Environmental Impact Assessment (Draft)

February 2014

Bangladesh: Flood and Riverbank Erosion Risk Management Investment Program

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

CURRENCY EQUIVALENTS

(as of 18 February 2014)

Currency unit	–	taka (Tk)
Tk1.00	=	$77.62500
$1.00	=	Tk0.012882

ABBREVIATIONS

ADB	–	Asian Development Bank
BWDB	–	Bangladesh Water Development Board
DDM	–	Department of Disaster Management
DPP	–	development project proforma/proposal
GOB	–	Government of Bangladesh
MFF	–	multitranche financing facility
NGO	–	nongovernment organization
O&M	–	operation and maintenance
PMO	–	project management office

GLOSSARY

Char	–	tentatively emerged islands in rivers
Upazila	–	administrative unit under a district
Union	–	administrative unit under a upazila

NOTES

(i) The fiscal year (FY) of the Government of Bangladesh ends on 30 June. “FY” before a calendar year denotes the year in which the fiscal year ends, e.g., FY2013 ends on 30 June 2013.

(ii) In this report, “$” refers to US dollars

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Abbreviations and 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
CC	Pre-cast concrete
CEGIS	Centre for Environment and Geographical Information Systems
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
ECAs	Ecologically critical area
EIA	Environmental impact statement
EOP	Environment-on-project
EMP	Environmental management plan
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
FRERMIP	Flood and Riverbank Erosion Risk Management Investment Program
FW	Future-with-project
FWO	Future-without-project
GRC	Grievance Redress Committee
GPA	Guidelines for Project Assessment
IEE	Initial environmental examination
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
JVT	Joint Verification Team
MFF	Multi-tranche financing facility
MPO	Master Planning Organization
NGO	Non-governmental organization
NWRD	National Water Resources Database
PC	Public consultation
PMBP	Padma Multipurpose Bridge Project
PMO	Project Management Office
PPTA	Project preparation technical assistance
PWD	Public Works Department (denotes survey datum)
RCC	Reinforced cast concrete
SRDI	Soils Resources Development Institute
UNEP	United Nations Environment Programme
WARPO	Water Resources Planning Organization

Glossary

Bengali terms and place names

Aman	Rice planted in Kharif and harvested in Rabi
Aus	Rice planted and harvested in Kharif
Beel	Seasonal or perennial water body located in low-lying area of the floodplain
Boro	Rice planted in Rabi and harvested in Kharif
Brahmaputra, Jamuna, Ganges, Padma	In northwestern Bangladesh, the Brahmaputra changes name to Jamuna at its confluence with the much smaller Teesta. Further downstream, the Jamuna and Ganges flow together to create the Padma. Flood and Riverbank Erosion Risk Management Investment Program (FRERMIP) covers 60 km of the Jamuna, 20 km of the Ganges, and the entire 100 km of the Padma.
Jhupri	With reference to housing, construction of mud walls, earth floor, thatch or CI sheetroof.
Kutcha	With reference to housing, construction of wood, bamboo, and other local materials
Khal	Channel
Kharif	Monsoon season; in Bangladesh, generally Mar-Oct
Kum	Deep areas of water bodies eg river scours, used by fish as shelter areas
Mauza	Jurisdictional unit without administrative offices, upazila subunit
Pukka	With reference to housing, construction entirely of concrete, cement, and iron.
Rabi	Winter season; in Bangladesh, generally Nov-Feb
Upazila	Administrative unit, district subunit

English terms

Flood land type classification	*Definition 1:* The flood land types (F0 to F4) defined by Master Plan Organization classify agricultural land in terms of the normal flooding characteristics that drive farmer choice of rice variety for a particular location: by *three-day duration* flood depth in the *1:2 year return period* flood event.[1] Land that remains flooded for three days or more to a maximum depth of 0-30 cm is classified F0 "flood free." Land that floods 30-90 cm is classified F1, 90-180 cm F2, 180-300 cm F3, and over 300 cm F4. Within a given area, the F0-F4 values *do not* vary from year to year. They *can* however change in response to interventions that modify flood hydrology eg. flood embankments, drainage enhancements. *Definition 2:* The land type designators F0-F4 are used by Bangladesh flood

[1]Master Plan Organization (MPO). 1987. "Agricultural Production System". Technical Report No. 14.Dhaka.

modellers to refer to the amount of land that floods *instantaneously* to the requisite depth interval in a numerical model of a *flood event of any return period.* In this formulation (which is conceptually different from and fundamentally incompatible with MPO's), the F0-F4 areas vary with return period; and, for the 1:2 year classification, the modeling classification, relative to the MPO values, may be biased towards deeper flooding given that it uses a less stringent flood duration criterion (instantaneous rather than three-day).

Revetment Generally, retaining wall or facing of masonry or other material, supporting or protecting a rampart, wall, embankment, etc. Specifically in this context, erosion-resistant materials placed directly on a streambank to protect the bank from erosion.

Executive Summary

Introduction

This report presents the findings of an Environmental Impact Assessment (EIA) carried out under the ADB project preparation technical assistance (PPTA) *Main River Flood and Bank Erosion Risk Management Program* (PPTA No. 8054 BAN). This EIA assesses the three Subprojects proposed for inclusion in Tranche 1 of ADB the Flood and Riverbank Erosion Risk Management Investment Program (FRERMIP, Project No. 44167-013). FRERMIP is a proposed Asian Development Bank (ADB)-funded multi-tranche 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.

Program outputs 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. The MFF would provide a loaned amount of approximately US$250 million in three tranches beginning in mid-2014 and concluding in mid-2023. The initial Tranche-1 receives external financing of US$ 75 million for total project cost of US$ 104 million.

Tranche 1 meets criteria for GOB environment category Red, and has been classified ADB environment category A. Environmental safeguards required by GOB and ADB for Tranche 1 are addressed by this EIA. The required environmental safeguards for Tranches 2 and 3 are set forth in a separate Environmental Assessment and Review Framework (EARF) document.

Critical Facts

The Context - FRERMIP

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 plans to move to more systematic riverbank stabilization, potentially leading towards river-reach stabilization during later tranches. The stabilization approach will make use of the currently ongoing consolidation of the river morphology developing towards a more accentuated channel pattern similar to the one observed in the 1970s, before the dramatic widening (from the 1970s to 2000s) took place. In parallel existing, degraded or eroded embankment lines, such as the Brahmaputra Right Embankment 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 residucal risk, for example if existing embankments unexpectedly breach.

[2] The MFF FRERMIP consists of three individual loans for three individual, 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.

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, river banks 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 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 will be planned 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 (etc) and (iii) increased agricultural production on less-flooded agricultural land.

The Assessed Project

The assessed Project is the proposed Tranche 1 of the MFF. Tranche 1 consists of three Subprojects: Jamuna Right Bank 1 (JRB-1), Jamuna Left Bank 2 (JLB-2), and Padma Left Bank 1 (PLB-1). JLB-2 and PLB-1 physical works consist of riverbank-erosion protection works along critically eroding areas. JRB-1 consists of very limited riverbank-erosion protection works in support of existing works and the restoration of degraded and eroded flood embankments, specifically a section of the Brahmaputra Right Embankment. Flood embankments will also be rehabilitated behind the JLB-2 and PLB-1 erosion protection works, but not until Tranche 2. These embankments do not meet ADB criteria for "associated facilities" of Tranche 1 and therefore are not included in this EIA analysis.

Significant Findings

JRB-1 Flood Embankment Potential Impacts

JRB-1 includes for a new/restored (10 km section of Brahmaputra Right Embankment destroyed in the mid-1990s) and rehabilitated flood embankments. The embankment will reduce flood depth and duration so as to reduce flood damage to crops and infrastructure, and to induce greater economic investment and productivity in floodplain agriculture and other activities by reducing flood risk.Currently, JRB-1 seasonally flooded land (i.e. within the proposed flood-protected area) consists of 12,000 ha that is flooded to 120-360 cm (F3 land type) and 4,000 ha that is deeply flooded to >360 cm (F4 land type). Of this, JRB-1 will transform about 40 per cent (6,600 ha) to flood-free conditions (F0 land type, 0-30 cm). Another 10 per cent (1900 ha) will be converted to moderately-flooded conditions (F1 and F2 land types, 30-120 cm). These hydrologic changes within the proposed JRB-1 flood-protected area have numerous potential secondary impacts. Intended beneficial impacts are significantly reduced flood damage to agriculture and infrastructure; increased cultivated area and cropping intensity; and the resulting increases in agriculture / aquaculture production.

Several negative impacts may occur without mitigation measures. Floodplain aquatic (wetland) habitats will be degraded or extirpated due to reduced flooded area, depth, and duration (mentioned above); reduced hydrologic connectivity; and physiochemical / water quality changes.

[3] The feasibility study of Capital Dredging and Sustainable River Management in Bangladesh currently investigates one single and and one multiple-channel option for Jamuna and Padma as first step towards the development of a river stabilization plan. The final report is expected in early 2014. Building on the Capital Dredging study and the initial morphological assessment of potential future channel patterns conducted as part of this feasibility study, the FRERMIP will conduct a comprehensive river stabilization plan to identify potential stabilization solutions, to be implemented in an adaptive and phased manner, with minimal impacts on the river and char environment.

This in turn will adversely affect floodplain-dependent openwater fish species migration, population levels, and catch levels, as well as wetland biodiversity, services, and products more generally. These impacts can in turn adversely affect the nutrition, health, and economic status of poor people. The embankment can impede cross-drainage resulting in drainage congestion, adversely affecting agriculture within the protected area, and block the movement of migrating fish.

The assessed status of fish migration in the study area is moderate to poor. The restored embankment forsees regulator rehabilitation and a number of additional regulators, allowing for all-year round flow in internal rivers and khals, such as the Hurashagar including certain limited flooding in places where distributaries branch off the main river. In addition, the more concentrated fish migration route through tributaries and distributaries (Hurashagar/Baral and Karatoya will be left unregulated.

Flood-control-led expansion of high-yielding varieties (HYVs) may increase utilization of ground water and surface water 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. 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. The sandy subsoil strata have generally high permeability, which reduces the risk of general groundwater depletion. In addition the embankment is left open to the Karatoya River during Tranche-1, which allows for periodic flooding.

Provision of embankment flood protection typically stimulates accelerated investment in the protected area. This project-induced investment has obvious economic benefits but paradoxically it also has less obvious costs: over time, an increasing amount of infrastructure, and potentially an increasing number of lives, come to be located in lower-lying areas compared to the without-project situation. Embankments can greatly reduce but not entirely eliminate the flood risk to such areas, as embankments can fail for various operational, hydrologic, hydraulic, and geotechnical reasons. Best-practice flood damage reduction assessment methodologies take this phenomenon into account, such as planned under the community-based flood risk management component that addresses the residual risk and increases resilience and preparedness.

JRB-1, JLB-2, and PLB-1 Riverbank Protection Works Potential Impacts

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, e.g. fishing with floating nets during the dry season.

Riverbank protection works at the three subproject sites has the purpose of protecting the existing floodplain habitat from continuous and systematic erosion. While the protection at the JRB-1 extends existing 10km long protection by 1km, new, several kilometer long riverbank protection at JLB-2 and PLB-1 is designed to protect valuable infrastructure and land from imminent erosion.

Riverbank protection works has 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 displaces 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, etc), including flood embankment breaches.

An additional *indirect* or *conditional* benefit of erosion protection and channel stabilization works is achieved when such works are located in front of an existing or prospective flood embankment: stabilization of the impacts of that embankment. In particular, erosion protection works secure (decreases risks to) the economic benefits of embankment flood protection, thereby making them available to justify the costs of the erosion protection and embankment physical works construction, rehabilitation, and maintenance. This erosion protection impact is deemed indirect or conditional because its valence and magnitude is entirely dependent on, and can be evaluated only with reference to, the valence and magnitude of the impacts of the associated flood protection embankment.

River changes associated with Tranch 1 riverbank protection work were assessed through a specific morphology study carried out as part of this PPTA. The morphology study concludes that the initial (Tranche-1) riverbank protection works has little impact on the overall morphology of the Jamuna, including the immediate downstream areas. In all cases the work invites 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-symetric 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, which is expected to remain stable without riverbank protection at both sides. Downstream, the river exhibits two channels, enclosing a large char. The initial 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 the two-channel solution appears to be the best in the long run, also meaning that the existing conditions would not be altered and the riverbank protection would support the currently existing natural river pattern.

First studies on the interaction of riverbank protection works with the environment have been conducted in 2007 and 2011[4]. 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

[4] 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 Geob-Bags Under Water; earlier the JMREMP design include an EIA and obtained environmental clearance from Government before starting the construction of geotextile bag revetments.

blocks tend to attrackt larger fish, specifically carnivores, but fewer numbers, while geobags, having more but smaller voids, attract smaller fish in larger numbers. CEGIS, 2011 identified overall positive impacts of geotextile bag revetements 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 scocio-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[5] 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 geobag 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 geobag use under water, it might be concluded that compared with CC block use alone, geo-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 Tranche 1 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 between the Tranche 1 influence area and India cannot be ruled out. Localized stable and deeper channels in front of Tranche-1 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.

Land Acquisition, Resettlement, and Construction Impacts

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

Routine impacts of construction-phase activitieswill 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

Two rounds of public consultation were undertaken during preparation of this EIA. The first presented the proposed project and EIA terms of reference to stakeholders for their review and suggestions, and the second presentedthe draft EIA results to stakeholders for their comments. Stakeholder concerns are of at most moderate significant, and are resolvable through continued dialogue and accommodation during design and implementation.

Recommended Actions

Overview

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

Mitigation of the aforementioned impacts is complex and challenging. It will not result in all residual impacts being reduced to insignificance, but it will reduce them to levels considered acceptable under the circumstances. To the extent possible, impacts will be mitigated through measures purpose-designed to the impact and setting. Many mitigation measures have been aggressively mainstreamed into the engineering designs, which also incorporate significant impact avoidance features e.g. leaving distributaries open and embankment afforestation.

Recognizing potential cumulative effects when moving from emergency type riverbank protection during an initial tranche towards more systematic river stabilization in the priority reaches during following tranches, the first tranche will incorporate 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 ongoing Wetland Biodiversity Rehabilitation Project of GIZ /Department of Fisheries/BWDB, currently under implementation in areas of Pabna adjacent to the JRB-1 project area..

- *Impacts on openwater fish biodiversity and production.* Measures to mitigate these impacts (i) include openwater fisheries-related measures 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 are documented in Final Report, Annex J1 Resettlement Framework, and Annex J2, Resettlement Plan for Tranche 1.

The EMP will be implemented by the Project Management Unit supported by an Institutional Strengthening and Project Management Consultant (ISPMC) team that will include an environment specialist, as well as an implementing NGO and a separately hired specialist environmental management organization outlinng the establishment of a biodiversity sanctuary 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.

Future Mitiagtion Measures – Preparing for Tranche-2 and 3

While the tranche-1 project consists of limited riverbank protection measures and the restoration/rehabiliation of an eroded/degraded embankment, future tranches plan to extend these measures. The limited and isolated riverbank protection measures of Tanche-1 do not change the existing channel pattern, as established by the morphological study. However, follow-on tranches, part of the total program, could do so when existing, initial work gets extended over greater length

of some ten kilometers. As such, the proposed Tranche-1 combines construction measures with very limited morphological impact with two extensive studies on (i) potential ways towards larger river-reach stabilization and (ii) the establishment of a river sanctuary.

Potential alternative river-reach stabilization alternatives, impacts, and mitigation measures will be assessed during Tranche-1 through several systematic studies. During the first two years of Tranche-1 a systematic river stabilization study will be conducted. The river stabilization study will build on the ongoing natural development towards a more consolidated channel pattern. Alternative solutions will be developed how to support this channel pattern towards a more systematic stabilization of the lives on the floodplain. Social and environmental consideratiosn will form an integral part of the study in order to determine the impacts of different stabilization options, but also collect missing data and broaden the understanding about critical social and environmental parameters. The study results are alternative solutions for river-reach stabilization that accounts for the multitude of different drivers, outline least-impact solutions, identify the optimimal alternative, and design the following tranche work.

Starting from there, the feasibility study for tranche-1, continaing environmental assessment, will be supplanted by by a specialist sanctuary study that details the requirements for a river sanctuary in response to negative impacts from river stabilization. The sanctuary study is part of the Tranche-1 design and scheduled for implementation during year-3 and 4. It will specifically address impacts on critical habitats and trans-boundary/internationally migrating/threatened species, following (i) the Padma Bridge Project terms of reference for biodiversity baseline studies and monitoring, and a biodiversity sanctuary; and (ii) India's recently-promulgated Dolphin conservation action plan, as well as (iii) assessing migratory bird impacts. It will also attempt to develop measures that enhance the river biodiversity, specifically providing sheltered aquatic habitats.

The EIA for Tranche-2, part of the feasibility study, continues to aggressively mainstream environmental aspects into the project design. In addition, the EIA will follow a parallel approach by building on the river stabiliuzation plan and the sancturary study, to (i) address remaining uncertainties associated with the database on the impacts of riverbank protection on the river habitat, while (ii) continuing to reduce the imminent erosion risk to the livelihoods of a large number of mostly poor people on the floodplain.

Design- and Implementation-Phase Public Consultation

Stakeholder consultation will continue during subproject design and implementation to provide information to stakeholders about the project and to receive their input and concerns.Meetings will include in particular 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

At each Tranche 1 subproject location, a local Grievance Redress Committee (GRC) will be set up during the design stage and continue in operation through the implementation phase. Each GRC will consist of a BWDB representative, the concerned Union Parishad chairperson(s), and a representative of resettlement-affected persons for subprojects with resettlement. GRCs will resolve grievances within one month of receipt. Aggrieved personsare free to access the country's legal

system regardless of GRC involvement. In addition, a Joint Verification Team (JVT) is responsible to address complaints related to the land acquisition process.

Reporting and Monitoring

Environmental monitoring reports will be issued for bi-annually disclosure on ADB's website. The environmental monitoring reports will also be incorporated into the December 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 officer with the help of the consulting team's environmental specialist.

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.

1. Introduction

1.1 Overview

1. The project area of the Flood and Riverbank Erosion Risk Management Investment Program (FRERMIP)comprises about 2,44,000 ha of which approximately 13 percent are occupied by rivers and a very minor percentage (approximately 0.6 percent) is occupied by other water bodies. The hydrology of the area is dominated by the three major rivers, the Jamuna, the Ganges and the Padma.

2. FRERMIPis an Asian Development Bank (ADB) multi-tranche financing facility (MFF) being prepared in partnership with the Government of Bangladesh (GOB). It aims to sustain incomes and livelihoods of people living along the three main rivers of Bangladesh – the Jamuna, the Ganges, and the Padma – by enhancing resilience to flood and riverbank erosion. Project outputs 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. The MFF would provide a maximum loaned amount of approximately US$250 million over a nine-year period in three tranches of USD60 million, USD100 million, and USD90 million respectively.

3. This report presents the findings of an Environmental Impact Assessment (EIA) of the three Subprojects proposed for inclusion in Tranche 1: Jamuna Right Bank (JRB) 1, Jamuna Left Bank (JLB) 2, and Padma Left Bank (PLB) 1.

4. A companion document, the Environmental Assessment and Review Framework (EARF) sets forth (i) the safeguards procedures to be followed during subsequent MFF tranches, (ii) safeguards-related criteria to be considered in the selection of subprojects for subsequent tranches, and, with regard to Executing Agency safeguards capacity, (iii) an assessment and recommendations for appropriate institutional strengthening.

5. The EIA and EARF 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).

1.2 Objectives

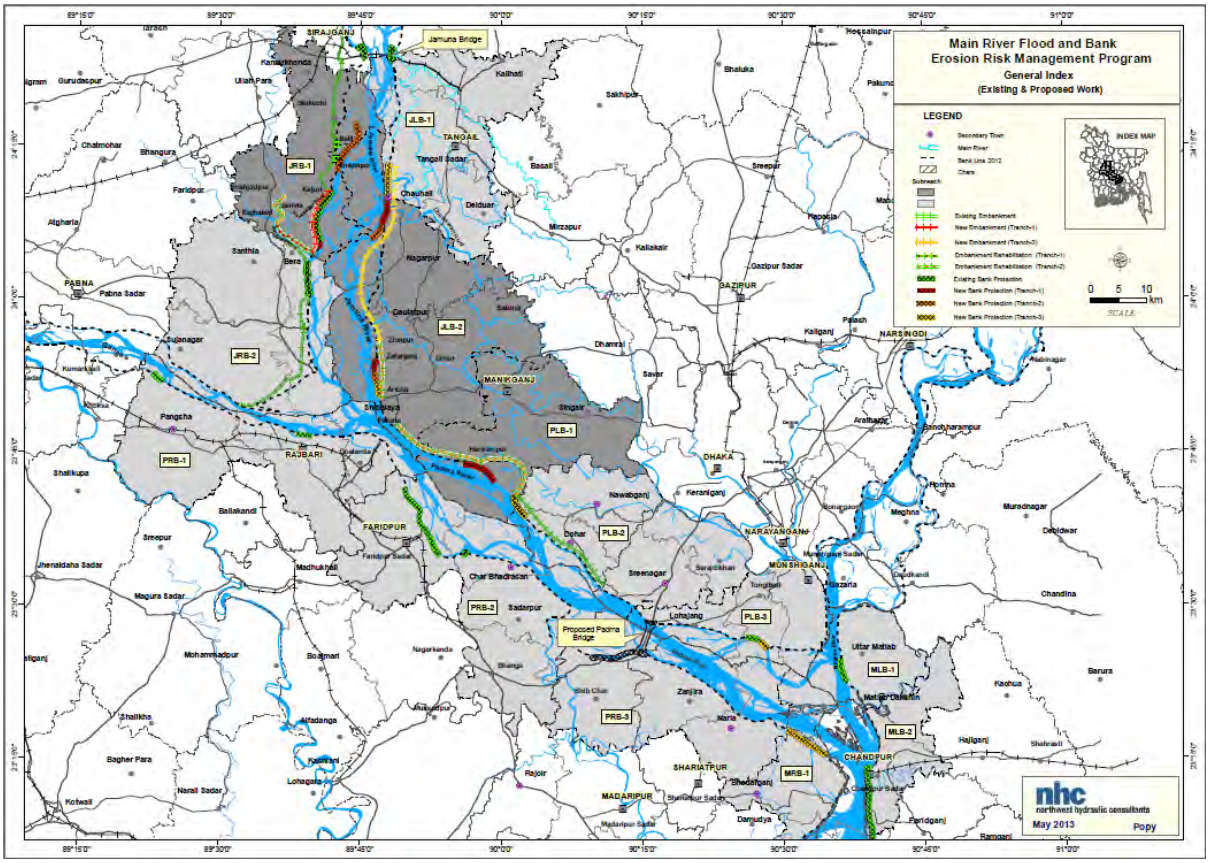
6. The main river flood and bank erosion risk management program (FFERMIP) is the follow-on project of the Jamuna-Meghna River Erosion Mitigation Project (JMREMP). It aims to sustain incomes and livelihoods of people living along the three main rivers of Bangladesh through establishing integrated non-structural and structural risk management measures at priority erosion sites and addressing their sustainability.

1.3 Project area

7. The project area of the proposed investment encompasses the river reach of the Jamuna River from below the Jamuna Bridge and the proposed Ganges Barrage site to Chandpuron the Lower Meghna. The Jamuna and Ganges river courses downstream of these two major river works are somewhat independent of upstream river developments.

8. These upstream areas are expected to be included in the Ganges Barrage project and the World Bank-supported Riverbank Improvement Project (RBIP). The project area covers 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.

9. The EIA/SIA studies have addressed the impacts of proposed interventions on three sub-reaches selected by feasibility study and possible inclusion in MRP tranche 1. These sub-reaches were selected from 13 sub-reaches into which the MRP area was divided based on discussions among BWDB, ADB, and the PPTA consultant. Sub-reaches are divided at upazila boundaries, most of which follow main river tributaries and distributaries and have not changed since 1961, facilitating the calculation of long-term trends from upazila-wise datasets. Eachsub-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 three – JRB-1, JLB-2, and PLB-1 – were retained for feasibility study.



Map1.1: Location of Project area

1.4 EIA Team members

10. International Consultant

Sara Bennett, PhD, International Environmental Specialist

11. CEGIS Team-

1. Mr. Mujibul Huq, Environmental Adviser, CEGIS
2. Dr. Anil Chandra Aich, Soil and Agriculture Specialist, CEGIS
3. Dr. Dilruba Ahmed, Senior Sociologist, CEGIS
4. Mr. Ashok Kumar Das, Senior Fisheries Biologist, CEGIS
5. Mr. Kazi Kamrull Hassan, Senior Water Resources Planner, CEGIS
6. Mr. Amanat Ullah, Senior Ecologist, CEGIS
7. Mr. Fahad Khan Khadim, Junior Water Resources Engineer, CEGIS
8. Mr. Roland Nathan Mondol, Junior Fisheries Biologist
9. Mr. Mobashir Bin Ansari, Junior Sociologist

10. Mr. Saifuddin Mahmud, Junior Sociologist
11. Mr. Zahid Hasan Dhali, Junior Agriculturist

1.5 Report Format

12. This EIA report has the following 10 (ten) 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 condition 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 rehabilitation plan.

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

Chapter 9: Environmental Management Plan

Chapter 10: Conclusion and recommendations.

2. Policy, Legal and Administrative Framework

2.1 Introduction

13. 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

a. National Conservation Strategy (1992)

14. National Conservation Strategy (NCS) was drafted in late 1991 and submitted to the Government in early 1992. This was approved in principle. However the final approval of the document is yet to be made by the government.

b. National Environmental Policy (1992)

15. Bangladesh National Environmental Policy of 1992 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 Environment Policy delineates the Department of Environment (DoE) as the approving agency for all such IEE/EIA's to be undertaken in the country.

c. National Environmental Management Action Plan (NEMAP) (1995)

16. The National Environmental Management Action Plan (NEMAP) is a wide ranging and multi-faceted plan, which builds on and extends 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 set out the framework within which the recommendations of the National Conservation Strategy are to be implemented.

17. NEMAP has the following broad objectives:

- Identification of key environmental issues affecting Bangladesh;
- Identification of actions necessary to halt or reduce rate of environmental degradation;
- Improvement of the natural and built environment;
- Conservation of habitats and biodiversity;
- Promotion of sustainable development; and
- Improvement in the quality of life of the people.

d. Bangladesh Climate Change Strategy and Action Plan (BCCSAP) 2009

18. The Bangladesh Climate Change Strategy and Action Plan 2009 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.[6]

2.1.2 Environmental Conservation Act (1995) and Amendments

ECA '95

19. 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, now repealed.

20. The main objectives of ECA '95 are (i) conservation and improvement of the environment; and (ii) control and mitigation of pollution of the environment.

21. The main strategies of ECA '95 can be summarized as:

- 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;
- Regulations in respect of vehicles emitting smoke harmful for the environment;
- Environmental clearance;
- 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;
- Promulgation of a standard limit for discharging and emitting waste; and
- Formulation and declaration of environmental guidelines.

22. 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.

[6]Government of Bangladesh. 2008. "Bangladesh Climate Change Strategy and Action Plan." http://www.moef.gov.bd/climate_change_strategy2009.pdf

23. A schedule attached to the Environment Conservation Rules 1997 categorizes projects as Green, Orange A, Orange B, and Red, and identifies for each category the level of environmental impact assessment required and other clearance application procedures and information.

24. 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 three years imprisonment or a maximum fine of BDT 300,000 or both. The Department of Environment (DOE) executes the Act under the leadership of the DG.[7]

ECA Amendment 2000

25. 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

26. 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; (v) authority for trials of environmental cases.

ECA Amendment 2010

27. 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.

Environment Court Act (2010)

28. The Environmental Court Act (2010) provides for the establishment of an 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.

Environmental Conservation Rules (1997)

29. These were the first Rules promulgated under the Environmental Conservation Act of 1995. These Rules defined categories of industries and projects and the types of environmental assessments each requires. There have been three amendments to these Rules, in February and August 2002, and in April 2003.

30. Among other things, the Rules set forth (i) National Environmental Quality Standards for ambient air, various types of water, industrial effluent, emission, noise, vehicular exhaust etc.;

[7]Government of Bangladesh. 1995. "The Bangladesh Environment Conservation Act, Act No. 1 of 1995" http://www.moef.gov.bd/html/laws/env_law/153-166.pdf

(ii) the requirement for and procedures to obtain environmental clearance; and (iii) the requirement for IEE/EIAs for the various categories of industries and projects.[8]

EIA Guidelines for Industries (1997)

31. The EIA Guidelines for Industries (1997) sets forth lEE and EIA requirements for various industrial sectors and activities.

Environmental Clearance Procedure for Red Category Projects

32. Figure 4.2 shows the application procedure for obtaining site / environmental clearance. To obtain an environmental clearance certificate for category Red projects (the category of the Project documented here), the following documents and materials must be submitted with the application to DoE:

- Project feasibility report, where applicable
- Environmental impact assessment report
- Environmental management plan
- No Objection Certificate from relevant local authority (where applicable)
- Other necessary information, where applicable

2.1.3 Water Policies, Plans,and Legislation

a) National Water Policy (1999)

33. The National Water Policy, 1999, aims to ensure efficient and equitable management of water resources; proper harnessing and development of surface and ground water; availability of water to all concerned; and institutional capacity building for water resource management. It also addresses issues such as river basin management; water rights and allocation; public and private investment; water supply / sanitation; and water needs for agriculture, industry, fisheries, wildlife, navigation, recreation, environment, preservation of wetlands, etc. It does not address issues like consequences of trans-boundary water disputes and watershed management.

34. Specifically with regard to river flooding and erosion, it states that through its responsible agencies Government will:

(i) Develop early warning and flood-proofing systems; designate flood risk zones;
(ii) Take appropriate measures to provide desired levels of protection for life, property, vital infrastructure, agriculture and wetlands guided by these principles:

(a) Highest priority is providing full flood protection to economical important regions (eg metropolitan areas, sea and air ports, export processing zones);

(b) A reasonable degree of flood protection will be gradually provided to other critical areas (district / upazila towns, important commercial centers and historic places);

(c) in other areas (except those protected by existing flood control infrastructure), people will be motivated to develop flood proofing measures (eg raised platforms for homesteads, market places, educational institutions, community centers) and adjust cropping patterns to suit the flood regime;

[8]Government of Bangladesh. 1997. Environment Conservation Rules, 1997, as Amended 2002 and 2003. http://www.doe-bd.org/2nd_part/179-226.pdf

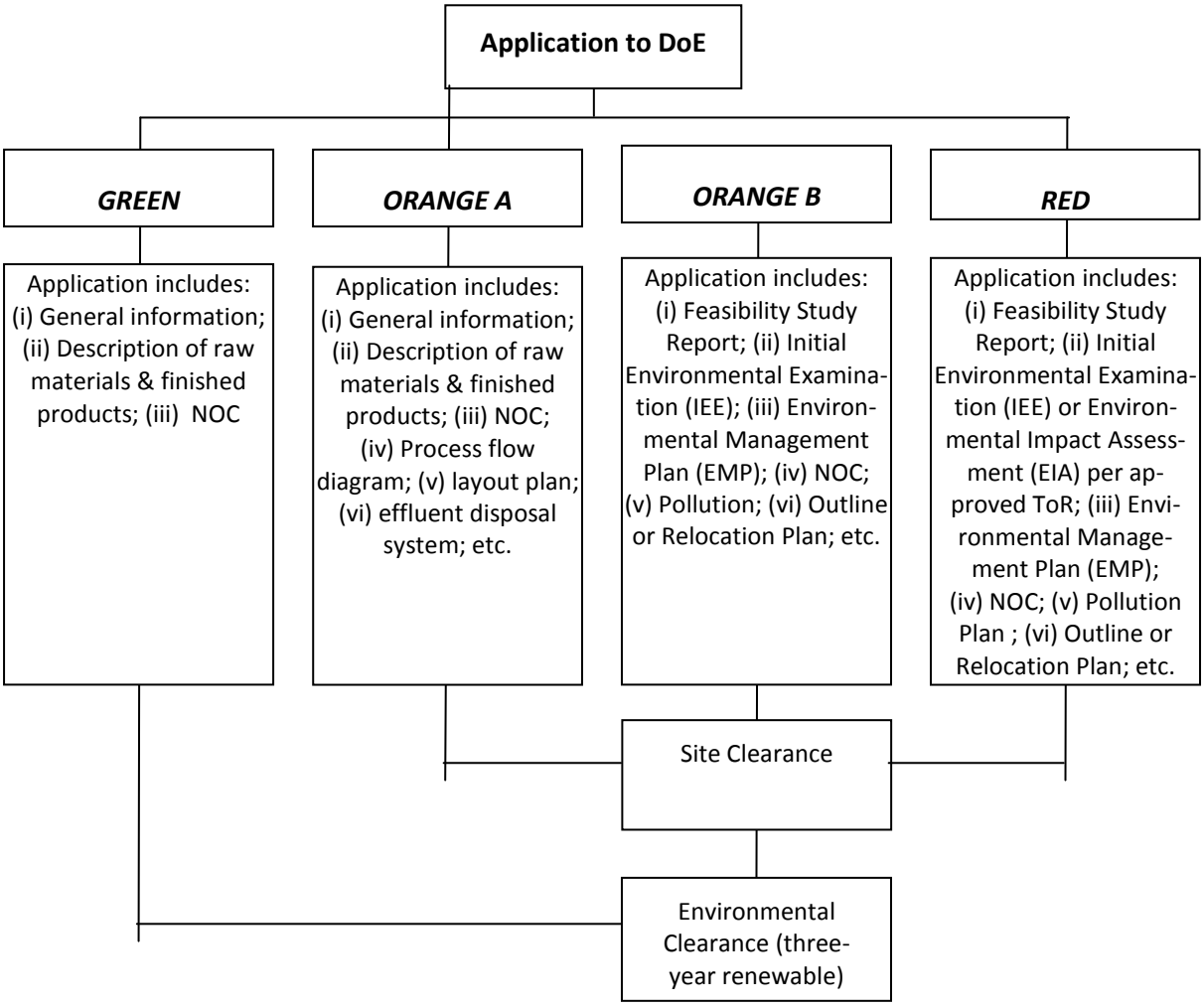


Figure 2.1: Application Procedure For Obtaining Site and Environmental Clearance

(d) All future national and regional highway, railway, and public building / facility new construction and reconstruction will be above the highest recorded flood level;

(e) All road and railway embankment plans will provide for unimpeded drainage;

(iii) Survey and investigate riverbank erosion problems, develop and implement river training and erosion control master plans that preserve scarce land and prevent landlessness and pauperization; and

(iv) Plan and implement coastal and river char land reclamation schemes.[9]

b) National Water Management Plan (2001, approved 2004)

35. The National Water Management Plan (NWMP) operationalizes the directives of the NWP. It is a "framework plan within which line agencies and other organizations are expected to plan and implement their own activities in a coordinated manner" in three phases – two of them now in the past (2000-5, 2006-10) and the third a perspective plan for 2011-25. Plan implementation was to be updated every five years but as of this writing has not been. NWMP has three central objectives, to be given equal importance: (i) rational management and wise use of water; (ii) quality of life

[9]Ministry of Water Resources. 1999. "National Water Policy". Government of Bangladesh, p. 6-7.

improved by equitable, safe, reliable access to water for production, health, and hygiene; (iii) sufficient, timely, clean water for multi-purpose use and for preservation of aquatic ecosystems. With regard to the main rivers, NWMP articulates the main aims as ensuring comprehensive structural and non-structural development and management for multipurpose use; integrating the needs of all users through comprehensive planning of river systems by the responsible agencies and working towards international river basin planning (p. 9). Several national programmes of main rivers studies and research (p. 17), and twelve main rivers projects (p. 27), are identified.[10]

c) Guidelines for Environmental Assessment of Water Management (Flood Control, Drainage and Irrigation) Projects (approved 2003, published 2005)

36. 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, in light of 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."[11]

d) National Policy for Safe Water Supply and Sanitation (1998)

37. The National Drinking Water Supply and Sanitation Policy (1998) goal is accessibility 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.

e) National Policy for Arsenic Mitigation (2004)

38. 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.

39. 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.[12]

f) Inland Water Transport Authority Ordinance (1958)

[10]Water Resources Planning Organization (WARPO). 2001. "National Water Management Plan". Ministry of Water Resources, Government of Bangladesh.http://www.warpo.gov.bd/nwmp.html

[11]Water Resources Planning Organization. 2005. "Guidelines for Environmental Assessment of Water Management (Flood Control, Drainage and Irrigation) Projects". Dhaka, Bangladesh: National Water Management Plan Project, Ministry of Water Resources, Government of the People's Republic of Bangladesh.

[12]Government of Bangladesh. 2004. "National Policy for Arsenic Mitigation". Department of Public Health Engineering (DPHE).http://www.dphe.gov.bd/pdf/National-Policy-for-Arsenic-Mitigation-2004.pdf

40. 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.[13]

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

a) Bangladesh Wildlife (Protection and Safety) Act 2012

41. The Act:

- 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 mollusk, 22 species of crustacean, 24 species of insect, six species of rodent, 41 species of plant and 13 species of orchid. Of these, eight amphibian, 58 reptile, 41 bird, and 40 mammal species are listed as endangered in the IUCN Red Data Book (2000).
- 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 ofwild animals, parts of wild animals, trophies, meat or other products without licence.
- 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.
- Mandates five years imprisonment and BDT 200,000 fine for killing a cheetah, clouded cheetah, gibbon, sambar deer, crocodile, gavial, whale, and dolphin.
- Mandates two years imprisonment and BDT 200,000 fine for killing a wild bird or migratory bird.
- Empowers the Government to create an eco-park, safari park, botanical garden, or breeding ground on any state-owned forest land, land or water-body.
- Mandates two years imprisonment for farming, woodcutting, burning, and construction on such reserves.[14]

b) Bangladesh Wildlife (Preservation) Order (1973) and Act (1974)

42. The Bangladesh Wildlife Preservation (Amendment) Act 1974 regulates the hunting, killing, capture, trade and export of wild life and wild life products. It designates a list of protected species and game animals. It 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:

- *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;
- *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;

[13]Government of Bangladesh. 1958. "Inland Water Transport Authority Ordinance." http://bdlaws.minlaw.gov.bd/pdf/282___.pdf
[14]Government of Bangladesh. 2012. "Wild Life (Protection and Safety) Act 2012 [in Bangla]." http://www.bforest.gov.bd/images/test/wildlife%20act.pdf

- *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 the purpose of protecting all natural resources, including wildlife vegetation, soil, and water.

43. The Act allows Government to relax any or all specified prohibitions for scientific purposes, for aesthetic enjoyment, or betterment of scenery.[15]

c) Protection and Conservation of Fish Act (1950)

44. This Act provides power to the government to:

- Make and apply rules to protect fisheries.
- Prohibit or regulate erection and use of fixed engines; and construction of temporary or permanentweirs, dams, bunds, embankments and other structures.
- Prohibit the destruction of fish by explosives, guns, and bows in inland or coastal areas.
- Prohibit the destruction of fish by poisoning, pollution, or effluents.
- Prescribe the seasons during which fishing is allowed.
- Prohibit fishing during spawning periods.
- Specify officials having authority to detect breaches of this Act.[16]

d) East-Bengal Protection and Fish Conservation Act (1950) and Amendments

45. 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 rule-making regarding destruction of, or any attempt to destroy, fish by poisoning of water or depletion of fisheries by pollution, industrial effluent, or otherwise.

e) Protection and Conservation of Fish Rules (1985)

46. 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.”

f) National Forest Policy (1994)

47. 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.

48. 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

[15]Government of Bangladesh. “Bangladesh Wild Life (Preservation) Order (1973).” http://bdlaws.minlaw.gov.bd/print_sections_all.php?id=452
[16]Government of Bangladesh. 1950. “Protection and Conservation of Fish Act, 1950.” http://bdlaws.minlaw.gov.bd/pdf/233___.pdf

goals and objectives. The Forest Policy also recognizes the importance of fulfilling the responsibilities and commitments under international multilateral environmental agreements.

g) Biodiversity Conservation Strategy and Action Plan 2004

49. 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:

- Identification of key environmental issues affecting Bangladesh;
- Identification of actions necessary to halt or reduce the rate of environmental degradation;
- Improvement of the natural and built environment;
- Conservation of habitats and biodiversity;
- Promotion of sustainable development; and
- Improvement in the quality of life of the people.

2.1.5 Agriculture and Land Use Policies and Legislation

a) National Agriculture Policy (1999)

50. 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 for upazila-level programs to address soil erosion in Madhupur Tract, Barind Tract, and the piedmont area.

b) New Agricultural Extension Policy (1996)

51. The goal of the New Agricultural Extension Policy 1996is 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 Bangladeshagriculture. 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.

52. 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.

53. 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; (v) effective linkages to support three-way information flow between farmers, extension agents, and research institute staff.

c) National Land Use Policy (2001)

54. 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 taking into account local geological differences, to rationalize the currently unplanned expansion of residential, industrial, and commercial construction.

2.1.6 Environmental Quality Standards

55. Environmental quality standards relevant to the Project, for air quality, noise, and sewage discharge, are provided in Tables 2.1, 2.2, and 2.3.

Table 2.1: Bangladesh Standards for Ambient Air Quality

No.	Area	Suspended Particulate Matter	Sulfur Dixide	Carbon Dioxide	Nitrogen Oxides
		(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 (Page 3123, Bangladesh Gazette, 28 August 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 reckoned as the time between 6 am. to 9 pm.
2. Nighttime is reckoned 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	^{o}C	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:

These standards are applicable for discharge into surface and inland water bodies.
Chlorination is to be done before final discharge.

2.2 Project-Relevant International Environmental Agreements In Force In Bangladesh

56. Of the international environmental agreements to which Bangladesh is a party,[17] 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 three objectives (a) sustainable use of biological diversity components, (b) fair and equitable sharing of genetic resources utilization benefits
(iv) 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

57. These instruments document the GOB commitment to biodiversity conservation generally, at all levels (global-national-regional-local and ecosystem-habitat-species), and specifically to the provisions of these particular agreements.

2.2.1 ADB Safeguards: Policy and Guidelines/Guidance Documents

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

59. Environment and Social

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

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

60. Environment

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

61. Social

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

3. Approach and Methodology

62. 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

63. The EIA study for the projectinterventions under**Tranch 1** has been carried out following the DoE and WARPO guidelines for water resources project. The overall approach of the study is shown in **Figure 3.1** below.

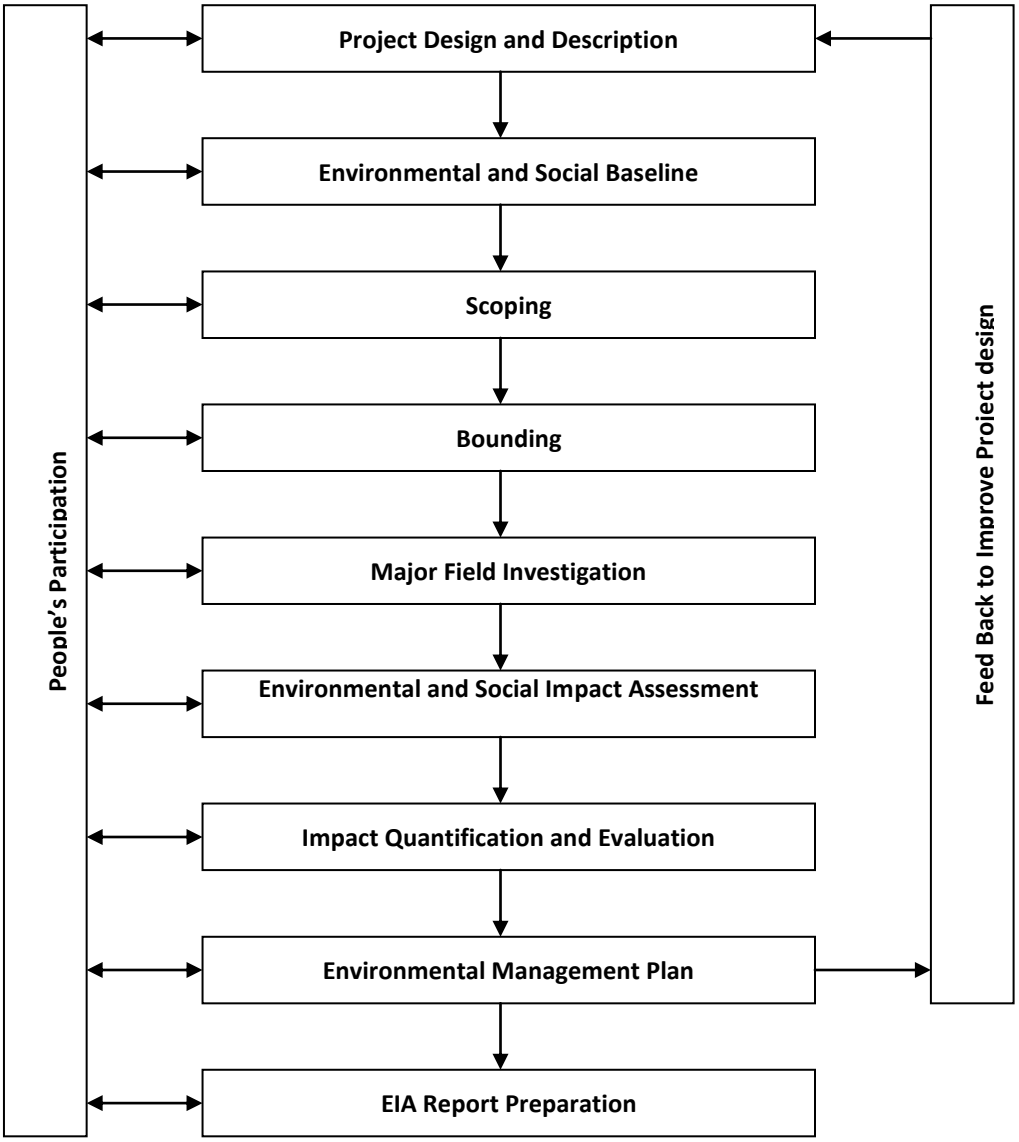


Figure 3.3-1: Overall approach of the EIA study

3.2 Methodology

64. The step-wise detail methodology followed for the EIA study is briefly described below.

3.2.1 Project design and description

65. Interventions proposed for **Tranch 1** was the basis of this EIA study. Initial information and specifications of the proposed interventions was obtained from the Main Consultant (MC). This was followed by development of base map using the images and data available with CEGIS in GIS data layers. Thereafter 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 the field visit. Opinion 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

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

a) Water resources

67. Water resource data under the heading river hydrology, river morphology, ground water 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 visit 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 etc.

68. 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 were 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 experts judgment.

69. The specific data on different events of water resources were gathered and analyzed using the methodology presented in the following table.

Parameter	Data Sources	Methodology

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 truthing
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

70. 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).

71. 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).

b) Land Resources

72. 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 Agriculture Extension (DAE) during field visit.

c) Agriculture Resources

73. 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 were collected from primary sources through extensive field survey by developing questionnaire 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 for last three years.

d) Livestock Resources

74. Present status of livestock (Cow/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 were also collected from secondary sources from Upazila Livestock office.

e) Fisheries Resources

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

76. **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 intervened area and non-intervened area to find the difference between them in terms of fisheries impact.

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

78. **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 etc.

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

80. **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, etc. were also collected.

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

82. **Data Analysis and Output:** Fish production 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 were estimated basin wise and then holistically. Secondary information that was collected from the UFOs and literatures were blended with primary data in production estimation.

f) Ecology

83. Information on bio-ecological zones and their characteristics has been collected from the publication of 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 landuse information on different ecosystem was generated through analysis of the recent satellite image. Field investigation methods included physical observation; transect walk, habitat survey and consultation with local people. Field visits were carried out in delineating the ecological baseline condition. Public consultation was carried out through FGD and Key Informants Interview methods. Inventory of common flora and fauna was developed based on field survey and data base of IUCN.

g) Socio-economic Resources

84. 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.

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

a) Data was collected from BBS, 2011 and reviewed relevant literatures from BWDB;

b) Reconnaissance field visit and discussion with BWDB officials and local stakeholders for primary data collection;

c) PRA /RRA, FGDs, KII for primary data collection

d) 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

86. A scoping process was followed for selecting Important Environmental and Social Components (IESCs) which are likely to be impacted by the proposed interventions under **Tranch 1**. Scoping was done in two stages. Individual professionals of EIA study team made a preliminary list of the components pertaining to their disciplines, which could be impacted by the project. The second

stage 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.

3.2.4 Bounding

87. Area likely to be impacted by the project interventions under Tranch 1 was delineated in consultation with the BWDB in addition to feed back received from the local people during baseline consultation.The processed RS tools were used for this purpose but there were some error 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.

3.2.5 Major Field Investigation

88. The EIA study team members collected intensive data on possible impact of the project after procuring the project plan. Intensive data on the IESCs were collected from the field during major field investigation stage. 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 professional 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.

3.2.6 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 as a result of interaction of specific project activities with the existing environmental settings. The impacts of proposed interventions were estimated on the basis of difference between the future-without-project (FWOP) condition and the future-with-project (FWIP) condition. The future-without-project (FWOP) conditions were generated through trend analysis and consultation with the local people. This reflected 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 future-with-project (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 asfollows:

i) Changes in the status of the IESCs pertaining to water resources;

ii) Changes in the status of the IESCs pertaining to land resources, agriculture, livestock and poultry;

iii) Changes in the status of the IESCs pertaining to fisheries;

iv) Changes in the status of the IESCs pertaining to ecological resources; and

v) Changes in the status of the IESCs pertaining to socio-economic condition.

3.2.7 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.

3.2.8 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.

3.2.9 EIA Report Preparation

93. At the end of the process, the present report was prepared incorporating all the findings of the EIA study.

4. Project Description

4.1 Introduction

94. The Project assessed by this EIA is Tranche 1 of the FRERMIP MFF. Section 4.2 immediately following describes the FRERMIP programme as the Project context and Section 04.3 describes the Project, Tranche 1.

4.2 Project Context: The FRERMIP Programme

4.2.1 FRERMIP Background and Objectives

95. Almost all of Bangladesh is floodplain delta at the confluence of three very large rivers. An integral part of the livelihoods of poor people is coping with water-related disasters – floods, drought, riverbank erosion caused by dynamic river channel shifting, cyclones, and tidal surges. All cause significant hardship.

Thus flood and riverbank erosion risk management can play a significant role in poverty reduction and economic growth. Riverbank erosionannually affects about 100,000 individuals who lose homestead, lands, agricultural crops, and displacement. Many erosion displacees relocate to insecure, marginal environments such as riverine fringe land, char land (river islands), and urban slums. Flooding, while integral to agriculture in the delta, causes displacement and economic losses, especially when high flooding occurs (approximately >1:10 return period).

96. FRERMIP aims to modify the flood season hydrology of a very large area of floodplain by providing new and rehabilitated embankments, leaving distributaries open, along selected reaches of the Padma / Jamuna River. To protect these embankments, river banks will be progressively stabilized, starting at critically eroding reaches. Over time, this approach may lead to general river stabilization, potentially transforming the geomorphology of the Padma / Jamuna in an unprecedented manner (particularly if a single-channel solution is implemented).[18] The anticipated benefits are considerable: (i) reduced loss of agricultural and other land to river erosion, (ii) reduced flood damage to agriculture (etc), and (iii) increased agricultural production on less-flooded agricultural land.

97. FRERMIP will build upon the riverbank protection methods developed in the Jamuna Meghna River Erosion Mitigation Project (JMREMP) to other river reaches. A morphological study will be undertaken in Tranches 2 and 3 to improve prediction of long-term morphological trends. This will support a shift from the currently approach of ad hoc, piecemeal protection of actively eroding damaged sites, to proactive siting of protection at sites expected to erode in the near future.

98. Behind FRERMIP riverbank protection works where river erosion risk – the main cause of embankment failure on the major rivers – has been reduced, FRERMIP will invest in new and rehabilitated embankment works, leaving major distributaries open, to mitigate flood levels during greater return period flood events while still allowing lower levels of beneficial flooding to occur.

99. The structural components of riverbank protection and embankments are accompined by non-structural components. These address institutional issues, on knowledgebase and planning level, and directly assist local communities in the sub-project areas in improving their preparedness to flood and erosion disaster. The latter will be implemented through DDM under a community-based flood risk management program covering around ome million people in the three subproject areas.

[18] As envisaged in: BWDB. 2012. Capital Dredging and Sustainable River Management Project, First Interim Report.

4.2.2 FRERMIP Location and Area

100. The FRERMIP area encompasses the Jamuna River reach starting below the Jamuna Bridge and the proposed Ganges Barrage site, down to Chandpuron the Lower Meghna. Downstream of the Jamuna Bridge and the Barrage site, theJamuna and Ganges river courses are somewhat independent of upstream river developments. The FRERMIP area covers 9,300 km³ with a total population of 10.5 million (2011 census) in 40 upazilas and 431 unions, with an average population density of nearly 1,600 persons per km² of floodplain land.

101. Map 1 shows the locations of proposed interventions during Tranches 1, 2, and 3. Red is used for Tranche 1 interventions, orange for Tranche 2, and yellow for Tranche 3. Map 4-2 provides a more detailed map of the proposed Tranche 1 interventions.

4.2.3 FRERMIP Implementation Schedule

102. Figure 4.1 shows the FRERMIP schedule for all three tranches.

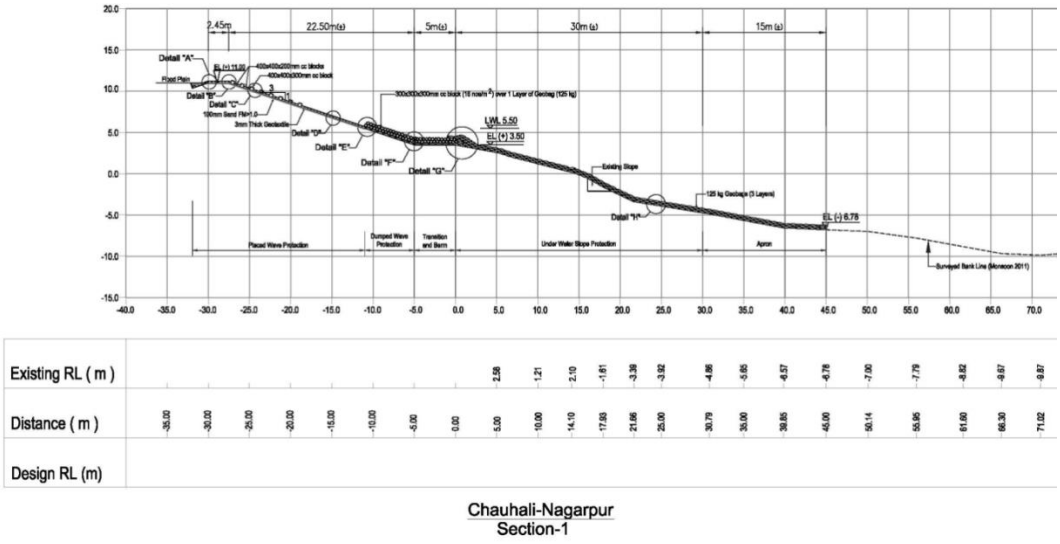
4.3 Project –Tranche 1

4.3.1 Proposed Interventions

103. Proposed interventions under Tranche 1 fall into four categories: (i) riverbank protection, (ii) new and rehabilitated road/flood embankments, (iii) drainage sluices and (iv) afforestation.

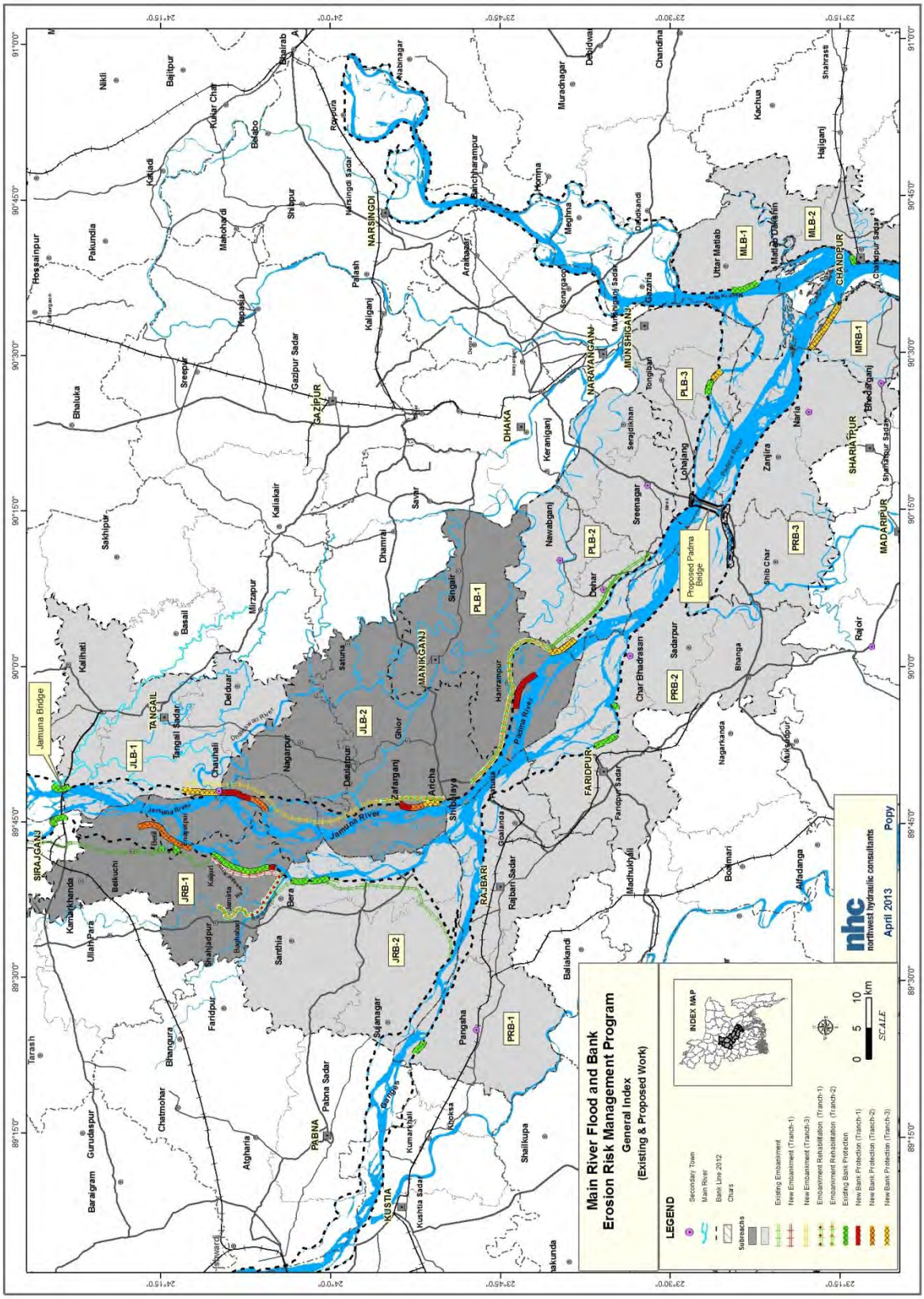
a) Riverbank Protection

104. Figure 4.2 shows a representative cross-section of riverbank protection works. Construction of riverbank protection typically involves the following activities. Labor sheds are constructed and stocked with construction materials (sand, cement, wood, shuttering materials etc.). Sanitation facilities for work crews are constructed. River bank slopes are developed with earth. Pre-cast concrete (CC) blocks are cast or manufactured. Geo-textile bags are placed onto the slope below water and CC blocks are placed onto the slope above water. Launching aprons are prepared at the toe of the underwater protection and geobags and are dumped, usually in a 15m wide strip in front of the toe. Embankment slopes and crests are turfed as needed.

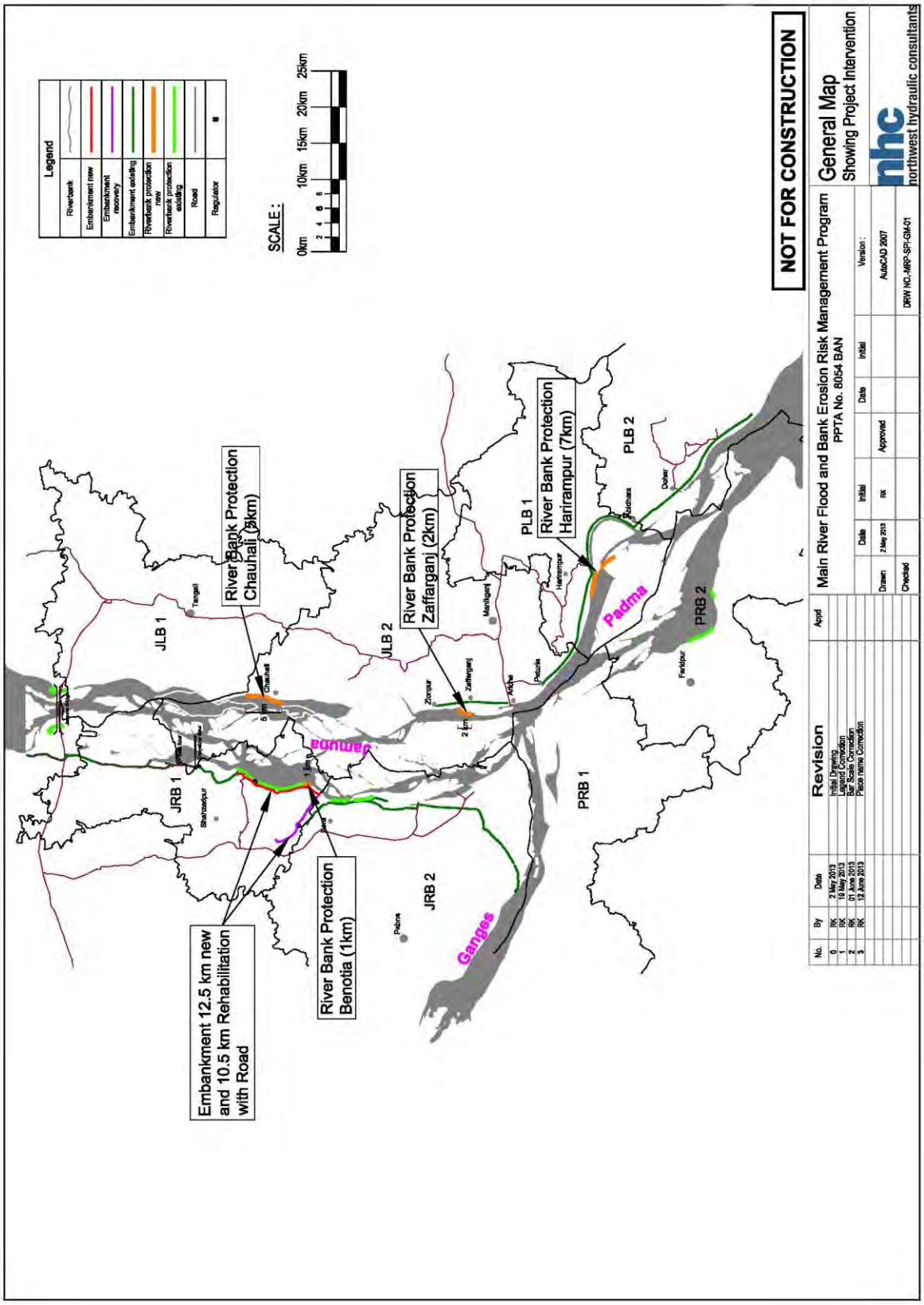


Chauhali-Nagarpur
Section-1

Figure 4-1: Riverbank Protection, Representative Cross-Section



Map 4.1: Proposed Interventions Color-Coded by Tranche



Map 4-2: Proposed Tranche 1 Interventions

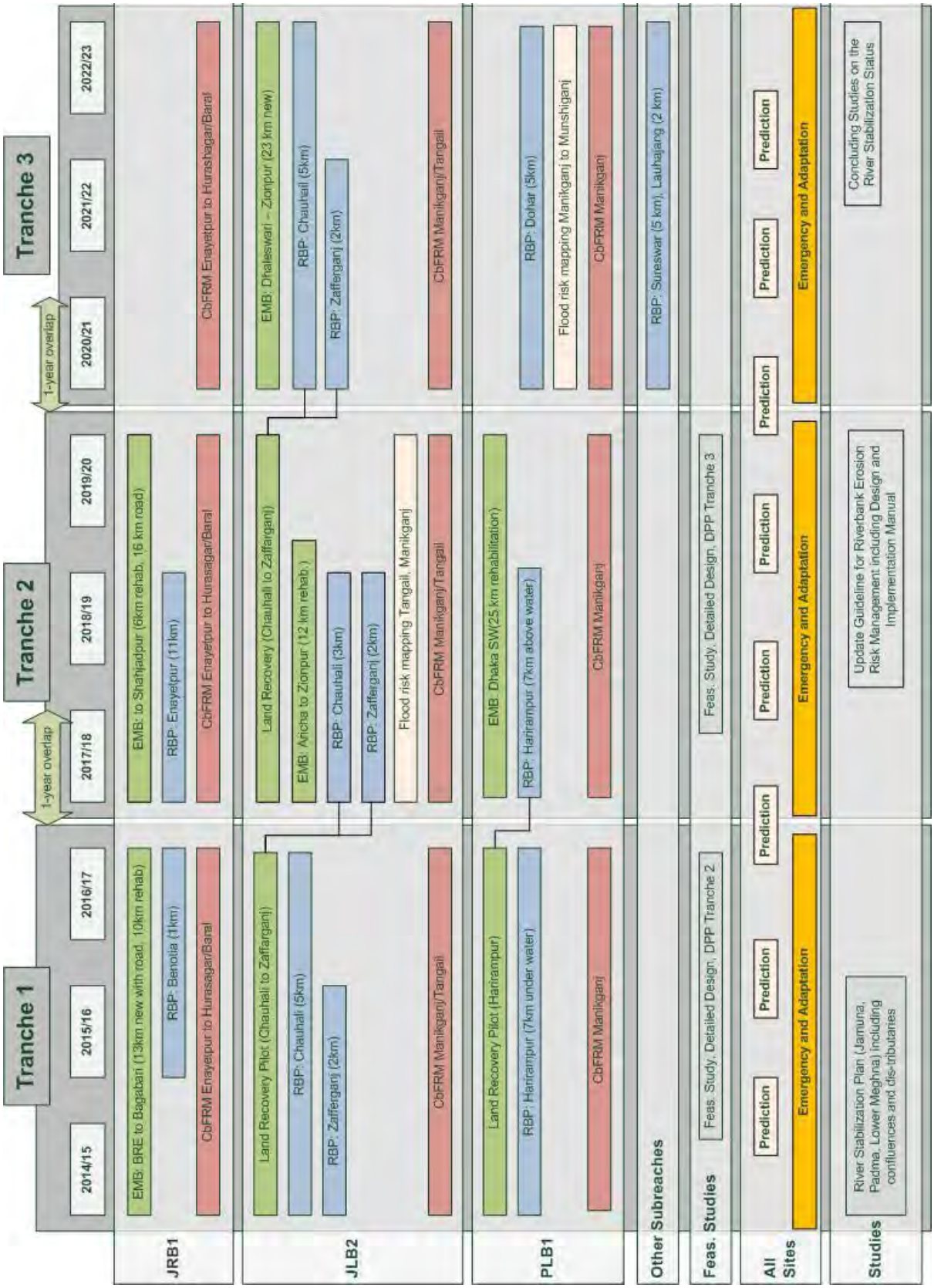
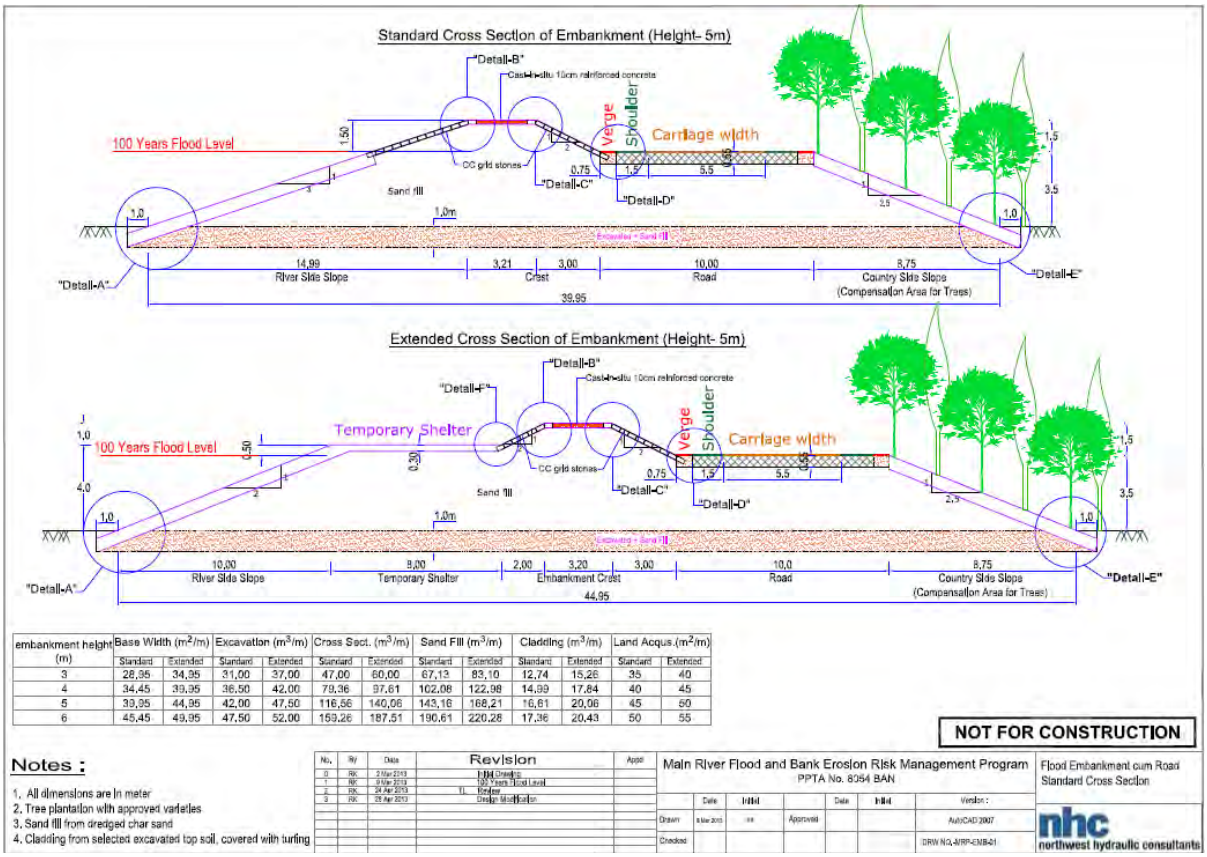


Figure 4.1: Construction Schedule

b) Embankments

105. Figure 4.3 shows a representative embankment cross section. Embankment construction typically involves the following activities. Labor sheds are constructed and stocked. Sanitation facilities for work crews are constructed. Under the supervision of the engineer in charge, the embankment alignment is marked out per engineering designs. As required by resettlement plans, resettlement activities are undertaken in the embankment footprint such that inhabitants are relocated and structures emptied out, such that they are no longer in use and can be dismantled and removed. Surface vegetation is cleared away. Construction tools are brought to the site and the final design is validated. Sand required for fill is pumped from the adjacent river by dredger, and clay required for surfacing is excavated from the embankment alignment. To achieve the desired rehabilitated or new embankment section, dredged sand is dumped and then compacted, sloped, and shaped in layers. When the design section has been reached, the embankment is surfaced with excavated clay and the embankment slope is turfed, watered and fertilized to establish a layer of biological protection from runoff surface erosion. The crest is paved for road access to the area. Later wave protection will be applied in critical zones on the riverside slope.



embankment height (m)	Base Width (m^2/m)		Excavation (m^3/m)		Cross Sect. (m^3/m)		Sand Fill (m^3/m)		Cladding (m^3/m)		Land Acqus.(m^2/m)	
	Standard	Extended	Standard	Extended	Standard	Extended	Standard	Extended	Standard	Extended	Standard	Extended
3	28,95	34,95	31,00	37,00	47,00	60,00	67,13	83,10	12,74	15,26	35	40
4	34,45	39,95	36,50	42,00	79,36	97,61	102,08	122,98	14,99	17,84	40	45
5	39,95	44,95	42,00	47,50	116,56	140,06	143,16	168,21	16,61	20,06	45	50
6	45,45	49,95	47,50	52,00	159,26	187,51	190,61	220,26	17,36	20,43	50	55

Figure 4.3: Embankment, Representative Cross-Section

c) Drainage Sluices

106. Pre-construction activities include labor shed construction and stocking with construction supplies; assembly of construction equipment and tools; construction of sanitation facilities; and construction site preparation (implementation of required resettlement actions and removal of structures and surface vegetation). To allow the construction site to be dewatered while maintaining the natural flow of water around it, ring bundhs and diversion channels are constructed. Foundation construction involves excavation and CC and reinforced cast concrete (RCC) works. Construction of

above-ground works involves cutting, bending and binding of rods, and casting and placement of CC blocks. Approach roads are constructed; gates and hoisting devices fitted, and gates painted. Per design, the sluice intake and outfall are constructed and CC blocks or geobags placed upstream and downstream for riverbed and -slope protection.

d) Afforestation

107. Figure 4.3 shows a representative cross section of an afforested embankment. Afforestation helps protect the country-side slopes and toe of the embankment from erosion by drainage from the crest and the road. Afforestation activities include establishing a temporary nursery to ensure seedling availability and plantation of appropriate species seedlings at species-appropriate intervals.

4.3.2 Project Implementation Arrangements

108. Appendix 5 documents the project implementation arrangements. BWDB is the executing agency, while DDM is the implementing agency for the community-based flood risk management component.As for all development projects, an inter-ministerial steering committee will review and discuss the project in annual meetings. A Panel of Experts will provide guidance related to river morphology, flood risk management, institutional development, regional/local capacity development, and other issues emerging during implementation.

109. A Project Management Office (PMO) integrated into BWDB administration will be set up, headed by a Project Director who will be a senior Superintending Engineer or an Additional Chief Engineer (with powers similar to the zonal Chief Engineer), supported by two Superintending Engineers. The PMO might be converted to proposed office of the Chief Engineer River Management and River Management Wing, once these posts are approved and staffed. The River Management Wing will be responsible for national river management activities such as char reclamation and materials procurement and strategic stockpiling, and for implementing works through existing zonal divisions (whose staff levels will be increased) that already construct embankments and revetments. In addition to the PMO in Dhaka, sub-project management offices (SMO) will be established in the divisional offices located in the project sites areas of Koitola, Tangail, and Manikgonj. In addition to the Project Director and the two superintendent engineers, the PMO will be staffed with four executive engineers, four sub-divisional engineers and one assistant engineer. All PMO staff will work full time on the project. One of the executive engineers will be responsible for environmental management, and will work with consultants to monitor and supervise activities in the project sites. Each SMO will be headed by an executive engineer who will be supported by a sub-divisional engineer, an assistant engineer, and three sub-assistant engineers. In the SMO, the sub-divisional engineer will be responsible for day to day management of environmental concerns.

110. BWDB is responsible for large-scale flood management and river erosion interventions, including the environmental aspects of their planning, assessment, and management, but it has very limited environmental staff in the Chief Planning office and no environmental- unit. Environmental management will be entrusted to executive engineer level PMO staff, supported by consultants. The PMO assures that environmental management will form part of construction contracts and regular monitoring of construction activities will be conducted. In addition future interventions will be studied at multiple levels to minimize negative impacts. A river stabilization study, and land recovery piloting, will assess potential river stabilization alternatives and their impacts, inter alia, on the environment. In addition, successive tranches will be designed through full feasibility studies, complying with ADB safeguard standard.

111. An Institutional Strengthening and Project Management Consultant (ISPMC) will provide consultancy and NGO services to support project implementation in a variety of ways, including the services of a specialist organization to conduct environmental assessment, planning and

management to support the PMO in environmental monitoring; and, in Tranches 2 and 3, to assist PMO to design and develop a new Environmental Monitoring and Management Unit.

112. The core components of this work relevant to Tranche 1 design and implementation include:

- Institutional support and project management (capacity development in river training, modern embankment construction, river surveying, and data management and evaluation; large-area flood hazard and risk mapping for larger areas; management information system development; construction management of large contracts; construction quality assurance / quality control); preparation of a river stabilization plan during the first two years of Tranche 1 for the Brahmaputra-Jamuna-Padma-Lower Meghna from the Bangladesh-India border to the estuary; and pilot activities to recover "lost" floodplain.
- Preparation and supervision by resettlement NGO of Resettlement Plan implementation at the three Tranche 1subprojects, supervised by an independent monitor.
- Implementation by a disaster management-experienced NGO of community-based flood risk management.
- Provision of specialist and NGO services required to implement Environmental Management Plan mitigation, monitoring, public consultation, and other activities. An environmental specialist will be included in the ISPMC team.
- Support to BWDB in the planning and initial staff training of a BWDB environmental monitoring and management unit under FRERMIP.

113. Additional details regarding the financing and potential scope of work of the advisory support are provided in Section 15.3.3, Advisory Support, of the Final Report, Main Volume.

4.3.3 Implementation Schedule

114. The scheduled start and end dates of Tranche 1 are 1 July 2014 and 30 June 2018. Tranche 2 is scheduled to start 1 July 2017 (Figure 4.1).

4.3.4 Tranche 1 Subprojects

115. Tranche 1 consists of three subprojects: Jamuna Right Bank 1 (Details in Annex 7), Jamuna Left Bank 2 (Detaisl in Annex 8) and Padma Right Bank 1 (Details in Annex 9). Table 4.1 through Table 4.4 summarizes key information for Tranche 1 interventions.

Table 4.1: Tranche 1Embankment Rehabilitation

No.	Location	Length (km)	Design Crest Width (m)	Design Crest RL (m +PWD)	Side Slope
1	Verakhola towards start of Hurashagar River	6.5	16.2 (section with different top elevation)	15.6	R/S 1V:3H C/S 1V:2.5H
2	Start of Hurashagar River to Korotoa bank	4	16.2 (section with different top elevation)	15.6	R/S 1V:3H C/S 1V:2.5H

Source: Final Report, Main Volume, 2013

Table 4.2: Tranche 1Embankment Construction

No.	Location	Length (km)	Design Crest Width (m)	Design Crest RL (m +PWD)	Side Slope
1	Kaizuri to Benotia	10.5	16.2 (section with different top elevation)	15.6	R/S 1V:3H C/S 1V:2.5H
2	Benotia to the start of Baral Khal	2	26.2 (section with different top elevation, includes temporary settlement)	15.6	R/S 1V:3H C/S 1V:2.5H

Source: Final Report, Main Volume, 2013

Table 4.3: Tranche 1Riverbank Protection

No.	Location	Length (km)	Design Crest Width(m)	Design Crest RL (m +PWD)
1	Benotia	2	-8	1V:3H Above LWL 1V:2H Below LWL
2	Chouhali	5	-2	1V:3H Above LWL 1V:2H Below LWL
3	Bachamara	2	-4.5	1V:3H Above LWL 1V:2H Below LWL
4	Harirampur	7	-8	1V:2H Above LWL 1V:2H Below LWL (temporary protection above LWL)

Source: Final Report, Main Volume, 2013

Table 4.4: Tranche 1 Drainage Sluices

No.	Location	Khal Name	Catchment Area (ha)	Vent Size and Number
1	not set	not set	870	1 vent - 1.5m x 1.8m
2	not set	not set	3600	4 vent- 1.5m x 1.8m
3	not set	not set	5700	6 vent- 1.5m x 1.8m
Rehabilitation of 2 existing 4 vent regulators				

Source: Final Report, Main Volume, 2013

4.3.5 Associated Facility Analysis

116. The JLB-2 and PLB-1 flood embankments of Tranche 2 were evaluated for inclusion in this impact analysis as "associated facilities" of Tranche 1 (ADB, 2009, p. 31). Associated facilities are those "not funded as part of the Project… [i] whose viability and existence depend exclusively on the Project, and [ii] whose goods or services are essential for successful Project operation."

117. The Tranche 2 JLB-2 and PLB-1 embankments do meet condition (i) but not condition (ii). With regard to condition (i), their viability and existence depends partially on the riverbank erosion protection constructed in Tranche 1 (the Project) (ie they also depend on additional erosion protection constructed in Tranches-2 and 3. Without it, they would not be built (viability) and if they were, they would be at risk of erosion damage or destruction (existence).

118. With regard to condition (ii), the embankments are not essential to the successful operation of the erosion protection. In the case of JLB-2, the Tranche 2 embankment flood damage benefits (ie the "goods and services" of the flood embankment) do however substantially cross-subsidize the cost of the Tranche 1 JLB-2 erosion protection works.[19]

[19] The economic analysis presented in Sec. 18 of the Final Report, Main Volume (version dated 21 July 2013) includes costs and benefits of all tranches, broken out by subreach. For JLB-2, 66 per cent of the benefits derive from reduced flood

4.3.6 Labor Requirement, Construction Materials, and Equipment

119. Table 4.5 to Table 4.8 provide estimates of labor requirements, construction materials, and equipment for embankment re-sectioning, new / retired embankment construction, river bank protection construction, and drainage sluice construction respectively.

damage, while 67 per cent of the costs derive from erosion protection works. For PLB-1, 72 per cent of the benefits derive from reduced erosion, and 77 per cent of the costs derive from the erosion protection.

Table 4.5: Embankment Re-Sectioning Details

Chainage and Placenames *(Para, Village/Mouza)*	**Length (km)**	**Design Crest**		**Side Slope**	**Soil Volume Required (m^3)**	**Borrow Pits – Placenames, Area (ha), Existing Land Use**	**Skilled and Unskilled Labour Required (person-day)**	**Earthworks Labour Shed Location**	**Soil Conveyance Method(s)**
		Width (m)	**Elevation (m)**						
Location 1: Baghabari in the direction of Shahzadpur (JRB-1)	6.5	3.2+3+10 = 16.2 m (sections have different top elevation	15.60 m PWD	R/S 1V:3H C/S 1V:2.5H	Sandy soil 465,000 m^3 Clay soil 86,000 m^3	Construction soil will be dredged from river bed	*Construction* Skilled: 2,200 Unskilled: 40,000 *Annual O&M* Skilled: 110 Unskilled: 2000	Temporary, in the alignment	Sand pumped from dredger Excavator for clay collection from existing embankment
Location 2: Shahzadpur-Korotoa bank (JRB-1)	4				Sandy soil 321,900 m^3 Clay soil 55,460 m^3		*Construction* Skilled: 1500 Unskilled 27,000 *Annual O&M* Skilled: 100 / year Unskilled: 1350 / year	Temporary, in the alignment	

Notes:

1. Skilled and un-skilled labour person-days requiredare calculated taking into account expected mechanization eg country made dredger and earth moving and compacting equipment.

2. Annual O&M labor for embankment resectioning and construction of new / retired embankments has been estimated at five per cent of total construction labour (see above). Additionally (not shown above), every ten years thereafter a major repair may be necessary; the estimated labour requirement is 20 to 30 per cent of total construction labour.

Table 4.6: New / Retired Embankment Construction Details

Chainage and Placenames (Para, Village/Mouza)	Length (km)	Land Ownership and Land Use Along Alignment	Design Crest width (m)	Design Crest R/L (m)	Side Slope	Soil Volume Required (m3))	Borrow Pits – Placenames, Area (ha), Existing Land Use	Skilled and Unskilled Labour Required (person-day)	Earthworks Labour Shed Location	Soil Conveyance Method(s)
Location 1: Kaizuri-Hurasagar offtake	10.5	Per LARP	3.2+3+10 = 16.2 m	15.60 m PWD	R/S 1V:3H C/S 1V:2.5H	Sandy soil 1,236,585	Construction sand will be dredged	Construction: Skilled: 5600	Temporary, in the	Sand pumped from dredger

(JRB-1)			(section with different top Elevation)			m3 Clay soil 174,405 m3	from riverbed Clay is taken from topsoil removed from embankment alignment prior to construction (not all topsoil is clay; sand is used for embankment core; Any unsuitable (non-sand, non-clay) materials eg peat is disposed per Engineer in Charge instruction	Unskilled: 105,000 Annual O&M Skilled: 380 Unskilled: 5200	alignment	Excavator for clay collection from embankment
Location 2: Kaizuri Benotia (JRB-1)	2.0		8+2+3.2+3+10 = 26.2 m (section with different top Elevation, includes temp settlement)			Sandy soil 282,540 m3 Clay soil 40,120 m3		Construction: Skilled: 1200 Unskilled 22,000 Annual O&M Skilled: 60 Unskilled: 1100		
Location 3: Hurasagar-Baghabari (JRB-1)	6.0		3.2+3+10 = 16.2 m (section with different top Elevation			Sandy soil 597,000 m3 Clay soil 94,800 m3		Construction Skilled: 2700 Unskilled: 48,000 Annual O&M Skilled: 140 Unskilled: 2400		

Notes:

1. Skilled and un-skilled labour person-days requiredare calculated taking into account expected mechanization eg country made dredger and earth moving and compacting equipment.

2. Annual O&M labor for embankment resectioning and construction of new / retired embankments has been estimated at five per cent of total construction labour (see above). Additionally (not shown above), every ten years thereafter a major repair may be necessary; the estimated labour requirement is 20 to 30 per cent of total construction labour.

Table 4.7: River Bank Protection Construction Details

Chainage and Placenames *(Para, Village/Mouza)*	**Length (km)**	**Design Bed R/L (m)**	**Side Slope**	**Soil Volume Required (m^3)**	**Soil Collection Locations**	**Concrete Blocks (number and size)**	**Geobags and Geotextile Filters**	**Skilled and Unskilled Labour Required (person-day)**	**Earthworks Labour Shed Location**	**Soil Conveyance Method(s)**
Benotia (JRB-1)	2.0	-8.0 m PWD	1V:3H above LWL	0.204 Mm^3	Bank slope from -2.00 to +9m PWD a 5.0m berm at	*Construction* 86,000 nos 40x40x30cm 197,000 nos	*Construction* 0.838M nos geobag-125 kg Geotextile filter- 74,000 sqm	*Construction* Skilled: 29000 nos Unskilled: 170,000 nos	Temporary rented locations	Carried by dump truck and excavator

Chainage and Placenames *(Para, Village/Mouza)*	**Length (km)**	**Design Bed R/L (m)**	**Side Slope**	**Soil Volume Required (m^3)**	**Soil Collection Locations**	**Concrete Blocks (number and size)**	**Geobags and Geotextile Filters**	**Skilled and Unskilled Labour Required (person-day)**	**Earthworks Labour Shed Location**	**Soil Conveyance Method(s)**
			1V:2H below LWL		the lowest level	40x40x20cm 500,000 nos 30x30x30cm *Annual O&M* [no blocks needed]	*Annual O&M* 16,500 nos geobag-125 kg	*Annual O&M* Skilled: 550 Unskilled: 3500		
Chouhali (JLB-2)	5.0	-2.0m PWD		0.540 Mm^3	Bank slope from +3.00 to +10.5m PWD a 5.0m berm at the lowest level	*Construction* 215,000 nos 40x40x30cm 493,000 nos 40x40x20cm 1,255,000 nos 30x30x30cm *Annual O&M* [no blocks needed]	*Construction* 1.914M nos geobag-125 kg 0.114M nos geobags-250 kg Geotextile filter- 0.185M sqm *Annual O&M* 35,000 nos geobag -125kg	*Construction* Skilled: 72,000 Unskilled: 428,000 *Annual O&M* Skilled: 1400 Unskilled: 8500		
Zaffarganj (JLB-2)	2.0	-4.5m PWD		0.256 Mm^3	Bank slope from +1.00 to +10.0m PWD a 5.0m berm at the lowest level	*Construction* 80,000 nos 40x40x30cm 185,000 nos 40x40x20cm 505,000 nos 30x30x30cm *Annual O&M* [no blocks needed]	*Construction* 0.760M nos geobag-125 kg 60,000 nos geobags-250 kg Geotextile filter- 70,000 sqm *Annual O&M* 15,000 nos geobag-125kg 1200 nos geobag-250kg	*Construction* Skilled: 29,000 nos Unskilled: 170,000 nos *Annual O&M* Skilled: 600 Unskilled: 3,500		
Harirampur (PLB-1)	7.0	-8.00 m PWD	1V:2H Above LWL 1V:2H	602,000 m^3	Bank slope from +0.00 to +8.5m PWD	*Construction* Char area therefore geobags will be used above LWL (ie temporary solution is	*Construction* 2M nos geobag-125 kg 1.5M nos geobag-250 kg Geotextile filter- 0.151M sqm	*Construction* Skilled: 86,000 nos Unskilled: 525,000 nos		

Chainage and Placenames *(Para, Village/Mouza)*	**Length (km)**	**Design Bed R/L (m)**	**Side Slope**	**Soil Volume Required (m^3)**	**Soil Collection Locations**	**Concrete Blocks (number and size)**	**Geobags and Geotextile Filters**	**Skilled and Unskilled Labour Required (person-day)**	**Earthworks Labour Shed Location**	**Soil Conveyance Method(s)**
			Below LWL			appropriate here) *Annual O&M* [no blocks needed]	 *Annual O&M* 40,000 nos geobag-125kg 30,000 nos geobag-250kg	*Annual O&M* Skilled:-1700 Unskilled: 10,500		

Notes:

1. Skilled and un-skilled labour person-days requiredare calculated taking into account expected construction methodologes.

2. Annual O&M labor for riverbank protection has been estimated at two per cent of total construction labour (see above). Unlike embankments, additional major repairs are not necessary.

Table 4.8: Drainage Sluice Construction Details

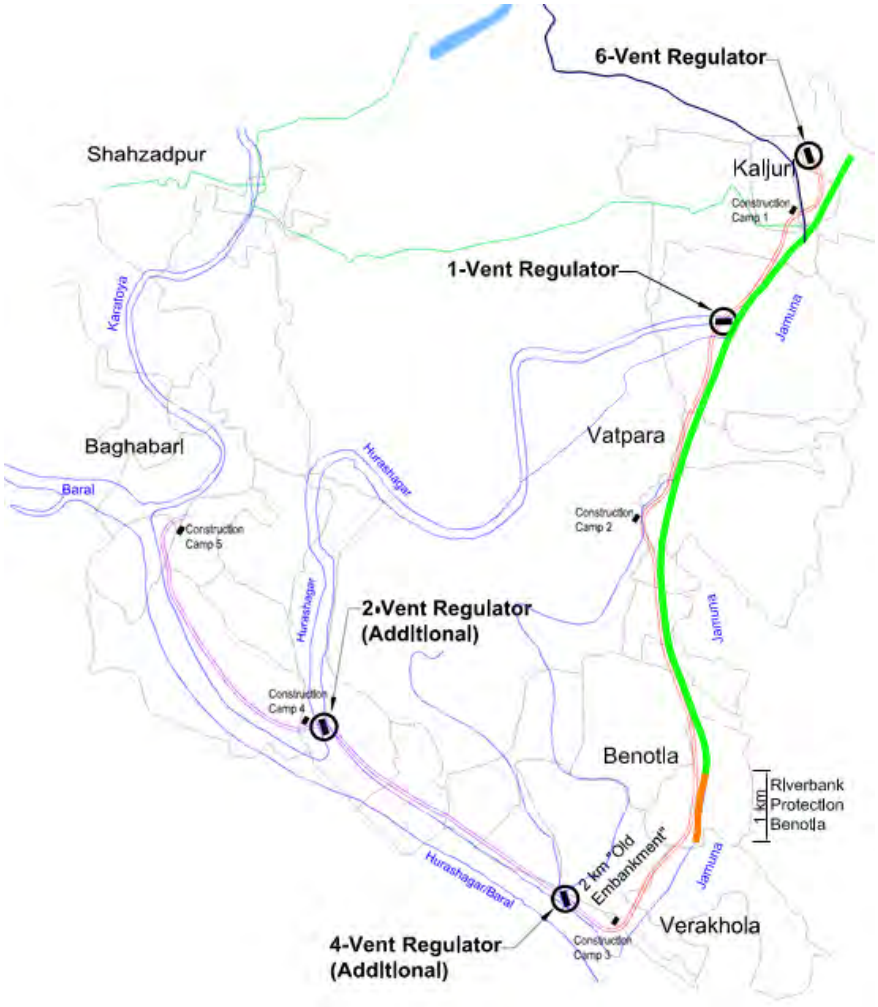
Chainage and Placenames *(Para, Village/Mouza)*	**Identifying Landmark (name of mosque, school etc)**	**Khal Name**	**Catchment area (ha)**	**Vents (number and size)**	**Construction Materials (type, number, conveyance)**	**Number of skilled/ unskilled labour (man-day)**	**Location of Labour Sheds and Construction Camps**
Gudhibari (JRB-1) 467619E; 671008N	NA	NA	870 ha	New 1 vent- 1.5mx1.8m	Cement: 140 tonne Sand: 230 m^3 Stone chips: 440 m^3 MS Rod: 79.00 tonne	*Construction* Skilled: 1700 Unskilled: 5800 *Annual O&M* Skilled: 17 Unskilled: 60	On rented land for two construction seasons
Gala (JRB-1) 465114E; 662557N	NA	NA	3600 ha	Existing 4 vent, adding 4 vents- 1.5mx1.8m	Cement: 270 tonne Sand: 430 m^3 Stone chips: 830 m^3 MSRod: 178.00 tonne	*Construction* Skilled: 2600 Unskilled: 9300 *Annual O&M* Skilled-26 Unskilled-95	
Lochna (JRB-1) 461392E; 665068N	NA	NA	3600 ha	Existing 4 vent, adding 2 vents- 1.5mx1.8m	Cement: 270 tonne Sand: 430 m^3 Stone chips: 830 m^3 MSRod: 178.00 tonne	*Construction* Skilled: 2600 Unskilled: 9300 *Annual O&M* Skilled-26 Unskilled-95	
Kaijuri, Gopalpur (new; JRB-1) 468742E; 673594N	NA	NA	5700 ha	New 6 vent- 1.5mx1.8m	Cement: 340 tonne Sand: 530 m^3 Stone chips: 1100 m^3 MSRod: 230.00 tonne	*Construction* Skilled: 3,100 Unskilled: 11,500 *Annual O&M* Skilled-31 Unskilled-115	

Notes:

1. NA – not applicable.
2. Skilled and un-skilled labour person-days required are calculated taking into account expected mechanization eg country made dredger and earth moving and compacting equipment.
3. Annual O&M labor for riverbank protection has been estimated as one per cent of total construction labour (see above). Additionally (not shown above), every ten years thereafter a major repair may be necessary; the estimated labour requirement is 20 to 30 per cent of total construction labour.

4.3.7 Camps

120. At each construction area (group of proximate construction sites), a camp to house project laborers will be constructed. The contractor will select camp locations after consultation with the local union parishad chairperson(s) and local residents. Camp locations are subject to the approval of the Engineer in Charge. Map 4.3shows the proposed locations of JRB-1 infrastructure and labor camps for embankment work crews. Riverbank protection does not require construction of camps as mostly local laborers are employed.



Map 4.3: JRB-1 Proposed Camp and Infrastructure Locations

4.3.8 Transportation of Materials

121. During implementation, trucks and inland vessels will carry heavy equipment and construction materials, including aggregates, cement, steel reinforcement, and sluice gate equipment, from various domestic locations to construction stock yards. Large quantities of earth will also be moved to construction stock yards by mechanical equipment such as excavators, pay loaders, dump trucks, trolleys, and to a lesser extent by manual labor. Materials will then be transported to individual work sites by trucks, smaller carts, non-motorized vans, and other smaller vehicles. The main construction material is sand. It will be mined locally in river areas approved by the designated engineer and transported by inland water vessels to construction stock yards and construction sites.

5. Environmental and Social Baseline

122. The environmental and social baseline condition in the study areahas been characterized 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:

- Bangladesh Bureau of Statistics (BBS)
- Bangladesh Water Development Board (BWDB)
- National Water Resources Database (NWRD)
- Water Resources Planning Organization (WARPO)
- Soils Resources Development Institute (SRDI)
- Bangladesh Meteorology Department (BMD)
- Department of Agricultural Extension (DAE)
- Department of Fisheries (DOF)
- International Union for Conservation of Nature (IUCN).

5.1 Physical Environment

5.1.1 Climate

a) Seasonality

123. Bangladesh has a sub-tropical monsoon-dominated climate. Seasons progress from a hot and dry pre-monsoon season March to May, to a rainy south-west monsoon season June to October, through a cool dry winter November to February. During the pre-monsoon, violent thunderstorms (referred to as “northwesters”) are common. During the rainy season, tropical depressions move inland from the Bay of Bengal. 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.

b) Meteorology Stations

124. Data used here is from two stations near the study area (Faridpur and Tangail) of Bangladesh Meteorological Division (BMD).

c) Rainfall

125. 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.

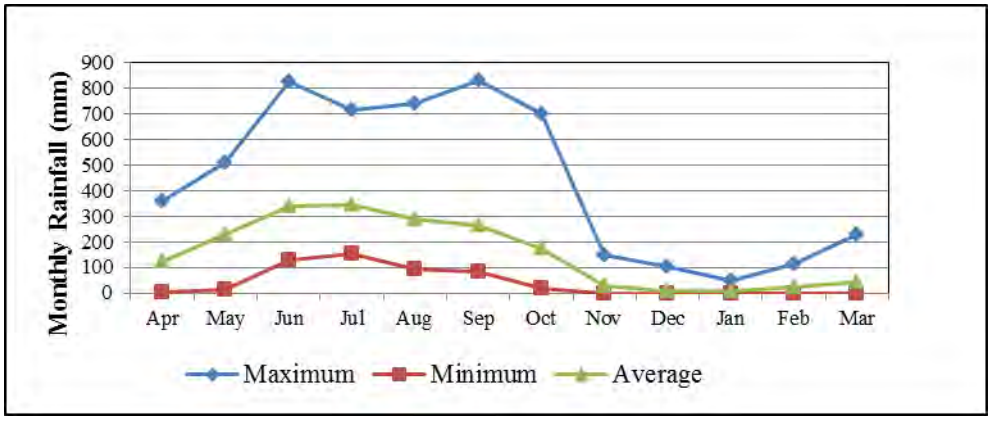


Figure 5.1: Monthly rainfall of the study area

d) Temperature

126. Figure 5.2 shows average monthly temperatures 1948-2010 at Faridpur and 1987-2010 at Tangail. These range from 18.2 to 28.9°C in Faridpur and 17.6°C-29.2°C in Tangail, with higher values (>27.4°C) from April to October, and lower values from November to March.

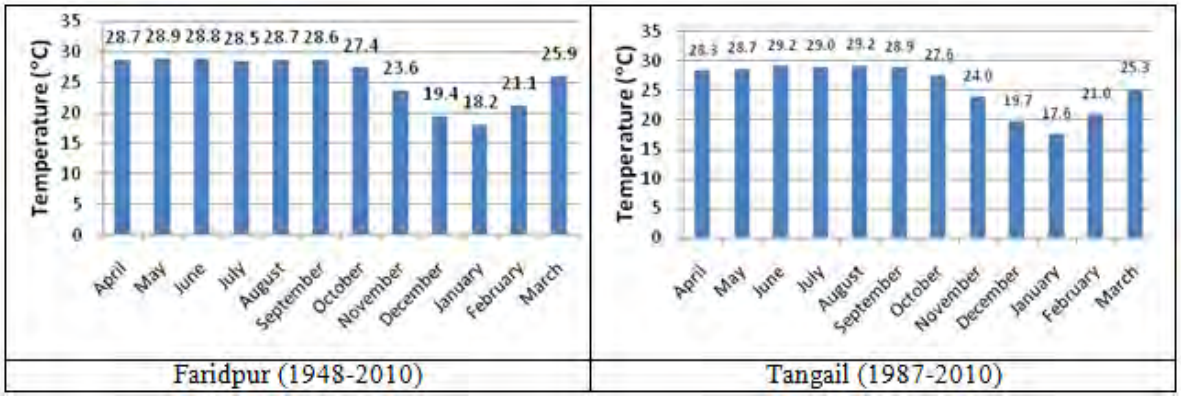


Figure 5.2: Monthly temperature of the study area

e) Humidity

127. Figure 5.3 shows average monthly humidity 1948-2010 at Faridpur and 1987-2010 at Tangail. These range from 71 to 87 per cent in Faridpur and 70 to 86 in Tangail, with lower values (≤ 81 per cent) from November to May and higher values from June to October.

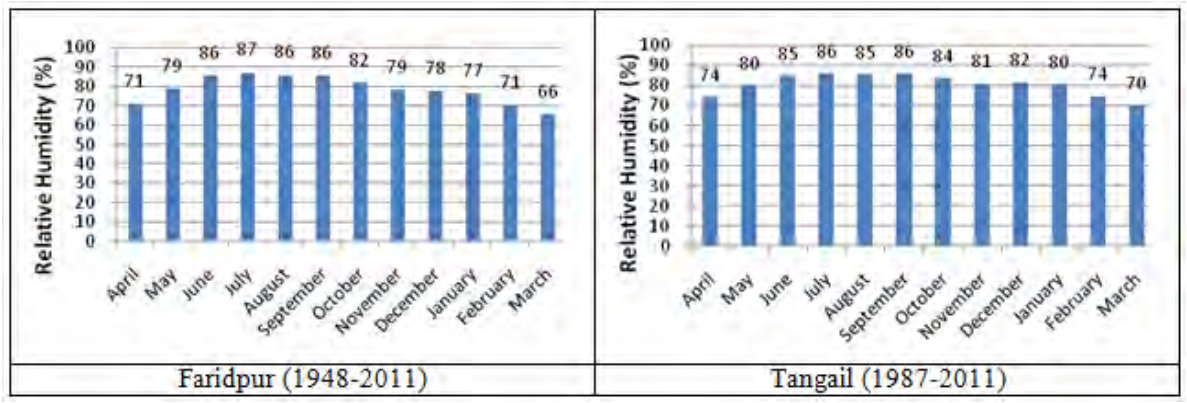


Figure 5.3: Relative humidity of the study area

f) Evaporation

128. Figure 5.4 shows average monthly evaporation 1987-2010 at Faridpur. Values range from 1.82 to 5.10 mm per day, with lower values (≤3.34 mm per day) July through February, and higher values from March through June.

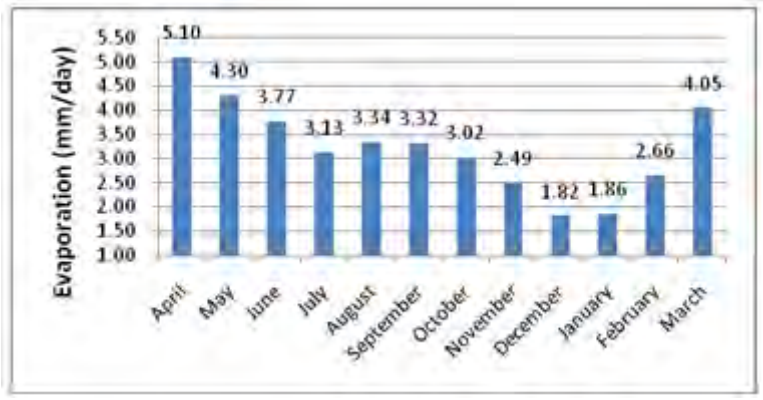


Figure 5.4: Evaporation of the study area

g) Wind Speed

129. Figure **Error! Reference source not found.**5.5 shows the average monthly wind speed 1948-2010 at Faridpur and 1987-2010 at Tangail. The highest value occurred in May (208 km/day in Faridpur) and the lowest in January (97 km/day in Tangail).

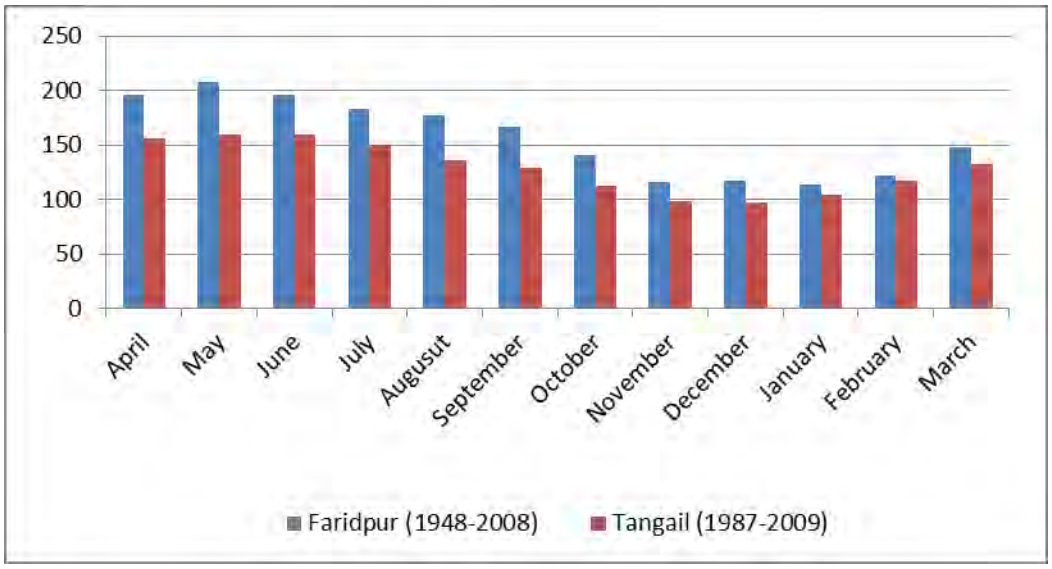


Figure 5.5: Windspeed of the study area

h) Sunshine Hours per Day

130. Figure 5.6 shows the average monthly sunshine hour per day data 1985-2008 at Faridpur and 1987-2008 at Tangail. The highest value occurred in April (8.1 hours per day in Faridpur) and the minimum in July (4.0 hours per day in Tangail).

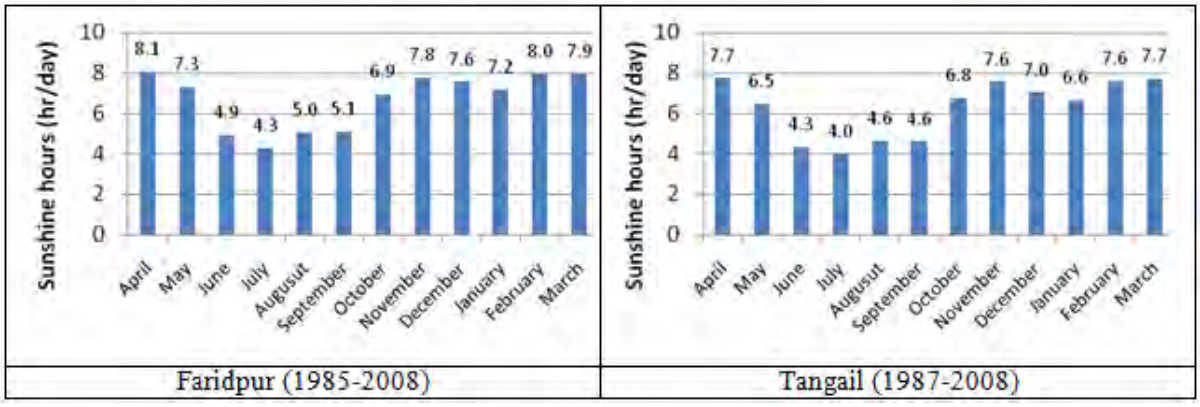


Figure 5.6: Sunshine hours per day

5.1.2 Stratigraphy and Seismicity

131. **Map 5.1** shows the ten tectonic units of Bangladesh. The study area lies mostly in the Faridpur trough. A small part of the study area in the northwestlies in the Calcutta-Mymensingh hinge. Map 5.1 shows the three seismic zones of Bangladesh. The study area falls in Zone-II. The Bask (BSC) coefficient for this zone is 0.05, which corresponds to medium earthquake vulnerability.

5.1.3 Topography

132. Map 5.2 shows 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, etc) 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.

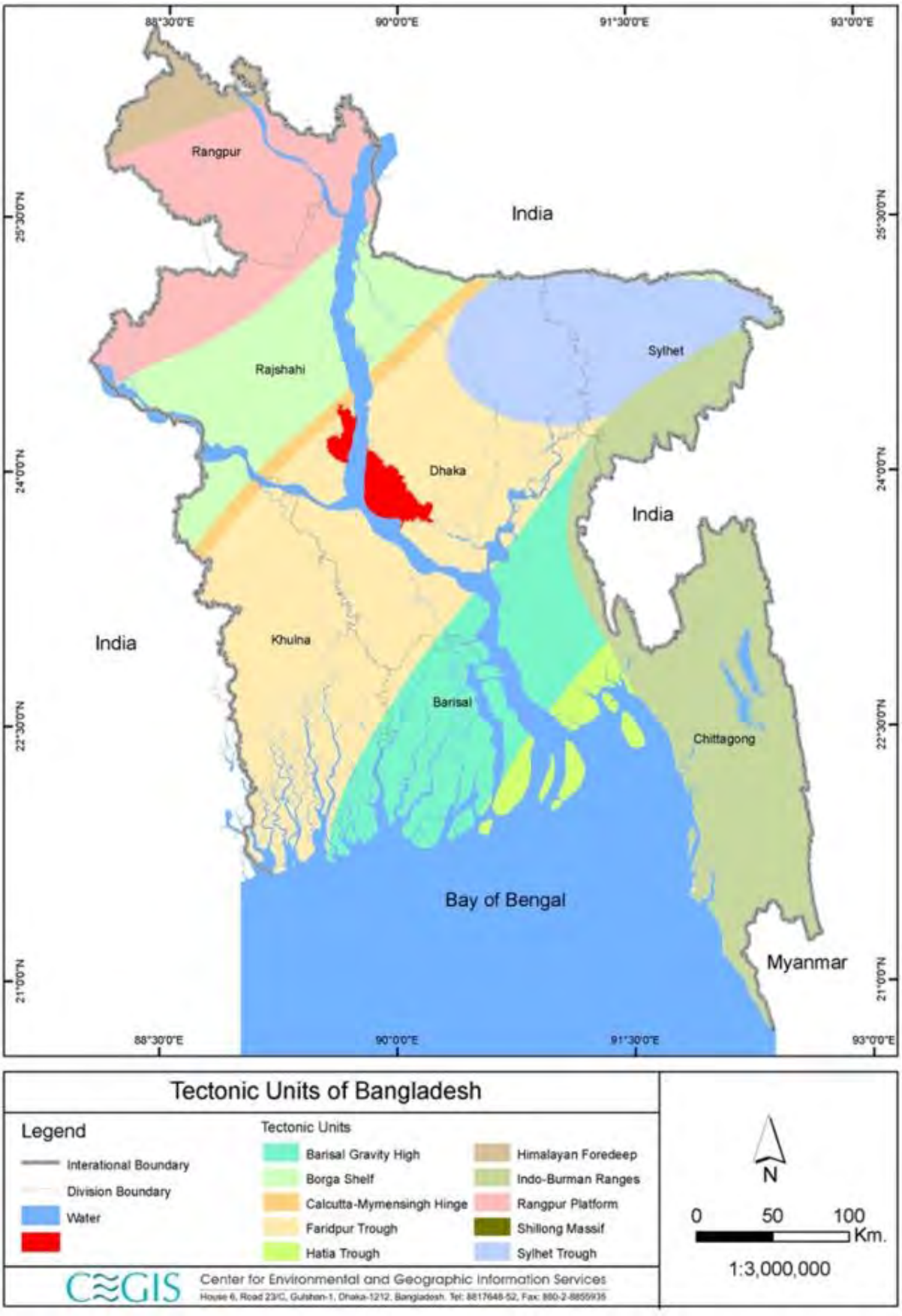
5.2 Water Resources

5.2.1 River System

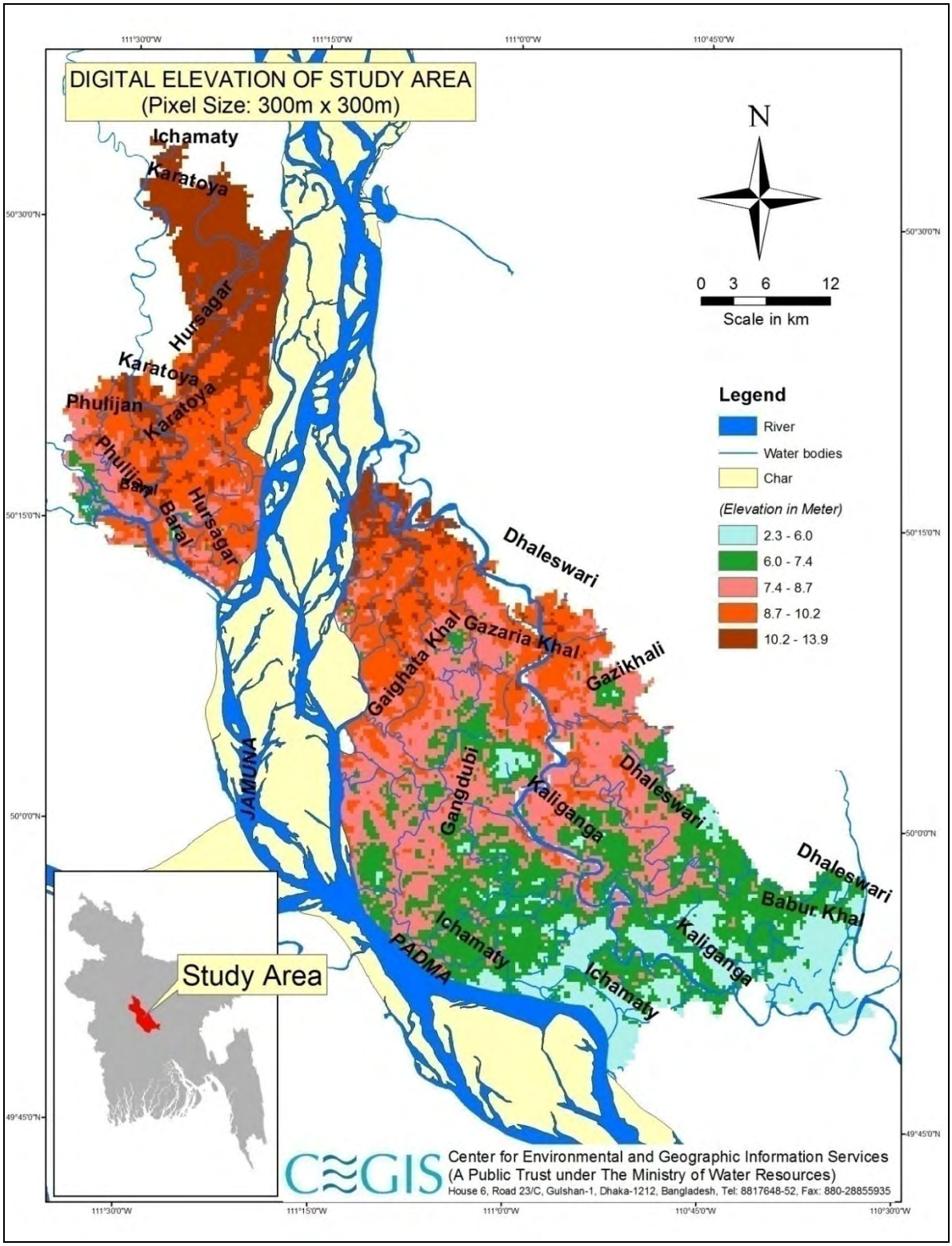
133. The study area (three sub-projects) comprises about 244,000 ha of which approximately 13 % are occupied by rivers and a very minor percentage (approximately 0.6 per cent) is occupied by other water bodies. The hydrology of the area is dominated by the three major rivers, the Jamuna, Ganges and the Padma into which they flow.

134. 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 m^3/s at Bahadurabad Transit. The flow varies from a low of 8000 m^3/s to a maximum of 100,000 m^3/s. Bankfull discharge is around 48,000 m^3/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.

135. The Ganges/Padma (above its confluence with the Jamuna) has a long-term mean flow of about 12,000 m^3/s or about 60 per cent of the Jamuna. Flood discharges reach80,000 m^3/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 m^3/s.



Map 5.1: Location of Study area in the Tectonnnnnnic units of Bangladesh



Map 5.2: Topography of the Study area

136. 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.

137. Table 5.1 and Table 5.2 show the seasonal and mean discharge values of the Jamuna and Padma rivers from 1981 to 2006 at two stations, Bahadurabad transit and Baruria transit (BWDB, 2006). The Jamuna maximum is about 50,000 m^3/s (July) while the Padma maximum is about 70,000 m^3/s (September-October).

Table 5.1: Seasonal Discharge of Jamuna and Padma

Season	Jamuna River (Bahadurabad Transit)	Padma River (Baruria Transit)
	m^3/s	
Dry (December-February)	9610	7330
Pre-Monsoon (March-May)	12700	9630
Monsoon (June-September)	35710	43250
Post-Monsoon (October-November)	25500	20660

Table 5.2: Mean Discharge (1981- 2006) of Jamuna and Padma

Season	Jamuna River (Bahadurabad Transit)	Padma River (Baruria Transit)
	m^3/s	
Dry (December-February)	6080	7650
Pre-Monsoon (March-May)	10360	10920
Monsoon (June-September)	41020	60030
Post-Monsoon (October-November)	20100	29910

Source: BWDB

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

139. The tributaries 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.

140. Some small water bodies (*Kadaibadla Beel, Pandaha Beel, Khalsir Beel, Nalai Beel, Bharua Beel, Gharilpur Beel* etc.) are found inside the study area. Most are connected to the tributary channels during monsoon.

5.2.2 Surface Water Levels and Quality

141. 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.

142. **Water levels.** Secondary data on water levels were collected for the Jamuna and Padma rivers fromthe BWDB stations at Sirajganj and Aricha. The data collected on water levels (2009) are shown below in Table 5.3. The table shows that in monsoon the average surface water levels of Jamuna and Padma riversremain about 11.73m PWD and 7.28m PWD, respectively. In the dry season, the Padma Riverbecomes extremely shallow but the JamunaRiver remains deep enough. Table 5.4 shows the average values of water levels of the two major rivers in different seasons (1991 to 2009).

Table 5.3: Water levels of Jamuna and Padma

Season	Jamuna River (Sirajganj station)	Padma River (Aricha Station)
m+PWD		
Dry(December-February)	6.84	2.85
Pre-Monsoon(March-May)	7.75	3.35
Monsoon (June-September)	11.73	7.28
Post-Monsoon (October-November)	5.5	5.80

Source: Bangladesh Water Development Board

Table 5.4: Jamuna and Padma Rivers Mean Water Levels(1991-2009)

Season	Jamuna River (Sirajganj station)	Padma River (Aricha Station)
m+PWD		
Dry (December-February)	7.60	3.23
Pre-Monsoon (March-May)	8.50	3.73
Monsoon (June-September)	12.55	8.19
Post-Monsoon (October-November)	10.32	6.22

Source: Bangladesh Water Development Board

143. **Water quality.** Sevensurface water quality parameters were collected from two BWDB stations at Bahadurabad and Aricha. The values of the parameters and their standard values set by the DoE are shown in Table 5.5andTable 5.6 respectively.

Table 5.5: Surface Water Quality of Jamuna and Padma

Station Name	River	Month	Temp (°C)	pH	DO (mg/l)	TDS (mg/l)	EC (μS/cm)	Fe (mg/l)	Cl (mg/l)
Bahadurabad Transit	Jamuna	January	29	7.8	8.29	22	66	0.02	11
		February	30	7.8	8.29	23	65	0	11
		Marh	32	7.8	8.29	21	66	0.02	10
		April	28	7.8	8.28	21	64	0.02	10
		May	28	7.7	8.26	21	65	0.01	11
		June	27	7.6	8.21	21	65	0	11
Aricha	Padma	January	28	7.3	8.16	24	69.2	0.2	12
		February	30	7.3	8.12	24	69.2	0.2	12
		Marh	30	7.3	8.16	25	69.2	0.2	10
		April	30	7.3	8.16	23	69.2	0.2	10
		May	27	7.3	8.1	22	69.2	0.2	10
		June	28	7.3	8.1	23	69.2	0.2	12

Source: Bangladesh Water Development Board

Table 5.6: Bangladesh Water Quality Standard

Water quality parameters	Standard value	Suitable for
pH	7.0-8.5	Irrigation
	6.7-9.5	Fishing
DO (mg/l)	4.0-6.0	Fishing
	5.0	Irrigation
Nitrate (mg/l)	0.01-2.0	Irrigation
	2.5-10.0	Fishing
Phosphate (mg/l)	0.01-2.0	Irrigation
	1.5-10.0	Fishing
Chlorine (mg/l)	22.0	Irrigation
	22.0	Fishing
Temperature (oC)	20-30	Irrigation
	20-30	Fishing

Source: Bangladesh Water Development Board

(i) Ground Water

144. Groundwater level data are analyzed using data of three BDWB observation wellsin three districts (Sirajganj, Manikganj and Tangail) of the study area. Figure 5.7 showsvariations of mean ground water level. The Tangail average ground water 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 drop in ground water table (up to 6 meters) was observed in 1997 and 2001.

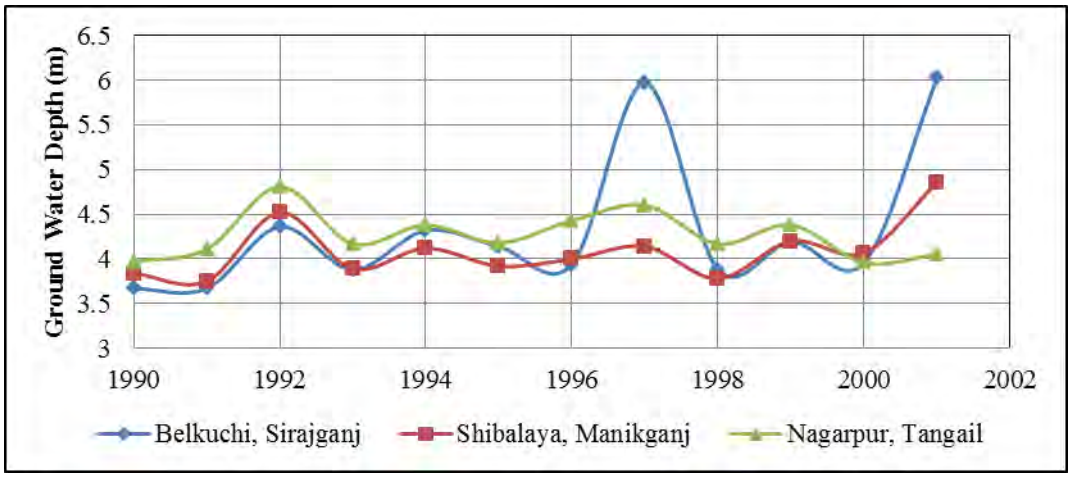


Figure 5.7: Mean Ground Water Levels, Sirajgang, Manikganj, and Tangail (1990-2001)

145. Table 10 under Annex 1 shows the ground water table (GWT) at ten year intervals at the three aforementioned locations. Values are shown for both the dry (April) and wet (September) period. In the dry season, increased use of ground water by local people lowers the GWT. During monsoon, surface water recharges the ground water and GWT rises upward. In 2000 compared to 1990, dry season GWThad dropped whereas wet season GWT had risen.

5.2.3 Water Resources Functions

146. The people of the study area not only depend on the existence of the surrounding water resources system, but also its adequate functioning. The assessment of the water resources functions is helpful to investigate the scenarios of different types of water use, as well as the consequences of natural flow phenomenon.

(a) Irrigation

147. The net cultivable area (NCA) for Tranche 1is approximately 184,200 ha, comprised of 51 per cent clay and 49 per cent loam soil. The water required to irrigate the entire NCA is approximately 2.8 Bm^3 for a single season of Boro rice planted in the Rabi winter season (generally Nov-Feb) and harvested in the Kharif monsoon season (generally Mar-Oct). Water to irrigate the NCA for Aus (rice planted and harvested in Kharif)and for Aman (rice planted in Kharif and harvested in Rabi) would be 0.55 Bm^3 each. Therefore around 3.9 Bm^3 water would be required for irrigating the entire 184,200 ha NCA. However, of this area, only 55 per cent area is irrigable. Table 5.7shows the proportion of irrigable areas and water consumed by these areas annually (Minor Irrigation Project, 2010). Approximately 2.15 Bm^3 of water is annually available for irrigation from different surface and ground water sources and around 1.75 bm^3 of water would be further required to provide irrigation in the entire NCA (Table).

Table 5.7: Irrigable Areas and Water Consumption

Irrigation methods used	Area (ha)	Percentage of NCA	Annual Water Requirements
Ground Water			
STW	94,840	51.15	2.0
DTW	6120	3.3	0.1
Surface Water			
LLP	1,020	0.55	0.05
Total Irrigated area	101,980	55	2.15 $Bm^3$of water is available for irrigation and another 1.75 Bm^3 of water is required to bring the remaining 45 per cent non-irrigated area into irrigation coverage
Total non-irrigated area	82,220	45	

Source: Minor irrigation Project, 2010

(b) Flood Management

148. Due to the flat topography of Bangladesh, just a small increase in water level above the river bank causes full-scale inundation. Figure 5.8 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.

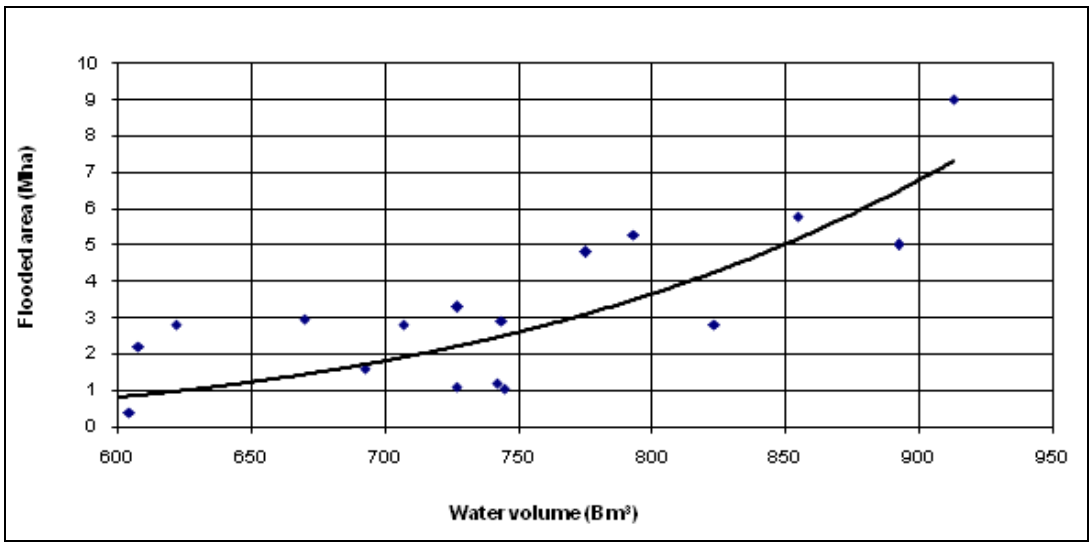


Figure 5.8: Flooded Area Vs Water Volume (1972-1993)

149. 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 19.5m PWD. The probability of flood in a year for the Padma is about 60 per cent and for the Jamuna is about 75 per cent. The average duration of flood is about 23 days in the Padma basin and about 14 days in the Jamuna basin. The durations of the floods previously affecting the Padma and Jamuna basins are given inTable 5.8.

Table 5.8: Flood Duration, Padma and Brahmaputra/Jamuna Basins

Padma Basin		Brahmaputra/Jamuna Basin	
Year	**Flood duration (days)**	**Year**	**Flood duration (days)**
1998	65	1998	63
1987	52	1974	44
2003	39	1970	26
1971	35	1984	24
1969	33	1977	22
1995	30	1973, 1980, 2007	21

Source: Flood Shelter Report, IWFM and BRAC

150. Table 5.9 and Table 5.10 show the frequency analyses of the annual maximum water levels of the Jamuna and Padma rivers (Flood Shelter Report, IWFM and BRAC). The tables explain the differences in water levels due to change in return periods. It is seen from the tables that the difference between the highest flood and the 20year flood is about 23 cm at Bahadurabad and 38 cm at Mawa.

Table 5.9: Flood Level Frequency Analysis, Jamuna at Bahadurabad

Probability distribution function	**Water level for the specified return period**(m PWD)					**Highest observed floods,** m+PWD (year)
	5 year	*10 year*	*20 year*	*50 year*	*100 year*	
Normal	20.11	20.29	20.44	20.6	20.72	20.61 (1988) 20.40 (2007) 20.37 (1998)
Log Normal	20.11	20.29	20.45	20.62	20.74	
Log Pearson Type III	20.11	20.26	20.38	20.5	20.58	
Gumbel	20.06	20.3	20.53	20.83	21.05	

Source: Flood Shelter Report, IWFM and BRAC

Table 5.10: Flood Level Frequency Analysis, Padma at Mawa

Probability distribution function	**Water level for the specified return period**(m PWD)					**Highest observed floods,** m+PWD (year)
	5 year	*10 year*		*5 year*	*10 year*	
Normal	6.5	6.67	6.81	6.97	7.08	7.14 (1998) 7.07 (1988) 6.84 (2004)
Log Normal	6.49	6.67	6.82	7.0	7.12	
Log Pearson Type III	6.5	6.64	6.76	6.88	6.95	
Gumbel	6.45	6.68	6.9	7.18	7.39	

Source: IWFM and BRAC Flood Shelter Report.

151. The severe land erosion along the river banks and char lands of the study area cause continuous siltation in a number of major tributary rivers (Karatowa, Baleswari, Baral, Hurasagar, Ichamati etc rivers) of the Padma and the Jamuna. This eventually reduces the depths of these rivers and during the dry periods these rivers become extremely shallow. As a result, water logging problems arise during the dry periods at a few locations (Ghashpukuria, Ghashkauliya, Bagutia etc villages under Chauhali and Daulatpur upazilas). The condition of drainage inside the area is poor. In the study area, drainage channels are not well developed. A significant portion of the entire study area suffers from drainage congestion problems during the wet period. As the major tributary

channels are becoming shallow because of heavy siltation, such rivers and water bodies do not provide the effective drainage needed during monsoon. Also due to the backwater effects of the two major rivers, drainage congestion problems occur. About 12.5 per cent of the total study area (some areas near JRB1 and PLB1 interventions at Belkuchi, Shahjadpur, Harirampur, Manikganj etc.) undergoes moderate drainage. The drainage of areas near the JLB2 intervention (Nagarpur, Saturia, Shibalaya etc locations) is poor.

(c) Morphology

152. 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.

(d) Erosion

153. Riverbank erosion is the most important natural cause of landlessness and forced resettlement of people in the study area. During 1973 to 2012, erosion and accretion along the Jamuna River was 87,363 ha and 16,479 ha respectively (net erosion was about 70,884 ha). In 2011, net erosion was about 1,999ha of which 250 ha were settlements. The eroded lands also included about 1,867 m of district road, 958 m of upazila road and 3019 m of rural road.

154. During the last four decades (1973 to 2011), erosion and accretion along the Padma River was 41,323 ha and 9,134 ha respectively (the net erosion was about 32,189 ha). 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. In 2011, about 679 ha of land were eroded, of which settlements were about 60 ha. On the other hand, 54 m of district road, 22 m of upazila road and 1294 m of rural road were eroded in that year. In the study area, about 360 ha of land were eroded in 2011 which included about 27 ha of settlements, 41m district road, 39m upazila road and 407m rural roads.

(e) Char Formation

155. Char lands 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 home-steads, render land unproductive, and destroy livestock. In the Jamuna floodplains, about 50 per cent people live in the island and attached chars whereas in the Padma char areas, the number is about 27 per cent (Bangladesh Flood Action Plan, 1993).

156. The study area comprises about 29,000 ha (about 12 per cent of the study area) of chars. About 90 per cent of these areas are used for different purposes (ie agriculture, settlement etc) by the local people. The remaining 10 per cent areas are not used by the local people because of its temporary existence. In the Jamuna River, about 85 per cent reduction in flow takes place during dry period. The mean depth of Jamuna River recorded near the Sirajganj Sadar reduces by approximately 39.5 per cent. About 87 per cent reduction in flow takes place in the Padma River from monsoon to dry period. The average depth of the river reduces by approximately 60 per cent (from 8.19 m during monsoon to 3.23 meters in the dry season). This significant reduction of dry season flow eventually increases the char lands during the dry season.

157. Char lands are formed mainly because of the low flow in the rivers in the dry season. Also the erosion along the sides of the Jamuna and Padma rivers result in the siltation of inside the rivers, which results in the formation of Char lands.

5.3 Land Resources

5.3.1 Agro-Ecological Regions

158. Bangladesh has a wide range of environmental conditions. Environmental diversity occurs not only at national and regional levels, it also occurs at upazila and village levels. Besides considerable year to year variability in moisture, the temperature and flood regimes create major problems for planning program on environment and agricultural research, extension and development activities.

159. Thirty agro-ecological regions and 88 sub-regions have been identified by adding successive layers of information on the physical environment which are relevant for land use and assessing agricultural potential (Map 5.3).These layers are: (i) physiography (land forms and parent materials); Soils and their characteristics; (ii) depth and duration of seasonal flooding; (iii) length of the rain-fed kharif and rabi growing periods; Length of the pre-kharif period of unreliable rainfall; (iv) length of the cool winter period and frequency of occurrence of extremely low temperature (below 0.40^{o}C); (v) winter temperature and (vi) frequency of occurrence of extremely high (> 400^{o}C) summer temperature.

160. The study area comprises of the following five agro-ecological regions:

(i) Karatoya-Bangali Floodplain (AEZ-4);
(ii) Active Brahmaputra-Jamuna Flood plain (AEZ-7);
(iii) Young Brahmaputra and Jamuna Floodplain (AEZ 8);
(iv) Active Ganges Floodplain (AEZ-10); and
(v) Low Ganges River Floodplain (AEZ-12).

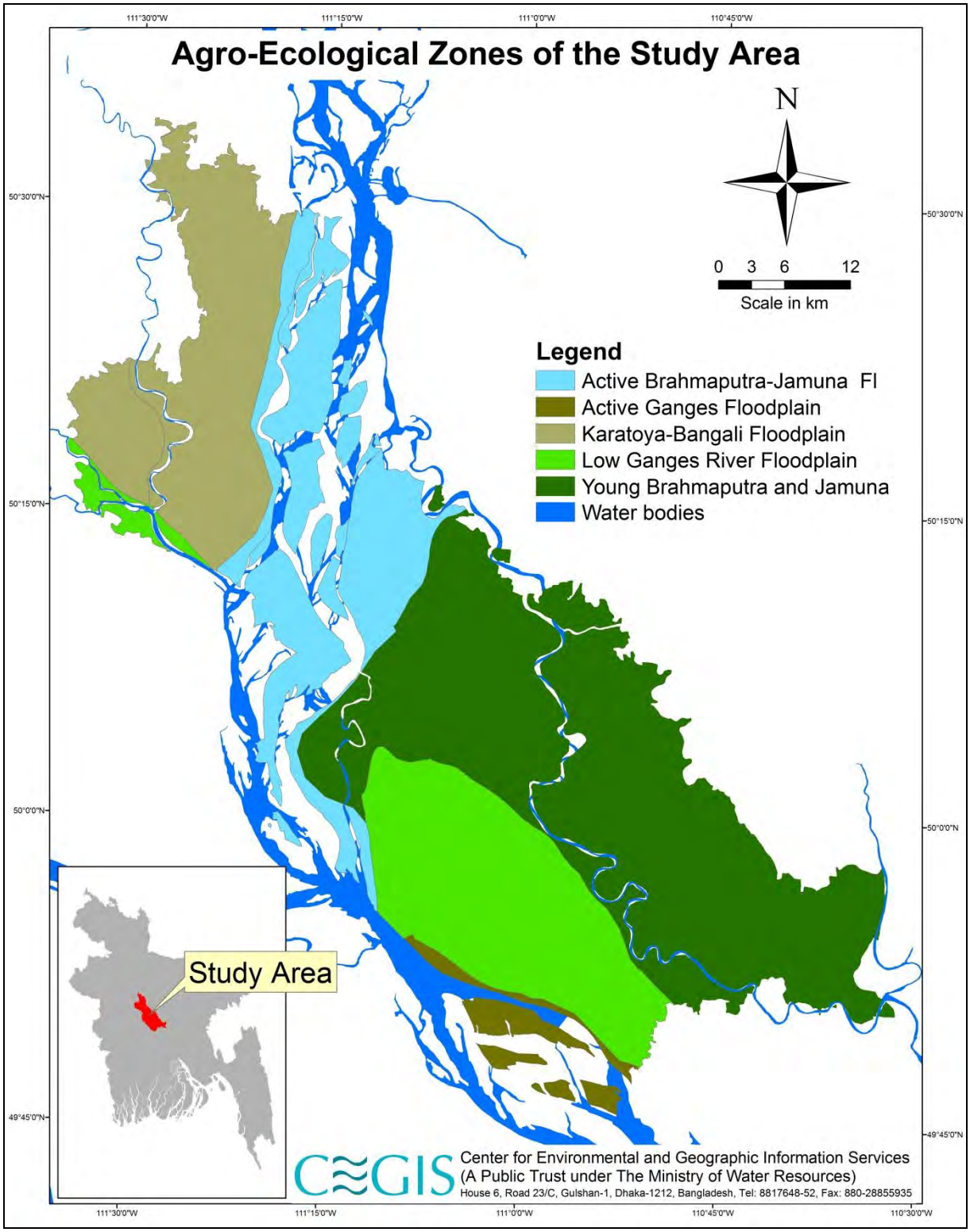
161. The distribution of agro-ecological regions in the study area is presented in **Error! Reference source not found.**5.11. Characteristics of study area agro-ecological regions are presented below.

Table 5.11: Agro-Ecological Zones

Agro-ecological Region	AEZ Area Within Study Area	
	(ha)	(per cent)
Active Brahmaputra-Jamuna	43,977	18
Active Ganges Floodplain	7,329	3
Karatoya-Bangali Floodplain	43,977	18
Low Ganges River Floodplain	46,420	19
Young Brahmaputra and Jamuna	102,613	42
Total	**244,316**	**100**

Karatoya-Bangali Floodplain Region (AEZ-4)

162. The floodplain apparently comprises of a mixture of Tista and Brahmaputra sediments. Most areas have smooth, broad, floodplain ridges and almost level basins. The soils are grey silt loams and silty clay loams on ridges and grey or dark grey clays in basins. Five general soil types occur in the region of which, Non-calcareous Grey Floodplain and Non-calcareous Dark Floodplain soils predominate. They are moderately acidic throughout. Organic matter content is low in ridge soils and moderate in basins. General fertility is medium. Some physico-chemical properties of soils of Karatoya-Bangali Floodplain Region are presented in Table 5.12.



Map 5.3: Agroecological Region of the Study Area

Table 5.12: Soil Characteristics, Karatoya-Bangali Floodplain Region

Major land type	Soil pH	Soil OM	Nutrients status								
			N	*P*	*K*	*S*	*Ca*	*Mg*	*Zn*	*B*	*Mo*
High land (23 per cent)	4.7-7.8	L	VL-L	L-M	L	L-M	Opt	Opt	L-M	L-M	Opt
Med highland (44 per cent)	5.4-7.9	L	VL-L	L-M	L	L-M	Opt	Opt	L-M	L-M	Opt
Med lowland (14 per cent)	6.2-7.7	L	VL-L	L-M	L	L-M	Opt	Opt	L-M	L-M	Opt

Source: BARC Fertilizer Recommendation Guide-2005.
Notes: OM=Organic matter; VL=Very low; L=Low; M=Medium; Opt=Optimum; H=High; VH=Very high.

Active Brahmaputra-Jamuna Flood plain Region (AEZ-7)

163. This subunit, which underlies agro-ecological region 7, comprises young, stratified, alluvial land within and adjoining the shifting channels of the Brahmaputra and Jumna Rivers, the Old Brahmaputra River and the Dhaleswari-Kaliganga River. The land formation (char) are liable to change shape each year as river banks are eroded,new alluvium is deposited within and alongside channels and older deposits are buried by layers of new alluvium. The relief varies from smooth to irregular, with differences in elevation of 2-3 meters or more between adjoining ridges and depressions. The depth of flooding varies from shallow to deep on different sites and the maximum depth may vary by a meter or more from year to year. The area is occupied by sandy and silty alluvium rich in minerals with slightly alkaline in reaction. The Brahmaputra sediments are greyer in color than the Ganges sediments. Six general soil types occupy the area of which only Non-calcareous Alluvium predominates. Organic matter content is low and fertility status low to medium. Some physico-chemical properties of soils of Active Brahmaputra-Jamuna Flood plain Region is presented in Table 5.13.

Table 5.13: Soil Characteristics, Active Brahmaputra-Jamuna Floodplain

Major land type	Soil pH	Soil OM	Nutrients status								
			N	*P*	*K*	*S*	*Ca*	*Mg*	*Zn*	*B*	*Mo*
Medium highland (37 per cent)	5.7-8.2	L	L	L-M	L-M	L-M	L-M	L-M	L-M	L-M	M
Medium lowland(20 per cent)	6.0-8.2	L	L	L-M	L-M	L-M	L-M	L-M	L-M	L-M	M

Source: BARC Fertilizer Recommendation Guide-2005.
Notes: OM=Organic matter; VL=Very low; L=Low; M=Medium; Opt=Optimum; H=High; VH=Very high.

Young Brahmaputra and Jamuna Floodplain Region (AEZ 8)

164. The region comprises of the area of Brahmaputra sediments. It has a complex relief of broad and narrow ridges, inter-ridge depressions, partially in filled cut-off channels and basins. This area is occupied by permeable silt loam to silty clay loam soils on the ridges and impermeable clays in the basins; neutral to slightly acid in reaction. General Soil Types include predominantly Grey Floodplain soils. Organic matter content is low in ridges and moderate in basins. Soils are deficient in N, P and S but the status of K and Zn is medium. Some physiochemical properties ofsoils of Young Brahmaputra and Jamuna Floodplain are presented inTable 5.14.

Table5.14: Soil Characteristics, Young Brahmaputra and Jamuna Floodplain

Major land type	Soil pH	Soil OM	Nutrients status								
			N	***P***	***K***	***S***	***Ca***	***Mg***	***Zn***	***B***	***Mo***
High land (18 per cent)	5.6-7.5	VL-L	VL-L	L	M	L	M	M	L-M	L-M	M
Med highland (42 per cent)	5.4-7.5	VL-L	VL-L	L	M	L	M	M	L-M	L-M	M
Med lowland (19 per cent)	5.4-7.5	L	L	L	M	L	M	M	L-M	L-M	M

Source: BARC Fertilizer Recommendation Guide-2005.
Notes: OM=Organic matter; VL=Very low; L=Low; M=Medium; Opt=Optimum; H=High; VH=Very high

Active Ganges Floodplain Region (AEZ-10)

165. The agro-ecological regions of Active Ganges Floodplain comprises of young, stratified, alluvium land within and adjoining the shifting channels of the Ganges River and its two main distributaries, the Gorai- Madhumati and Arial khan. The alluvial formations (chars) are liable to change shape each year as river bank are eroded, new alluvium are deposited within and along channels and older deposits are buried by layers of new alluvium. The relief varies from smooth to irregular, with 2-3 meters or more difference in elevation between the adjacent ridges and depressions. Seasonal flooding varies from shallow to deep on different sites and may vary in depth by more than a meter between years. The area has complex mixtures of calcareous sandy, silty and clayey alluvium. The general soil types predominately include Calcareous Alluvium and Calcareous Brown Floodplain soils, which are low in organic matter and mildly alkaline in reaction. The fertility status generally is medium. Physiochemical properties of soils of Active Ganges Floodplain Regionare presented inTable 5.15.

Table5.15: Soil Characteristics, Active Ganges Floodplain Region

Major land type	Soil pH	Soil OM	Nutrients status								
			N	*P*	*K*	*S*	*Ca*	*Mg*	*Zn*	*B*	*Mo*
High land (12 per cent)	7.1-8.1	L	L	L-M	M	L-M	H	H	L	M	M
Med highland (33 per cent)	7.1-8.1	L	L	L-M	M	L-M	H	H	L	M	M
Med lowland (18 per cent)	7.1-8.1	L	L	L-M	M	L-M	H	H	L	M	M

Source: BARC Fertilizer Recommendation Guide-2005.
Notes: OM=Organic matter; VL=Very low; L=Low; M=Medium; Opt=Optimum; H=High; VH=Very high.

Low Ganges River Floodplain (AEZ-12)

166. This region comprises of the north-eastern, eastern and south-eastern parts of the Ganges Meander Floodplain which are lower lying than the western part. The ridges are mainly shallowly flooded, but basins become moderately deeply or deeply flooded in the rainy season.

167. The soils of the Low Ganges River Floodplains are silt loams and silty clay loams on the ridges and silty clay loams to heavy clays on lower sites.General soil types predominately include Calcareous Dark Grey, Grey and Calcareous Brown Floodplain soils. Organic matter content is low in ridges and moderate in the basins. Soils are calcareous in nature having neutral to slightly alkaline in reaction. General fertility level is medium. Some physiochemical properties of soils of Low Ganges River Floodplainare presented inTable 5.16.

Table 5.16: Soil Characteristics, Low Ganges River Floodplain

Major land type	Soil pH	Soil OM	Nutrients status								
			N	*P*	*K*	*S*	*Ca*	*Mg*	*Zn*	*B*	*Mo*
High land (13 per cent)	6.8-8.2	L	VL-L	VL-L	M-Opt	L-M	Opt-H	Opt-H	L-M	M-Opt	Opt
Medium highland (29 per cent)	6.2-8.3	L-M	VL-M	VL-M	M-Opt	L-M	Opt-H	Opt-H	L-M	M-Opt	Opt
Medium lowland (31 per cent)	6.0-8.3	L-M	L	L	M-Opt	L-M	Opt-H	Opt-H	L-M	M-Opt	Opt
Lowland (14 per cent)	6.0-7.7	M	L	L	M-Opt	L-M	Opt-H	Opt-H	L-M	M-Opt	Opt

Source: Fertilizer Recommendation Guide-2005, BARC
Notes: OM=Organic matter; VL=Very low; L=Low; M=Medium; Opt=Optimum=High; VH=Very high

5.3.2 Land use

168. The total study area is about 244,316ha of which about 184,200 ha is net cultivable area (NCA). Settlements and water bodies constitute about 11 per cent and 13 per cent respectively of the total area of the project. The settlements and river constitute about 23 per cent and 8 per cent respectively of the total area. Details of land use of the study area are presented in Table 5.17.

Table 5.17: Land Use of the Study Area

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

Sources: CEGIS estimation from SOLARIS.

5.3.3 Land type

169. Land type classifications are based on depth of inundation on agriculture land during monsoon season due to normal flooding. There are five land type classes: high land (0-30 cm), medium highland (30 - 90 cm), medium lowland, (90 -180 cm), low land (180 - 300 cm), and very lowland (>300 cm). The percentages of land type of high land, medium highland, medium lowland, lowland and very lowland are about 4, 37, 37, 21 and 0.3 respectively of the NCA. Detailed land type is presented in Table 5.18.

Table 5.18: Land Types of the Study Area

Land type	**Area** (ha)	**Per cent of NCA**
Highland	8,153	4
Medium Highland	68,045	37
Medium Lowland	68,023	37
Lowland	39,376	21
Very Lowland	605	0.3
Total	**184,200**	**100**

Sources: CEGIS estimation from SOLARIS.

5.3.4 Soil Texture

170. Soil texture is the relative proportions of sand, silt and clay. It is very important for agriculture crop production. The percentages of texture of surface soil of the study areas are about 7, 44, 39, 6 and 4 per cent for clay, clay loam, loam, sand, sandy loam respectively of the NCA. Data on soil texture is presented in Table 5.19.

Table 5.19: Soil Texture, 0-15 cm Depth

Texture	Area(ha)	Percentage of NCA
Clay	13,157	7
Clay Loam	80,193	44
Loam	72,511	39
Sand	11,389	6
Sandy Loam	6,950	4
Total	**184,200**	**100**

Sources: CEGIS estimation from SOLARIS.

5.3.5 Available Soil Moisture

171. The available soil moisture is very important for the cultivation of Rabi crops. The high (72.9%) and medium level (26.9%) of available soil moisture has been observed in the study area. The distribution of available soil moisture is presented in Table5.20.

Table 5.20: Soil Moisture of the Study area

Soil Moisture	Area	Per cent of NCA
High	134,373	72.9
Medium	49,485	26.9
Low	342	0.2
Total	184,200	100.0

Source: CEGIS estimation from SOLARIS.

5.3.6 Drainage Characteristics

172. 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 5.21.

173. Most of the area (83%) of the NCA is under imperfectly drained condition. The rest (17 per cent) 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 5.21: Drainage Characteristics of the Study Area

Drainage classes	Drainage characteristics	Area (ha)	Percent ofNCA
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 metre 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 Agriculture Resources

5.4.1 Farming Practices

174. Farming practices in the study area are largely controlled by physical, biological, climatological and socioeconomic factors. Agricultural crops are grown by cropping seasons. There are two distinct cropping seasons in a year. They are Kharif and Rabi seasons. The Kharif season starts from March and ends in October while the Rabi season starts from November and ends in February. Based on crop adaptability and crop culture, the Kharif season has been further sub-divided into Kharif-1 (March-June) and Kharif-II (July-October) season.

175. Kharif-I is characterized by high temperature, low humidity, high evaporation, high solar radiation and uncertainty of rainfall of low alternating dry and wet spells. In this season, mainly Aus rice, Jute and Vegetables are grown. The Kharif-II season is characterized by high rainfalls, lower temperatures, high humidity, low solar radiation and high floods that recede towards the end of the season. Rice is the predominant crop grown during this season due to the submergence of soil. Excessive soil moisture also restricts other crops suitable for a high temperature regime. Local transplanted Aman (LT Aman) and High Yielding Varieties of Transplanted Aman (HYV Aman) rice are grown in Kharif-II season in the study area.

176. The Rabi season starts from November and ends in February. During this season, crops are favored with high solar radiation, low humidity and temperature, but inadequate soil moisture due to very low or no rainfall depresses crop yield throughout the season. Wide ranges of crops can be grown in this season. Major crops grown in this season in the study area are HYV Boro (Photo 5.1), Pulses, Spices, Mustard (Photo 5.2), Potato and Vegetables. However, there are occasional overlaps such that Kharif-II season crops (Aman rice) are harvested in Rabi season and Rabi season crop (Maize, Potato and vegetables) are harvested in Kharif-I season and Jute is harvested in Kharif-II season.

Photo 5.1: Boro Seedbed

Photo 5.2: Mustard

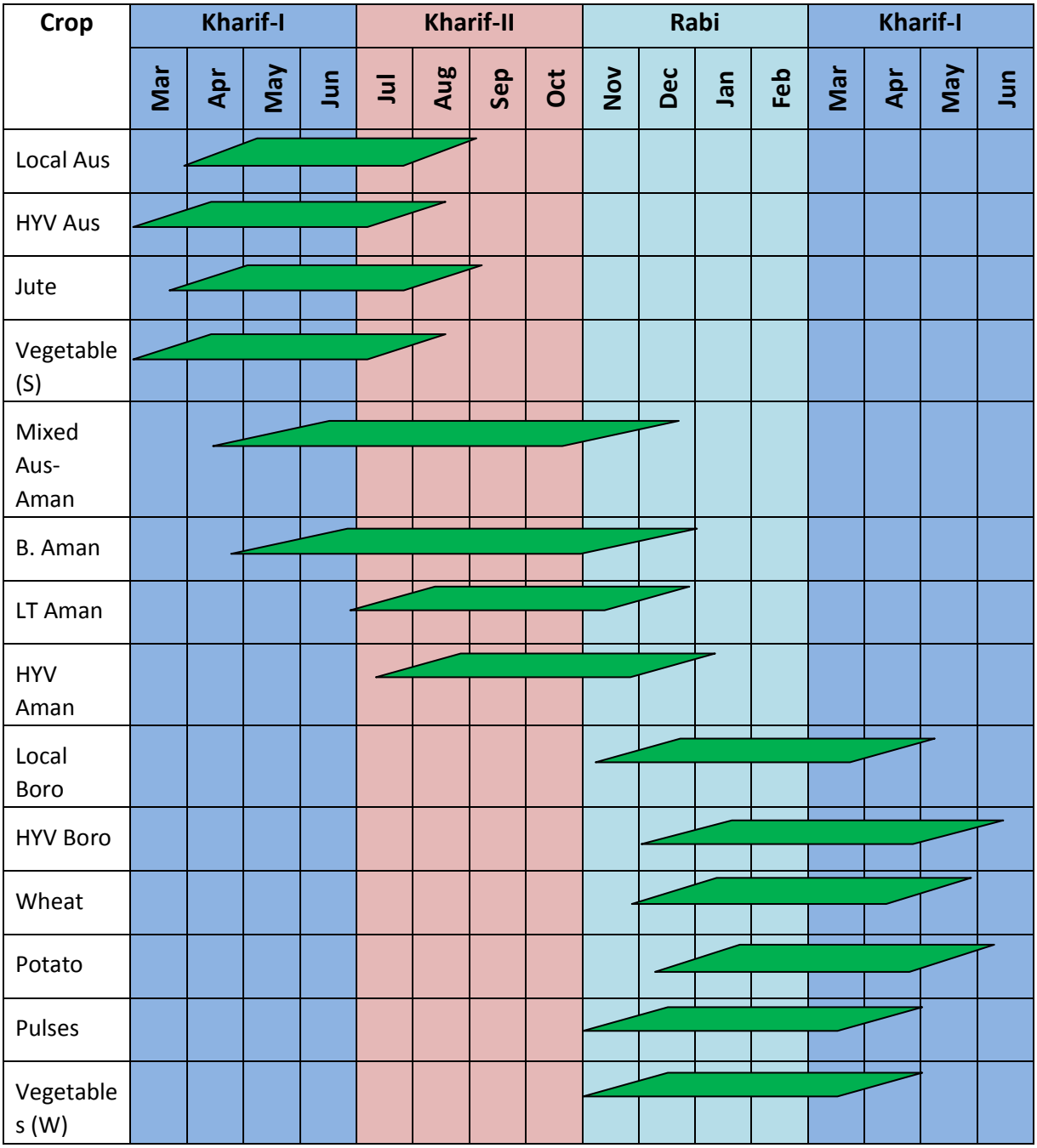
5.4.2 Crop Production Constraints

177. The main constraints that are found in the study area are erosion of river, drainage congestion, siltation of different internal river and drainage khals, scarcity of irrigation water in Boro season etc. Siltation of different internal Khals caused drainage congestion which affected transplantation of HYV Aman crops. Jute, Vegetables and Maskalai are also affected. Scarcity of irrigation water affect Boro cultivation and river bank erosion cause loss of fertile agriculture lands.

5.4.3 Crop Calendar, Crop Pattern andCropping Intensity

178. Figure 5.9 shows the crop calendar.

Figure 5.9: Crop Calendar



179. Cropping pattern, defined as the sequence of crops grown in Kharif-I, Kharif-II and Rabi crops in a plot of land in any one year, varies with flood timing, land type, and soil fertility.

180. Cropping patterns practiced on land types in the study area are presented in Table 5.22, which shows 24 major cropping patterns on five land types. Dominant high land cropping patterns are HYV Aus-Fallow-Mustard and Jute-Fallow-Lentil. Dominant medium high land cropping patterns in the include Fallow-HYV Aman-HYV Boro, HYV Aus-HYV Aman-Onion, Jute-HYV Aman-HYV Boro, Jute-Fallow-Mustard, Fallow-LT Aman-Wheat and local Aus-HYV Aman. Dominant medium low

landcropping patterns are B. Aman-HYV Boro, LT Aman and Fallow-Fallow-HYV Boro. Dominant cropping on low land and very low land respectively are single-cropped HYV Boro and Local Boro.

Table 5.22: Cropping Pattern by Land Type

Land type	Kharif-I (March-June)	Khartif-II (July-Oct)	Rabi (Nov-Feb)	Area (ha)	Per cent of NCA
High Land	Vegetables	Vegetables	Vegetables	1150	0.7
	Maize	Fallow	Potato	1,500	0.8
	HYV Aus	Fallow	Mustard	3,853	2.1
	Jute	Fallow	Lentil	1,650	0.9
	Sub-total:			*8,153*	*4.43*
Medium High Land	Fallow	HYV Aman	HYV Boro	13,625	7.4
	HYV Aus	HYV Aman	Onion	7,173	3.9
	Maize	HYV Aman	HYV Boro	1,608	0.9
	Fallow	HYV Aman	Ground nut	2,873	1.6
	Dhaincha	HYV Aman	HYV Boro	4,229	2.3
	Sesame	Fallow	Mustard	4,650	2.5
	Jute	HYV Aman	HYV Boro	8,770	4.8
	Jute	Fallow	Mustard	5,912	3.2
	Fallow	Local T Aman	Wheat	7,040	3.8
	Local Aus	HYV Aman	HYV Boro	8,080	4.4
	Maize	Fallow	HYV Boro	4,085	2.2
	Sub-total:			*68,044*	*36.9*
Medium Low Land	B. Aman	B. Aman	HYV Boro	15,000	8.1
	B.Aman	B.Aman	Black gram	8,341	4.5
	Mixed Aus+ B.Aman	B. Aman	Kheshari	8,540	4.6
	B. Aman	B. Aman	Kheshari	6,500	3.5
	Fallow	Local T. Aman	HYV Boro	11,321	6.1
	Fallow	Fallow	HYV Boro	12,931	7.0
	Fallow	Local T. Aman	Garlic	5,390	2.9
	Sub-total:			*68,023*	*36.9*
Low Land	Fallow	Fallow	HYV Boro	39,375	21.4
	Sub-total:			*39,375*	*21.4*
Very Low Land	Fallow	Fallow	Local Boro	605	0.3
	Sub-total:			*605*	*0.3*
Total:				***184,200***	***100.00***

Source: CEGIS field survey, 2013, plus secondary data from Upazila Agricultural Offices of the study area.

5.4.4 Cropped Area

181. Detailed areas of crops are shown in Table 5.23 which exhibits that total cropped area is 335,099 ha of which 240,052 ha is under rice crop cultivation. Therefore, about 72 per cent of the total cropped area in the study area is under rice crop and the rest (28.3 per cent) is covered with non-rice crops. Pulses and Jutes are the major among the non-rice crops which occupied about 26.3 per cent and 17.1per cent of the total cropped area respectively. The other non-rice crops covered

56.6 per cent of the total cropped area which include spices, oilseeds, wheat, potato and vegetables crops.

Table 5.23: Crop Production

No.	Crop	Area (ha)	Damage-Free			Damaged			Total Production (tons)
			Area (Ha)	Yield (t/ha)	Production (Tons)	Area (Ha)	Yield (t/ha)	Production (Tons)	
1	Local Aus	8,080	6,060	1.4*	8,526	2,020	0.7*	1,353	9,880
2	HYV Aus	11,026	7,718	1.7*	10,860	3,308	1.2*	2,216	12,213
3	Jute	16,332	13,066	2.4	18,383	3,266	1.5*	2,188	19,737
4	Maize	7,193	7,193	6.5	10,121	-	-	-	11,474
5	Vegetables	3,450	2,588	14	3,641	863	8	578	4,994
6	Sesame	4,650	4,650	0.95	6,543	-	-	-	7,896
Kharif-1 Total:		**50,731**	**41,274**		**58,073**	**9,457**		**6,336**	**59,426**
7	Mixed Aus-Aman	8,540	8,540	0.80*	12,016	-	-	-	12,016
8	B. Aman	29,841	19,397	0.85*	27,291	10,444	0.7*	7,697	28,644
9	HYV Aman	39,185	23,511	2.1*	33,080	15,674	1.3*	11,552	34,433
10	Local Aman	23,751	17,813	1.3*	25,063	5,938	0.8*	4376	26,417
Kharif-2 Total:		**101,317**	**69,261**		**97,450**	**32,056**		**23,625**	**98,803**
11	HYV Boro	119,024	101,170	4.0*	142,347	17,854	2*	35,886	143,700
12	Local Boro	605	605	1.9*	851	-	-		851
13	Wheat	7,040	7,040	2.4	9,905	-	-		9,905
14	Potato	1,500	1,500	15	2,111	-	-		2,111
15	Mustard	14,415	14,415	0.96	20,282	-	-		20,282
16	Pulses	25,031	25,031	1	35,219	-	-		35,219
17	Spices	12,563	12,563	4.6	17,676	-	-		17,676
18	Ground nut	2,873	2,873	1.5	4,042	-	-		4,042
Rabi Total:		**183,051**	**165,197**		**232,433**	**17,845**		**35,886**	**233,786**
Cropped Area		335,099	275,733			59,358			
NCA		184,200							
Cropping Intensity		**182 per cent**							

Source: CEGIS field survey, 2013, plus secondary data from Upazila Agricultural Offices of the study area.

182. From the Table 5.23 it is calculated thatamong the rice crops, Aus covers 11.5 per cent, Aman covers 38.7 per cent and Boro covers 49.8 per cent of the cropped area. About 70.5 per cent of the area is occupied by high yielding varieties and rest of the area is covered by local varieties of rice crop. Among the non-rice crop, Pulses cover about 25,031 ha; Jute 16,332 ha; Mustard 14,415 and spices 12,563 ha. About 3,450 ha of the total cropped areas are used for both summer and winter vegetable cultivation.

5.4.5 Crop Production

183. Crop production data, presented inTable 5.23, indicates that the major agricultural production of the study area comes from the rice crops. In the study area, the annual total rice production stands at about 268,154 metric tons. There is a production loss in rice production in the study which is calculated as 63,080 MT. Among the rice crops, Boro is contributing about 54 per cent (144,551 MT) followed by T. Aman 33 per cent (89,494 MT), T Aus 8 per cent (22,093 MT) and Mixed Aus-Aman 4 per cent (12,016 MT) of the total rice production. Different types of non-rice crops are grown in about 95,047 ha land and production is about 1,33,336 MT. The non-rice crops are Pulses

(about 35,219 MT), Spices (about 17,676MT), Jute (about 19,737MT), Mustard (about 20,282 MT), Vegetables (about 4,994MT) and Potato (about 2,111 MT).

5.4.6 Crop Damage

184. Table 5.23 also articulates the crop damage area and damaged yield in the study area. During the field survey, it was found that major crop damaging factors are heavy rainfall, floods, river erosion, drainage congestion and hailstorm during monsoon period; irrigation water scarcity and drought during dry season and pest infestation throughout the year. Boro crop of the study area suffered due to non-availability of surface water and lowering of ground water table during the flowering stage. For this reason, about 15 per cent of Boro crop area suffered damage annually and yield of this crop was reduced by about 24 per cent to 26 per cent. Aus crop was damaged due to heavy rainfall during the month of June and July at harvesting period of this crop. Jute also suffers during their sowing period when the distribution of rainfall is uneven. Farmers try to meet up the demand of water with the help of irrigation water. But their attempts fail due to non-availability of surface water due to siltation of the khals/rivers. About 35 per cent area of Aman crop was affected by flood, river erosion and drainage congestion during the months of August and September. Early drought also delay transplanting and harvesting of crop which affect the growing of Rabi crops after Aman rice. This crop also faces maximum drought stress during panicle initiation to the maturity stage. Crop production loss has been calculated using the formula: Crop production loss = Total cropped area × normal yield - (damaged area ×damaged yield+ damage-free area × normal yield).

5.4.7 Agricultural Inputs

185. Fertilizers and pesticides are used for all crop cultivated in the study area (Table 5.24). However, the rate of use of fertilizer per hectare varies considerably from farmer to farmer depending on soil fertility, cropping pattern and financial ability. The major fertilizers used in this area are Urea, TSP, MoP and Gypsum. Urea is widely used for potato (300-350 kg/ha), vegetables (200-300 kg/ha) HYV Boro (200-250 kg/ha) crop while less fertilizer is used in pulses (20-50 kg/ha), jute (60-100 kg/ha) and B. Aman (60-100 kg/ha). The use of pesticides depends on the degree of pest infestation. The major insects as reported by the farmers are stem borer, gal midge, leaf roller, rice bug, rice hispa, brown plant hopper and caterpillar for rice crop. Different types of fungus damages the Rabi crops. Local farmers reported that they are using different types of pesticides and fungicides to prevent pest infestation in croplands. Mainly pesticides are used in liquid form. Diazinon (Raison-60EC), Carbofuran (Brifer-5G), Sipermethrin (Siperin-10EC), Fipronil (Regent-3G), Melathion (Sifanon-57EC) are the main pesticides available in the study area. The most use of pesticide is for cultivating vegetables, farmers use 700ml/ha liquid pesticides in 2-3 times for the cultivated period, while less pesticides are used (0-1 times with 700ml/ha) for HYV Aus, local aman, wheat, pulse and jute. Details of fertilizer and pesticides application of the study area is presented in Table 5.24.

5.4.8 Minor Irrigation

186. Table 5.25 shows that in the study area about 55% of the cultivable areas are irrigated. Ground water irrigation coverage is about 99% of total irrigation coverage in the dry season. Mainly shallow tube-wells (STW) are used for lifting ground water for irrigation. The remaining 1 % is irrigated by low-lift pumpsand traditional methods that lift surface water from rivers, canals, and beels (Photo 5.3).

Table 5.24: Fertilizer and Pesticides

Crop name	Fertilizer (Kg/ha)				Pesticides		
	Urea	TSP	MP	Gypsum	No. of Appli.	Liq. (ml/ha)	Gran. (Kg/ha)
Local Aus	100-140	-	-	-	-	-	-
HYV Aus	100-140	40-60	0-40	0-40	0-1	700	7-8
HYV Aman	120-180	60-80	20-40	0-40	1-2	700	7-8
Local Aman	100-140	40-60	20-40	0-40	0-1	700	7-8
B. Aman	60-100	0-40	-	-	-	-	-
HYV Boro	200-250	100-120	80-100	50-100	1-2	700	7-8
Wheat	180-220	60-80	40-50	40-60	0-1	700	7-8
Pulses	20-50	40-50	20-40	-	0-1	700	7-8
Oilseeds	100-180	40-60	30-40	30-40	0-1	700	7-8
Spices	200-250	120-160	100-150	60-100	0-2	700	7-8
Potato	300-350	100-150	150-200	20-40	1-2	700	8-10
Vegetables (W)	200-300	100-200	100-200	-	2-3	700	8-10
Vegetables (S)	200-300	100-200	100-200	-	2-3	700	8-10
Jute	60-100	30-40	30-40	0-50	0-1	700	7-8

Source: CEGIS field survey, 2013, plus Irrigation statistics secondary data from study area Upazila Agricultural Offices.

Photo 5.3: Surfacewater-Irrigated Agricultural Field

Table 5.25: Minor Irrigation

Mode of Irrigation Equipment	Number	Irrigated Area (ha)
Deep Tube Well	283	6,094
Shallow Tube Well	47,705	94,530
Low Lift Pumps	108	1360
Total	48,096	101,984 (55.4 per cent)

Source: BADC Minor Irrigation Survey Report, 2009-10.

5.5 Livestock and Poultry

187. Livestock and poultry play a significant role in the agro-based economy of Bangladesh. Table 5.26 shows estimates livestock and poultry numbers in the study area. Livestock constitute an important part of the wealth in the study area, providing draft power, leather, meat, milk, and cow dung for fuel and fertilizer. Many individuals earn their livelihood through work associated with raising cattle and poultry. Draught power for tilling the land, the use of cow dung as manure and fuel, and animal power for transportation, a ready source of capital and meat, milk and eggs for human consumption make up the demand of the local area. In addition, hides and skins, bones,

feathers, etc, help in earning money. Livestock resources also play an important role in the sustenance of landless people.

Table 5.26: Livestock and Poultry

Live stock/Poultry	Number of Livestock/Poultry
Cattle/cow	974,817
Buffalo	1,563
Goat	290,967
Sheep	89,843
Horse	2,438
Chicken	2,876,480
Duck	524,564
Pigeon	93,580

Source: Upazila Livestock Offices and Census of Agriculture.

5.5.1 Livestock and Poultry Health

188. The health of an animal is a major concern in the study area. Health issues include infection by bacteria, virus, mycoplasma, or parasite. Disease outbreaks cause considerable economic loss in livestock farming. A bacterial or viral disease normally kills an animal, whereas parasites are mainly associated with debility and loss of production. Major bacterial diseases include *peste des petits ruminants* (PPR), foot and mouth disease (FMD), anthrax, badla (black quarter), diarrohea, pneumonia, and parasitic diseases such as worm infestation. In addition, a number of arthropods, including flies, ticks and mites, have economic importance mainly due to their role in pathogen transmission. Major poultry diseases are duck plague, paralysis, Newcastle, fowl pox and dysentery etc. Infectious disease is most prevalent in the rainy season between Septembers to October months, though most diseases continue at lower levels throughout the year.

5.5.2 Constraints of Livestock and Poultry Rearing

189. Livestock owners face problems due to shrinking and degrading pastures, coupled with fodder shortages due to dried up grazing land, during the December-April period. In Kharif-II season, almost all higher lands remain under crops and lower-lying areas are flooded. Grazing area shortages throughout the year aggravate the livestock feeding problem. Household poultry survives by scavenging and though generally no feed supplements are provided, kitchen waste can be a significant food source. Feed prices in the study area are high.

190. Another constraint of livestock and poultry production in the study area is a lack of veterinary health services, veterinary support services, quality production inputs, veterinary extension services and cooperation between private and public sectors dealing with prevention, diagnosis, treatment, and control of disease. Upazila Livestock Office capacity is limited.

191. Additional factors constraining livestock in the study area include low levels of knowledge of local people, frequent natural hazards, slaughtering of young cattle during religious festivals, and unplanned slaughtering of cattle for meat throughout the year.

5.6 Fisheries

192. Fisheries resources of the study area are diversified with different fresh water fish habitats. Open water fish habitat consists of seasonal and perennial rivers, *khals, beels*, and floodplain. The major rivers Jamuna and Padma and *beels*account for most of the fish production in the area. *Khals*act as major arteries of fish migration between habitats and playa vital role in maintaining species richness and fisheries productivity. Photo 5.4 and Photo 5.5 show the open water fish habitats of the study area.

Photo 5.4: Openwater Fish Habitat

Photo 5.5: Openwater Fish Habitat

193. Fish biodiversity is relatively rich, however, it is decreasing due to indiscriminate fishing, obstruction of migration routes (especially in the dry season), discharge of industrial waste, poor fisheries management, siltation, oil spills, insecticide contamination, and loss of critical habitats to siltation and bank erosion. Indiscriminate fishing practices include capture of brood-fish especially during the over-wintering period and use of *current jal* to catch juvenile fish (local name jatka), especially *hilsa*, and dewatering of *beels* for irrigation or fishing.

194. Aquaculture is also present in the study area. Two types are practiced, traditional and semi-intensive,

5.6.1 Open Water Fish Habitat

195. **Habitat Classification.**Fish habitats of the study area are classified into river, khal, seasonal beel. The Jamuna and Padma contain water year round. The other water bodies present in the study area are beel, floodplain, fish pond,khaland seasonal *beels*.

196. **Habitat Distribution.**Map 5.4shows a map of fish habitats of the study areaupazilas (seven in Manikganj, one in Tangail, and four in Sirajganj districts). Capture fisheries habitats with an area of 92,740 ha include rivers, *khals*, perennial and seasonal *beels* and floodplain. Table 5.27 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 fishes take shelter when river water levels drop. Deep areasplay a vital role in fish propagation. The major problems in these riverine fish habitats are siltation and erosion.

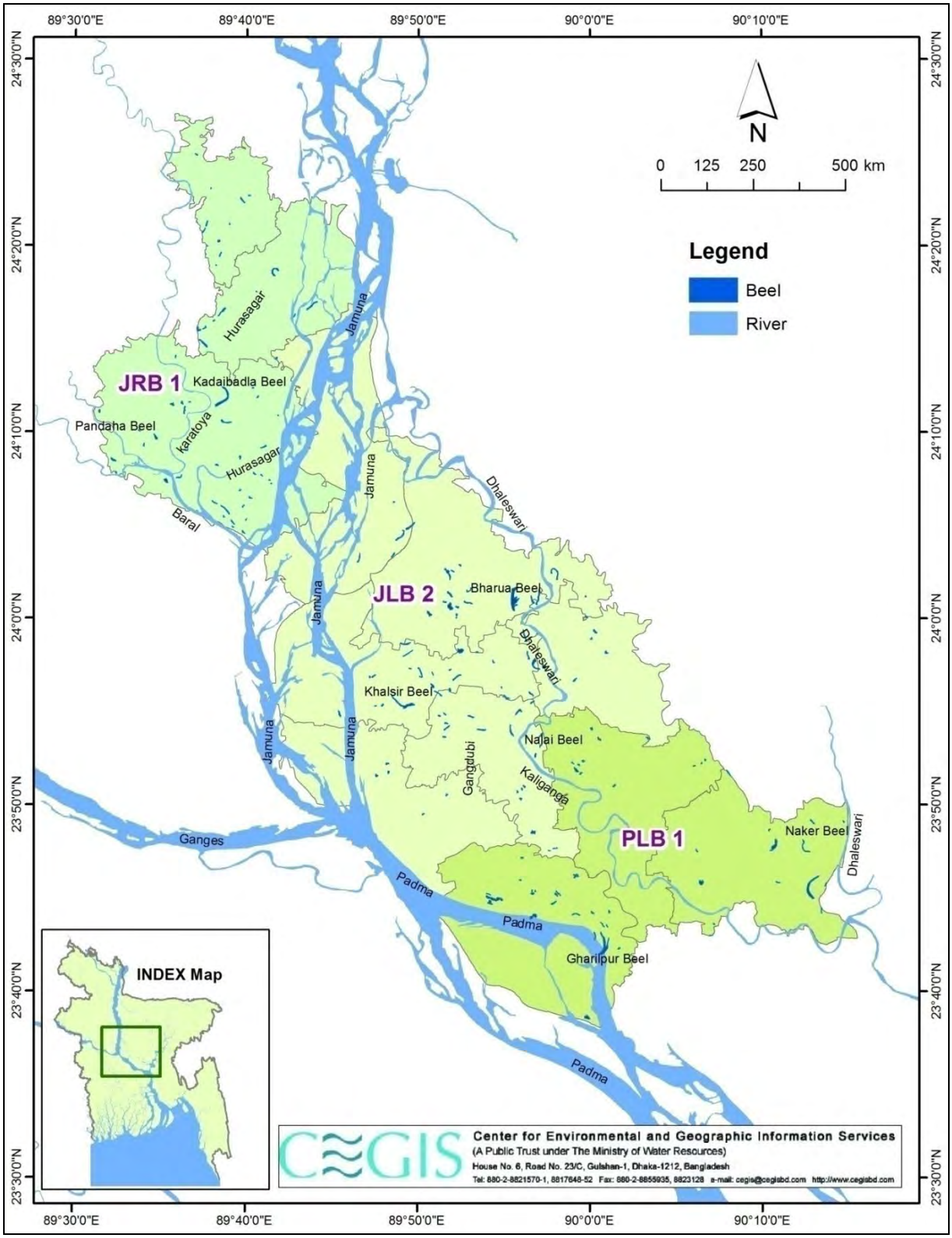
Table 5.27: Fish Habitat

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	Fish pond	1,235
		Sub total:	1,235
		Total:	**93,975**

Source: CEGIS field Survey, 2013

Culture fisheries

197. Aquaculture is moderate in this study area. Different types of fish culture system are adopted by the local people, like monoculture and poly-culture in small ditches and ponds. Improved pond cultures are not found in the study area due to flooding. The estimated pond area is 1,235 ha. Both perennial and seasonal ponds are found.



Map 5.4: Fish Habitat area in the study area

5.6.2 Fish Production

198. Table 5.28 show fish production for each habitat type. As these illustrate, most fish production is from the capture fishery and rest coming from the culture fishery. Estimated total fish production is about 21,659 MT.

Table 5.28: Fish Production by Habitat

Sl. No.	Habitat Category	Habitat Type	Total production (MT)
1	Capture	River	4,617
		Khal	47
		Beel	722
		Kol (Semi closed water body)	871
		Floodplain	11,956
		Sub total:	18,213
2	Culture	Fish pond	3,446
		Sub total:	3,446
		Total:	**21,659**

Source: Field observation, FRSS 2010-11.

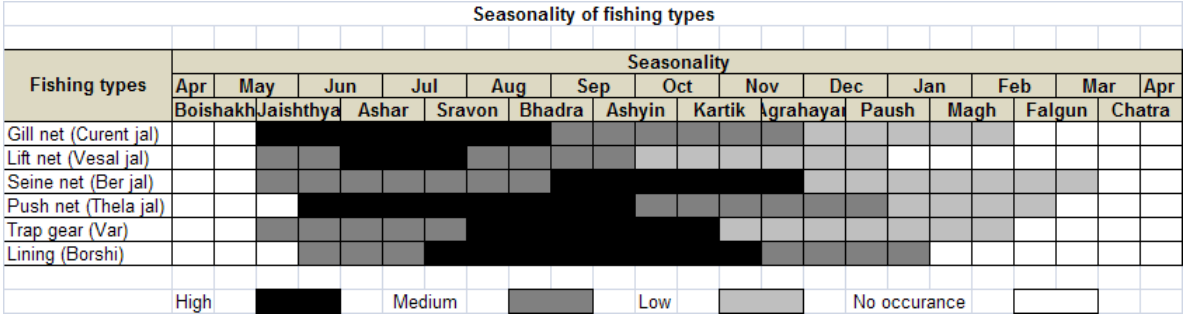
Fishing Effort

199. **Fisher number**. Two types of fishers found in the study area are commercial and subsistence fishers. But no part-time fishers have been recorded. The number of commercial fisher household is 6,983 which constitute 89 per cent of the total fishers. Maximum commercial fishers have been recorded in Daulatpur (22 per cent) and Horirumpur (49 per cent) of Manikganj district. Subsistence fishers have been found as 11 per centof total fishers. Diversified fishing community structure has been found in this study area. In Nagarpur Upazila of Tangail district, *hindu* community covers about 84 per cent and in some villages like *Dhamshar, Madhupur, Ulail, Mulkandi, Daulatpur Sadar, Binodpur, Charakholsi, Boinna, Bishnopur, Shamganj* of Daulatpur Upazila of Manikganj district is about 100 per cent. However, about 90 per cent of the fishers come from the Muslim community in total. They usually catch fish in the nearby *beels*, floodplains, rivers and *khals* using country boat and *dingi* boats particularly during wet season.

200. **Fishing season.**Fishing in floodplain, *beel*, river and *khals* starts in May and continue up to November except river. The seasonality of major fishing is furnished in theTable 5.29.

201. **Fishing crafts and location.**Country fishing boats are widely used to catch the fish in the study area. The fishers catch the fish in Jamuna, Karotoa, Ichamati, Baral, Dhalai, Sonai, Hura-sagar (old part of Jamuna river) and Dhaleshwary rivers round the year. However, fishing in seasonal beel and floodplain are done in monsoon only. The subsistence fishers catch the fish in same water bodies in the study area both in monsoon and dry season.

Table 5.29: Seasonality of Fishing Types



202. **Fishing gears.**Different types of nets/gears are used for fishing in the study area. These are: (i) *currant jal* used to catch *baim, tengra, punti, baila*, etc; (ii) *kona jal*used to catch *rui, catla, baim,*

tengra and small fishes, fry and fingerlings; (iii) *jhaki jal*used to catch *baila, punti, tengra, gulsha, shole, taki,* etc; (iv) *thela jal* used to catch *gura chingri, baila, punti, tengra*; (v) *dharmo jal* used to catch *gura chingri, baila, punti, tengra* etc. and (vi) *Berjal* used to catch small and big fish. Fish spears mostly target *shol, magur, gozar, boal*, etc. Only 25 to 30% of fishers have fishing boats and around 80% fishers have fishing gears/nets. The other fishing practices in the area are through lining (*Borshi*), spear (*koch*), trap (polo, bamboo traps, *chotka and dori*), *hajari borshi* (a lot of serial spear at one baseline) and *katha* fishing (*nim* fishing). These gears are used to catch *boal, rui, katla, air, punti, common carp, tilapia, shole, taki* etcin both the capture and culture fisheries.

5.6.3 Fish Migration

203. Overall status of fish migration in the study area is moderate to poor. The river Jamuna and Padma acts as main fish migration route between *beel* and adjacent *beel* and floodplain. The Jamuna river is connected with the other four rivers named Karotoa, Ichamati, Baral, Dhalai, Sonai, Hura-sagar (old part of Jamuna river) and Dhaleshwary which internally connect Sirajganj, Tangail and Manikganj district in the study area. Moreover, during pre-monsoon and monsoon period (availability of water in khal) *Shameshpur khal, Banigati Khal, Balorampur Khal,* etc *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* etc for the Manikganj district maintain the major arteries of the fish migration. These khals carry waters from the above mentioned river to both the perennial and seasonal beel.Fish migration usually occurs during pre-monsoon to some extent and largely during peak monsoon. Reportedly, feeding and spawning migration of riverine and beel resident fish species occur through open khals and channels between beels and rivers and over bank spill during the period of late May to August. During this period such fish species as *tengra, punti, chela, baim, gutum, taki, koi etc*migrate through khals to beels and floodplain each year. Seasonal water bodies such as *Kholsi beel, Kumuria beel, Shampur kum beel* etc are used as feeding and nursing ground by most of the open water fishes. Many fish species migrate horizontally to these water bodies as part of their life cycle. Nevertheless, aggradations of external rivers and internal khals of the study area due to siltation and water regulatory structures on the khals cause the reduction of the length of successive migratory routes.

204. Some of the fishes throughout their life cycle have no dependence on the floodplain. But some of the fishes are found more dependent on floodplain to complete their life cycle. Table 5.30 lists migratory fish species (species that migrate between river and floodplain). Table 5.31 lists the khal locations and their connections to other water bodies in the study area. Table 5.32 lists beel sanctuaries in the study area.

Table 5.30: Migratory Fish Species

No.	Scientific Name	Local Name
1	Labio rohita	Rui
2	Catla catla	Catla
3	Cirrhinus mrigala	Mrigal /Mirka
4	Cirrhinus reba	Raik
5	Labeo bata	Bata
6	Labeo boga	Bhangan
7	Labeo calbasu	Kalbaus
8	Labeo gonius	Ghonia
9	Aorichthyes aor	Ayre
10	Aoichthyes seenghala	Guzzi ayre
11	Mystus blekeeri	Golsha Tengra
12	Mystus cavasius	Kabashi Tengra
13	Chela laubuca	Kash khaira
14	Securicula gora	Ghora chela
15	Salmostoma bacaila	Katari chela

No.	Scientific Name	Local Name
16	Salmostoma phulo	Fulchela
17	Gudusia chapra	Chapila
18	Eutropiichthyes vacha	Bacha
19	Pseudeutropius atherinoides	Batasi
20	Ompok bimaculatus	Kani Pabda
21	Ompok Pabo	Pabda
22	Ompok pabda	Modhu pabda
23	Wallagu attu	Boal
24	Notopterus chitila	Chital

Source: FAP 17, Supporting Volume No. 10.

Table 5.31: Khal Locations and Connections

Name of District	Name of Upazila	Source River	Connecting Khal	Connecting Water Bodies (Beel / River / Floodplain).
Sirajganj	Belchuchi	Jamuna	Balorampur Khal	Chondi beel
		Hura-Sagor (Old part of Jamuna)	Shameshpur khal	Floodplain
			Banigati Khal	Kamarullahpara beel
			Khashnamoki Khal	
			Kamarullahpara Khal	
	Shahjadpur	Baral	-	Kadaibadla beel
		Sonai	-	Charkai beel
		Bag-Jamuna Nageswary	Barabil Khal	-
		Bag-Jamuna Nageswary	Barabil Khal	Pandaho beel
		Karotoa	Potazia Khal	Pranonathpur beel
			Madla Khal	-
		Dholail	-	Shaildar beel
	Kamarkhand	Hura-Sagor (Old part of Jamuna)	Shampur Khal	Nandinamadhu beel
			Chaubari khal	Dashsika beel
			Balorampur Khal	Pakuria beel
Tangail	Nagarpur	Dhaleshwary	Shureshwary Khal	Shonshi beel
			Baro Khal	Mailjani Rag beel
			Nardohi Khal	Autpara beel
		Jamuna	East Dhadra Vikon Khal	Alokdia beel
				Kustia beel
				Bara Pasha beel
			West Dhadra Vikon Khal	Bonogram beel
Manikganj	Daulatpur	Jamuna	Tutium Dhamshar Khal	Mixes with Kaliganga river
			Kholshi-Kumuria Khal	Kholsi beel
				Kumuria beel
		Old Dhaleshwary	Jeonpur Laotara Khal	Kholsi beel
			Mandatta Khal	Bahora Mola beel
				Dharer beel
			Dhamsar Kakna Khal	Dhala Pukur beel
		Dhaleshwary	-	Nilua beel
				Niraligala beel
				Pasthobi beel
				Ulail beel
				Nimaikhali beel
				Shampur kum beel
	Ghior	Old Dhaleshwary	-	Choto Niluar beel
				Char Ghior Mollar beel

Name of District	Name of Upazila	Source River	Connecting Khal	Connecting Water Bodies (Beel / River / Floodplain).
		Jamuna	-	Char Bailjuri Jala beel
				Char Bailjuri beel

Table 5.32: Beel Sanctuaries

Name of District	Name of Upazila	Nos. of Sanctuary	Name of Beel Sanctuary
Sirajganj	Belkuchi	2	Kamarullapara
			Saratoil-1
			Saratoil-2
	Shahjadpur	1	Potajia beel
	Kamarkhand	1	Kutirchar beel
Tangail	Nagarpur	2	Shonshi beel
			Bara Pasha beel
Manikganj	Daulatpur	3	Bahora Mola beel
			Dhala Pukur beel
			Nilua beel

Source: Upazila fisheries offices.

5.6.4 Fish Species Suitable for Fish Pass/Friendly Structures in Jamuna Catchment

205. **Swimming characteristics of fishes**. For fish pass/friendly structure planning, the speed and endurance of migratory fish was examined. Three aspects of swimming speeds, which vary with fish species, can be defined:

- Cruising speed: one that can be maintained for long period of time (hours);
- Sustained speed: one that can be maintained for minutes; and
- Darting speed: a single effort, not sustainable (estimated maximum duration, 10 seconds).

206. Table 5.33, Table 5.34 and Table 5.35 provide information on fish characteristics relevant to establishing fish pass/ fish-friendly structures, for a number of fish species of importance in the study area.

Table 5.33: Fish Pass/Fish Friendly Structure: Large Non-Carp Fish Species

Group	Species	Type	Minimum Size			Maximum Size (cm)		
			TL	**Vc**	**Vm**	**TL**	**Vc**	**Vm**
			(cm)	(cm/s)		(cm)	(cm/s)	
Large Catfish	Boal	B	48	35	70	115	85	170
	Air	B	43	30	60	85	65	130
	Baghir	B	80	60	120	180	135	270
	Rita	B	33	25	50	55	40	80
Knifefish	Chital	P	43	150	300	100	350	700
Herring	Ilish	P	28	100	200	45	160	320
Spiny Eel	Baim	B	38	30	60	80	60	120

Notes: TL total length, Vc cruising velocity, maximum (burst) velocityl
Source: FAP 6.

Table 5.34: Fish Pass/Fish Friendly Structure: Barbs and Catfish

Group	Species	Type	Minimum Size*	Maximum Size**

			TL	Vc	Vm	TL	Vc	Vm
			(cm)	(cm/s)		(cm)	(cm/s)	
Small Barbs	Puti	P	3.5	10	20	10	35	70
	Mola	P	4.5	15	30	9	30	60
	Chela	P	5.5	20	40	15	55	110
Small Catfish	Bacha	P	17	60	120	25	90	180
	Garua	P	16	55	110	25	90	180
	Baspata	P	7.5	25	50	10	35	70
	Batashi	P	5.5	20	40	7	25	50
	Tengra	P	9	5	10	15	10	20
	Gulsha	B	11	10	20	18	15	30

Source: FAP 6.

Table 5.35: Fish Pass/Fish Friendly Structure: Other Small Fish Species

Group	Species	Type	Minimum Size*			Maximum Size**		
			TL	Vc	Vm	TL	Vc	Vm
			(cm)	(cm/s)		(cm)	(cm/s)	
Loach	Rani	B	7.5	5	10	12	10	20
Spiny Eel	Shile Baim	B	14	10	20	25	20	40
	Tara Baim	B	14	10	20	28	20	40
Needlefish	Kaikka	P	18	65	130	25	90	180
Sardine	Chapila	P	11	40	80	15	55	110

Source: FAP 6.

5.6.5 Fish Biodiversity

207. The area, which includes reaches of the Jamuna and Padma Rivers, is rich in fish biodiversity; 120 fish species are recorded as available in the area.[20] A fish species list is presented in Table 5.36.

Table5.36: Fish Species of the Study area

Scientific Name	Local Name	Habitat		
		Beel and floodplain	River and khal	Pond
Hilisha ilisha	Ilish	A	P (River)	A
Pangasius pangasius	Pungus	A	P (River)	A
Glossogobius giuris	Baila	P	P	A
Puntius sophore	Jatputi	P	P	A
Prawn sp.	Chingri	P	P	A
Macrognathus aral	Tara baim	P	P	A
Mastacembelus armatus	Sal baim	P	P	A
Anabas testudineus	Koi	P	A	A
Heteropneutes fossilis	Shing	P	A	A
Channa panchtatus	Taki	P	A	A
Nandus nandus	Veda	P	A	A
Mystus vitatus	Tengra	P	P	P
Notopterus notopteus	Foli	P	A	A
Hypophthalmichthys molitrix	Silver Carp	A	A	P
Aristichthys nobilis	Bighead Carp	A	A	P
Ctenopharyngodon idella	Grass Carp	A	A	P
Catla catla	Catla	P	P	P
Labeo rohita	Rui	P	P	P
Labeo bata	Bata	P	P	P
Cirrhinus mrigela	Mrigel	P	P	P

[20] 1995. Flood Action Plan 17, Supporting Volume 10.

Scientific Name	Local Name	Habitat		
		Beel and floodplain	River and khal	Pond
Ciprinus carpio	Carfu	A	A	P
Labeo calbasu	Kalibaus	P	P	P
Oreochromis mossambicus	Tilapia	A	A	P
Oreochromis niloticus	Nilotica	A	A	P
Clarias batrachus	Magur	P	A	A
Channa striatus	Shol	P	P	A
Gudusia chapra	Chapila	P	P	A
Amblypharingodon mola	Mola	P	P	A
Wallago attu	Boal	P	P	A
Ompak pabda	Pabda	P	P	A
Mystus bleekri	Gulsha Tengra	P	P	A
Aorichthys aor	Ayre	P	P	A
Lepidosephalus guntia	Gutum	P	P	A
Macrognathus aculatus	Guchi baim	P	P	A
Rasbora daniconius	Darkina	P	P	A
Xenentodon cancila	Kakhila	P	P	A
Colisa fasciata	Khalisa	P	P	A
Corica soborna	Kaski	P	P	A
Puntius gonionotus	Thai Sarpunti	A	A	P

208. Fish biodiversity and abundance has been declining. Causes include water quality degradation including non-point source agricultural pollution (agrochemicals and pesticides) and point-source industrial pollution (from garmentfactories and other industries, especially in Sirajganj district). Other causes are obstruction to fish migratory routes, silting in and obstruction of internal khals, silting in of floodplain wetland fish habitats and shrinkage of spawning and feeding grounds.

5.6.6 Species of Conservation Significance

209. Fish species which are locally unavailable for last 10-15 years or have become rare as reported by the local fishers and concerned elderly people are given in the followingTable 5.37.

Table 5.37: Fish Species of Conservation Significance

Scientific name	Local name	Local Status	
		Rare	Unavailable
Puntius sarana	Deshi Sarputi	√	
Ompak pabda	Pabda		√
Lepidosephalus guntia	Gutum		√
Notopterus chitila	Chital	√	
Mastacembelus armatus	Sal baim	√	
Labeo bata	Bata		

Source: Upazila fisheries offices.

5.6.7 Area of Conservation Significance

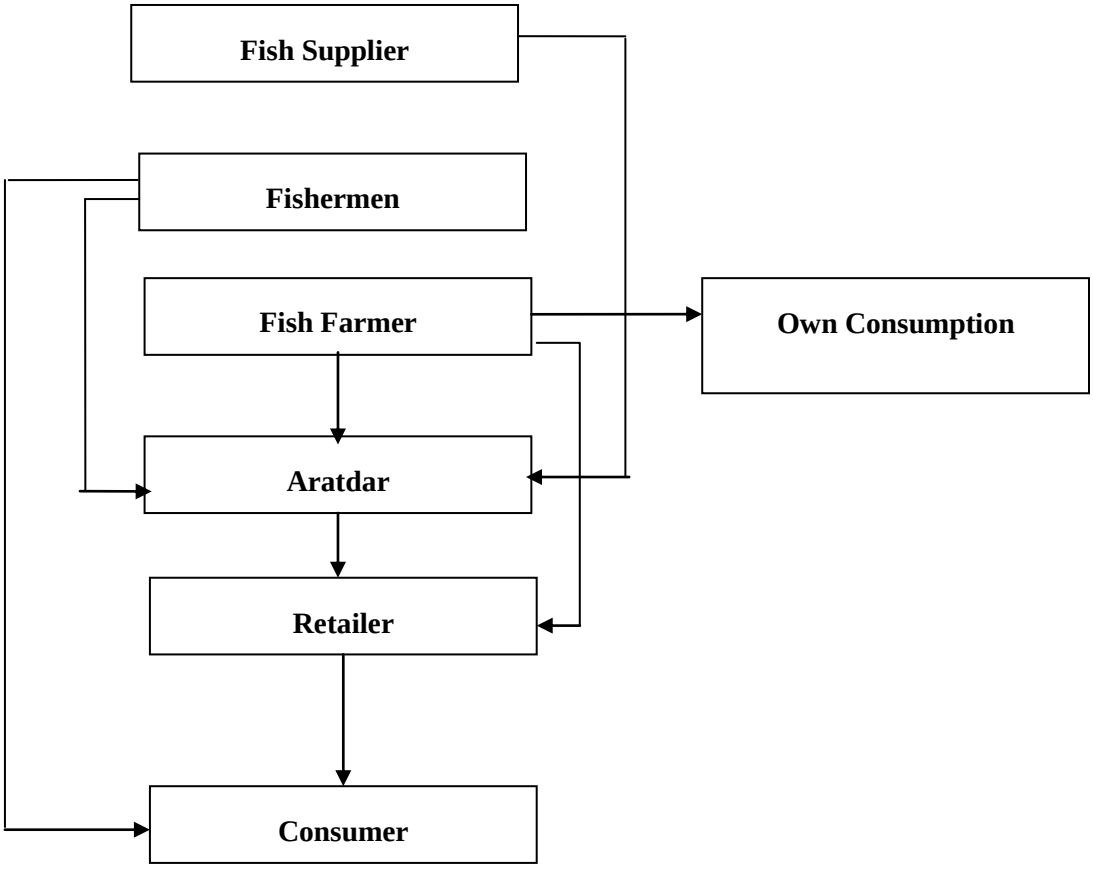
210. The water bodies in the study area are used as feeding and spawning ground of most of the open water fishes. Both perennial and seasonal beel are present in the study area. The deep portion of the *beel* can be conserved for fisheries propagation in the area. Department of fisheries (DoF) has declared fish sanctuaries in the area. They have made first a boundary around the selected water bodies using bamboo or concrete pillar and net. Then they have made some block at the bottom of water bodies for fishes' shelter. DoF and local people jointly manage these *beels* so that nobody can catch fish or disturb these fish species. In monsoon period when the water level rise up to 2m for all

the beel area then the local people are allowed to catch fish in the beel except the sanctuary area. There are 10*beel* sanctuaries present in the study area.

5.6.8 Fish Marketing and Post-Harvest Facilities

211. Fish edible quality is in good condition for human intake.But the use of agrochemicals and pesticides is deteriorating the fish edible quality and causing fish diseases especially in dry season. Some of the frequently observed diseases are tail and fin rot disease and cotton fungus. The local fishermen sell bulk of their fishes either directly to the local fish market (bazaars at Baghabari, Rautara, Bantiar,Betil etc. in Sirajganj District; Nagarpur, Dupuria, Vadra,Sabadpur in Tangail District; and Jhitka, Nayarhat,Andharmanik,Balra in Manikganj district). There are fifteen ice factories in the study area mainly located near whole sale markets. A few fish landing centers with poor structure have been found in this study area. Frequently occurred river bank erosion is the main cause of this status. There are no storage facilities. Transportation facility at root level is on foot, rickshaw and CNG auto rickshaw. Fish marketing channel is shown in Figure 5.10.

Figure 5.10: Fish Marketing Channels



5.6.9 Fisher's Lifestyle

212. Average daily income of commercial fishers isBDT 300-350 in monsoon period (May to November). Income level of commercial fisher is decreasing day by day. Consequently, they are changing their occupation. Most of the fishers are living in Horirampur Upazila. This upazila covers vast part of the study area. The fishers are also vulnerable to the musclemen who convert open water fish habitats into culture fishery. Some of the fishers are involved with fish trading, fry trading and some are working as labor in fish farm especially in dry season.

5.6.10 Fisheries Management

213. Fisher based community association has been found in Shahjadpur of Sirajganj, Nagarpur of Tangail and Daulatpur in Manikganj District in the study area. Fishing right on existing fish habitats is limited. Upazila Fisheries office conducts technical training on fish culture for fish farmers and some activities such as awareness meeting, nursery management, linkage development among the fish traders in future. Enforcement of fisheries regulation is also weak.

5.7 Ecological Resources

5.7.1 Bioecological Zones - Introduction

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 Beeland (v) Ganges floodplain.

(a)Teesta Floodplain

214. The Teesta floodplain bio-ecological zone is spread over Nilphamari, Lalmonirhat, Rangpur, Kurigram, Gaibandha, Bogra and Naogaon district. The Teesta River has occupied and later abandoned several channels during the last few thousand years. These are now occupied by the Mahananda, Punarnava, Atrai, Choto Jamuna, Kortoya and Ghagat Rivers.

215. Prior to clearance for agriculture, this zone was heavily forested, and it is still fairly wooded. Many valuable indigenous timber species are found here: Sal (*Shorea robusta*), Banyan tree (*Ficus bengalensis*), and Aswatha (*Ficus religiosa*). Fruit-bearing indigenous tree species are also found here:Mango (*Mangifera indica*), Guava (*Psidium guajava*), Sharifa (*Anona squamosa*), Tamarind (*Tamarindus indica*), Jackfruit (*Artocarpus heterophyllus*), Nut (*Terminalia catappa*), and Date Palm (*Phoenix sylvestris*), etc (Bari, 1979).

216. Early records show that tigers, leopards, buffaloes, deer, monkeys, wild boars, etcwere common in this zone until the end of the 19th century, but gradually were extirpated due to loss of habitat. Squirrels, rats, mice, shrews, jackals, foxes, frogs, and toads are still widely distributed in this zone. Commonly-found reptile species include the Bengal monitor (*Varanus bengalensis*), other lizards, snakes, freshwater tortoises and turtles and different species of poisonous and non-poisonous snakes. Among the bird species, the common peafowl (*Pavo cristatus*), once common in this zone, has now completely disappeared. Many other birds once common and widely distributed are generally less plentiful now. Most of the common bird species of Bangladesh is still found in this zone (Bari, 1979).

(a) Major Rivers

217. 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. Newly accreted land, if it does not erode quickly, is initially colonized by grass, particularly catkin grass (Saccharum spontaneum, for example). Dense growth of catkin grass can accelerate silt deposition on chars. The Jamuna River yields the highest amount of char lands. 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 waterfowls are directly or ecologically dependent on these rivers and their associated ecosystems. However, it is quite alarming that with the exception of a few species of turtles, all other river biodiversity is threatened with extinction.

(b) Brahmaputra–Jamuna Floodplain

218. 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 (ie 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 etc, many of which yield valuable products. Bushes of reeds and canes are also found here. The faunal diversity in this zone is also rich. The most common poisonous snake in this area is the Banded krait (*Bungarus fascinatus)*, which could easily be identified by its broad black and yellow bands. In mammalian species, bats, several species of monkeys, pangolins, and raptorial birds are found.

(c) Chalan Beel

219. Chalan Beel, the center of which is located some 10km north of the JRB-1 area 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 more or less 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.

220. Significant species diversity of Chalan Beel is as follows. At present amphibian fauna in the *beel*include seven species of frogs and one species of toad. A total of 34 species of reptiles are found in this zone of which ten are turtles and tortoise, nine are lizards and the remaining 15 include various snake species. Of the turtles and tortoise, the Asiatic Soft-shell Turtle and three-keeled land tortoise are globally threatened. A total of 195 bird species from 51 families are recorded in this zone of which 140 are resident and 55 are migratory. Similarly a total of 27 species of mammals from 12 families are recorded in the beel.Of them, the smooth-coated otter is vulnerable in Bangladesh.

221. The common tree species in this area are Barun *Crataeva nurvala*, Aswatha *Ficus religiosa*, Aum *Mangifera indica*, and Hijol *Barringtonia acutangula*. The banks of the *beels* are vegetated with dense stands of Kash *Saccharum spontaneum*, Paddo *Nelumbo nucifera*, Nol *Arundo donax*, Dhol Kalmi *Ipomoea fistulosa*, Shimul *Bombax ceiba* and Date palm *Phoenix sylvestri*).

222. The northern palm squirrel, smooth-coated otter, fishing cat, cotton-pigmy-goose, small buttonquail, purple swamp hen, three-stripe roof turtle, painted roofed turtle, common krait are common wildlife species in this zone.

(d) Ganges Floodplain

223. 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. A noteworthy aspect here is that the Gangetic alluvium is readily distinguishable from the old Brahmaputra, Jamuna and Meghna sediments by its high lime content. Beside this the relief is locally irregular alongside the present and former river courses, especially in the west, comprising a rapidly alternating series of linear low ridges and depressions. The Ganges and Jamuna channel is constantly shifting within its active floodplain, eroding and depositing large areas of new charlands in each flooding season. But it is less braided than those of the Brahmaputra-Jamuna. Interestingly enough, both plants and animals move and adapt with the pattern of flooding (Brammer, 1996).

224. Significant species diversity of the Ganges Floodplainis as follows. This floodplain is characterised by mixed vegetation. The presence of lot of stagnant water bodies and channels, rivers and tributaries in this zone support a habitat of rich biodiversity to some extent. In the beels and other water bodies, free-floating aquatic vegetation is prominent. The dominant floral types are Panimorich *Polygonum orientale*, Jhanji *Hydrilla verticillata*, Helencha *Alternanthera philoxeroides*, Topapana *Pistia strateote*), Chechra *Schenoplectus articulatus*, Shada shapla *Nymphaea nouchali*, Keshordam *Ludwigia adscendense*, Kolmi *Ipomoea aquatica*, Dhol kolmi *I. fistulosa*, Hijal

Barringtonia acutangula, Tentul *Tamarindus indica*, Biash *Salix tetrasperma*, etc.Moreover, grasses are abundant in the Ganges Floodplain and begin to grow as soon as the floodwater begins to recede.The Hunuman Langur, Five-Striped Palm Squirrel, Smooth-Coated Otter, Refuse-Tailed Hare, Water Cock, Bank Myna, Asian Paradise Flycatcher, River Tern, Yellow Monitor, Common Vine Snake, Painted-Roofed Turtle, Balloon Frog, etc, occur in this zone.

225. Nearly all the major groups of oriental birds are represented in this zone by one or more species. In addition, a large number of migratory birds are found here during the winter. Besides, different species of freshwater tortoises and turtles are also found in the rivers and ponds, most of which are a popular delicacy among non-Muslims. The amphibian species found in this zone include a few species of toads, frogs and tree frogs.

5.7.2 Terrestrial Habitats and Flora

226. Terrestrial habitats of the study area can be categorized under the following divisions: (i) settlement/ homestead vegetation (ii) cropland vegetation, (iii) river-bank vegetation, (iv) social forest, and (v) roadside vegetation. Species lists of terrestrial flora and cropland vegetation are provided in Annex 1 (Table1 and Table).

227. **Settlement/ homestead vegetation**. Settlement/ homestead vegetation is a man-made plantation cultivated in the yard adjacent to the house. This type of vegetation has been practiced by community traditionally for financial and mundane needs.The Narikel *Cocos nucifera*, Aam *Mangifera Spp*., Supari *Areca catechu*, Bansh *Bambusa Spp*), Akashmoni *Acacia auricauliformes*, Bot *Ficus bengalensis* etc were observed frequently during the field survey. Chatim and Swarna Lata are present but less common.

228. **Cropland vegetation**. Cropland vegetation is found on the periphery of cultivated lands as weeds that grow and expand through self-propagation. Dominant weed species are Shyama Ghash, Durba Ghash, Badali ghash, Chawla ghas etc.

229. **Riverbank vegetation**. Riverbank vegetation consists primarily of small to large trees. The large species are Pitali *Trewia nudiflora*, Pakur *Ficus religiosa*, Neem *Azadirachta indica*, Shimul Tula *Bombax ceiba*, Kul etc. The small to medium-sized species are Bhat *Cleodendrum viscosum*, Chon, Dhol Kolmi, Dumur *Ficus hispida*, Bhadi *Lannea coromandelica*, Khejur *Phoenix sylvestris*, etc. Among grasses, Durba and Chawla are common.

230. **Social forest.** Social forests in this study area are found on small areas of fallow lands, croplandperiphery, and in the vicinity of settlements and graveyards. Social forestry species are Akashmoni(*Acacia auricauliformes*, Bansh *Bambusa Spp*., Mehogany *Swietenia mahogany* etc.

231. **Roadside vegetation**. Roadside vegetation consists of a variety of floral species, some wild and some planted. Roadside vegetation is planted in some locations with the concept of public-private partnership to protect roads from erosion. The Ghora Neem *Melia azadirachta*, Pakor *Ficus religiosa*, Akashmoni *Acacia auricauliformes,* Sisu *Dalbergia siso*mo, Pitali *Trewia nudiflora*, Bamboo *Bambusa Spp.*, Khejur *Phoenix sylvestris*, Bon Begun *Solanu nigrum*, Kachu, etc are common. Less common floral species are Dumur *Ficus hispida*, Debdaru *Polyalthia longifolia*, Pakor *Ficus religiosa*, etc.

232. **Urban Area**. Urban and built up areas have a low density of vegetations. Because of serious disturbance due to urbanization and dense road network with heavy traffic load, the wildlife population and floral condition and distribution are poor. But still some small mammals, reptiles, and birds were sighted during the field survey.

5.7.3 Seasonal and Perennial Wetland Habitats and Flora

233. **Overview**. Wetland habitats of the study area include charland, swamp, and grassland. Annex 1: Table 3 provides a species list of wetland vegetation.

234. **Charland**.Charland occupies significant part of the study area. The Jamuna and Padma Riversare 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 observed in a given area depends on the time since char formation. At species level, Shon *Crotolaria 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 fistulosa* appear.

235. **Swamps**. Chalan Beel area is favorable for a good growth of wetland trees like Hizal *Barringtoniaacutangula* and Barun etc.

236. **Grassland**.Grassland species include Binna *Vetiveria zizanioides* and Durba Gash *Cynodon dactylon*.

5.7.4 Terrestrial Fauna

237. **Overview**. Among the terrestrial fauna, groups of animals present in the area include birds (Annex 1: Table 4), mammals (Annex 1: Table 5), amphibians (Annex 1: Table 6), and reptiles (Annex 1: Table 7).

238. **Amphibians**. Amphibians are found in terrestrial and aquatic environments. Very common terrestrial species observed during the survey were Indian Common Toad *Bufo melanostictus* and Indian Bullfrog *Hoplobatrachus trigerinus*. The rests were Common Tree Frog *Polypedates maculates* which inhabits in association with human settlement and periphery of the village forest and Balloon Frog *Uperodon globulosus* habituated both in burrows and forest patches and agricultural land. These are considered rare species within the study area.

239. **Reptiles**. House Gecko *Hemidactylus flaviviridis*, Common Garden Lizard *Calotes versicolor*, Yellow Monitor *Veranus flavescens* and Banded Krait *Bungarus fasciatus*, were observed during the field survey. King Cobra *Ophiophagus hannah* and Indian Cobra *Naja naja* were reported to be found within the site. Among reptiles Yellow Monitor *Veranus flavescens* is categorized as endangered (EN) by IUCN-Bangladesh (2000).

240. **Terrestrial birds – residents and short-range migrants**. Terrestrial birds that occupy or visit terrestrial habitats in the study area are Asian Pied Starling *Sturnus contra*, Common Myna *Acridotheres tristis*, Red-Vented Bulbul *Pycnonotus cafer*, Spotted Dove *Streptopelia chinensis*, Black Drongo *Dicrurus macrocercus*, Pompadour Green Pigeon *Treron pompadora*, Blue Rock Pigeon *Columba livia*, Oriental Magpie Robin *Copsychus saularis* and Brahminy Kite *Haliastur indus*. These were very common throughout the study area. Some rarely seen terrestrial birds were Eurasian Hoopoe *Upupa epops* and Red-Whiskered Bulbul *Pycnonotus jocosus*. Only the Eurasian Hoopoe *Upupa epops* is considered to be nationally uncommon resident bird.

241. **Terrestiral birds – long-range migratory species.**Bangladesh is on the Central Asian Flyway between the Palaearctic and the Indian subcontinent (Map 5.5). Migratory birds that move along the Central Asian Flyway utilize the Brahmaputra-Jamuna-Padma-Ganges char and other habitats potentially affected by Tranch 1.[21]

242. **Mammals**. The situation of mammals in Bangladesh country is saddening, especially that of the large mammals which have gone extinctsince the 1970s due to habitat shortage,foodscarcity and hunting pressures. Mammmal species still present are Field Rat *Mus booduga*, Jungle Cat *Felis chaus*, Asiatic Jackal *Canis aureus*, Common Mongoose *Herpestes edwardsi*, Malayan Giant Squirrel *Ratufa*

[21]Ministry of Environment and Forest. 2002. "Country Paper of Bangladesh." Seventh Meeting of the Conference of Parties of Convention on the Conservation of Migratory Species of Wild Animals. Bonn, Germany: Government of Bangladesh. http://www.cms.int/bodies/COP/cop7/proceedings/pdf/national_reports/national_report_bangladesh.pdf

bicolor, Indian Flying Fox *Pteropus giganteus* and Greater Short-Nosed Fruit Bat*(Cynopterus sphinx*. The Asiatic Jackal *Canis aureus* is nationally categorized as Vulnerable(VU) by IUCN-Bangladesh.

5.7.5 Aquatic Ecosystems

243. 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.

244. 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.

(a) Aquatic Flora

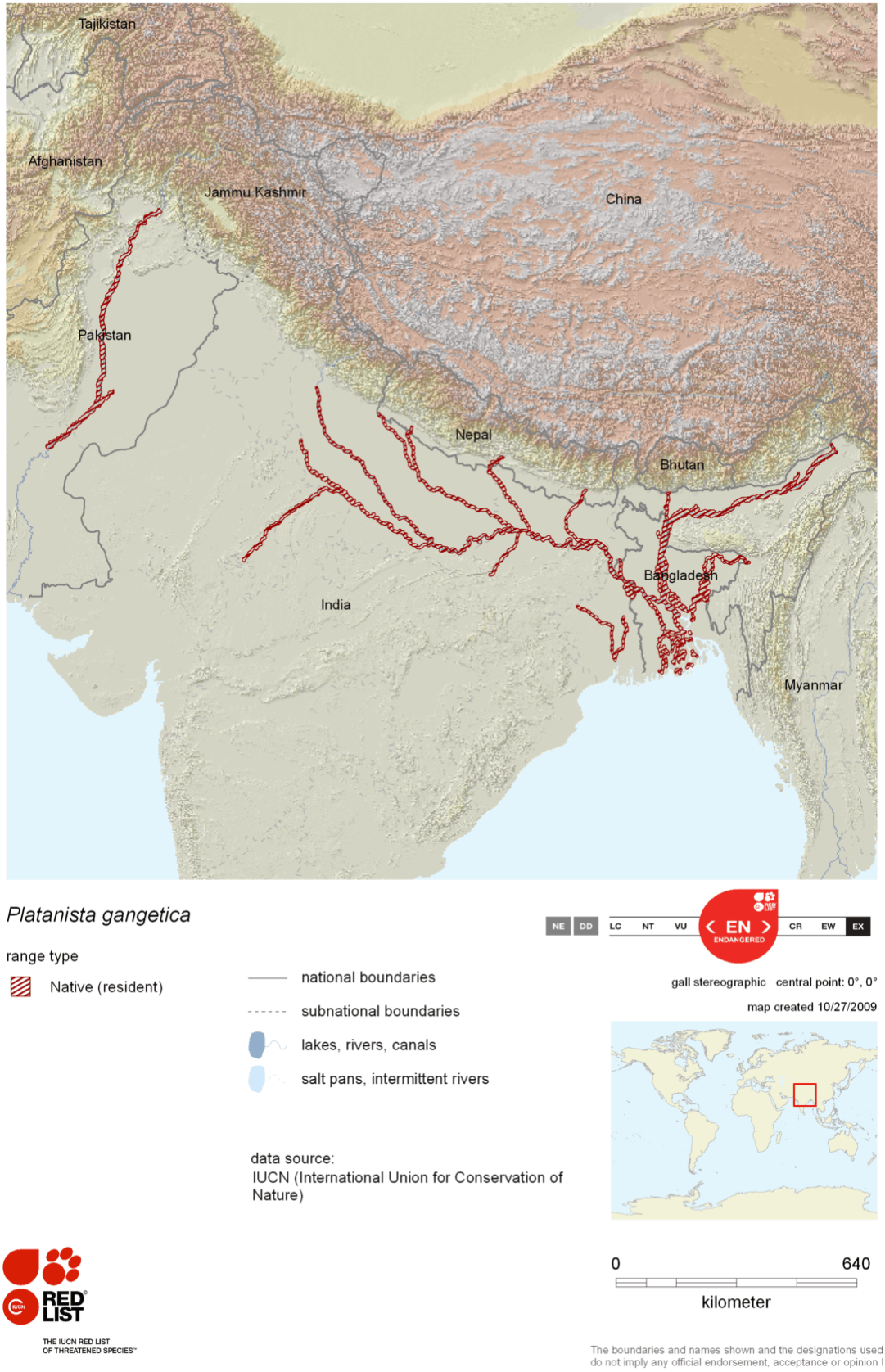
245. Aquatic floraispresent in both seasonal and perennial water bodies. The submerged species are Fodder *Hydrilla verticillata*, *Vallisnaria spirali, Aponogeton Sp*. and Gechu. The free-floating species mentionable here are Kachuripana *Eichhornia crassipes*, Kutipana *Azolla* Sp., and Khudipana *Lemna perpusilla*. Of the rooted floating species, Keshordam *Jussicea repens* and Shapla *Nymphae nouchali* are common especially in perennial and seasonal beel.

(b) Aquatic Fauna: South Asian River (Gangetic) Dolphin

246. The South Asian River (Gangetic) Dolphin *Platanista gangeticagangetica* is native to the Ganges and Brahmaputra rivers in Bangladesh and India (Map 5.5).

247. During January-September 2011, a Dolphin survey was carried out in the Padma, Jamuna, and Hurashagar-Baral Rivers of Pabna district.[22] Seventy-four transects (including upstream and downstream) were made over 79 km of river reach by mechanized boats to estimate abundance and habitat use. The dolphin population of the studied area was found to vary from 58 during early monsoon and to 103 during late monsoon. The mean dolphin population was 19.67 (one dolphin per 1.72 km) in the Padma and one per 0.69 km in the Jamuna. Adults accounted for 65 per cent and juveniles for 35 per cent of observed individuals. Dolphin concentrations were found in 22 river locations and found in every count in three scours (Bangla *kum)*: Mohanganj *kum* of Jamuna-Hurashagar River, Nazirganj ferry ghat *kum* of Padma River, and Nagarbari *kum* of Jamuna River. Dolphins were slightly more abundant during the low water Jan-Apr period (one per 1 km) than in the monsoon high water Jun-Jul period (one per 1.06 km). The local community in particular fishers were involved in river dolphin conservation.

[22]Rashid, S.M.A., Abdul Wahab Akonda, and Bashir Ahmed. 2012. "Occurrences of South Asian River Dolphin (Platanista Gangetica) in the Padma and Jamuna Rivers, Pabna." In Book of Abstracts, 130. Dhaka: Bangladesh Fisheries Research Forum.
http://bfrf.org/bookofabstracts/BFRF%205th%20Fisheries%20Conference%20and%20Research%20Fair%202012%20-%20Book%20of%20Abstracts.pdf.



Map 5.5: Map - Range, South Asian River (Gangetic) Dolphin

248. Dolphins utilizing riverine habitats potentially affected by Tranche 1 are part of a transboundary (Bangladesh-India) population that may include individuals who

migrateinternationally between Bangladesh and India.Most international movement of Dolphins occurs within peri-border areas as short-range tributary-to-mainstem trips, but longer-range migrations of individuals between the Tranche 1 influence area and India cannot be ruled out.

249. South Asian River (Gangetic) Dolphin is on the IUCN Red List as Endangered. It is listed in Appendices I and IIof the Convention on the Conservation of Migratory Species of Wild Animals (CMS). CMS Appendix I listed species are deemed in danger of extinction throughout all or a significant proportion of their range and meriting from CMS Parties (Bangladesh is a signatory) strict protection, conservation or restorationof habitats, mitigation of migration obstacles, and control of other threats to survival. Appendix II listed species have an unfavourable conservation status or would benefit significantly from international co-operation organised by tailored agreements. It is also listed in Appendix I of the Convention on International Trade in Endangered Species (CITES) as a species in which international trade is probihited. Specific Threats to dolphins are summarized in Annex 2.

5.7.6 Other Aquatic Fauna

250. Among amphibians, Skipper Frog (*Euphlyctis cyanophlyctis*) and Indian Pond Frog (*Euphlyctis hexadactylus*) are frequently observed. Both species prefer to live in ponds, ditches, stagnant rainwater and paddy-fields. The latter species is categorized as Endangered (EN) by the IUCN-Bangladesh (2000).

251. The aquatic reptiles are frequent in this area. The Red-crowned Roofed Turtle (*Batagur kachuga*) and Smooth Water-snake (*Enhydris enhydris*) are present.

252. The diversity of aquatic birdsdepends on the area and quality of aquatic habitat. The aquatic habitat in this area is large and holds water year-round except seasonal water bodies. Thus, aquatic fauna are not dominant compared to terrestrial ecosystem. The Little Egret (*Egretta garzetta*), Indian Pond Heron (*Ardeola grayii)*, Little Cormorant (*Phalacrocorax niger*), Pied Kingfisher (*Ceryle rudis)*, White-throated Kingfisher (*Halcyon smyrnensis),* Asian Open-bill (*Anastomus oscitans*) and White-breasted Waterhen (*Amaurornis phoenicurus)* are common throughout the study area. Some of area especially char lands are used as a shelter place for migratory birds.

5.7.7 Aquatic Ecosystem Services

253. The flood plain 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. Flood cycle and its associated ecosystem purify the water quality deteriorated by several waste discharging or other ways.

5.7.8 Threats to Aquatic Ecosystems

254. In the study area, river erosion and siltation is occurring 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. Population of flora and fauna is disrupted.

5.8 Socioeconomic Condition

5.8.1 Area and Location

255. Socio-economic information is presented for the study area upazilas – twelve upazilas of Sirajganj, Tangail and Manikganj districts (Table 5.38).

Table 5.38: Administrative Units of Bangladesh

Divisions	Districts	Upazillas
Rajshahi	Sirajganj	Kamarkhanda
		Belkuchi
		Chauhali
		Shahjadpur
Dhaka	Manikganj	Ghior
		Shibalaya
		Manikganj sadar
		Singair
		Saturia
		Harirampur
		Daulatpur
	Tangail	Nagarpur

Source: Spatial GIS Analysis, CEGIS 2012.

5.8.2 Demography

256. Table 5.39 presents key demographic data of the study area. 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 1200 persons km^2.

Table 5.39: Demographic Information

Households	Population			Size of Household
	Total	**Male**	**Female**	
661,136	2,893,578	1,424,675	1,468,903	4.37
		49.24 per cent	50.76 per cent	

Source: BBS Population Census 2011.

257. Table 5.40shows age group composition of the area. About 34 per cent of the population is under 15 years of age; 57 per cent is between 15 and 59; and 9 per cent is over 60 years of age, for an approximate dependency ratio of 75.

Table 5.40: Age Distribution

Age Range (Years)	**0-4**	**5-9**	**10-14**	**15-19**	**20-24**	**25-29**	**30-49**	**50-59**	**60-64**	**65+**
Percentage of Population	10	13	11	8	8	9	25	7	3	6

Source: BBS Population Census 2011.

258. Most people live in dwellings owned by their household (Figure 5.11).[23] The exception is Manikganj sadar upazila which is more urbanized, where most dwellers live in dwellings owned by others.

[23]BBS distinguishes tenancy status of dwelling units into three classes such as- i) Owner: Dwelling unit found occupied and used by household owning it; ii) Rented: Dwelling unit found occupied and used under arrangement of contractually rented; and iii) Rent free: Dwelling unit found occupied and used without rent.

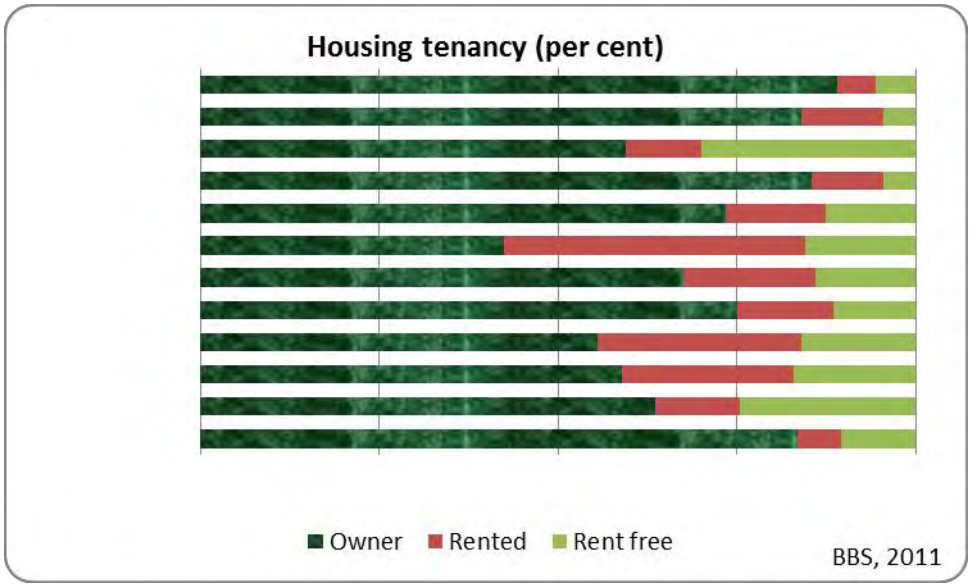


Figure 5.11: Housing Tenancy

5.8.3 Livelihood

(a) Occupation

259. Agriculture is the main occupation of 76 percent of households. About 16 percent of the population works in the service sector; and the remaining 8 percent works in the industrial sector(Table 5.41**Error! Reference source not found.** and Photo5.6)

260. Male and female are equally engaged in livelihood activities. However, participation of female member is nominal in comparison to male participation. In the study area only 2 per cent female members are working whereas 98 per cent male members are engaged in income generating activities.

Table 5.41: Primary Occupation

Upazilas	Agriculture (per cent)		Industry (per cent)		Service (per cent)	
	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: BBS Population Census 2011.

Photo 5.6: Livelihoods

Photo 5.6.1: Jhupri House

Photo 5.6.2: Kutcha House

Photo 5.6.3: Semi-Pukka House

Photo 5.6.4: Pukka House

(b) Employment

261. Figure 5.12shows the employment status of people in the study area. About 40 per cent of total population is employed, 47 per cent is engaged in household work, only below than one per cent is looking for work and about 13 per cent of total population is not working (it includes children and physically challenged population).

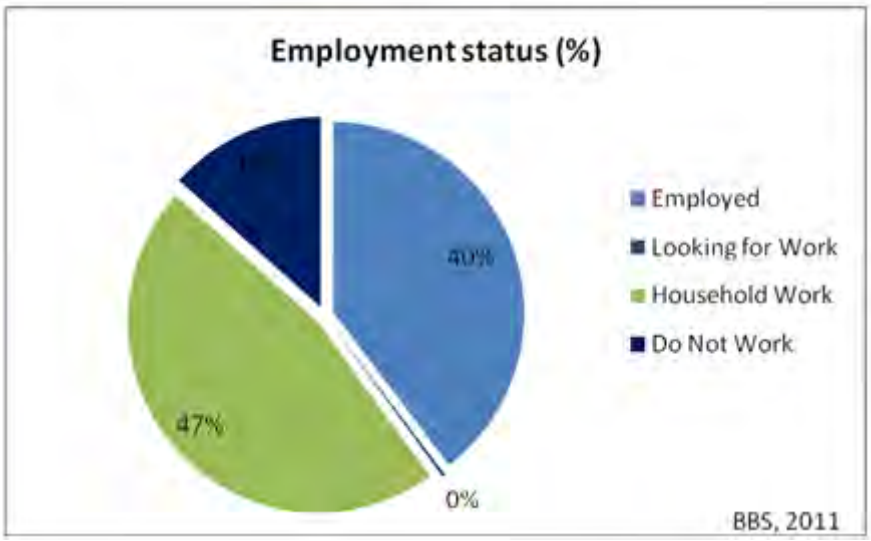


Figure 5.12: Employment Status

262. Table 5.42 shows the distribution of employment status by male and female in the study area. It is found that only four per cent female members are employed whereas 34 per cent male members are employed in the study area.

Table 5.42: Employment

Upazilas	Employed (per cent)		Looking for Work (per cent)		Household Work (per cent)		Do Not Work (per cent)	
	Male	Female	Male	Female	Male	Female	Male	Female
Kamarkhanda	38.82	2.54	0.16	0.05	0.30	45.09	5.88	7.16
Belkuchi	38.67	2.97	0.14	0.08	0.29	41.16	7.77	8.93
Chauhali	39.27	2.16	0.34	0.10	0.35	47.59	5.16	5.01
Shahjadpur	39.58	1.80	0.20	0.10	0.45	43.30	6.55	8.02
Ghior	36.53	1.61	0.17	0.07	1.04	49.01	4.56	7.00
Shibalaya	37.50	1.85	0.23	0.06	0.52	47.26	5.33	7.25
Manikganj sadar	35.81	2.81	0.17	0.05	0.45	46.63	5.97	8.12
Singair	37.43	1.38	0.29	0.07	0.66	46.09	6.28	7.80
Saturia	37.65	2.06	0.21	0.10	0.39	49.42	4.04	6.13
Harirampur	36.81	1.83	0.17	0.11	0.78	46.93	5.73	7.66
Daulatpur	35.49	1.39	0.22	0.08	0.88	49.82	5.34	6.77
Nagarpur	35.84	1.24	0.25	0.08	0.54	49.59	5.54	6.92

Source: BBS Population Census 2011.

5.8.4 Quality of Life

(a) Housing

263. In the study area, overall housing condition is not satisfactory. On an average, only three per cent houses are pukka (made of bricks and mortar) whereas 88 per cent are *kutcha* (made of wood/bamboo, and other local materials; Figure 5.13). Photo 5.6.3, show examples of these housing. Statistics shows that *kutcha* households are dominant in whole of the study area. It can be

concluded that the people living in the study area belong to extremely poor category in term of housing type.[24]

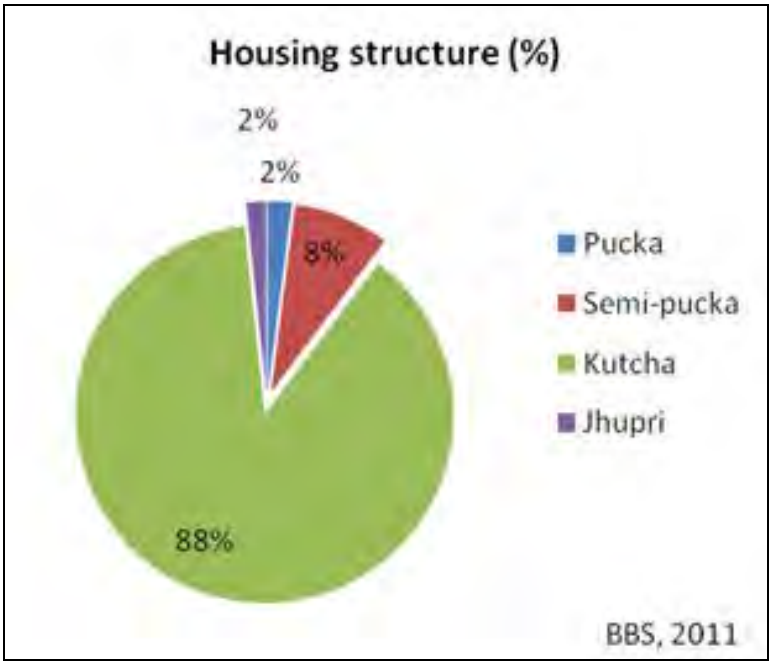


Figure 5-1.13: Distibution of Housing Types

(b) Drinking Water

264. The overall status of drinking water in the area is satisfactory. Tube-well coverage is quite good in some upazilas eg Belikuchi, Ghior, Nagarpur, Shibalaya and Harirampur. But in other area, people collect water from biologically unsafe sources such as ponds (with or without pond sand filter) and rivers. Of all households, 96 per centuse tube-well water and the rest other sources (Figure 5.14).

265. Sanitation facilities are unsatisfactory in the study area. Prevalence of the various types of sanitation facilities in the study area is shown in Figure 5.15which shows a typical arrangement.[25] Only 18 per cent of study area households use hygienic (water-sealed) facilities; 58 per cent use non-water-sealed facilities, 23 per cent use non-sanitary facilities; and one per cent lacks access to sanitation facilities.

[24]BBS distinguishes housing structures into four classes such as- i) Jhupri: House which consist mud walls of 1.5 to 3.0 ft thickness, which carry the roof load. Earthen floor, thatch or CI sheets are used as roofing materials. . There is no monolithic joint between the wall and the roof. ii) Kutcha: Walls: Organic materials like jute stick, catkin grass, straw, and bamboo mats. Split are bamboo framing. In some areas wall are made by earth. Foundation: Earthen plinth with bamboo or timber posts. Roof: Thatch-rice or wheat or maize straw, and catkin grass, with split bamboo framing; iii) Semi-pucka: Walls: Bamboo mats, CI sheet, Timber or bamboo framing. In some areas wall are made by earth, sometimes part or full brick. Foundation: Earthen plinth; Brick perimeter wall with earth infill; Brick and concrete also use. Roof: CI sheet with timber or bamboo framing; and iv) Pucka: House which is made by fully concrete, cement, and iron.

[25]BBS defined four types of sanitary facilities: (i) Sanitary water-sealed, pit latrine with a water barrier to prevent odors and insect, rodent, etc infestation; (ii) Sanitary not water-sealed, latrine with slab or other secure cover or polyethylene flap over the drop hole to prevent infestation; and (iii) non-sanitary (kutcha):latrine, a frame or platform extending over earth or water; an open pit latrine without squat platform or slab; and (iv) no facilities, defecation in bushes, fields, or other outdoor location.

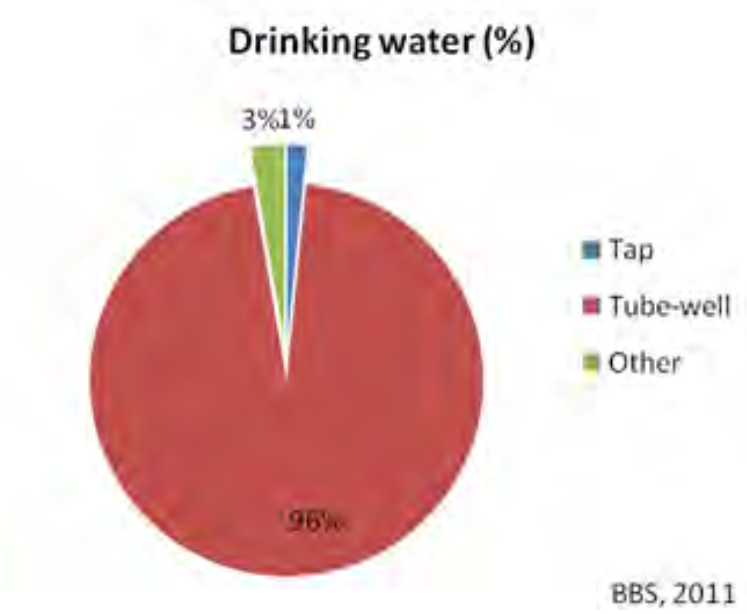


Figure 5.14: Drinking Water Sources

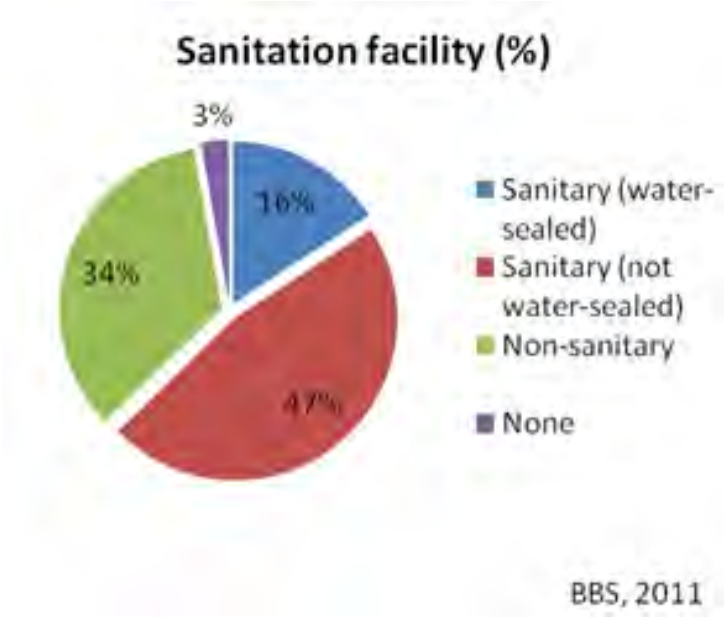


Figure 5.15: Sanitation

(c) Disease Incidence Ranking

266. According to local people's report, the diseaseswith highest incidence in the area ranked from highest to lowest are diarrhoea, influenza, heart disease, hypertension, gastric illness, asthma, skin disease, hepatitis, chicken pox, and arsenicosis (CEGIS fieldwork, 2012).

(d) Health Services and Facilities

267. It is found that in the study area, trained medical doctors are accessed by about 20 % of households; paramedic/diploma practitioners by 30 % and untrained ("quack") practitioners by 40 %. All types of medical treatment are inaccessible to the remaining 10 per centdue to

impoverishment and communication problems (Figure 5.16). Local people's report that they are very dissatisfied with the very poor quality of available health services and facilities.

Figure 5.16: Medical Treatment

5.8.5 Education

268. In the study area literacy rate is quite satisfactory in terms of national average. Manikganj sadar has the highest literacy rate (56%) and is followed by Ghior (55%) upazilas (Table 5.43). However, the tendency to be educated is now growing among the local people. People show their interest in education. They send their children to the institutions in due time and try to continue with their education.

Table5.43: Literacy Rates

Upazilas	Literacy Rate (per cent)		
	Total/Both	Male	Female
Kamarkhanda	46	49	44
Belkuchi	46	48	43
Chauhali	37	41	33
Shahjadpur	38	42	35
Ghior	55	58	51
Shibalaya	53	57	49
Manikganj sadar	56	59	53
Singair	46	48	44
Saturia	47	52	43
Harirampur	48	50	47
Daulatpur	35	40	30
Nagarpur	43	46	40

Source: BBS Population Census 2011.

5.8.6 Electricity

269. According to secondary census data, electrification in the study area is available to only 48 %of households (Figure 5.17). In contrast, the RRA found that local people reported about 80% coverage of national grid connection; in addition, some households receive electricity from solar and other

sources. In consequence, the use of modern technology and access to information and entertainment is high.

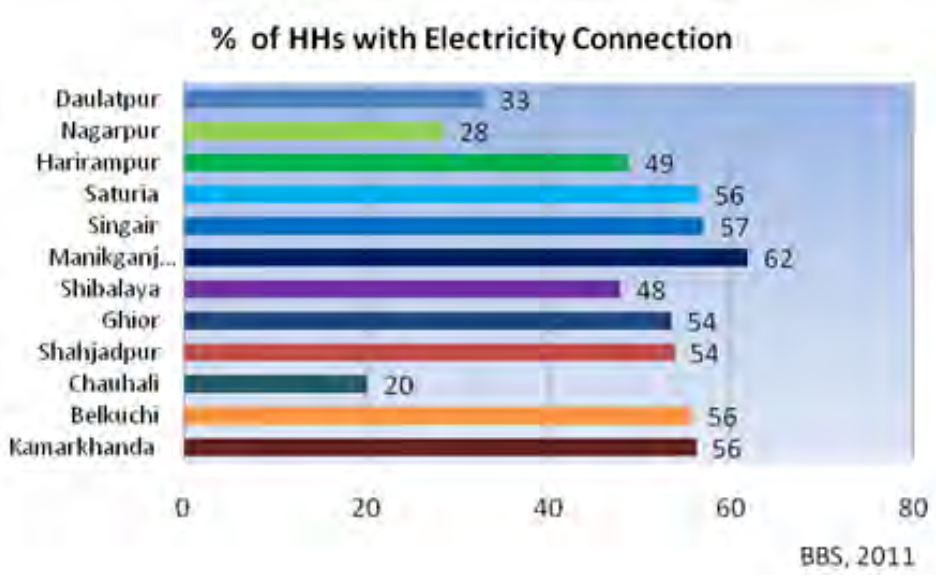


Figure 5.17: Household Access to Electricity

5.8.7 Poverty and Safety Nets

(a) Landownership Pattern

270. The landownership pattern is correlated with poverty incidence in the area. The RRA found that about 30 %of households are absolute or landless and the remaining 70 % have land for mainly agriculture use and also for settlement and commercial uses (see Table 5.44).

Table 5.44: Landownership

Land Holding Categories	Distribution of Household (per cent)
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.

271. 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% (see Figure 5.18).

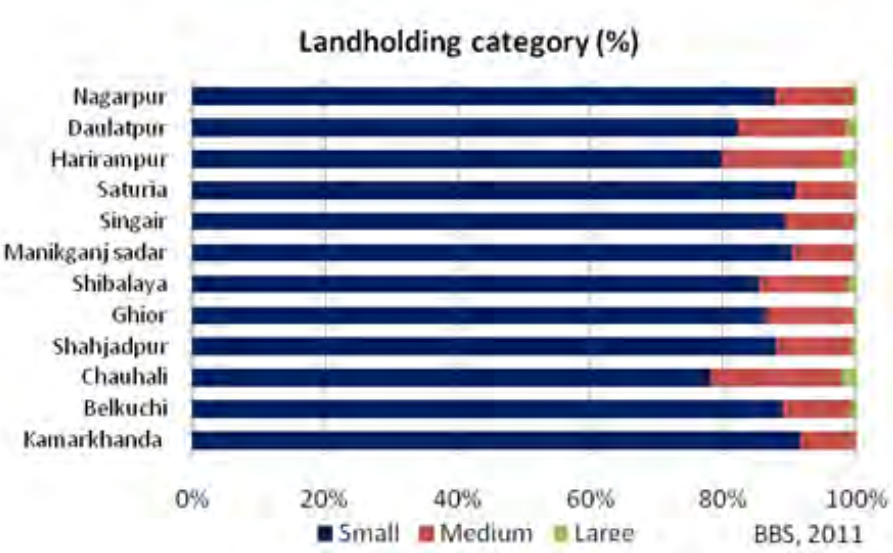


Figure 5.18: Landholding

(b) Income Poverty

272. 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.

273. 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 ownersand businessmen, are in a surplus position (Figure 5.19). Thus in the study area consumption is higher than income which perpetuates poverty intergenerationally.

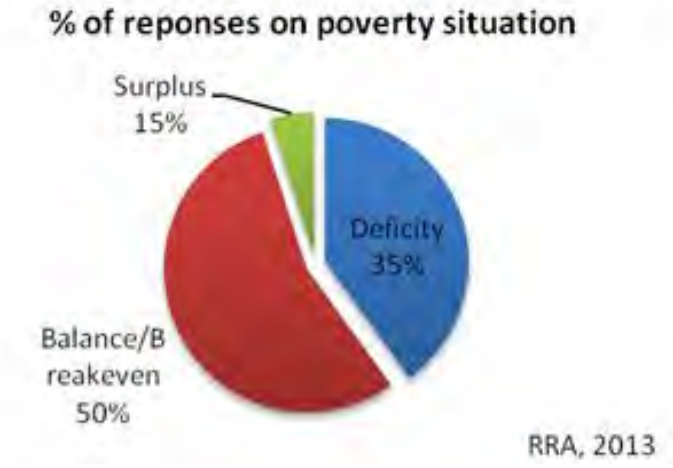


Figure 5.19: Self-Assessed Poverty Status

(c) Income and Expenditure

274. Household income and expenditure are key indicatorsof socio-economic status. In the study area, monthly household income and expenditure vary from BDT 5000 to 20,000. About 75% of

households hire out agricultural labor. The wage rate varies between BDT 150 to 350 per day. A few in-migrating laborers stay in the area for a year, returninghome at the end of the year with all their income. Women's participation in the agricultural sector is negligible (Table 5.45). Field findings show that most income comes from three sectors ie agriculture, small business and remittance, and that household consumption and housing account for most expenditure.

Table 5.45: Annual Income and Expenditure Level

Range (BDT/month)	Expenditure	Income
Less than 1,000	-	2
1,000 - 2,000	5	3
2,000 – 5,000	35	30
5,000 - 9,000	42	40
9,000 - 20,000	15	20
More than 20,000	3	5

Source: CEGIS fieldwork 2013.

5.8.8 Natural Disasters

275. 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 5.46.

Table 5.46: Effects of Recent Natural Disasters

Disaster	Frequency	Affected Area (per cent)	Affected House Holds (per cent)	Crop Damaged (per cent)	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.

5.8.9 Social Safety Nets and Poverty Reduction Measures

276. The major social safety nets and poverty reduction programs initiated in the area include the Vulnerable Group Development, Food/Taka for Work (F/TFW), Food for Education/Cash for Education, Rural Maintenance Program (RMP), Old Age Allowance, Freedom Fighter Allowance and Integrated Poverty Reduction Program. These programs have created food security as well as social safety nets among the targeted poor households and vulnerable communities (Table 5.47).

Table 5.47: Social Safety Net Programs

Social Safety Net Programs	Households/Communities Served (per cent)
Vulnerable Group Development (VGD)	6
Food/Taka For Work (F/TFW) of PIO	4
Food for Education/Cash for Education	10
Rural Maintenance Programme (RMP)	6
Old Age Allowance	5
Freedom Fighter Allowance	3
Integrated Poverty Reduction Program of BRDB	6

Source: CEGIS fieldwork 2013.

277. A number of local, national, and international NGOs work in the study area. Their main activities are micro credit programs among the rural poor and landless women/men. The major NGOs working in the area include BRAC (Bangladesh Rural Advancement Centre), ASA (Association for Social Advancement), TMSS (Thengamara Mohila Sobuj Songho), Manob Mukti Sangstha (MMS),Proshika, Muslim Aid UK, CARE and Karitas (Table .48). These NGOs are serving with micro

credit while BRAC, ASA, and Uttaran are working for non-formal education, Health, human rights, water and sanitation, gender and children development programs. About 40 per cent of households are found to benefit from NGO interventions.

Table 5.48: NGOs Programs

NGO	Type of Programs							
	Credit	Education	Water and Sanitation	Health	Human Rrights	Gender	Children	Disaster
BRAC	✓	✓	✓	✓	✓	✓	✓	-
ASA	✓	✓	-	-	✓	✓	-	-
TMSS	✓	✓	✓	-	✓	-	✓	-
Manob Mukti Sangstha	✓	-	-	-	-	-	-	-
CARE	✓	✓	✓	-	✓	✓	-	-
UK Muslim Aid	-	✓	✓	✓	✓	-	-	✓
Karitas	-	-	-	-	-	-	-	✓

Source: CEGIS fieldwork 2013.

5.8.10 Transportation

(a) Road way

278. Overall about 1011 km of roads exist in the 12 upazilas of the area, of which: 65 km roads are national: 200 km are FRA (connecting road from upazila to district); 253 km are FRB (connecting road from union to upazila); and 493km are R1 (regional road within the districts). Table 5.49presents data on the road network in the study area.

Table5.49: Road Network

Upazilas	N	FRA	FRB	R1
Daulatpur	-	6	22	33
Ghior	8	13	13	34
Harirampur	-	13	27	28
Manikganj Sadar	10	19	28	58
Saturia	3	12	8	52
Shibalaya	18	12	9	56
Singair	-	19	41	56
Belkuchi	-	25	9	43
Chauhali	-	2	23	2
Kamarkhanda	8	22	14	17
Shahjadpur	17	27	22	62
Nagarpur	-	30	37	53
Total	**65**	**200**	**253**	**493**

Source: NWRD database 2013.

(b) Waterways

279. Waterways are the most important means of communication in the area. Navigation routes in the study area include: 390 km of routes less than 25 m wide; 170km of routes25 to 50 m wide; 126 km that are 50 to 100 m wide and 207 km above100 m wide (see Table 5.50). The area has one ferry ghat, two inland river ports, and two pilot stationswithin the study area. Waterwaysare gradually decreasing in size due to siltation.

Table 5.50: Navigation Routes

Upazilas	Below 25m	25m - 50m	50m - 100m	Above 100m
Daulatpur	30	9	15	6
Ghior	24	25	15	8
Harirampur	12	37	4	11
Manikganj Sadar	14	8	41	34
Saturia	7	23	11	16
Shibalaya	25	20	0	10
Singair	48	12	29	15
Belkuchi	7	17	0	7
Chauhali	32	5	0	13
Kamarkhanda	22	10	2	4
Shahjadpur	82	3	0	60
Nagarpur	86	1	8	24
Total	**390**	**170**	**126**	**207**

Source: NWRD database 2013.

5.8.11 Educational Institutions

280. The area has 914 primary and secondary schools, 48 colleges, and 92 *madrasas* (religious schools; Table 5.51). Some area students go to Rajshahi and Dhaka for secondary education. Educational institutions are mostly concentrated in larger settlements, although primary schools are distributed equally in all unions of the area.

Table 5.51: Academic Institutions

Upazilla	School	College	Madrasha
Kamarkhanda	125	7	15
Belkuchi	173	6	11
Chauhali	134	7	23
Shahjadpur	264	15	30
Ghior	102	5	3
Harirampur	98	3	2
Daulatpur	18	5	8

Source: CEGIS fieldwork 2013.

5.8.12 Population Migration

281. Seasonal labor migration is common throughout the study area. Permanent in- and out-migration is negligible.

282. Area residents tend to out-migrate to Dhaka, Tangail, Sylhet and Rajshahi, for better livelihood (60 per cent). These out-migrants are both male and female and from both excluded/impoverished and privileged backgrounds.

283. A significant number of labourer sliving in the area (20 per cent) are in-migrantswho came seeking subsistence wages (Table 5.52). Most of these in-migrants are male, aged 15 to 47 and from socially excluded and economically impoverished backgrounds.

Table 5.52: Labor Migration

Type of	Out Migration	In Migration

Migration	Destination	Per cent of population	Origin	Per cent of population
Seasonal labor migration	Dhaka, Tangail, Narayangong, Slyet, Rajshahi, Manikgonj	60	Rajshahi, Pabna, Rangpur, Natore, Gaibandha, Bogra etc	20 (during harvesting period)
Permanent household migration	-	-	-	-

Source: RRA 2012.

5.8.13 Gender and Women

284. Restrictions on women's mobility, male-female discrepancies in wages, mortality, health, nutrition, and education are some of the key gender issues in the study area. Women have little role in decision-making in the family and community. The RRA found that area women and girls face social and economic discrimination within the family and the community. Figure 5.20shows the scope of decision-making by women in the study area.

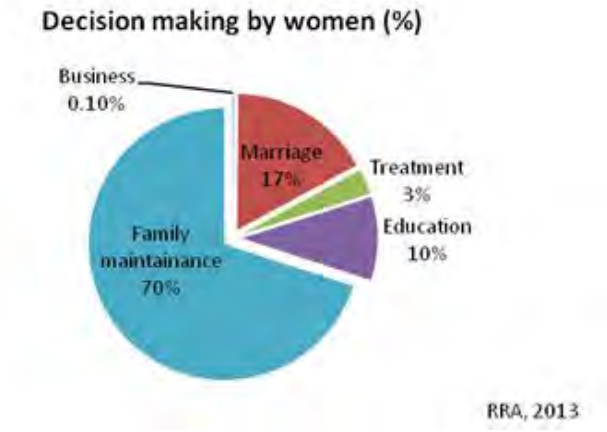


Figure 5.20: Decision-Making By Women

285. Women mobility in the area is mostly localized except for travel to obtain medical treatment, fetch water, engage in farming activities, and visit relatives.

286. Growing consciousness among local people, health services provided by the public and other healthcenters and NGO programs have each contributed to recent decreasesin higher mortality rates for women. About 15 per cent women are living with good health condition and the rest are suffering from various diseases such as low blood pressure and premature delivery. About 20 per cent women are getting proper nutrition and about 10 per cent have access to the health centers, which are around 15 km away on average from their residence.

287. As shown in Figure 5.21**Error! Reference source not found.**, women's literacy in the study area has been increasing gradually, to 58 per cent, while school attendance of males and females is now almost equal.

288.

289.

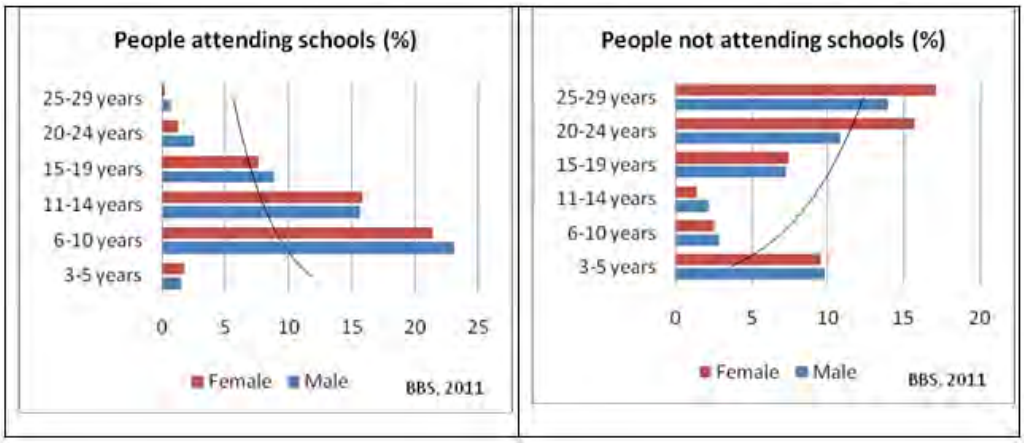


Figure 5.21: School Enrollment

5.8.14 Vulnerable Communities

290. In the study area, three types of people could be considered as vulnerable. These are: (i) marginal farmers having less than BDT 5000 monthly income; (ii) fishermen; and (iii) women-headed households. Even though most land owners 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.

5.8.15 Common Property Socio-Cultural Places and Resources

291. The common property socio-cultural places and resources of the area include mosques, graveyards, temples, cremation grounds, playgrounds, *eidgahs* (places for offering Eid prayers) and the BWDB embankment. Local people frequently use theseplaces for religious, social, and cultural gatherings.

6. Public Consultation and Disclosure

6.1 Disclosure, Consultation, and Participation during Project Preparation

292. Two 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. 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 VESCs to be assessed for project impacts.

293. A second round of PCMs was be undertaken when this environmental assessment report became available in draft form, 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.

6.2 Stakeholder Comments and Concerns

6.2.1 First Round

294. During the environmental assessment process a first round of public consultation meetings was held in four locations (Map 6.1) to present the location to stakeholders and document their concerns. The records of this round are presented in Annex 3.

295. 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.

296. Judging from 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.

297. 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.

298. 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 notcovered 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, laborers, etc. 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.

Map 6.1: First Round Public Consultation Meeting Locations

6.2.2 Second Round

299. 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 2nd to 9th 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 Annex 4.

300. 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.

301. 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.

6.3 Summary of Concerns, All Meetings

302. **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 designswill have to be changed unless construction of erosion works begins this year (2013). To allow this construction to start in 2013, 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 2013 construction start avoid future problems.

303. **Dredging.**River dredging has not been included in subprojectdesigns. Participants stated that embankmentswill not control flooding or erosion withoutit, and therefore it should be incorporatedin the project. Some participants suggested capital dredging from Jamuna Bridge to Brahmankanda of Horirampur Upazia under Manikgonj District. Participants also suggested that fisheries habitat could restored through dredging of internal channels in the Tranche 1area.

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

305. **Flood protection plans**. Participants expressed concerned 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.

6.4 Additional Concerns from Specific Meetings

306. **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 9000 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 very much threatened by erosion this year. To protect this area,participants suggested seeking preparatory fundsfrom Asian Development Bank (ABD) and Water Development Board. River bank protection from Kaijuri to Baghabari is also essential this year 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.

307. **Shahjadpur, Sirajganj (JRB-1)**. Co-ordination 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 upazila embankment and revetment.

308. **Chouhali, Sirajganj (JLB-2)**. The area of Chouhali upazila most vulnerable to erosion is the upazila sadar, where 40 to 50 per cent of the area has already eroded away. BWDB has been using sandbags in attempt to control the erosion, but these have been ineffective given the intensity of the erosive attack. Participants stated that sandbag revetments are ineffective in the Jamuna due to its 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 built in this upazila at a cost of BDT 38 crore was already destroyed by erosion. 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, even though these have been expressed repeatedly in meetings with the Project Implementation Officer (PIO).

309. **Harirampur, Manikganj (PLB-1)**. The 5 km riverbank protection proposed in this upazila should be extended an additional 2 km up to Dhulsura. Bahadurpur union should be included with the project. Participants were concerned about the successful implementation of the project. They think that projects initiated by the ruling party will have lower priority if and when the opposition is in power. Participants hope the subprojectwill be implemented in 2013, and agreed to make whatever sacrifices would be required to expedite this. Participants stated that the priority should be to protect Harirampur before providing protection to Manikgonj town. Priority work should start as soon as possible. A quality control committee should be struck to ensure quality construction work. Local stakeholders should be involved in regular embankment maintenance.

6.5 Incorporation of Concerns in Project and Mitigation Designs

310. Some concerns relate to known issues that have been and are being attended to (eg 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 (eg 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.

6.6 Implementation-Phase Stakeholder Disclosure, Consultation and Participation

311. 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.

6.7 Grievance Redress Mechanism

312. At each Tranche 1 subproject location, 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 UnionParishad chairperson(s) and for subprojects with resettlement, a representative of resettlement-affected persons.

313. GRCswill 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 personsare 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.[26]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[27].

6.8 Reporting and Monitoring

314. Environmental monitoring reports will be issued bi-annually disclosure on ADB's website. The environmental monitoring reports will also be incorporated into the December 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 officer with the help of the consulting team's environmental specialist.

315. 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.

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

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

7. Important Environmental and Social Components

7.1 Introduction

316. 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 IESCs, and, as needed, identified additional IESCs they believed could be impacted by the proposed interventions.

317. 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

318. Every year, bank line erosion in the study area grasps huge amount of lands damaging valuable assets and infrastructures. 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 theavailable surface water can hardly meet the demand of local people. The interventions of will have significant effects in 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 (proposed in JLB-2 sub-reach) may affect the net accretion inside the Jamuna River. Considering these issues, erosion and accretion have been selected as an IESC.

7.2.2 Flooding

319. 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 infrastructures, causing bank erosion, disrupting communication system etc. Interventions such as construction and re-sectioning of embankments are likely to cause significant impacts in the flood occurrence, extent and duration. Therefore, flooding was selected as an IESC.

7.2.3 Drainage Congestion

320. 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 which eventually cause water logging 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. Considering this phenomenon, drainage congestion was selected as another IESC.

7.2.4 Water Logging

321. 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 level which may create

water logging on a permanent basis. Provision of regulators is likely to resist the occurrence of water logging, but in places where regulators would not be placed, water logging problems might arise. Moreover, no intervention has been proposed to re-excavate some of the shallow rivers and lakes which might affect the water logging scenario. Considering all these possibilities, water logging was selected as an IESC.

7.2.5 Water Availability and Water Use

322. Availability of water for agricultural and other uses is selected as anIESC. In the dry season, ground water as well as surface water is used to some extent for irrigation and domestic purposes while in the wet season, surface water is used predominantly. 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 would affect the local people's access to surface water and its use on multipurpose.

7.2.6 Navigation

323. Navigation through the major and internal rivers is an important phenomenon in the study area. It is important for the socio economic aspects, ecological balance and the different uses of water. The provision of interventions may affect the navigation status of the rivers. As such, navigation was considered as anIESC.

7.2.7 Surface Water Quality

324. Surface water quality is another IESC for the project. It 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 are likely to impact the quality of surface water. The bank revetment works would impact the 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

325. Land type depends on the depth of inundation on cultivated land during the wet season. Area under different land types was selected as an IESC.

7.3.2 Sand Carpeting

326. Sand carpeting or casting on agricultural land takes place through overtopping of embankment during high flood levels in the river. Area of agricultural land affected by sand casting was selected as anIESC.

7.3.3 Land Loss

327. Land loss through river bank erosion is a major problem in the study area. The proposed bank protection is expected to check such loss of agricultural land. Temporary loss of agricultural land is likely to take place during the pre-construction phase if labor 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

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

7.4.2 Crop production

329. Agricultural crop production is expected to increase through river bank 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

330. 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& Irrigation Water Availability

331. Irrigation supports greater and more reliable agricultural productivity. Surface water and ground water are used for irrigation use.

7.5 Fisheries

7.5.1 Fish Habitat

332. Any change of land types due to the proposed interventions might modify the quality and quantity of fish habitat. The project possesses some pockets and floodplain that goes under water in wet season and thus contribute towards the development of fisheries resources. The proposed interventions will modify the fish habitats in the study area. In this context, fish habitat was considered as anIESC in this study.

7.5.2 Riverine Fish Habitats

333. Continues sedimentation of river bed, establishment of different types of structures such as cross fish pata, katha/komor, shrimp gher on the river slope, agriculture practice by building mud bunds, housing and other engineering construction by encroaching the river causes the river habitat unsuitable for fish migration as well as fish production. The proposed interventions may modify the riverine fish habitats in the study area. Considering these aspects, riverine fish habitat was taken as an IESC for this study.

7.5.3 Beel and Khal Fish Habitats

334. Some of the riverine fishes migrate towards the beels through khal for breeding purpose and propagation. Beels are the breeding and feeding grounds of the indigenous species of fishes and play a vital role in stock recruitment. The khals are silted up due to closure, construction of water regulating structures, mud bund etc. Besides these beels are silted up rapidly and the indigenous

species of fishes might disappear from the area. The proposed interventions will modify the fish habitats in the study area In this context, beel and khal fish habitats are considered as IESC.

7.5.4 Floodplain Fish Habitat

335. The floodplain fisheries may be impacted due to the construction of embankment of the study area if the connecting khals/ canals are not restored properly.

7.5.5 Fish Migration

336. Fish migration is considered important for maintaining fish bio-diversity and production.

7.5.6 Fish Species Diversity

337. Fish biodiversity is an indicator of aquatic ecosystem health and has implications for income and nutrition of poor people.

7.5.7 Capture and Culture Fish Production

338. Fish production that comes from different open water sources may be reduced 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 the fish production. Therefore, capture fish production was considered as an IEC for this study.

7.6 Ecological Resources

7.6.1 Terrestrial Ecosystem

339. Terrestrial ecosystem provides habitat for all the 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 terrestrial ecosystem as well as its population. Physical settings of the existing ecosystem may be changed e.g. terrestrial's communities due to bank protection of river. So the terrestrial ecosystem was considered as one of the IEC.

7.6.2 Aquatic Ecosystem

340. Aquatic ecosystems provide support not only to aquatic inhabitants but also supply the vital ingredients to terrestrial ecosystems. Unlike terrestrial ecosystems, any impact on aquatic system is generally not confined to local area, it also cover 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, niche etc. That is why aquatic ecosystem is considered as an IEC of this project.

7.6.3 Floral Composition and Diversity

341. Composition and floral diversity of khal, beel, homestead and crop field vegetations are sensitive to hydro-morphological condition of its habitats. The impact of the proposed bank protection activities would change the hydro-morphological condition of river and would change the floral composition and diversity both on terrestrial and aquatic in the study area. Hence, the floral composition and diversity was considered anIESC.

7.6.4 Faunal Composition and Diversity

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

7.7 Socio-Economic Condition

7.7.1 Land Acquisition

343. Land will have to be acquired for implementation of the bank protection work. So, land acquisition was selected as anIESC for the proposed erosion protection activity.

7.7.2 Income Generation

344. Project interventions could increase employment opportunities in agriculture and fishery sectors as well as in the field of non-agricultural trades. Therefore, income generation was selected as anIESC.

7.7.3 Communications

345. One of the objective of bank protection work is to save embankments from river erosion and the outcome of the project will protect this embankment from erosion and the road over the right embankment which is a major road for communication in that area and will not be affected further because of erosion and will serve the communication purpose of the local people. Therefore, communication was selected as an IESC.

7.7.4 Poverty

346. People can cultivate the agricultural lands by the side of the river and thus the production will be increased. Food securities of the local people will be ensured by producing more crops in the protected agricultural lands. Thus, poverty was selected as anIESC.

8. Impact Assessment and Mitigation Measures

8.1 Categorization and Quantification

347. The Important Environmental Components (IECs) for the project have been selected and validated in Chapter 7. Following the analyses of all the secondary information available, major field investigation were conducted in May 2013, by a multidisciplinary team of experts from CEGIS. The information collected from that field visit was analyzed in order to assess and evaluate the impacts of each previously selected IEC. This chapter contains the details on impact assessment and evaluation for the implementation of the project.

348. The impact assessment concentrates on the Tranche-1 project but also prepares for aspects that will be addressed during later tranches, as part of the whole program[28]. Impacts distinguish between the impacts of restoring the eroded Brahmaputra Right Embankment at the JRB-1 subproject and building riverbank protection at critically eroding locations at all three sub-project sites. This work could provide the foundation for more systematic riverbank stabilization work covering river reaches of several ten kilometers in length. The stabilization of first river reaches can be expected to have larger impacts than the limited riverbank protection planned under Tranche-1. Consequently, tranche-1 incorporates investigations into suitable stabilization solutions, minimizing potential impacts of larger scale river stabilization, and suggesting appropriate mitigation measures for successive tranches. Expected impacts (from literature) and mitigation measueres associated with the 9-year program are summarized at the end of this chapter.

349. An attempt has been made to evaluate the impacts with and without mitigation measures by assigning numerical scores. The scores have been assigned using expert level judgments of the study team. The impacts and mitigation measures distinguish pre-construction, construction, and post construction phases and are detailed for the following five resource categories:

- Physical and Water Resources
- Land Resources
- Agriculture Resources
- Fisheries Resources
- Ecological Resources
- Socio-economic Resources

350. The level of impact has been assessed as follows:

Negative Impact (-); Positive Impact (+);

No impact (0);
Low Impact (1-3);
Medium Impact (4-6);
High Impact 7-8;
Very High Impact (9-10).

[28] The program, in ADB's terminology consists of three individual loans, referred to as Tranche-1, Tranche-2 and Tranche-3. Each tranche is an individual project, with work at different subproject sites, covering the three priority subprojects JRB-1, JLB-2, and PLB-1, but not being limited to them.

351. Fish production estimates are based on the following figures:

Habitat Category	Habitat Type	Production rate kg/Ha	Total Production
Capture	River	150	Area x Production rate
	Khal	151	
	Beel	574	
	Kol	1440	
	Floodplain	200	
Culture	Fish pond	2790	

(Source: Fisheries Statistical Year Book of Bangladesh 2010-2011,Department of Fisheries, Ministry of Fisheries and Livestock).

352. Annual Crop production has been calculated as follows:
Baseline Situation:

Sl. No.	Crop	Area (ha)	Damage-free			Damaged			Total production (Tons)
			Area (Ha)	Yield (t/ha)	Production (Tons)	Area (Ha)	Yield (t/ha)	Production (Tons)	
1	Local Aus	8,080	6,060	1.4*	8,526	2,020	0.7*	1,353	9,880
2	HYV Aus	11,026	7,718	1.7*	10,860	3,308	1.2*	2,216	12,213
3	Jute	16,332	13,066	2.4	18,383	3,266	1.5*	2,188	19,737
4	Maize	7,193	7,193	6.5	10,121	-	-	-	11,474
5	Vegetables	3,450	2,588	14	3,641	863	8	578	4,994
6	Sesame	4,650	4,650	0.95	6,543	-	-	-	7,896
	Kharif-1 Total:	***50,731***	**41,274**		**58,073**	**9,457**		**6,336**	**59,426**
7	Mixed Aus-Aman	8,540	8,540	0.80*	12,016	-	-	-	12,016
8	B. Aman	29,841	19,397	0.85*	27,291	10,444	0.7*	7,697	28,644
9	HYV Aman	39,185	23,511	2.1*	33,080	15,674	1.3*	11,552	34,433
10	Local Aman	23,751	17,813	1.3*	25,063	5,938	0.8*	4376	26,417
	Kharif-2 Total:	***101,317***	**69,261**		**97,450**	**32,056**		**23,625**	**98,803**
11	HYV Boro	119,024	101,170	4.0*	142,347	17,854	2*	35,886	143,700
12	Local Boro	605	605	1.9*	851	-	-		851
13	Wheat	7,040	7,040	2.4	9,905	-	-		9,905
14	Potato	1,500	1,500	15	2,111	-	-		2,111
15	Mustard	14,415	14,415	0.96	20,282	-	-		20,282
16	Pulses	25,031	25,031	1	35,219	-	-		35,219
17	Spices	12,563	12,563	4.6	17,676	-	-		17,676
18	Ground nut	2,873	2,873	1.5	4,042	-	-		4,042
	Rabi Total:	***183,051***	**165,197**		**232,433**	**17,845**		**35,886**	**233,786**
Total Cropped Area		**335,099**	**275,733**			**59,358**			

Souce: CEGIS field information and consultation with DAE;*Indicates cleaned rice

"Without Project" Situation (WOP)

Sl. No.	Crop	Area (ha)	Damage-free			Damaged			Total production (Tons)
			Area (Ha)	Yield (t/ha)	Production (Tons)	Area (Ha)	Yield (t/ha)	Production (Tons)	
1	Local Aus	7,478	4,487	1.2	5,384	2,991	0.65	1,944	7,328
2	HYV Aus	10,197	5,608	1.5	8,413	4,589	1	4,589	13,001
3	Jute	15,126	8,319	2.2	18,302	6,806	1.2	8,168	26,470
4	Maize	6,628	6,590	6	39,540	-	-	-	-
5	Vegetables	3,569	2,141	12	25,696	1428	8	11421	37,117
6	Sesame	4,249	4,225	0.85	3,591	-	-	-	-
	Kharif-1 Total:	***47,246***	**31,370**		**100,926**	**15,814**		**26,121**	**83,916**
7	Mixed Aus-Aman	7,818	7,818	0.75	5,864	-	-	-	5,380
8	B. Aman	27,362	17,785	0.75	13,339	9,577	0.65	6,225	19,564
9	HYV Aman	34,840	19,162	2	38,324	15,678	1.1	17,246	55,569
10	Local Aman	21,754	14,140	1.1	15,554	7,614	0.75	5,710	21,264
	Kharif-2 Total:	***91,773***	**58,905**		**73,080**	**32,868**		**29,181**	**101,777**
11	HYV Boro	109,788	82,341	3.8	312,895	27,447	1.5	41,170	354,065
12	Local Boro	510	507	1.7	862	-	-	-	862
13	Wheat	6,458	6,422	2.2	14,128	-	-	-	14,128
14	Potato	1,360	1,352	12	16,224	-	-	-	16,224
15	Mustard	13,256	13,181	0.9	11,863	-	-	-	11,863
16	Pulses	22,943	22,813	0.95	21,672	-	-	-	21,672
17	Spices	11,557	11,491	4.2	48,262	-	-	-	48,262
18	Ground nut	2,719	2,704	1.4	3,786	-	-	-	3,786
	Rabi Total:	***168,590***	**140,811**		**429,692**	**27,291**		**40,937**	**470,862**
Total Cropped Area		**307,610**	**231,086**		**603,698**	**75,973**		**96,239**	**699,938**

Souce : CEGIS field information and consultation with DAE;*Indicates cleaned rice

With Project Situation (WIP)

Sl. No.	Crop	Area (ha)	Damage-free			Damaged			Total production (Tons)
			Area (Ha)	Yield (t/ha)	Production (Tons)	Area (Ha)	Yield (t/ha)	Production (Tons)	
1	Local Aus	10,666	10,133	1.5	15,199	533	0.95	507	15,706
2	HYV Aus	14,554	13,826	1.8	24,887	728	1.4	1,019	25,906
3	Jute	21,558	20,480	2.5	51,200	1,078	1.8	1,940	53,140
4	Maize	9,495	9,495	6.8	64,566	-	-	-	-
5	Vegetables	1,518	1,442	15	21,632	76	10	759	22,391
6	Sesame	6,138	6,138	1	6,138	-	-	-	-
Kharif-1 Total:		***63,929***	**61,514**		**183,622**	**2,415**		**4,225**	**117,143**
7	Mixed Aus-Aman	6,543	6,543	0.95	6,216	-	-	-	6,216
8	B. Aman	24,427	23,206	0.9	20,885	1,221	0.8	977	21,862
9	HYV Aman	61,192	58,132	2.2	127,891	3,060	1.4	4,283	132,175
10	Local Aman	22,097	20,992	1.4	29,389	1,105	0.9	994	30,383
Kharif-2 Total:		***114,259***	**108,873**		**184,381**	**5,386**		**6,255**	**190,636**
11	HYV Boro	112,171	106,562	4.1	436,906	5,609	2.2	12,339	449,245
12	Local Boro	605	605	2	1,210	-	-	-	1210
13	Wheat	9,293	9,293	2.5	23,233	-	-	-	23,233
14	Potato	1,980	1,980	18	35,640	-	-	-	35,640
15	Mustard	19,028	19,028	1	19,028	-	-	-	19,028
16	Pulses	20,092	20,092	1.2	24,110	-	-	-	24,110
17	Spices	13,598	13,598	4.8	65,270	-	-	-	65,270
18	Ground nut	3,792	3,792	1.8	6,826	-	-	-	6,826
Rabi Total:		***180,559***	**174,950**		**612,223**	**5,609**		**12,339**	**624,562**
Total Cropped Area		**358,747**	**345,338**		**980,226**	**13,409**		**22,818**	**1,003,045**

Souce: CEGIS field information and consultation with DAE;*Indicates cleaned rice

353. Mitigation measures are included in the following tables to allow the direct comparison of the scoring of impacts and after mitigation measures for the five resource categories. Mitigation measures for future potential impacts will be worked out during subsequent studies, as outlined at the end of this chapter.

8.2 Climate Change

354. Climate change is believed to impacts 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 (see main reports, section 2.4 and IWM, 2008). The increase in discharge might be offset by increased water storage for hydro-power generation. 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.

355. 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 adusting their bed within a short time (refer for example to the Padma Bridge Study). This means that design levels for embankment 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.

8.3 Physical and Water Resources

8.3.1 Construction Phase

Jamuna Right Bank 1						
Activity: Construction of labor shed, stock yard and construction camp, mobilization of labor, materials, equipment and other machineries, construction of CC blocks at site.						
Air quality	- Possible locations of labor shed (Dombarla, Locha, Dorta Mehi, Jagtala, Gopalpur mauzas); stock yard (to be selected by the Engineer in Charge) and site of CC block construction (Benotia Mauza). - Road side places used for transportation of materials (Kaijuri-shahjadpur road and the rural roads from Hat panchil to barnia mauzas and from Nagardala to Shelachapri mauzas).	Air quality is good as no dust is generated at present.	Minor impact may occur from the small amount of dust generated due to movement of vehicles, construction materials and machineries; construction of labor shed and stock yard; preparation of CC block at site.	-2	- Construction materials should be covered with thick materials (i.e. polythene) during transportation. - Water to be sprinkled to control the generation and spreading of dust; as and where required.	-1
Noise	- Possible locations of labor shed (Dombarla, Locha, Dorta Mehi, Jagtala, Gopalpur mauzas), stock yard (to be selected by the Engineer in Charge), site of CC block construction (Benotia Mauza). - Road side places through which construction materials would be transported (Kaijuri-shahjadpur road and the rural roads from Hat panchil to barnia mauzas and Nagardala to Shelachapri mauzas).	Sound is within tolerable limit, No significant source of noise found.	Low impacts caused due to noise generation for mobilization of construction materials and construction of labor shed, stockyard and CC blocks.	-2	- Noise levels due to vehicular movement are to be kept within permissible limit. - Construction camps, labor shed, and sites for CC blocks construction are to be located far away from settlements	-1

IEC	Location	Baseline condition	Impacts	Magnitude of Impact*	Mitigation Measure	Magnitude with EMP*
Jamuna Left Bank-2 (JLB-2)						
Activity: Construction of labor shed with water and sanitation facilities, garbage disposal system, construction of stock yard and construction camp, labor and material/equipment mobilization						
Air quality	- Possible locations of labor camps (Char Jajuria and Khashkaulia mauzas at Chauhali and Char Raghunathpur at Jafarganj). - Location of stock yard (to be selected by the Engineer In Charge). - Location of CC blocks construction (Khashkaulia mauza at Chauhali and Raghunathpur mauza at Jafarganj).	Air quality is good. No dust is generated at present.	Small amount of dust would be generated during movement of vehicles, construction materials and machineries; construction of labor shed and CC block.	-2	- Construction materials to be covered with thick materials i.e. polythene during transportation. - Water to be sprinkled to control the generation and spreading of dust; as and where needed.	-1
Noise	- Possible locations of labor shed (Char Jajuria and Khashkaulia mauzas at Chauhali and Char Raghunathpur at Jafarganj). - Location of stock yard (to be selected by the Engineer In Charge). - Location of CC blocks construction (Khashkaulia mauza at Chauhali and Raghunathpur mauza at Jafarganj). - Roadside locations to be used during material transportation (Char Jajuria, Khashkaulia mauzas at Chauhali and Raghunathpur and Paila mauzas at Jafarganj)	Sound is within tolerable limit, No significant source of noise found.	Low impacts caused due to noise generation due to mobilization of construction materials and construction of labor shed, stockyard and CC blocks. There is a high school and an upazilla office at the construction site of Chauhali and one primary school at Jafarganj which would face minor impacts due to noise generation.	-2	- Noise levels due to vehicular movement are to be kept within permissible limit. - Construction camps, labor shed, and sites for CC blocks construction are to be located far away from settlements, school, offices.	-1

IEC	Location	Baseline condition	Impacts	Magnitude of Impact*	Mitigation Measure	Magnitude with EMP*
Padma Left Bank-1 (PLB-1)						
Activity: Construction of labor shed with water and sanitation facilities, garbage disposal system, construction of stock yard and construction camp, labor and materials/equipment mobilization						
Air quality	- Possible locations of labor camps (Ramkrishnapur and Andarmanik mauzas) - Location of stock yard (to be selected by the Engineer In Charge), - Location of CC block construction (Andarmanik mauza) - Roadside locations to be used in carrying construction materials (Harirampur-Rathora road; Andarmanik and Ramkrishnapur mauzas)	Air quality is good. No dust is generated at present.	Small amount of dust generation during movement of vehicles, construction materials and machineries, construction of labor shed and CC blocks.	-2	- Construction materials to be covered with thick materials i.e. polythene during transportation - Water to be sprinkled to control the generation and spreading of dust; as and where needed	-1
Activity: Construction of labor shed and construction camp; labor and materials/equipment mobilization						
Noise	- Possible locations of labor camps (Ramkrishnapur and Andarmanik mauzas) - Location of stock yard (to be selected by the Engineer In Charge), - Location of CC block construction (Andarmanik mauza) - Roadside locations to be used in carrying construction materials (Harirampur-Rathora road; Andarmanik and Ramkrishnapur mauzas)	Noise level is within permissible standard	Minor impact would be generated due to the construction of CC block, labor shed, stock yard and mobilization of materials.	-2	- Noise levels are to be kept within permissible standard	-1

8.3.2 Construction Phase

IEC	Location	Baseline condition	Impacts	Magnitude of impact*	Mitigation Measure	Magnitude with EMP*
Jamuna Left Bank-1 (JLB-1)						
Activity: Excavation of earth materials from the location of embankment; dredging of soil from the Jamuna River; dumping of earthen materials on the embankment; embankment surface lavelling and compaction through mechanical equipment; movement of vehicles for carrying materials.						
Air quality	- Places adjacent to the Jamuna River bank where the new embankment would be constructed (from Hat Panchil to Benotia mauzas). - Places adjacent to the existing embankment of the Baral river (from Verakhola to Dambarla mauzas). - At Benotia where the bank protection works is to be carried out. - Road side places through which transportation of construction materials would be carried out (Kaijuri-shahjadpur road and rural roads from Hat panchil to barnia mauzas and Nagardala to Shelachapri mauzas).	Air quality is good.	Minor amount of dust may be generated during excavating and dumping of earth materials, surface leveling with dumping machine and vehicular movements.	-3	Water to be sprinkled on regular intervals, as and where required.	-2
Noise	- Road side places for transportation of construction materials (Kaijuri-shahjadpur road and rural roads from Hat panchil to barnia mauzas and Nagardala to Shelachapri mauzas). - Location of embankment (from Kaijuri to Karatoya offtake)	Sound is within tolerable limit, No significant source of noise found.	Low impacts would be caused during excavation and dredging of soil and vehicular movements.	-2	- Noise levels due to vehicular movement, excavation and dredging activities are to be kept within permissible limit.	-1
Activity: Dredging of earth materials from the Jamuna Rivers; placing of geo-bags and CC blocks on the river banks; construction of sluices, disposal of waste generated from the labor shed.						
Surface	- Jamuna River (from Hat Panchil to Benotia	Aesthetic	The surface water quality might	-4	- Dredged spoil should be	-1

IEC	Location	Baseline condition	Impacts	Magnitude of impact*	Mitigation Measure	Magnitude with EMP*
water quality	mauzas) and Baral River (from Verakhola to Dambarla mauzas). - Possible locations of construction of drainage sluices	quality of river water is good.	be affected due to the disposal of waste generated from the labor shed into the river. Additionally, minor quantity of sediments would be generated in the rivers during dredging of soil from river bed, which would temporarily hamper the aesthetic quality of river water.		carefully dealt with. - Proper waste disposal system is to be implemented.	
Activity: Rehabilitation of embankment						
Drainage congestion	- Hurasagar river	Drainage characteristics are good at present	Low impact may occur due to the rehabilitation of embankment blocking the Hurasagar offtake. The river has two mouths at present, meeting the Baral river and blocking any one of these might stress the drainage characteristics of the other.	-2	- Constructing a sluice at one of the two channel mouths. (Currently there is a sluice at one of the two mouths of Hurasagar river, which will be rehabilitated and extended, another sluice will be built at the Jamuna.).	-1

IEC	Location	Baseline condition	Impacts	Magnitude of impact*	Mitigation Measure	Magnitude with EMP*
Jamuna Left Bank-2 (JLB-2)						
Activity: Movement of vehicles for carrying earth materials						
Air quality	Places along the left bank of the Jamuna river where bank protection works would be carried out (Char janjira, Khasdalai, Atapara, Khash kaulia mauzas at Chauhali upazilla and Char pailadhusar, Raghunathpur, Banghabari and Paila mauzas at Jafarganj of Shibalaya upazilla)	Air quality is good	Small amount of dust generated due to movement of vehicles and construction materials.	-2	Water to be sprinkled on the roads at regular intervals.	-1
Activity: Waste disposal, generated from the labor shed						

IEC	Location	Baseline condition	Impacts	Magnitude of impact*	Mitigation Measure	Magnitude with EMP*
Surface water quality	Possible locations of labor shed (Char Janjira and Khashkaulia mauzas at Chauhali and Char raghunathpur at Jafarganj).	Aesthetic quality of water is good	Impacts can be generated due to improper disposal system which may eventually contaminate the water of Jamuna River.	-4	Proper waste disposal system, not interfering with the Jamuna river flow.	-1

IEC	Location	Baseline condition	Impacts	Magnitude of impact*	Mitigation Measure	Magnitude with EMP*
Padma Left Bank-1(PLB-1)						
Activity: Movement of vehicles for carrying earth materials; placing of geo-bags; temporary slope pitching with geobags						
Air quality	Places along the left bank of the Padma river, where bank protection works would be carried out (Ram krishnapur, Andarmanik and Boyra mauzas of Harirampur upazilla).	Air quality is good.	Minor amount of dust generation during placing and dumping of Geo-bags; temporary slope preparation and geobag laying, and movement of vehicles and construction materials.	-2	Water to be sprinkled as and where needed.	-1
Activity: Waste disposal from the labor sheds.						
Surface water quality	- Possible locations of labor camps (Ramkrishnapur and Andarmanik mauzas)	Aesthetic quality of water is good	Impacts can be generated due to improper disposal system which may eventually contaminate the water of Padma River.	-4	Proper waste disposal system, not interfering with the padma river flow.	-1

8.3.3 Post-Construction Phase

IEC	Location	Baseline condition	FWOP	FWIP	Impacts	Magnitude of impact*	Mitigation Measure	Magnitude with EMP*
Jamuna Left Bank-1 (JLB-1)								
Erosion	Location adjacent to the bank protection work (Benotia mauza)	Severe erosion at Benotia mauza, along the right bank of Jamuna River. Each year, approximately	Erosion along the bank of Jamuna river will continue to propagate inside Shahjadpur. Without	Bank erosion will be protected; roads and other valuable infrastructures, agricultural lands and	Savings in agricultural lands and settlements would take place. Roadway	+6	N/A	N/A

IEC	Location	Baseline condition	FWOP	FWIP	Impacts	Magnitude of impact*	Mitigation Measure	Magnitude with EMP*
		200 hectars of land are eroded by the Jamuna river, at and near Benotia mauza	the project, in ten years, approximately 2,000 hectors of land would be eroded.	settlements would be saved from erosion.	communication will be established along the Jamuna river.			
Drainage congestion	Karatoya and Hurasagar rivers, which drain out water from the sub reach to the Baral and Jamuna rivers.	The entire sub-reach is of high topography, with elevations ranging from 8 to 10 meters. As such, water drain out quickly from the area after of rainfall.	The area will be free from drainage congestion problems.	Drainage congestion problems might occur as water may be entrapped in the area due to the construction of new embankment.	Low impact may be generated as the conveyance capacity of internal rivers and lakes will be stressed, resulting in drainage congestion problems.	-1	Provision of sluices at the mouth of Hurasagar river, and places where required.	0
Flood	Entire sub reach (especially near the location of embankment works i.e. from Hat Panchil to Benotia mauzas and from Verakhola to Dambarla mauzas).	The area is susceptible to regular flooding. The existing values of Reduced Level (RL) near the river banks are within 6 to 8 meters and the same in the entire sub reach is around 8-10 meters. Regular flood level is around 8-9 meters and each year, around 80-90% of the entire sub reach area gets inundated. Average duration of flood is 30-45 days.	Regular damage due to flood will keep affecting the socio-economic status of the local people. The farmers would not be able to practice Aman cropping in the wet season. Regular monsoon flooding will affect the communication system as well.	Flooding would be reduced near the banks by a considerable margin. The tranche 1 of the project only entails embankment rehabilitation works from Verakhola to the Karatoya offtake (Dambarla mauza). However there is no embankment at present from the Nagardala-Ratankandi bridge to the Karatoya offtake (there used to be an embankment which has been eroded in the flood of 1998). This embankment breach covers a total length of 7	The improvement in regular flooding would be around 30% in the entire sub-reach. This would lead to a better control in both irrigation and social status of the people in the subreach.	+5	N/A	N/A

IEC	Location	Baseline condition	FWOP	FWIP	Impacts	Magnitude of impact*	Mitigation Measure	Magnitude with EMP*
				kilometers through which significant water would enter during flood. However, the new embankment along the Jamuna right bank and embankment rehabilitation along the Baral river would result in around 30% improvement of flooding whereas almost 80-90% improvement would have been achieved if the embankment rehabilitation works at ratankandi (in tranche-2) would be carried out in tranche-1				
Water Availability and Use	Agricultural lands near the possible location of regulators and sluices.	Due to regular flooding in monsoon, farmers cannot practice monsoon cropping in their fields.	Farmers will not be able to undergo Aman cropping in future; this would result in increased socio-economic losses.	Farmers would have a better control on surface water and as such, they can use water for irrigation during monsoon.	The socio-economic status of the farmers would be enhanced due their increased chances of practicing Aman crops	+3	N/A	N/Asian Development BankAsian Development Bank

**No impact (0); Negative Impact (-); Positive Impact (+); Low Impact (1-3); Medium Impact (4-6); High Impact 7-8; Very High Impact (9-10).*

IEC	Location	Baseline condition	FWOP	FWIP	Impacts	Magnitude of impact*	Mitigation Measure	Magnitude with EMP*
Jamuna Left Bank-2 (JLB-2)								
Erosion	- From Atapara to Khash	Severe erosion at both Chauhali and Shibalaya upazilas, at	Erosion along the bank of Jamuna river will continue to propagate	River banks will be protected. Roads and other infrastructures,	Massive impact to the livelihood of the local people. Due to the bank protection	+8	N/A	N/A

IEC	Location	Baseline condition	FWOP	FWIP	Impacts	Magnitude of impact*	Mitigation Measure	Magnitude with EMP*
	kaulia mauzas at Chauhali upazila - From Gangadia to the end of Paila mauzas at Jafarganj of Shibalaya upazila	the left bank of Jamuna River. Each year, approximately 1400 hectors of land in total are eroded in these locations (1000 ha at Chauhali and 400 ha at Shibalaya)	inside the sub reach, destroying various places under both Chauhali and Shibalaya upazilas. In a period of ten years, around 14,000 hectors of land would be eroded in the entire sub reach if no protective works are carried out immediately. Loss of livelihoods, assets and infrastructures would occur.	agricultural lands and settlements would be saved from erosion.	works at Chauhali and Jafarganj, huge amount of agricultural lands and settlements will be saved. Communication facilities will be re-established over the left bank of Jamuna river.			

**No impact (0); Negative Impact (-); Positive Impact (+); Low Impact (1-3); Medium Impact (4-6); High Impact 7-8; Very High Impact (9-10).*

IEC	Location	Baseline condition	FWOP	FWIP	Impacts	Magnitude of impact*	Mitigation Measure	Magnitude with EMP*
Padma Left Bank-1 (PLB-1)								
Erosion	Ram krishnapur, Andarmanik and Boyra mauzas of Harirampur upazilla	Harirampur upazilla undergoes erosion /accretion features every year. Generally, in every each year around 300 ha of lands are eroded.	Erosion along the left bank of Padma river will continue to through the Harirampur upazilla. In about ten years' time, around 3,000 hectors of land would be eroded if the project is not implemented. Huge amount of agricultural lands, settlements, roads will be eroded.	River bank erosion protection would save existing roads and other assets/ infrastructures; agricultural lands and settlements would also be saved from erosion.	Huge impacts in the impacted area. River Bank protection work at Harirampur will save agricultural lands and settlements. Communication system will be enhanced. The economic status of livelihood would improve.	+7	N/A	N/A
Flood	Ram krishnapur,	The area undergoes regular monsoon	Regular flooding will affect the socio-economic status of	The risk of embankment breaches	Minor impact in flooding. The improvement in	+3	N/A	N/A

IEC	Location	Baseline condition	FWOP	FWIP	Impacts	Magnitude of impact*	Mitigation Measure	Magnitude with EMP*
	Andarmanik and Boyra mauzas of Harirampur upazilla.	flooding as the area is relatively low, with average RLs near the river banks ranging between 2-4 meters. Around 20-30% of the area gets inundated each year for 1~2 months.	local people as the farmers would be unable to cultivate Aman in monsoon. The communication system of the area will aggravate as well.	would be reduced to some extent near the left bank of the Padma river at Harirampur.	regular flooding would be around 5%.			

**No impact (0); Negative Impact (-); Positive Impact (+); Low Impact (1-3); Medium Impact (4-6); High Impact 7-8; Very High Impact (9-10).*

8.4 Land Resources

8.4.1 Pre-Construction Phase

IEC	Location	Baseline condition	Impacts	Magnitude of impact*	Mitigation Measure	Magnitude with EMP*
Jamuna Right Bank-1 (JRB-1)						
Activity	***Construction of labor sheds, stocking yard with CC block preparation yard for Embankment Rehabilitation activities***					
Land loss	Location-1: Dombaria (Baghabari towards Shahzadpur-6.5km)	About 1.04 ha of land	About 1.04 ha of existing embankment area would be used temporarily	0	• Construction of labor sheds and stocking yard in existing embankment so that the agri. land would not be lost. • Constructing materials of the protective works should be stored in such a manner that the agriculture lands and standing crops would not be damaged. • Area for executing construction activities, storage of construction materials, labor sheds, and other project related activities should be optimized with the purpose of minimum disruption to cultivable lands and standing crops. • The contractor should ensure that no vehicular movements would take place inside cultivation fields. • The contractor should maintain liaison with communities (WMOs) for better performance.	+1
	Location-2: Lochha (Shahzahdpur-Korotoa bank-4.0km)	About 1.08 ha of land	About 1.08 ha of existing embankment area would be used temporarily	0		+1
	Sub-total	**2.12 ha**				

IEC	Location	Baseline condition	Impacts	Magnitude of impact*	Mitigation Measure	Magnitude with EMP*
Activity	***Construction of labor shed and stocking yard for construction of new embankment activities***					
Land loss	Location-1: Gopalpur (Kaizuri-Hura sagar offtake-10.5km)	About 1.02 ha of land	About 1.02 ha of agricultural land would be lost temporarily	-1	• Construction of labor sheds and stocking yard preferably is constructed in khas/fallow land. • Constructing materials of the new embankment should be stored in such a manner that the agriculture lands and standing crops would not be damaged.	+2
	Location-2: Jagtala Kaizuri-Benotia-2.0km)	About 1.04 ha of land	About 1.04 ha of agricultural land would be lost temporarily	-1	• Area for executing construction activities, storage of construction materials, labor sheds and other project related activities should be optimized with the purpose of minimum disruption to cultivable lands and standing crops.	+2
	Location-3: Doriamehi (Hura sagar – Baghabari-6.0km)	About 1.0 ha of land	About 1.0 ha of agricultural land would be lost temporarily	-1	• In cases where the disruption to farming becomes unavoidable, adequate cash compensation should be provided to the land owners. /share croppers. • Exact amount of compensation should be determined based on the amount of land temporarily going out of cultivation. • The rate should be decided on the basis of the crop usually grown on the pieces of land. • The contractor should ensure that no vehicular movements would take place inside cultivation fields. • The contractor should maintain liaison with communities (WMOs) for better performance.	+2
	Sub total	**3.06 ha**				
Activity	***Construction of labor sheds, stocking yard and CC block preparation yard for Bank Protective activities***					
Land loss	Location-1: (Benotia-2.0km)	About 1.0 ha of land	About 1.0 ha of agricultural land would be lost temporarily	-1	• Construction of labor sheds and stocking yard preferably be done in khas/fallow land. • Constructing materials of the protective works should be stored in such a manner that the agriculture lands and standing crops would not be damaged. • Area for executing construction activities, storage of construction materials, labor sheds, and other project related activities should be optimized with the purpose of minimum disruption to cultivable lands and standing crops. • In cases where the disruption to farming becomes unavoidable, adequate cash compensation should be provided to the land	+2

IEC	Location	Baseline condition	Impacts	Magnitude of impact*	Mitigation Measure	Magnitude with EMP*
					owners. /share croppers. • Exact amount of compensation should be determined based on the amount of land temporarily going out of cultivation. • The rate should be decided on the basis of the crop usually grown on the pieces of land. • The contractor should ensure that no vehicular movements would take place inside cultivation fields and would maintain liaison with communities (WMOs) for better performance.	
	Sub total	**1.0ha**				
Jamuna Left Bank (JLB-2)						
Activity	***Construction of labor sheds, stocking yard and CC block preparation yard for Bank Protective activities***					
Land loss	Location-2: (Chauhali-5.0km)	About 1.02ha of land	About 1.02 ha of agricultural land would be lost temporarily.	-1	• Construction of labor sheds and stocking yard preferably is made in khas/fallow lands. • Constructing materials of the protective works should be stored in such a manner that the agriculture lands and standing crops would not be damaged. • Area for executing construction activities, storage of construction materials, labor sheds, and other project related activities should be optimized with the purpose of minimum disruption to cultivable lands and standing crops. • The contractor should ensure that no vehicular movements would take place inside cultivation fields. • The contractor should maintain liaison with communities (WMOs) for better performance.	+2
	Location-3: (Bachamara-2.0km)	About 1.01 ha of land	About 1.01 ha of agricultural land would be lost temporarily.	-1		+2
	Sub total	**2.03ha**				
Padma Left Bank (PLB-1)						
Activity	***Construction of labor sheds and bag-filling yard for Bank Protective activities***					
	Location-4: (Harirampur-7.0km)	About 1.04 ha of land	About 1.04 ha of char land/ agricultural land would be lost temporarily.	-1	• Construction of labor sheds and stocking yard preferably is made in khas/fallow lands. • Constructing materials of the protective works should be stored in such a manner that the agriculture lands and standing crops would not be damaged. • Area for executing construction activities, storage of construction materials, labor sheds, and other project related activities should	+2

IEC	Location	Baseline condition	Impacts	Magnitude of impact*	Mitigation Measure	Magnitude with EMP*
					be optimized with the purpose of minimum disruption to cultivable lands and standing crops. • The contractor should ensure that no vehicular movements would take place inside cultivation fields. • The contractor should maintain liaison with communities (WMOs) for better performance.	
	Sub total	**1.04ha**				
Jamuna Right Bank (JRB-1)						
Activity	***Construction of labor sheds and stocking yard for construction of drainage sluices activities***					
Land loss	Location-1: (Not fix up)	About 0.05ha of land	About 0.05 ha of agricultural land would be lost temporarily	-1	• Construction of labor sheds and stocking yard preferably is made in khas/fallow lands. • Constructing materials of the protective works should be stored in such a manner that the agriculture lands and standing crops would not be damaged. • Area for executing construction activities, storage of construction materials, labor sheds, and other project related activities should be optimized with the purpose of minimum disruption to cultivable lands and standing crops. • The contractor should ensure that no vehicular movements would take place inside cultivation fields. • The contractor should maintain liaison with communities (WMOs) for better performance.	+1
	Location-2: (Not fix up)	About 0.08ha of land	About 0.08ha of agricultural land would be lost temporarily	-1		+1
	Location-3: (Not fix up)	About 0.08ha of land	About 0.08ha of agricultural land would be lost temporarily	-1		+1
	Sub total	**0.21ha**				
	Grand total	**9.46 ha**				

8.4.2 Construction Phase

IEC	Location	Baseline condition	Impacts	Magnitude of impact*	Mitigation Measure	Magnitude with EMP*
Jamuna Right Bank-1						
Activity	***Collection and disposal of constructing materials for Embankment rehabilitation activities***					
Land loss	Location-3: Doriamehi (Hura sagar-Baghabari-6.0km)	About 0.6ha	About 0.6ha of agricultural land would be lost permanently	0	Top soil (0-15cm) should be managed properly for conserve the soil fertility. The filling /disposal materials should be collected preferably from river bed using sand pumped from dredger and excavator and clay collection from existing embankment.	+1
	Location-2: Lochha (Shahzahdpur-Korotoa bank-4.0km)	About 0.4ha of land		0	Area for executing construction and other project related activities should be optimized with the purpose of minimum disruption to cultivable lands and standing crops. Disposal of spoil/ constructing materials for bank rehabilitation work should preferably be place on existing embankment so that the new area might not be affected for growing crops. In cases where the disruption to farming becomes unavoidable, adequate cash compensation should be provided to the land owners. /share croppers. Exact amount of compensation should be determined based on the amount of land temporarily going out of cultivation. The rate should be decided on the basis of the crop usuallygrown on the pieces of land.	+1
	Sub total	**1.0 ha**				
Activity	***Collection and disposal of earth materials for construction of new embankment activities***					
Land loss	Location-1: Gopalpur (Kaizuri-Hura sagar offtake-10.5km)	About 1.05ha	About 1.05ha of agricultural land would be lost permanently.	-1	Top soil (0-15cm) should be managed properly for conserve the soil fertility. The filling /disposal materials should be collected preferably from river bed using sand pumped from dredger and excavator and clay collection from existing embankment.	+2
	Location-2: Jagtala Kaizuri-Benotia-2.0km)	About 0.2ha	About 0.2ha of agricultural land would be lost permanently	-1	Area for executing construction and other project related activities should be optimized with the purpose of minimum disruption to cultivable lands and standing crops.	+2

IEC	Location	Baseline condition	Impacts	Magnitude of impact*	Mitigation Measure	Magnitude with EMP*
					Disposal of spoil/ constructing materials for bank rehabilitation work should preferably be place on existing embankment so that the new area might not be affected for growing crops. In cases where the disruption to farming becomes unavoidable, adequate cash compensation should be provided to the land owners. /share croppers. Exact amount of compensation should be determined based on the amount of land temporarily going out of cultivation. The rate should be decided on the basis of the crop usually grown on the pieces of land.	
	Sub total	**1.25ha**				
Activity	***Collection and disposal of construction materials for bank protection activities***					
Land loss	Location-1: (Benotia-2.0km)	About 0.2ha of land	About 0.20 ha of land would be lost.	-1	Top soil (0-15cm) should be managed properly for conserve the soil fertility. The filling /disposal materials should be carried by dump truck and excavator for loading and unloading. Precautionary measure should be taken so that the dumping materials would not be spreading on agricultural land during carrying. Area for executing construction and other project related activities should be optimized with the purpose of minimum disruption to cultivable lands and standing crops. Disposal of spoil/ constructing materials for bank protective work should preferably be place on existing embankment so that the new area might not be affected for growing crops. In cases where the disruption to farming becomes unavoidable, adequate cash compensation should be provided to the land owners. /share croppers. Exact amount of compensation should be determined based on the amount of land temporarily going out of cultivation. The rate should be decided on the basis of the crop usually grown on the pieces of land.	+2
	Sub total	**0.2ha**				
Jamuna Left Bank(JLB-2)						

IEC	Location	Baseline condition	Impacts	Magnitude of impact*	Mitigation Measure	Magnitude with EMP*
Activity	***Collection and disposal of construction materials for bank protection activities***					
Land loss	Location-2: (Chauhali-5.0km)	About 0.5ha of land	About 0.5ha of land would be lost.	-1	Top soil (0-15cm) should be managed properly for conserve the soil fertility. The filling /disposal materials should be carried by dump truck and excavator for loading and unloading. Precautionary measure should be taken so that the dumping materials would not be spreading on agricultural land during carrying. Area for executing construction and other project related activities should be optimized with the purpose of minimum disruption to cultivable lands and standing crops. Disposal of spoil/ constructing materials for bank protective work should preferably be place on existing embankment so that the new area might not be affected for growing crops. In cases where the disruption to farming becomes unavoidable, adequate cash compensation should be provided to the land owners. /share croppers. Exact amount of compensation should be determined based on the amount of land temporarily going out of cultivation. The rate should be decided on the basis of the crop usually grown on the pieces of land.	+2
	Location-3: (Bachamara-2.0km)	About 0.2ha of land	About 0.2ha of land would be lost.	-1		+2
	Sub total	**0.7ha**				
Padma Left Bank(PLB-1)						
Activity	***Collection and disposal of Bank protection activities***					
Land loss	Location-4: (Harirampur-7.0km)	About 0.7ha of land	About 0.7ha of land would be lost for temporary protection.	-1	Top soil (0-15cm) should be managed properly for conserve the soil fertility. The filling /disposal materials should be carried by dump truck and excavator for loading and unloading. Precautionary measure should be taken so that the dumping materials would not be spreading on agricultural land during carrying. Area for executing construction and other project related activities should be optimized with the purpose of minimum disruption to cultivable lands and standing crops. Disposal of spoil/ constructing materials for bank protective work	+2

IEC	Location	Baseline condition	Impacts	Magnitude of impact*	Mitigation Measure	Magnitude with EMP*
					should preferably be place on existing embankment so that the new area might not be affected for growing crops. In cases where the disruption to farming becomes unavoidable, adequate cash compensation should be provided to the land owners. /share croppers. Exact amount of compensation should be determined based on the amount of land temporarily going out of cultivation. The rate should be decided on the basis of the crop usually grown on the pieces of land.	
	Sub total	**0.7ha**				
Jamuna Right Bank(JRB-1)						
Activity	***Disposal of dumping spoil for construction of drainage sluices***					
Land loss	Location-1: (Hurashagar outfall)	About 0.01ha of land	About 0.01ha of land would be lost	-1	The top soil (0-15cm) should be managed properly for conserving the soil fertility. Area for executing construction activities and other project related activities should be optimized with the purpose of minimum disruption to cultivable lands and standing crops. Disposal of spoil/ constructing materials for construction of drainage sluice should preferably be place on non agricultural land so that the new area might not be affected for growing crops. In cases where the disruption to farming becomes unavoidable, adequate cash compensation should be provided to the land owners. /share croppers. Exact amount of compensation should be determined based on the amount of land temporarily going out of cultivation. The rate should be decided on the basis of the crop usually grown on the pieces of land.	+1
	Location-2: (Hurashagar inlet)	About 0.02ha of land	About 0.02ha of land would be lost	-1		+1
	Location-3: (widening of existing sluice gate)	About 0.02ha of land	About 0.02ha of land would be lost.	-1		+1
	Sub total	**0.05ha**				
	Grand total	**4.55ha**				
Land type change	Entire project area	Presently, land type status is about:	Land type might change due to the activities of rehabilitation of embankment,	-2	The sequence of work (rehabilitation of embankment, construction of new embankment, bank protective work and construction of regulators/sluices) in the water channels would be carefully planned to avoid disruption of drainage system.	+2

IEC	Location	Baseline condition	Impacts	Magnitude of impact*	Mitigation Measure	Magnitude with EMP*
		Highland - 4.4%; Medium Highland - 36.9%; Medium Lowland- 36.9%, Lowland- 21.4%, Very low land- 0.3%.	construction of new embankment, bank protective work and construction of drainage sluices. If proper measures would not be taken, there is a possibility of increase of drainage congestion.		Alternate bundh (embankment) should be prepared for the protection of intrusion of flood water. Sufficient Low Lift Pumps should be made available for removal of excess /rain water. The activities should be done in dry season as far as possible. The contractor would ensure no negative impacts on crop cultivation in monsoon season. The contractor would maintain liaison with communities of WMOs.	

8.4.3 Post-Construction Phase (Loss of land from erosion)

IEC	Location	Baseline	FWOP	FWIP	Impacts	Magnitude of impact*	Mitigation Measure	Magnitude with EMP*
Land use	Entire project areas (for all locations)	Present land use is about: (i) Single crop area:28.7% (ii) Double crop area:49.8% and (iii) Triple cropped area:21.5% Present NCA=184,200ha.	Land use would be about: (i)Single crop area:26.3% (ii)Double crop area:43.5% and (iii)Triple cropped area:30.2% NCA would decrease to	Land use would be about: (i)Single crop area:22.5% (ii)Double crop area:32.4% and (iii)Triple cropped area: 45.1%. NCA would remain as	Minimize River bank erosion, so that, (a)About 30% of the NCA might be impacted positively in JRB-1, (Kaizuri and Bachamara area). (b)About 5% of the NCA (3% of the NCA in Chauhali and Nagarpur area and 2% of the NCA in Jafarganj-Bachamara area) might be impacted in JLB-2 area. (c) About 5% of the NCA might be impacted positively	+2	• Thecommunity organizations should be formed and strengthening through orientation on embankment management, smooth functioning of regulators, improve of the drainage system of the project, integrated water management, on farm development etc.	+4

IEC	Location	Baseline	FWOP	FWIP	Impacts	Magnitude of impact*	Mitigation Measure	Magnitude with EMP*
			169,950 ha.	baseline.	in PLB-1, Harirampur area.			
Land type	Entire project areas (for all locations)	Highland -4.4%, Medium Highland - 36.9%, Medium Lowland-36.9%, Lowland-21.4%, and Very low land-0.3%.	Highland-4.5%, Medium Highland - 37.0%, Medium Lowland-36.8%, Lowland-21.4%, and Very low land-0.3%.	Highland-5.8%; Medium Highland - 48.8%; Medium Lowland-28.3%, Lowland-16.8%, and Very low land-0.3%	Land type would be improved especially in JRB-1 area.	+2	Thecommunity organizations should be formed and strengthening through orientation on embankment management, smooth functioning of regulators, improve of the drainage system of the project, integrated water management, on farm development etc.	+4
Sand carpeting	Entire project area(all locations)	Presently sand carpeting affects (i) JRB-1 area, about 5%, (ii) JLB-2 area, about 3% and (iii) PLB-1 area ,about 1% of the NCA in concerned area	Sand carpeting would continue	Sand carpeting area would be minimized	Minimize sand carpeting for the rehabilitation of proposed interventions.	+4	• Formation of WMOs, strengthening through imparting training need to be done. • Involvement of community organizations in project activities (maintenance of embankment, functioning of regulators, etc) would improve the project situation. • Land of sand carpeting area might bring under cultivation through removal of coarse sand from field, incorporation of	+6

IEC	Location	Baseline	FWOP	FWIP	Impacts	Magnitude of impact*	Mitigation Measure	Magnitude with EMP*
							organic manure in the land, practicing of green manure, crop diversification through leguminous crops etc.	

**No impact (0); Negative Impact (-); Positive Impact (+); Low Impact (1-3); Medium Impact (4-6); High Impact 7-8; Very High Impact (9-10).*

N.B: The project area is an erosion prone area. If the project is not implemented, there would be negative impact on agricultural land by river erosion gradually. According to local people, erosion of JRB-1, JLB-2 and PLB-1 areas, river bank erosion is increasing gradually for the last 10 (ten) years. But the intensity of erosion has been found higher in last 3 (three) years. It is estimated that an average of about 1,900 ha of lands are being eroded every year. On the other hand, the accretion of land (char) is being created in both right and left bank of the river. It is assumed from previous experiences that, if the project is not be implemented, about 19,000 ha of fertile agricultural land might be lost after 10(ten) years from the present base year. In the study area about 75% land is under cultivation over total area. Therefore about 14,250 ha cultivable land would be lost. So, about (184200- 14,250) = 1, 69, 950 ha land might be considered as net cultivable area (NCA) under the FWOP condition in 2023.

8.5 Agriculture Resources

8.5.1 Pre-Construction Phase

356. There would be no impact during pre-construction phase

8.5.2 Construction Phase

IEC	Location	Baseline condition	Impacts	Magnitude of impact*	Mitigation Measure	Magnitude with EMP*
Jamuna Right Bank(JRB-1),Jamuna Left Bank(JLB-2) and Padma Left Bank(PLB-1)						
Activity->	*Construction of labor sheds, stocking yard for Bank rehabilitation, construction of new embankment, bank protection and construction of drainage sluices and disposal of spoils activities*					
Loss of crop Production	(i) Dombaria (ii) Lochha (iii) Gopalpur (iv) Jagtala (v) Doria mehi	Total expected crop land loss is about 9.24 ha. for: (a)Construction of labor sheds and	Expected crop production loss would be about 27.9 metric ton (Rice-23.1metric ton and Ground nut 4.8 metric	-2	• Top soil (0-15cm) should be managed properly to conserve the soil fertility. • Construction of labor sheds and stocking yard/ disposal spoils for rehabilitation of embankment, construction of new	+2

IEC	Location	Baseline condition	Impacts	Magnitude of impact*	Mitigation Measure	Magnitude with EMP*
	(vi)Benotia (vii)Chauhali (viii)Bachamara (ix) Harirampu (x)Location-1(Yet to be fixed) (xi)Location-2 (Yet to be fixed) (xii)Location-3 (Yet to be fixed)	stocking yard: 7.34 ha (b)Disposal of spoils for new embankment: 1.90 ha.	ton) for: (a) Loss of rice 18.35metric ton for construction of labor sheds and stocking yard: (b) Loss of rice 4.75 metric ton and ground nut 4.8 metric ton for disposal of spoils.		embankment, bank protective work and construction of drainage sluices should be placed in non-agricultural land as far as possible. • In cases where the disruption to farming becomes unavoidable, adequate cash compensation should be provided to the land owners. /share croppers. • Exact amount of compensation should be determined based on the amount of land temporarily going out of cultivation. • The rate should be decided on the basis of the crop usually grown on the pieces of land.	
Disrupt drainage system	Entire project area	River and khals silted up	It is expected that the drainage congested area might increase during the implementation of rehabilitation of embankment, construction of new embankment, bank protection and construction of drainage sluice activities.	-2	• The sequence of work during construction of drainage sluices in the water channels would be carefully planned to avoid disruption of drainage. • During construction period contractor should construct a by pass canal to avoid disruption of drainage. • The contractor would ensure no negative impacts on crop cultivation in monsoon season. • The contractor would maintain liaison with communityorganizations.	+2
Disrupt irrigation facilities	Entire project area	Presently, surface water irrigated area is about 1% of the study area	Irrigation facilities might be disrupted due to construction of embankment and	-2	• The sequence of work during construction of embankment and drainage sluices in the water channels would be carefully planned to avoid disruption of irrigation.	+2

IEC	Location	Baseline condition	Impacts	Magnitude of impact*	Mitigation Measure	Magnitude with EMP*
			drainage sluices.		• During construction period contractor should construct a by pass canal to ensure irrigation in dry season. • The contractor would ensure no negative impacts on crop cultivation in monsoon season. • The contractor would maintain liaison with communityorganizations.	

**N.B: ***The area of labor sheds for (i) rehabilitation of embankment /disposal of rehabilitation of embankment, and (ii) disposal of bank protection activities have not been considered as the activities would continue in existing embankment*.

8.5.3 Post-Construction Phase (JRB-1)

IEC	Location	Baseline condition	FWOP	FWIP	Impacts	Magnitude of impact*	Mitigation Measure	Magnitude with EMP*
Cropping intensity	Entire project area	Cropping intensity is about 182%	Cropping intensity would be about 181%	Cropping intensity would be about 195%	The cropping intensity would be increased by about 14% under FWIP over FWOP.	+4	-	+4
Crop Production	Entire project area	Rice production is about 202,886 metric tons	Rice production would be about 400753 metric tons	Rice production would be about 662,584 metric tons	Additional rice production would be about 204,948 metric tons	+7	-	+7
Expansion of irrigated area	Entire project area	Irrigated area is about 55% of which ground water irrigation is 54% and 1% is under surface water.	Would more or less same	It is expected that irrigated area would be increased to 70% in dry season (ground water 60% and surface water 10%).	Additional irrigated area would be increased 15 % (ground water 16% and surface water 9%).	+6	-	+6

**No impact (0); Negative Impact (-); Positive Impact (+); Low Impact (1-3); Medium Impact (4-6); High Impact 7-8; Very High Impact (9-10).*

8.6 Fisheries Resources

8.6.1 Pre-Construction Phase

357. There will be no impact in the pre-construction phase.

8.6.2 Construction Phase

IEC	Location	Baseline condition	Impacts	Magnitude of impact*	Mitigation Measure	Magnitude with EMP*
Jamuna Right Bank – 1(Embankment Rehabilitation)						
vity: Dumping of earthen materials on the embankment						
Fish habitat	6.5 km of the Verakhola towards start of Hurashagar river (Char Andharmanik)	The proposed location generally contains vegetation covers (Chon, Nol, Kaisa, Mutha, Binna, Durba etc.). Fish and prawn species (major carps, i.e., rui, catla, mrigel etc., big and small catfishes, Golda, gura chingri etc.) use this habitat as spawning, grazing and refuge grounds during the inundation of habitat in the monsoon flood season (June to September).	Temporary damage would occur in the seasonal fish habitat of 10.5 km long right bank of the Boral river due to either clearance of vegetation cover or draped by the filling earth during earth work for the fish species of marginal vegetation feeder.	-1	Vegetation clearance should be done as low as possible	-1
	4km from the starting point of Hurashagar (Char Andharmanik) to Korotoa bank			-1		-1
Fish biodiversity	Same as above	Riverine species diversity is rich with more than 100 species	Riverine fish species i. e. major carp species, grass carp and other herbivorous species, eel (*baim*), big and small cat fish (*boal, ayr, magur*), might shift from the project area	-1		-1
				-1		-1
Fish production	Same as above	Fish production from the proposed portion of the Jamuna river is 16.5 MT	Capture fish production would temporarily be declined by 3.3 MT within the project area.	-1		-1
		Fish production from the proposed portion of the Jamuna river is 10 MT	Capture fish production would temporarily be declined by 2 MT within the project area.	-1		

IEC	Location	Baseline condition	Impacts	Magnitude of impact*	Mitigation Measure	Magnitude with EMP*
Activity: Collection of earth materials from Jamuna Riverl through dredging						
Fish habitat	Same as above	More than 10 deep pools or locally called dor/duars are located at 20-40m far from the right river bank. These areas play an important role for hilsa production. Moreover, other larger fish species, i.e., boal, ayr, baghayr, rui, catla etc. use these habitat particularly during the dry season (December-March)	- Water quality (stream flow, temperature, pH, turbidity, DO, hardness etc.) of that portion of the Boral river will temporarily be changed which would change the behavior of riverine fish species (both the juveniles and adults). - Feeding habitat for the demersal (boal, ayr) and benthopelagic (baim) fish species would be damaged. - Deep pools (dor/duars) would temporarily be damaged.	-2 -1	1. Dredging will have to done during the dry season. 2. Proper protective device (silt fence) will have to take to protect the deep pools (dor/duars).	-1 -1
Fish migration	Same as above	1. Lateral migration occurs through flooding water. 2. Larvae and juveniles migrate from the river to the adjacent beels (Kadaibadla beel, Nuar beel, Mathavanga beel, Merpahnir beel, Kumirpecha beel, Moakholar beel etc) for feeding and growth during the dry season (December to March)	Both the Longitudinal (hilsa) and lateral migration for fish will be temporarily disturbed.		Dry season (December-March) is proposed for dredging.	
Fish biodiversity	Same as above	Riverine species diversity is rich with more than 100 species	Riverine fish species i. e. hilsa, major carp species, eel (*baim*), big and small cat fish (*boal, ayr, magur*), etc. might shift from the project area	-5	1. Dredging will have to be done during the dry season.	-3
Fish production	Same as above	Fish production from the proposed portion of the Jamuna river is 16.5 MT	Capture fish production would temporarily be declined by 3.3 MT within the project area.	-1	2. Proper protective device (silt fence) will have to be taken to protect the deep pools (dor/duars).	-4
		Fish production from the proposed portion of the Jamuna river is 10 MT	Capture fish production would temporarily be declined by 2 MT within the project area.	-1		

IEC	Location	Baseline condition	Impacts	Magnitude of impact*	Mitigation Measure	Magnitude with EMP*
Activity: Construction of sluice gate						
Fish Migration	Not fixed up	- There is good connectivity between the Baral khal to Hurashagar which flows over the Mohakholar Beel and Kumir pecha Beel. - The water of Baral khal goes to the Nuar Beel, Mathavanga Beel, Merpahnir Beel, Kossailkar Beel and Gobindapur Beel through the Verakhola khal	Fish migration would be hindered	-3	1. Fish friendly structure with suitable water depth, water velocity etc. should be maintained. 2. Gates should be operated with the knowledge of fish migration behavior with suitable season	-1
Fish biodiversity			Fish biodiversity would slightly be reduced, because they can enter the mentioned beel through another migration route.	-2	Same as above	-1
Fish production			Production would slightly be lowered	-2	Same as above	-1
New Embankment Construction						
vity: Collection of earth materials from the location of embankment through excavator, pay loader, head load , dump truck and trolley						
Fish habitat	10.5 km of the Jamuna river bank from Hat Pachil Bazar, Kaizuri to Benotia Hat/Bazar	The proposed location generally contains vegetation covers (Chon, Nol, Kaisa, Mutha, Kolmi, Binna, Durba etc.). Fish and prawn species (major carps, i.e., rui, catla, mrigel etc., big and small catfishes, Golda, gura chingri etc.) use this habitat as spawning, grazing and refuge grounds during the inundation of habitat in the monsoon flood season (June to September).	Temporary damage would occur in the seasonal fish habitat due to either clearance of vegetation cover or draped by the filling earth during earth work for the fish species of marginal vegetation feeder.	-1	The area of vegetation clearance should be minimized	-1
	2 km from Benotia Hat/Bazar to the start of Baral Khal, Verakola Hat			-1		-1

IEC	Location	Baseline condition	Impacts	Magnitude of impact*	Mitigation Measure	Magnitude with EMP*
Fish migration	Same as above	Fish migration occurs through flooding water during the monsoon flood season (June to September)	Lateral migration for fish will be temporarily disturbed.	-2	Same as above	-1
Fish biodiversity	Same as above	Riverine species diversity is rich with more than 100 species	Riverine fish species i. e. major carp species, grass carp and other herbivorous species, eel (*baim*), big and small cat fish (*boal, ayr, magur*), might shift from the project area	-1 -1	Same as above	-1 -1
Fish production	Same as above	Fish production from the proposed portion of the Jamuna river is 26.62 MT	Capture fish production would temporarily be declined by 13.3 MT within the project area. In opposite, culture fisheries practice would be increased.	-3	Same as above	-1
		Fish production from the proposed portion of the Jamuna river is 10 MT	Capture fish production would temporarily be declined by 2 MT within the project area.	-1		
vity: Collection of earth materials from Jamuna river through dredging						
Fish habitat	Same as above	More than 10 deep pools or locally called dor/duars are located at 20-40m far from the right river bank. These areas play an important role for hilsa production. Moreover, other larger fish species, i.e., boal, ayr, baghayr, rui, catla etc. use these habitat particularly during the dry season (December-March)	1. Water quality (stream flow, temperature, pH, turbidity, DO, hardness etc.) of that portion of the Boral river will be temporarily changed which would change the behavior of riverine fish species (both the juveniles and adults). 2. Feeding habitat for the demersal (boal, ayr) and benthopelagic (baim) fish species would be damaged. 3. Deep pools (dor/duars) would temporarily be damaged.	-2 -1	1. Dredging will have to done during the dry season. 2. Proper protective device (silt fence) will have to take to protect the deep pools (dor/duars).	-1 -1
Fish migration	Same as above	1. Lateral migration occurs through flooding water. 2. Larvae and juveniles migrate from the river to the adjacent beels (Kadaibadla beel, Nuar beel, Mathavanga beel, Merpahnir beel, Kumirpecha beel,	Both the Longitudinal (hilsa) and lateral migration for fish will be temporarily disturbed.		Dry season (December-March) is proposed for dredging.	

IEC	Location	Baseline condition	Impacts	Magnitude of impact*	Mitigation Measure	Magnitude with EMP*
		Moakholar beel etc) for feeding and growth during the dry season (December to March)				
Fish biodiversity	Same as above	Riverine species diversity is rich with more than 100 species	Riverine fish species i. e. hilsa, major carp species, eel (*baim*), big and small cat fish (*boal, ayr, magur*), etc. might shift from the project area	-5	1. Dredging will have to done during the dry season. 2. Proper protective device will have to be taken to protect the deep pools (dor/duars).	-3
Fish production	Same as above	Fish production from the proposed portion of the Jamuna river is 26.62 MT	Capture fish production would temporarily decline by 13.3 MT within the project area. Culture fisheries practice would be increased. Net fish production would increase by 25 MT	+3	Same as above	-1
		Fish production from the proposed portion of the Jamuna river is 10 MT	Capture fish production would temporarily be declined by 2 MT within the project area. Culture fisheries practice would be slightly increased.	-1		-1
Activity: Construction of sluice gate						
Fish Migration	Not fixed up	1. There is goodl connectivity between the Baral khal to Hurashagar which flows over the Mohakholar Beel and Kumir pecha Beel. 2. The water of Baral khal goes to the Nuar Beel, Mathavanga Beel, Merpahnir Beel, Kossailkar Beel and Gobindapur Beel through the Verakhola khal	Fish migration would be hindered	-3	1. Fish friendly structure with suitable water depth, water velocity etc. should be maintained. 2. Gates should be operated with the knowledge of fish migration behavior with suitable	-1

IEC	Location	Baseline condition	Impacts	Magnitude of impact*	Mitigation Measure	Magnitude with EMP*
					season	
Fish biodiversity			Fish biodiversity would slightly be reduced, because they can enter the mentioned beel through another migration route.	-2	Same as above	-1
Fish production			Production would slightly be lowered	-2	Same as above	-1
Riverbank Protection Work						
Activity: Embankment slope pitching and turfing						
Fish habitat	2 km from Benotia Hat/Bazar toward the start of Baral river.	proposed location generally contains vegetation covers (Chon, Nol, Kaisa, Mutha, Kolmi, Binna, Durba etc.). Fish and prawn species (major carps, i.e., rui, catla, mrigel etc., big and small catfishes, Golda, gura chingri etc.) use this habitat as spawning, grazing and refuge grounds during the inundation of habitat in the monsoon flood season (June to Sept.).	Temporary damage would occur in the seasonal fish habitat due to either clearance of vegetation cover or draped by the filling earth during earth work for the fish species of marginal vegetation feeder.	0	Vegetation clearance should be done as low as possible	-1
Fish biodiversity		Riverine species diversity is rich with more than 100 species	Riverine fish species i. e. major carp species, grass carp and other herbivorous species, eel (*baim*), big and small cat fish (*boal, ayr, magur*), might shift from the project area	-1		-1
Fish production		Fish production from the proposed portion of the Boral river is 10 MT	Capture fish production would temporarily be declined by 2 MT within the project area.	-1		-1
vity: Placing and dumping of C.C. blocks as per design						
Fish biodiversity	2 km from Benotia Hat/Bazar to the start of Baral Khal	Riverine species diversity is rich with more than 100 species	Riverine fish species i. e. hilsa, major carp species, eel (*baim*), big and small cat fish (*boal, ayr, magur*), etc. might shift from the project area. Different types disease producing materials/chemicals would be input	-5	1. Sloping will have to done during the dry season. 2. Proper protective device will have to take to protect the deep pools (dor/duars).	-3
Fish production		Fish production from the proposed portion of the Jamuna river is 10 MT	Capture fish production would temporarily decline by 2 MT within the project area.	-1		

IEC	Location	Baseline condition	Impacts	Magnitude of impact*	Mitigation Measure	Magnitude with EMP*
			Culture fisheries practice would be slightly increased.			
Jamuna Left Bank – 2 (Riverbank Protection Work)						
vity: Riverbank protection slope pitching with concrete blocks (above low water level)						
Fish habitat	5 km of the Jamuna Left bank from Chauhali Sadar to Atpara	1. During the pre-monsoon (April-early June) period small to larger fish species (boal, ayr, baghayr, pangas, taki, magur, baim, gura chingri etc.) go against the higher water current nearby the river bank for their breeding. 2. Cultured practice of high-valued fish species (tilapia, pangas and major carps) in cultured pond and baropit is happened near the river bank which is highly vulnerable to river bank erosion.	Boropit would be lost somewhat near the river bank at Chauhali sadar (East and North Khaskaulia	-1	Not applicable	-1
	2 km of the Jamuna Left bank from Jaffarganj to Bachamara		Not applicable	0		0
Fish biodiversity	Same as above	Riverine species diversity is moderate to rich with more than 60 species	Not applicable	0		0
Fish production	Same as above	Fish production from the proposed portion of the Jamuna river is 591.5 MT	Capture and culture fish production would be the same as the base.	0	Proper training to increase the culture practice of high-valued fish species	0
		Fish production from the proposed portion of the Jamuna river is 236.6 MT	Culture fish production would temporarily be declined by 47.32 MT within the project area.	-1		-1
Padma Left Bank -1 (Riverbank Protection Work)						
vity: Riverbank protection temporary slope pitching with geobags above low water level						
Fish habitat	7 km of the Padma Left Bank at Harirampur	1. The proposed location generally contains vegetation covers (Chon, Nol, Kaisa, Mutha, Kolmi, Binna, Durba etc.). Fish and prawn species (major carps, i.e., rui, catla, mrigel etc., big and small catfishes, Golda, gura chingri etc.) use this habitat as spawning,	- Temporary damage would occur in the seasonal fish habitat due to clearance of vegetation cover for the fish species of marginal vegetation feeder. - Spawning ground would be lost	-4	egetation clearance should be done as low as possible Spawning ground should be taken under special consideration	-2

IEC	Location	Baseline condition	Impacts	Magnitude of impact*	Mitigation Measure	Magnitude with EMP*
		grazing and refuge grounds during the inundation of habitat in the monsoon flood season (June to September). 2. There is a major spawning ground of major carps (rui, catla, mrigel etc.) at Andharmanik Ghat of Bayra Union.			during the earthwork and earth filling	
Fish migration		Major carps migrated toward the spawning ground (created before the 7 years) through the flooding water and Padma river channel.	Migration route would be disturbed	-3	Construction with take place during the dry season	0
Fish biodiversity		Riverine species diversity is rich with more than 100 species	Riverine fish species i. e. major carp species, grass carp and other herbivorous species, eel (*baim*), big and small cat fish (*boal, ayr, magur*), might shift from the project area	-2		-2
Fish production		Fish production from the proposed portion of the Padma river is 1,183 MT	Capture fish production would temporarily be declined by 592 MT within the project area.	-1		-1

8.6.3 Post-Construction Phase

IEC	Location	Baseline condition	FWOP	FWIP	Impacts	Magnitude of impact*	Mitigation Measure	Magnitude with EMP*
Jamuna Right Bank – 1 (Embankment Rehabilitation)								
Fish habitat	6.5 km of the Verakhola towards start of Hurashagar river	Fish habitat area is 4322.5 ha Capture: 4322.5 ha Culture: 0 ha	Fish habitat area in FWOP would be 4429 ha Capture: 4429 ha (Capture area would increase since floodplain area would increase for ongoing	Fish habitat area in FWIP would be slightly reduced to 107.7 ha Capture: 97.7 ha (Capture area would decrease by 5814.8 ha because of embankment construction and ring bundh construction on floodplain area) Culture: 10 ha	Estimated net loss to fish habitat area would be 4321.3 ha	-10	1. Aquatic trees and herbs should be planted on the slope of the bank. 2. Proper protective	-6

IEC	Location	Baseline condition	FWOP	FWIP	Impacts	Magnitude of impact*	Mitigation Measure	Magnitude with EMP*
			siltation through spill over channel)	(Culture area would be increased since flood induced risk would be minimized)			device will have to be taken to protect the deep pools (dor/duars). 3. Use of surface water during the breeding period should be stopped. 4. Culture fisheries should be developed 5. Perennial beels should be developed under a biodiversity program	
	4km from the starting point of Hurashagar to Korotoa bank	Fish habitat area is 1660 ha Capture: 1660 ha Culture: 0 ha	Fish habitat area in FWOP would be 1729 ha Capture: 1729 ha (Capture area would increase since floodplain area would increase for ongoing siltation through spill over channel)	Fish habitat area in FWIP would be 70 ha Capture: 69 ha (Capture area would decrease by 1591 ha because of embankment construction and ring bundh construction on floodplain area) Culture: 1 ha (Culture area would be increased since flood induced risk would be minimized)	Estimated net loss to fish habitat area would be 1659 ha	-4		-2
Fish migration	Same as above	Fish migration is in good condition	Fish migration would increased due to the increase of floodplain area	Fish migration would be obstructed along the floodplain because of embankment rehabilitation	Degraded fish migration	-5	Sluice gates operated by communities following the GIZ approach at Pabna	-3
Fish biodiversity	Same as above	Riverine species	Fish diversity would remain same as base	The present structure (species composition, population size per	Capture fish species diversity	-2	1. Proper protective	-2

IEC	Location	Baseline condition	FWOP	FWIP	Impacts	Magnitude of impact*	Mitigation Measure	Magnitude with EMP*
		diversity is rich with more than 100 species	condition or increased slightly	species etc.) of the fish community particularly SIS would decline in the following way: Floodplain migration will be declined ↓ Habitat area will be declined ↓ Population size (number of individuals) of source habitat (rivers) will be declined ↓ Increase of Vulnerability to Natural calamities ↓ Increase of Demographic calamities ↓ Decrease of Fish biodiversity High-valued culture fish species (Major carps, minor carps, Tilapia, Pangas, Thai koi etc.) would be increased	would be moderate to low		device will have to be taken to protect the deep pools (dor/duars). 2. Use of surface water during the breeding period should be stopped. 3. Culture fisheries should be developed 4. Perennial beels should be developed under a biodiversity program 5. Proper training to increase the culture practice of high-valued fish species	
	Same as above	Same as above	Same as above	Same as above	Capture fish species diversity would be moderate to low	-2		-
Fish production	Same as above	Production: 1216 MT	Fish production in FWOP would be 1229	Fish production in FWIP would be 49.5 MT	Estimated net loss to fish	-5		-3

IEC	Location	Baseline condition	FWOP	FWIP	Impacts	Magnitude of impact*	Mitigation Measure	Magnitude with EMP*
		Capture: 1216 MT Culture: 0 MT	MT Capture: 1229 MT (Fish production would be declined because of capture fish habitat quality would deteriorate) Culture: 0 MT (Culture fish production would decline due to flood induced risk; fish farmers would feel discourage to culture fish commercially)	Capture: 16.5 MT (Fish production would decrease because of migration obstacle along the floodplain through the bank protection work. All fish cannot migrate through high velocity water. During monsoon riverine fish species laterally migrate to floodplain and other capture habitat for food and spawning. Fish migration would totally be lost because of proposed intervention. Culture: 33 MT (Culture fish production would increase due to minimizing river bank erosion and flood induced risk)	production: 1179.5 MT			
	Same as above	Production: 464 MT Capture: 464 MT Culture: 0 MT	Fish production in FWOP would be 476 MT Capture: 476 MT (Fish production would be declined because of capture fish habitat quality would deteriorate) Culture: 0 MT (Culture fish production would decline due to flood induced risk; fish farmers would feel	Fish production in FWIP would be 15 MT Capture: 12 MT (Fish production would decrease because of migration obstacle along the floodplain and huge flow of water through the regulator during wet season. All fish can not migrate through high velocity water. During monsoon riverine fish species laterally migrate to floodplain and other capture habitat for food and spawning. Fish would not migrate freely	Estimated net loss to fish production: 461 MT	-9		-5

IEC	Location	Baseline condition	FWOP	FWIP	Impacts	Magnitude of impact*	Mitigation Measure	Magnitude with EMP*
			discourage to culture fish commercially)	because of proposed intervention. Culture: 3 MT (Culture fish production would increase due to minimizing flood induced risk)				
New Embankment Construction								
Fish habitat	10.5 km of the Jamuna river bank from Hat Pachil Bazar, Kaizuri to Benotia Hat/Bazar	Fish habitat area is 11183 ha Capture: 11183 ha Culture: 0 ha	Fish habitat area in FWOP would be 11206 ha Capture: 11206 ha (Capture area would increase since floodplain area would increase for ongoing siltation through spill over channel)	Fish habitat area in FWIP would be reduced to 167.5 ha Capture: 157.5 ha (Capture area would decrease by 11025 ha because of embankment construction and ring bundh construction on floodplain area) Culture: 10 ha (Culture area would be increased since flood induced risk would be minimized)	Estimated net loss to fish habitat area would be 11038.5 ha	-9	1. Aquatic trees and herbs should be planted on the slope of the bank. 2. Proper protective device will have to take to protect the deep pools (dor/duars). 3. Use of surface water during the breeding period should be stopped.	-6
	2 km from Benotia Hat/Bazar to the start of Baral Khal, Verakola Hat	Fish habitat area is 460 ha Capture: 460 ha Culture: 0 ha	Fish habitat area in FWOP would be 469 ha Capture: 469 ha (Capture area would increase since floodplain area would increase for ongoing siltation through spill over channel)	Fish habitat area in FWIP would be 61 ha Capture: 60 ha (Capture area would decrease by 400 ha because of embankment construction and ring bundh construction on floodplain area) Culture: 1 ha (Culture area would be increased since flood induced risk would be minimized)	Estimated net loss to fish habitat area would be 409 ha	-5		-4
Fish migration	Same as above	Same as the above scenario	Fish migration would increase due to the increase of floodplain	Fish migration would be obstructed along the floodplain because of embankment	Degraded fish migration	-5	operation of regulators during	-5

IEC	Location	Baseline condition	FWOP	FWIP	Impacts	Magnitude of impact*	Mitigation Measure	Magnitude with EMP*
			area	rehabilitation			migration periods	
	Same as above		Fish migration would increased due to the increase of floodplain area	Fish migration would be obstructed along the floodplain because of embankment rehabilitation	Degraded fish migration	-5	Not applicable	-5
Fish biodiversity	Same as above	Same as the above scenario	Fish diversity would remain same as base condition or increased slightly	The present structure (species composition, population size per species etc.) of the fish community particularly SIS would decline in the following way: Floodplain migration will be declined ↓ Habitat area will be declined ↓ Population size (number of individuals) of source habitat (rivers) will be declined ↓ Increase of Vulnerability to Natural calamities ↓ Increase of Demographic calamities ↓ Decrease of Fish biodiversity High-valued culture fish species	Capture fish species diversity would be moderate to low	-2	Not applicable	-2

IEC	Location	Baseline condition	FWOP	FWIP	Impacts	Magnitude of impact*	Mitigation Measure	Magnitude with EMP*
				(Major carps, minor carps, Tilapia, Pangas, Thai koi etc.) would be increased				
	Same as above	Same as the above scenario	Fish diversity would remain same as base condition or increased slightly	Same as above	Capture fish species diversity would be moderate to low	-2	Not applicable	-
Fish production	Same as above	Production: 890 MT Capture: 890 MT Culture: 0 MT	Fish production in FWOP would be 894 MT Capture: 1094 MT (Fish production would be declined because of capture fish habitat quality would deteriorate) Culture: 0 MT (Culture fish production would decline due to flood induced risk; fish farmers would feel discourage to culture fish commercially)	Fish production in FWIP would be 861 MT Capture: 828 MT (Fish production would decrease because of migration obstacle along the floodplain and huge flow of water through the regulator during wet season. All fish cannot migrate through high velocity water. During monsoon riverine fish species laterally migrate to floodplain and other capture habitat for food and spawning. Fish would not migrate freely because of proposed intervention. Culture: 33 MT (Culture fish production would increase due to minimizing flood induced risk)	Estimated net loss to fish production: 33 MT	-5	Proper training to increase the culture practice of high-valued fish species Sluice gate construction and joint operation with communities following the GIZ approach at Pabna district	-3
	Same as above	Production: 78 MT Capture: 78MT Culture: 0 MT	Fish production in FWOP would be 79 MT Capture: 79 MT (Fish production would be	Fish production in FWIP would be 13 MT Capture: 10 MT (Fish production would decrease because of migration obstacle along the	Estimated net loss to fish production: 66 MT	-6	Not applicable Sluice gate construction and joint	-6

IEC	Location	Baseline condition	FWOP	FWIP	Impacts	Magnitude of impact*	Mitigation Measure	Magnitude with EMP*
			declined because of capture fish habitat quality would deteriorate) Culture: 0 MT (Culture fish production would decline due to flood induced risk; fish farmers would feel discourage to culture fish commercially)	floodplain and huge flow of water through the regulator during wet season. All fish can not migrate through high velocity water. During monsoon riverine fish species laterally migrate to floodplain and other capture habitat for food and spawning. Fish would not migrate freely because of proposed intervention. Culture: 3 MT (Culture fish production would increase due to minimizing flood induced risk)			operation with communities following the GIZ approach at Pabna district	
Jamuna Right Bank – 1 (Bank Protection Work)								
Fish habitat	2 km from Benotia Hat/Bazar to the start of Baral Khal	Fish habitat area is 60 ha Capture: 60 ha Culture: 0 ha	Fish habitat area in FWOP would be 69 ha Capture: 69 ha (Capture area would increase since floodplain area would increase for ongoing siltation through spill over channel)	Fish habitat area in FWIP would be 58 ha Capture: 57 ha (Capture area would decrease by 12 ha because of embankment construction and ring bundh construction on floodplain area) Culture: 1 ha (Culture area would be increased since flood induced risk would be minimized)	Estimated net loss to fish habitat area would be 1 ha	-2	1. Aquatic trees and herbs should be planted on the slope of the bank. 2. Proper protective device (declaration of Sanctuary) will have to take to protect the deep pools (dor/duars). 3. Use of	-1

IEC	Location	Baseline condition	FWOP	FWIP	Impacts	Magnitude of impact*	Mitigation Measure	Magnitude with EMP*
							surface water during the breeding period should be stopped.	
Fish migration		Same as the above scenario	Fish migration would increased due to the increase of floodplain area	Fish migration would be obstructed along the floodplain because of embankment rehabilitation	Degraded fish migration	-4	Not applicable Sluice gate construction and joint operation with communities following the GIZ approach at Pabna district	-4
Fish biodiversity		Same as the above scenario	Fish diversity would remain same as base condition or increased slightly	Same as above	Capture fish species diversity would be moderate to low	-2	Not applicable Sluice gate construction and joint operation with communities following the GIZ approach at Pabna district	-2
Fish production		Production: 10 MT Capture: 10 MT Culture: 0 MT	Fish production in FWOP would be 12 MT Capture: 12 MT (Fish production would be	Fish production in FWIP would be 13 MT Capture: 10 MT (Fish production would decrease because of migration obstacle along the	Estimated net gain to fish production: 1 MT	+1	Not applicable Sluice gate construction and joint operation with	+1

IEC	Location	Baseline condition	FWOP	FWIP	Impacts	Magnitude of impact*	Mitigation Measure	Magnitude with EMP*
			declined because of capture fish habitat quality would deteriorate) Culture: 0 MT (Culture fish production would decline due to flood induced risk; fish farmers would feel discourage to culture fish commercially)	floodplain and huge flow of water through the regulator during wet season. All fish can not migrate through high velocity water. During monsoon riverine fish species laterally migrate to floodplain and other capture habitat for food and spawning. Fish would not migrate freely because of proposed intervention. Culture: 3 MT (Culture fish production would increase due to minimizing flood induced risk)			communities following the GIZ approach at Pabna district	
Jamuna Left Bank – 2 (Bank Protection Work)								
Fish habitat	5 km of the Jamuna Left bank from Chauhali Sadar to Atpara	Fish habitat area is 3511.4 ha Capture: 3500 ha Culture: 11.4 ha	Fish habitat area in FWOP would be 4900 ha Capture: 4900 ha (Capture area would increase due to the river bank erosion by 40%) Culture: 0 ha. (Due to the river bank erosion)	Fish habitat area in FWIP would be slightly reduced to 3511.4 ha Capture: 3500 ha (Capture area would be the same as the base condition) Culture: 11.4 ha (Culture area would be the same since erosion induced risk would be minimized)	Estimated net loss to fish habitat area would be 1388.6 ha	-3	1. Aquatic trees and herbs should be planted on the slope of the bank. 2. Proper protective device (i.e., declaration of Sanctuary) will have to take to protect the deep pools (dor/duars). 3. Use of	-1
	2 km of the Jamuna Left bank from Jaffarganj to Bachamara	Fish habitat area is 1400 ha Capture: 1400 ha Culture: 0 ha	Fish habitat area in FWOP would be 1960 ha Capture: 1960 ha (Capture area would increase due to the	Fish habitat area in FWIP would be 1410 ha Capture: 1400 ha (Capture area would be the same as the base condition) Culture: 10 ha	Estimated net loss to fish habitat area would be 550 ha	-3		-1

IEC	Location	Baseline condition	FWOP	FWIP	Impacts	Magnitude of impact*	Mitigation Measure	Magnitude with EMP*
			river bank erosion by 40%)	(Culture area would be increased since flood induced risk would be minimized)			surface water during the breeding period should be stopped.	
Fish migration	Same as above	Have no significant migratory routes	Would be developed	Would be blocked	Migration would be hindered permanently	-1	sluice gates would provide limited migration opportunity	-1
	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above
Fish biodiversity	Same as above	Riverine species diversity is moderate to rich with more than 60 species	Would be the same as the base condition	Would be the same as the base condition	Fish biodiversity would be reduced	-1	Same as above	-1
	Same as above	Same as the above scenario	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above
Fish production	Same as above	Production: 591.5 MT Capture: 575 MT Culture: 37.5 MT	Fish production in FWOP would be 591.5 MT Capture: 575 MT (Fish production would be the same as the base condition) Culture: 37.5 MT (Fish production would be	Fish production in FWIP would be 591.5 MT Capture: 575 MT (Fish production would be the same as the base condition) Culture: 37.5 MT (Fish production would be the same as the base condition	Not applicable	Not applicable	Proper training to increase the culture practice of high-valued fish species Not applicable	+2

IEC	Location	Baseline condition	FWOP	FWIP	Impacts	Magnitude of impact*	Mitigation Measure	Magnitude with EMP*
			the same as the base condition					
	Same as above	Production: 236.6 MT Capture: 236.6 MT Culture: 0 MT	Fish production in FWOP would be 284 MT Capture: 284 MT (Fish production would be increased at 20%)) Culture: 0 MT (Culture fish production would be same)	Fish production in FWIP would be 285 MT Capture: 236.6 MT (Due to the reduction of erosion induced risk). Culture: 48 MT (Culture fish production would increase due to minimizing flood induced risk)	Estimated net gain to fish production: 1 MT	+1		+3
Padma Left Bank – 1(Bank Protection Work)								
Fish habitat	7 km of the Padma Left Bank at Harirampur	Fish habitat area is 7,111 ha Capture: 7000 ha Culture: 111 ha	Fish habitat area is 7811 ha Capture: 7700 ha (Due to river bank erosion) Culture: 111 Spawning ground would be lost	Fish habitat area is 7133 ha Capture: 7000 ha Culture: 133 ha (Due to the increased erosion induced risk)	Estimated net loss to fish habitat: 678 ha.	-6	1. Vegetation clearance should be done as low as possible Proper protective device will have to take to protect the deep pools (dor/duars).	-2
Fish migration		Major carps migrate toward the spawning ground (created before 7 years) through the flooding water and Padma river channel.	Major carps migrated toward the spawning ground (created before the 7 years) through the flooding water and Padma river channel.	Migration route would be disturbed	Migration route would be disturbed	-2		-1

IEC	Location	Baseline condition	FWOP	FWIP	Impacts	Magnitude of impact*	Mitigation Measure	Magnitude with EMP*
Fish biodiversity		Same as above scenario	Riverine species diversity is rich with more than 100 species	Riverine fish species i. e. hilsa, major carp species, eel (baim), big and small cat fish (boal, ayr, magur), etc. might shift from the project area	Riverine fish species i. e. hilsa, major carp species, eel (baim), big and small cat fish (boal, ayr, magur), etc. might shift from the project area	-5		-3
Fish production		Production: 1548 MT Capture: 1183 MT Culture: 365 MT	Production: 1666 MT Capture: 1301 MT Culture: 365 MT	Production: 1620 MT Capture: 1183 MT Culture: 437 MT	Estimated net loss to fish production: 46 MT	-5		-3

** No impact (0); Negative Impact (-); Positive Impact (+); Low Impact (1-3); Medium Impact (4-6); High Impact (7-8); Very High Impact (9-10).*

8.7 Ecological Resources

8.7.1 Pre-Construction Phase

358. There will be no impact in the pre-construction phase.

8.7.2 Construction Phase

IEC	Location	Baseline condition	Impacts	Magnitude of impact*	Mitigation Measure	Magnitude with EMP
Jamuna Right Bank – 1(Embankment Rehabilitation)						
Activity: Rehabilitation of embankment						

IEC	Location	Baseline condition	Impacts	Magnitude of impact*	Mitigation Measure	Magnitude with EMP
Terrestrial Ecosystem Aquatic ecosystem. Floral composition and diversity. Faunal composition and diversity.	6.5 km of the Verakhola towards start of Hurashagar river (Char Andharmanik). 4km from the starting point of Hurashagar (Char Andharmanik) to Korotoa bank .	Dense vegetations like trees, shrubs and herbs are present besides the River bank. Trees are used as nesting and breeding places. Plantation action should be implemented.	Shrubs and herbs and other vegetation of bank slopes will be damaged. Feeding and resting ground will be damaged completely. After 2-3 year the situation will same as base situation.	- 4	Do not cut the big trees Do not clean the additional area. Do not dump large volume of excavated soil on bottom of the aforesaid trees. Different species of sapling should the planted. Use the area as less as possible.	+2
Construction of New Embankment						
Activity: Collection of earth materials and construction of new embankment						
Terrestrial Ecosystem Aquatic Ecosystem. Floral composition and diversity Faunal Composition and diversity	10.5 km of the Jamuna river bank from Hat Pachil Bazar, Kaijuri to Benotia Hat/Bazar 2 km from Benotia Hat/Bazar to the start of Baral Khal, Verakola Hat	River banks holds dense vegetations like trees, shrubs and herbs etc.	Shrubs and herbs and vegetation of bank slopes will be damaged by excavated soil dumping. Less damage of trees of bank slope. Aquatic flora as well as zooplankton and phytoplankton will be destroyed After 2-3 year the situation will return as base situation.	-3	Use the area as required. Do not dump large volume of excavated soil on bottom of the aforesaid trees.	+2
Bank Protection Work of Jamuna Right Bank-1, Jamuna Left Bank – 2, Padma Left Bank – 1						
Activity: Slope protection activities						

IEC	Location	Baseline condition	Impacts	Magnitude of impact*	Mitigation Measure	Magnitude with EMP
Terrestrial ecosystem Aquatic ecosystem. Floral composition and diversity Faunal composition and diversity	2 km from Benotia Hat/Bazar to the start of Baral Khal, Verakola Hat. 5 km of the Jamuna Left bank from Chauhali Sadar to Atpara. 2 km of the Jamuna Left bank from Jaffarganj to Bachamara 7 km of the Padma Left Bank at Harirampur.	River bank holds dense vegetations like trees, shrubs and herbs. Faunal diversity is moderate in this region Homestead and roadside vegetations like fruit bearing and timber trees, shrubs and herbs are located beyond the 2-10 m far from the river bank.	Vegetation of river banks will temporarily be damage and disturbed. Aquatic fauna i.e., little egret, Indian pond heron etc. would not exist near the river bank.	-2	Do not dump the large volume of excavated soil on bottom of the aforesaid trees. Bot, Pakur, Shimul and other big trees are suggested to be protected Plantation of different species of saplings should be implemented along the country side slope of the embankment	+2
Activity: Plantation Activities						
Terrestrial ecosystem. Aquatic ecosystem. Floral composition and diversity Faunal Composition and diversity	6.5 km of the Verakhola towards start of Hurashagar river (Char Andharmanik) 4km from the starting point of Hurashagar (Char Andharmanik) to Korotoa river bank. 10.5 km of the Jamuna river bank from Hat Pachil Bazar, Koijuri to Benotia Hat/Bazar 2 km from Benotia Hat/Bazar to the start of Baral Khal, Verakola Hat.	River bank holds dense vegetations like trees, shrubs and herbs. Faunal diversity is moderate in this region Homestead and roadside vegetations like fruit bearing and timber trees are present	Vegetation of river banks will temporarily be damage and disturbed. Some trees will lose due to implementation of proposed intervention.	-3	About 50,000 species of different, sapling e.g. timber, fruit and water tolerance trees should the planted. Cut the trees as less as possible.	+5

**No impact (0); Negative Impact (-); Positive Impact (+); Low Impact (1-3); Medium Impact (4-6); High Impact 7-8; Very High Impact (9-10).*

8.7.3 Post-Construction Phase

IEC	Location	Baseline condition	FWOP	FWIP	Impacts	Magnitude of impact*	Mitigation Measure	Magnitude with EMP
Jamuna Right Bank – 1 (Embankment Rehabilitation)								
Terrestrial ecosystem Aquatic ecosystem. Floral composition and diversity. Faunal composition and diversity	10.5 km from Verakhola toward the Korotoa bank at Mohakhola	River bank holds dense vegetations like trees, shrubs and herbs. Faunal diversity is moderate in this region Homestead and roadside vegetations like fruit bearing and timber trees are present.	Vulnerable due to bank erosion and flooding. Will be more vulnerable e.g. bank mayna due to flooding and bank erosion. Wildlife population will be same as baseline	Bank erosion will be protected Vegetation will be protected but less in quantity. Vegetation will be improved and healthy. Faunal composition will improve simultaneously	Protection of homestead, roadside and social forest habitat will improve bio-diversity. Vegetation coverage of the project area will improve. Faunal composition and diversity would be improve simultaneously	+3	Plantation of different species of saplings should be implemented	+5
Jamuna Right Bank – 1 (Construction of New Embankment)								
Terrestrial ecosystem Aquatic ecosystem. Floral composition and diversity. Faunal composition and diversity	12.5 km of the Jamuna river bank from Hat Pachil Bazar, Kaizuri toward the Korotoa bank at Mohakhola.	Vegetation of embankment moderate. Faunal composition is moderate to rich.	Vulnerable due to bank erosion and flooding. Will be more vulnerable e.g. bank mayna due to flooding and bank erosion. Wildlife population will be same as	Habitat protection from river erosion and flood. Vegetation will be improved and healthy. Faunal composition will improve	Protection of homestead, roadside and social forest habitat that will improve faunal diversity.	+2	Plantation of different species of saplings should be implemented.	+4

IEC	Location	Baseline condition	FWOP	FWIP	Impacts	Magnitude of impact*	Mitigation Measure	Magnitude with EMP
			baseline	simultaneously.				
Bank Protection Work of Jamuna Right Bank -1, Jamuna Left Bank – 2, Padma Left Bank – 1								
Activity: Slope protection activities								
Terrestrial ecosystem Aquatic ecosystem. Floral composition and diversity Faunal composition and diversity.	2 km from Benotia Hat/Bazar to the start of Baral Khal, Verakola Hat. 5 km of the Jamuna Left bank from Chauhali Sadar to Atpara. 2 km of the Jamuna Left bank from Jaffarganj to Bachamara 7 km of the Padma Left Bank at Harirampur	Vegetation of embankment moderate. Faunal composition is poor to moderate. Homestead habitat moderate. Roadside vegetation moderate, but vulnerable due to flood.	Vulnerable due to bank erosion and flooding. Will be more vulnerable e.g. bank mayna due to flooding and bank erosion. Wildlife population will be same as baseline	Habitat protection from river erosion and flood. Vegetation will be improved and healthy. Faunal composition will improve simultaneously.	Protection of homestead, roadside and social forest habitat will improve bio-diversity	+3	Plantation action should be implemented	+3
Activity: Plantation Activities (JRB-1)								
Terrestrial ecosystem Aquatic ecosystem.	6.5 km of the Verakhola towards start of Hurashagar	River bank holds dense vegetations like trees, shrubs and herbs.	River bank will erroted and destroyed the homestead and	Protection of river bank will protect the trees that will	Vegetation of river banks will temporarily be damage and	-3	Plantation of different species of saplings should be	+5

IEC	Location	Baseline condition	FWOP	FWIP	Impacts	Magnitude of impact*	Mitigation Measure	Magnitude with EMP
Floral composition and diversity. Faunal composition and diversity	river (Char Andharmanik) 4km from the starting point of Hurashagar (Char Andharmanik) to Korotoa bank. 10.5 km of the Jamuna river bank from Hat Pachil Bazar, Kaijuri to Benotia Hat/Bazar 2 km from Benotia Hat/Bazar to the start of Baral Khal, Verakola Hat.	Faunal diversity is moderate in this region Homestead and roadside vegetations like fruit bearing and timber trees are present.	road side plantation in the area.	maintain the ecological balance.	disturbed. Some trees will lose due to implementation of proposed intervention.		implemented.	

**No impact (0); Negative Impact (-); Positive Impact (+); Low Impact (1-3);Medium Impact (4-6); High Impact 7-8;Very High Impact (9-10).*

8.8 Socio-economic

8.8.1 Pre-Construction Phase

IEC	Location	Baseline	Impacts	Magnitude of impact*	Mitigation Measure	Magnitude with EMP*
Jamuna Right Bank-1(JRB-1)						
Activity->	Construction of labor shed with proper water and sanitation facilities, garbage disposal system, construction of stock yard and construction camp, mobilization of labor, materials, equipment and other machineries; preparing CC blocks at site.					
Resettlement	10.5 km of the Jamuna river bank from Hat Pachil Bazar, Kaizuri to Benotia Hat/Bazar 2 km from Benotia Hat/Bazar to the start of Baral Khal, Verakola Hat These villages/ mauzas are: Ratankandi Selachapri Dumbaria Alokdia Nundao	About more than 2500 HHs are living near embankment area for last 20 years and those who are living on embankment, mostly they are migrated from outside of these area.	About 1130 HHs in the different locations of project area will be displaced.	-1	Proper land compensation, PAPs should be ensured for displaced peopled of project area (refer to the resettlement plan)	0
Gender Issues	The whole project study area i.e. Ratankandi Mohakhola Sontosha	Women are mainly engaged in household level works and their involvement in outside of the home is now growing.	Labor mobilization may create disturbance for the local women.	-2	The labor mobilization activities should be strictly followed up by project authority.	-1

IEC	Location	Baseline	Impacts	Magnitude of impact*	Mitigation Measure	Magnitude with EMP*
Public Health	Kashipur Dholai Marma Binotia	About 40 percent people tend to receive health service from quack and 30 percent from paramedic/ diploma physicians and 20 percent from trained physicians. But it is noteworthy that about 10 percent do not receive treatment facility due to their impoverishment and communication problems	Because of having limited access to toilet and unhygienic environment, huge gathering of labors can create disturbance to health.	-1	Proper health and sanitation system should be ensured for labors.	0

** No impact (0); Negative Impact (-); Positive Impact (+); Low Impact (1-3); Medium Impact (4-6); High Impact (7-8); Very High Impact (9-10).*

IEC	Location	Baseline	Impacts	Magnitude of impact*	Mitigation Measure	Magnitude with EMP*
Jamuna Left Bank-2 (JLB-2)						
Activity->	Construction of labor shed with water and sanitation facilities, garbage disposal system, construction of stock yard and construction camp, labor and material/ equipment mobilization					
Resettlement	5 km of the Jamuna Left bank from Chauhali Sadar to Atpara 2 km of the Jamuna Left bank from Jaffarganj to Bachamara These villages/ mauzas are: Andharmanik	About more than 2000 HHs are living near embankment area for last 20 years and those who are living on embankment, mostly they are migrated from outside of these area.	About 534 HHs in the different locations of project area will be displaced.	-2	Proper land compensation, PAPs should be ensured for displaced peopled of project area	-1

IEC	Location	Baseline	Impacts	Magnitude of impact*	Mitigation Measure	Magnitude with EMP*
Jamuna Left Bank-2 (JLB-2)						
	Beda khola Mohakhola Kashipur Ata para Noya Para Dholai Kaulia Marma					
Employment	Possible locations of labor camps (Char Janjira and Khashkaulia mauzas). Location of stock yard (to be selected by the Engineer In Charge). Location of CC blocks construction (at Khashkaulia mauza).	About 40 percent of total population is employed, 47 percent is engaged in household work, only less than one percent is looking for work and about 13 percent of total population is not working (it includes children and physically challenged population).	A temporary employment opportunity will be created for local labors during labor shed construction.	+1	-	0
Gender Issues	The whole study area i.e. Andharmanik Beda khola Mohakhola Kashipur Ata para Noya Para Dholai Kaulia Marma	Women are mainly engage in household level works and their involvement in outside of the home is now growing.	Labor mobilization may create disturbance for the local women.	-2	The labor mobilization activities should strictly follow up by project authority.	-1
Public Health		About 40 percent people tend to receive health service from quack and 30 percent from paramedic/diploma physicians and 20 percent from trained physicians. But it is noteworthy that about 10 percent cannot	Because of having limited access to toilet and unhygienic environment, huge gathering of labors can create disturbance to health.	-1	Proper health and sanitation system should be ensured for labors.	0

IEC	Location	Baseline	Impacts	Magnitude of impact*	Mitigation Measure	Magnitude with EMP*
Jamuna Left Bank-2 (JLB-2)						
		receive treatment facility due to their impoverishment and communication problems				

** No impact (0); Negative Impact (-); Positive Impact (+); Low Impact (1-3); Medium Impact (4-6); High Impact (7-8); Very High Impact (9-10).*

IEC	Location	Baseline	Impacts	Magnitude of impact*	Mitigation Measure	Magnitude with EMP*
Padma Left Bank-1(PLB-1)						
Activity->	Construction of labor shed with water and sanitation facilities, garbage disposal system, construction of stock yard and construction camp, labor and materials/equipment mobilization					
Resettlement	Possible locations of labor camps (Ramkrishnapur and Andarmanik mauzas) Location of stock yard (to be selected by the Engineer In Charge), Location of CC block construction (Andarmanik mauza) These villages are: Jaghannathpur Boxor Andharmanik Bholabaj Boyra	About more than 2000 HHs are living near embankment area for last 20 years and those who are living on embankment, mostly they are migrated from outside of these area.	Due to temporary slope protection no displacement will take place but some construction disturbance might take place	-2	Construction disturbance should be minimized	-1
Gender Issues	The whole project study area i.e. Jaghannathpur Boxor	Women are mainly engage in household level works and their involvement in outside	Labor mobilization may create disturbance for the	-2	The labor mobilization activities should	-1

IEC	Location	Baseline	Impacts	Magnitude of impact*	Mitigation Measure	Magnitude with EMP*
Padma Left Bank-1(PLB-1)						
	Andharmanik Bholabaj	of the home is now growing.	local women.		strictly follow up by project authority.	
Public Health	Boyra	About 40 percent people tend to receive health service from quack and 30 percent from paramedic/diploma physicians and 20 percent from trained physicians. But it is noteworthy that about 10 percent cannot receive treatment facility due to their impoverishment and communication problems	Because of having limited access to toilet and unhygienic environment, huge gathering of labors can create disturbance to health.	-1	Proper health and sanitation system should be ensured for labors.	0

** No impact (0); Negative Impact (-); Positive Impact (+); Low Impact (1-3); Medium Impact (4-6); High Impact (7-8); Very High Impact (9-10).*

8.8.2 Construction Phase

IEC	Location	Baseline condition	Impacts	Magnitude of impact*	Mitigation Measure	Magnitude with EMP*
Jamuna Right Bank-1(JRB-1)						
Activity->	Excavation of earth materials from the location of embankment; dredging of soil from the Jamuna and Baral rivers; dumping of earthen materials on the embankment; embankment surface labeling through dumping machine; movement of vehicles for carrying earth materials.					
Employment	Places adjacent to the Jamuna River bank where the new embankment would be constructed (from Hat Panchil to Benotia	About 40 percent of total population is employed, 47 percent is engaged in household work, only below than one percent is looking for work and about 13 percent of total	A temporary employment may be created for laborer during bailing out activities.	+1	-	0

IEC	Location	Baseline condition	Impacts	Magnitude of impact*	Mitigation Measure	Magnitude with EMP*
	mauzas). Places adjacent to the existing embankment of the Baral river (from Verakhola to Dambarla mauzas). At Benotia where the bank protection works is to be carried out.	population is not working (it includes children and physically challenged population)				
Income generation		In the study area it is found that most of the income and expenditure are varying from 5,000 Tk. to 20,000 Tk. /month. About 75% of total household hire labor for agricultural production. The wage rate varies between 350 Tk. to 150 Tk. /day.	The additional income source may bring betterment of family happiness in the project area	+1	-	0
Labor migration	Labor would be internally in-migrated from adjacent upazilas/ districts.	People from the project area tend to migrate to Dhaka, Tangail, Sylhet and Rajshahi for better livelihood (60%) while a significant number of labor (20%) migrate to the project area with a view to subsisting the economy.	The in-migrated people may take part in construction work and this will bring opportunities for them also.	+2	-	0
Activity->	Dredging of earth materials from the Jamuna rivers; placing of geo-bags and CC blocks on the river banks; construction of sluices.					
Employment	Jamuna River (from Hat Panchil to Benotia mauzas). Baral River (from Verakhola to Dambarla mauzas). Other possible locations of construction of drainage sluices.	About 40 percent of total population is employed, 47 percent is engaged in household work, only below than one percent is looking for work and about 13 percent of total population is not working. About 75% of total household hire labor for agricultural production.	A temporary employment opportunity will be created for many labors.	+1	-	0
Income		About 55% of people earn	A small number of	+1	-	0

IEC	Location	Baseline condition	Impacts	Magnitude of impact*	Mitigation Measure	Magnitude with EMP*
generation		5000tk-20,000tk per month and also being unemployed for days in a year and they keen on to involve in alternative works.	low earned people will enhance their income with this additional income source.			

** No impact (0); Negative Impact (-); Positive Impact (+); Low Impact (1-3); Medium Impact (4-6); High Impact (7-8); Very High Impact (9-10).*

IEC	Location	Baseline condition	Impacts	Magnitude of impact*	Mitigation Measure	Magnitude with EMP*
Jamuna Left Bank-2(JLB-2)						
Activity->	Movement of vehicles for carrying earth materials					
Employment	Places along the left bank of the Jamuna river where bank protection works would be carried out (Char janjira, Khasdalai, Atapara, Khash kaulia mauzas at Chauhali upazilla and Char pailadhusar, Raghunathpur, Banghabari and Paila mauzas at Jafarganj of Sirajganj upazilla)	About 40 percent of total population is employed, 47 percent is engaged in household work, only below than one percent is looking for work and about 13 percent of total population is not working (it includes children and physically challenged population).	A temporary employment will be created for many labors during bailing out activities.	+1	-	+1
Income generation		Approximately over 55% of people earn 20000tk-5000tk per month also being unemployed for many days in a year and they are keen on to involve in alternative works.	A small number of low earned people will enhance their income with this additional income source.	+1	-	+1
Labor migration	Labor would be internally in-migrated	Overall 20% of labors are in-migrated in the study area.	Opportunities for in-migrant labors	+2	-	+2

IEC	Location	Baseline condition	Impacts	Magnitude of impact*	Mitigation Measure	Magnitude with EMP*
	from adjacent upazilas/ districts.		could be ensured during earthwork activities.			
Public Health	The whole project study area i.e. Andharmanik Beda khola Mohakhola Kashipur Ata para Noya Para Dholai Kaulia	About 40 percent people tend to receive health service from quack and 30 percent from paramedic/diploma physicians and 20 percent from trained physicians. But it is noteworthy that about 10 percent cannot receive treatment facility due to their impoverishment and communication problems	Because of having limited access to toilet and unhygienic environment, huge gathering of labors can create disturbance to health.	-1	Proper health and sanitation system should be ensured for labors.	-1

** No impact (0); Negative Impact (-); Positive Impact (+); Low Impact (1-3); Medium Impact (4-6); High Impact (7-8); Very High Impact (9-10).*

IEC	Location	Baseline condition	Impacts	Magnitude of impact*	Mitigation Measure	Magnitude with EMP*
Padma Left Bank-1(PLB-1)						
Activity->	Movement of vehicles for carrying earth materials					
Employment	Places along the left bank of the Padma River, where bank protection works would be carried out (Ram krishnapur, Andarmanik and Boyra mauzas of	About 40 percent of total population is employed, 47 percent is engaged in household work, only less than one percent is looking for work and about 13 percent of total population is not working. About 75% of total household hire labor for	Temporary employment opportunities will be created for labors during bailing out activities.	+1	-	-

IEC	Location	Baseline condition	Impacts	Magnitude of impact*	Mitigation Measure	Magnitude with EMP*
	Harirampurupazilla).	agricultural production.				
Income generation		About 55% of people can earn 20000tk-5000tk per month, they are unemployed for many days in a year and keen on to involve in alternative works.	A small number of low earned people will enhance their income with this additional income source.	+1	-	-
Labor migration	Labor would be internally in-migrated from adjacent upazilas/districts.	Overall 20% of labors are in-migrated in the study area.	Opportunities of in-migrant labors could be created during earthwork activities.	+2	-	-

** No impact (0); Negative Impact (-); Positive Impact (+); Low Impact (1-3); Medium Impact (4-6); High Impact (7-8); Very High Impact (9-10).*

8.8.3 Post-Construction Phase

IEC	Location	Baseline	FWOP	FWIP	Impacts	Magnitude of impact*	Mitigation Measure	Magnitude with EMP*
Jamuna Right Bank-1(JRB-1)								
Communication	Possible locations for communication in project area - Hat Panchil - Benotia - Verakhola - Dambarla	Embankment cum road is locally used for communication and some light vehicle as well.	Embankment cum road could wipe out for last 10 years. In near future, main road of Hat Panchil to Benotia would be affected.	Communication facilities will be improved both in local and upazila level.	Road communication may be improved which convey better economy by expanding business option.	+3	-	0
Employment	- Ratankandi - Selachapri	About 40 percent of total	Temporary employment	More employment	In future, a number of	+4	-	0

IEC	Location	Baseline	FWOP	FWIP	Impacts	Magnitude of impact*	Mitigation Measure	Magnitude with EMP*
Jamuna Right Bank-1(JRB-1)								
	- Dumbaria - Alokdia - Nundao	population is employed, 47 percent is engaged in household work, only below than one percent is looking for work and about 13 percent of total population is not working. About 75% of total household hire labor for agricultural production.	will be created for many labors during labor shed construction.	opportunities will be created for farmers and fishers of the project area.	employment opportunities may be generated in culture fish and agriculture sector.			
Income generation		Approximately over 55% of people earn 20000tk-5000tk per month, are unemployed for many days in a year and keen on to involve in alternative works.	A small number of low earned people will enhance their income with this additional income source.	People income will increase in future by creating more work options.	Income will be increased for all classes i.e. labor to businessmen.	+4	-	0

** No impact (0); Negative Impact (-); Positive Impact (+); Low Impact (1-3); Medium Impact (4-6); High Impact (7-8); Very High Impact (9-10).*

IEC	Location	Baseline	FWOP	FWIP	Impacts	Magnitude of impact*	Mitigation Measure	Magnitude with EMP*
Jamuna Left Bank-2(JLB-2)								
Protection of municipal area including markets and homesteads	Chouhali bazaar and adjacent villages Jafarganj bazaar and adjacent village	Damages of municipal areas due to erosion	Municipal area including markets and homesteads will certainly be eroded	Protective work will protect the municipal area including markets and homestead	Municipal area, markets and homesteads will be protected and business will be run properly. Government office, and educational and religious institutions will be protected	+6	N/A	N/A
Employment	Char janjira Khasdalai Khash kaulia Pailadhusar Raghunathpur Paila	About 40 percent of total population is employed, 47 percent is engaged in household work, only below than one percent is looking for work and about 13 percent of total population is not working. About 75% of total household	A temporary employment will be created for many labors during labor shed construction.	More employment opportunities may be created for farmers and fishers of the project area.	In future, a number of employment opportunities may be generated in culture fish and agriculture sector.	+4	-	+4

IEC	Location	Baseline	FWOP	FWIP	Impacts	Magnitude of impact*	Mitigation Measure	Magnitude with EMP*
		hire labor for agricultural production.						
Income generation		Approximately over 55% of people earn 20000tk-5000tk per month, are unemployed for many days in a year and keen on to involve in alternative works.	A small number of low earned people will enhance their income with this additional income source.	People income will increase in future by creating more work options.	Income will be increased for all classes i.e. labor to businessmen.	+4	-	0

** No impact (0); Negative Impact (-); Positive Impact (+); Low Impact (1-3); Medium Impact (4-6); High Impact (7-8); Very High Impact (9-10).*

IEC	Location	Baseline	FWOP	FWIP	Impacts	Magnitude of impact*	Mitigation Measure	Magnitude with EMP*
Padma Left Bank-1(PLB-1)								
Communication	The possible locations for communication system are: Jaghannathpur Boxor Andharmanik Bholabaj Boyra	Bank protection cum road is locally used for communication and some light vehicle as well.	Bank protection cum road wiped out recently. In near future, main road of Alfadanga to Faridpur would be	Communication facilities will be protected at its current levelboth in local and upazila level.	Road communication will remain the same	+3	-	0

IEC	Location	Baseline	FWOP	FWIP	Impacts	Magnitude of impact*	Mitigation Measure	Magnitude with EMP*
			affected.					
Protection of municipal area including markets and homesteads	Ramkrishnapur bazaar and adjacent other villages Andharmanik bazaar and adjacent other village	Damages of municipal areas due to erosion	Municipal area including markets and homesteads will certainly be eroded	Protective work will protect the municipal area including markets and homestead	Municipal area, markets and homesteads will be protected and business will be run properly. Government office, and educational and religious institutions will be protected	+6	N/A	0
Employment	The possible locations for employment opportunities in future are: Jaghannathpur Boxor Andharmanik Bholabaj Boyra	A number of labor, man powers are unemployed in many days in a year and 6% of skilled worker are permanently out-migrated. Also, 23% of seasonal out migrants daily out-migrated for employment.	A temporary employment will be created for many labors during labor shed construction.	More employment opportunities will be created in agriculture and fisheries field.	In future, a number of employments will generate in fish culture and agriculture activities.	+4	-	0

IEC	Location	Baseline	FWOP	FWIP	Impacts	Magnitude of impact*	Mitigation Measure	Magnitude with EMP*
Income generation		Over 55% of people earn 20000tk-5000tk per month, are unemployed for many days in a year and keen on to involve in alternative works.	A small number of low earned people will enhance their income with this additional income source.	People income will increase in future by creating more work options.	Income will be increased for all classes i.e. labor to businessmen.	+4	-	0

** No impact (0); Negative Impact (-); Positive Impact (+); Low Impact (1-3); Medium Impact (4-6); High Impact (7-8); Very High Impact (9-10).*

8.9 Summary of anticipated environmental Impacts and Mitigation Measures

8.9.1 JRB-1 Flood Embankment Potential Impacts

359. The reconstructed Brahmaputra Right Embankment[29] along the Jamuna and rehabilitated flood embankment works along the Hurashagar/Baral included in JRB-1 could have adverse impacts on the floodplain water resources. Residual adverse impacts from the JRB-1 embankment are a possibility, and contribute to the rationale for the classification of Tranche 1 as ADB environmental category A.

360. The primary and intended impact of the JRB-1 flood embankments is to reduce flood damage to crops and infrastructure, and to induce greater economic investment and productivity in floodplain agriculture and other activities by reducing flood risk. Figure 8.1 shows the modeled effect of the JRB-1 embankment works on water levels behind the embankment (the difference between with-project and without-project water levels) for 2003 river flood levels which approximate the 1:2 year return period flood.

361. The land type changes induced by the embankment are shown inTable 8.1, Figure 8.2, and Figure 8.3. Currently, JRB-1 seasonally flooded land (ie within the proposed flood-protected area) consists of 12,000 ha that is flooded to 120-360 cm (F3 land type) and 4,000 ha that is deeply flooded to >360 cm (F4 land type). Of this, JRB-1 will transform about 40 per cent (6,600 ha) to flood-free conditions (F0 land type, 0-30 cm). Another 10 per cent (1900 ha) will be converted to moderately-flooded conditions (F1 and F2 land types, 30-120 cm). These hydrologic changes within the proposed JRB-1 flood-protected area have numerous potential secondary impacts. Intended beneficial impacts are significantly reduced flood damage to agriculture and infrastructure; increased cultivated area and cropping intensity and the resulting increases in agriculture / aquaculture production.

Table 8.1: JRB-1 Impacts on Land Type

Pre and Post Project Change (post-pre)	F0 0-30 cm	F1 30-90 cm	F2 90-120 cm	F3 120-360 cm	F4 >360 cm	Total
(ha)						
Pre	12673	117	2313	12024	3825	30952
Post	19315	1116	3177	5319	2178	31105
Change	6642	999	864	-6705	-1647	153
% change	52%	854%	37%	-56%	-43%	0%

Notes: Land type areas are taken from the flood modelling of the area enclosed by the embankments, for the 2003 flood event, adjusted to reflect RADARSAT flood extent information. 2003 was chosen to approximate the average moderate *bonna* 1:2 flood event.

Source: Tables 5-3 and 5-4, Final Report, Annex D – Flood Modelling (revision 13 dated 21 June).

[29] This embankment eroded from 1996 onwards after having protected the Hurashagar Flood Control and Drainage Project. The embankment was not rebuilt and progressive erosion lead to a more than 10km wide gap. Since 2009, the JMREMP project protected 10km of riverbank from erosion allowing the reconstruction of the embankment.

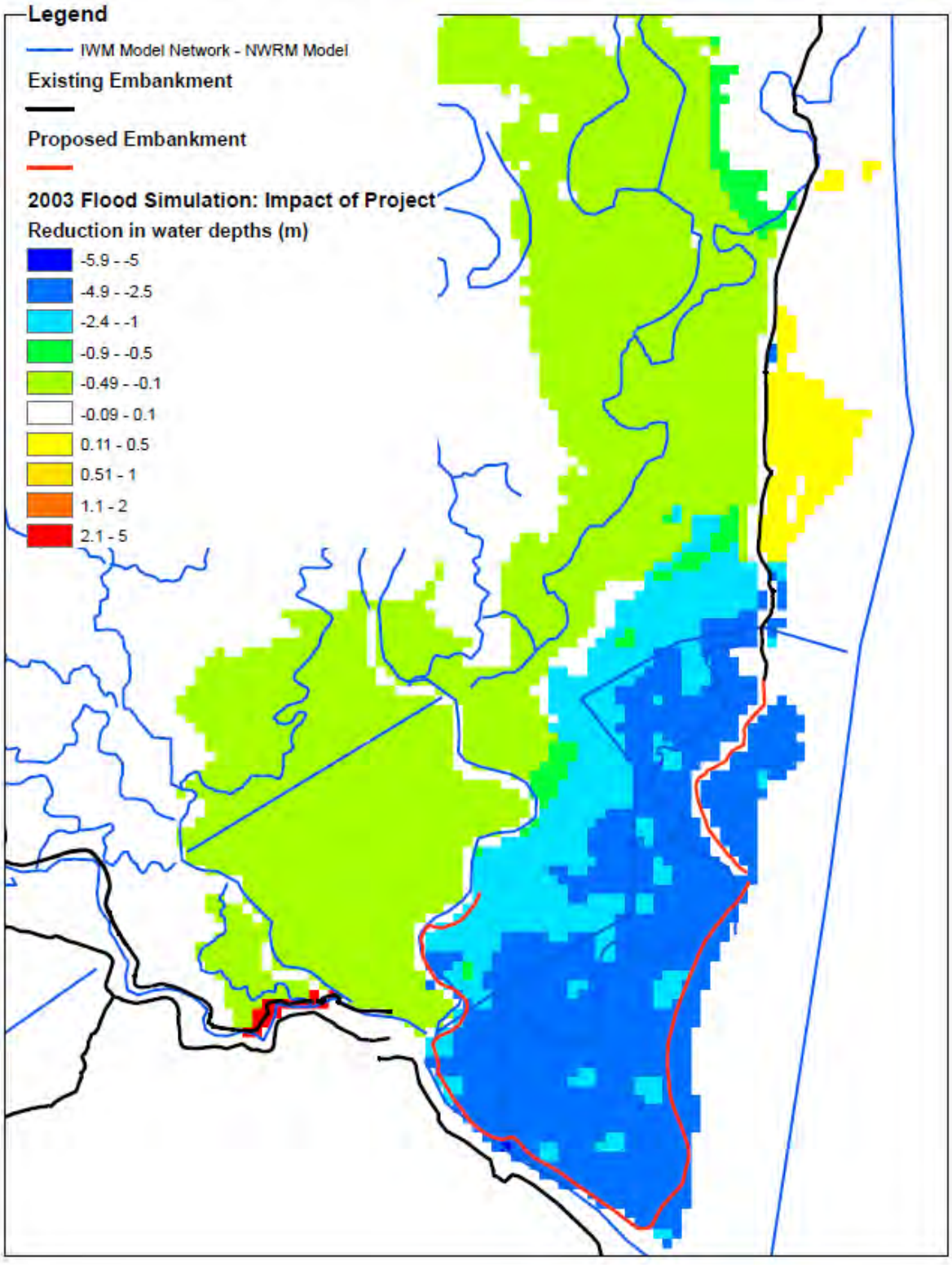


Figure 8.1: Effect of JRB-1 on Water Levels, 2003 Flood Condition

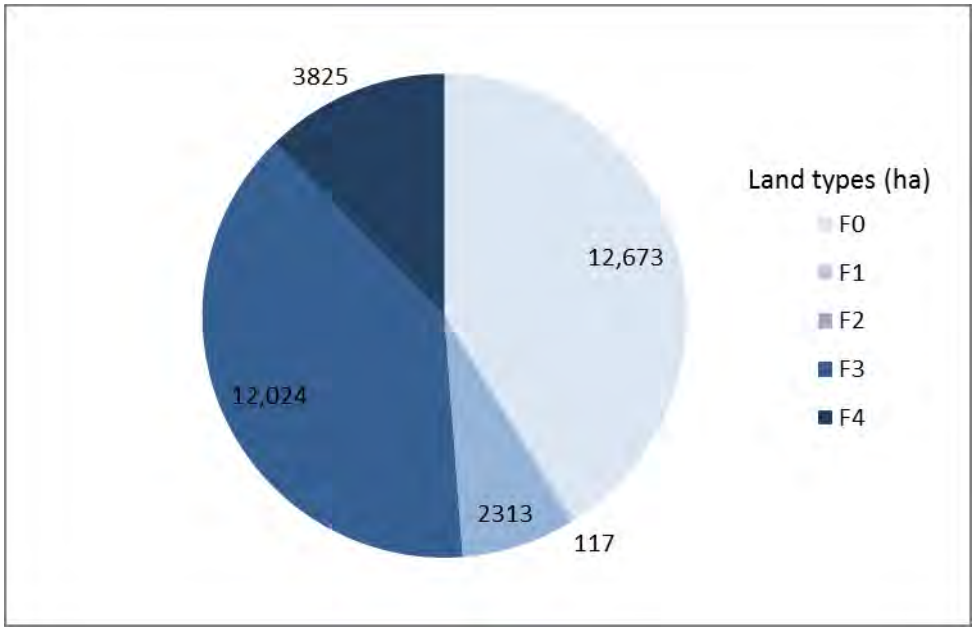


Figure 8.2: JRB-1 Land Type Areas, Pre-Project

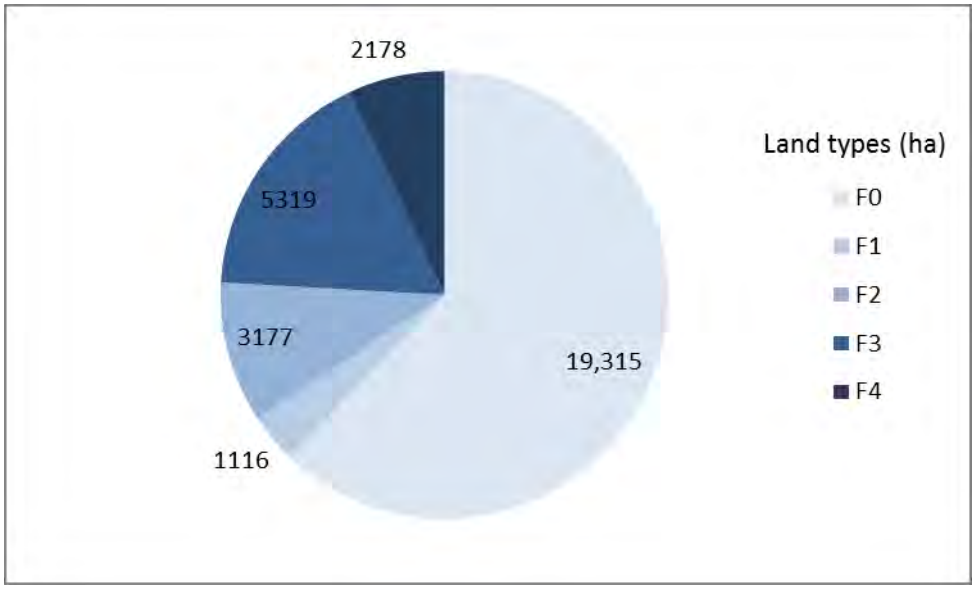


Figure 8.3: JRB-1 Land Type Areas, Post-Project

362. Potential adverse impacts of the hydrologic and land type changes described above are diverse. *Floodplain aquatic (wetland) habitats will be degradated or extirpated* due to reduced flooded area, depth, and duration (mentioned above); reduced hydrologic connectivity; and physiochemical / water quality changes. This in turn will *adversely affect floodplain-dependent openwater fish* species migration, population levels, and catch levels[30], as well as *wetland biodiversity*, services, and products more generally. Wetland products (mostly fish and aquatic plants) in Bangladesh have been documented to be worth as much as US$650/ha.[31] This production

[30]The project team estimates the loss of 15.3MT in capture fish production (see Chapter 8)
[31]Thompson, Paul M. (2008). Conserving and Restoring the Benefits from Bangladesh Wetlands. Presented at the 12th Biennial Conference of the International Association for the Study of Commons - Governing Shared Resources: Connecting

will be lost where more deeply-flooded F3-F4 land is converted to F0-F2 higher land types. However, the loss of open water fisheries will be compensated by the increase in culture fisheries, resulting in a net gain in fish production. The embankment can *impede cross-drainage* (drainage congestion), adversely affecting agriculture within the protected area, and blocking the movement of migrating fish. A number of sluice gates will reduce the risk of drainage congestion and allow some cross movement of fish during the migration season.

363. The loss of floodplain fisheries will be further mitigated through a program enhancing wetland biodiversity and aquaculture. The program will be implemented through a specialist NGO and supervised through the Department of Fishereis (DOF). Vulnerable groups, specifically the poor, project affected people, and women will be given preference in these activities.The overall status of fish migration in the study area is moderate to poor (refer to chapter 5.6.3) while the project design includes a number of additional sluice gates/regulators (refer to table 4.4). Both facts and in addition the positive effect of the existing geobag revetment on small fish somewhat reduce the impact of the embankment construction on migratory fish or carnivorous fish species depending on them. The more concentrated migration route through the Hurashagar/Baral tributary is not blocked.

364. Flood-control-led expansion of high-yielding varieties (HYVs) may *increase utilization of ground water and surface water 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. 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. Given the close vicinity to the Jamuna on one side and its tributaries Hurashagar/Baral and Karakoya combined with generally permeable, sandy soil sub-strata, there are little risk of depleting the groundwater table significantly. In order to reduce the amount of fertilizer and pesticides integrated crop and pest management measures, part of the program of the Department of Agricultural Extension (DAE) will be encouraged.

365. Provision of embankment flood protection typically stimulates accelerated investment in the protected area. This *project-induced investment* has obvious economic benefits but paradoxically it also has less obvious costs: over time, an increasing amount of infrastructure and potentially an increasing number of lives, come to be *located in lower-lying areas* compared to the without-project situation.[32] Embankments can greatly reduce but not entirely eliminate the flood risk to such areas, as embankments can fail for various operational, hydrologic, hydraulic, and geotechnical reasons.[33]

366. Best-practice flood damage reduction assessment methodologies address the residual risk of embankment failures[34]. The feasibility level designs studied different special risks, such as earthquake, pore over-pressure due to repid draw-down at the end of the flood season, and the risk of seepage. The embankment width and side slopes were designed to withstand the loads to be expected. As such the feasibility level design of the embankments accounts for technical regulations in effect in Bangladesh and common engineering practice world-wide and assures that the embankments do not fail for the design loads. In addition, an extensive community-based flood risk management program addresses the residual risk in developing volunteer groups that support enhanced awareness and preparedness to the flood risk.

Local Experience to Global Challenges, University of Gloucestershire, UK. http://iasc2008.glos.ac.uk/conference%20papers/papers/T/Thompson_220701.pdf

[32]Whipple, William. 1969. "Optimizing Investment in Flood Control and Floodplain Zoning." Water Resources Research 5 (4) (August): 761–766. doi:10.1029/WR005i004p00761.

[33]National Research Council. 2000. *Risk Analysis and Uncertainty in Flood Damage Reduction Studies*. Washington DC: Committee on Risk-Based Analysis for Flood Damage Reduction, Water Science and Technology Board. National Academies Press. http://www.nap.edu/catalog.php?record_id=9971, p. 51.

[34]Mori, Koichiro, and Charles Perrings. 2012. "Optimal Management of the Flood Risks of Floodplain Development." Science of The Total Environment 431 (August): 109–121. doi:10.1016/j.scitotenv.2012.04.076.

8.9.2 JRB-1, JLB-2, and PLB-1 Riverbank Protection Works Potential Impacts

367. Riverbank protection works at the three subproject sites has the purpose of protecting the existing floodplain habitat from constinuous and systematic erosion. The Jamuna has widened by around 4km from 1973 to 2013 mostly as a consequence of the sediment wave triggered by the Great Assam Earthquake in August 1950. This sediment wave 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.

368. Specific changes associated with Tranch 1 riverbank protection work were assessed through a specific morphology study carried out as part of this feasibility study. The morphology study concludes that the initial (Tranche-1) riverbank protection works has little impact on the overall morphology of the Jamuna, including the immediate downstream areas and are found to be minor in terms of morphological impact. In all cases the riverbank protection work encourages deeper channels along the protected bank but with expected little impact on downstream areas.

369. The morphology study also assessed future potential channel options to assess if the riverbank protection conflicts with the natural established channel pattern currently observed. The non-symetric Jamuna Bridge has substantially changed the lower part of the 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, which is expected to remain stable without riverbank protection at both sides. Downstream, the river exhibits two channels, enclosing a large char. The initial 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. The same holds true for the situation in the upper Padma River, where the two-channel solution appears to be the best in the long run, also meaning that the existing conditions would not be altered and the riverbank protection would support the currently existing natural river pattern.

370. The consequence of the transformation of the river environment on the habitat was not systematically studied. Not much is know about the impact on the biodiversity of the conversion of a river characterized by few deep channels to a multitude of shallow channels. Furthermore, this development is superimposed by dramatic population growth (from around 70million to 150 million) with increasingly intensifying land use on the flood plains but also systematic fishing in the rivers using floating nets in the main ones. Fish specialists indicate that the total fish population has decreased over time.

371. First attempst have been made to assess the impact of riverbank protection on fish[35]. 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 attrackt larger fish, specifically carnivores, however in fewer numbers; while geobag revetments attract smaller fish in larger numbers. CEGIS, 2011 identified overall positive impacts of geotextile bag revetements 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 scocio-economic conditions are improved for the local population, providing employment opportunities during construction, health and sanitation conditions, fishing opportunities, and especially improving the situation of mostly home-bound women. Geotextile bag revetments might change the composition of fish species, alter the habitat of the bethic community, as well as cause local shifting of the migratory routes of the dolphins[36] during construction. However, these effects

[35] 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 Geob-Bags Under Water

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

are reversible and the constructed revetments do not impact on thefree movement of dolphins and the benthic habitat is quickly restored over geobag revetments.

372. With respect to the overall use of the recommended riverbank protection technology, CEGIS 2011 concludes: *Considering all environmental, social and technical consequences of the geobag use under water, it might be concluded that compared with CC block use alone, geo-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.*

373. Overall the proposed Tranche-1 riverbank protection of limited length has no siginificant negative impacts on the river but the potential to enhance the biodiversity in places. Locally more stable and deeper channels, as encouraged by riverbank protection, support fish populations. The deeper channels provide a better refugium especially during systematic fishing with floating nets, are more attractive for dolphins which depend on the deeper channels also for migration. 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. Benthos communities are known to settle on geotextile bags and apart from the disturbance during the dry season construction, when benthos are not active, the inert geobag revetments do not have significant negative impacts on the river. The Program proposes to establish supporting enhancement measures during later tranches by placing navigation buoyage alongside protected riverbanks, which would discourage systematic, wide-scale fishing with floating nets, and to study sanctuary / protected area options.

8.10 Future Mitigation Measures

374. While the tranche-1 project consists of limited riverbank protection measures and the restoration/rehabiliation of an eroded/degraded embankment, future tranches plan to extend these measures. The limited and isolated riverbank protection measures of Tanche-1 do not change the existing channel pattern, as established by the morpholol gical study. However, follow on tranches, part of the total program, could do so when existing, initial work gets extended over greater length of some ten kilometers. As such, the proposed Tranche-1 combines construction measures with very limited morphological impact with two extensive studies on (i) potential ways towards larger river-reach stabilization and (ii) the establishment of a river sanctuary.

375. Potential alternative river-reach stabilization alternatives with impacts and mitigation measures will be assessed during Tranche-1 through several systematic studies. During the first two years of Tranche-1 a systematic river stabilization study will be conducted. The river stabilization study will build on the ongoing natural development towards a more consolidated channel pattern. Alternative solutions will be developed how to support this channel pattern towards a more systematic stabilization of the lives on the floodplain. Social and environmental consideratiosn will form an integral part of the study in order to determine the impacts of different stabilization options, but also collect missing data and broaden the understanding about critical social and environmental parameters. The study results are alternative solutions for river-reach stabilization that accounts for the multitude of different drivers, outline least-impact solutions, identify the optimimal alternative, and design the following tranche work.

376. Starting from there, the feasibility study for tranche-1, continaing environmental assessment, will be supplanted by by a specialist sanctuary study that details the requirements for a river sanctuary in response to negative impacts from river stabilization. The sanctuary study is part of the Tranche-1 design and scheduled for implementation during year-3 and 4. It will specifically address impacts on critical habitats and trans-boundary/internationally migrating/threatened species, following (i) the Padma Bridge Project terms of reference for biodiversity baseline studies and

monitoring, and a biodiversity sanctuary; and (ii) India's recently-promulgated Dolphin conservation action plan, as well as (iii) assessing migratory bird impacts.

377. Building on the outcome (recommended approach) of the river stabilization study, a river sanctuary study is part of the Tranche-1 design, to be conducted in year 3 and 4 by a specialist firm/NGO. This study will plan a river sanctuary that mitigates all identified negative impacts of river stabilization and additionally attempts to enhance the river biodiversity, specifically providing sheltered aquatic habitats. In addition to this study, the program design for Tranche-2 already contains an element of enhancing the aquatic environment along protected banks

378. The environmental assessment for Tranche-2, part of the feasibility study continues the aggressively mainstreamed environmental aspects into the project design. In addition, the EIA will follow a parallel approach to (i) address remaining uncertainties associated with the database on the impacts of riverbank protection on the river habitat including migratory species, while (ii) continuing to reduce the imminent erosion risk to the livelihoods of a large number of mostly poor people on the floodplain.

9. Analysis of Alternatives

379. The three sub-reaches selected for FRERMIP physical works– JRB-1, JLB-2, and PLB-1 – were chosen from 13 sub-reaches into which the FRERMIP project area was divided based on discussions among BWDB, ADB, and the PPTA consultant. These 13 were evaluated using a multi-criteria assessment approach taking into consideration three primary criteria (riverbank erosion, flooding, and poverty) and several secondary criteria (related to planning, design, cost-benefit, and safeguards issues) (refer to Annex 10). Of the six sub-reaches scoring highest[37], three were screened out due to a lack of active erosion and/or conflicts with other immediately planned interventions.

380. While riverbank protection was placed according to immediate needs especially for growth centers ("something to defend"), embankment construction considered alternatives especially for the areas JLB-2 and PLB-1. BWDB contemplates the establishment of two polders (ring-embankments) covering large parts o JLB-2 and PLB-1 with very long ring embankment lines. These were compared to the solution of an embankment only along the riverbanks of the main rivers, reducing the length of the embankments and as such minimizing the footprint and related land acquisition and resettlement. In addition, open distributaries would allow all-year-round water flow to the area, which specifically enhances the dry season water management[38].

[37] The highest ranking sites scored between 300 and 370 points, while the lower ranking sites ranged between 200 and 260 points.

[38] Annex D of the feasibility study, "River and Charland Morphology and River Engineering" provides more background.