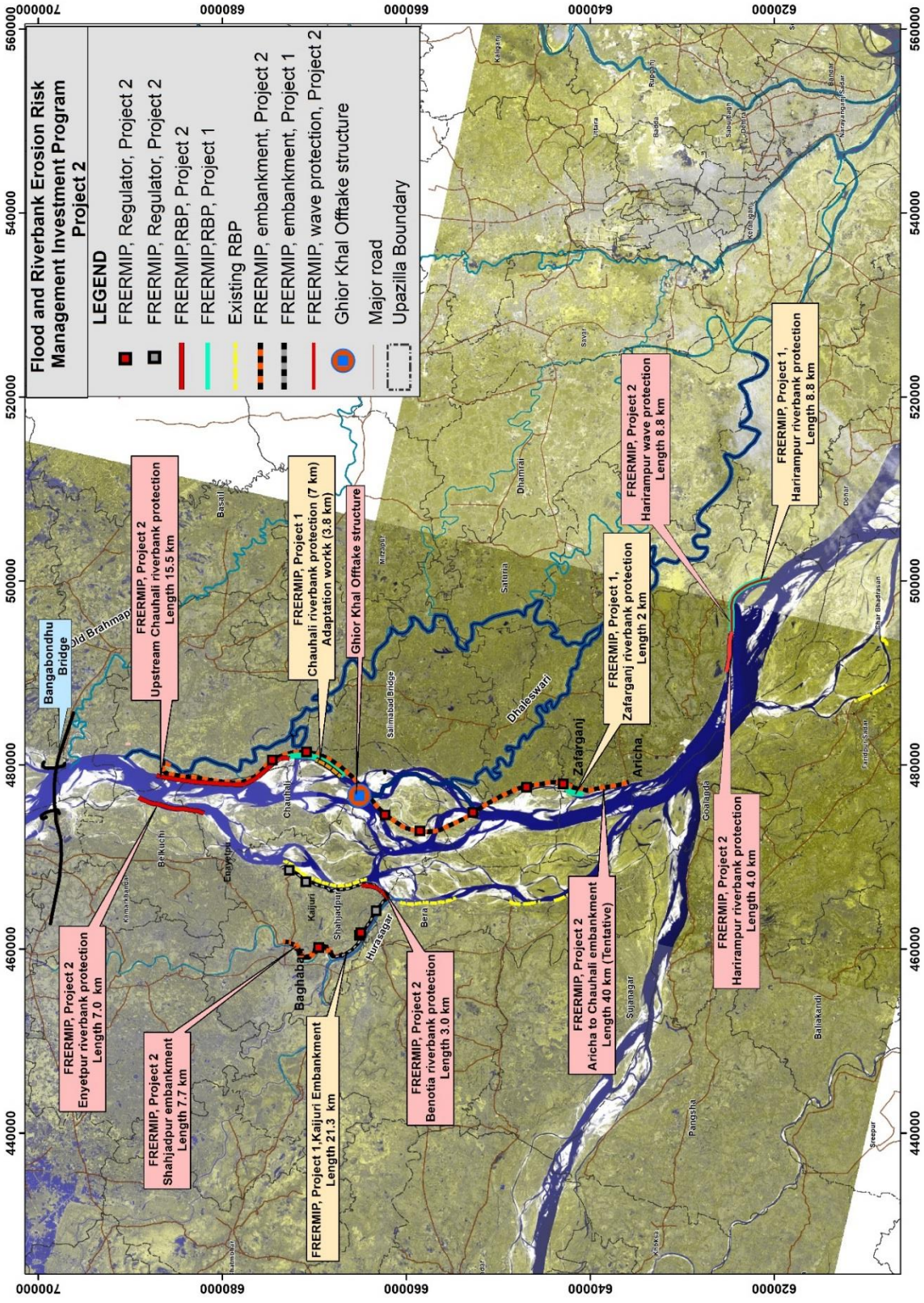


Figure 4-1. FRERMIP Tranche/ Project 1 and Project 2 works

4.2 Description of proposed dredging

96. Dredging within the context of river stabilization may include dredging for:

(i) Underwater slope preparation for riverbank protection works, particularly on unconsolidated loose char soils,
(ii) River training purposes including forming pilot or cut-off channels and choking (overloading with sediment) unwanted channels
(iii) Embankment construction (sand core),
(iv) Low-flow navigation channels,
(v) Speeding up land reclamation of char-lands by filling with dredged material, and
(vi) Speeding up offtake and distributary re-development by increasing capacity and flows along the distributaries for improved water supply as well as inland navigation.

97. Project-2 will use five of six possible dredging measures compared in Table 4-1.

Table 4-1. Comparative Assessment of Different Types of Dredging

Purpose	**Dredging proportion**	**Technical feasibility and appropriateness of measure for Project-2**	**Likely economic benefit**	**Risks/ Uncertainty**
For revetment construction particularly on weaker soils to establish stable slopes and deeper apron setting levels	Depending on soil conditions and related apron setting level	Feasible measure and suitable to establish more stable underwater slopes prior to dumping geo-bags. This reduces need for strengthening/adaptation work. Implementation during dry season is demanding as higher dredging requirement is required	• Reduced risk of failure • Reduced maintenance and strengthening/ adaptation works requirements	• Low – this measure reduced risk • Deep water/ high capacity dredging required
River training measures including (i) pilot channels for leading/ training flow, (ii) sand plug / choking channel ("*building with nature*")	90%	Measure likely suitable for river stabilisation and training, but needs study and piloting for effectiveness. This is planned for Solimabad – downstream of Chauhali (JLB-2)	• Effective stabilisation measure • Dredged material will be used for channel closure	Measure is a pilot and results will be compared against model work and lessons will lead to future refinement/ improvement
Dredging sand for embankment construction	> 60% of construction cost, and depending on volume of wave protection and regulators	Standard measure for modern embankments which minimize the use of fertile, intensively agriculturally used topsoil.	• Reduced environmental impact • Improved bearing capacity for road construction • Contribution to channel stabilization	Low, as technically sound measure also implemented under Tranche 1
Dredging low-	100%	Navigation dredging to	• Low at this	• Dredging at

Purpose	Dredging proportion	Technical feasibility and appropriateness of measure for Project-2	Likely economic benefit	Risks/ Uncertainty
flow channels, particularly between protected river bank bends for navigation		flow river stabilisation, and likelihood of larger ships needing navigable river in FRERMIP area	time due to limited dry season navigation	this time likely to be less economically feasible • Taken up by BIWTA
Speeding up land reclamation of char lands by filling with dredged material	100%	Technically feasibility but depending on (i) social acceptability/ land holding/ resettlement aspects, and feasibility of removing large quantities of sediment from the river with degradation	• Depends on land use after reclamation – beneficial for agriculture • suited to land allocated for commercial developments	• River destabilisation due to over dredging locally. • Lack of demand from developers for commercial real estate
Speeding up offtake and distributary re-development by increasing capacity and flows along the distributaries for improved water supply as well as inland navigation	100%	Flood management structure required at head of distributary before dredging initiated for dry season flows. Dredging along distributary to increase/ restore dry season flows should ideally follow on from flood management structure construction at head. Disposal of dredged material may be problematic	Likely to be high to: (i) address declining water tables and quality, (ii) increase availability of surface lean season flows for irrigation, reducing dependence on tubewells, (iii) increased supply to Dhaka metropolis, (iv) improved navigation, (v) improved connectivity for fisheries, and (v) improved habitats	• Increased flows along distributary may lead to some bank instability leading, for example, to failure of bridges/ other structures. • Disposal of dredged material • Studies required to firm up desired flows

4.3 Technologies used

98. Project-2 river stabilization depends on three technologies, in line with government priorities:

(i) Providing a reliable **boundary between floodplain and river**, or land and water through long-guiding revetments acting as “bend control” to encourage a more meandering and stable channel pattern. These revetments have a demonstrated self-dredging ability and result in a more predictable channel pattern even when only built along parts of the riverbank. This technology is classified as structural measure.

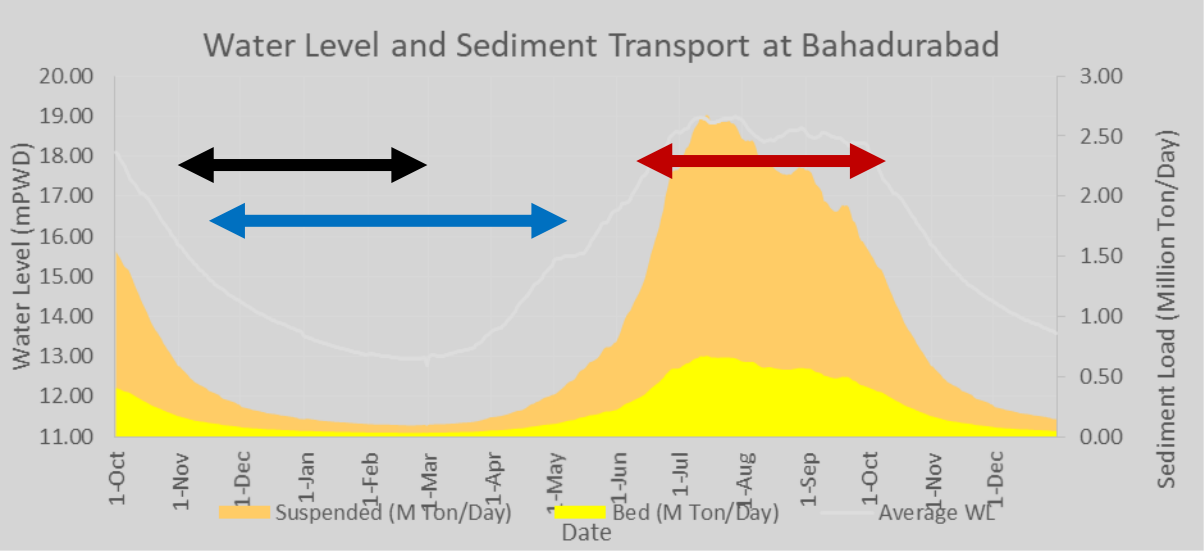
(ii) **Multi-purpose dredging** supports a more stable river environment, through navigation dredging during the dry season, supporting the construction of

riverbank protection, and providing the source material for revetment and embankment construction[10], and the raising of land above high flood levels. Dredging is limited to the sand fraction of the transported sediment (bed material load) which only constitutes around one quarter of the total sediment load.

(iii) Sediment harvesting extends river stabilization into the flood season by capturing the dominant part of the sediment transport, the suspended sediment. This deposited finer sediment provides Bangladesh's fertile topsoil allowing multiple cropping. The suspended sediment can best be attracted through the indigenous technique of reed plantations. Applied systematically, it turns into a bio-engineering technique in "**Building with Nature**". The technology was planned for pilot testing under Tranche-1 at Solimabad during the flood season 2019.

99. The combination of above three technologies provides significant advantages as it allows an integrated, phased approach and reduces cost due to actively encouraging natural forces to participate in the stabilization effort. Figure 4-2 provides an overview of the application particularly in line with the sediment transport, which is relevant for two of the technologies. Consistent with FRERMIP Tranche-1, riverbank protection will provide the backbone for stabilizing the Lower Jamuna channel while continuing the development process of long-term sustainable solutions. River stabilization techniques particularly dredging and "building with nature" will be developed and applied for recovering some 6,000 ha of land downstream of Chauhali, Sirajganj District.

[10] The use of compacted dredged sand for 21km of embankment construction at Shahjadpur, Sirajganj Division allowed completion of the embankment in one season at significantly lower cost.



DREDGING **RIVERBANK PROTECTION** **BUILDING WITH NATURE**

Figure 4-2. The three basic technologies for river stabilization and their use during the year

100. Project-2 will build almost 7.9km of flood embankments allowing the work started under Tranche-1 will be completed at Shahjadpur. Embankment construction will use compacted sand, dredged from the river and provide for a number of regulators with fish passes, to connect floodplain waterbodies with the main rivers.

4.4 Innovations applied

101. In Project-2, innovative technologies will be further applied following the piloting and successful implementation in Tranche-1, namely (i) embankment construction with compacted dredged materials.

4.4.1 Grout-filled Jute Mattress

102. Utilization of grout-filled jute mattress aims to replace wave protection made of placed concrete blocks through a mattress that is much faster to implement and also saves material, resulting in lower costs and a smaller environmental impact. Use of jute as mattress material instead of more conventionally used geotextile allows the utilization of locally available material while avoiding the use of artificial materials (Figure 4-3).

Figure 4-3. Installation of grout-filled jute mattress (Harirampur Feb 2019)

4.4.2 Embankment construction with compacted dredged materials

103. FRERMIP has successfully introduced a modern work design and construction methodology for embankment fill dependant on directly placed and compacted dredged sand-fill for the embankment core (Figure 4-4). This modern design not only increases construction speed, allowing the embankment to be built in one dry season, but also reduces the cost as well as the social and environmental impact, by not mining valuable topsoil used for farming.

Figure 4-4. Embankment construction at JRB-1 with compacted dredged sand (Kaijuri,

5 ENVIRONMENTAL AND SOCIAL BASELINE

104. The environmental and social baseline condition in the study area has been characterized by using both primary and secondary data. Primary data were collected by the EIA field team during visits to the study area, through rapid rural appraisal (RRA), focus group discussions (FGD), key informant interviews (KII) and public consultations. Secondary data sources included:

(i) Bangladesh Bureau of Statistics (BBS)
(ii) Bangladesh Water Development Board (BWDB)
(iii) National Water Resources Database (NWRD)
(iv) Water Resources Planning Organization (WARPO)
(v) Soils Resources Development Institute (SRDI)
(vi) Bangladesh Meteorology Department (BMD)
(vii) Department of Agricultural Extension (DAE)
(viii) Department of Fisheries (DoF)

5.1 International Union for Conservation of Nature (IUCN).

105. Note that an expanded Environmental and Social Baseline is provided in Annex O, while a summary is provided in Chapter 5, in response to request from the ADB on 18 May 2020 to reduce the length of the main document.

5.2 Physical Environment

5.2.1 Rainfall

106. The project influence area lies in the northwest part of Bangladesh where the climate is sub-tropical in nature 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 pedologically drier than the rest of the country. The rainy season is hot and humid with about 88% 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 the month of June and recedes in late October. During the pre- and post-monsoon periods (March-May and October-December), cyclones can occur, sometimes generating very large storm surges that cause significant flood damage to the coastal area. Mean annual rainfall in the project area is approximately 1800 mm/year (FAP-3, 1992). Figure 5-1 shows the 1959-2008 rainfall record from Faridpur station**.** Significant rainfall occurs from June to October, and little or no rainfall from November to February. The maximum recorded monthly rainfall was 831 mm in September 1986.

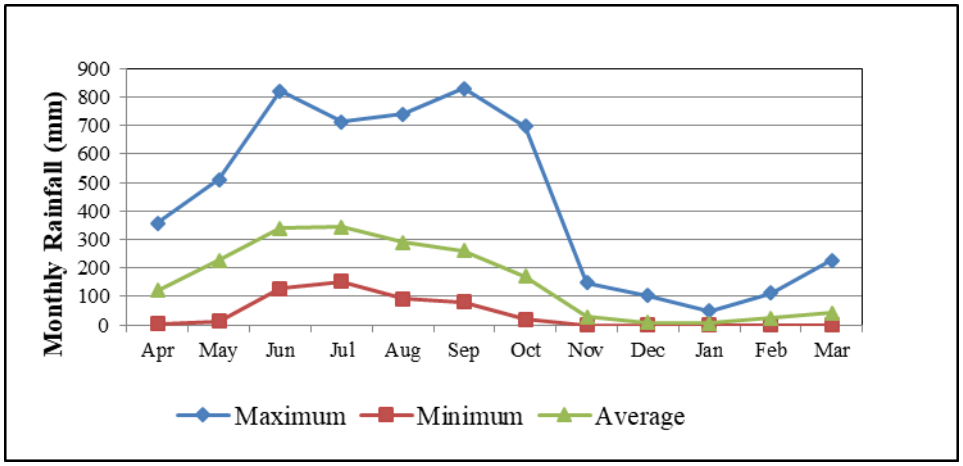


Figure 5-1. Monthly rainfall

5.2.2 Topography

107. Figure 5-2 shows the study area topography as rendered by a digital elevation model. The topography of the study area is low and flat and affected by river flooding annually during the monsoon season. Land elevation varies from 0.39 to 1.39 m above mean sea level (AMSL). The average land level is 0.81 m AMSL. The area slopes gently downward from north to south. The higher northern portion (Khamarkhanda, Belkuchi, parts of Sirajganj, and so on) and the lower southern portion (JLB-2 areas near Singair and Shibalaya in Manikganj district) have average land elevations of 1.15 m and 0.54 m AMSL respectively.

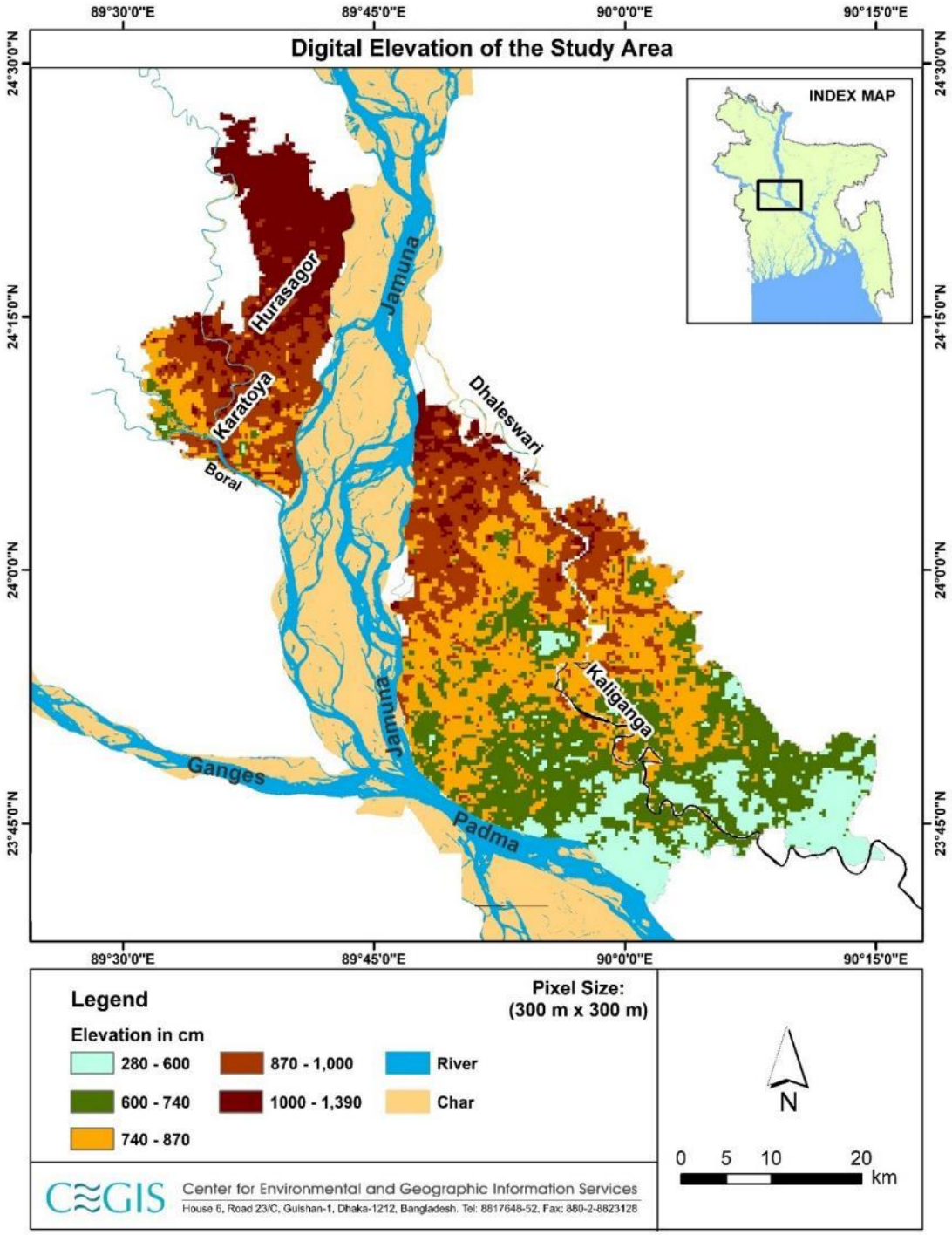


Figure 5-2. Topography of the study area

5.3 Water Resources

5.3.1 River System

108. The study area, consisting of the two sub-reaches JRB-1 and JLB-2, comprises about 244,316 ha of which approximately 13% are occupied by rivers and a very minor percentage (approximately 0.6 per cent) is occupied by other water bodies. The hydrology of the area is dominated by the three major rivers: Jamuna, Ganges and Padma.

109. The Jamuna River is the 240 km-long lower reach of the Brahmaputra River from the India-Bangladesh border to the confluence with the Ganges. The Jamuna has an annual

average discharge of around 20,000 m³/s at Bahadurabad Transit. The flow varies from a low of 8,000 m³/s to a maximum of 100,000 m³/s. Bankfull discharge is around 48,000 m³/s. The river typically peaks in July-August. The average width is 11.8 km, the average floodwater slope of the river is 7.5 cm/km and the average median size of bed material at Bahadurabad is 0.20 mm.

110. The Ganges/Padma (above its confluence with the Jamuna) has a long-term mean flow of about 12,000 m³/s or about 60% of the Jamuna. Flood discharges reach 80,000 m³/s. The Ganges/Padma typically peaks later than the Jamuna in August-September. The Ganges/Padma has the lowest water yield, particularly in the dry season, with flows dropping below 650 m³/s.

111. The Padma (below its confluence with the Jamuna) drains the combined Ganges/Padma-Jamuna. It is approximately 120 km long. The reach-averaged width of the river is 10.3 km but varies from 2.5 km to 20 km. The average median size of the bed material at Mawa is 0.12 mm. It has an average discharge at Mawa of around 30,000 m^3/s. Discharge varies from a minimum of 10,000 m^3/s up to 120,000 m^3/s. Substantial overland flow occurs along the Padma to the southern coastal area, and as such, counters salinity intrusion, but this also leads to reduced in-channel discharges downstream. The Padma is weakly tidal during the dry season. At the downstream end of the project area, the Padma joins the Meghna River near Chandpur.

112. Table 5-1 and Table 5-2 show the seasonal maximum and minimum and mean discharge values of the Jamuna and Padma rivers from 1981 to 2015 at two stations, Bahadurabad transit and Baruria transit (BWDB, 2015). The Jamuna maximum is about 100,000 m^3/s (July) while the Padma maximum is about 140,000 m^3/s (September-October).

Table 5-1. Seasonal maximum & minimum discharge of Jamuna and Padma (1981-2015)

Season	Jamuna River (Bahadurabad Transit)		Padma River (Baruria Transit)	
m^3/s	Maximum	Minimum	Maximum	Minimum
Dry (December-February)	16232	3140	17384	3040
Pre-Monsoon (March-May)	43600	2702	40700	3196
Monsoon (June-September)	103129	10500	141935	9528
Post-Monsoon (October-November)	66100	6190	77800	9050

Source: BWDB

Table 5-2. Mean discharge of Jamuna and Padma (1981- 2015)

Season	Jamuna River (Bahadurabad Transit)	Padma River (Baruria Transit)
m^3/s		
Dry (December-February)	5685	7829
Pre-Monsoon (March-May)	9869	10722
Monsoon (June-September)	40101	57712
Post-Monsoon (October-November)	18432	28809

113. Main river water levels and discharges are not strongly related to local precipitation, since the majority of river runoff is generated outside the country. The most severe floods occur when the Jamuna and Ganges Rivers peak together such as occurred in 1988.

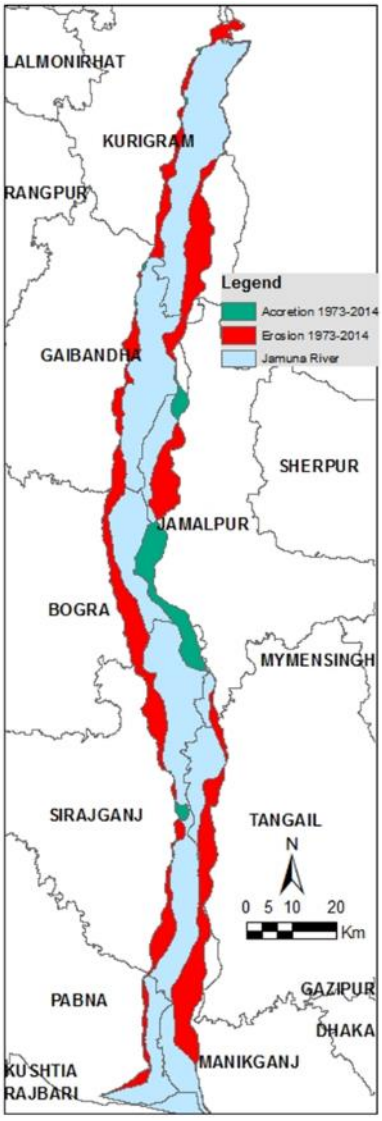
114. The distributaries of these major rivers inside the study area are Hurasagar, Dhaleswari, Kaliganga, Baral, Gohala, and Ichamati rivers. The Ichamati is the only Padma

tributary passing through the study area; the other tributaries connect directly to the Jamuna. Some small water bodies (*Kadaibadla Beel, Pandaha Beel, Khalsir Beel, Nalai Beel, Bharua Beel, Gharilpur Beel* and so on) are found inside the study area. Most are connected to the tributary channels during monsoon.

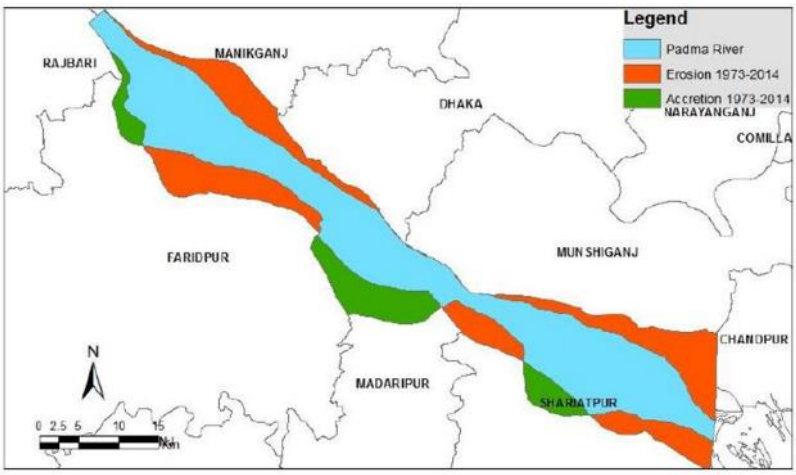
5.3.2 Erosion and Accretion

115. The width of Jamuna River has changed over the years and analysis shows a widening trend since 1900 which accelerated after the 1980s, causing an increase in bank erosion. The erosion rate was high before the 1990s, but since the start of this century it has decreased significantly due to natural causes and human interventions such as the construction of riverbank protection structures. However, the last 40 years has seen more erosion than accretion.

116. A westward migration of the Jamuna riverbed has been a prominent feature since the initiation of the avulsion of the Brahmaputra River from its old path into the Jamuna River. The Jamuna transported some 1 billion tons of sediment annually in the 1960s, but since then its sediment load has gradually dropped by 2.5 times during the 1980s. It is believed that a sediment slug generated by the great Assam earthquake of 1950 has attributed to this rapid decrease of sediment.



117. The Padma River carries the combined discharge of Brahmaputra and Ganges and has an annual average discharge of 30,000 m^3/s, mainly due to southwest monsoon precipitation occurring in June-October while the remainder is generated from base flow and snow melt in the Himalayas. In terms of discharge it is the third largest river in the world.



ma

Rivers in 1973-2014 (CEGIS, 2014)

5.3.3 Surface Water Levels and Water Quality

118. Surface water data records for water level, water quality, and discharge of the two major rivers were collected from several BWDB stations covering various time intervals. The following sections provide a discussion of surface water characteristics in the study area.

119. Water levels Secondary data on water levels were collected for the Jamuna and Padma rivers from the BWDB stations at Sirajganj and Aricha. The maximum and minimum water levels in different seasons (1981-2015) are shown below in Table 5-3. The table shows that in monsoon the average surface water levels of Jamuna and Padma rivers remain about 12.50 m PWD and 8.04 m PWD, respectively. In the dry season, the Padma River becomes extremely shallow, but the Jamuna River remains deep. Table 5-4 shows the average values of water levels of the two major rivers in different seasons (1981 to 2015).

Table 5-3. Maximum and minimum water levels of Jamuna and Padma (1981-2015)

Season	**Jamuna River (Sirajganj station)**		**Padma River (Aricha Station)**	
m+PWD	Maximum	Minimum	Maximum	Minimum
Dry (December-February)	9.14	6.11	4.88	2.00
Pre-Monsoon (March-May)	12.38	6.03	7.30	1.94
Monsoon (June-September)	15.11	9.17	10.76	4.26
Post-Monsoon (October-November)	13.69	7.79	9.50	3.75

Source: Bangladesh Water Development Board

Table 5-4. Jamuna and Padma Rivers mean water levels (1981-2015)

Season	**Jamuna River (Sirajganj station) [m+PWD]**	**Padma River (Aricha Station) [m+PWD]**
Dry (December-February)	7.41	3.22
Pre-Monsoon (March-May)	8.30	3.72
Monsoon (June-September)	12.50	8.04
Post-Monsoon (October-November)	10.24	6.20

Source: Bangladesh Water Development Board

120. **Water quality –**The standard values of seven surface water quality parameters and their suitability set by the DoE are indicated in Annex O. On the whole, water quality seems reasonable to good in the Jamuna and Padma rivers, except dissolved oxygen (DO), which is low during the months July-November/December.

5.3.4 Groundwater

121. Groundwater level data are analysed using data of three BDWB observation wells in three districts (Sirajganj, Manikganj and Tangail) of the study area. Figure 5-4 shows variations of mean groundwater levels. The Tangail average groundwater level is slightly lower than those of the other two districts. Manikganj and Tangail average ground water levels were similar during the observation periods, whereas at Sirajganj station, a decline in groundwater table (up to 6 meters) was observed in 1997 and 2001.

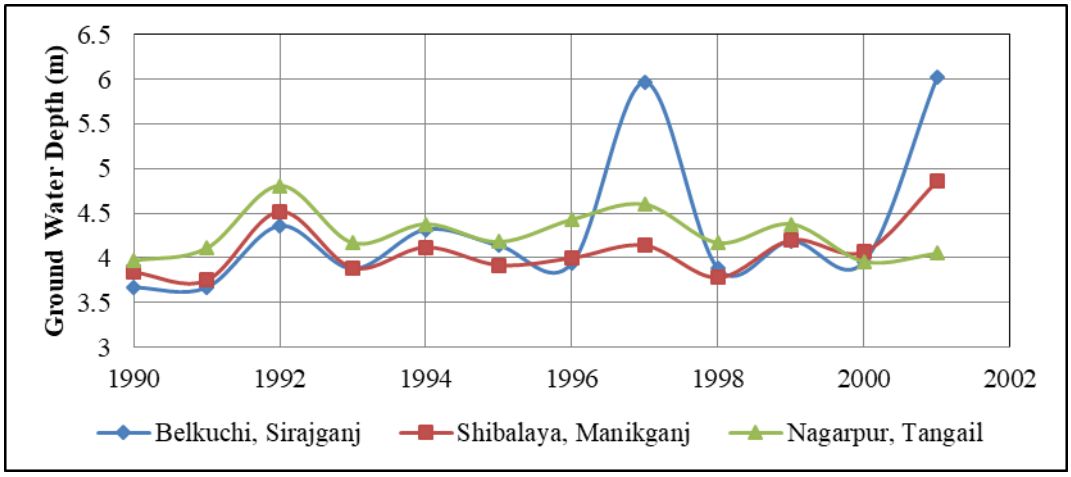


Figure 5-4. Mean groundwater levels in Sirajganj, Manikganj, and Tangail (1990-2001)

122. shows the groundwater table (GWT) at 10-year intervals at the three locations. Values are shown for both the dry (April) and wet (September) period. In the dry season, increased use of groundwater by local people lowers the GWT. During the monsoon, surface water recharges the groundwater and GWT rises upward. In 2000 compared to 1990, the dry season GWT had dropped whereas wet season GWT had risen.

Table 5-5. Groundwater depth at three locations at three 10-year intervals

Well ID	**Location**	**Groundwater Depth (m)**					
		1980		1990		2000	
		April	September	April	September	April	September
8811001	Shrenagar village, Belkuchithana, Sirajganj	6.78	2.83	4.51	1.70	5.84	1.42
5678012	Uthali village, Shibalayathana, Manikganj	6.31	1.39	5.91	1.89	7.07	0.90
9376032	Bhalkutia village, Nagarpurthana, Tangail	6.46	1.64	5.51	1.94	6.31	1.52

5.3.5 Flood Management

123. Due to the flat topography of Bangladesh, just a small increase in water level above the riverbank causes full-scale inundation. Figure 5-5 shows a relation between the flooded areas (Mha) and the total volume (Bm^3) of river water. During monsoon the Jamuna and Padma rivers attain their peak discharges which consequently lead to higher flooding as well as drainage congestion during the period.

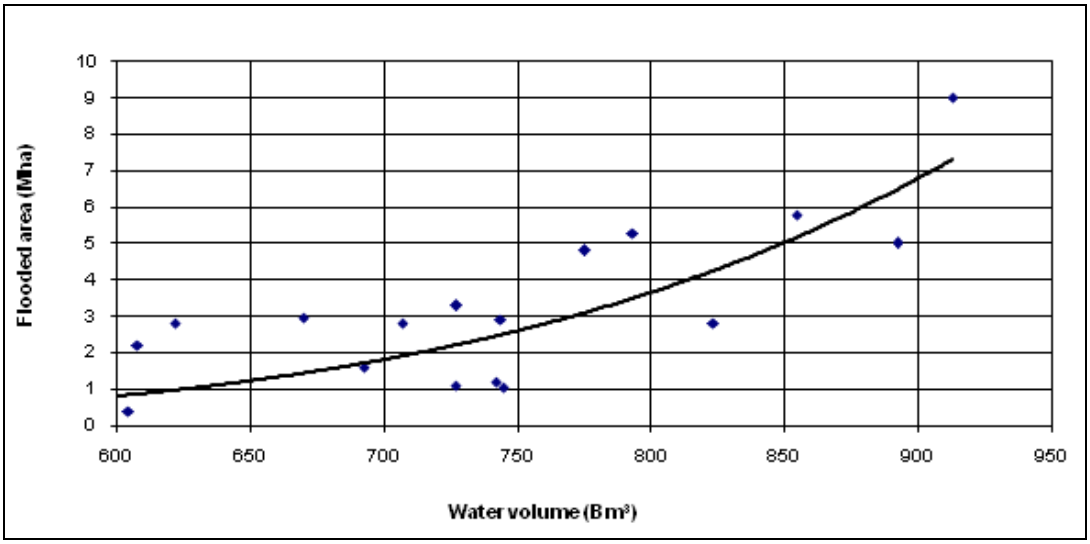


Figure 5-5. Flooded area vs water volume (1972-1993)

124. The occurrence of flood is indicated when the water level of the river exceeds its danger level. The danger level of the Padma at Mawa is 6.0 m PWD and the Jamuna at Bahadurabad is 19.5 m PWD. The probability of flood in a year for the Padma is about 60 % and for the Jamuna is about 75%. The average duration of flood is about 23 days in the Padma basin and about 14 days in the Jamuna basin. Major floods may last up to 65 days on the Padma (e.g. 1998) and up to 63 days on the Brahmaputra-Jamuna (e.g. 1998).

5.3.6 Morphology

125. The morphology of the two major rivers adjacent to the study area has enormous impacts on the lives and livelihood of the local people. During the last few decades the lower reach of the Jamuna River changed its plan form from a single threaded meandering river to a complicated braided river. The location of the confluence of the Hurasagar River shifted several kilometers upstream during the last 40 years and became fixed at the present position about two decades back. Channel development and abandonment, movement of bars, islands and bank lines is very common in this river. The Padma, on the other hand is a meandering river and less dynamic.

5.3.7 Erosion

126. Riverbank erosion is the most important natural cause of landlessness and forced resettlement of people in the study area. During 1973 to 2018, erosion and accretion along the Jamuna and Padma rivers was 132,766 ha and 30,983 ha respectively (net erosion was 101,783 ha). In 2018, net erosion along the Jamuna and Padma was 2,168 ha of which 385 ha were settlements. The eroded lands also included about 63 m of district road, 1,645 m of upazila road and 1,967 m of rural road. The rate of widening of the Padma River was 160 m/year in the 1980s, which increased to 230 m/year in the 1990s. Recently, the rate of widening has reduced to 130 m/year.

Table 5-6. Erosion & accretion from 1973-2018 (cumulative)

River	Erosion, Ha	Accretion, Ha	Net Erosion, Ha
Jamuna	94,616	16,738	77,878
Ganges	37,412	27,071	10,341
Padma	38,150	14,245	36,725
Total	**170,178**	**58,054**	**124,944**

Source: CEGIS 2019, Prediction of Riverbank Erosion April 2019, p. 1-3

5.3.8 Char Formation

127. Charlands refer to mid-channel islands that periodically emerge from the riverbed as a result of accretion (Elahi, Ahmed, and Mafizuddin 1991). The residents of chars and mainland adjacent to main rivers are extremely vulnerable to erosion and flooding as it can destroy their crops and homesteads, render land unproductive, and destroy livestock. In the Jamuna floodplains, about 50% of the people live in the island and attached chars whereas in the Padma char areas, this is about 27% (Bangladesh Flood Action Plan, 1993). Charlands are formed mainly because of the low flow in the rivers in the dry season. Erosion along the sides of the Jamuna and Padma rivers result in the siltation of inside the rivers, which results in the formation of charlands.

5.4 Land Resources

5.4.1 Land Use

128. The total study area is about 244,316 ha of which about 184,200 ha is net cultivable area (NCA). Settlements and water bodies constitute about 11% and 13% respectively. Land use in the study area is presented in Table 5-7.

Table 5-7. Land use

Land use	Area (ha)	% of total area
NCA	184,200	75
Settlements	27,764	11
Rivers & Water Bodies	32,352	13
Total	*244,316*	*100*

Sources: CEGIS estimation from SOLARIS

5.4.2 Drainage Characteristics

129. Drainage plays a vital role in the management of soil in the study area. As per the SRDI, the drainage characteristics have been divided into six classes from the agriculture point of view. Detailed drainage characteristics along with area of the project are presented in Table 5-8.

130. Most of the area (83%) of the NCA is under imperfectly drained condition. The rest (17%) is under poorly drained condition. The dominance of imperfectly drained soil of the study area indicates that the removal of water in rainy/monsoon season is the main constraint for growing dry land crops in the study area.

Table 5-8. Drainage characteristics

Drainage classes	**Drainage characteristics**	**Area (ha)**	**% of NCA**
Imperfectly Drained	Water drained from soil badly or slowly. This soil often remains wet in rainy season due to rainfall. In normal situation, water does not stand on land more than 15 days at a stretch. In rainy season, groundwater stands within 1 m at least for some time.	31,314	17
Poorly Drained	The soil remains under water from 15 days to 7/8 months. Water is drained from the soil slowly. In most cases, the land remains wet/water-logged for a considerable period of time after the rainy season.	152,886	83
Total		*184,200*	*100*

Source: CEGIS estimation from SOLARIS (NWRD).

5.4.3 Land reclamation

131. About 150,000 ha of land is to be stabilized and reclaimed under the RSP programme, which is to consist of currently (unstable) char land and low-lying floodplain land. Figure 5-14 provides a map of the areas and locations to be reclaimed. It is anticipated that land stabilization will lead to reduced human suffering, greater investment and higher productivity, but also greater use of agrochemicals (and hence pollution), loos of floodplain habitats and competing land claims.

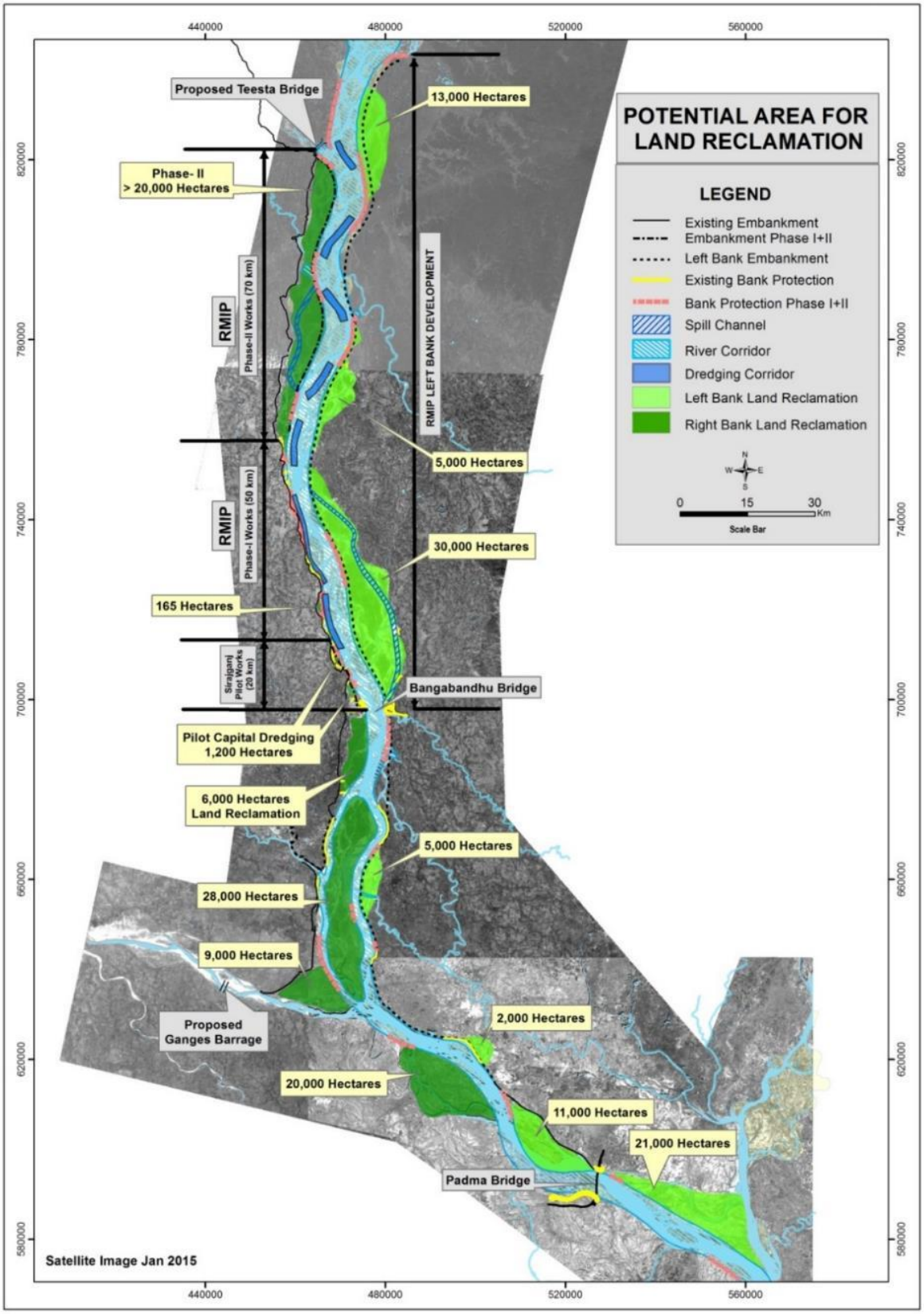


Figure 5-6. Land Reclamation Plan under FERMIP Interventions

5.5 Fisheries

5.5.1 Introduction

132. The study area is a major fish producing region of the country with diversified freshwater fisheries resource bases consisting of the Jamuna, Padma and Meghna rivers, their tributaries and distributaries, seasonal and perennial Khals (canals), Beels (floodplain depressions) and the associated flood lands. The tributaries/distributaries and the canals act as the major connecting links between the river and the floodplain and thus play a vital role in maintaining fisheries biodiversity and productivity. Fish biodiversity is also rich in the area but is declining due to indiscriminate fishing, obstruction of migration routes (especially in the dry season), discharge of industrial wastes, poor fisheries management, siltation, oil spills, insecticide contamination, and loss of critical habitats to siltation and bank erosion.

5.5.2 Problems and Issues

133. Major problems and issues identified during the baseline study are as follows:

(i) Loss of connectivity from the main river to the beel specially in the dry season.
(ii) Decrease in capture fisheries production due to the loss of habitat and change of present aquatic ecological condition.
(iii) Reduction of and obstruction to fish migration mainly between the river and the floodplain.
(iv) Fishing of brood fish especially in the overwintering period.
(v) Breeding and feeding grounds are gradually being destroyed and decreasing due to dewatering, siltation and bank erosion.
(vi) Decrease of fish production due to the use of current jal, mainly used to catch the fingerlings (i.e. young fish).
(vii) Use of harmful insecticides in the crop fields, which along with the industrial pollutants affect the aquatic ecosystem.

5.5.3 Fish Migration

134. Thirty-six (17%) of 218 freshwater fish species in Bangladesh are considered migratory, but the overall fish migration in the study area is moderate to poor. The Jamuna and Padma rivers form the base for fish migration; tributaries/distributaries and canals are the migration routes connecting the floodplains. Major distributaries in the Project-2 area are Hurasagar on the right bank and the Pungli, Old Dhaleshwari and Ghior Khal/Ichamoty which connects the project influence area. Moreover, during pre-monsoon and monsoon (availability of water in khal) Shameshpur Khal, Banigati Khal, Balorampur Khal for Sirajganj district, Shureshwary Khal, Baro Khal, East Dhadra Vikon Khal etc for Tangail district as well as Tutium Dhamshar Khal, Kholshi-Kumuria Khal, Mandatta Khal for the Manikganj district maintain the major arteries for fish migration.

135. Fish migration usually occurs during pre-monsoon to some extent, but largely during peak monsoon. Reportedly, feeding and spawning migration of riverine and beel resident fish species occurs through open khals and channels between beels and rivers and over bank spill during the period of late May to August. Certain categories of fish (i.e. the 36 species mentioned above) are dependent on migration to complete their lifecycle and when opportunity of migration fails particularly due to the loss of river-floodplain connectivity, their lifecycle cannot be completed which affects their propagation and contribution to fisheries. Fish migrations may be categorized as bi-directional, from river to floodplain and vice versa, and bi-dimensional, passive and active. All migrations from the floodplain to the river in the post monsoon are, however, active movements. These fish migrations between river and floodplain will be affected by the project interventions, particularly by the embankments. Some possible measures like designing fish friendly sluice gates with fish passes and other

fish supporting structures and fish friendly operation of the sluice gates will minimize the adverse impacts on fish migration.

5.5.4 Beels

136. Beels are wetlands that are temporary connected to the river during flood season through khals (natural channels that receive water during high water levels) and disconnect after the flood. As freshwater reservoirs these are important for biodiversity by acting as spawning grounds for several fish species. There is a total of 24 beels in the area out of which 13 are proposed to be fish sanctuaries. A list including coordinates in Bangladesh Transverse Mercator Projection (BTM) is shown below (Table 5-10). Figures 5-7 and 5-8 indicate the locations of these beels.

Table 5-9. Beels in the project area

Name of Beel	Proposed sanctuary	Upazila	Easting	Northing
Arial Beel	No	Sreenagar	486695	759376
Banagram Beel	Yes	Nagorpur	482718	663713
Belabadh	No	Horirumpur	498690	625599
Bohora	No	Daulatpur	486397	647835
Chandahar beel	Yes	Singair	521289	627509
Dholeshwari river	Yes	Saturia	496158	650665
Diyar Beel	No	Horirumpur	495666	626342
Gajaria Beel	No	Sadar Manikgon	498568	639687
Ichamati kol	Yes	Shibalay	482200	638636
Kanthapur Ichamati dead river	Yes	Horirumpur	499561	626268
Ichmati river	No	Dohar	505359	622082
Joymontop kol	No	Singair	518337	632214
Kadaibadla Beel	Yes	Shahjadpur	462999	674980
Kushumhati khal	Yes	Kartikpur	508244	613156
Kutirchar Ichamati dead river	Yes	kamarkhand	459293	694441
Majar kol	No	Shahjadpur	460332	673684
Mallar Beel	Yes	Char ghior	489003	643027
Neelwaya Beel	No	Ghior	486140	647127
Nimaikhali Beel	Yes	Daulatpur	486146	648775
Padma river	No	Mainat Ghat	507017	611861
Patal Beel	Yes	Sadar Manikgon	502187	637840
Shunshi Beel	Yes	Nagorpur	492396	657421
Uthuli	No	Shibalay	481881	636623
Kodalia Beel	Yes	Chowhali	481023	665413

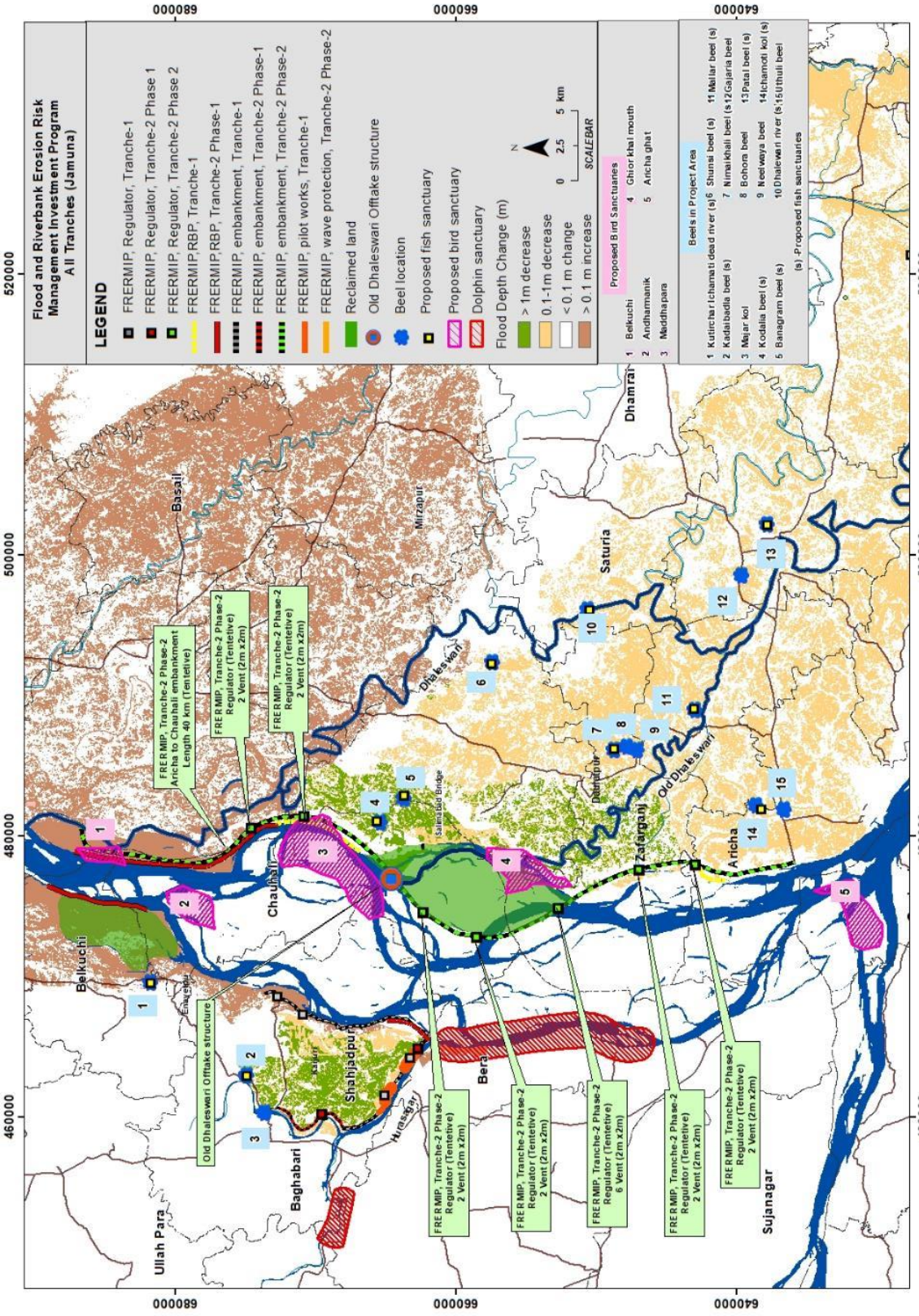


Figure 5-7. Map of beels and Project-2 interventions (a)

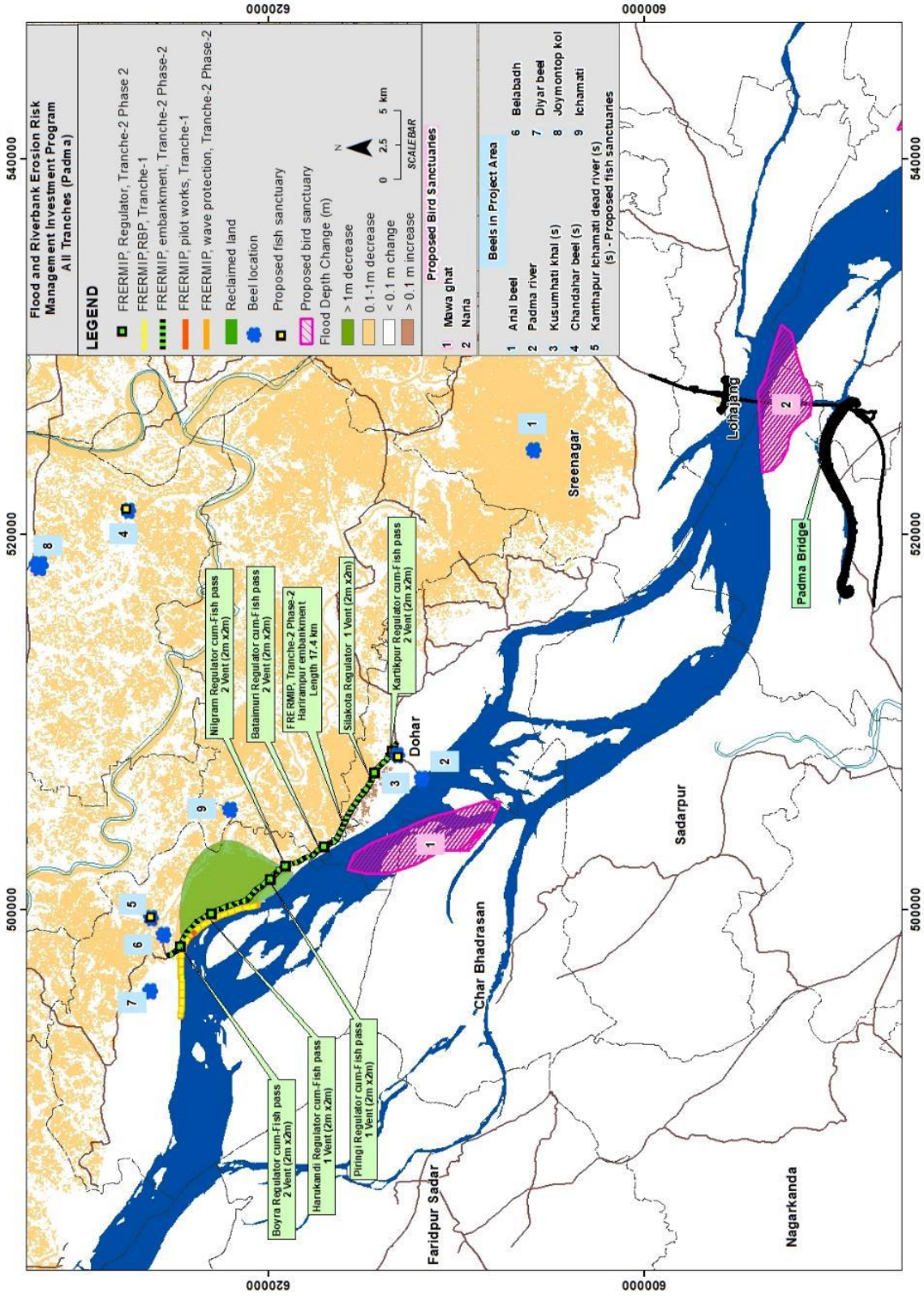


Figure 5-8. Map of beels and Project-2 interventions (b)

5.5.5 Fish Biodiversity

137. Fish biodiversity and abundance is declining in recent years. Major causes are both natural and anthropogenic interventions. Natural causes are mainly siltation of the water

bodies resulting in the shrinkage of spawning and feeding grounds affecting natural recruitment and production. Man made hazards are overfishing, negative impacts of water management interventions particularly affecting river-floodplain connectivity impeding flooding of the fish habitat and fish migration affecting fish propagation and production, agro-chemical and industrial pollutions causing deterioration of water quality of the aquatic ecosystems.

138. Efforts for conservation of fish and fisheries are limited except for the Hilsha fishery for which a program of the Department of Fisheries (DoE) is running resulting in substantial improvement in Hilsha catch in recent years. Overfishing is the major challenge which may be tackled by awareness development and making arrangement to discourage indiscriminate fishing. FRERMIP plans to initiate such work in the study area.

5.6 Ecological Resources

5.6.1 Fish habitats

139. Fish habitats of the study area may be divided into basically two types: River Fish habitat and Floodplain Fish habitat. The former can be sub-divided into (i) Bankline habitat; (ii) Charland habitat and (iii) Main Channel habitat, each having distinctive bio-ecological features. Basic differences among these three sub-habitats are seasonality, depth and characteristic fishery. Main channels form the deepest parts and perennial areas making safe home for deep water fish, dolphin and shelter for overwintering river fish. The bankline ecosystem consists of the river corridor area beyond the main channel on two sides of the main channel. In the peak season, bankline habitat is flooded making good base for breeding and shelter of fishlings. In the lean season, the shallow bankline area dries out. Charlands are usually sandbars situated beyond the main channel. As it matures, it may be coalesced with the riverbank forming the river floodplain. Charlands may be vegetated or non-vegetated. Submerged vegetated charlands are also a safe eco-niche for breeding and early development of many fish.

140. Floodplain fish habitat consists of (i) distributaries and canals; (ii) beels and floodlands; and (iii) closed water bodies. Most distributaries are perennial though some are now heavily silted off takes. Canals are seasonal or perennial. Beels are also seasonal or perennial. Floodlands are seasonal by nature. Closed water bodies are mostly homestead ponds and impoundments which may be seasonal or perennial.

141. In the aquatic ecosystem (river and floodplain) of the study area a characteristic fisheries-related annual bio-ecological cycle takes place. As the water level rises in the river in March, bankline and charland vegetated areas are inundated creating breeding and shelter sites for early development of fishlings. At the same time, floodplains are inundated by river flow and thereby creating shallow waters with vegetation suitable for breeding and fishlings. With respect to breeding and early development there are four categories of fish: (i) river fish with breeding and early development in the river; (ii) river fish breeding in the river but early development in the floodplain; (iii) river fish breeding and early development in the floodplain; and (iv) floodplain fish breeding and early development in the floodplain.

142. Fish breeding starts in March and continues up to August (in the river). In shallow waters of the floodplain, fishlings grow through September. When the river water starts receding, grown-up fish sub-adults along with their migrating parents return from the floodplain to the river. Similarly, river-born sub-adults move from bankline and charland shallow waters to the deeper waters as the bankline and charland dry up. Synchronously, reed vegetation of the bankline and charlands will end their annual lifecycle in September-October and dry up making room for newer seedlings which make next year's fish breeding ground. The braided river system provides a good niche for fish and fishery.

143. The study area consists of 8 Upazila's of 4 Districts (3 in Sirajganj, 2 in Manikganj, 2 in Dhaka and 1 in Chandpur district) under 2 sub-reaches (JRB-1, JLB-2). Field studies conducted in the three sub-reaches show that capture fisheries habitats with an area of some 93,975 ha include rivers, khals, perennial and seasonal beels and seasonal floodlands while culture ponds measure only 1,235 ha. Table 5-10 shows the area of fish habitat categories. In the dry season, average river water depth is 4 to 7 m which is adequate for fish habitation. In deep areas (kum), both large and small riverine fish take shelter when river water levels drop. Deep areas play a vital role in fish propagation. The major problems in these riverine fish habitats are siltation and erosion.

Table 5-10. Fish habitats

Sl. No.	Habitat Category	Habitat Type	Area (ha)
1	Capture	River	30,783
		Khal	312
		Beel	1,258
		Kol	605
		Floodplain	59,782
		Sub total:	*92,740*
2	Culture	Fishpond	1,235
		Sub total:	*1,235*
		Total:	*93,975*

Source: CEGIS field Survey, 2013

5.6.2 Bioecological Zones - Introduction

144. The study area comprises five different bioecological zones of the country (Nishat at el, 2002): (i) Teesta floodplain, (ii) Major rivers, (iii) Brahmaputra–Jamuna floodplain, (iv) Chalan Beel, and (v) Ganges floodplain.

145. **MAJOR RIVERS.** Bangladesh consists mainly of riverine and deltaic deposits of three large and extremely dynamic rivers entering the country: the Brahmaputra, the Ganges and the Meghna rivers. Many of the species' natural distribution, migration and storage primarily continue via these rivers into other wetland ecosystems (GoB-IUCN, 1992). A diverse range of waterfowl are directly or ecologically dependent on these rivers and their associated ecosystems. However, river biodiversity is under severe pressure.

146. **BRAHMAPUTRA–JAMUNA FLOODPLAIN.** The Brahmaputra-Jamuna floodplain comprises the active channel of the Brahmaputra River and the adjoining areas of the young floodplain lands formed since about 1780, when the river shifted to its present course (i.e. the Jamuna River) to the south of Dewanganj in Jamalpur district. The main river course is strongly braided and consists of several interconnecting channels. This floodplain possesses a unique variety of plants, medicinal herbs, fruit yielding trees, many jungle shrubs, creepers and climbers, flowering trees and so on, many of which yield valuable products. The faunal diversity in this zone is also rich.

147. **CHALAN BEEL.** Chalan Beel, the center of which is located some 10 km north-westest of the JRB-1 area (outside project area, but under influence of project) astride the Dhaka-Rajshahi highway in Ullapara upazila, Rajshahi Division, is an extensive low land area at the lower Atrai basin. It consists of a series of beels connected to one another by various channels to form a continuous water body during the rainy season. The beel area expands into a vast water body. The Jamuna remains flooded during the monsoon with dense aquatic vegetation. However, it dries up in the winter leaving only patches of water holes in the central part of this zone. Significant species diversity of Chalan Beel includes amphibian, reptiles, turtles and tortoises and otters, along with a host of wetland associated plants.

148. **GANGES FLOODPLAIN.** The Ganges floodplain basically consists of the active floodplains of the Ganges River and the adjoining meandering floodplains. It is mostly situated in the districts of Rajshahi, Pabna, Jessore, Kushtia, Faridpur, Shariatpur and Barisal. The adjoining meander floodplains mainly comprise a smooth landscape of ridges, basins and old channels. The Ganges-Jamuna channel is constantly shifting within its active floodplain, eroding and depositing large areas of new charlands in each flooding season. The stagnant water bodies and channels, rivers and tributaries of the Ganges floodplain support a habitat of rich biodiversity to some extent, including free-floating aquatic vegetation is prominent. Nearly all the major groups of oriental birds are represented in this zone by one or more species. In addition, migratory birds are found here during the winter. In addition, different species of freshwater tortoises, turtles and amphibians are also found in the rivers and ponds.

5.6.3 Seasonal and Perennial Wetland Habitats and Flora

149. Wetland habitats of the study area include charland, swamp, and grasslands:

(i) **Charland** occupies significant part of the study area. The Jamuna and Padma Rivers are constantly shifting within their active floodplains, eroding and depositing large areas of new charlands each flood season. New charlands exhibit considerable plant succession such that the char vegetation depends on the time since char formation. At species level, Shon *Crotalaria retusa*, Nol *Phragmites karka* and Kaisa are the first colonizers, whereas Mutha *Cyperus sp*, Kolmi *Ipomoea sp*, Binna *Vetiveria zizanioides,* Durba *Cynodon sp* etc, are the second level successor. At the terminal succession, some bushy plant species such as Dholkolmi *Ipomoea carnea* ssp. *fistulosa* appear.

(ii) **Swamps.** Chalan Beel area is favorable for a good growth of wetland trees like Hizal *Barringtonia acutangula* and Barun.

(iii) **Grassland** species include Binna *Vetiveria zizanioides* and Durba Gash *Cynodon dactylon*.

5.6.4 Aquatic Ecosystems

150. The hydrological cycle regulates ecosystem function by providing varying water levels and flows that create diverse aquatic habitats to be utilized by aquatic biota. In this area, aquatic ecosystems include a range of riverine, floodplain, and pond habitats that become maximally interconnected in the monsoon season.

151. Freshwater wetlands (rivers, khals, ponds, and beels) are classified as seasonal and perennial. Seasonal wetlands usually remain inundated for four to five months. Seasonal wetland occupies the lower croplands and provides refuge and shelter for many aquatic flora and fauna. In addition, wetlands serve as the grazing ground for fish and other aquatic fauna. Perennial wetlands hold water throughout the year.

5.6.5 Aquatic Ecosystem Services

152. The floodplain and wetland ecosystem of the study area play an important role in the purification of water quality of the area, fertilization of the agricultural land, recreation and fodder for livestock and food sources for community. The flood cycle and its associated ecosystem purify the water quality deteriorated by the discharge of effluents and waste and use of agrochemicals.

5.6.6 Threats to Aquatic Ecosystems

153. In the study area, river erosion and siltation occur every year. Consequently, threats on surrounding aquatic ecosystem and its biodiversity are increasing. Some of the aquatic plant species being rare have become extinct due to erosion and siltation. Due to this

process habitat quality is deteriorating day by day. The population of both flora and fauna is disrupted.

5.7 Socio-economic Conditions

5.7.1 Area and population

154. Socio-economic information is presented for the study area upazilas – twelve upazilas of Sirajganj, Tangail and Manikganj districts (Table 5-11). The study area population is 2.89 million (BBS Census Report, 2011). This includes 1.42 million males and 1,47 million females in 661,000 households having an average household size of 4.37 persons. Population density is about 1,200 person /km^2.

Table 5-11. Administrative units of Bangladesh

River Reach	BWDB Zone	Sub-project	Districts	Upazilas
3	North West	JRB-1	Sirajganj	Belkuchi
				Kamarkhanda
				Shahjadpur
3	North Central	JLB-2	Manikganj	Daulatpur
				Ghior
				Saturia
				Shibalaya
			Sirajganj	Chauhali
			Tangail	Nagarpur

Source: Spatial GIS Analysis, CEGIS 2012

5.7.2 Livelihoods

OCCUPATION

155. Agriculture is the main occupation of 76% of households. About 16% of the population works in the service sector; and the remaining 8% works in the industrial sector (Table 5-12).

156. Both male and female members of households are engaged in livelihood activities, but the participation of female members is small compared to male participation. In the study area only 2% female members are working whereas 98% male members are engaged in income generating activities.

Table 5-12. Primary occupation

Upazilas	Agriculture		Industry		Service	
	Male	Female	Male	Female	Male	Female
Kamarkhanda	55.98	0.59	18.40	3.68	19.47	1.88
Belkuchi	32.31	0.69	46.23	4.48	14.33	1.96
Chauhali	75.08	2.00	11.59	0.57	8.10	2.65
Shahjadpur	58.72	1.41	24.33	1.39	12.61	1.54
Ghior	78.42	1.67	5.58	0.80	11.78	1.75
Shibalaya	74.89	1.67	2.90	0.60	17.50	2.44
Manikganj sadar	62.99	1.39	5.82	1.81	23.91	4.07
Singair	79.09	1.37	5.85	0.86	11.49	1.33

Saturia	75.60	1.66	6.73	1.43	12.47	2.10
Harirampur	81.00	2.55	3.24	0.21	11.03	1.97
Daulatpur	90.29	3.20	2.75	0.23	3.19	0.33
Nagarpur	79.82	1.46	5.67	0.47	11.17	1.40

Source: Bangladesh Bureau of Statistics

5.7.3 Poverty and Safety Nets

LANDOWNERSHIP PATTERN

157. The land ownership pattern is correlated with poverty incidence in the area. The RRA found that about 30% of the households are absolute or landless and the remaining 70% have land for mainly agriculture use and also for settlement and commercial uses (Table 5-13).

Table 5-13. Landownership

Land Holding Categories	Distribution of Household (%)
Absolute Landless (0 decimal)	20
Functional Landless (up to 49 decimal)	10
Marginal (50-100 decimal)	40
Small (101-249 decimal)	20
Medium (250-749 decimal)	7
Large (more than 750 decimal)	3

Source: CEGIS fieldwork 2013

158. In the study area the Agricultural Census conducted by BBS in 2008 has found that most of the land is held in small holdings. BBS classifies land holdings into three broad categories: (i) small, 0.05 to 2.49 acre cultivated land; (ii) medium 2.50 to 7.49 acres; and (iii) large, 7.50 acres and above. In the upazilas of the project area, small holdings comprise between 78 and 93% of agricultural area, medium holdings comprise between 10 and 20%, whereas large holdings comprise far less, between 0.5 and 2%.

INCOME POVERTY

159. Income poverty is measured through self-assessment in the study area. In this process, respondents were asked to assess the overall condition of people living in the study area. Their responses are assigned to three categories: deficit, balance or break-even and surplus.

160. Local people assessed that on an average about 50% of the local population are in a balance or break-even position, meaning that their economic activities are subsistence-oriented, 35% people are in deficit, meaning they must borrow all year long to finance consumption and 15%, mainly large land owners and businessmen, are in a surplus position. In the study area consumption is higher than income which perpetuates poverty intergenerationally.

INCOME AND EXPENDITURE

161. Household income and expenditure are key indicators of socio-economic status. In the study area, monthly household income and expenditure vary from BDT 5000 to 20,000. About 75% of households are engaged in agricultural labour. The wage rate varies between BDT 300 to 400 per day. A few in-migrating labourers stay in the area for a year, returning home at the end of the year with all their income. Women's participation in the agricultural sector is negligible. Field findings show that most income comes from three sectors i.e. agriculture, small business and remittance, and that household consumption

5.7.4 Natural Disasters

162. The local inhabitants of the study area have identified river erosion, drought, and floods as the major hazards in the area. Details about the disasters and their affects in the area are presented in Table 5-14.

Table 5-14. Effects of recent natural disasters

Disaster	Frequency	Affected Area (%t)	Affected House Holds (%)	Crop Damaged (%)	Major Damaged Crop
River erosion	Every year	50	100	90	Rice
Drought	2007, 2009, 2011	50	40	30	Rice
Floods	1998, 2005, 2009	60	100	90	Rice

Source: CEGIS fieldwork 2012.

5.7.5 Vulnerable Communities

163. In the study area, three types of people could be considered as vulnerable. These are (i) marginal farmers having less than BDT 5,000 monthly income; (ii) fishermen; and (iii) women-headed households. Even though most landowners cultivate their own land, sharecropping-in land is an important source of income for vulnerable households. Fishing in the open water bodies is another significant income source for these households.

5.7.6 Historical, Cultural and Archaeological Sites

Significant historical, cultural and archaeological sites in the program area are indicated on the map on Historical, Cultural and Archaeological sites in Annex O. These will not be adversely affected by the project, and to some extent they will receive more adequate protection from flooding by implementation of the project.

6 PUBLIC CONSULTATION AND DISCLOSURE

6.1 Introduction

164. This chapter presents the objectives, process and outcome of the consultations carried out with the institutional as well as grass root stakeholders (i.e. local communities) of the FRERMIP. Also discussed in this chapter are the disclosure requirements for the present EIA. FRERMIP is a large-scale project impacting directly on the lives of the people as well as communities living in and around the existing and proposed alignments. This project has multiple dimensions encumbering agriculture, fishery, livelihood, physical environment and others. It aims at protecting lives and properties in addition to consolidating livelihood opportunities in the area. It involves a large amount of physical activities such as earthworks, construction and others – activities that may potentially have negative impacts on the environment and people, as discussed in this EIA report. The consultations have been conducted with representative communities and governmental officials to solicit their opinions and views about the project and its potential impacts.

6.2 Objectives of Public Consultation and Disclosure Meetings

165. The consultations have enquired into topics such as agricultural practices, flooding, loss of crops, fisheries, water use, flora and fauna, and other aspects relevant to the proposed project. During consultation the project proposed intervention were explained, and the consultees were asked for their opinions, suggestions and concerns.

166. The key objectives of the consultations carried out for the FRERMIP include the following:

(i) Inform key stakeholders about the project objectives and key interventions.
(ii) Share with the stakeholders the nature, objective and extent of the present EIA study.
(iii) Promote participation of the local people, local level government stakeholders, elected representatives and other community representatives to create opportunity to play a role and express their views.
(iv) Analyze household and community level issues and draw early attention for mitigation and/or resolution of issues.
(v) Acquire suggestions of the community for mitigating anticipated adverse environmental and social impacts and expected benefits of the Project.
(vi) Obtain the views of vulnerable groups, discuss project impacts and benefits on these groups, and ascertain their expectations regarding project benefits.
(vii) Develop strategies to minimize potential social and environmental adverse impacts in conjunction with government stakeholders.
(viii) Prepare the community with confidence and capacity to deal with displacement, environmental and resettlement management.

6.3 Approach and Methodology of Public Consultation and Disclosure Meeting

167. Public consultation is a qualitative exercise with an empirical approach. It enables raising issues with the direct and indirect stakeholders and through a process of consultation and discussion and registering views and opinions. Public meetings, Focus Group Discussions (FGDs), Key Informant Interviews (KII), and Personal Interviews are the main tools of data collection that have been employed for the present consultations.

168. The respondents were selected purposively and carefully. Thematic aspects (e.g.

agriculture, ecology, fisheries) were given importance in the selection of the respondents. With the help of checklists and obtaining prior consent, the FGDs were conducted in a systematic manner with an attention of gender balance in the composition of the respondents. The consultation sessions were open, interactive, and were properly recorded.

169. The respondents who shared their views and opinions included the following: public representatives, general residents of the area, squatters, tenants, river erosion victims, farmers, fishermen, vendors, and small-scale businessmen. Some of them live on the embankment; some on char lands while others were from the countryside. The institutional consultations were carried out with officials of the key departments including BWDB, Department of Environment (DoE), Agriculture Department, Fisheries Department, and local body institutions.

6.4 Disclosure, Consultation and Participation during Project Preparation

170. Three rounds of stakeholder engagement were undertaken during project preparation. A first round of public consultation meetings (PCM) was carried out as part of this study and was started in early-2013 on February 26, 2013. The objectives of this round of consultation were (i) disclosure of project information to stakeholders, (ii) consultation with the public on issues to include in the assessment, and (iii) participation of stakeholders in the formulating the set of Important Environmental and Social Components (IESCs; see chapter 7) to be assessed for project impacts.

171. A second round of PCMs was undertaken when this environmental assessment report became available in draft form in mid-2013, with three objectives: (i) disclosure of the draft report contents, including the proposed GRM and EMP; (ii) consultation with stakeholders on the results of the assessment; and (iii) discussion of stakeholder participation in environmental management activities during construction and implementation.

172. A third round of consultation was conducted for particularly the Tranche-2 interventions, i.e. in 2016/2017, specifically focusing on the Tranche-2 works of the FRERMIP.

6.5 Stakeholder Comments and Concerns

6.5.1 First Round (Started on 26/02/2013)

173. During the environmental assessment process, a first round of public consultation meetings was held in four locations (Figure 6-1) to present the location to stakeholders and document their concerns. The records of this round are presented in Appendix E.

174. The purpose, time and location of the first-round meetings were disseminated to stakeholders by sending hard-copy letters in Bengali to all relevant upazila-level officials in the meeting catchment. These letters included the request to circulate the information to other stakeholders. Meetings were also publicized to stakeholders during all field work including focus group discussions, with FGD attendees being asked to contact other stakeholders. The means of secondary and tertiary notification was almost exclusively by cell phone voice calls.

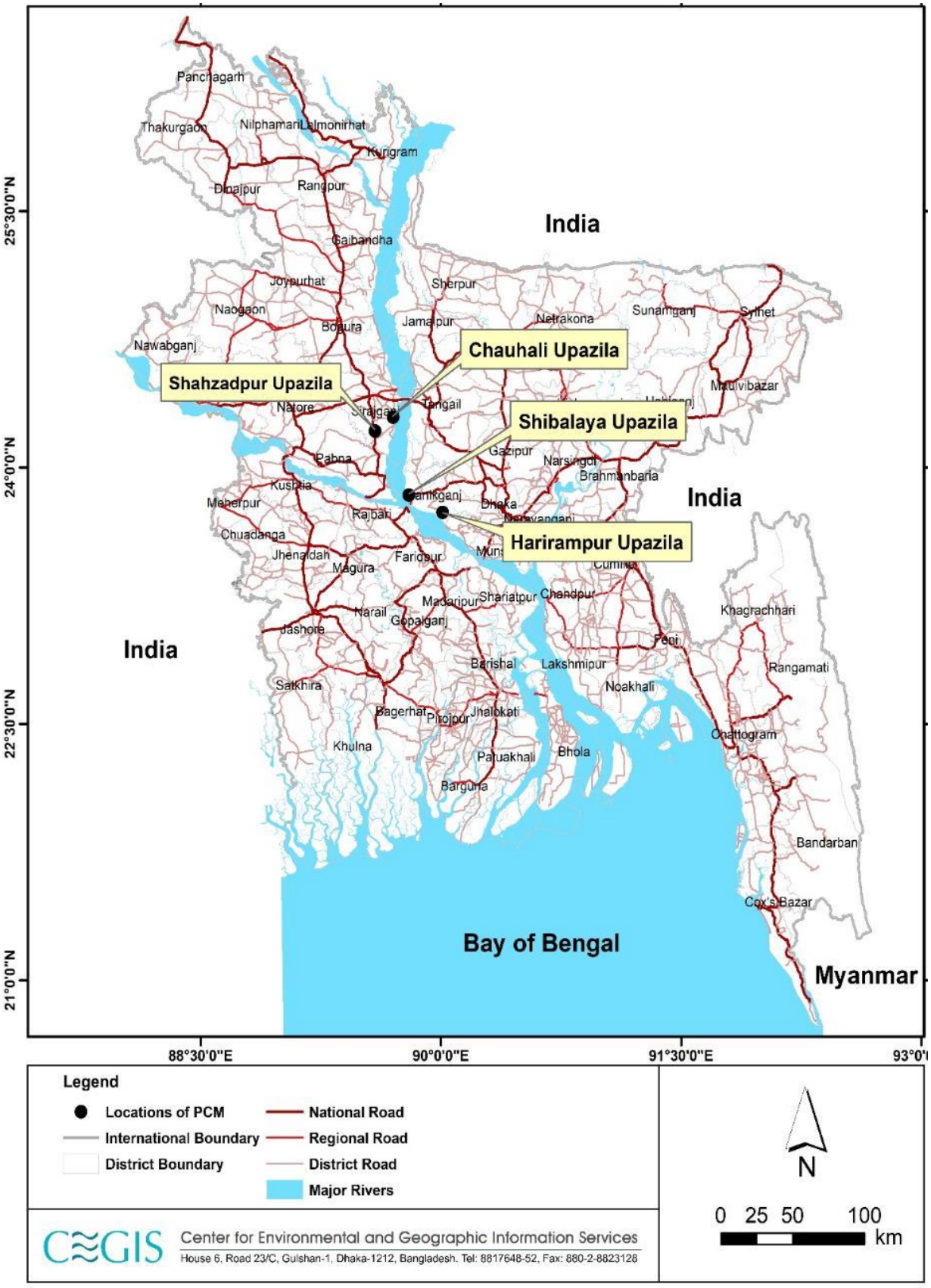


Figure 6-1. First round public consultation meeting locations

Note: Harirampur was first included in Project-2, hence it was included in the consultation meetings.

175. Judging from the level of meeting attendance, notification appeared to have been effective – now that "everyone" in Bangladesh has access to a cell phone – in reaching a large number and all types of stakeholders. The only stakeholder type noted to be seriously

underrepresented in the public meetings was women. This was addressed by having separate women-only focus group discussions about the project and the environmental impacts.

176. There was a high degree of unanimity among stakeholders. Stakeholders, even some who would be resettled by construction, expressed strong support for the project to be implemented as quickly as possible to solve their severe and urgent erosion and flooding problems. No reservations were expressed regarding potential adverse impacts.

177. An issue identified by CEGIS meeting facilitators is that some stakeholders are unhappy that their area (which is suffering from flooding and/or erosion) is not covered by Tranche-1, and they do not understand why areas other than theirs have been selected for priority intervention. This highlights a potential risk to the dynamic siting approach, which is supposed to determine intervention locations on the basis of morphologic/hydrologic modeling, but may be vulnerable to local stakeholder pressure. Another potential risk is of increased social conflict between protected/unprotected communities or between unprotected communities and project proponents, contractors, labourers, and so on. These risks will be addressed through the implementation-phase public consultation program, which can include dissemination of information on how siting decisions are made, and the GRM.

6.5.2 Second Round

178. A second round of public consultation meetings was conducted to present the draft EIA results to stakeholders for their comments. The EIA reports and Bengali presentations were disclosed to the public on 2-9 July 2013 in four meetings, held at Shahjadpur (JRB-1), Shibalay and Chouhali (JLB-2), and Harirampur (PLB-1) of Manikganj and Sirajganj districts. The records of this round are presented in Appendix F.

179. The main meeting objectives were to present the findings of the final draft EIA report and receive feedback from local stakeholders who attended the meetings. Stakeholders including persons affected by Tranche-1 expressed their views in favor of the Project and their support for early implementation to protect them from natural flood and erosion disasters. CEGIS consultants shared the Tranche-1 feasibility and EIA process and results first with BWDB officials and Upazila Parishad Chairpersons (UZPC), Upazila Nirbahi Officers (UNOs), and Project Implementation Officers (PIOs) of polder areas. In turn, these individuals assisted in identifying and inviting union-level public representatives and key persons by phone to the consultation meetings.

180. Not surprisingly, given the higher level of information provided to meeting participants about the subprojects and their potential impacts, participants expressed more substantive concerns about the when, where, what and how of subproject interventions.

6.5.3 Third Round

181. In continuation of the first and second round of public consultation, a third round was conducted between October 2016 and October 2017 to assess opinions and receive feedback from local stakeholders on specifically the Tranche-2 interventions. The proposed works were explained to the public in six public meetings, i.e. two meetings held at Harirumpur (PLB-1), one at Shahjadpur (JRB-1) and three at Chauhali (JLB-2) of Sirajganj and Manikgonj districts. The records of this round are presented in Appendix G.

182. The major objectives of the meetings were to disclose the proposed interventions of Tranche-2 and receive the local stakeholder’s opinion and suggestions on the interventions. The stakeholders including persons affected by river erosion and flooding expressed their views in favour of the Tranche-2 interventions and were satisfied by the implementation of

the Tranche-1 works. They demanded extension of the bank protection works and protection from monsoon flood through embankments and provision of regulators for drainage and fish movement. The EIA team sheared these stakeholder opinions with BWDB officials and ISPMC's team members for technical solution.

183. Participants of the different meetings urged to implement the project as soon as possible. They expressed their concern about compensation of land and homesteads that will be lost due to the project interventions and the loss of livelihoods. Almost all participants in the meetings consented to accept temporary air pollution and noise generated during the construction phase of the project.

184. Participants in the different meetings requested to provide regulators with fishpasses to get rid of drainage congestion and obstruction to fish migration at suitable locations in the embankments.

185. Local people in public and FGD meetings noted that migratory birds are being hunted illegally, particularly at night, and that therefore less migratory birds are found during the winter season in the project area. They demanded to take lawful administrative action against poachers.

186. While discussing the protection against flooding by construction of embankments that will bring safety to homesteads, crops and fisheries and improve communication and health and hygiene, people welcomed the project. Stakeholders realized that flood protection works by construction of embankments will or may sacrifice their lands. However, they demanded compensation for the land, homesteads, etc. that will be affected by the project.

187. During meetings at Solimabad in Chauhali Upazila the people demanded to protect their land, homestead and other assets from the recently developed (3-4 years ago) active channel from Jamuna. While disclosing the proposed intervention (closure dam) to mitigate sufferings of the local people, they expressed their full consent to the proposed interventions and urged to implement the work swiftly. They also expressed to render full cooperation during implementation of the work.

6.6 Summary of Concerns, All Meetings

188. **Conditions identified as important for success of subprojects –** (i) Participants emphasized the need to ensure that construction work is of high quality. (ii) Almost all participants stated that erosion will destroy areas currently under attack and subproject designs will have to be changed unless construction of erosion works begins this year (2017). To allow this construction to start in 2017, they requested that contingency funds be arranged now. (iii) Participants are concerned that development projects initiated by the ruling party will lose priority if/when the opposition party is in power. Participants strongly urge a 2017 construction start to avoid future problems.

189. **Dredging.** River dredging has not been included in subproject designs at the time of the meetings, and participants stated that embankments will not control flooding or erosion without it, and therefore it should be incorporated in the project. Some participants suggested capital dredging from Jamuna Bridge to Brahmankanda of Harirampur Upazila under Manikgonj District. Participants also suggested that fisheries habitat could be restored through dredging of internal channels in the Tranche-2 area. In the meantime, however, revision of Tranche-2 design means that multi-purpose dredging is now included in the interventions, in combination with riverbank protection works, so at least part of the concerns has now been addressed. Primary capital dredging of the river is not being considered as this is regarded as unsustainable and too costly.

190. **Pollution.** Stakeholders were advised that the construction phase would cause temporary air pollution and noise. Almost all stakeholders present consented to accept these temporary impacts during construction.

191. **Flood protection plans.** Participants expressed concern about the effectiveness of the subprojects in controlling flooding. They stated that flood protection plans should be developed based on an assessment of water levels. Proposed interventions should be designed to provide protection from the highest monsoon water levels.

6.7 Additional Concerns from Specific Meetings

192. **Shibalay, Manikganj (JLB-2 area).** The upazila areas most affected by erosion are Zafargonj and Bachamara. Local MP Mr. A.B.M Anwerul Haq stated that over last five years, more than 9,000 affluent households of Zafargonj area were forced by erosion to leave the area and now live in difficult circumstances in Dhaka city. Participants recommend that construction should start from November in the dry season. The northern part of Zafargonj Bazar is threatened by erosion this year (2017). To protect this area, participants suggested seeking preparatory funds from the ABD and the BWDB. Riverbank protection from Kaijuri to Baghabari is also essential this year (2017) as these areas are vulnerable. Participants believe permanent protection works are required in the Padma and Jamuna Rivers as temporary erosion protection works are not viable there. A reservoir to hold water for rice cultivation and fish culture should be added to the subproject.

193. **Shahjadpur, Sirajganj (JRB-1).** Coordination among involved departments should be ensured during subproject implementation. Eroding locations should be properly identified and protection works provided there. Participants requested adding construction of a water reservoir to the project, to hold water for rice cultivation and aquaculture, and immediate repair of the existing embankment and revetment. While disclosing the proposed flood embankment along Hurasagar, they are in favour of the proposed intervention. Participants demanded construction of road-cum-flood embankment as it will facilitate smooth communication to Shahjadpur Sadar and Dhaka-Tangail road. They also informed that the existing embankment on this alignment is partially eroded due to river erosion and suggested to use this alignment to reduce the land acquisition cost.

194. **Chouhali, Sirajganj (JLB-2).** The area in Chouhali Upazila most vulnerable to erosion is the Upazila Sadar. BWDB has been using sandbags as temporary measure to protect the riverbank from sudden severe erosion, but these temporary measures are found not effective as sustainable solution. Many participants stated that these sandbag revetments are presently not suitable for the mighty Jamuna river due to its severe erosion intensity. Most participants stated that capital dredging should be undertaken from the Jamuna Bridge to Aricha. River dredging is required to ensure the survival of any future embankment works. An embankment of 12 km built in this Upazilla along the right bank of Jamuna River during the year at significant cost, was eroded due to severe flood and intensive erosion of mighty Jamuna River. A flow divider should be incorporated in the project design. Participants expressed frustration that the subproject design does not reflect the concerns and suggestions of local people. They demanded to extend the length of the protective work and necessary repairs of the protective works already done under Tranche-1. Local people urged in two public meetings at Solimabad to control the erosion which started a few years back and aggravated seriously recently.

6.8 Incorporation of Concerns in Project and Mitigation Designs

195. Some concerns relate to known issues that have been and are being attended to (e.g. quick start of construction, construction quality control); where prevailing funding, capacity and other constraints obviate technical solutions, this will be communicated to stakeholders during subsequent consultation activities. Other concerns relate to participants'

perceptions of technical issues (e.g. role of dredging in flood and erosion control and fish habitat restoration; flow divider) that may or may not accord with engineering analyses and understandings. Addressing these concerns first requires a technical assessment of the feasibility of modifying designs per stakeholders' wishes/suggestions; where feasible, appropriate modifications can be made. Addressing concerns without ready technical solution likely will involve an ongoing conversation between planners/designers and stakeholders, in which information about analytical tools and results in appropriate forms is provided to stakeholders and stakeholders are provided with opportunities to share their local knowledge and observations with planners/designers, especially where it contrasts with technical understandings. Currently detailed designs are underway, and the public continues to be consulted.

6.9 Implementation-Phase Stakeholder Disclosure, Consultation and Participation

196. Stakeholder engagement will continue during implementation facilitated by an NGO engaged for this purpose. Selected parts of this EIA, specifically related to impacts, mitigation measures and stakeholders' views, will be translated and made available to the public at different local levels, suitably the locations of the consultation meetings. On a larger scale this EIA will be published on ADB's webpage as part of the project documents.

6.10 Grievance Redress Mechanism

197. At each of the Project-2 subproject locations, a local Grievance Redress Committee (GRC) will be set up during the design stage and operate throughout the implementation phase. Each GRC will consist of a BWDB representative (Executive Engineer (Field) or equivalent) as the chair, a BWDB Sub Assistant Engineer as member-secretary, and as members the concerned Union Parishad chairperson(s) and for subprojects with resettlement, a representative of resettlement-affected persons.

198. GRCs will review and resolve grievances within one month of receipt and maintain written records of complaints received, actions taken and meeting minutes with dated photos. Aggrieved persons are free to access the country's legal system at any stage regardless of GRC involvement. In addition, a Joint Verification Team (JVT) is responsible to assess complaints related to the land acquisition process [11] but also related to the environment, including the use of natural resources, such as fish associated with sluice gate operation or the use of embankment slopes based on long-term lease agreements[12].

199. A further elaboration on the establishment and operation of the Grievance Redress Mechanism is provided in Chapter 9.

6.11 Reporting and Monitoring

200. Environmental monitoring reports will be issued bi-annually disclosure on ADB's website. The environmental monitoring reports will also be incorporated into the January and July version of the quarterly progress report, which is at the beginning and end of every construction season. Environmental monitoring reports will be prepared by the Project Management Office, under the direction of the nominated Environmental Focal Person with the help of the consulting team's environmental specialists.

[11] Annex J1, Resettlement Framework, version dated 2 Aug 2013.

[12] Long term lease agreements will be worked out after identification of stakeholder groups, associated with community disaster management units and considering vulnerable groups (such as hard-core poor families, women-headed households) identified during the implementation of the resettlement process.

201. Monitoring will be undertaken for timely detection of conditions requiring remedial measures; to provide information on mitigation and institutional strengthening progress; and to assess compliance with required safeguards. Overall implementation progress including EMP implementation will be reviewed during periodic review missions involving ADB, the Implementing Agency, the Executing Agency, and the Implementation Consultant.

7 IMPORTANT ENVIRONMENTAL AND SOCIAL COMPONENTS

7.1 Introduction

202. The environmental and social components likely to be impacted by the project interventions are called Important Environmental and Social Components (IESC). IESCs were formulated through a two-stage scoping process. In the first stage, IESCs were identified by the experts of the EIA/SIA team in a multi-disciplinary scoping process. In the second stage, local scoping sessions were held in which local communities reviewed and validated the EIA/SIA team's IESCs, and, as needed, identified additional IESCs they believed could be impacted by the proposed interventions.

203. The IESCs for water, land, agriculture, fisheries, ecosystem and socio-economic conditions that were formulated for this study, and their selection rationale, are described below.

7.2 Water Resources

7.2.1 Erosion and Accretion

204. Every year, bankline erosion in the study area grasps a huge amount of land damaging valuable assets and infrastructure. On the other hand, continuous accretion in the rivers reduces the navigability. In the dry period, the shallow rivers are silted up with chars and the available surface water can hardly meet the demand of local people. The interventions will have significant effects on the morphological changes (i.e. erosion and accretion) of the area. The bank revetment works are likely to affect the river erosion/ accretion scenario, whereas the process of guided siltation may affect the net accretion inside the Jamuna River.

7.2.2 Flooding

205. The study area is highly vulnerable to regular flooding during monsoon. Due to flat topography and geographic location of the area, small rise in water levels causes full scale inundation. Floods cause immense sufferings to the local people by damaging valuable assets and infrastructure, causing bank erosion, disrupting communication system, and so on. Interventions such as construction and re-sectioning of embankments are likely to cause significant impacts in the flood occurrence, extent and duration.

7.2.3 Drainage Congestion

206. The major internal tributaries of the area are becoming shallow due to continuous siltation and hence do not provide effective drainage needed during monsoon. This leads to drainage congestion problems that eventually cause waterlogging and inundation in some parts of the area. The proposed bank revetment works, and provision of regulators are likely to affect the drainage situation of the water bodies inside the area to some extent.

7.2.4 Water logging

207. In the wet season, some parts of the study area suffer from temporary water logging problems. However, there is no permanent water logging condition in the dry period. The construction and re-sectioning of embankments is likely to increase water levels, which may create water logging on a permanent basis. Provision of regulators is likely to resist the occurrence of waterlogging, but in places where regulators would not be placed, waterlogging problems might arise.

208. Excavation of canals connecting the floodplain will enhance flooding. Excavation of beels to ensure that parts are at least 2m deep in the dry season, will increase beel productivity by promoting dry season survival. Six beels recommended to be established as fish sanctuaries are prioritized for deepening; these are: Chandahar, Char Ghior Mallar, Gomorki, Kadaibadla, Patal and Shonsi beels.

7.2.5 Water Availability and Water Use

209. In the dry season, groundwater as well as surface water is used to some extent for irrigation and domestic purposes, while in the wet season, surface water is predominantly used. The availability of water for different uses therefore is a valued component for the lives and livelihood of local people. The interventions proposed in the study area may affect the local people's access to surface water and its multipurpose usage.

7.2.6 Navigation

210. Navigation through the major and internal rivers is an important mode of transport in the study area. It is important for socio-economic aspects, ecological balance and the different uses of water. The provision of interventions may affect the navigation status of the rivers.

7.2.7 Surface Water Quality

211. Surface water quality is important for the environmental sustainability. Better quality of surface water would ensure improved use of water for domestic, irrigation and drinking purposes. The proposed interventions may impact the quality of surface water. The bank revetment works would impact siltation rates and overall quality of rivers. The construction and re-sectioning of embankments would also affect the quality of surface water during the construction phase.

7.3 Land Resources

7.3.1 Land Type

212. Land types are categorized based on the depth of inundation of cultivated land during the wet season. Areas under different 'land types' was selected as an IESC.

7.3.2 Dredging and Sand Carpeting

213. Dredging results in spoils that may be used to fill sandbags for riverbank protection works, river closures (sandplug) or for dumping on charland, in other river sections, on other (e.g. agricultural) land, or may be used for landfills (economic zones, settlements). Although dredging is an important part of the Project-2 interventions, spoils are mostly used to fill sandbags and built embankments and the river closure at Chauhali. Large-scale land covering with dredging spoils is not foreseen for the Project-2 works. Sand carpeting or smothering of agricultural land may take place through overtopping of embankment during high flood levels in the river. Area of agricultural land affected by sand carpeting was selected as an IESC.

7.3.3 Land Loss

214. Land loss through riverbank erosion is a major problem in the study area. The proposed bank protection is expected to check and largely reduce such loss of agricultural land. Temporary loss of agricultural land is likely to take place during the pre-construction phase if labour sheds are constructed and/or construction materials are stored on agricultural land. Agricultural land may also be lost if dredged spoil/re-excavated soils are

disposed on agricultural land. Permanent and temporary loss of agricultural land was selected as IESCs.

7.4 Agriculture

7.4.1 Cropping Pattern and Intensity

215. Changes in area under different land types are expected to bring changes in cropping patterns. Increase in area under higher land type (F_0/F_1) would create scope for multiple cropping, leading to increased cropping intensity.

7.4.2 Crop Production

216. Agricultural crop production is expected to increase through riverbank protection and changes in area under different land types. This is expected to be achieved through increased cropping pattern, reduction in crop damage, increased area under high yielding varieties of rice with increased provision of both primary and supplemental irrigation and overall adoption of improved crop management practices.

7.4.3 Crop Damage

217. Crops are presently damaged in the study area due to flood, drainage congestion, and drought. Changes in crop damage would be reflected in aerial extent as well as increased yield per hectare contributing to increase in crop production.

7.4.4 Irrigated Area and Irrigation Water Availability

218. Irrigation supports greater and more reliable agricultural productivity. Both surface water and groundwater are used for irrigation use.

7.5 Fisheries

7.5.1 Fish Habitat

219. There will be changes in fish habitat both in the river and floodplain area due to the river stabilization process. River habitat will be altered due to the direct effect of bank revetment, dredging and reduction of braided system. Floodplain habitat will be indirectly affected by the embankments by being under flooded due to the reduction of river-floodplain connectivity.

7.5.2 Riverine Fish Habitats

220. In the river, fish habitat will reduce in spatial dimensions simply because the river will become narrower and confined between revetments. The bankline ecosystem will be altered from vegetated soft substrata to non-vegetated harder substrata altering the present pristine habitat. The river will also become deeper, and the shallower, bank-line ecosystem will be reduced. Braided habitat systems as well as the charland ecosystems will shrink, while bottom habitat will be deeper. Therefore, the size and characteristics of the river ecosystem will be altered significantly by the project interventions.

7.5.3 Beel and Khal Fish Habitats

221. Some of the riverine fishes (37 out of 200+ freshwater species) migrate towards the beels through khals for breeding and propagation. Beels are the breeding and feeding grounds of indigenous fish species and play a vital role in stock recruitment. The khals are at present silted up due to closure, construction of water regulating structures, the construction of earthen bund, and so on. In addition, the beels have also silted up rapidly and indigenous

fish species might disappear from the area. The proposed interventions will modify fish habitats in the study area.

7.5.4 Floodplain Fish Habitat

222. Floodplain fish habitat, consisting of beels, khals and flooded land, will be impacted indirectly but significantly by the river stabilization interventions. The embankment along the riverbanks to contain flooding will reduce the connectivity between the river and the floodplain, which will in turn affect fish habitats.

7.5.5 Fish Migration

223. Under the pristine situation, large number of fish undertake migratory movement between the rivers and the floodplain for breeding, early development, feeding and overwintering. But this will be largely affected by the riverbank embankments to contain flooding. The fish migration issue is included as an IESC under this study.

7.5.6 Fish Species Diversity

224. When there will be negative changes in the floodplain ecosystem due to reduced inundation of fish habitat and impeded fish migration, there will be significant reduction in natural recruitment and biodiversity. Besides, the beels may silt up rapidly and the indigenous species of fishes might disappear from the area.

7.5.7 Capture and Culture Fish Production

Fish production will be impacted due to the river stabilization interventions both in the river and floodplain area. In the river ecosystem, reduction and alteration of habitat will affect fish production. Deeper rivers will, however, support the deep river fishery and dolphins. In the floodplain fish production will be decreased due to loss of habitat with reduction in water area. Besides this, the unfavorable environment in terms of reduced dissolved oxygen (DO) and pH level and water temperature could also change fish production.

7.6 Ecological Resources

7.6.1 Terrestrial Ecosystem

225. The terrestrial ecosystem provides habitat for terrestrial plants. Several indicators such as biodiversity, species richness and habitat suitability can be used to assess the physical condition of the ecosystem. Therefore, assessing the population dynamics of local plants and wildlife communities including terrestrial birds can measure the health of the terrestrial ecosystem as well as its population. Physical settings of the existing ecosystem may be changed, for example, terrestrial communities due to bank protection of the river.

7.6.2 Aquatic Ecosystem

226. Aquatic ecosystems provide support not only to aquatic life but also supply vital ingredients to terrestrial ecosystems. Unlike terrestrial ecosystems, any impact on the aquatic system is generally not confined to the local area, it also affects the surrounding areas. Change in flow regime of water in the study area will change the habitat suitability for resident plants, aquatic birds and wildlife, niches, and so on.

7.6.3 Floral Composition and Diversity

227. Composition and floristic diversity of khal, beel, homestead and crop field vegetations are sensitive to the hydro-morphological condition of its habitats. The impact of the proposed bank protection activities would change the hydro-morphological condition of rivers and

change the floristic composition and diversity both on terrestrial and aquatic habitats in the study area.

7.6.4 Faunal Composition and Diversity

228. Developing of bank protection activities might have impacts on faunal composition and diversity both on terrestrial and aquatic faunas. This IESC was selected to identify and evaluate the potential impacts on terrestrial and aquatic fauna for this project.

7.7 Socio-Economic Conditions

7.7.1 Land Ownership and Tenure

229. Much of the land is occupied or used in one way or another but many people do not own the land in the sense that they posses a formal title, particularly on char lands. Large areas are 'khas' (government) land, however, and much of the land is privately owned while some of the khas land has been leased out to current land users. Land use on large areas will change as a result of the river protection works, and this will or may affect current users. Many of these are among the most vulnerable and disadvantaged people in the country who should not be further deprived by development of the lands which would go against government's policy of reducing regional disparity.

7.7.2 Land Acquisition

230. Land will be acquired for implementation of the riverbank protection works, embankment and regulators constructions following the FRERMIP Land Acquisition Plan of ADB Guidelines and GoB's related acts, rules and guidelines.

7.7.3 Income Generation

231. Project interventions could increase employment opportunities in agriculture and fishery sectors as well as in the field of non-agricultural trades.

7.7.4 Communications

232. One of the outcomes of the project is to protect embankments from erosion and roads on top of embankments, important for transport and communication in an area will therefore not be affected.

7.7.5 Poverty

233. People cultivate agricultural lands by the side of the river, and this contributes to production. Food security of the local people will be ensured by increased crop production in protected agricultural lands.

8 IMPACT ASSESSMENT AND POSSIBLE MITIGATION MEASURES

8.1 Environmental categorization

234. The Important Environmental and Social Components (IESCs) for the project have been selected and validated in Chapter 7. Following the analyses of all the secondary information available, major field investigation was conducted in May 2013, by a multidisciplinary team of experts from CEGIS. The information collected from that field visit period was analysed in order to assess and evaluate the impacts of each previously selected IESC. Further field work was conducted during implementation of Tranche-1 works in the period November 2015 to January 2017. This chapter contains the details on impact assessment and evaluation for the implementation of the Project-2 works.

235. The impact assessment concentrates on the Project-2 works. Impacts focus on the main interventions, i.e. riverbank protection through the deposition of geo-textile sandbags and concrete blocks, construction of embankments, and drainage/fish pass structures, as well as the establishment and operation of worker's camps, and transport of materials, whether by boat, road or else. Consequently, this EIA aims at supporting the investigation of suitable stabilization solutions, minimizing potential impacts of larger scale river stabilization, and suggesting appropriate mitigation measures for the ongoing Tranche-1 and the proposed Project-2.

236. During the second phase of the scoping process, the Project-2 EIA study team conducted compliance monitoring of the Environmental Management Plan (EMP) implementation of Tranche-1 construction works which yielded important insight in which impacts were significant, and which were not. This team also conducted the Strategic Environmental and Social Assessment (SESA) of the wider long-term River Stabilization Plan (RSP) that identified significant impacts. RSP was already approved by the competent authority on 24.06.2020 and SESA have recently (Q1 2020) been updated, with that of the SESA following feedback and extensive comments from the Netherlands Commission for Environmental Assessment (*Commissie voor de milieueffectrapportage* or *MER Commissie*).

237. As the long-term river stabilization plan for the targeted river system contains a number of uncertainties, the RSP follows an Adaptive Delta Management approach whereby decisions relating to the design stabilised river are continually adjusted in line with growing basic planning data and observed impacts of initial activities. In the short term (until 2030), implementation of the RSP (including Project-2) will focus on systematic stabilization of two mid-reaches (reaches 3 & 4), alongside continuous collection of core river data and addressing erosion issues in the remaining reaches on an as-needed basis before preparing stabilization strategies for Reaches 1, 2 and 5 based on in-field experience.

238. Works are proposed for Project-2 along three sub-projects, namely Jamuna Right Bank-1 (JRB-1), the Jamuna Left Bank-2 (JLB-2) and Padma Left Bank-1(PLB-1), are listed in Table 8-1 below. The total capital costs are around USD 205 million, of which about 30% is included for dredging works.

Table 8-1. List of Tentartive Works under FRERMIP (Project-2)

Sub-Project	Site/Work	Description	Length	Cost	Dredging*
			km	M USD	M USD
JRB-1	Benotia	Bank protection	3	8.7	0.9
	Enayetpur	Bank protection&char recovery	7	17.6	5.8
	Shahjadpur	Embankment	7.9	6.1	2.4
JLB-2	US Chauhali	Bank protection with dredging	3	16.4	5.9
		Bank protection without dredging	5	18.7	2.9
		Bank protection (intermediate)	7.5	7.4	2.3
	Solimabad closure	Sand plug & char recovery	0.9	33	31
	Aricha - Chauhali	Embankment	40	53.8	38.8
	Offtake structure	Flood management structure for Dhaleswari offtake including surrounding bank protection	0	15	5.5
PLB-1	Harirampur	Bank protection wave protection	9	8.1	0.2
	Harirampur extension	Bank protection	4	3	1.1
Unallocated	Adaptation	for bank protection	40	15.3	4.7
	Fish sanctuaries	Environmental work		2.2	2.2
			Total	205.3	103.7
* dredging is included in the total cost per work item in the previous column					

8.1.1 Environmental category according to Government of Bangladesh

239. Schedule 1 of Government of Bangladesh's (GoB) Environmental Conservation Rules act of 1997 lists 69 types of projects listed as Red category, including: i) Engineering works where the capital investment is more than 1 million Taka; and ii) Construction/reconstruction/expansion of flood control embankment, polder, dike, etc… Hence, according to GoB regulations the project is a Red category project requiring an IEE, EIA and EMP for environmental clearance from the Bangladesh DoE.

8.1.2 Environmental category according to Asian Development Bank policies

240. Compliance monitoring of the Environmental Management Plan (EMP) implementation of Tranche-1 construction works yielded important insight in which impacts were significant, and which were not. Based on these insights, potential impacts along with their level and likelihood of occurrence were listed for Project-2, and the main impacts are listed in Table 8-2. Construction will also have a host of additional impacts reported in this EIA, such as noise, dust pollution, increased traffic hazards, disposal of hazardous waste, enhanced carbon emissions during construction, and so on. However, most of these are temporary, and are often at least partially mitigable.

Table 8-2. Potential main environmental impacts during implementation of Project-2

	Potential impact	Level & likelihood of impact
1	Significant effects on the morphological changes (i.e. erosion and accretion) of the area, also impacting riverine habitats linked to this morphology.	Significant and likely permanent, but perhaps more on a cumulative basis
2	The construction and re-sectioning of embankments is likely to increase water level which may create waterlogging on a permanent basis.	Unlikely, and levels are uncertain

	Potential impact	Level & likelihood of impact
3	Interventions proposed may affect the local people's access to surface water.	Positive in some areas, possibly negative in others; uncertain, requiring monitoring via EMP
4	Fish habitat will be reduced simply because the river will be narrower than its present width. Floodplain aquatic (wetland) habitats will be degraded or extirpated due to reduced flooded area, depth, and duration; reduced hydrologic connectivity; and physiochemical / water quality changes.	Likely and significant, only partially mitigable
5	This in turn will adversely affect floodplain-dependent open water fish species migration, population levels, and catch levels, as well as wetland biodiversity, services, and products more generally. In turn, this may affect the nutrition, health, and economic status of poor people.	Likely and significant, only partially mitigable
6	Flood-control-led expansion of high-yielding varieties (HYVs) may increase utilization of ground- and surface waters for irrigation, and may increase fertilizer and pesticide usage, that in turn may adversely affect water quality and availability for other uses or at other locations.	Likely and potentially significant, but mitigable
7	Newly flood-free lands may have less than optimal residual moisture for winter agriculture, compromising yields or causing high irrigation water consumption and costs in these areas.	Likely, but moderate and (partly) mitigable
8	Turbidity due to dredging is not considered as directly problematic as the dredging quantities are very small compared to the total sediment load of the Padma River. Hence dredging has no major short-term impact on the river morphology.	Likely, but moderate and temporary impacts
9	Direct disposal of these dredged materials in the river will increase turbidity of river water, and as a result river fishes and aquatic animals will be affected.	Likely and potentially significant, albeit during construction phase only

241. As identified in the SESA and the RSP, potential or likely **significant** negative impacts of the RSP interventions, including those of Project-2, are expected to include the following:

(i) Temporary disruption of social coherence in already vulnerable char land communities due to loss of chars and resettlement to large-scale, lower land quality land recovery sites, elite land grab and increased regional social disparity.
(ii) Reduced river connectivity between the river and the (current) floodplain, affecting surface and groundwaters and fisheries resources. This is expected to be permanent, and partly mitigable.
(iii) Loss of natural terrestrial, aquatic and wildlife habitat, affecting biodiversity and fisheries production. This includes in the river corridor, where the impacts are expected to be permanent and mitigable to a limited degree only.

242. The temporary disruption of social coherence in char land communities and the need for resettlement was recognized during the scoping phase, and as this meets the standards

of significant according to ADB standards[13], Project-2 is categorized as Category A under Involuntary Resettlement, and a resettlement plan, including an assessment of social impacts is required and has been produced.

243. In terms of environmental category, according to SESA and RSP the impacts on fish, fisheries and wildlife (-habitat) are expected to be significant and lasting. Based on this alone, the project is to be listed as **environment Category A**, as "it is likely to have significant adverse environmental impacts that are irreversible, diverse, or unprecedented. These impacts may affect an area larger than the sites or facilities subject to physical works. "Also, ADB's policy on Environment Safeguards (2012)[14] states that "A project's category is determined by the category of its most environmentally sensitive component, including direct, indirect, cumulative, and induced impacts in the project's area of influence." and the policy requires that "environmental impact assessments evaluate transboundary and cumulative impacts of ADB projects or programs". Cumulative impacts of RSP implementation on fish and fisheries, and wildlife habitat, are expected to be even greater over time and only partially mitigable, hence further triggering classification as Category A, requiring a full EIA and EMP according to ADB policy and guidelines.

244. Both positive and negative impacts of the Project-2 works have been identified for the construction and post-construction (operation and maintenance) phases, as well as mitigation measures, and these are detailed in the following sections (sections 8.2–8.6). As similar works will be conducted in the three Project-2 sub-reaches, the impacts have been generalized, but at the end of this chapter the main expected negative impacts and mitigation measures are summarized per site.

8.2 Positive Impacts

8.2.1 Construction – Overview

245. Construction of the works will require a large labour force (thousands of workers) for prolonged periods of time. Labourers will be contracted mostly from local communities. This will increase income and thereby boost the local economy.

8.2.2 Operation and Maintenance – Overview

246. After completion of the construction works, the interventions are expected to have multiple positive and beneficial effects on the people and economy of the area. First of all, the riverbank protection will prevent recurrent riverbank erosion and the associated loss of homesteads and cultivated land. Also, the improved embankment will also significantly reduce the flooding events and associated economic losses. Finally, roads constructed on embankments will facilitate local mobility as well as long-distance transportation. These factors are likely to have profound positive impacts on the local people and their economic conditions. The permanent delineation of river and floodplain will provide stability and allow the riparian population to plan. The increased safety against riverbank erosion and flooding as well as improved mobility and connectivity will bring in further development and investment to the protected areas that is currently not possible because of the exposure of these areas to natural hazards coupled with the vulnerability due to relative isolation and poor infrastructure. Three of the more significant positive impacts are further described in the following sub-sections.

[13] Asian Development Bank (2013) Operations Manual Bank Policies (BP), OM Section F1/BP, 21 pp. October 2013.

[14] Asian Development Bank (2012) Environment safeguards. A good practice sourcebook, draft working document December 2012.

8.2.3 Control of Riverbank Erosion

247. During the last four to five decades, the Jamuna-Padma-Meghna river system has undergone significant changes in width, bank erosion and braiding intensities. Recent research suggests that sediment slugs generated by the 1950 Assam earthquake were the main driver for those rapid changes. Riverbank erosion has resulted in loss of valuable land along the riverbanks. For example, the average rate of riverbank erosion along the Jamuna River north of Jamuna Bridge during last 40 years has been about 6 ha per km per year, resulting in loss of about 15,700 ha of valuable land during the period (RMIP, 2015). Along the same reach, another 6,000 ha may be lost due to riverbank erosion during the coming 30 years if no measures are taken to arrest the trend. The riverbank erosion not only causes loss of land but also attacks the already existing embankment, causing frequent breaches that in turn result in flooding of the protected floodplain causing substantial losses to private and public assets as well as crops and cultivation fields.

248. If no protective measures are taken and if the River Management Master Plan is not implemented (the Without-Intervention Scenario), the prevailing situation of a highly dynamic river and floodplain environment will remain, resulting in severe riverbank erosion at many locations and land accretion at others, and continued significant loss of land annually; it is estimated that around 1850 ha will be lost every year by erosion. This will in turn cause disruptions of lives and loss of livelihoods of around 15,000 people annually, as they lose their land and are forced to move onto the embankments or migrate to urban centres where victims of riverbank erosion constitute a large percentage of slum dwellers. Also, frequent flooding events disrupt lives and livelihoods, major negative impacts include the loss of crops, disruption of schooling, health issues, and gender specific impacts (discussed below).

8.2.4 Improved Flood Protection

249. Overbank spills regularly cause flooding in vast areas along the banks of the Jamuna-Padma-Lower Meghna River system. Over the years, embankments have been built along the banks but increasingly these have come under attack from bank erosion causing the embankment to breach. After such breaches, embankments usually need to be retired backwards, away from their original alignment and reconstructed. Retired embankments are typically constructed with around a 200-m setback distance to prevent flooding, which however corresponds to only few years of more significant erosion. In many places, the embankment has been retired multiple times. Presently, many reaches of embankment are close to the riverbank line, making the closing of breaches increasingly difficult. Consequently, the integrity of the embankments is being threatened and large areas of rural and urban areas are increasingly exposed to flooding.

250. As part of the economic analysis of the program, the average yearly value of the above-described damages is being estimated. There are three main benefit streams: (i) avoided flood losses – to infrastructure including houses and crops; and (ii) incremental agricultural and aquaculture benefits from increased production. Other benefit streams, such as navigation or road transport, potential industrialization, and so on, are typically not taken into account. (iii) the embankment rehabilitation and reconstruction works envisaged under the proposed program will help avoid the losses described above and will result in savings the annual losses that are likely to take place caused by the flooding if no protective measures are undertaken.

251. The rehabilitation of existing and construction of new embankment will greatly improve the effectiveness of these structures against floods. Under the proposed program, the condition of the existing embankment has been reconsidered and re-designed: the width is increased to ensure that breaches and seepage do not take place and height is being increased catering to 100-year flood level (and a freeboard) with climate change provision. In

addition, squatters will be removed from the embankment (after payment of compensation), allowing effective monitoring and maintenance of the new embankment once constructed. This will greatly reduce the risks of embankment breaching or over-topping hence significantly increase the protection of the area from floods and associated losses. Stable riverbanks will remove the problem of squatting as no families are involuntarily resettled by erosion anymore. In addition to the above the increased protection against riverbank erosion and flooding – combined benefits of the riverbank revetment and embankment reconstruction – will also bring in area development as well as investment that are currently not feasible because of the threats of bank erosion and flooding.

8.2.5 Land Cover and Land Use Changes

252. The program influence area is dominated by settlements and cultivation. Although cropping intensity on the floodplains is high, there is good potential to further moderately increase it. Protection against erosion and flood damage will stimulate farmers towards increased crop intensity and toward high value crops. However, the cropping pattern could be changed by increasing the trend of growing high value crops. Area coverage of different crops is expected to increase in some locations due to protection of seasonal flood by the embankment. On the other hand, area coverage of some crops may decrease due to poor profit margins. The trends of crop production per unit area for a couple of decades suggest that increase of yield (t/ha) for different crops will continue for some time by using modern production technologies and increased inputs. Once there is no threat of flood, it is expected that farmers will invest in more cultivation inputs and as a result the production per unit area will increase.

253. Earlier studies (for example RMIP, 2015) indicate that based on the changed cropping pattern and increased yield, there will be an increase in the agricultural income from the program influence area. While the western floodplain has been embanked, the eastern one is largely without embankment. Hence, increased agriculture production is expected in the newly embanked areas.

254. While increased agricultural income will positively impact the livelihood of local farmers, the increased cropping intensity and changed cropping pattern will potentially cause an increased use of agrochemicals such as urea, TSP (Triple Super Phosphate) and MP (Muriate of Potash). The increased use of agrochemicals can potentially cause an enhanced level of soil and water contamination and pose health hazards for the farm workers and for other communities in the project influence area.

8.2.6 New Fisheries Habitat

255. The envisaged riverbank protection works are almost exclusively longitudinal river training revetments made of geotextile bags filled with sand below the low waterline and concrete blocks or grout-filled mattresses above this line. Contrary to the unprotected riverbank that mainly consist of compressed but loose sand that erodes rapidly, the bags and blocks form a stable substrate that may provide shelter, feeding and breeding places for some fish and other (semi)aquatic life. As the bags and blocks do not form a completely flat and closed layer, small openings may remain that provide shelter. Algae and other small organisms may find a suitable substrate on the bags and blocks on which fish and other vertebrates may feed. Revetments (esp. concrete blocks) are generally known to create good fish habitats.

256. The planned interventions will result in a non-braided stable river ecosystem with narrower and deeper, faster flowing channels. This will create an aquatic environment favourable for deep water and current-dependent fauna such as Hilsha fish, but is unfavourable for shallow-water fish that prefer low current velocities, such as most

fingerlings. As opposed to the steep eroding riverbank, the protected one provides easy access to the river.

8.3 Negative Impacts

8.3.1 Construction – Overview

257. The key potentially negative impacts associated with the construction phase of the Project-2 works include changes in aquatic habitat because of riverbank protection works (e.g. slope levelling) as well as from sand extraction from the riverbank; changes in land form and land use because of rehabilitation of existing and construction of new embankment; land acquisition for construction of new embankment and resulting displacement of people; use of natural resources particularly river sand; health and safety risks associated with handling of hazardous materials and operation of construction machinery; air quality deterioration because of operation of construction vehicles and machinery as well as excavation activities; noise generation caused by the operation of construction machinery and vehicles; contamination of land and water caused by wastes generated from construction activities and camp operation; loss of trees that need to be removed for construction of embankment; risk of accidents associated with movement of construction vehicles and machinery; blockage of local routes caused by construction activities; and impacts on sensitive receptors such as schools along the embankment.

258. Most of these adverse impacts are of a local and temporary nature (e.g. during the construction phase only) and can be mitigated relatively easily with proper mitigation measures that form part of best international practice. Permanent negative impacts associated with the construction works such as lost or damaged properties (trees, houses, land) and livelihoods are to be compensated for as per relevant policies of the GoB and financing agencies and in accordance with the Resettlement Action Plan (RAP) that has been developed and is to be implemented by the program.

8.3.2 Operation and Maintenance – Overview

259. The potentially negative impacts associated with the O&M phase of the interventions include changes in river morphology caused by riverbank protection; changes in aquatic habitat caused by riverbank revetment; blockage of local routes caused by embankment and roads; effects on water bodies and associated habitats caused by disruption of hydrological and ecological connectivity between main river and internal rivers, beels and khals; noise generation and air quality deterioration caused by vehicular traffic on embankment roads; risks of accidents associated with vehicular traffic on embankment roads; and increased usage of agrochemicals caused by agricultural intensification due to enhanced protection against riverbank erosion and flooding. The loss of vertical riverbanks results in the disappearance of nesting habitat for a range of bird species.

260. Once the river training works have been constructed some 6,000 ha of land will be reclaimed in subproject JLB-2 (Feasibility Report for Tranche- 2 (Project 2), August 2019) while it is government policy to ensure food self-sufficiency (particularly rice) and that reclaimed land should be made available for the landless and marginal farmers. It has also been noted that there is a large and growing demand gap in the supply of meat, milk and eggs (particularly in urban areas) and it is policy for agriculture to intensify and diversify. However, much of the land to be stabilised and reclaimed is of low fertility which may take 12-15 years to bring to a condition where rice cropping can contribute to food self-sufficiency and much of the land is char land that is currently being used for arable agriculture. There is a need to ensure that these current land users, who are amongst the most vulnerable and disadvantaged people in the country, are not further disadvantaged by the development of these lands that would go against government’s policy of reducing regional disparity.

8.3.3 Riverbank Protection & Construction/Rehabilitation of Embankments & Regulators

261. **Impact.** These interventions result in significant changes in land use, land cover and habitats, and limit the supply of water to support local communities, agriculture and fisheries throughout the year. If no, inadequate or insufficient regulators/fish passes are provided, the connectivity between the main river and floodplain will be affected, which is of importance for migratory fish and other animal species since their reproduction and survival rely on such connectivity. Even with mitigation measures, the post-construction condition will be less favourable for the aquatic environment as compared to prior to the intervention. Compensation measures, if diligently carried out, may however, cover some of the anticipated fish production losses.

262. Adverse on-site environmental impacts of constructing bank protection and embankment works will mostly be of a local and short-term nature and can be mitigated by minimizing pollution of the environment by proper management practices on construction sites as well as in and near worker's camps.

263. New embankment construction may result in the loss of agricultural land, homesteads and/or businesses resulting in a loss of income and livelihood. The rehabilitation of embankments may also result in loss of income depending on the degree to which the embankment has been squatted upon. Both interventions are likely to require resettlement programmes and income and livelihood restoration.

264. Social impacts of these works are on livelihoods through income reduction and livelihood dislocation that can be mitigated by focusing on income and livelihood restoration since most affected people are likely to be day labourers and/or sharecroppers rather than landowners.

265. **Mitigation.** As noted above, negative impacts of the riverbank protection and embankment works will need to be addressed through implementation of a fair and effective resettlement and/or compensation program and through various management interventions that include ensuring connectivity between the river and the floodplain through operation of regulators and fish passes, and actions that enhance fisheries – as is outlined below.

8.3.4 Dredging and Excavation Works

266. **Impact.** The impact of dredging largely depends on the location and on what is done with the dredging spoil. Under FRERMIP, dredging has so far primarily been done for the collection of sand for filling of geotextile bags and for embankment construction and is conducted in the river itself where the sand content of the river floor is highest. Usually this is within a distance of a few kilometres from the construction sites. Impact of this type of dredging during the dry season construction window is believed to be low, local and temporary: fish, dolphins and other wildlife will temporarily avoid the area but will return once the dredger has ceased work or moved elsewhere. Impact on on-site fish habitat is also expected to be low or insignificant as most of the river's bottom sediment is expected to be loose material. Some dredging works in channels will be part of Project-2 implementation, and a channel near Chauhali will be closed with dredged sand (sandplug). This will be so-called "intelligent dredging" designed to stimulate certain river morphological developments. Dredging may also be done to keep navigation channels open during the dry season. Giving priority to large-scale dredging as the key intervention for river stabilization in Bangladesh, as promoted by the Prime Minister in January 2018, it not foreseen under FRERMIP.

267. Dredgers are usually noisy due to lack of adequate noise silencing equipment, and produce smoke and smell, being mostly a nuisance to their crew. People, animals and plants on land will usually not be affected.

268. Impacts of dredging and excavation may be different when spill canals are to be created, or when silted canals or distributaries need to be opened or deepened. This may involve loss of used land, damage to crops or other assets, loss of natural habitat, and hindrance to people and animals.

269. Dredged spoils may be dealt with in different ways. These will either be transported by barge to geotextile sandbag filling or embankment construction sites, or be dumped somewhere else, mostly to fill low lying areas that are potentially secured or reclaimed. Transport to bag filling or embankment construction areas will not involve significant impacts i.e. other than engine fumes, noise produced by barges, and carbon emissions. Spoil dumping may involve transport by barge as well or pumping through floating pipes to disposal sites. The latter may be other parts of the river (open water where this will not hamper navigation) or char or khas land.

270. Dredged spoil deposition sites may cover large areas that prior to the works are in use for agriculture, livestock, fisheries or that provide habitat for wild animals and plants and that temporarily or permanently will be lost. Spoil deposits can be expected to have a high sand content and thus low soil fertility, and therefore it may take years before these lands become productive. However, this is not expected in Project-2, where dredge spoils will be used for geotextile bag filling and for the Solimabad closure.

271. Dredging will or may affect the aquatic environment in four possible ways: (i) destabilizing the bottom ecology, (ii) channel deepening creates an altered ecosystem that may not be good for aquatic life, (iii) destroying potential fisheries habitat as the spoil deposition sites are targeted to be partly water bodies, and (iv) changing water quality. Changes in water quality include:

(i) pollution from dredging equipment and fuel
(ii) increased turbidity (already high, but expected to increase significantly, e.g. locally by an order of magnitude), and
(iii) suspended solids (these contribute to turbidity, but also directly affect aquatic life, e.g. by smothering plants and fish gills).

272. These impacts on water quality are mostly temporary and local (i.e. in a plume many km's downstream), although smothered plants and other biota may take time to recover.

273. **Mitigation.** Pollution, health and safety issues associated with the dredging activities and in and around workers' camps (air, noise, solid/liquid waste) are to be prevented through adequate best practice management and frequent monitoring.

274. Negative impacts of the dredging and excavation works can, to some extent, be mitigated by creating and enhancing alternative fish and wildlife habitats, for example through the establishment of Fish and Wildlife Sanctuaries – see below.

275. Fish habitat and fish production losses may not be possible to mitigate, the resultant impact in terms of fish production loss may be made up by appropriate compensation measures.

Lost or damaged lands, crops or other assets will be compensated for in line with a Resettlement Action Plan that is to be developed for the proposal programme.

276. Conducting a water quality monitoring programme prior (for baseline), during and after construction. Especially TSS, visibility and EC will be important.

8.3.5 Reduced Flooding – Baseflow

277. **Impact.** The overall river stabilization works (dredging, bank protection and embankments to prevent flooding) are expected to reduce the width of the river system (from the current braided system to a one or two channel system) and to deepen the main channel(s) which is expected to lower to some extent the low water levels. This may particularly impact water levels in distributaries, notably the Old Brahmaputra, Dhaleswari and Arial Khan.

278. The Old Brahmaputra and the Dhaleswari have been receiving less water in the past few years, which has led to a gradual decrease in flow along these rivers and resulted in many other impacts downstream such as deterioration of groundwater availability, reduction in surface water availability, impact on domestic water supplies, reduced irrigation opportunity, reduced crop and fisheries production, reduction in navigability, declining biodiversity and (particularly with the Dhaleswari) increase in both surface and groundwater pollution. The Arial Khan has not experienced a recent reduction of inflow, but also here the inflow depends on the morphological conditions at the offtake.

279. Preparation of the program includes study of the offtakes of these three rivers with the aim of re-establishing/maintaining flow from the main rivers as well as determining minimal environmental base flow. An IWM study in 2015 of the Dhaleswari offtake noted that the aim is to divert 245 m^3/s from the Jamuna River into the Dhaleswari/Pungli/Bangshi/Turag/Buriganga river system with 141 m^3/s to the Buriganga River to bring the dissolved oxygen levels up to 4 mg/l from the current 1 mg/l.

280. Reduced flooding will affect the floodplain fisheries ecosystem and thereby fish production. Advantages are: groundwater recharge, fisheries, navigation, water quality, irrigation improvement.

281. **Mitigation.** In general the social and environmental impacts of re-establishing/maintaining flow along these distributary rivers will be overwhelmingly positive but there will also be negative social and environmental impacts associated with the construction works at the offtakes where mitigation measures such as those outlined above will be required.

8.3.6 Reclaimed Land & char dwellers

282. **Impact.** Impacts of land reclamation are felt at various levels and concern dredging and excavation (8.3.4), reduced flooding (8.3.5), fisheries (8.3.7), natural habitats and wildlife (8.3.8) and of course on local (char dwelling) communities, which is dealt with here. Part of the land to be stabilised and reclaimed under Project-2 is char land. The inhabitants of most of the chars and their land are not included in much of Bangladesh's official data and estimates of the char population vary. Char people, the choira, are defined by their vulnerability and poverty. Their main income source is (subsistence) agriculture supplemented by animal husbandry, small businesses and fishing. Riverine chars are characterised by a population that is severely deprived and faces multiple livelihood challenges with high poverty levels not only through lack of income and assets but also who experience limited access to healthcare, education, markets and other government institutions as well as inadequate infrastructure. Labour markets are also constricted with limited diversification and few off-farm employment opportunities.

283. Most char households are reliant on daily wage labour for survival and the limited and sporadic opportunities do not allow improvements or asset accumulation. Although local government does exist on chars the remote location and difficult environment means that many services are limited, absent or lacking. Power is invested in local elites through stable lines of patronage and deeply entrenched social and cultural norms.

284. Riverine char households are particularly sensitive to seasonal income fluctuations and are the most food insecure in Bangladesh with monga (seasonal hunger) present from September to November often exacerbated by monsoon erosion and flooding and resulting in reduction in food consumption, asset sale and high interest loans.

285. As for land tenure, for the choira, land is their most important capital and the whole riverbed is considered their property and is passed on to the next generation. Land is also bought and sold always by the inhabitants of a single Union. Land currently under water can also be traded; in this case the char-dwellers speak of 'buying water.' Mouza maps are used to determine the location of plots even under water and when new land emerges and every settlement has an 'amin', a survey fieldworker who knows the location of plots. According to law, land that has been under water for more than thirty years becomes Government owned land (khas) and char people regularly pay taxes for land under water as if it were usable.

286. Stabilization and reclamation of land involves the risk that poor and marginalized farmers lose their land due to development by influential politicians and businessmen. At the same time, more stable land leads to investment and higher productivity, which at the same time leads to increased pollution loading of surface waters including wetlands and rivers.

287. As the river corridor becomes narrower due to channel stabilization, this results in a change in river morphology from a wide, braiding system to a narrower, less braiding one. In the process, riverine habitat important for fish, birds and wildlife will be permanently lost, and this can be mitigated for in only a small degree, e.g. by replanting shore lining vegetation. Some habitats such as gravel islets important as nesting areas for terns, will largely be lost in the subproject area.

288. **Mitigation.** In the development of stabilised and reclaimed land there is a need to ensure against marginalisation of char dwellers and possible land grabbing by elites. Initial indications from a social survey of char dwellers perceptions regarding char stabilisation show that they would welcome char stabilisation, they do not want to leave their chars and would welcome manufacturing/industrial development to provide employment.

289. Land quality of reclaimed lands needs to be assessed for deciding the optimal land use. One method of land quality assessment is Land Zoning and the Ministry of Land is in the process of undertaking Land Zoning for the whole country. Unfortunately, the Jamuna-Padma corridor is one of the last areas to be completed. The rationale behind the exercise is to promote optimal land use, to reduce land degradation by 'improper land use,' to reduce the indiscriminate conversion of agricultural land to other uses and to maintain ecosystem services and biodiversity as much as possible. Land Zoning is a tool for GoB in stimulating, facilitating and regulating the land resources of the country and as such will be important in the land use planning of stabilised and reclaimed land.

290. An assessment of land tenure in the reclaimed land will be required as part of the planning process. However, many authors note the complex nature of land tenure, land administration and management in Bangladesh with Monzur Hossain (2015) saying that the land administration is 'characterised by inefficiency and corruption' and that 'an inappropriate land administration and management system is the root cause of unplanned growth'. USAID (2011) states that 'land rights are insecure in large measure because of an inefficient, expensive, and corruption-prone system of land titling and registration'. Zaman (1996) notes that compliance with donor safeguards is hampered by an inadequate legal framework, the absence of an appropriate institutional framework and often the lack of administrative and political will. CARE (2003) notes that while tenants' rights are enshrined in legislation they are 'almost invariably ignored in practice' and goes on to document the costs of corruption in transferring or securing access to land. This has unfortunately not changed significantly

since and was recently (March 2020) raised by the NEMC on discussions about the SESA for FREMIP.

291. It can be assumed that the development of the stabilised and reclaimed land in the river corridor will be a mix of land uses of agriculture (low, medium and high input), industry (manufacturing/agro-industry/Special Economic Zones), livestock, forestry, fisheries and settlement and therefore the process by which different land uses are selected for different areas needs to be set out. At present this is largely conceptual, but the aim is to set out government's vision against the requirements of different land uses against land in the river corridor.

292. A two-stage process is envisaged:

(i) **Stage 1.** Assessment of suitability of each LSRA (Land Stabilization and Reclamation Area) block for major land uses – SEZ & Settlement, Commercial Agriculture, Medium-scale Supported Agriculture
(ii) **Stage 2.** Planning of development of each LSRA block for the whole range of land uses – as above plus livestock, forestry, aquaculture and low input agriculture

293. The two-stage process allows for the identification of areas most suitable for immediate development where the first stage is a screening stage. This will identify LSRA blocks most suitable for immediate investment and can highlight what infrastructure investments need to be made as well as enabling a phased approach to be planned.

294. The second stage will be the land use planning of each block with areas identified for different land uses. This phase will require a high level of stakeholder consultation.

295. Further detail on land reclamation, land use and the planning process is provided in a FRERMIP Technical Note on Land Reclamation (June 2016).

8.3.7 Fisheries

296. **Impact.** Rapid, large-scale expansion of flood control developments that started in Bangladesh in second half of the 20th century, caused serious concern about its impact on inland fisheries because catches from floodplains began to fall. This triggered studies into the impact of flood control on inland fisheries, including those of the Flood Action Plan (FAP) 17. Some of the main impacts are described below, as well as possible mitigation measures derived from these and other studies that are relevant for and applicable to the current plan/program.

297. **River stabilization.** Channelization or removal of a braided of a river system will or may result in (i) loss of fisheries habitat; (ii) an altered ecosystem, good for deep water fish but unfavourable for shallow water fish; (iii) increased river flow, which may be good for rheophilic (current loving) fish, unfavourable for fish that prefer lower flow velocities; or may be achieved by (iv) dredging which will affect the fisheries ecosystem by destabilizing bottom fisheries, and creating a deeper river bed that may no longer provide a habitat for current biota; dredged materials may destroy potential fisheries habitat. Revetment of riverbanks to contain bank erosion will replace soft fragile aquatic habitat by stable, relatively harder eco-base the precise impact of which will have to be determined but may not be significantly harmful for the fisheries. Construction or rehabilitation of embankments along riverbanks to contain river flooding may result in the loss of river floodplain connectivity affecting floodplain flooding and obstructing fish migration making the floodplain less productive.

298. ***Loss of catch through loss of habitats.*** There will be fisheries habitat loss due to the channelization of the rivers and reduced flooding due to the levee development even with the provision of sluice gates. The habitat loss will result in the reduction of fish catch.

299. ***Reduced biodiversity and migratory fish.*** Flood control has an adverse impact on fish diversity, and comparison of different fish groups shows that there is greater reduction in diversity of migratory fish species than floodplain residents. Fish species that migrate to the floodplain either for breeding or early development will be affected by the loss or reduction of river-floodplain connectivity. Reduced hydrological connectivity across embankment sluice gates reduces lateral fish movements in two ways: first, by reducing the number of fish entry points on to the floodplain and thereby concentrating fish into fewer channels where they are more susceptible to capture, and secondly by closing gates of regulators for extended periods during pre-monsoon and monsoon (high river water levels). Gate closure also blocks the entry of fish hatchlings or fingerlings carried downstream in rivers by passive drift and prevents them reaching nursery areas on floodplains. Even when gates are open, severe hydraulic conditions (current) reduce densities and supply rates in regulated rivers.

300. ***Increased capture at regulators.*** Regulators/fish passes prove to be excellent points to capture fish. Flood control structures are deliberately closed to prevent or hinder the passage of fish, or opened, to facilitate capture. If improperly designed or sited, structures may act as obstacles to passage: for example, some fish may avoid long and narrow passages, where water flow may be too high.

301. ***Agriculture practice.*** Exclusion of external river water under full flood control for increased cultivation of HYV T. aman substantially reduces the options available to mitigate against adverse impacts of fisheries, compared to those available under controlled flooding for deepwater aman cultivation, which leaves the fisheries ecosystem functional.

302. ***Social and economic impacts.*** In case of a reduction of fish production due to flood control, all groups dependent on the fisheries lose income, a cheap source of animal protein and employment opportunities. This affects subsistence, seasonal and professional fishermen, and leaseholders and fish traders.

303. **Mitigation and Compensation.** In addressing adverse impacts of flood control works on fisheries a distinction is required between mitigation and compensation. Compensation measures rely on aquaculture or culture-based methods to increase fish production and thereby compensate for lost tonnage of fish due to flood control. In contrast, mitigation measures are designed to reduce or avoid losses to capture fisheries.

304. Fisheries production loss due to river stabilization interventions cannot be fully mitigated, compensation measures will have to be adopted and fortunately there is ample scope to do it in the planning area.

305. Planned and recommended structural and non-structural fisheries impact mitigation/ compensation measures are described below.

(i) ***Structural Measures*** include the following:
   (a) Development of major distributaries such as the Dhaleswari, Arial Khan and Old Brahmaputra to sustain natural flow to feed adjacent floodplain ecosystems. Measures will need to be taken to increase the flow in the Dhaleswari system to flush the dead ecosystem of Buriganga.
   (b) Spill way canals to provide additional supply floodplains to support the fisheries ecosystems.
   (c) Provision of fish passes along sluice gates that favour fish migration.

(d) Fixing RL of Regulators to maintain flooding of F2-F4 land types[15] to support fisheries ecosystems.
(e) Excavation of canals connecting floodplain will enhance flooding. Excavation of beels will increase beel productivity.
(f) Establishment of Fish/Biodiversity Sanctuaries in the floodplain and, if possible, in rivers (various sanctuaries are proposed – see Appendix C [bird sanctuaries] and Appendix D [fish sanctuaries]).

(ii) ***Non-structural Measures*** that may be applied include:
(a) Fish friendly operation of regulators.
(b) Community based management of fisheries related activities.
(c) Management of fisheries particularly for rational fishing.
(d) Providing training for (a) awareness building and (b) adoption of improved technology.
(e) Extension support for fisheries management and improved aquaculture.
(f) Other measures that may be considered within full flood control and controlled flooding areas, some with a more regional focus, are the following.

306. ***Production of deep water aman and capture fisheries*** contrary to expectations of planners, farmers usually prefer controlled flooding by external rivers for the continued production of deepwater rice rather than attempting to convert to HYV Aman on lowlands prone to rainfall flooding – but this practice is in decline now.

307. ***Habitat rehabilitation and protection*** to reduce the loss of winter and pre-monsoon habitats. Important dry season habitats such as perennial beel and baor in which the magnitude, extent and duration of flooding has been reduced should be rehabilitated by reconnection to original feeder river systems and maintenance of adequate dry season water levels.

308. ***Beel management*** meant to increase survival of fish broodstock during the dry season when vulnerability to over-fishing in flood controlled areas is widespread. This can be achieved by establishment of Fish Sanctuaries, which provides shelter for fish and prevents the most opportunistic fishing methods. Floating buoys along the riverbank have been proposed by for example RMIP to prevent the use of floating nets, and this will reduce pressures on river fish.

309. ***Prohibited fishing zones on regulators.*** Flood control structures that block or delay movements of fish in rivers or canals thereby increasing their susceptibility to capture should be legally declared prohibited fishing zones. Such zones vary depending on size and location of the structure and size and nature of the regulated water course.

310. ***Protection of river (duar) fisheries***. River duar (scour holes) are of great importance as winter refuges for large species of fish, particularly catfish and carp. These sites are intensely fished during the dry season. Fishing during the dry season should be prohibited but requires frequent river patrols by DoE to enforce regulations.

311. ***Conversion of full flood control to partial control.*** In some areas full control and river confinement has resulted in high water levels and responses to cut embankments to reduce flooding. Conversion to a partial control regime would allow for deep water aman and increase fisheries potential.

[15] F2 (medium land (0.9m-1.2m)), F3 (low land (1.2m-3.6m)) and F4 (very low land (> 3.0m)) based on the inundation depth.

312. ***Establishment and/or strengthening local water-user groups*** to represent the full range of sectors affected by modified flooding patterns, including those engaged in capture fisheries. Representatives should form a local committee in association with relevant government departments to establish and run operating procedures of regulatory structures.

8.3.8 Natural Habitats and Wildlife

313. **Impact.** As a result of the river stabilization works, the active river corridor will be narrower and thereby a substantial part of the char lands will disappear. These low-lying lands are, like the entire river system itself, highly dynamic but parts of these provide resting and feeding grounds for wildlife, particularly migratory birds for part of the year, especially in winter (October-March), when water levels are receding, thereby exposing potentially rich feeding areas.

314. Also, the areal extent and diversity of areas with varying water depth (shallow, medium, deep) will be reduced, and thereby this will limit the availability of suitable or preferred habitat for fish, dolphins and other aquatic life.

315. Natural terrestrial habitats will be affected too. Although the riverbank protection and embankment works will require clearing of some vegetation including trees, the main impact here is loss of floodplain habitat, including patches of natural vegetation (reeds, shrub, bush, trees) associated with water fringes, depressions and low-lying areas that may not be flooded or provided with less or no water at all because of the proposed works, and loss of vertical riverbanks that provide breeding habitat for a range of bird species.

316. The level of impact is difficult to predict but is believed to be substantial. It is expected that biodiversity in the impact area will reduce. On the other hand, birds and other wildlife are highly mobile, they usually select those areas for feeding and resting where these is little disturbance and sufficient food. But as the river channel is so dynamic, these change all the time.

317. **Mitigation.** As compensation for natural habitat lost it is advised to establish nature sanctuaries. Two dolphin sanctuaries have been established already near Jamuna Bridge, but it is to be assessed to what extent these are successful, and how these will be affected by the proposed development.

318. Also, the Bangladesh Bird Club (BBC) has developed a couple of years ago a proposal for establishment of two sanctuaries for migratory birds (one north of Jamuna Bridge and the other in the Lower Ganges) and submitted these the DoE, but for various reasons this did not result on formal establishment, so such proposal should be reconsidered and re-submitted. In November 2017 the BBC provided a report on possible locations where bird sanctuaries may be established (Appendix C). The feasibility and possible incorporation of these in the FRERMIP implementation works will be further assessed.

8.3.9 Worker's Camps

319. **Impact.** Construction of riverbank protection and flood control works requires large numbers of labourers. Although some of these are from the immediate surroundings, many of them live far away and are accommodated in worker's camps. Typically, these camps are temporary settlements consisting of basic tents for hundreds of workers and which are located on hired land close to a project office. The camps include basic support facilities such as one or more tube-wells, cooking sites and simple sanitary facilities. The latter particularly may give rise to complaints by nearby residents in the areas concerned, such as is the case in some of the worker's camps already established under FRERMIP. Here people from the surrounding areas complain about a bad smell and unhealthy conditions that

negatively affect their living conditions. Also waste management is of a low standard or absent almost everywhere in these camps, and tube-wells are not or poorly protected.

320. The root cause of the noted problems may be with the Contractors, and their supervisors: although there is an Environmental Management Plan (EMP) enclosed in their contracts they generally show little interest in it and sometimes even do not know what is in it. Although in principal (and per contract) Contractors are to provide minimum sanitary facilities, they merely leave it up to the workers to 'manage' these.

321. As per the ADB guidelines for project management, the project promoter (BWDB) is responsible for establishing and running a Grievance Redress Mechanism (GRM) at each site which require strengthening for effective implementation of Project-2.

322. **Mitigation.** Contractors are to comply with their contract requirements in terms of environmental management, which includes among others the appointment of a full-time Environmental Inspector, improving basic support facilities and waste management.

323. The project promoter is to establish and run a Grievance Redress Mechanism in accordance with agreed obligations.

8.3.10 Ecosystem services

324. **Impact.** The cycle of regular flooding of the floodplains does not only lead to human suffering, but also provides a number of ecosystem services such as replenishment of nutrients (e.g. by deposition of a thin layer of fertile silt in agricultural land), restocking of wetlands (e.g. beels, jeels) with fish and other aquatic species, flushing of pollutants (e.g. agrochemicals flushed out of agricultural land) and groundwater recharging. Receding floodwaters also contribute to the maintaining of water levels in the rivers, and hence add to an overall buffering of water resources. Reducing levels and extent of flooding has highly positive impacts by reducing human suffering and increasing acreages of stable agricultural land, but this comes at the cost of reducing the aforementioned ecosystem services.

325. **Mitigation.** Some of the impacts can be mitigated, for example, by adding regulations and fish-passess, increasing connectivity of distributary rivers with the floodplain, and excavating (some of) the beels. However, a number of ecosystem services will need to be replaced (e.g. more fertilisers used by farmers to replace nutrients deposited as silt), or at a minimum need to be monitored to assess actual impacts as these are difficult to predict (e.g. impact on groundwater recharging).

8.4 Climate Change & Emissions

8.4.1 Climate change

326. Climate change is believed to impact on the river and floodplains in two ways: (i) the discharges in the rivers will increase, which potentially means higher river instability and increased flooding, and (ii) the sea level rise will result in flatter river slopes, potentially leading to more flooding and substantial river adjustment processes. Based on modeling results, discharges in the main rivers are expected to increase between 6 and 15% for moderate and average flood events by 2040 (see PPTA main reports and IWM, 2008). The increase in discharge might be offset by increased water storage for hydro-power generation (outside Bangladesh). Overall there is a risk that inundation depths will increase for the without project scenario. The second potential climate change impact on the sea level is not expected to influence the program area within the design life (30-years). River adjustment processes related to an increase in sea levels work upstream over decades or centuries and do not have a direct impact.

327. The program addresses climate change in several ways: increases in discharge only result in small increases in water levels in the rivers, first due to the vast expanse of the river system and secondly because alluvial rivers can cope with increased discharges by adjusting their bed within a short time (refer for example to the Padma Bridge Study). Higher flow velocities could potentially lead to increased scouring and deeper channels. The embankments are setback from the riverbank. Furthermore, embankment designs follow best international practice providing the opportunity to raise embankments later in response to climate change requirements within the typical construction width applied in Bangladesh. This means that design levels for embankments do not need to be raised (also given the large freeboard). The riverbank protection is built in an adaptive manner which allows adjustments in terms of river depth and location as and when required.

8.4.2 Emissions & implementation of RSP

328. Realization of the RSP along about 400 km of Jamuna and Padma rivers provisionally implies 220 km of new river training works, 1,500 km^2 of land recovery, an approximately 350-m wide navigable channel in the main rivers, 600 km of new flood embankments, and restoration of 5 distributaries.

329. Materials used for these interventions have been decided during earlier feasibility studies and are relatively easy to produce and apply and at low cost, i.e. geotextile bags manually-filled with dredged river sediment (sand) and manually-cast concrete (CC) blocks or grout-filled mattresses above low water level. One of the few alternative materials for the interventions below water would have been hard rock but as this not readily available in Bangladesh this is to be imported from India or Bhutan, adding to cost and GHG emissions. As per BWDB rates, the cost of hard rock is USD137/m^3, compared to USD73/m^3 of CC blocks and USD35/m^3 of (6 x 250kg) sand-filled geotextile bags.

330. Emissions linked to usage of hard rock in revetments are mainly related to mining and transport but are not well researched in Bangladesh. The emissions relating to mining include carbon monoxide, nitrogen oxides, CO_2 and hydrogen sulphide, while transport emissions are associated with moving rock by barges from Assam and surrounding states to Bangladesh.

331. For concrete, about 90% of the mixture by weight is made up of water, sand, stone or gravel, and other ingredients. The process of mining, crushing and combining these ingredients requires relatively little energy: the bulk of the CO_2 embodied in concrete derives from the cement content in the concrete mix. According to Sanal (2018), per tonne of concrete, the cement component leads to 0.35 to 0.91 tonnes of CO_2 emissions, depending on the cement type and mix. The other components of the concrete have a joint emission factor of about 0.22-0.27 tonnes of CO_2. However, the environmental impact of rock mining – apart from CO_2 emissions – are significant. In North-eastern India leads to forest denudation, water depletion and pollution, soil and air pollution, reduction in biodiversity, soil erosion, rock instability, and degradation of agricultural land (Lamare & Singh, 2016). For these reasons it is known that in Assam, geotextile bags are being used despite the presence of hard rock in the area, following a ban on mining to reduce emissions and the pollution of nearby rivers and streams.

332. With regard to the transport of materials, transport by barge – or 'inland waterways vessel' – is an environmentally friendly transport mode compared to trucks on the road. Various studies (Pillot, Guiot, Le Cottier, Perret, & Tassel, 2016) with barges using a pusher tug give CO_2 emissions of between 30 and 60 kg per km, for cargo loads between 2,700 and 4,000 tonnes. This corresponds to about 13 gCO_2 emissions per tonne of cargo. ECTA (2011) uses a slightly higher figure of 18.1 gCO_2 per tonne-km for downstream transport, however this is based on a 50% load factor only. For transport from Assam to Bangladesh,

the transport is in downstream direction, with the vessels likely to return empty. Using heavy 40-44 tonne trucks with a near-full load, the carbon emission factor is 39.7 gCO_2 per tonne per km (ECTA, 2011). Note that all these figures are based on international data and the use of outdated vessels or vehicles may lead to higher emissions. In all cases the final emissions calculation will also depend on the use of the transport mode in the opposite direction: if the vessel or vehicle returns empty, higher emissions have to be assigned to the one-way transport.

333. A key difference between the use of concrete blocks versus geotextile bags is the volume and weight of transportable cargo. As the geotextile bag containers are hydraulically filled with sand at or near the site prior to placement, only the containers themselves will need to be transported. Therefore, for concrete blocks the number of trips and/or the cargo load per trip will be significantly higher, with resulting higher emissions.

334. An analysis of the energy demand for a design using geotextile bags only underwater with concrete blocks above low water level, and another using concrete blocks throughout, showed that the option with geotextile bags was responsible for between 14 and 41 GJ per linear meter of works compared to 184 GJ per linear meter for the option with concrete blocks only (Zellweger, 2007). This considered the production of cement and geotextile from the raw materials and the transport of this and other associated materials including sand and shingle to site. In reality, concrete blocks alone are also not viable technically as they are liable to fail through winnowing between the blocks and steepening of launched slopes over time.

335. By equating these emissions to the construction materials required for 1km of underwater protection using a geotextile bags only, or another using a mix of concrete blocks and geotextile bags as have currently been proposed for BWDB projects, estimates of emissions for the production of each of the elements can be developed. However, emissions related to construction and construction materials are in general not well researched in Bangladesh. The one study found was carried out in BUET and assessed CO_2 emissions of different mixes of concrete. It estimates that a 1:3:6 cement: sand: brick aggregate mix is responsible for approximately 1.08 kg CO_2/ kg of concrete or 10392 g CO_2/cft (Islam and Tofa, 2015). In contrast, a study looking at geotextile emissions not specific to Bangladesh suggested that emissions were in the order of 2.35 tonnes CO_2 per tonne of geotextile (Raja et al., 2015). These estimates do not relate to the emissions during construction, which are likely to be comparatively smaller and show that the CO_2 emissions for geotextile bags alone are approximately 959,200 kg CO_2 per km of riverbank protection, about one third of that of concrete blocks if using brick aggregate (approximately 2,974,000 kg CO_2 per km). These estimates are indicative only and reliant on only single studies and therefore should be subject to more scientific research.

336. Further environmental considerations relate to the long-term performance of geotextile bags against concrete blocks or hard rock. The design life of geotextile bags underwater is sometimes assumed to be 30 years based on the economic life on the project, but in reality, this is likely to be significantly longer as long as the bags are not exposed to ultraviolet light. In reality often they are covered either with sediment or biological growth. Geotextile bags dumped in 2004 under the JMREMP project continue to function, and further study is proposed estimate whether there has been any decomposition of the material in the bags over time in addition to accelerated aging tests on the geotextile. Any biological growth on the bags is likely to reduce this decomposition significantly by binding the materials. Although the extent and the timescale of long-term degradation of the bags would likely result in some micro-plastic pollution in the river, their use remains positive, from an environmental perspective, compared to concrete blocks or rocks. This should continue to be reviewed during the design of the River Stabilisation Plan when determining the type of

materials to be used both above and below the low water level and the final locations of the proposed works.

8.5 Cumulative & Induced Impacts

337. Cumulative impacts can be defined as the additional changes caused by a proposed development in conjunction with other similar developments or as the combined effect of a set of developments, taken together. Induced impacts include both direct and indirect impacts. These cumulative and induced impacts include the following:

338. ***Flood affected area.*** Upstream (transboundary) water diversion schemes to transfer water from the Jamuna/Brahmaputra Basin to water-scarce regions in India, and other planned or existing development, may reduce river discharge in the medium/long-term significantly and could thereby affect the flood affected area in the study area. This may require other or additional interventions to reduce negative impacts. Dams that store floodwater and discharge this during the dry season may alter the hydrograph.

339. ***Downstream flood risk*** constructing flood embankments on the flood plains along the (stabilised) banks will reduce the respective risk behind these dikes but will further increase the flood water levels, when no additional flood conveyance compensation is being realised. This effect is evident in the initial stages, but also in the long-term when cumulative effects are felt leading to bed degradation, and flood levels may still rise for extreme floods.

340. ***River morphology & risk of breaching.*** The cumulative effect of the envisaged works will be beneficial in controlling further erosion and flooding of the river system's floodplains and displacement of hundreds of thousands of people. Channel flows will be controlled by the structures installed and it is likely that these will maintain greater depth and flow velocities. This would increase stability of the channels and reduce the risk of raised riverbeds. On the other hand, stabilized river channels may lower low water levels both in Bangladesh and India and reduce dry season inflow to distributaries, causing regional or local water shortage. The works will increase the security of existing flood embankments against breaching and may promote expansion of new embankments into presently un-protected sections of the floodplain.

341. ***Aquatic biodiversity.*** Experience from other countries (People's Republic of China: Yellow River, USA: Mississippi) and in Bangladesh learns that cumulative impacts of river stabilization works on aquatic biodiversity will generally be negative. 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.

8.6 Summary of Main Anticipated Impacts & Mitigation Measures per Project-2 Project Site

8.6.1 JRB-1

342. Riverbank protection work will be placed alongside the riverbank in the same manner as earlier works without impacting much on land and water habitat. Land acquisition and resettlement activities are less than during Tranche-1. On average, it is assumed that a strip of approximately 50m to 100m width will be acquired alongside the whole length of the riverbank protection works.

343. For the flood embankment, a full land-acquisition and resettlement process will be conducted. However, the flood embankment alignment has been chosen to reduce the impact on existing settlements and therefore minimizing the resettlement impact.

344. In terms of environmental enhancement, different measures are planned:

(i) Along all protected riverbanks navigation buoys will be suggested to BIWTA/DoF (Department of Fisheries) to place with kilometer spacing to protect fish habitats from systematic overfishing with floating nets. BWDB will provide necessary data to DOF & BIWTA for the purpose[16].
(ii) Two (2) regulators with fish passes are to be installed to improve connectivity and facilitate fish migration.
(iii) Both the landward and riverside slopes of the embankment may be planted with Vetiver, Katkin & Dhoincha for slope protection as well as to help re-establishing a diverse vegetation cover.
(iv) The riverside slope of the embankments shall be covered with resilient grass (e.g. katkin / *Saccharum spontaneum*) suitable to provide limited wave protection, where no full wave protection shall be required.
(v) Two regulators with fish passes will be constructed to assure connectivity between the main river and the floodplain.
(vi) Bird-, dolphin- and/or fish sanctuaries will or may be established at appropriate locations.

8.6.2 JLB-2

345. The land acquisition and resettlement alongside riverbank protection works follows established principles and is summarized under subproject JRB-1.

346. The potential acquisition of land for embankment work on the char will be discussed with local stakeholders, as char ownership and delineation of plots is different from the ownership on the floodplains, which can be well defined geographically. The program fully acknowledges that no embankment lines have been established on chars yet and consequently this first work requires intensive stakeholder discussion. Typically, the land used alongside the protection char banks would be in the order of 250m wide, and contain the slope protection above low water level, a berm and the embankment.

347. In other locations, land acquisition and resettlement impact is not expected as most work takes place in the river channel and in flood spill channels on the char.

348. Environmental mitigation and enhancement measures follow the same principles as applied to the upstream works at JRB-1. In addition to the typical works alongside the floodplains, the around 100m wide strip between the protected riverbank and the embankment on the char shall be covered with dhoicha, katkin, vetiver or any other plant helpful for reclamation to combine a technical function with income generation and environmental enhancement. The thick layer of reeds provides habitat while dampening the wave impact on the embankment.

349. As an additional measure, ten 10 regulators with fish passes are to be installed to improve connectivity and facilitate fish migration.

[16] Installing navigation buoys in support of fishreies will be an innovative approach for Bangladesh, and neither DoF nor the BIWTA has any experience to do such work and may need to recruit expertise for this purpose.

8.6.3 PLB-1

350. Around 8.5 km of wave protection to complete underwater protection built under Tranche 1 at PLB-1 (Harirampur). Riverbank protection work will be placed alongside the riverbank in the same manner as earlier works without impacting much on land and water habitat. On average, it is assumed that a strip of approximately 50m to 100m width will be acquired alongside the whole length of the riverbank protection works.

351. Environmental mitigation and enhancement measures follow the same principles as applied to the upstream works at JRB-1 and JLB-2. In addition to the typical works alongside the floodplains, the around 100m wide strip between the protected riverbank and the embankment on the char shall be covered with dhoincha, katkin, vetiver or any other plant helpful for reclamation and to provide habitat.

Two (2) regulators (1 regulators with fish-passes and 1 with fishpass cum boatpass) are planned to be installed (during Project-2) to improve connectivity and facilitate fish migration. including 4 regulators (drainage only) installed during Tranche-1.

8.6.4 Impact of Tranche-1 and JMREMP Intervention

352. JMREMP built 17 km of bank protection work at right bank of lower Jamuna from Koitola to Koijhuri. Almost full length of these bank protective work is in good condition. There is a big local bazar named Nakalia bazar which was under tremendous threat of erosion is now substantially protected by the bank protection work. So, the control of erosion ensured the settlement living along the river side and trading sites resulting poverty reduction and enhancement of socio-economic status of the local people. The JMREMP bank protection work also provide additional domestic use of river water as the protection work have the flexible under water works (geo-bags).

353. In the contrary important bank protective work have been constructed under Tranche-1 at Chauhali and Harirampur. In both the cases late construction after the 2015 flood season has resulted in less desirable river alignment as the eroding channel had cut deeply into the floodplains with higher than expected land loss creating an insecure situation of the local people. The Embankment planned for Tranche-1 is completed by March 2020, and the impact of embankment construction is yet to be fully experienced.

9 GRIEVANCE REDRESS MECHANISM

9.1 Tranche-1 Experience

354. Key Tranche-1 experiences are summarized below, both for social and environmental aspects.

9.1.1 Social

355. There was in incidence whereby the upper slope of the works was cut back before the resettlement plan had been implemented, which meant that houses were removed before the land had been acquired. This is against regulations and is of course unacceptable.

356. The principle of temporary protection in the first years was developed during Tranche 1 to allow geotextile bags to be placed on the natural bank level in the first year while underwater dumping occurs and then hard protection, which requires a shallower slope to be placed a year later, when land acquisition has been completed. This technique also allows emergency or critical work to be implemented without being subject to delays due to land acquisition.

357. Land acquisition delays for the embankment and in particular for the approach and exit channels of the new regulators in Tranche 1, resulted in delays in construction and regulators not being operational during the 2019 flood season despite being completed. Starting the land acquisition process as soon as possible allows the land up to riverbank level to be demarked as BWDB land and stopping people settling there would greatly improve the effectiveness of Project-2 embankment construction.

358. Due to fund shortages, some of the social plans, such as resettlement villages for squatters, could not be implemented. These should be prioritised in Project-2 as they are a key part of for displaced persons to find a new hold in society.

9.1.2 Environmental

359. A systematic long-term fish study was carried out under FRERMIP Tranche 1 which found new types of fish and fish behavioural patterns in the study / project area. More research on the aquatic habitat in future is recommended to better understand the effects of the works and to optimise these where possible

360. With some monitoring, in most cases Contractors were following the minimum environmental standards as per their environmental management plan. The main issues that required improvement were dust levels and so a greater focus on dust suppression e.g. through water spraying should be given in Project-2.

9.2 ADB's Guidance on GRM

361. According to the ADB Safeguard Policy Statement (2009)[17] on the Local Grievance Redress Mechanism: "ADB requires that the borrower/client establish and maintain a grievance redress mechanism to receive and facilitate resolution of affected peoples' concerns and grievances about the borrower's/client's social and environmental performance at project level. The grievance redress mechanism should be scaled to the risks and impacts of the project. It should address affected people's concerns and complaints promptly, using an understandable and transparent process that is gender responsive, culturally appropriate, and readily accessible to all segments of the affected people."

362. The EARF provides the general guidance on GRM establishment and operation, and states among others: "The BWDB will determine a suitable grievance redress mechanism to address concerns related to environmental and social safeguards. The grievance redress system will include a system by which parties affected by project activities, could raise their concerns to contractors, relevant government officials, and officers of the BWDB."

363. Stakeholders with concerns have the option of contacting community-based organizations formed during implementation; the upazila chairman's office; and/or the local BWDB divisional office. Stakeholders may present complaints verbally or in writing. Complaints received will be logged and documented. Complaints received by community-based organizations (CBO) will either be promptly resolved locally if possible or referred to the upazila chairman's office. Similarly, at this level complaints will be promptly resolved or referred to the local BWDB section office (sub-project management office). If not resolved at this level the complaints will be forwarded to the Grievance Redress Committee (GRC) – see Figure 9-1.

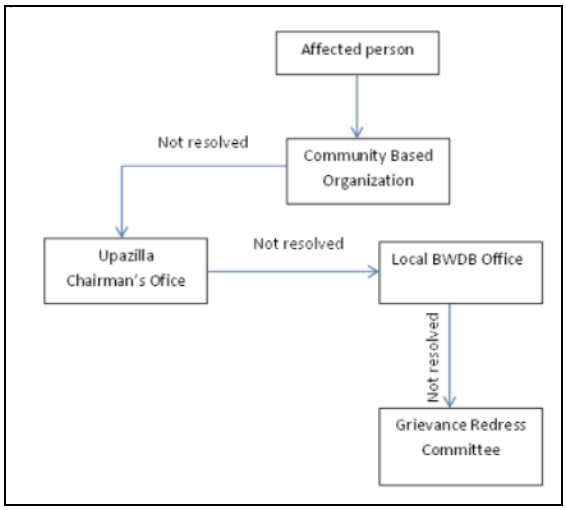


Figure 9-1. Proposed resolution of complaints

364. A GRC will be established including representatives of government, BWDB, affected persons and others as maybe considered necessary. The GRC should establish a procedure on how complaints will be received and resolved, and have regular meetings to discuss and resolve complaints. The meetings are to be open to the public, and decisions will be recorded and distributed among those present. All records of the GRC meetings and how grievances were addressed will be maintained by the respective section office, and the public will have access to these records. When obtaining the information from the

[17] Asian Development Bank (2009) - Safeguard Policy Statement. Policy Paper. June 2009. 92 pp.

complainant, either in verbal or written form, the receiving party should complete a Grievance Action Form (GAF).

365. At a minimum, the information to be recorded in this form will include (i) basic information about the affected person (name, address, contact number); (ii) category of grievance filed (legal, social, environmental, technical/engineering, financial, etc.); (iii) detailed description of grievance; and (iv) type of action taken. The GAF will be filled out by the person receiving a grievance and signed by the affected party and the receiver of the complaint. The affected party will receive a copy signed by both. Each sub-project management office will have on display a sign/notice board providing the public on the contact details of staff responsible for registering complaints.

9.3 GRM Implementation

366. For implementation of the GRM it is proposed to assign two national GRM specialists, one female and one male, who regularly visit the Project-2 implementation sites, consult with the local communities and site office staff (Supervising Consultant and Contractor), and who report on their findings on a quarterly basis. Their tasks and responsibilities are as follows:

(i) Familiarize with the Project-2 works, the EARF and the EIA for the works, and main project parties (BWDB/PMO, ISPMC, site office staff and contractors, communities, CBOs, upazila chairman's office, etc.);
(ii) Setting up a formal local complaint mechanism including a simple Modus Operandum (manual) with standard Grievance Action Form (GAF), routing and filing system, and how to ensure public access;
(iii) Facilitating the establishment of local Grievance Complaint Committees and a procedure on how complaints will be received and resolved, record keeping, and reporting;
(iv) Quarterly Progress Reporting in a format agreed with the BWDB and the development partner ADB .

367. Both GRM Specialists are to be appointed at the start of and for the duration of the entire the Project-2 contract – their approximate time input is estimated at on average one (1) person-month per quarter during the construction seasons (November-June), although establishing the GRCs at the start of the Project-2 works is expected to require initially a near fulltime input.