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Environmental Baseline

(Reviewed Draft)

Environmental Assessment for River Bank Improvement Program

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Environmental Assessment for River Bank Improvement Program

Submitted to

Joint Venture Fichtner – Northwest Hydraulic Consultants

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Bangladesh Water Development Board

Submitted by

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List of Acronyms

AEZ	Agro-Ecological Zone
amsl	Above mean sea level
BADC	Bangladesh Agricultural Development Corporation
BARI	Bangladesh Agricultural Research Institute
BBS	Bangladesh Bureau of Statistics
BMD	Bangladesh Meteorological Division
BNBC	Bangladesh National Building Code
BRE	Brahmaputra Right-bank Embankment
BRRI	Bangladesh Rice Research Institute
BWDB	Bangladesh Water Development Board
CARINAM	Centre for Advanced Research In Natural Resource and Management
CEGIS	Center for Environmental and Geographic Information Services
CPUE	Catch per unit effort
DAE	Department of Agricultural Extension
DEM	Digital elevation model
DLS	Department of Livestock Services
DOE	Department of Environment
DoF	Department of Fisheries, Bangladesh
DPHE	Department of Public Health Engineering
DTW	Deep Tube Well
EIA	Environment Impact Assessment
EMF	Environmental Management Framework
EMP	Environmental Management Plan
FAO	Food and Agriculture Organization
FAP	Flood Action Plan
FFP	Fourth Fisheries Project
FGD	Focus group discussion
FHRC	Flood Hazard Research Centre
FRSS	Fisheries Resources Survey System
GIS	Geographic Information System
GoB	Government of Bangladesh
GSB	Geological Survey of Bangladesh

HIES	Household Income and Expenditure Survey
HL	High Land
HSC	Higher Secondary Certificate
HYV	High Yielding Variety
IEC	Important Environmental Component
IEE	Initial Environmental Examination
IUCN	International Union for Conservation of Nature
IWFM	Institute of Water and Flood Management
KII	key informant interview
km	Kilometer
LL	Low Land
LLP	Low Lift Pump
MHL	Medium Highland
MLL	Medium Lowland
MPO	Master Plan Organization
NGO	Non-governmental organization
NiH	Nipah Virus
PRA	Participatory rural appraisal
PWD	Public Works Department
RBIP	River Bank Improvement Program
RRA	Rapid Rural Appraisal
RS	Resettlement Site
SAAO	Sub-Assistant Agricultural Officer
SANEM	South Asian Network on Economic Modeling
SIS	Small Indigenous (Fish) Species
SSC	Secondary School Certificate
STW	Shallow tube well
TSP	Triple Super Phosphate/total suspended solids
VLL	Very Lowland
WB	World Bank

Glossary

Bed Material	The bed material load is the portion of the sediment that is transported by a stream that contains material derived from the bed. Bed material load typically consists of all of thebed load, and the proportion of the suspended load that is represented in the bed sediments. Its importance lies in that its composition is that of the bed, and the material in transport can therefore be actively interchanged with the bed. For this reason, bed material load exerts a control on river channel morphology. Bed load and wash load (the sediment that rides high in the flow and does not extract non-negligible momentum from it) together constitute the total load of sediment in a stream
Beel	A natural depression, which generally retains water throughout the year and in some cases seasonally connected to the river system.
Charland/ Char	Char is a tract of land surrounded by a river, sea, lake or stream. The land is developed due to erosion and accretion of river.
Khal	A drainage or irrigation channel usually small, sometimes man-made. These may or may not be perennial.
Kole	Kole is a seasonal closed water body separated from river, formed when river water started to dried up; act as nursery and feeding ground for fish and become merged with river again during high flow season. These are generally embayments in chars
Sediment wave	Sediment often enters channels in large pulses from landslides, fires, and other disturbances. These pulses are accentuated in both time and space in contrast to an increased supply of sediment in the watershed network as a whole. At some time, the sediment from these pulses is going to be transmitted via a sediment wave that translates and disperses

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1. Introduction

The Government of Bangladesh (GoB) is planning to undertake the River Bank Improvement Program (RBIP)[1] primarily to rehabilitate and improve the existing right bank embankment of the Brahmaputra River, and also to undertake river bank protection and construction of a road over the embankment. The GoB is seeking financial assistance from the World Bank (WB) to implement this project. In line with the national regulatory as well as the WB policy requirements, an environmental assessment of the RBIP is being carried out. The present report prepared as part of this assessment describes the existing environmental and social baseline (conditions) of the project influence area.

1.1. Project Background

Bangladesh is mainly comprised of the fertile alluvial floodplains and the delta of the Ganges-Brahmaputra-Meghna river system (Brahmaputra south through Bangladesh, named as the Jamuna). These three rivers combine within the country to form the world's third largest river, the Lower Meghna, which drains into the Bay of Bengal via a constantly changing network of estuaries and tidal creeks. Bangladesh is one of the most vulnerable countries to natural disasters, mainly by upstream river floods during monsoon season and coastal cyclones from the Bay of Bengal. Floods are of recurring phenomena in Bangladesh, and in each year about 22 percent of the country is inundated. Major floods occur when upland flood flows of the three rivers converging to Bangladesh coincide and combine with the heavy monsoon rainfall. It is also difficult to regulate these flood flows as over 90 percent of their river catchments areas are outside the Bangladesh.

Brahmaputra is the largest of the three rivers with highest erosion and bank movements. Prior to the construction of Brahmaputra Right-bank Embankment (BRE), over bank spills along the 220 km stretch of the right bank of the Brahmaputra River used to cause flooding on an area of about 240,000 ha. In early 1960s, the BRE was built to protect from this flooding problem and to foster agricultural growth in the protected area (see **Figure 1.1**). The original BRE had a setback of about 1.5 km from the Brahmaputra's right bank. In the 1970s the embankment started to fall under sporadic erosion attacks. During 1980s, the frequency of the BRE breaches by erosion increased rapidly as longer sections came within the range of rapidly eroding river bends which could cause bank-line erosion rates of several hundred meters per year in early stages of bend formation. To prevent flooding, these breaches were typically closed by local BRE retirements at about 200 meter set-backs. As a result of this minimal set-back distance the BRE has been retired several times in many places and at present perhaps only 50 km of the original BRE has remained in place. Currently, many long stretches of the BRE are very close to the river-bank line. Hence when embankment is breached at many places it is often left open as closing of such breaching is becoming impossible. Consequently, security of area protected by the BRE has been seriously threatened and large areas of land and cities with large population like Sirajganj are exposed to flooding.

[1] Also denoted as the project or the proposed project in this document.

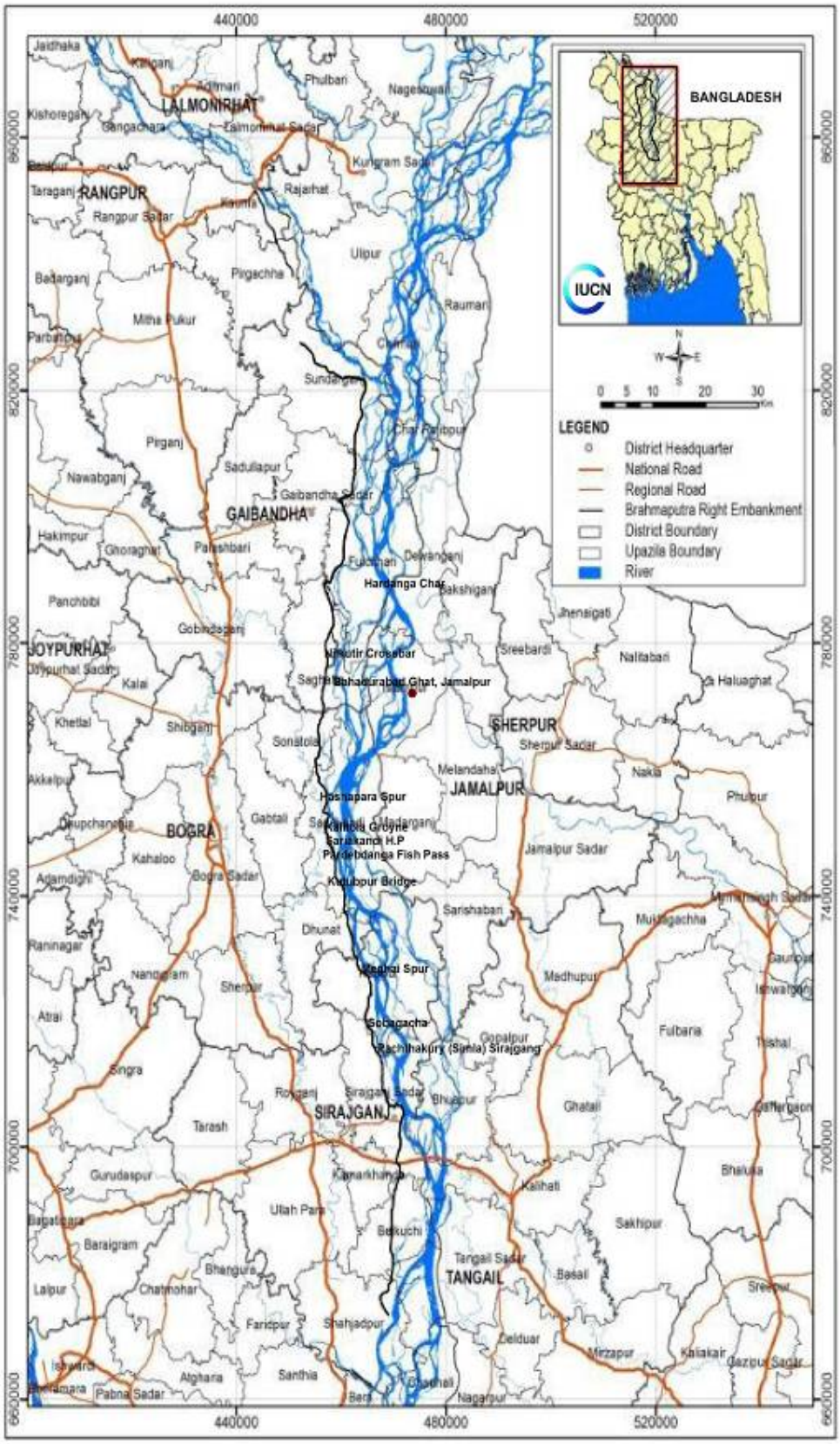


Figure 1.1: Jamuna River and Location of Brahmaputra Right-bank Embankment

Under Flood Action Program a Master Plan was prepared in 1993 (River Training Studies of the Brahmaputra River, 1993) for improving the performance of BRE that preparing a revamping program to be implemented over a period of 30 years with identified priority ainvestments in phasing. Based on these studies several hard points were identified and river bank protection revetments were constructed at Sirajganj, Sariakandi, Mathurapar and Kalitola and the embankment sections were improved. These protection works have performed very well in keeping the BRE anchored without much ongoing maintenance.

1.2. The Proposed Project and its Location

The main focus of the BRE rehabilitation work under RBIP is on its length alongside the Brahmaputra/ Jamuna River from Bangabandhu (Jamuna) Bridge to the Teesta River (**Figure 1.1**). The priority works will cover the approximately 50-km long priority reach from Sailabari to Hasnapara (see **Figure 1.2**).

The project's physical works will include:

- River bank protection on portions of the western (right) bank;
- Embankment upgrading, reconstruction and realignment, including adding drainage/control;
- structures (regulators); and
- A new road on the embankment. The project may also include the option of a toll road (highway) associated with the flood embankment.

The project will also provide livelihood and resettlement support to the displaced people. Based on the field reconnaissance and the preliminary morphological assessment, the project works has been divided into three phases as shown in **Table 1.1** below.

Table 1.1: Project Phases

Description	Length (km)	Phase	Tentative Implementation Year
Embankment and riverbank protection from Simla to Hasnapara	50	Phase I	2015 to 2020
Embankment and riverbank protection from Jamuna Brdige to Simla and Hasnapara to Belka	87	Phase II	2017 to 2022
Road on embankment	137	Phase III	2018 to 2023

The proposed project will be financed by WB with GoB contribution and the project has to comply with the policies and legislative requirement of the World Bank and the GoB.

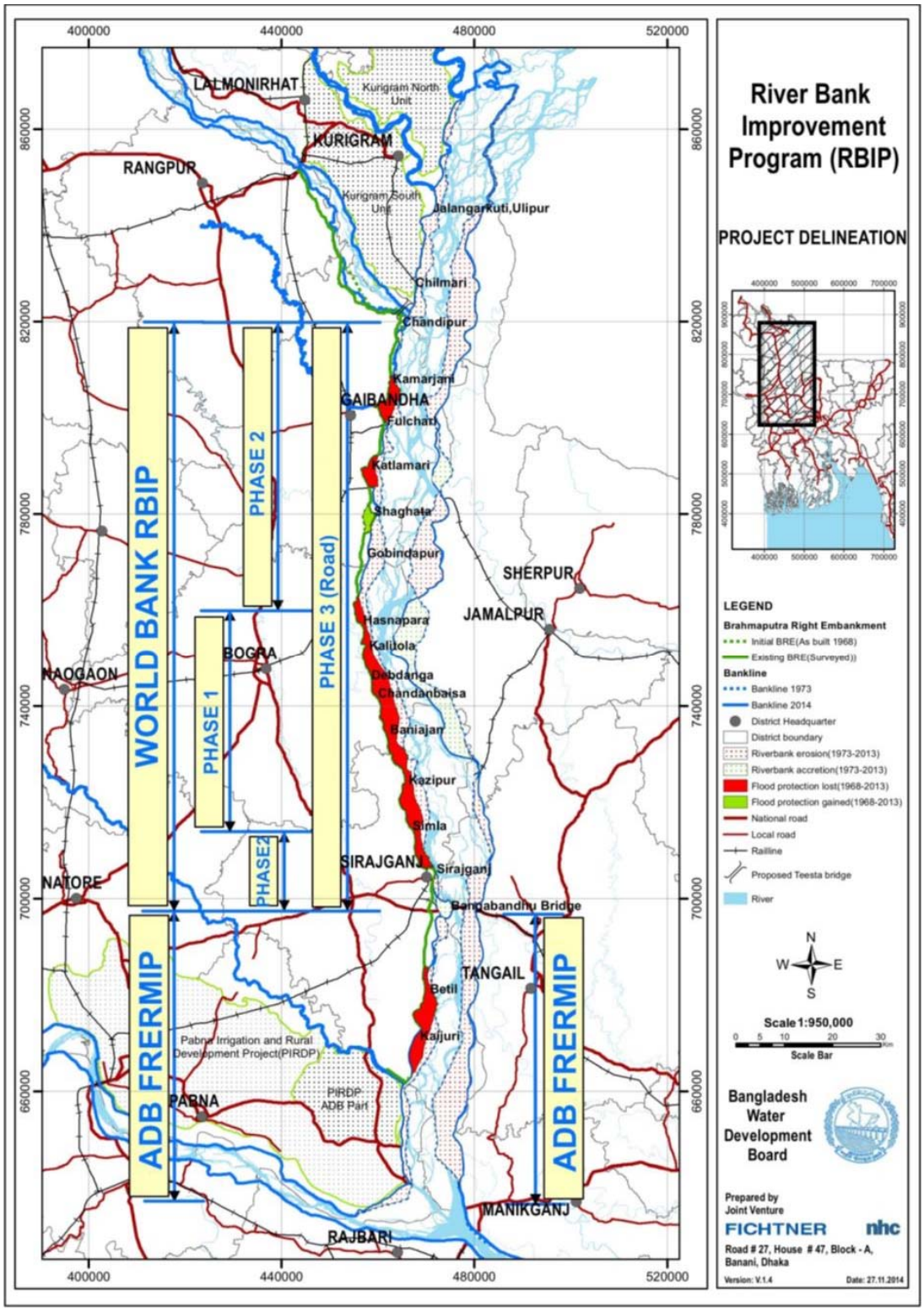


Figure 1.2: Location of Priority and Remaining Works under RBIP

Table 1.2 summarizes key project interventions in the priority and remaining reaches. Interventions in the priority reach will be designed in detail, whereas those in the

remaining reaches will be tentative as based on the existing river morphology - their final design will depend on the amount of river change between the present feasibility study and the detailed design phase and the desired level of reclamation and river training identified during the first year of Phase I.

Table 1.2: Summary of physical interventions

Intervention	Priority Reach	Remaining Reach
Reconstructed BRE	50 km	87 km
New Riverbank Protection	17 km	25km
Upgraded Revetment	7.2 km	5.4 km
Upgraded Spur	6	-
Upgraded hard point	-	1
Upgraded Groyne	1	-
Upgraded cross bar	-	4
Regulators	2	14
Fish Passes	4	-
Culverts	2	-
Bridges	0	1

1.3. Objectives and Scope of Baseline Report

The objective of baseline study is to prepare an environmental, ecological, and social baseline of the RBIP project influence area, to support assessment of potential effects, identification of important ecosystem components and development of environmental management and monitoring plans.

The scope of the present report comprises description of the existing environmental and social conditions in the project influence area, i.e., the environmental and social baseline. This baseline description has been prepared on the basis of the secondary literature reviewed as well as primary sources by field data collected during the present study. The baseline comprises physical environment including physiography, air quality, and water resources; biological resources including terrestrial as well as aquatic flora and fauna, sensitive habitats, endangered and threatened species; and finally social and socioeconomic conditions of the area.

1.4. Report Structure

Chapter 2 of the report presents the methodology employed to collected baseline data on various environmental and social aspects. **Chapter 3** describes the physical environment of the project influence area and covers topography, geology, soils, and water resources.**Chapter 4** provides data on environmental quality including ambient air, noise, and water quality. Ecological environment including flora, fauna, ecosystems, and habitats are covered in **Chapter 5** and **Chapter 6**. Social profile and socioeconomic conditions of the area are detailed in **Chapter7**, and finally, agricultural resources are discussed in **Chapter 8.**

2. Methodology

This Chapter presents the methodology adopted to collect baseline data and to compile the present report.

2.1. Reconnaissance Field Visit

A reconnaissance field visit was organized from 13 to 16 July to have a first-hand idea about the project, its components and its probable impacts on the local environment and community. Mr. Mohammad Omar Khalid, independent environment specialist was accompanied by Dr. Istiak Sobhan, EMP specialist and Md. Sunil Boron Debroy, Hydrologist and two field staff of IUCN. From the main consultant design engineering)team, Mr. Habibur Rahman, Deputy Team Leader led the team in the field. During the reconnaissance visit, the team also visited 13 proposed resettlement sites for an initial environmental screening. Some photographs showing the project influence area are presented below.

(a)

(b)

(c)

(d)

Figure 2.1: **Present condition of project site (a) Baliaghugri existing embankment, Changacha union of Sirajganj (b) Pukuria Bhanderbari existing embankment in Goshaibari,Dhunat,Bogra(c)PerDebdanga Fishpass, Sariakandi Bogra(d) Erosion of Brahmaputra river bank in Kurigram Sadar**

2.2. Project Influence Area/Study Area

The influence area of the project has been derived considering areas that are likely to be directly or indirectly affected by the RBIP construction and operation, including but not limited to: the extent the project would have an impact on the floodplain areas, lateral fish migration, hydrological network and road network, and the project footprint. The following criteria have been considered to define the influence area:

- Floodplain area: The extent of flood plain area that will be protected from the floods by the flood embankments (BRE) has primarily been considered as the project influence area. This area has been derived based on the latest satellite maps and GoB topographic maps through digital elevation model (DEM).
- Flood Inundation: The extent of flood inundation caused by breaches of BRE. Satellite maps were analyzed for August-September, 2014 to understand the extent of flooding from breaches and internal rivers like the Dharla, Dudhkumar, Teesta, Karotoya, Bengal, Ichamati, and Hurasagar.
- Connectivity: The oringal BRE has blocked the network of khals[2] (water channels) which carry flood waters from the Jamuna to the internal rivers on the western side of the project influence area. The proposed interventions under RBIP aim to restore the connectivity of khals with the Jamuna and hence the network of khals that join the Jamuna is included in the influence area.
- Lateral Fish Migration: Some fish species of Jamuna, such as major carps, undergo lateral migration from Jamuna to floodplains for spawning. The migratory routes have been blocked by the existing BRE and the proposed interventions aim to restore the lateral migratory routes. Therefore the extent of lateral migration from Jamuna to floodplains has been included in the project influence area. The other type of fish migration in Jamuna is longitudinal migration between upstream and downstream (e.g. hilsa migration from sea to Jamuna). Since the BRE and proposed interventions will not have any impacts on the longitudinal migratory routes, these areas are not included in the project influence area. The downstream boundary of the influence area is considered as the Jamuna bridge and upstream boundary of the influence area is taken as ten kilometers upstream of proposed project interventions.
- Road network: Road network and other flow barrier structures have been considered. The western boundary of the influence area is thus the Dhaka-Bogra highway which impedes flood waters to flow westward. The southern boundary is defined as Jamuna bridge since it will be connected with the project road.
- Significant Habitats (Eco-dynamic area): There are many significant ecological habitats in the project influence area especially in the chars. The project will not have any impact on the chars. However, the nearest chars were also considered to be a part of the influence area.
- Movement of inhabitants – Areas and routes that are used as resource harvest, communication, and livelihood by the local communities have been included in the project influene area.

[2] Khal is a drainage or irrigation channel usually small, sometimes man-made. These may or may not be perennial.

- Project footprint: Also included in the project influence aera is the footprint of the project and its ancillary facilities, temporary construction areas and worker camp sites, borrow areas, access roads to the project facilities for transport of material, and also the areas that will be affected by the emissions from construction and by operation of traffic.

The Project influence area is shown in **Figure 2.2**.

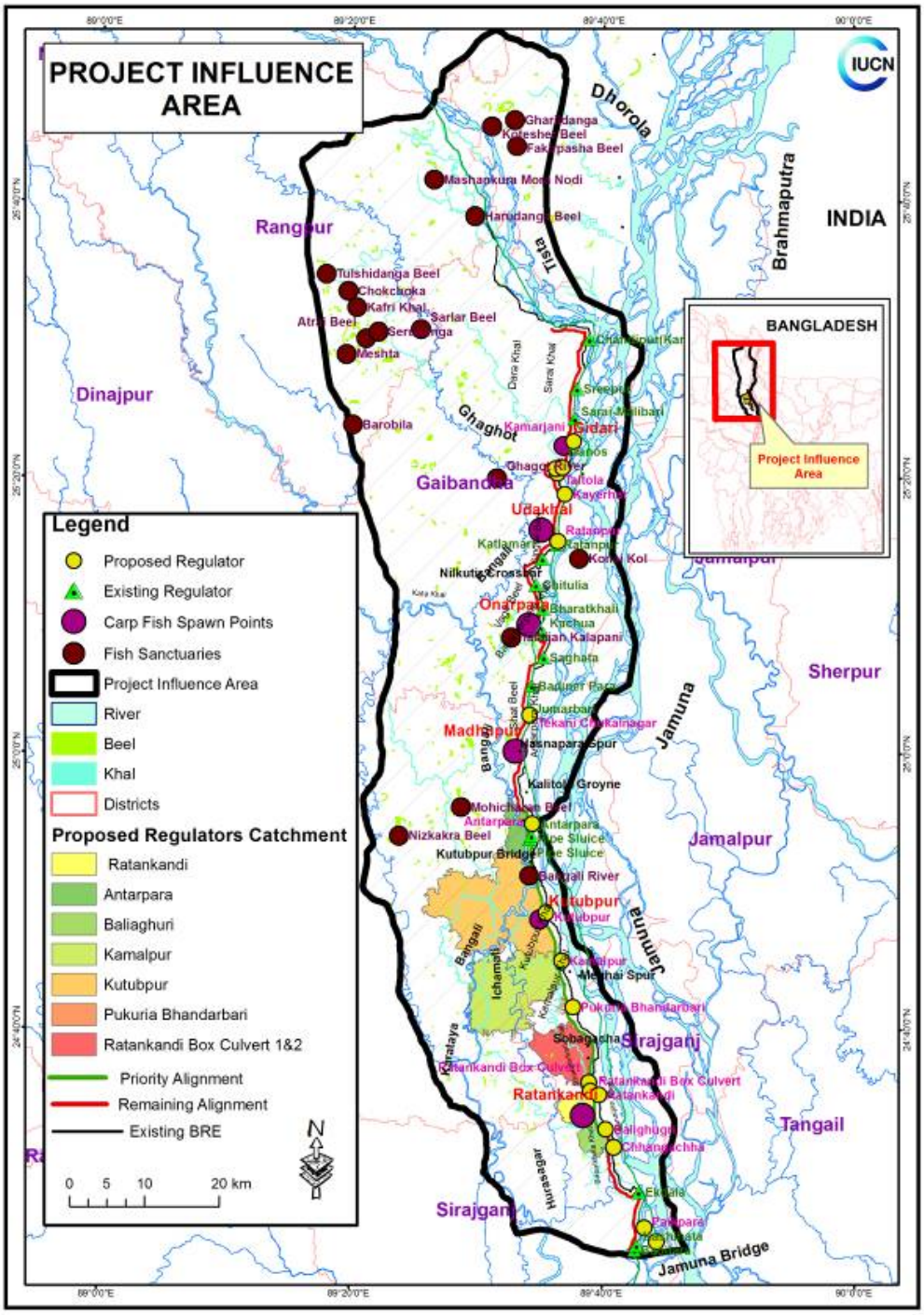


Figure 2.2: Project Influence Area

2.3. General Approach for Baseline Data Collection

The baseline condition of the project influence area has been formulated on the basis of the information collected from secondary and primary data sources through literature review, field investigations and consultations with different stakeholders. The baseline has been established in respect of air quality, noise, river morphology, surface and ground water quality, settlements, agriculture, livestock, fisheries, forestry, ecology, terrestrial and aquatic flora and fauna, socio-economic and institutional condition. Primary data on water resources, air quality, noise, agriculture, livestock, fisheries, forestry, ecology, and terrestrial as well as aquatic flora and fauna has been collected by conducting an intensive field survey. Additional data and information has been collected through rapid rural appraisals (RRA), participatory rural appraisals (PRA), focus group discussions (FGD) and key informant interviews (KII).

Maps prepared by using GIS and Remote Sensing have been used in collection and development of baseline database. In this regard IUCN team coordinated with main consultant and their associates, such as CEGIS. The RS based GIS maps have been prepared and used in designing the traverse line surveys carried out the field work along the traverse lines. The field teams used appropriate survey instruments, e.g. checklists and semi-structured formats to record the information on different resources.

2.4. Secondary Literature review

All relevant secondary information was collected to describe the baseline of the environmental and ecological setup.

2.5. Field Investigations

Field surveys have primarily been conducted by the field investigators with biology, fisheries and engineering background. They have been guided, monitored and supported by the senior specialists in the EIA team. The field team has collected field data using structured questionnaires in addition to FGD, PRA and KII.

The team walked through the entire length of the RBIP[3] (182 km) and collected data from the proposed alignment of the embankment cum road and the nearest river channel from the right bank. The field investigations were carried out during September and October 2014. The key field observations are presented in **Annex A.**

2.6. Soil Quality

To establish the baseline soil quality in the project influence area and to monitor future impacts, soil samples were collected near the proposed construction areas of the embankment and bank protection works. Seven sites are identified for soil sampling in a way to cover overall project influence area with adequate distribution. These locations Balighurghuri, Changacha union of Sirajganj, Pukuria Vandarbari and Anterpara of Bogra and analyzed various parameters such as pH, texture, total phosphorus, total Nitrogen, Total Potassium, Total Sulpher and Pesticide residue for quality. Locations of the sampling sites are shown in **Figure 2.3**.

2.7. Air Quality

Ambient air quality has been measured in seven locations close to the proposed embankment alignment. The sampling sites are selected in a way to cover major towns

[3] Length of total RBIP (including priority embankment and future embankment)

where there is relatively high traffic and the areas dominated by agricultural lands where relatively there is no pollution sources. Two samples each in Sirajganj, Bogra and Kurigram districts. Air quality parameters proposed in national air quality standards are considered for sampling. Locations for the field data collection points are provided in **Annex B** and also in **Figure 2.3**.

2.8. Ambient Noise

Noise data has been collected from seven sites as the same location of air quality measurement. At each site, noise data has been recorded for two times-day and night. Locations for the field data collection points are provided in **Annex B** and also in **Figure 2.3**.

2.9. Water Resources

2.9.1. Surface Water

Data was collected on the general pattern of surface water distribution and major drainage patterns, including rivers, small waterways, *beels*[4], *khals* and flooded areas. FGD and public consultation were done at all sites to collect primary information and anecdotal data. In particular, the following information was collected from both primary data (Field Investigation) and secondary data:

- Drainage System (natural and artificial) and their distribution
- Seasonal changes in water level
- Seasonal changes in drainage
- Extent, periods of occurrence and causes of water logging
- Effects of existing infrastructure (roads, canals, building) on drainage
- Extent of interconnection
- River erosion
- River stages and discharges for standard return periods
- Water availability for irrigation

Secondary data was also collected on the hydrological cycle within the overall watershed encompassing the project influence area, giving mean, maximum and minimum discharges and water levels for all major (lotic) flowing water bodies including main rivers. Data on canal sources and also for lentic (standing) water bodies like *beels* were collected from field investigation. Information was also gathered on hydrological problems in project influence area are including; flooding (Flash floods and other types), water logging and inadequate drainage.

To understand the river water quality, historical record of water quality has been collected from the Department of Environment (DoE) at Teesta bridge, Jamuna bridge, downstream of Jamuna bridge near Jamuna Fertilizer Plant, and Nandina. Data of both dry and winter season has been collected.

[4] Beel is a natural depression, which generally retains water throughout the year and in some cases seasonally connected to the river system.

During the field investigations, water samples were collected from surface water resources (rivers, beels) considering the connectivity of khals and location of proposed regulator. The parameters considered for water quality are: dissolved oxygen, biological oxygen demand, total dissolved solids, electrical conductivity, pH and temperature. Locations of these sampling sites are shown in Figure 2.3. Details of sampling methods and results are given in Chapter 4.

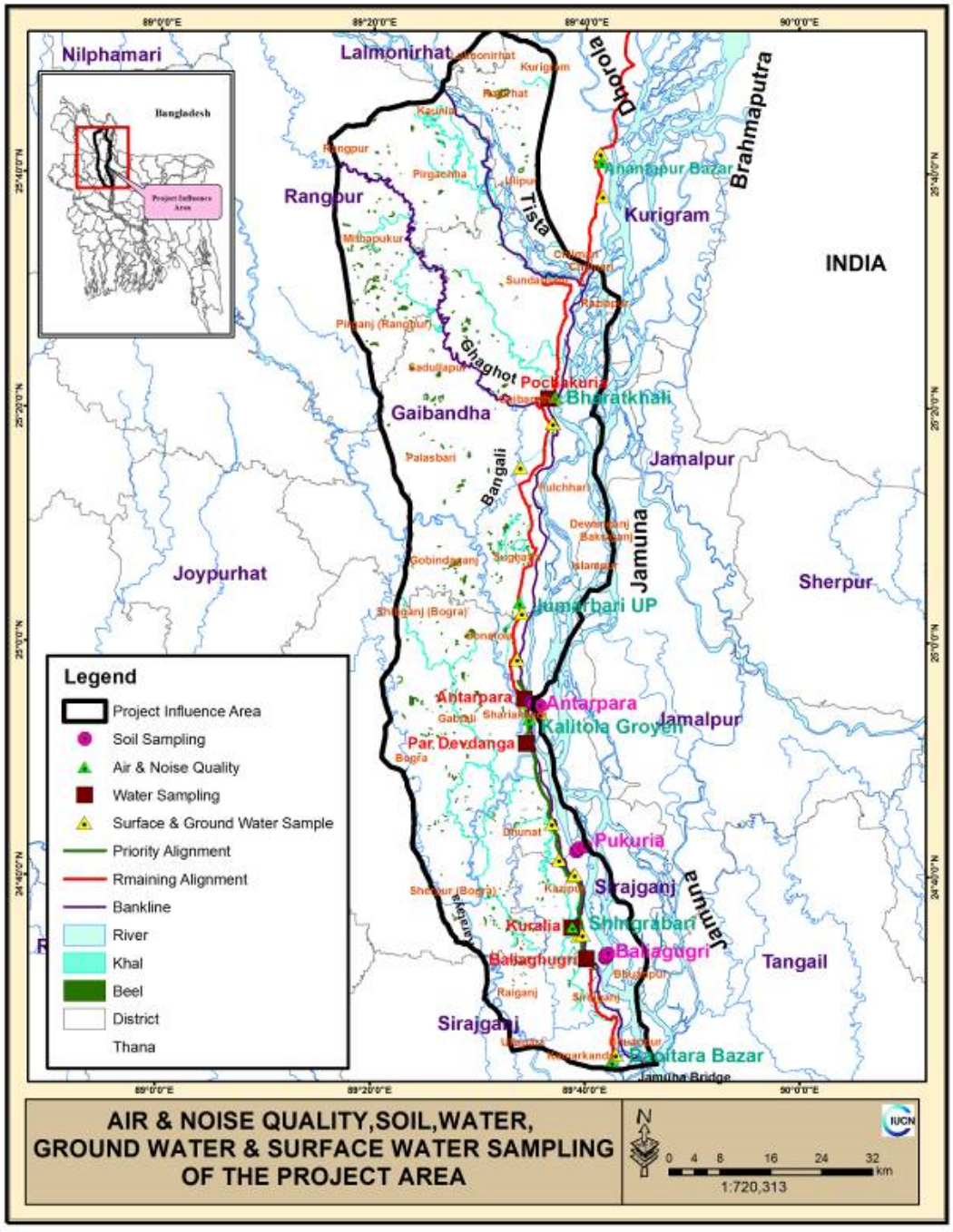


Figure 2.3: Sampling Sites for Air Quality, Noise, Water Quaity and Soil Quality

2.9.2. Groundwater Quality

Groundwater is the primary source of drinking in the project influence area. Ground water samples were collected from two tube wells, which are located upstream and downstream of the priority area. The groundwater samples have been tested against drinking water standards (pH, chloride, iron, bicarbonate and total dissolved solids). Locations of groundwater sampling sites are shown in **Figure 2.3.**

2.10. Ecology

2.10.1. Ecologically Sensitive Ecosystem

During the study, all sensitive ecosystems have been identified in the project influence area particularly along the embankment alignment and into the river and nearby *charlands* (river islands or shoals). GPS locations have been collected for all ecologically important locations. All sensitive ecosystems have been mapped for the entire Area of Influence of the project. Questionnaires and data collection sheets for ecological field survey are provided in **Annex C**.

2.10.2. Terrestrial Environment

For development the baseline information of the terrestrial environment the following parameters have been collected by the field team:

- Terrestrial flora
  - General vegetation pattern on the site
  - Nearby homestead vegetation including major tree species according to their canopy cover (estimation of canopy cover percentage)
  - Information on plantation or orchards (if any)
  - Cropland and woodland (if any) and their landuse
  - Roadside vegetation
  - Grassland (if any in the vicinity) composition and their importance for wildlife especially avifauna
  - Fallow land (if any) why fallow and landuse and importance
  - Utilization
  - Wetland vegetation
  - Recent trends (whether increasing or decreasing, key prevailing threats)
- Terrestrial fauna
  - Terrestrial wildlife species and their importance and status
  - Identification of important wildlife habitats and their movement/migration pattern (especially for the wildlife that depends on the river for drinking and fishing, e.g. fishing cat)
  - Recent trends (whether increasing or decreasing, key prevailing threats)
- Biodiversity including terrestrial Species diversity
- Homestead vegetation

2.10.3. Aquatic Environment

The following data was collected on the wetlands and types of aquatic habitat in the project's Area of Influence:

- Aquatic flora
  - Ecology and plant community
  - Abundance and distribution
  - Growing period
  - Recent trends (whether increasing or decreasing, key prevailing threats)
  - Utilization
  - Recent trends (whether increasing or decreasing, key prevailing threats)
- Aquatic fauna
  - Aquatic wildlife species and their importance and status
  - Identification of their habitats, breeding and migration patterns in the project influence area
  - Wetland birds
  - Recent trends (whether increasing or decreasing, key prevailing threats)
  - Impact on aquatic wildlife from the project activity including short and long term impacts (impact from changed landuse, noise, human presence)
  - Utilization
  - Recent trends (whether increasing or decreasing, key prevailing threats)
- Biodiversity (including aquatic Species diversity and recent trends.

2.10.4. Floral Survey

Baseline scenario of floral species has been prepared with special emphasis on endangered and protected species. Classification of satellite images and reconnaissance field visit has been made to assess the various vegetation types / ecosystems present within the direct impact area and charlands near the project site. The major ecosystems found from the images have been visited and a species assessment has been made. Standardized transects were established in order to assess species composition and vegetation structure. Also, recent trends have been determined on the basis of field data, interviews, and literature review.

2.10.5. Charland Survey

Data collection on charlands (shoals or river islands) included Remote Sensing image analysis, vegetation and wildlife survey. Also, recent trends will be determined on the basis of field data, interviews, and literature review.

2.10.6. Faunal Survey

Mammals have been assessed on an opportunistic basis by all of the teams. The small mammals (eg, like Small Indian Mongoose, Short-nosed fruit bat) are easily observed during walk over surveys. Interviews have also been held with known "hunters" in the area to assess the presence of game species.

For the assessment of amphibian and reptile species diversity in the project influence area line transects and opportunistic surveys have been used. Amphibian transects were selected focusing on croplands, stagnant water, running water and bushy areas as typical habitats. Additional interviews have been conducted with local people using photographs of amphibians and reptiles to determine the presence of species. The surveys were carried out during both day (5:30am-6:30am) and night (6pm-9pm) times by the following methods.

Gangetic Dolphin. Line transects survey were carried out to determine the population size of the Dolphin in the project sites. The length of line transects was 1km and during survey team used a boat with a speed of 2 km. Surveys were conducted between 9.30 am and 11.30 am. Two observers scanned the water surface for the sign or dolphin, whereas a third observer took notes by direct counting the species. All sightings were noted with GPS coordinates.

Gharial (*Gavialis gangeticus*), also known as the gavial, and the fish-eating crocodile, is a crocodilian of the family Gavialidae, native to the Indian Subcontinent. Although, the species is no longer have a viable population in the Jamuna river but it is still regarded as the most suitable habitat for this species. In last few years several juvenile has been captured by the fishermen. Anecdotal information was collected during interviews with the community about the presence and sighting of gharial. The probable habitats were also identified during the field investigations.

Birds including Migratory Birds. Birds have been assessed during walk-over surveys. Identification was done by both visual and vocal characteristics with added support from photographic evidence. The bird inventory has been linked to the vegetation / ecosystem types identified during the floristic survey. Interviews with the local villagers were held to find out the presence of migratory birds during winters. Further information on the migratory bird has been obtained through literature review.

2.11. Fish and Fisheries Resources

A fish and fisheries survey was carried out in the project influence area of the proposed RBIP to prepare a fisheries baseline of the project influence area and also to identify the important fishery components those need to be taken care of. At the initial stage the study, a baseline survey was conducted. The methodologies used are - direct field data collection and sighting, public consultation, secondary data analysis, focal points interview, market survey, fish catch assessment survey, application of remote sensing and GIS tools and extensive literature review. A logically designed fish catch assessment survey was carried out to identify fish biodiversity of the project project influence area. The survey conducted in the priority area was more intensive than that of the remaining reaches of the RBIP. The survey was conducted from 25 Aug to 15 Sep 2014 during the high flow season. A total of 33 FGD, 10 Catch Assessment Survey (of different gears), transect walk and in-situ observations were carried out during this period. Locations of FGDs and consultations carried out to collect baseline ecological data are presented in **Figure 2.4**.

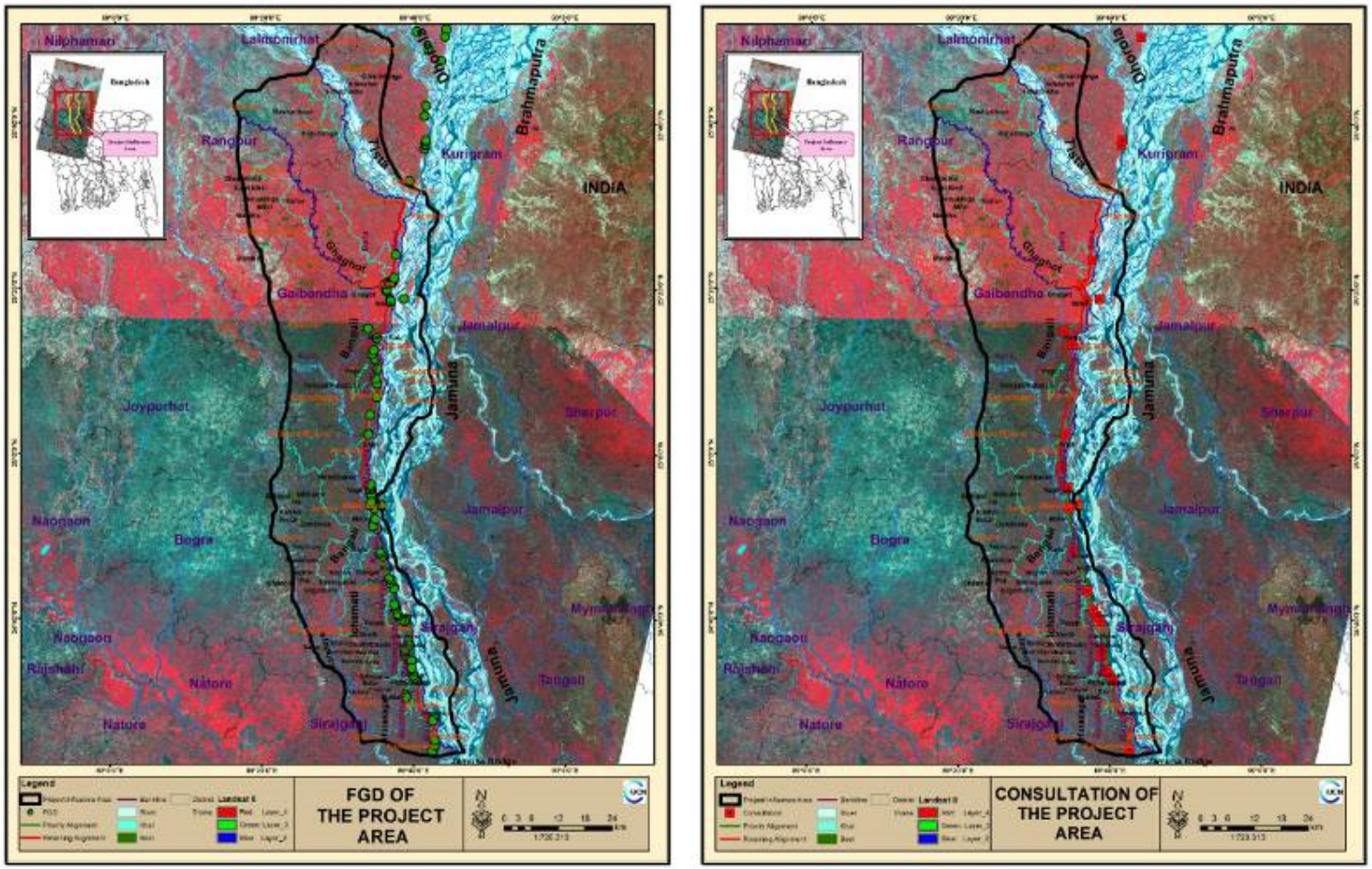


Figure 2.4: Locations of FGDs and Consultations

2.11.1. Fisheries Survey

Survey methodology was selected on the basis of the reconnaissance survey outcome and various subsequent discussions held within the EIA team. Initial desk analysis was carried out to assess fish biodiversity and fisheries resource status. The survey was designed to fill up the knowledge gaps of the identified major fisheries resources. The key parameters of the survey are provided in the **Table 2.1**.

Table 2.1: Fish Survey Details

Parameters	Method	Sampling Site	Sampling Schedule
Species richness, Identification of pre-dominant indicator species those sensitive to the different constructions, Species composition, Biology of the indicator species, Fish production, Habitat analysis, Migration route/season, Breeding and feeding ground, Limnology, Fishing effort, Fishing Season	Catch assessment survey using different gears of fishermen, interview, FGD, market chain analysis, fishermen livelihood analysis, Area of conservation demarcation/GPS coordinating, Biodiversity analysis	Project Influence Area	Aug-Sep 2014

2.11.2. Site selection

Sampling sites were selected for each of the indicators by considering the characteristics of the sub-habitat types of the Jamuna river system, associated environmental factors, major fisheries characteristic, local knowledge, past and present scenarios, time and resource constraints. The study locations were selected after field visits and detail corresponding with the stakeholders of the project. Specific spots identified considering sampling strategies as per selected method. GPS readings were taken for each sampling spot. However, probable locations of the catch assessment survey were selected after a reconnaissance visit in the project influence area. In total, 20 sites along the 5 river cross sections at the distance interval of 10 km along the river and interval of 0.5 km across the river carried out within the project influence area along the 50 Km of the Jamuna Right Bank for which EIA is being conducted (**Figure 2.5**).

In addition, catch assessment was carried out in another 5 locations of the connected canals of the right bank which are identified by local community as potential fish shelter grounds. Beside, a questionnaire survey was also carried out in different fishing village and among the associated stakeholders to collect the necessary fisheries information. The frequency for the remaining area was much lesser at an interval of 25 km along the proposed alignment of the embankment. The catch assessment survey also carried out for beels and khals.

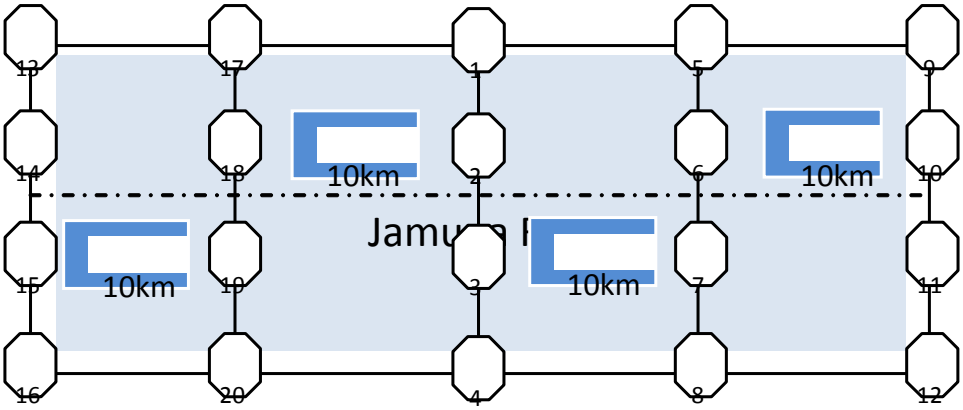


Figure 2.5: Sampling Locations

2.11.3. Sampling Materials

Specific depth and sampling time was recorded along with special information on weather condition e.g. sunny or rainy day. Local fishing gears and boats were used for catch assessment survey. Sampling times were recorded accordingly. Sorting, counting and identification of fishes were carried out in situ. Identification of the fish species has done by following standard literatures and FAO web tools for fish identification e.g. www.fishbase.org. Photographs of the identified fishes were collected giving unique code to identify at the later stage. Fish catch composition, total length, body weight, age, sex, were also collected in situ. A catch assessment survey sheet was used to record the collected data for each sample (**Annex D**). Different field equipment was used for sorting, identification and determination of the necessary measurements of captured fishes. Market survey was also carried out to compare the fish catch composition. FGD, market chain analysis and fishermen livelihood analysis has also been initiated this time using a checklist. Area of conservation significance i.e. fish breeding grounds were demarcated using GPS machine.

2.11.4. Fishing gears and traps

Set gill net, Drift gill net, Clap net, Cast net, Seine net and Lift net were used for sampling from different habitats of the project influence area. Range of the mesh sizes of the gears used were 0.4 inch to 2.5 inch. Length of gears was from 10m to 200m. Fishing depth was 1 to 6 meters. Besides, different types of locally made fishing traps were used for fishing the SIS (Small Indigenous Species) e.g. Dury, Chi, and Vaer.

2.11.5. Fishing craft

Fishing crafts those used for sampling were e.g. Kosha, Dingi, Chandi and Karki. Average length of the crafts was around 8-9 m.

2.11.6. Haul duration

Duration of fishing (haul) were different depend on the gears and crafts. However, average duration per haul was considered as 30 min.

2.11.7. Assessment techniques

The specific methodologies to collect fisheries data and information on the selected parameters and associated analysis are described below.

Catch assessment survey

Fish catch assessment survey is considered as a successful method which reflects the divergence of all the important fishery components. Catch assessment survey carried out through field sampling from the Jamuna River and its connected canals of the project influence area. Appropriate number of fish catch samples was collected from some pre-selected sites. Samples collected by using local available fishing gears for a specific duration to get the catch effort (catch/ haul) data. Catch composition, abundance of individual species, fish species diversity, total production and production rate assessed for each specific habitat. Fish migration channels demarcated by consulting with the local fishermen and historical catch location data analysis of the Jamuna River.

Breeding ground demarcation

Breeding ground demarcated using GPS machine by collecting the information from the local fishermen. Fry collectors interviewed to assess the overall status of breeding grounds.

Market survey

Local market surveys carried out to collect fish catch composition data. These data used to validate the field sampling catch composition and species diversity estimation through catch assessment survey. Market chain analysis will be carried out to identify the status of the fish fry collection and trading at different sites.

KII (Key informant interview) and FGD

Selected key persons of the project influence area were interviewed to the get real scenario of changes in fisheries and to collect information on the fisheries resources and fishermen status. KII results were used to validate the field sampling data more authentically. In addition, several FGD conducted at different fishing villages of the both banks and Chars (River Island) using a checklist.

2.12. Socio-economic Aspects

Data was collected on present demographic and socio-economic status, educational and cultural properties of the area, area vulnerabilities and development activities. Demographic and socio-economic status refers to a wide variety of parameters. This study particularly refers to population, community structures, employment and labor market, income and expenditure patterns of households, public health, education, vulnerabilities, values and customs. Most of the data was obtained from the social safeguard team in addition to the secondary resources.

2.13. Soil and Agriculture Resources

The production related data including soil resources were collected through secondary and primary sources. The secondary sources included: a) review and collection of data and documents available with other research teams of the RBIP like design, socio-economic; b) data and documents collected from the related organizations like DAE, BADC from the project influence area. The primary data were collected through: a) FGD (Focused Group Discussion), b) KII (Key Informant Interview), d) in-depth interview with potential farmers.

Review of Documents (Desk Review): Existing relevant documents available with the concerned organizations such as BWDB, DAE, BADC, BARI, and BRRI were collected and reviewed for having an initial idea and understanding of the crops and cropping of

the areas. As part of project review, the environmental team attended workshop on RBIP organized by BWDB using national and international consultants.

Reconnaissance Field Visit cum Rapid Appraisal: After completion of the desk review, the consultant made a reconnaissance field visit to the embankment sites to further understand of the existing socio-economic conditions to identify the potential location for organizing the FGDs. The visiting team members made a Rapid Appraisal/Assessment on crop production scenarios through discussions with key stakeholders (BWDB staff, Local NGO officials, officials of Government service departments like DAE, BRRI, BARI, DLS, DoF pesticide/fertilizer Dealers, farmers) both at group and individual levels.

Focus Group Discussions (FGDs): Numbers of FGDs, one in each Upazila (11 total) were carried out using semi structured checklists outlined on the basis of the issues relevant to study objective and scope. The numbers of participants in each FGD were 10-15 farmers.

Key Informant interview (KII): During the field study numbers of open-ended KIIs were also conducted with representative stakeholders especially with the field staff of DAE using semi-structured checklist.

3. Physical Environment

3.1. Brahmaputra River Overview

The hydrology and inundation cycles of the project influence area is dominated by the Jamuna River. The River is the 240 km-long lower reach of the Brahmaputra River from the India-Bangladesh border to the confluence with the Ganges. The river originates in the northern Himalayas in Tibet, flows through China as the Yarlung Tsangpo and India as the Brahmaputra and enters Bangladesh at Noonkhawa. The Teesta, Manas, Sankosh, Dharla and Dudhkumar rivers are the major tributaries of Brahmaputra. Downstream of Teesta, at Dewanganj, the Old Brahmaputra originates on the left bank of the Brahmaputra and main channel flows as Jamuna until it reaches Aricha, where it combines with the Ganges to form the Padma river. The Brahmaputra-Jamuna river system displays characteristics of a braided river and is highly susceptible to migration and avulsion. In plan form, the river typically shows two to three channels per cross-section and a total width of 8 to 12 km. The Brahmaputra/Jamuna is characterized by its widening as a consequence of the Great Assam Earthquake in 1950. In Assam, India it has widened along its 650km length from an average 6 to 9km and along its 250km in Bangladesh from 8 to 12km.

The Jamuna has an annual average discharge of around 20,000 m^3/s at Bahadurabad transit. Over 75 percent of the discharge of the Jamuna river is generated from rainfall and snowmelt from upstream countries, as a result, the flow pattern is not strongly related to local precipitation.

The mean monthly flow discharges of Jamuna are shown in **Figure 3.1** at Bahadurabad transit station. **Table 3.1** shows the seasonal mean discharge values of the Jamuna river from 1976 to 2011 at Bahadurabad transit station. The river usually peaks in July when the average maximum discharge is about 50,000 m^3/s and flow reduces in the dry season with average lowest in February at 4700 m^3/s.Historical analysis displays an increasing trend of average annual peak flows at Bahadurabad in Jamuna river. The lowest and highest flows recorded during 1976 to 2011 are: 3,178 m^3/s on 24 February 2001 and 102,535m^3/s on 9 September 1998.

Table 3.1: Seasonal Mean Discharge (1976 - 2011) of Jamuna

Season	Jamuna River (Bahadurabad Transit)
m^3/s	
Dry (December-February)	6014
Pre-Monsoon (March-May)	10,300
Monsoon (June-September)	39,700
Post-Monsoon (October-November)	18.760

Source: Bangladesh Water Development Board

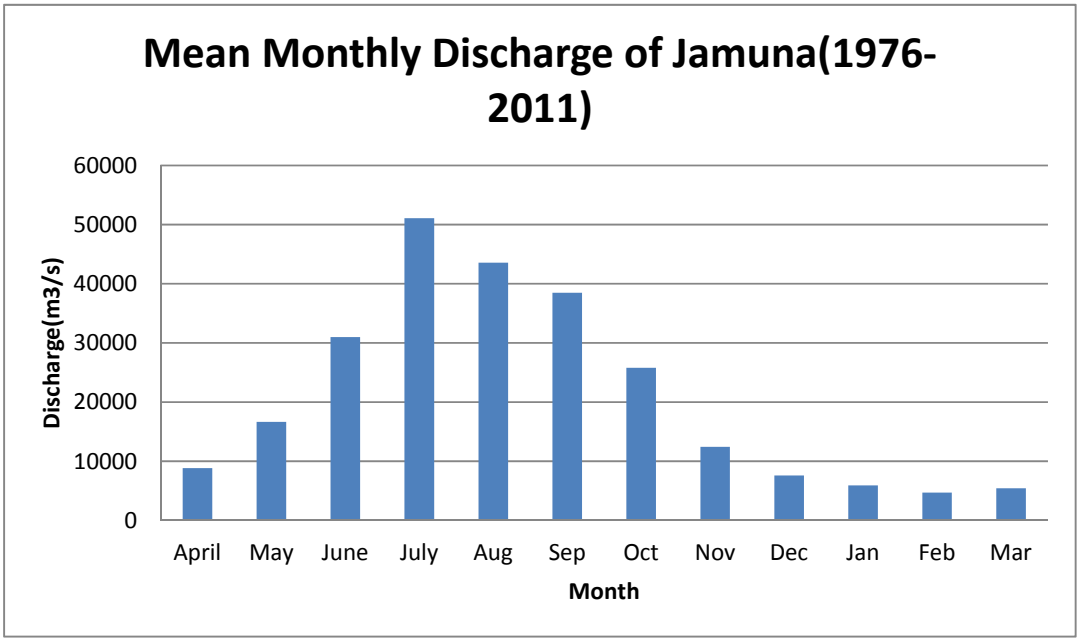


Figure 3.1: Mean Discharge of the Jamuna river (1976-2011) (Source: BWDB)

Secondary data on water level were also collected for the Jamuna at Sirajganj. The data shows that the water level in the Jamuna river varies from 15.11m to 6.05m. The highest water level occurs in July which has an average monthly water level of 13m and the lowest in February with average water levels. **Table 3.2** shows the average values of water levels of the Jamuna in different seasons (1945 to 2013).

Table 3.2: Water levels of Jamuna (1945-2013)

Season	Jamuna River (Sirajganj station)
m+PWD[5]	
Dry(December-February)	7.4
Pre-Monsoon(March-May)	8.8
Monsoon (June-September)	12.5
Post-Monsoon (October-November)	10

Source: Bangladesh Water Development Board

Flood frequency analysis was also conducted on the long-term historical water level data recorded at Sirajganj, Kazipur and Mathurapara. The two stations at Sirajganj and Mathurapara span the extent of the Priority Reach. The record length at Maturapara is considerably shorter than at the other stations. The results are summarized in **Table 3.3** for the three stations. The upper and lower 95 percent confidence limits show the range in the estimates is typically ± 0.4 m of the mean values. These results indicate that during

[5] Public Works Department datum. A horizontal datum applied by PWD, BWDB and others. It is defined by a network of SOB and BWDB benchmarks with a specified elevation above PWD. Its zero level is located 0.46 m below the Mean Sea Level (MSL) defined in 1909.

extreme floods, the water level increases by about 4.3 m between Sirajganj and Mathurapara. The long-term average annual minimum water level in the Priority Reach is 6.9 m PWD at Sirajganj, and 10.5m PWD at Mathurapara.

Table 3.3: Water level (m) frequency analysis at gauging stations

Station	50-year	100-year	200-year
Sirajganj	15.1	15.3	15.5
Kazipur	16.8	16.9	17.0
Mathurapara	19.1	19.5	19.8

3.2. Climate

The project influence area lies in the northwest part of Bangladesh where the climate is sub-tropical in nature with three seasons namely summer/pre-monsoon from March to May, monsoon from June to October, and winter season from November to February. Lower rainfall makes this area both atmospherically and pedagogically drier than the rest of the country. The rainy season is hot and humid with about 88 percent of the annual rainfall in the area. The winter is predominately cool and dry. The summer is hot and dry interrupted by occasional heavy rainfall, whereas monsoon comes in the month of June and recedes in late October. Meteorological data such as rainfall, temperature, humidity and wind speed were collected from Bangladesh Meteorological Division (BMD) and analyzed for assessing local climate that are directly related to water resources of the project influence area.

3.2.1. Temperature

Temperature data of Bogra station for the period 1948-2010 has been used for this report. The data shows that the monthly maximum temperature varies from 25ºC to 35ºC. Maximum temperature occurs in the month of April and minimum temperature in January. Monthly minimum temperature ranges from 21ºC to 30ºC. The average temperature during monsoon is about 34º C. **Figure 3.2** shows the monthly maximum, mean and minimum temperature at Bogra station whereas **Figure 3.3** shows the yearly average temperature at the same location.

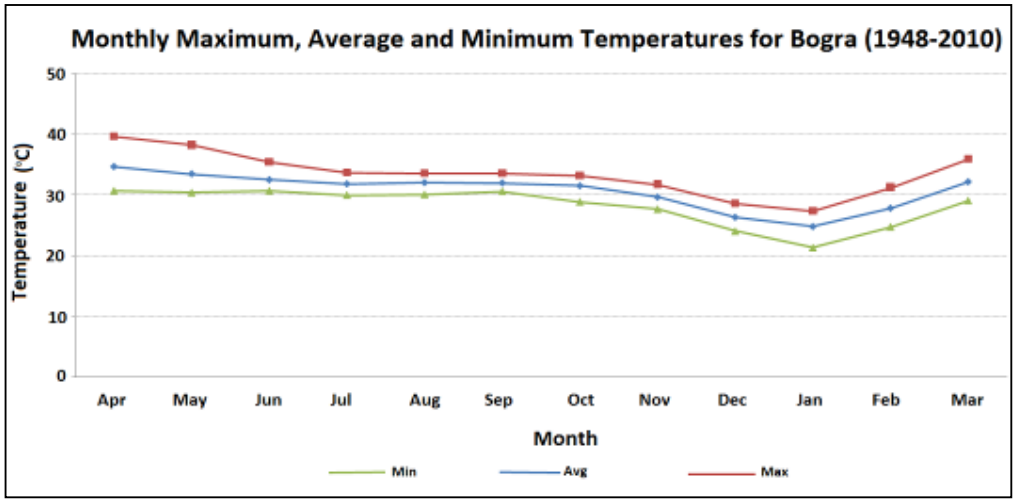


Figure 3.2: Monthly Temperature Data for Project Influence Area (Source: BMD)

Yearly data of average, maximum and minimum temperature have also been analyzed for the same station (from 1948-2010).

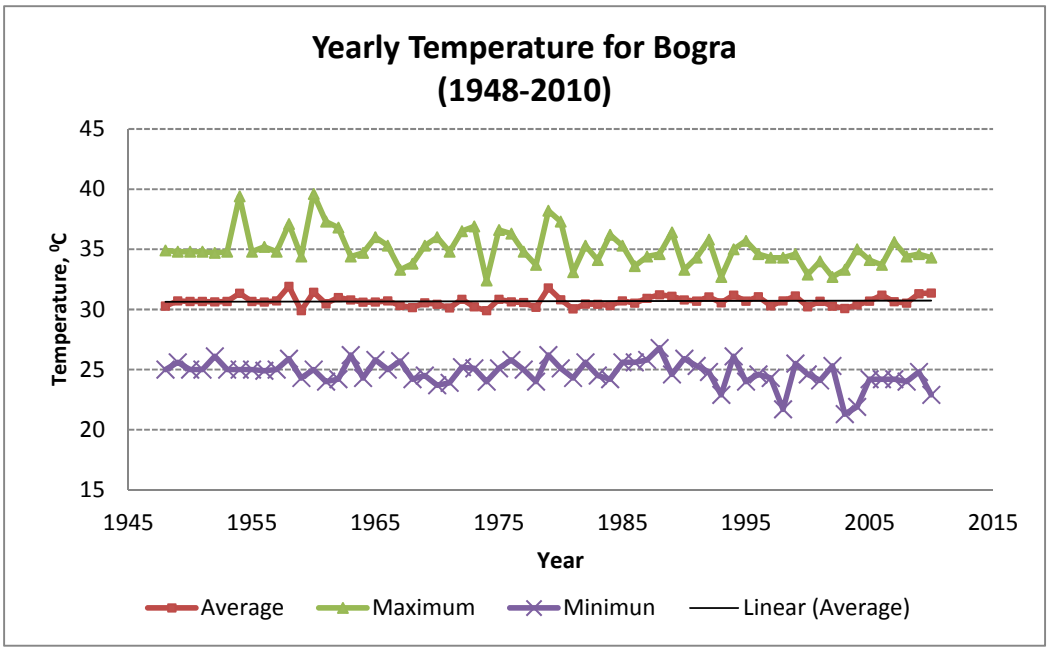


Figure 3.3: Yearly Average Temperature in Project Influence Area (Source: BMD)

3.2.2. Precipitation

The North-West Region of Bangladesh can be considered as the driest region of Bangladesh. Average annual rainfall in this region is around 1900 mm is below the average of Bangladesh, which is around 2300 mm.

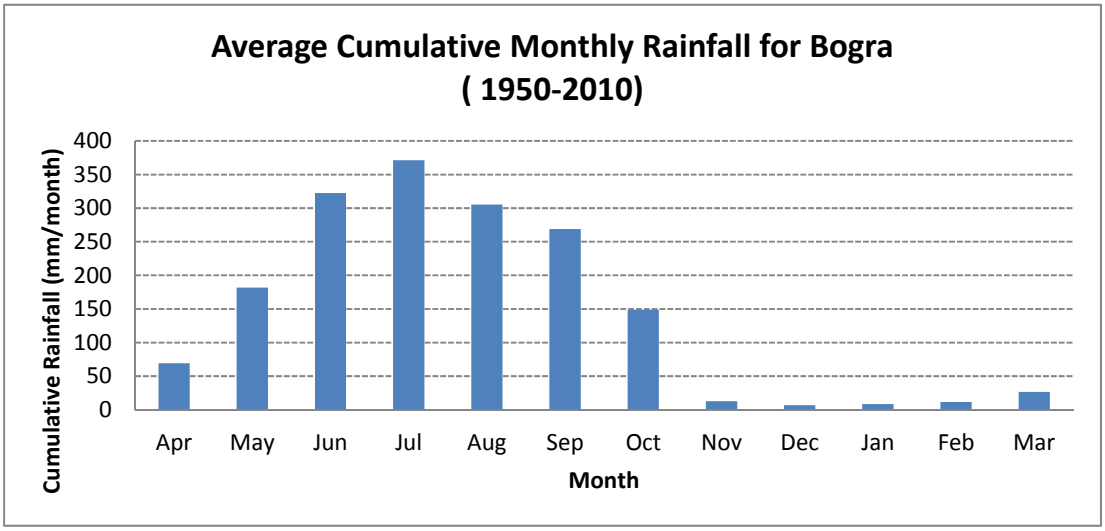


Figure 3.4: Average Monthly Rainfall for Bogra (Source: BMD)

Mean annual rainfall in the project influence area (represented by Bogra station) is approximately 1705 mm/year. **Figure 3.4** shows the average monthly rainfall for 1950-2010 recorded from Bogra station**.** Almost 74 percent of rainfall occurs from June to September and little or no rainfall from November to February. During pre-monsoon (March-May) cumulative rainfall is 276mm, in monsoon (June-September) total rainfall is 1267 mm and; post monsoon and dry season contributes 187mm rainfall. The maximum recorded monthly rainfall was 371 mm/ month.

3.2.3. Wind speed

Figure 3.5 shows the average monthly wind speed at Bogra station. The highest value occurs in April and the lowest in November.

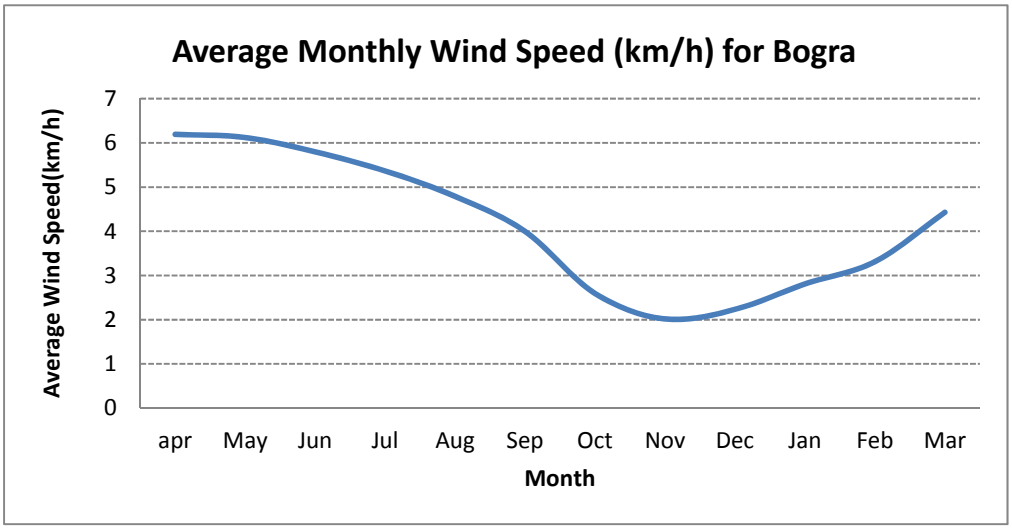


Figure 3.5: Average Monthly Wind Speed in Bogra (Source: BMD)

3.2.4. Humidity

Humidity data was also collected from BMD for Bogra station for the period 1950-2010. The relative humidity is highest during monsoon at 86.3 percent in July. **Figure 3.6** shows the relative humidity for Bogra station.

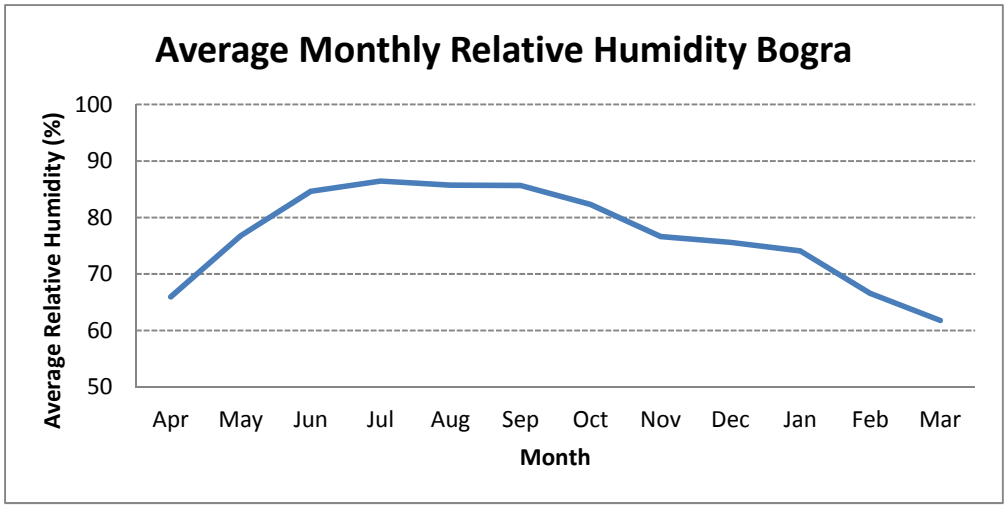


Figure 3.6: Average Monthly Relative Humidity in Bogra (Source: BMD)

3.3. Topography

Topographically, this area is flat and before construction of the BRE, the area was exposed to flooding from the Jamuna River during the monsoon season. **Figure 3.7** shows the project influence area topography as rendered by a digital elevation model. Land elevation varies from 21m to 4.7m amsl but most of the area is within 8-16 m. The area slopes gently downward from north to south and towards the east. The highest part is situated in the northern portion (Shaghata, Jhumabari, parts of Gaibandha) and the lower elevation area is in the southern portion (Sirajganj).

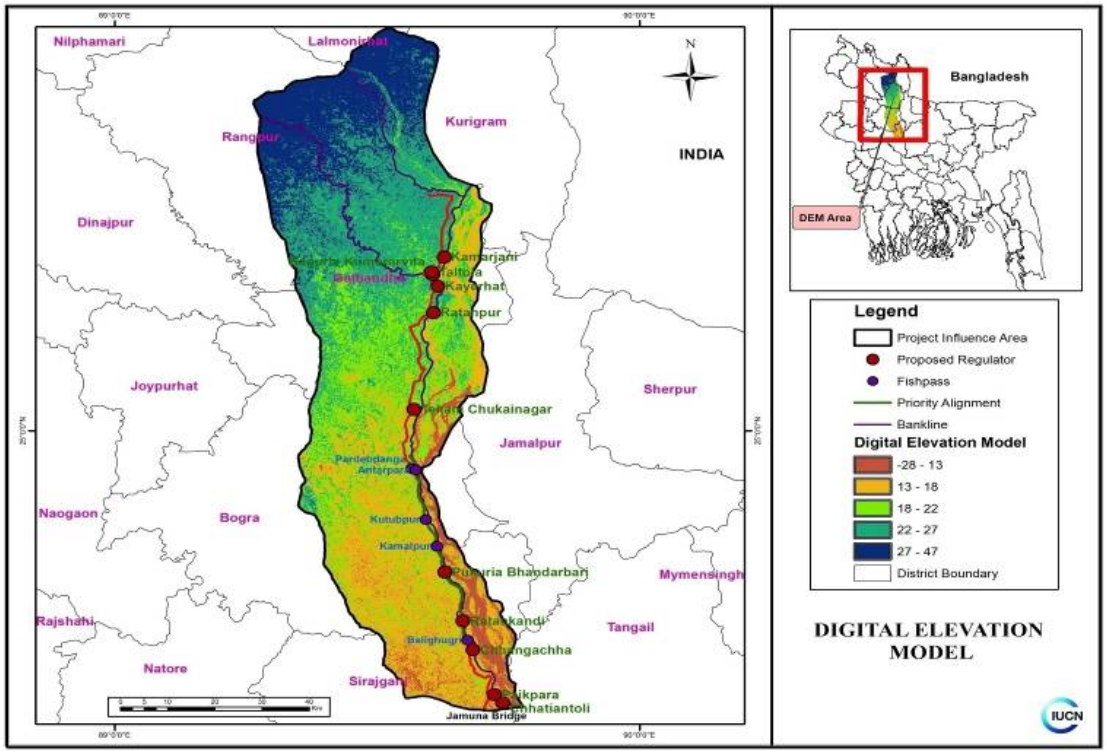


Figure 3.7: Digital Elevation Model (DEM) of the Project Influence Area

3.3.1. Floodplains

The lands of the project are a part of the Karotoya-Bangali and the Active Brahmaputra-Jamuna flood plain (Asiatic Society, 2006). The eastern part of the area has broad floodplain ridges and almost level basins. While the land adjacent to Jamuna river and the chars comprise of a belt of unstable alluvial land constantly being formed and eroded by shifting river channels. It has an irregular relief of broad and narrow ridges and depressions. About 53 percent of the total project influxes area (PIA is 268,466 ha) is available for agriculture. The rest of the land is occupied by settlement, homestead forestry, bamboo plantations and chars and water bodies.

3.3.2. Charland

Char or Shoal is an important feature of a braided river like the Jamuna. Analysis of time series satellite images of 1973 to 2014 show that over 90 percent of the area within the riverbanks of the Jamuna had been char at one time during the 27-year period. Chars are variable in time and space in terms of its geographic location. It survives through the constant interplay of erosion and accretion. The same analysis shows that about 75 percent of the chars remained between one and nine years, while only about

10 percent lasted for 18 years or more (Asiatic Society, 2006). It is important to note that as far as duration of existence is concerned, there are mainly three types of chars: dead, mature, and running or existing chars. The dead chars are usually permanent land formations; mature chars have not faced any major change for 10-15 years and existing or running chars face regular changes due to the action of the river and continuously emerge and submerge. The emergence and erosion determines the intensity of vulnerability in the 'chars'. Typically a new char land requires at least 10 years of continuous survival before it becomes habitable for human being.

Field investigations during 1-15 September have identified 159 chars of various sizes. Of these, 64 chars exist in the priority area from Sirajganj to Sariakandi. The names of the nearest inhabited chars to the right bank are given in **Table 3.4**.

Table 3.4: Chars/ River Islands in the Project Influence Area

District	Sub-District (Upazila)	Name of Chars
Sirajganj	Sirajganj Sadar	Simla, Kharoya, Khas Para, Par Simla, Noya Para, Dumber Char, Jhumkal Char
Bogra	Dhunat	Maiz Bari, Vanger Bari, New Sariakandi, Pukuria, Boroikandi, Baniajan, Atai, Koiya Gari, Sohora, Boishaki, Adhanagor, Fuljhur, Mollik Para, Shree Pur, Noi Khola, Dhakuria, Boyan Char, Majhira, Shanbandha, Promitibari, Agura Maizbari
	Sariakandi	Kuripara, Khapur Para, Antarpara, Kazla, Ghager Char, Diga Para, Chokorthinatha, Konnobari, Kormoja, Housherpur, Sujatpur, Bauliapara, Banupur, Dhorbon, Pakuriachar, Jamtoil,Manik, Nobboi, Barabajbari, Chanpara, Hasnapara, Dakat Mara, Indurmara, Joyantirpara, Nolcia, Fazilpur, Gobindapur
	Kazipur	Saouthtola, Megai, Manikpotol, Fultola, Shimultola, Polashpur, Char Kazipur, Masuakandi, Maijbari Fulchar, Bhurungi
	Sonatola	Khabilla, PatilChar, Shollia, Auchar, BoroVanga
Gaibandha	Shaghata	Hatbari, Delabari, Jamira,Shatilar Char, Batoner Char
	Fulchari	Khatiamari, Harodanga, Satardanga, Kauyapara, Kuchkhali, Jora bari, Kabilpur, Fazlurpur, Kalosona, Chomohan, Krishnomoni, Rahamatpur, Khazjani, Kauyabada, Zira bari, Satarkandi char
	Gaibandha Sadar	Raidasbari, Faliar gob, Kalaibari, Khasjani, Patdiara, Kundarpara, Batkamari, Fazlurpur, Kalosona, Chomohan, Krishnomoni, Khazjani, Zira bari, Kauyabada, Rahamatpur, Satarkandi char, Folar cock, Sayedpur, Satarkangi, Khazjani, Kalaibari, Aijazbari, Khamarjani, Karaibari, Batkamari, Kandolpara, Kolmu, Sidhai, Puran char
Kurigram	Chilmari	Nil char, Chutarmari, Bagdharabadh, Nauer char, Borovitar char, Bongram char, Damar char, Char horipur, Gorghoti char
	Ulipur	Durgapur, Gujimari, Uttar gujimari, Dakkhingujimari, Sukherbati, Char Bagua, Parar char, Kaziar char, Anantapur char
	Kurigram Sadar	Prothomalo, Bangardola, Mirgamari char, Pocha kata, Shantiar, Rolakata, Narayanpur, Astoasi, Jhumkar,Raulia char,Char Rasulpur, Majher char, Catlar char, Fakirere char, Kathgirir char, Motherganj char, Barobisha, Khaser char, Balduba, Porar char, Kath giri

3.4. Hydrology and Floods

3.4.1. Other Surface Water Resources

The influence area of the project is dominated by the Jamunariver and also the Bengali, Ichamati and Hurasagar rivers to a lesser extent in the eastern part of the area. All these rivers are interconnected by numerous channels (khals), tributaries and distributaries forming a hydrological network in the entire northwest region. For example, Mahananda, Punorbhaba which are major rivers of the northwest region, are connected to the Atrai-Karatoya-Bengali system which drains to the lower Jamuna through the Hurasagar/Baral in the south east corner of the region. Surface water bodies are shown in **Figure 3.8.**

At the northern boundary of the project influence area is the Teesta, which is a major tributary of the Brahmaputra. The braided Teesta River is the largest fan river in Bangladesh originating in Sikkim, India and avulsed into its present course at the end of the 18th century. Before avulsing, the Teesta flowed through todays Atrai as one of three channels, draining the western areas of Bangladesh into the Ganges.

Other types of surface water resources include beels, wetlands and natural canals or khals. These were identified from field investigations and images downloaded from Google Earth. **Table 3.5** shows the distribution of surface water bodies in the project influence area.

Table 3.5: Rivers in the Project Influence Area

Upazila Name	River Name	Area (Ha)
Priority Area		
Sirajganj sadar, Sherpur, Sariakandi, Roygang, Kazipur, Gabtali, Dhunat, Bogra Sadar	Jamuna	10,676.501
	Karataya	838.530
	Hurasagar	39.171
	Ichamati	86.542
	Bangali	868.671
Total		**12,652.911**
Remaining Area		
Sundargang, Sonatola, Saghatta, Sadullapur, Pirgang, Palashbari, Mithapukur, Islampur, Gobindaganj, Gaibandha sadar, Fulchhari,Ulipur, Rangpur, Rajarhat, Pirgachha, Lalmonirhat sadar,Kurigram sadar, Kaunia, Chilmari	Bangali	1,094.80
	Ghagat	352.22
	Tista	3,302.34
	Jamuna	11,512.73
	Brahmaputra	5,987.61
Total		**22,249.71**

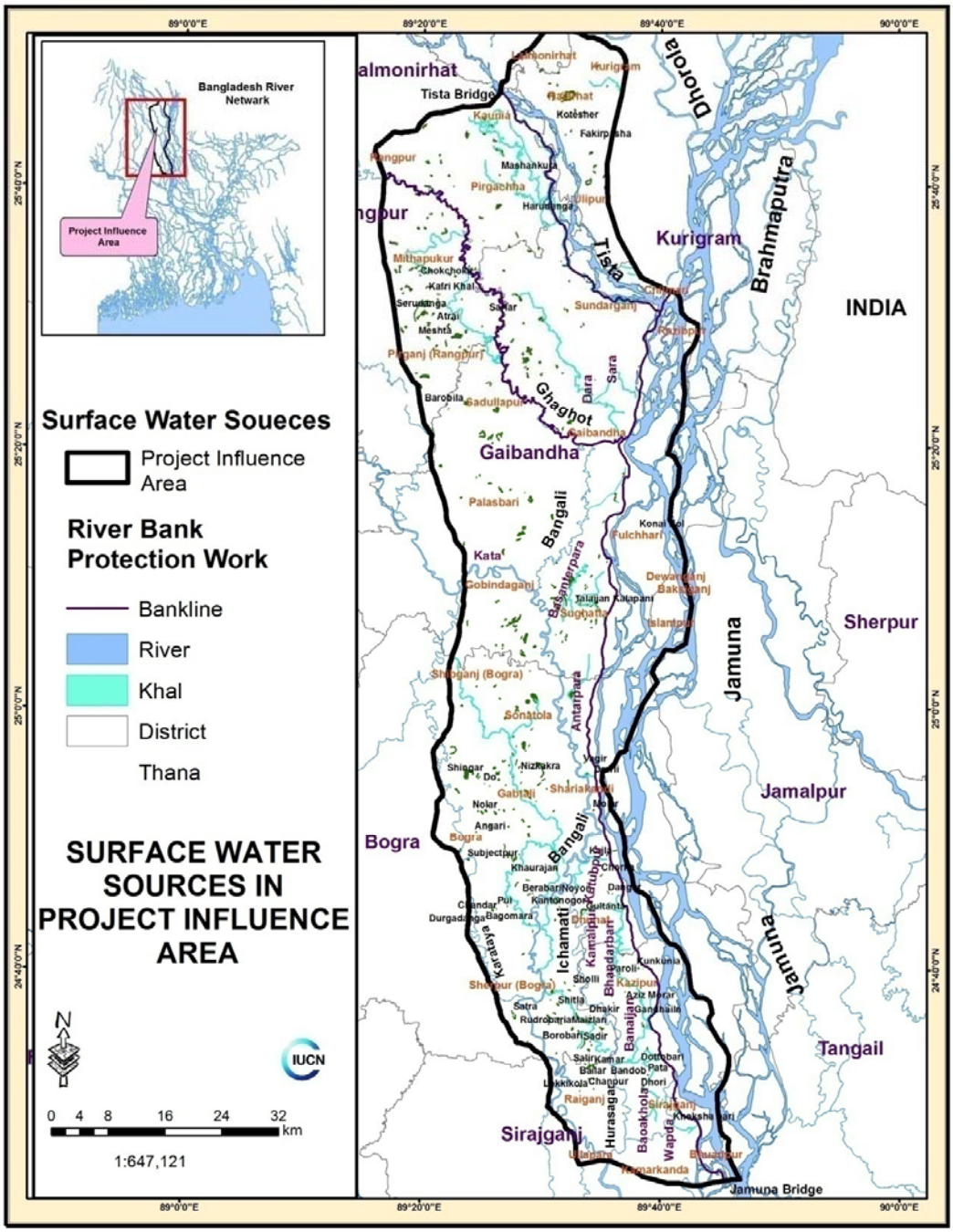


Figure 3.8: Rivers and Khals of the Project Influence Area

Field investigations show there are around 18 khals in the project influence area. The average water level of the khals during monsoon varies from 3m to 4.5m and width of the khals varies between 20m to 35m.According to local informants many of these khals become disconnected at places in the dry season. The river and khal network is shown in **Figure 3.8** and names given in **Table 3.6**

Table 3.6: Khals of the Project Influence Area

District	Upazila	Name of Canal/Khal
Sirajganj	Sadar	WAPDA Khal, Bahuka khal, Baliaghugri khal, Doi Vanger khal
	Kazipur	Halot khal, Meghai khal
Bogra	Dhunat	Shimulbari khal, Madhob Danga
	Sariakandi	Kata khal, Kuripara canal, Shalukar canal, Char bati canal
Gaibandha	Fulchari	Gopaldoba
	Sadar	Kamarjani khal, Dara/Canal
Kurigram	Chilmari	Gidari canal, Anantapur canal
	Sadar	Girainodi/Khal

3.4.2. Jamuna Tributaries

River flow data for major tributaries of Jamuna in the project influence area such asTeesta, Bengali at Khanpur and Hurasagar at Baghabari has been collected from Bangladesh Water Development Board and analyzed to describe the baseline situation.

Teesta River

The average maximum discharge of Teesta has not changed over time with the highest recorded peak reaching 8,710m³/s in 1987, while the dry season flow has drastically reduced as result of barrage operations. Two barrages regulate the dry season flow, one since 1985 in India and another since 1990 in Bangladesh and result in increasing sediment load due to the extraction of water for irrigation purposes. The river reacts somewhat flashy to high local rainfalls during the monsoon season. Data given in **Figure 3.9** for 1973-1985 show that the maximum monthly average discharge of the Teesta for that period is 2,459 m^3/s and for 2000-2009 maximum average discharge is 1,499 m^3/s. The reduced discharge can be attributed to barrages on the Teesta at Gojoldoba in West Bengal, India and at Dalia in Bangladesh. The maximum average water level is 28.6mPWD.

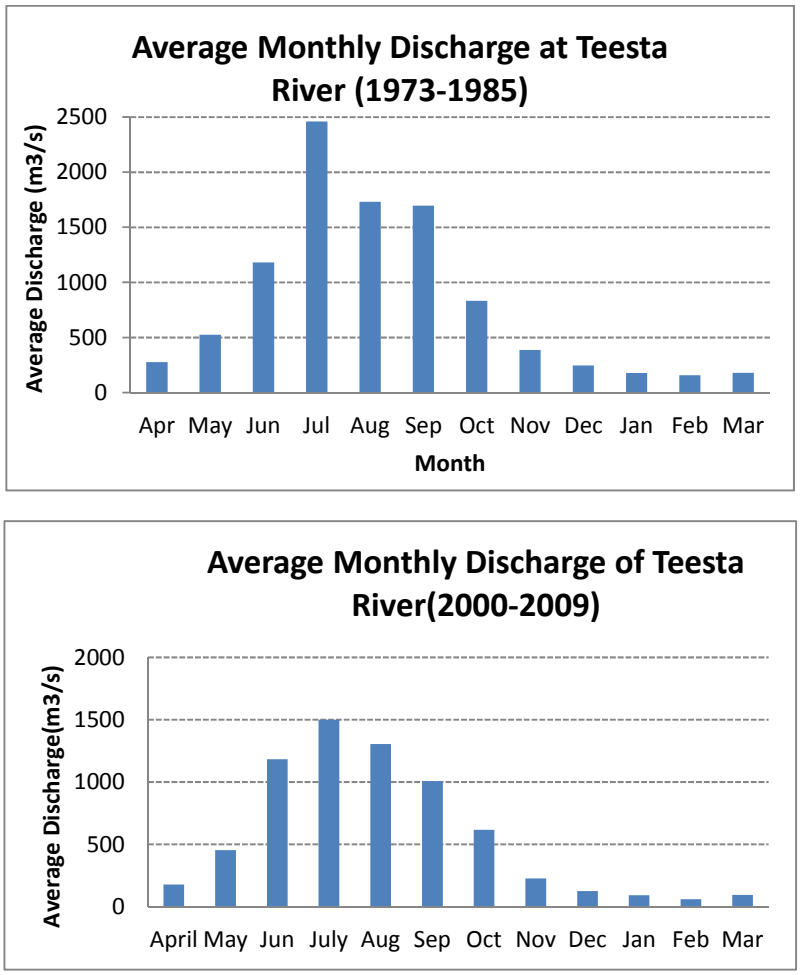


Figure 3.9: Average Monthly Discharge of the Teesta River (Source: BWDB)

Bangali River

Discharge data at Khanpur station for the period 1985-2007 show that the maximum monthly average discharge of the Bengali river is 350 m^3/s and the river peaks in July. In the dry season especially in the beginning of April the flow reduces drastically. The maximum monthly average water level is 12m (PWD). **Figure 3.10** shows the average discharge of the Bengali River.

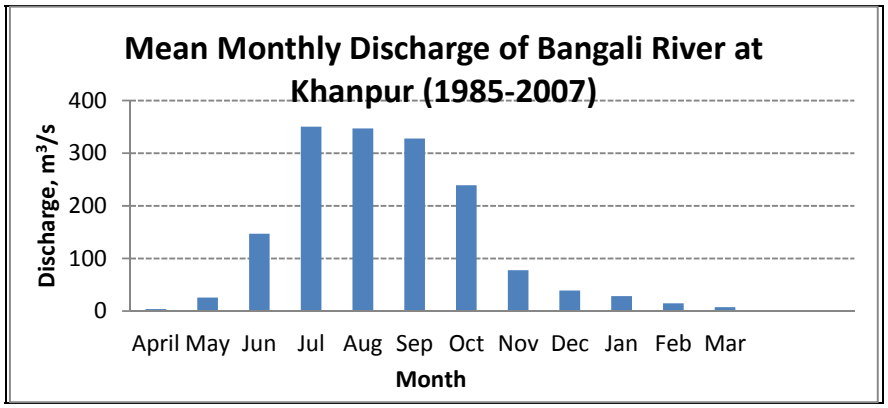


Figure 3.10: Average Monthly Discharge of the Bengali River (Source: BWDB)

Hurasagar River

Discharge data at Baghabari station for the period 2000-2006 show that the maximum monthly average discharge of the Hurasagarriver is 284.4 m^3/s and the river peaks in September. In the dry season especially in the beginning of April the flow reduces drastically. The maximum monthly average water level is 6.3m (PWD). **Figure 3.11** shows the average discharge of the Hurasagar River.

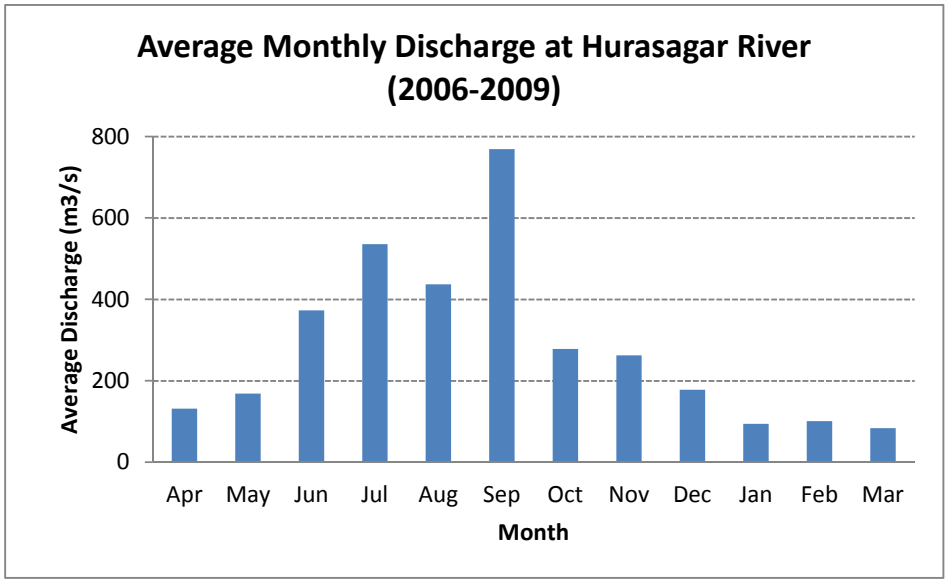


Figure 3.11: Average Monthly Discharge of the Hurasagar River (Source: BWDB)

3.4.3. Floods

Each year in Bangladesh about 26,000 sq. km, that is around 18 percent of the country is flooded (Nandan, 2014) In fact, the Bengali language distinguishes between the normal floods of the rainy season, which are locally known as barsha, and the more harmful floods of abnormal depth and timing, which are termed bonna (Nishat et al, 2011). During severe floods, the affected area may exceed to 55 percent of the total area of the country. In the event of catastrophic floods, it has been anticipated that about two-thirds of the country can get affected (Ahmad et al., 2000).

The hydrology and inundation cycles of almost 40 percent of the flood plains in Bangladesh are influenced by the Jamuna. As a result, the major floods that have occurred over the years can be linked to high water levels in the river. **Table 3.7** gives a picture of the extreme flood events that have occurred in recent years and **Table 3.8** extent of flooding of some years for the Jamuna.

Table 3.7: Some Notable Flood Disasters of Bangladesh

Event	Impact
1954 Floods	Affected 55% of the country.
1974 Floods	Moderately severe, over 2000 deaths, affected 58% of country, followed by famine with over 30000 deaths.

Event	Impact
1984 Floods	Inundated 52520 km^2, damage estimated at US$ 378 million.
1987 Floods	Inundated over 50000 km^2**,** estimated damage US$ 1.0 billion, 2055 deaths.
1988 Floods	Inundated 61% of country, estimated damage US$ 1.2 billion, more than 45 million homeless, between 2000-6500 deaths.
1998 Floods	1100 deaths inundated nearly 100000 km^2, rendered 30 million people homeless, damaged 500000 homes, heavy loss to infrastructure, estimated damage US$ 2.8 billion.
2004 Floods	Inundation 38%, damage US$ 6.6 billion, deaths 700, affected people nearly 3.8 million.

(Source: Hossain, 2006)

Table 3.8: Comparison of Major Flood Impacts in the Jamuna

Year	Flood Duration (Days)	Flooded Area(km2)	Flood Level (m)
1988	27	89,970	-
1998	66	100,250	20.37 m
2004 (up to 31 July, 2004)	16	56,000	20.18m

The 1998 flood has the highest published discharge (103,129 m^3/s) on the Jamuna River, at Bahadurabad, followed by the flood in 1988 (98,300 m^3/s). However, the 1998 peak water level at Bahadurabad was lower than in 1988. Both floods have shown extensive inundation of the region. For the Bangali river, the highest discharge (915 m^3/s) and water level (14.66m PWD) were also measured in 1998. The highest water level in the Hurasagarriver is recorded at 12.55m PWD in 2012. The highest water level of the Jamunariver at Sirajganj corresponding to 100 year flood is 15.5 mPWD based on historic flow.

However, flood damage is mostly related to theaccidental breaches that occur in the flood embankments along the Jamuna, rather than the severity of the flood event. Since, flood embankments (BRE) along the Jamuna has been designed to protect the project influence area from normal as well as extreme floods, flooding in the flood protected areas is primarily due to breaches in the embankments along the Jamuna which dominates the inundation cycle of the area.

The Bengali-Ichamati-Hurasagarrivers are meandering rivers and have very limited capacity to drain out the flood discharge during the times of peak flows. Again, the water levels of the Jamuna are much higher than the internal rivers. Combination of both these factors causes flooding and drainage congestion in the Bengali-Atrai-Hurasagar rivers, especially the lower reaches. Even in dry years, large areas of land are inundated from rainfall and river flooding.

3.4.4. Navigation in River and Khals

The Jamuna river is categorized as Class II[6] by Bangladesh Inland Water Authority (BIWTA, 1991), which means the river remains navigable throughout the whole year and links major inland ports or places of economic importance to class-I routes. **Figure 3.12** shows the available average draft in the Jamuna is 1.75m across the river and recent surveys show the minimum available water depth in the river from Sirajganj to Bahadurabad is 1m to 1.3m and from Bahadurabad to Chilmari is a 1.2m to 2.2m (Mishra and Hussain, 2012). The river is also a part of the India-Bangladesh protocol route and the route is used by cargo vessels to carry goods to Pandu in India. At the local level, people from charlands use the river to access the mainland mainly for earning livelihood, education and healthcare purposes. Smaller mechanized boats are used mainly for carrying people and goods and also for fishing activities.

Bengali River and Ichamoti River are comparatively small river navigation activities are less than that of the Jamuna river. The internal lakes/khals like Banaijan khal, Baoikhola Khal, Shimulbari khal, katakhal, Wapda Khal of the project influence area are suitable for the movement of mostly small non-motorized boats only. The depth is around 3m to 3.2m in monsoon drying up to less than 1m and becoming unnavigable in dry season.

3.4.5. Erosion and Sediment Loading

The banks and the charlands of the Jamuna river are highly susceptible to erosion and erosion processes are complex, with the magnitude and rate of erosion varying temporally and spatially.

Studies show erosion along the right and left bank have caused the river to widen at most places (Sarker, 2009). This is due to the Great Assam Earthquake in 1950. In Assam, India it widened along its 650km length from an average 6 to 9km and along its 250km in Bangladesh from 8 to 12km. The associated riverbank erosion is on average around 2 km at each bank. In other rivers, for examples in the Teesta, since the early 2000s very low overall erosion rates are recorded.

Long-term pattern of bank erosion along the entire Jamuna River over the period 1973 to 2012 show that the greatest erosion on the right bank of the river has occurred between approximately Sirajganj and Mathurapara. This corresponds to the RBIP's priority reach for rehabilitation and upgrading of the BRE. The annual erosion rate increases with the annual maximum flood discharge (CEGIS, 2009), although the rate of erosion along the left bank is more sensitive to the annual maximum discharge than along the right bank due to morphological characteristics of the river. **Figure 3.13** shows the pattern of bank erosion and channel width changes using digitized banklines compiled from satellite imagery. The digitized data sets extend over a distance of 85 km upstream of Jamuna Bridge and show bank positions at 500 m intervals along both the left and right banks of the river.

Sedimentation is also a problem in the project influence area. The Brahmaputra-Jamuna system is one of the most heavily sediment-laden large rivers of the world and a large part of this sediment is deposited in the flood plains. A part of this sediment is fine sand which is heavier than clay and silt and is deposited on the river bank as the flood waters

[6]The navigable waterways are assigned to four Classes that define the level of service to be guaranteed taking into account the economic importance of the river as well as the technical and financial capacity to maintain the level of service.

recede, renders the land uncultivable. . On the other hand, fertility of cropland will increase when nutrient rich silt and clay particles from river water are deposited on flood plains.The khal system is also choked with very fine sediments, especially when there is not enough discharge to remove the deposits and causes the bed level to rise and reduces their conveyance capacity

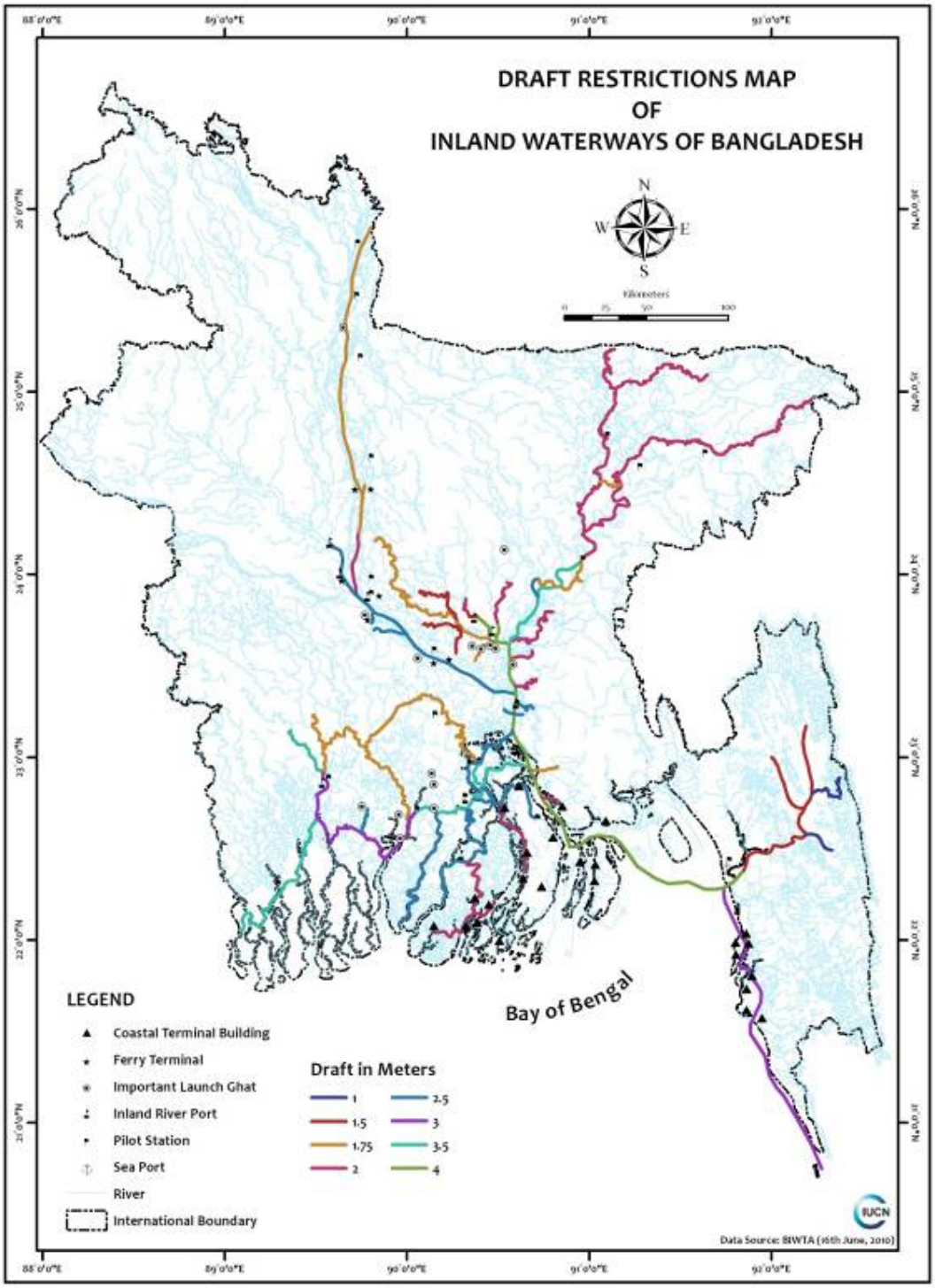


Figure 3.12: Draft Restriction of Inland Waterways of Bangladesh

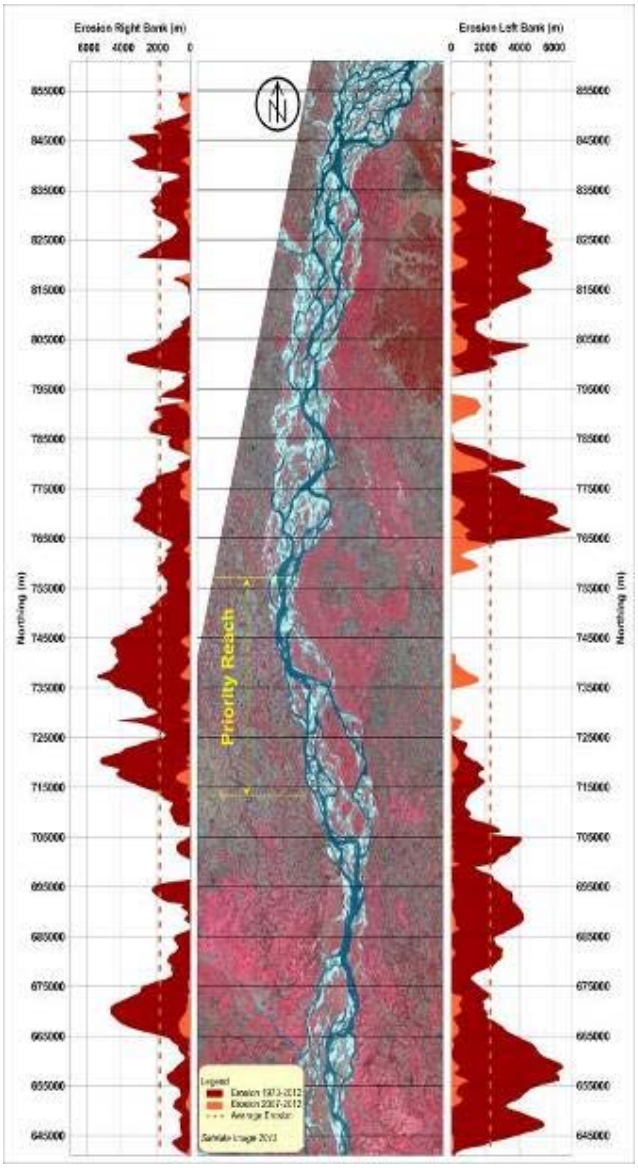


Figure 3.13: Pattern of bank erosion on Jamuna River, 1973 to 2013 (Source: Fichtner, 2014)

From Assam (India), the Brahmaputra carries a huge load of sediment acquired from the rain-soaked Himalayan tributaries. In fact, with a suspended sediment load of 13 million tonnes per day during the flood season, the river is considered to be one of the most heavily sediment-laden large rivers of the world (Nishat, 2014).The typical bed material of the Jamuna River is fine sand. Most of the bed material transport occurs in suspension mode..Analysis of bed material load as measured by the BWDB from 1966 to 1989 showed that the sediment load in the Jamuna River had reduced more substantially during the 1980s than in the late 1960s (Delft Hydraulic and DHI, 1996c. Sarker and Thorne (2006) related the change in bed material load in the Jamuna River to the propagation of sediment wave through the Brahmaputra-Jamuna-Padma-Lower Meghna River system due to the huge landslides in the Himalayas caused by the Great Assam Earthquake of 1950.

3.5. Geology and Hydrogeology

3.5.1. Soils

The soils in this region are usually grey silt loams and silty clay loams on ridges and grey or dark grey clays in basins.Sample collections from project influence area show that in Sirajganj, along the bank soil consists of alluvial deposit of non-cohesive materials of loose to medium dense silty fine sand mixed with trace amount of mica up to the depth of 20 m from the existing ground level. In Bogra and Gaibandha upto Teesta river the upper deposits consist of loose to medium dense non-cohesive materials of fine sand mixed with varying amount of silt and mica. The soils in the bore holes collected from embankment and road consists of non-cohesive and cohesive deposits of fine sand and clayey silt mixed with trace amount of mica. The drainage qualities of the soils at upper region are low to medium in non-cohesive materials and very poor to poor in cohesive deposits.

3.5.2. Geology

The project project influence area is situated in the Brahmaputra-Jamuna basin, that is the geology is dominated by quaternary sediments deposited by the Ganges-Padma and Brahmaputra-Jamuna-Teesta and their numerous tributaries and distributaries. The area is underlain by Tertiary and Quaternary sediments and recent alluvial deposits originating in the foothills of the Himalaya. The stratification of the sediments is generally composed of non-cohesive materials of sand and silt with patched of cohesive deposit of clay.

Bangladesh is situated in a seismically active region of the world. The seismic zoning map of Bangladesh proposed by Geological Survey of Bangladesh (GSB) and incorporated in the Bangladesh National Building Code the project influence area lies within Zone I which corresponds to high risk to earthquakes (BNBC, 2006).

3.5.3. Groundwater

The groundwater level varies across the year. Data for Bogra station shows that during October the groundwater level is at its highest at 3.8 m below existing ground level and lowest in April at 7m below existing ground level. However, water levels at Sirajganj and Gaibandha are slightly higher with highest water levels at 1.67 and 1.2 respectively. **Figure 3.14** compares the groundwater levels for Bogra, Sirajganj and Gaibandha.

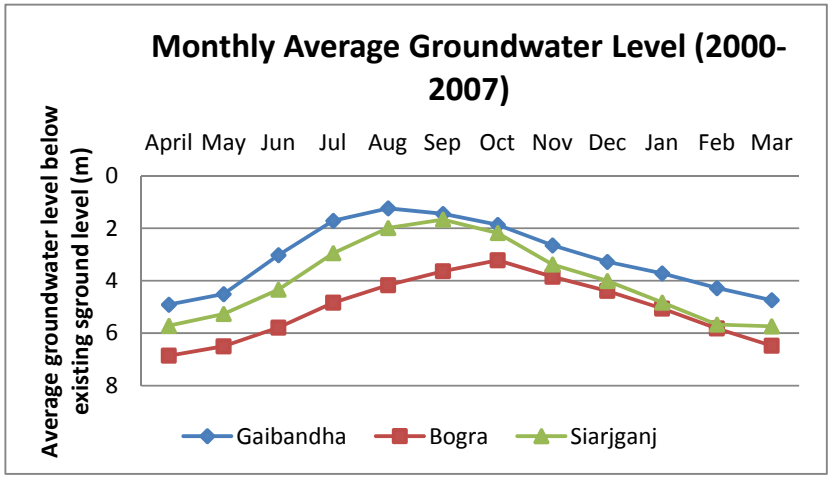


Figure 3.14: Monthly Average Groundwater Level at Gaibandha, Bogra and Sirajganj (Source: BWDB)

3.5.4. Landuse and Land Cover Analysis

Land use maps were generated based on analysis of satellite images of April, 2014 and verified through field investigation during September 2014. Details of present the land of the area are illustrated in. **Table 3.9** and **Figure 3.15** (next page) show the land use distribution in the project influence area.

Table 3.9: General Land Use in Project Influence Area

Category	Area(Hectares)	Percentage
Sandbar/Char	29,021.59	10.81
Water body	20,190.16	7.52
Agriculture and Vegetation	142,496.00	53.08
Settlement	76,758.00	28.59
Total	**268,465.75**	**100.00**

The distribution of land types for agriculture is shown in **Table 3.10**. This land type classification is based on depth of inundation during monsoon season due to normal flooding on agriculture land. There are five land types: High Land (HL, flooding: depth 0-30 cm); Medium Highland (MHL, flooding depth: 30-90 cm); Medium Lowland (MLL, flooding depth: 90-180 cm); Low Land (LL, flooding depth: 180-360 cm); and Very Lowland (VLL, flooding depth: above 360 cm) (MPO, 1986).

Table 3.10: Land Types in project Influence area

Location	Cultivable land (%)	Land type by flood water level (area in %)					Total
		High land	Medium High land	Medium Low land	Low land	Water body	
Sirajganj	67	28	41	25	3	3	100
Bogra	70	25	51	16	6	3	100
Gaibandha	74	31	34	25	9	2	100
Kurigram	69	20	38	29	11	2	100
All	70	26	41	24	7	2	100

Source: Upazila Agricultural Officer, DAE

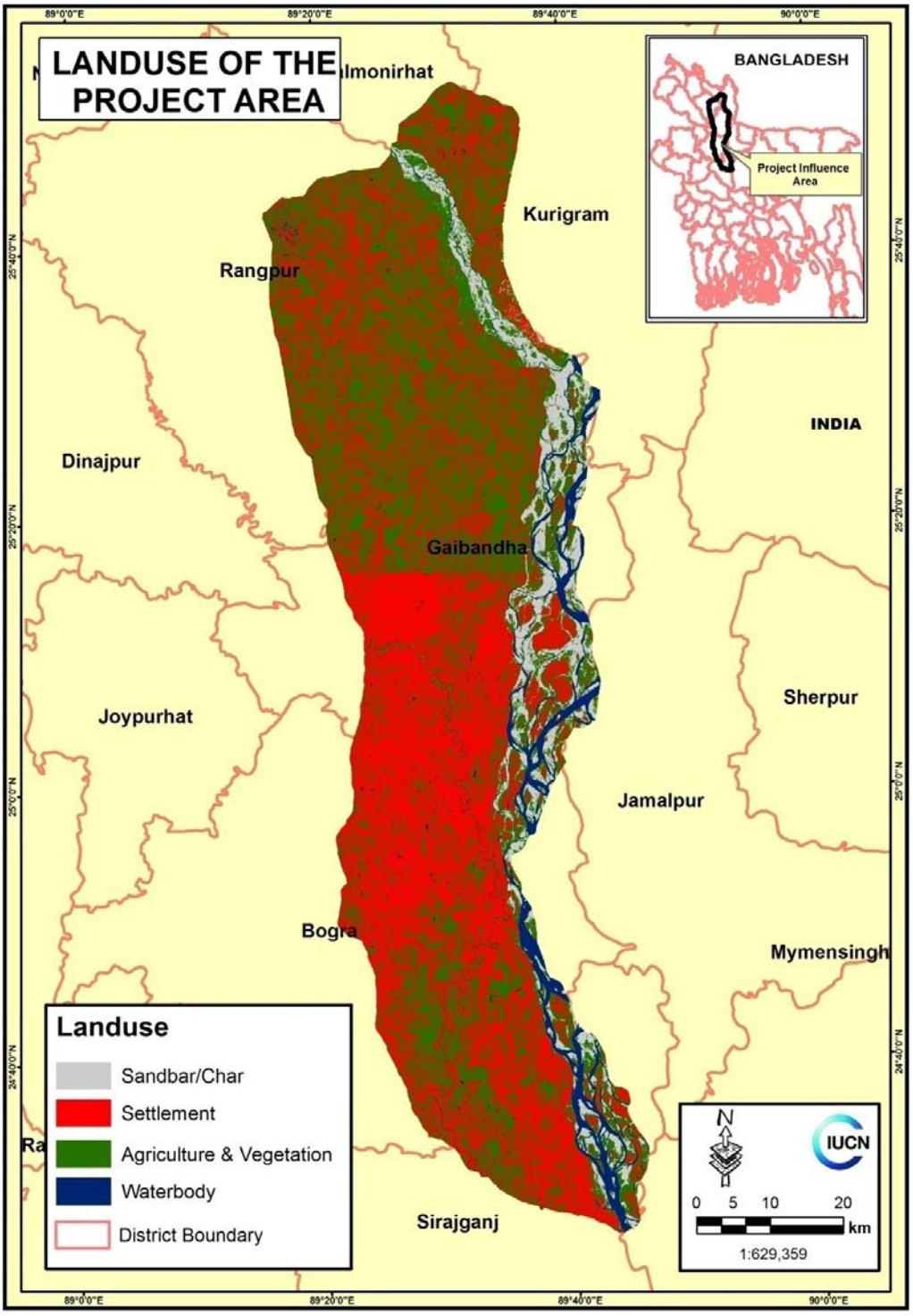


Figure 3.15: Land Use in the Project Influence Area

4. Quality of Environment

In order to understand the quality environment primary and secondary data and information has been used. The primary investigation includes assessment of air quality and noise; and sampling of surface water, groundwater and soil which were later tested in laboratories for certain parameters. The locations for sampling and assessment are shown in **Figure 2.1**.

4.1. Ambient Air Quality in the Project influence area

4.1.1. Air Quality Parameters

Air quality of an area impacts human health, especially sensitive populations such as children, the elderly, and individuals suffering from respiratory diseases. There are no major industries in the project influence area. Taking this into account, the key air quality parameters (suspended particulate matter -SPM, oxides of sulfur - SOx, and oxides of nitrogen - NOx) were analyzed from samples collected over an 8 hour period at each sampling site. Test results (**Table 4.1**) show the parameters are within the standard values set by Ministry of Environment and Forests for five of the locations. However, Suspended Particulate Matter measured at Jumarbari, Saghata, Gaibandha and Sariakandi Hard Point, Bogra exceed the national standard (**Table 4.2**) and WB standards (**Table 4.3**). Possible reasons for these exceedances are discussed in Section 4.1.2.

Table 4.1: Ambient Air Quality Parameters in Project Influence Area

Sampling Location*	Classification of the Area	Suspended Particulate Matter (µg/m^3)	Sulfur Dioxide (µg/m^3)	Nitrogen Oxides (µg/m^3)
Jumarbari, Saghata, Gaibandha	Commercial and mixed	811	Not detected	8.39
Bharatkhali, Saghata, Gaibandha	Residential and rural	260	Not detected	6.54
Baoitara, Saidabad, Sirajganj	Commercial and mixed	593	Not detected	11.90
Ratankandi, Ratankandi, Sirajganj	Commercial and mixed	298	Not detected	7.14
Singrabari, Kajipur, Sirajganj	Residential and rural	261	Not detected	6.35
Sariakandi Hard Point, Sariakandi, Bogra	Commercial and mixed	1,188	Not detected	10.56
Anantapur, Ulipur, Kurigram	Commercial and mixed	375	Not detected	7.56

Source: IUCN Field survey, 4-10 November 2014

Table 4.2: Bangladesh Standards for Ambient Air Quality

Category	Area	Suspended Particulate Matter	Sulfur Dioxide	Nitrogen Oxides
		($\mu g/m^3$)		
Ka	Industrial and mixed	500	120	100
Kha	Commercial and mixed	400	100	100
Ga	Residential and rural	200	80	80
Gha	Sensitive	100	30	30

Note: The averaging period is counted as per 8-hour

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 4.3: Ambient Air Quality (WBG EHS standards)*

Averaging period	Suspended Particulate Matter	Sulfur Dioxide	Nitrogen Oxides
	($\mu g/m^3$)		
24 hrs	50	500	200

Source: World Bank Group Environmental, Health, and Safety (EHS) Guidelines

4.1.2. Sources of Pollution

The main sources of pollution in Jumarbari (market place), Saghata, Gaibandha and Sariakandi, Bogra include the local vehicles especially trucks, *karimons* and *nasimons* (locally manufactured small three-wheelers). In Jhumerbari, the location of air quality measurement was at near union parishad which is situated in Bazar. Surrounding area was overcrowded place and the amount of dust was at extensive level. The measurement was done in the evening when the market started and people began to gather.

In Sariakandi Hardpoint, the measurement was done at the stopping point of Nochimon (a type of local vechicle having engine which provides service as like Mini Van or Bus) which maybe considered as the temporary parking place. During the starting, emission of gas is very high. Sariakandi hard point is also used as recreational centre point for people. Various types of engine boats and launches also operate in the area. Concrete cement block construction for revetment was another activity causing air pollution at that place.

4.2. Ambient Noise Levels in Project influence area

Vehicular traffic on road is the key source of noise in the project influence area. Measurements were taken in seven locations and are shown in **Table 4.4**. The measured

noise values are within the prevailing standards set by DoE for mixed areas (**Table 4.5**), and by WB standerds (**Table 4.6**).

Table 4.4: Noise Levels in Project Influence Area

Sampling Location	Category of the area	Date	Noise(dBA) (Day)	Noise(dBA) (Night)
Jumarbari, Saghata, Gaibandha	Commercial and mixed	04/11/14	34-36	30-32
Bharatkhali, Saghata, Gaibandha	Residential and rural	04/11/14	34-38	31-33
Baoitara, Saidabad, Sirajganj	Commercial and mixed	07/11/14	36-38	32-34
Ratankandi, Ratankandi, Sirajganj	Commercial and mixed	07/11/14	34-36	30-32
Singrabari, Kajipur, Sirajganj	Residential and rural	08/11/14	36-38	31-34
SariakandiHP,Sariakandi, Bogra	Commercial and mixed	09/11/14	46-51	46-48
Anantapur, Ulipur, Kurigram	Commercial and mixed	10/11/14	34-37	30-33

Source: IUCN Field survey, 4-10 November 2014

Table 4.5: Noise Quality Standards of Bangladesh

	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).

*Note*s:

1. Daytime is considered as the time between 6 am to 9 pm.
2. Nighttime is considered 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 4.6: World Bank Group EHS Standards for Noise

Area Category	Standard Values (dBA)	
	Day (07:00-22:00)	Night (22:00-07:00)
Residential, institutional, educational area	55	45
Commercial and industrial area	70	70

Source: World Bank Group Environmental, Health, and Safety (EHS) Guidelines

4.3. Surface Water Quality

The surface water quality in the project influence area is influenced by the hydrological and water quality conditions of Jamunariver and upstream rivers such as Teesta, Karotoya, Atrai. Data on water quality parameters were collected from primary and secondary sources and analyzed. Data for foursurface water quality parameters was collected from BWDB stations at Bahadurabad for the Jamuna. The values of the parameters from BWDB and their standard values set by the DoE are shown in **Table 4.7** and **Table 4.8,** respectively.

Table 4.7: Surface Water Quality of Rivers in Project Influnce Area (2006)

Station Name	Season	pH	DO (mg/l)	TDS (mg/l)	EC (µS/cm)
Teesta River					
Teesta Bridge	Wet Season	7.2	7.6	54	87
	Dry Season	7.0	6.0	50	75
Brahmaputra River					
Near Jamalpur	Wet Season	6.85	6.2		90
	Dry Season	7.1	5.0		110
Jamuna River					
Nandina	Wet Season	7.1	4.0		108
	Dry Season	7.7	3.5		150
Jamuna Bridge	Wet Season	7.7	6.2	48	87
	Dry Season	8.7	7.1	85	75
Jamuna Fertilizer	Wet Season	6.5	6,8		123
	Dry Season	7.12	5.5		256

Source: Bangladesh Water Development Board

Table 4.8: Bangladesh Water Quality Standards

	Best Practice based Classification	Parameters			
		pH	BOD (mg/l)	DO (mg/l)	Total coliform (number /100)
1	Source of drinking water for supply only after disinfecting	6.5–8.5	2 or less	6 or above	50 or less
2	Water usable for recreational activity	6.5 – 8.5	3 or less	5 or more	200 or less
3	Source of drinking water for supply after conventional treatment	6.5 – 8.5	6 or less	6 or more	5000 or less
4	Water usable by fisheries	6.5 – 8.5	6 or less	5 or more	-
5	Water usable by various process and cooling industries	6.5 – 8.5	10 or less	5 or more	5000 or less
6	Water usable for irrigation	6.5 – 8.5	10 or less	5 or more	1000 or less

Source: Environmental Conservation Rule (ECR)'97

Notes:

1. In water used for pisiculture, maximum limit of presence of ammonia as Nitrogen is 1.2 mg/l.
2. Electrical conductivity for irrigation water – 2250 □mhos/cm (at a temperature of 25□C); Sodium less than 26 percent; boron less than 0.2 percent.

Table 4.9 presents the water quality measured during field investigations in selected locations of the project influence area. Ambient surface water and ground water quality is represented by some selected parameters, which are crucial for drinking purpose, agricultural activities, industries and to maintain optimum aquatic environment. The standard values of these indicators set by the Department of Environment, Bangladesh are also shown for comparison purposes. APHA method was used to measure the parameters for the surface water.

Table 4.9: Water Quality in Project Influnce Area

Sample Location		Water Quality Parameters				
	Temperature (°C)	TDS (ppm)	EC (μS/cm)	BOD_5 (mg/L)	DO (mg/L)	pH
Banaijan Khal, Kuralia, Ratankandi, Sadar, Sirajganj	27.4	262	526	12.6	4.27	7.25
Ichamoti river, Baliaghugri, Changacha, Sadar, Sirajganj	27.6	250	416	22.4	2.2	7.33
Deulibeel, Antarpara, Sariakandi Union, Sariakandi, Bogra	27.4	135	262	15.9	2.95	7.3
Bangali River, Pardevdanga, Kutubpur, Sariakandi, Bogra	27.5	62	105	4.25	6.25	7.32

Sample Location		Water Quality Parameters					
		Temperature (°C)	TDS (ppm)	EC (µS/cm)	BOD_5 (mg/L)	DO (mg/L)	pH
Ghagot River, Pochakhuria, Gidari, Sadar, Gaibandha)		27.7	87.2	133	12.0	3.85	7.18
Standard Value (Bangladesh)	Irrigation	20-30	-	-	10 or less	5.0	7.0-8.5
	Fishing	20-30	-	-	6 or less	4.0-6.0	6.7-9.5
WBG EHS Guideline Standard							

Source: IUCN field survey, 12 October 2014, period of analysis: 19/10/2013 to 03/11/2014 by Bangladesh *Council of* Scientific & *Industrial Research (BCSIR).*

4.3.1. Water Temperature

The temperature of water bodies affects fish habitats and their oxygen holding capacity. The mean temperature of the water bodies in the project influence area ranges from 27.4 to 27.7°C (**Table 4.9**) in October. This value lies within the DoE standards for both irrigation and fish habitats.

4.3.2. Taste and Odor

The taste and odorof water bodies have been found to be agreeable and unobjectionable.

4.3.3. pH

The hydrogen ion concentration of water is expressed by its pH value. A pH value of 7 indicates a neutral solution, neither alkaline nor acidic. In most of the water bodies of the area, the pH range is found well within the DoE standards.

4.3.4. Dissolved Oxygen (DO)

Dissolved oxygen is necessary to many forms of life including fish, invertebrates, bacteria and plants. Decrease in DO values below the critical level of 3 mg/l causes death of most fishes and other aerobic aquatic organisms. DO is relatively lower in the dry season than in the wet season. The values of DO of Bengali and Bangshi rivers in the project influence area (measured in the month of October) was within 4-6 mg/l, which complies with the DoE standards for irrigation as well as for fisheries and aquatic life. However, DO for water samples from Ichamatiriver, DeuliBeel and Ghaghot rivers are below the standard. In Ichamatiriver and DeuliBeel, the water level during sampling was very low and many habitats within the vicinity account for the low DO levels. Gaibandha city is located on the banks of the Ghaghotriver and untreated waste from this municipality is main reason for low DO levels.

4.3.5. Conductivity

Conductivity in streams and rivers is affected primarily by the geology of the area through which the water flows. Discharges to streams can change the conductivity depending on their make-up. A failing sewage system would raise the conductivity

because of the presence of chloride, phosphate, and nitrate; an oil spill would lower the conductivity. EC as a water quality indicator is useful for estimating the amount of minerals, assessing the effect of diverse ions on chemical equilibrium, physiological effects on plants or animals, and corrosion rates. It is an indirect measure of the TDS (TDS = 640 × EC), the effects of which have been discussed above. The values of EC inside the polder ranged between 0.105mS/cm and 0.526mS/cm. The low values of EC indicate that the water bodies inside the project influence area are fresh water.

4.3.6. BOD_5

Biochemical oxygen demand (BOD) is the amount of dissolved oxygen needed by aerobic biological organisms in a body of water to break down organic material present in a given water sample at certain temperature over a specific time period. The term also refers to a chemical procedure for determining this amount. This is not a precise quantitative test, although it is widely used as an indication of the organic quality of water. The highest BOD_5 recorded in the samples is from Bangaliriver at 22mg/L and DeuliBeel at 15.9mg/L and indicates moderate pollution. The rest of the samples are below 15mg/L.

4.3.7. Total Dissolved Solids (TDS)

Dissolved solids are also important to aquatic life by keeping cell density balanced. However water containing excessive dissolved solids adversely affects drinking water. Continuous use of such water may cause a general loss of condition, weakness, scouring, reduced production, bone degeneration and ultimately death. TDS may influence the toxicity of heavy metals and organic compounds for fish and other aquatic life. The natural range of TDS concentration in the water bodies of the project influence area are between 262 mg/L to 62 mg/L.

4.4. Groundwater Quality

The groundwater quality parameters, measured in the area during the month of September, were found to comply with the drinking water quality standards set by DOE. Tetrimetric method was used to measure the water quality parameters for ground water The ground water quality of the area is presented in **Table 4.10**.

Table 4.10: Groundwater quality in the Project Influnce Area

	Groundwater Quality Parameters				
	pH	**Chloride (mg/l)**	**Iron (Fe) (mg/l)**	**Bicarbonate (mg/l)**	**TDS (mg/l)**
Tube-well, 120 feet, Baliaghugri, Changacha, Sadar, Sirajganj	7.15	1.74	0.16	284	322
Tube-well, 50 feet, Pardevdanga, Kutubpur, Sariakandi, Bogra	7.15	2.34	2.76	297	289

Source: IUCN field survey, October 2014

According to local stakeholders, all drinking water tube-wells within the project influence area have been analyzed for Arsenic by Department of Health Engineering (DPHE).

However, none of the tube-wells have been marked 'red' which means traces of arsenic in groundwater have not been detected.

4.5. Soil Quality

Soil samples were collected from deep channels, shallow channels and banks of the Jamuna at seven different locations. The collected soil samples were analyzed for pH, moisture content, nitrogen, phosphorus, potassium and sulfur; the analysis results are given in **Table 4.11.**

Table 4.11: Analysis of Soil Samples collected from Project Influnce Area

Sample ID	pH	Moisture Content	Texture	Total Nitrogen (ppm)	Total Phosphorus (ppm)	Total Potassium (ppm)	Total Sulfur (ppm)
Antarpara (Country Side)	7.29	31.17 %	Silty Clay Loam	710	710	4270	5720
Antarpara (Embankment)	7.44	7.08 %	Silt Loam	890	730	3960	3540
Antarpara (Right Bank, River Side)	7.30	28.22 %	Silt Loam	1050	640	5440	4540
Antarpara (Deep channel of Jamuna)	7.77	22.15 %	Fine Sand	380	660	1890	1650
Antarpara (Left Bank, Char)	7.32	24.50 %	Silt Loam	830	670	5000	4280
Baliaghuri (Country Side)	7.39	20.92 %	Silt Loam	1190	750	4720	5450
Baliaghuri (Embankment)	7.40	10.69 %	Silt Loam	890	740	3510	3760
Baliaghuri (Right Bank, River Side)	7.48	20.26 %	Silt Loam	820	760	4400	4930
Baliaghuri (Deep channel of Jamuna)	7.62	20.15 %	Fine Sand	490	450	1160	1460
Baliaghuri (Left Bank, Char)	7.42	22.27 %	Loamy Fine Sand	440	600	3350	2740
Pukuria (Country Side)	7.32	25.23 %	Loam	650	620	4540	4410
Pukuria (Embankment)	7.43	20.36 %	Loam	940	580	4670	3890
Pukuria (Right Bank, River Side)	7.15	28.22 %	Sandy Clay Loam	690	570	4980	5670
Pukuria (Deep channel of	7.96	21.50 %	Fine Sand	790	450	1310	1500

Sample ID	pH	Moisture Content	Texture	Total Nitrogen (ppm)	Total Phosphorus (ppm)	Total Potassium (ppm)	Total Sulfur (ppm)
Jamuna)							
Pukuria Left Bank, Char)	7.39	17.84 %	Silt Loam	710	710	4270	5720

Methodology / Instruments:

01	pH = pH meter	05	Sulfur = Turbidimetric method
02	Moisture Content = Moisture Analyzer	06	Total Potassium = Flame Photometer
03	Texture = Hydrometer method	07	Phosphorus = Vanadomolybdophosphoric yellow color method in nitric acid system
04	Total Nitrogen = Kjeldahl method		

The soil samples were also tested for pesticide residues (including dieldrin, endrin, 4,4′-DDT, 4,4′-DDD, and aldrin) by gas chromatography method and results came out negative indicating soil samples to be of adequate quality.

5. Ecological Environment

This Chapter presents the prevailing condition and status of the biological resources found in the project influence area.

5.1. Overview: State of Biodiversity

Bangladesh has a rich biological heritage, because of its location in the subtropical belt, at the confluence of two biotic realms, namely 'Indo-Himalayas' and 'Indo-China'. The distributional ranges of many species typical to each of these two biotic realms have overlapped in Bangladesh. This makes the country's biodiversity exceptionally rich (**Table 5.1**).

Table 5.1: Biodiversity in Bangladesh and in Project Influence Area

Taxon	Species in Bangladesh (Number)	Species in Project influence area	
		(Number)	% of the Country's Total
Fauna	**1051**	**331**	**31.5**
Mammals	128	25	20
Birds	706	255	36
Reptiles	168	36	21
Amphibians	49	15	31
Flora	**7095**	**67**	**0.944**
Algae	3,600		
Bryophytes	290		
Pteridophytes	200		
Gymnosperms	5	2	40
Angiosperms	3,000	512*	17

Source: IUCN-Bangladesh 2000, Consultant Ecological Survey, Khan 2014, Hassan 2003.

In the past, several surveys were conducted to know the biodiversity status of Bangladesh, but there was no such attempt in the project influence area despite the fact that the area is situated near the 'Himalayan Hotspot' which is one of the important biodiversity hotspots among the 35 biodiversity hotspots of the world (Conservation International 2014). Therefore, a detailed baseline survey is required, covering all the seasons and all the habitat types, so that the actual status of biodiversity in the project influence area is known.

The project influence area falls within two of the 12 Bio-ecological Zones of Bangladesh, as designated by IUCN in 2002 (Nishat*et al*. 2002). These are 'Major Rivers' and 'Floodplain (Teesta)' (**Figure 5.1**). Therefore, the ecosystems and the species composition are relatively homogeneous across the project influence area (**Table 5.2**). The area, however, harbors some excellent habitats of the Ganges River Dolphin (*Platanista gangetica*) and wintering grounds of many migratory birds. The two newly-declared (declared in 2013) dolphin sanctuaries (Nagarbari-Mohanganj Wildlife Sanctuary -

408.11 ha, and Shilonda-Nagdemra Wildlife Sanctuary - 146.00 ha) in the downstream of the project influence area support the source population of the Ganges River Dolphin. These sanctuaries were declared under the Wildlife (Conservation and Security) Act, 2012. Since both are newly established, no management plan has yet been prepared and implemented, but the areas get the protection on the basis of the Clauses 13-16 of the Wildlife Act.

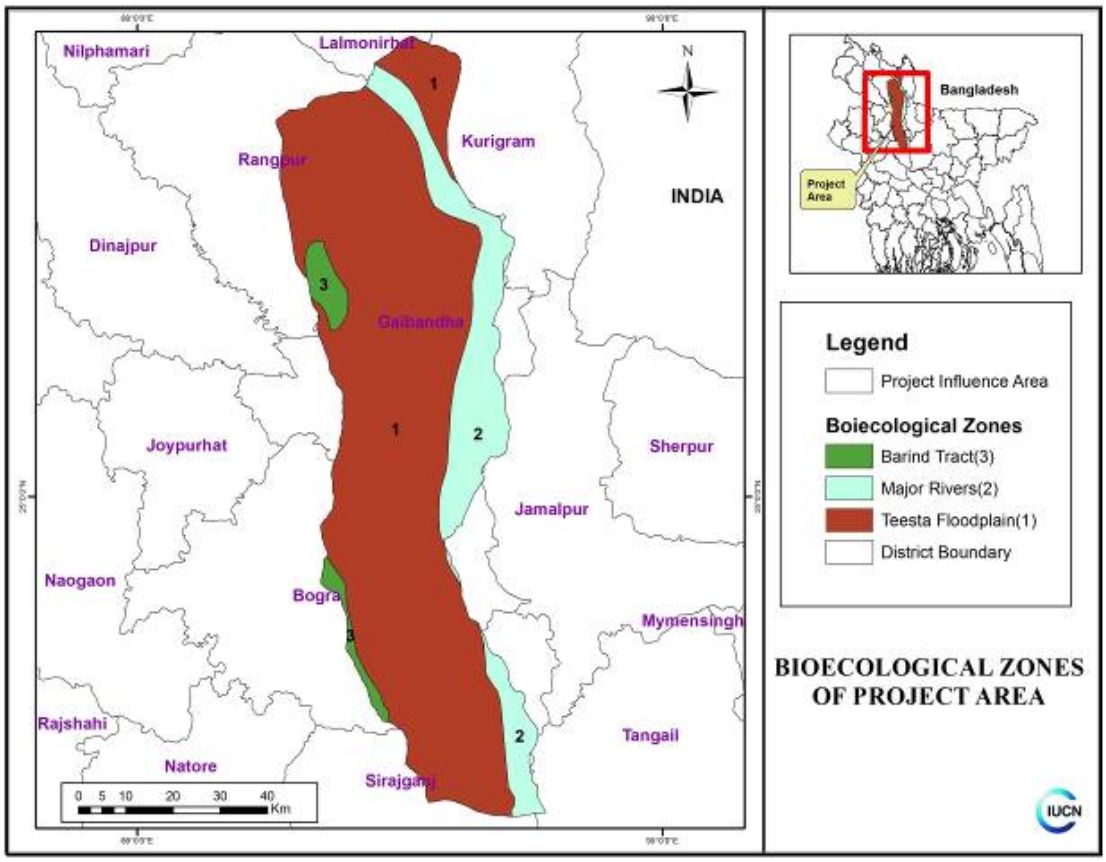


Figure 5.1: Bio-ecological Zones in the Project Influene Area

Table 5.2: Notable floral and faunal diversity of two Bio-ecological Zones ['Major Rivers' and 'Floodplain (Teesta)']

Bio-ecological Zone	Notable Flora	Notable Fauna
Major Rivers	Binna Ghash (*Vetiveria zizanioides*), Kansh (*Saccharum spontaneum*), Ghagra (*Xanthium indicum*), Ban Palang (*Rumex meritimus*)	Ganges River Dolphin (*Platanista gengetica*), Bengal Fox (*Vulpes bengalensis*), Greater Bandicoot Rat (*Bandicota indica*), River Lapwing (*Vanellus duvaucelii*), Black-bellied Tern (*Sterna acuticauda*), Sand Lark (*Calandrella raytal*), Spot-billed Duck

Bio-ecological Zone	Notable Flora	Notable Fauna
		(*Anas poecilorhyncha*), Small Pratincole (*Glareola lactea*), Cantor's Softshell Turtle (*Pelochelys cantorii*), Gharial (*Gavialis gangeticus*), Ganges Softshell Turtle (*Aspideretes gangeticus*), Median Roofed Turtle (*Kachuga tentoria*), Jerdon's Bull Frog (*Hoplobatrachus crassus*), Skipper Frog (*Euphlyctis cyanophlyctis*)
Floodplain (Teesta)	Aam (*Mangifera indica*), Kanthal (*Artocarpus heterophyllus*), Kalo Jam (*Syzygium cumini*), Litchu (*Litchi chinensis*), Bhant (*Clerodendrum viscosum*), Danda Kalash (*Leucus aspera*), Jiban (*Trema orientalis*), Pitali (*Trewia nudiflora*), Barun (*Crataeva nurvala*), Hijal (*Barringtonia acutangula*), Kachuripana (*Eichhornia crassipes*), ShadaShapla (*Nymphaea nouchali*), Panchuli (*Nymphoides indicum*), Singara (*Trapa bispinosa*), Bara Nukha (*Monochoria hastata*), Foxtail (*Rhynchostylis retusa*), Rasna (*Vanda roxburghii*)	Five-striped Palm Squirrel (*Funambulus pennanti*), Jungle Cat (*Felis chaus*), Tomb Bat (*Taphozous saccolaimus*), Darter (*Anhinga melanogaster*), Brown Fish Owl (*Ketupa zeylonensis*), Black Francolin (*Francolinus francolinus*), Sand Lark (*Calandrella raytal*), Three-striped Roofed Turtle (*Kachuga dhongoka*), Brown Roofed Turtle (*Kachuga smithii*), Dark-bellied Marsh Snake (*Xenochrophis cerasogaster*), Slender Work Snake (*Typhlops porrectus*), Ornate Microhylid (*Microhyla ornata*), Red Microhylid (*Microhyla rubra*)

(Source: Nishat *et al.* 2002)

5.1.1. Ecosystem Diversity

Broadly the ecosystem in the project influence area can be divided into two groups: i) freshwater aquatic, and ii) terrestrial. The aquatic ecosystem is mostly rivers and other natural wetlands that can be further divided into lentic and lotic depending on the flow of water. The terrestrial ecosystem, on the other hand, includes both human-induced (villages and crop fields) and natural (riparian grasslands, reed-lands and sandbars) areas.

5.1.2. Threatened Species

Though the project influence area does not support any globally threatened species of plants, it has five species of plants that are nationally threatened, which are:

- Sarpogandha or Indian Snakeroot (*Rauvolfia serpentina*),
- Haritaki (*Terminalia chebula*),
- Jay Ghash (C*ymbopogon osmastonii*),
- *Gastrodia zeylanica* and
- *Limnophila cana* (according to the *Red Data Book of Vascular Plants of Bangladesh* by Khan *et al.* 2001).

The bio-ecological zones between Jamuna and Padma (**Figure 5.1**) carry a number of threatened species of vertebrates (**Table 5.3**). Among them the Ganges River Dolphin is

most significant. The project influence area also supports a healthy population of this globally and nationally threatened species. A total of nine species of globally threatened vertebrate (wildlife) occur in the area. In terms of nationally threatened species, as many as 32 vertebrate wildlife and 22 freshwater fish are known to occur in the project influence area. For the threatened wildlife other than the Ganges River Dolphin, the population is either small or is supported only during winter periods such as migratory birds.

Table 5.3: Globally and Nationally Threatened Species of Vertebrates in Project Influence Area

Name of Species	Global Status	National Status
MAMMALS		
Ganges River Dolphin (*Platanista gangetica*)	Endangered	Endangered
Jackal (*Canis aureus*)	-	Vulnerable
Jungle Cat (*Felis chaus*)	-	Endangered
Fishing Cat (*Prionailurus viverrinus*)	Vulnerable	Endangered
Common Mongoose (*Herpestes edwardsi*)	-	Vulnerable
Common Palm Civet (*Paradoxurus hermaphroditus*)	-	Vulnerable
Large Indian Civet (*Viverra zibetha*)	-	Endangered
Small Indian Civet (*Viverra indica*)	-	Vulnerable
BIRDS		
Comb Duck (*Sarkidiornis melanotos*)	-	Critically Endangered
Brown Fish Owl (*Ketupa zeylonensis*)	-	Vulnerable
River Lapwing (*Vanellus duvaucelii*)	-	Endangered
Black-bellied Tern (*Sterna acuticauda*)	Vulnerable	Endangered
Darter (*Anhinga melanogaster*)	-	Vulnerable
Lesser Adjutant (*Leptoptilos javanicus*)	Vulnerable	Endangered
REPTILES		
Gharial (*Gavialis gangeticus*)	Endangered	Critically Endangered
Median Roofed Turtle (*Pangshura tentoria*)	-	Endangered
Indian Eyed Turtle (*Morenia petersi*)	Vulnerable	Vulnerable
Ganges Softshell Turtle (*Aspideretes gangeticus*)	Vulnerable	Endangered
Peacock Softshell Turtle (*Nilssonia hurum*)	Vulnerable	Endangered
Asiatic Softshell Turtle (*Chitra indica*)	Endangered	Critically Endangered
Spotted Flapshell Turtle (*Lissymis punctata*)	-	Vulnerable
Bengal Monitor (*Varanus bengalensis*)	-	Vulnerable
Yellow Monitor (*Varanus flavescens*)	-	Endangered
Common Vine Snake (*Ahaetulla nasutus*)	-	Vulnerable
Indian Rat Snake (*Ptyas mucosa*)	-	Vulnerable

Name of Species	Global Status	National Status
Common Wolf Snake (*Lycodon aulicus*)	-	Vulnerable
Common Krait (*Bungarus caeruleus*)	-	Endangered
Banded Krait (*Bungarus fasciatus*)	-	Endangered
Monocled Cobra (*Naja kaouthia*)	-	Vulnerable
Spectacled Cobra (*Naja naja*)	-	Endangered
AMPHIBIANS		
Ornate Microhylid (*Microhyla ornata*)	-	Vulnerable
FISH		
Humped Featherback (*Notopterus chitala*)	-	Endangered
Grey Featherback (*Notopterus notopterus*)	-	Vulnerable
Indian Grass Barb (*Chela laubuca*)	-	Endangered
Kalbasu (*Labeo calbasu*)	-	Endangered
Olive Barb (*Puntius sarana*)	-	Critically Endangered
Firefin Barb (*Puntius ticto*)	-	Vulnerable
Necktie Loach (*Botia dario*)	-	Endangered
Long-whiskered Catfish (*Aorichthys aor*)	-	Vulnerable
Giant River-catfish (*Aorichthys seenghala*)	-	Endangered
Assamese Batasio (*Batasio tengana*)	-	Endangered
Rita (*Rita rita*)	-	Critically Endangered
Pabdah Catfish (*Ompok pabda*)	-	Endangered
GaruaBacha (*Clupisoma garua*)	-	Critically Endangered
BatchwaBacha (*Eutropiichthys vacha*)	-	Critically Endangered
ShilondiaVacha (*Silonia silondia*)	-	Endangered
Pungas (*Pangasius pangasius*)	-	Critically Endangered
Gangetic Goonch (*Bagarius yarrellii*)	-	Critically Endangered
Elongate Grass-perchlet (*Chanda nama*)	-	Vulnerable
Indian Glassy Fish (*Pseudambassis ranga*)	-	Vulnerable
Mottled Nandus (*Nandus nandus*)	-	Vulnerable
Giant Snakehead (*Channa marulius*)	-	Endangered
Tire-track Spinyeel (*Mastacembalus armatus*)	-	Endangered

(Source: BirdLife International 2014, IUCN 2014, IUCN-Bangladesh 2000)

5.1.3. Critical Natural Habitats

In the project influence area there is no legal or officially proposed Protected Area. However there are some area with high conservation value uch as char land where migratory bird inhabit each year and some spot of Jamuna river where dolphin population

was found. Among the available habitats, however, the most notable are parts of the river (unpolluted, deep and rich in fish) that are hotspots (i.e. high density areas) for the Ganges River Dolphin and the uninhabited 'Char' lands that are the shelters of thousands of migratory winter birds and the nesting grounds of many resident birds like wild ducks and terns. Based on the field visits and on the FGDs in and around the project influence area, the high density areas for dolphins and winter birds were marked (**Figures 5.2** and **5.3**).

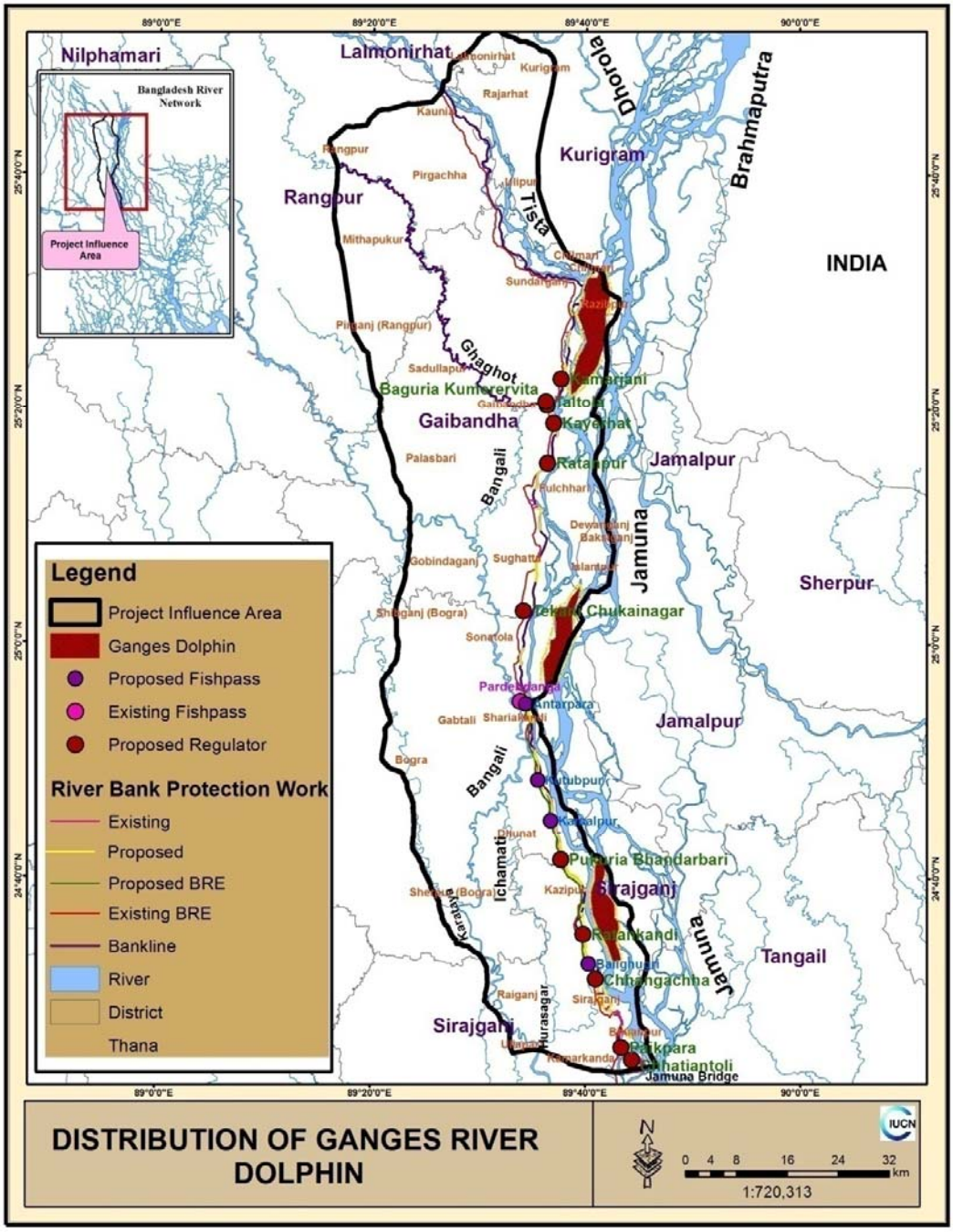


Figure 5.2: Distribution (i.e. high density areas) of Ganges River Dolphin in the Project Influence Area (marked with red shade).

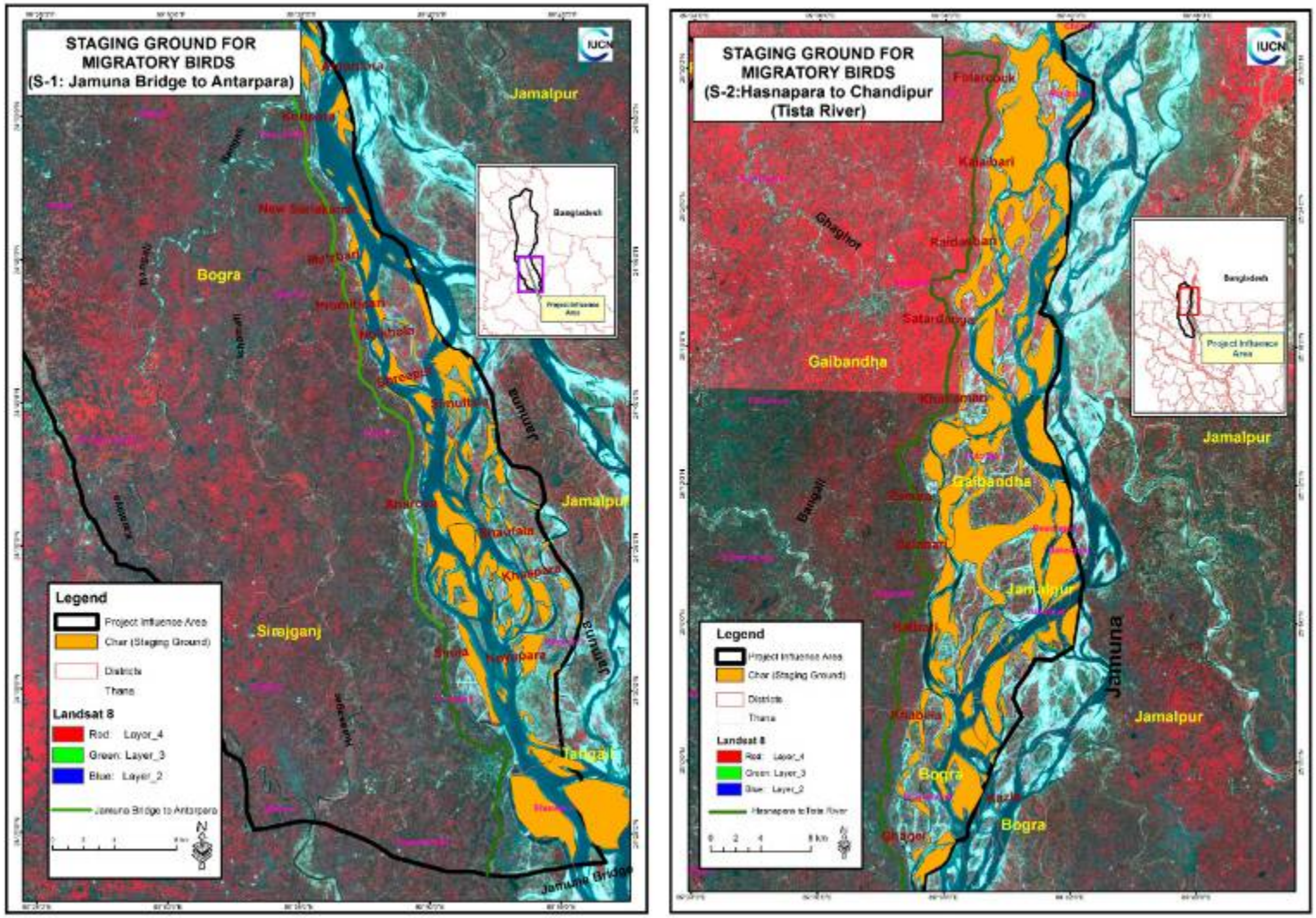


Figure 5.3: Wintering/Staging Grounds for Migratory Winter Birds in the Project Influence Area (marked with orange color)

5.2. Project influence area Ecosystems

Most of the project influence area is under some kind of human influence, because very high population pressure, which includes new settlements and expansion of agriculture even in remote 'Char' lands of the river. The total area of ecosystem in the project influence area is 268,466 ha, of which the agricultural land (about 53 percent) and the settlement (about 29 percent) are very dominant (see **Figure 3.15** and **Table 3.9**).

5.2.1. Human Influence

The people living in the project influence area exert high regressive influence on the surrounding ecosystems. Most of the people living in that area possess a sub-standard primitive life style. Their main source of livelihood is agriculture. Vast areas of stable and unstable floodplains have been subjected to the regression of tillage, mostly due to extensive agricultural activities. Such activities of the local people have seriously jeopardized the natural vegetation. There is no sign of natural succession, rather retrogation of the natural vegetation is commonly seen.

Since the unstable areas are subjected to frequent erosions, the local people do not plant any long rotation species in these areas. Very often fast growing species on a very short rotation cycle are planted in these areas. Commonly used species is Eucalyptus, which not only deplete the soil but also impairs the wildlife diversity, especially of the birds in the rural areas. Our FGDs and consultation meetings it transpired that the local people in the unstable zones has their choice for fast growing species whereas those in stable zones has their choice for long rotation horticultural species such as jackfruit and mango. Under this given scenario, the project may bring in opportunities of planting more of the long rotation species such as tamarind, mahogany, and may also induce 'social forestry' programs. Such type of initiatives is likely to help the local people to develop their socio economic condition and improve biodiversity as well. In the stable floodplains people build houses and plant long rotation horticultural and timber species.The planted horticultural species are used by people in many ways and allows small pockets of natural vegetation in the interspaces of the planted trees, particularly in the backyards of the homesteads.

5.2.2. Terrestrial Ecosystems

The terrestrial ecosystem in the project influence area is dynamic and is heavily influenced by the water flow of the mighty Brahmaputra-Jamuna River System. It is dominated by the agricultural landscape and homestead areas (see **Figures 5.4** and **5.5**), but there are also vast areas of Char lands that are covered by sungrass, reeds and other natural vegetation. Strong bond exists between the terrestrial and aquatic ecosystems through the food chain and the exchange of energy. The terrestrial ecosystems are often shaped and controlled by the flow of the river, and sometimes even engulfed by the riverbank erosion. In the terrestrial ecosystems all along the project influence area the proportional areas with canopy cover and the crop cover are inversely correlated (R^2 = -0.779) in all 12 Upazila of the project influence area (**Figure 5.6**). It indicates that the crop cover areas gradually convert into canopy cover, because canopy cover is seen in the permanent floodplains around human settlements. This is relatively a recent trend, probably due to the high demand of land for cultivation. Thus agriculture is getting extended even to the new fragile floodplains. These floodplains are mostly under agricultural use and tree planting is minimal.

Figure 5.4: Homestead Vegetation in the Project Influence Area

Figure 5.5: Agricultural land and Planted Exotic Eucalyptus Trees in the Project Influence Area

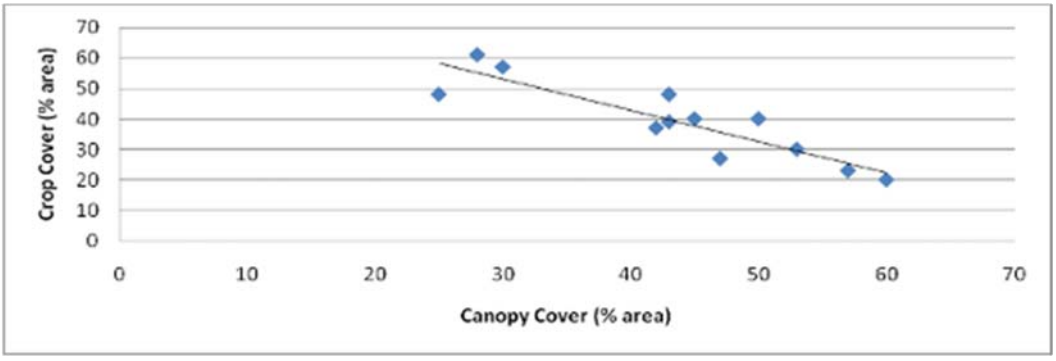


Figure 5.6: Strong Negative Linear Relationship between Canopy Cover and Crop Cover across 12 Upazila of the Project Influence Area

5.2.3. River-Charland-Wetland Ecosystems

The most important ecosystems in terms of biodiversity are the river-char-wetland ecosystems with natural vegetation and mudflats (see **Figure 5.7**) that support a wide variety of wildlife, particularly the migratory winter birds.

Figure 5.7: Charland Ecosystem in the Project Influence Area

River Ecosystem

The Jamuna River and its tributaries provide three important functions:

- Habitat for numerous species of vertebrates and invertebrates. Most of those species are found throughout Jamuna and also other rivers and floodplain systems in the country; for them the project influence area is not a critical biotope. For a number of endangered species, however, the area might have special value. Various fish breeding and nursing grounds are located close to the area. The fresh water aquatic ecosystem of Brahmaputra–Jamuna River and its tributaries are the lifeline of the Ganges River Dolphin and some threatened species of turtles (**Table 5.3**).
- Corridor for migratory species, including fish (to and from breeding and nursing grounds) and birds (using the river as migration guidance). For numerous non-migratory species the river systems provide an opportunity for survival of fragmented or isolated communities. The corridor function of rivers for plant seeds and spores is important as well.
- Production of harvestable organisms, mainly fish. The Jamuna is fished throughout the year by professional and temporary fishermen with a variety of gear.

Charland Ecosystem

Charlands (shoals) are newly accreted lands from river deposits. The Jamuna main channel is constantly shifting within its active floodplain, eroding and depositing large areas of new charland in each flooding season. If new charlands do not erode quickly, they are colonized by pioneer vegetation (especially *Crotolaria retusa, Phragmites karka, Saccharum spontaneum and Ipomoea sp.*). Dense growth of these tall grasses starts anchoring the loose deposits and accelerates further silt deposition. Subsequently, either natural succession (by other grasses, bushes and finally trees) or human activities result in development of habitable land. Details of charlands in the project influence area are given in **Section 3.3.2**. The ecological importance of these charlands is considerable; they provide:

- Habitat. Young, vegetated charlands form a major habitat for the Bangladeshi vertebrate fauna: mammals, birds, reptiles and amphibians. The areas are relatively free from noise and other disturbances, whereas the mixed vegetation and the large number of water bodies support a rich hunting, feeding and roosting habitat. A range of waterfowl, both local and migratory, are directly or ecologically dependent on charland ecosystems. In winter, migratory birds roam in these chars and some resident birds use these charlands as their breeding grounds. Charlands having less or no human interference harbor rich bird diversity. In the project influence area based on our FGD we found that 'charland' which is situated at least 10-12 km away from countryside harbor a good number of bird species, probably due to less human disturbances.
- Reproduction area. This represents the foremost ecological importance of charlands and their submerged extensions (wetlands and shallow riverine areas). Aquatic reptiles (among which the endangered turtles) lay their eggs in the sandy beaches, mostly between December and February. For many riverine fish and crustacean species the shallow submerged parts of the charlands are indispensable breeding and nursing grounds.
- Settlement and livelihood. Given the shortage of land in Bangladesh, stabilized charlands are quickly occupied by farmers and fishermen, profiting from the natural richness of these new and fertile lands.

5.3. Vegetation

The vegetation in the project influence area can be divided into planted and natural vegetation. The common tree species are 39 in number. They are commonly Eucalyptus, Acacia, Jackfruit, and Mango. The relative diversity of major plant species across 12 Upazila in the project influence area (based on samples taken) exhibits that four Upazilas (Sirajganj Sadar, Kazipur, Sariakandi and Gaibandha Sadar) possess higher tree diversity over the others (**Figure 5.8**). Based on the direct observations and FGDs, a total of 66 plant species were identified that are commonly seen, of which there are 39 trees, 24 herbs and shrubs, and 3 bamboo (**Table 5.4**). The relative abundance, out of the 36 species; 14 are Very Common, 14 Common, 8 Uncommon, and no Rare species.

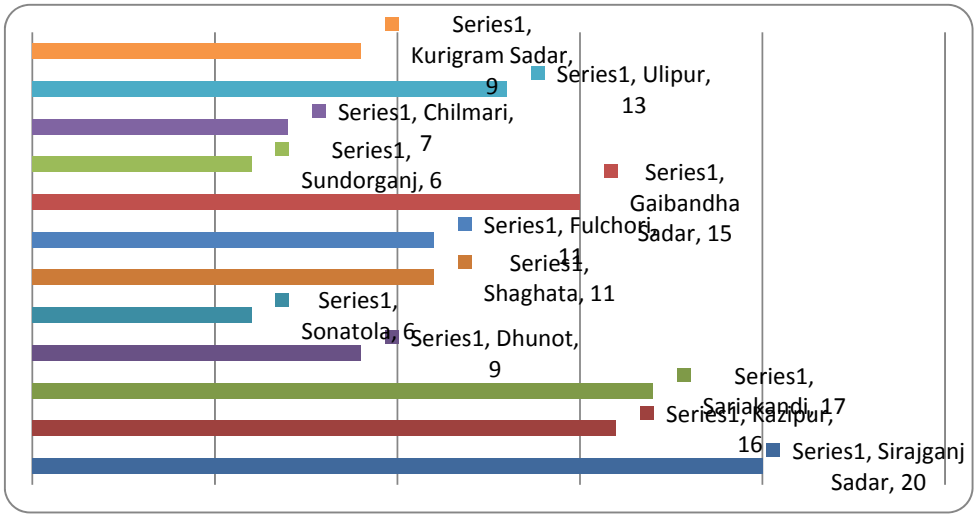


Figure 5.8: Relative Diversity of Major Plant Species across 12 Upazilas of the Project Influence Area (based on the presence of major plant species in quadrats)

Table 5.4: Occurrence of Common Flora across 12 Upazilas of the Project Influence Area (based on direct observation and FGD)

Local Name	Scientific Name	Status	SirajganjSadar	Kazipur	Sariakandi	Dhunot	Sonatola	Shaghata	Fulchori	Sundorganj	GaibandhaSadar	Ulipur	KurigramSadar	Chilmari
Tree														
Arjuna	*Terminalia arjuna*		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Amla	*Phyllanthus emblica*		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Ashoka	*Saraca indica*		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Australian Phyllode Acacia	*Acacia auriculiformis*	C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Baniyan Tree	*Ficus benghalensis*	C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Billeric Myrobalan	*Terminalia belerica*		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Black berry	*Syzygium cumini*	C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Chebulic Myrobalum	*Terminalia chebula*		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Eucalyptus	*Eucalyptus spp.*	V	o	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Gamar	*Gmelina arborea*	C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Golden Shower Tree	*Cassia fistula*	V	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Indian Coral Tree	*Erythrinavariegata*	U	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Indian Palm	*Ziziphus jujuba*	C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Jackfruit	*Artocarpus*	V	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Local Name	Scientific Name	Status	SirajganjSadar	Kazipur	Sariakandi	Dhunot	Sonatola	Shaghata	Fulchori	Sundorganj	GaibandhaSadar	Ulipur	KurigramSadar	Chilmari
	heterophyllus													
Jiga	*Lannea coromandelica*	V	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Kadamba	*Anthocephalusc hinensis*	V	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Khuksha (LN)	*Ficus hispida*	V	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Krishnachura (LN)	*Delonix regia*	C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Mahagoni	*Swietenia mahagoni*	C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Mangium	*Acacia mangium*	C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Mango	*Mangifera indica*	V	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Neem	*Azadirachta indica*	C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Olive	*Olea europaea*	C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Pipal	*Ficus religiosa*	U				✓	✓	✓	✓	✓	✓	✓	✓	✓
Rain tree	*Albizia saman*	C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Red Silk Cotton Tree	*Bombax ceiba*	C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Sugar Apple (Ata)	*Annona squamosa*	U	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Wild Mango/Hog Plum	*Spondia spinnata*	U	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Bael	*Aegle marmelos*	U	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓
Herbs and Shrubs														

Local Name	Scientific Name	Status	SirajganjSadar	Kazipur	Sariakandi	Dhunot	Sonatola	Shaghata	Fulchori	Sundorganj	GaibandhaSadar	Ulipur	KurigramSadar	Chilmari
Guava	*Psidium guava*	V	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Durba Grass	*Cynodon dactylon*	V	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Nol Grass	*Eriochloa procera*	C				✓	✓	✓	✓	✓	✓			
Common Basil	*Ocimum sanctum*		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Dhoincha	*Sesbania aculeata*	V	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Kashia grass	*Saccharum spontaneum*	V	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Jute	*Corchorus spp.*	V	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Coconut	*Cocos nucifera*	U	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Bajra Grass(LN)	*Pennisetum typhoides*	U	✓	✓	✓	✓	✓							
Napier Grass	*Pennisetum purpureum*	U			✓	✓	✓	✓	✓	✓				
Bamboo														
Makhla Bash (LN)	*Bambusa nutans*	V				✓	✓	✓	✓	✓	✓	✓	✓	✓
Tolla Bash (LN)	*Bambusa longispiculata*	C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Bora Bash (LN)	*Bambusa balcooa*	V	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

(Legend: V - Very common, C - Common, and U - Uncommon; i.e. relative abundance as recorded in the project influence area)

5.3.1. Terrestrial Vegetation

In the terrestrial ecosystems, the trees are normally found in the homesteads, settlements and along the embankment. The trees of different species were counted in the random quadrats in all the 12 Upazilas of the project influence area (**Figures 5.9** to **5.20**). It is evident that both the diversity and density of the tree species vary across 12 Upazilas. There are timber trees to meet the needs of timber and the fruiting trees to provide food, but there are many other trees that are used for various purposes. Some of them are used for medicinal and construction purposes. These tree and shrub species help people to meet their daily needs by providing fuel wood, and fruits. Among all these species Jackfruit is one of the most popular species because of its multi output. As this species provide fruit, fuel wood, fodder and timber as well. But it is less in number where flood is very frequent and land formation change in every year. Based on FGD it was found that the three main purposes of planted trees are fruit, firewood and timber production (**Figure 5.21**), but it slightly varies across the 12 Upazilas. In the open and uncultivated areas the plants that are normally seen are Binna Ghash (*Vetiveria zizanioides*), Kansh (*Saccharum spontaneum*), Chhan (*Impera tacylindrica*), Ghagra (*Xanthium indicum*), Ban Palang (*Rumexmeritimus*), Kolmi (*Ipomoea*spp.), and legumes.

In the agricultural fields, on the other hand, the common cultivated crops are paddy (*Oryza sativa*), wheat (*Triticum aestivum*), jute (*Corchoruscapsularis*), sugarcane (*Saccharumofficinarum*), potato (*Solanumtuberosum*), mustard (*Brassica campestris*), ground-nut (*Terminalia catappa*), pea (*Pisum sativum*) and a wide variety of seasonal vegetables. Wide variety of paddy is cultivated in different season, synchronizing with the water condition. More than one crop is cultivated in most of the agricultural fields. The fields might remain barren for short periods of time between the cropping seasons.

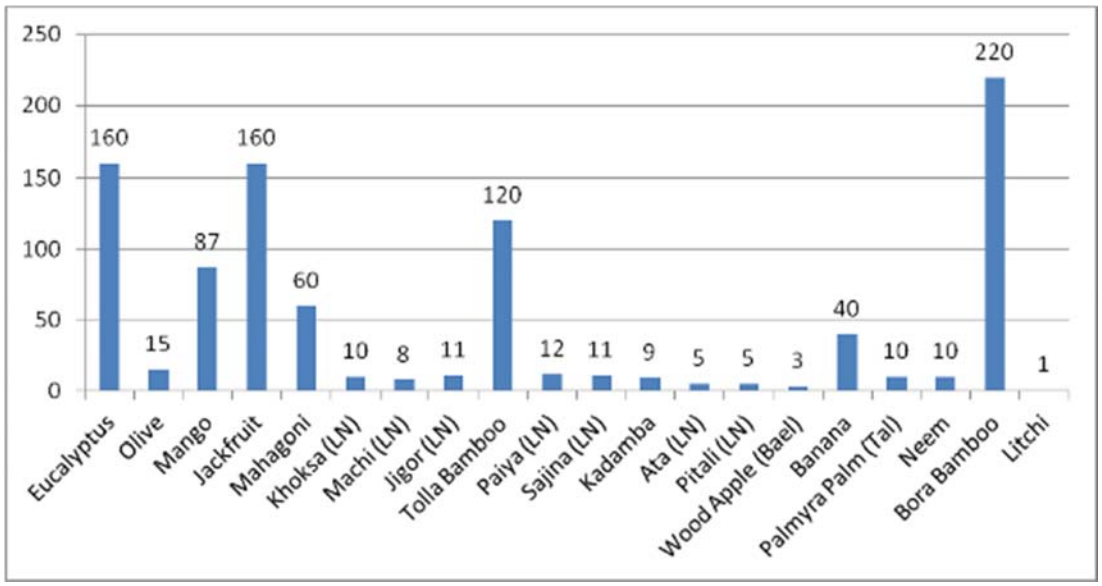


Figure 5.9: Frequencies of different major flora counted in five quadrats (100*100 m) in Sirajganj Sadar Upazila

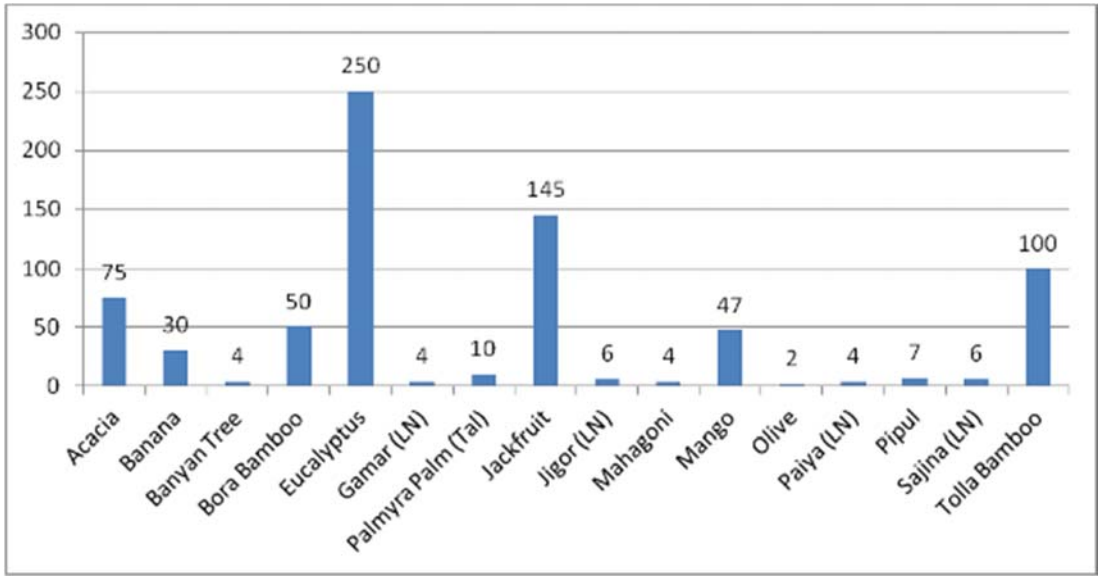


Figure 5.10: Frequencies of different major flora counted in five quadrats (100*100 m) in Kazipur Upazila

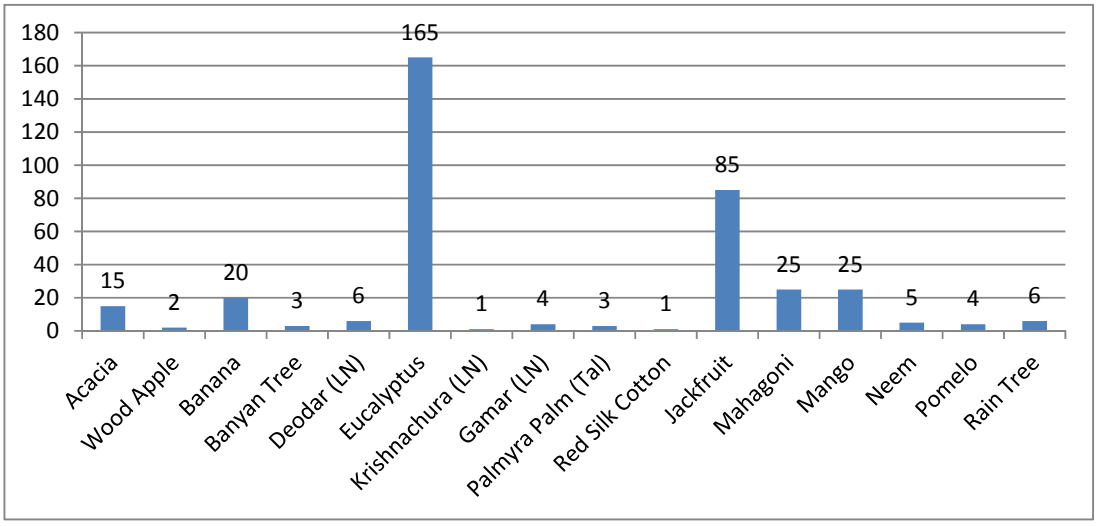


Figure 5.11: Frequencies of different major flora counted in four quadrats (100*100 m) in Sariakandi Upazila

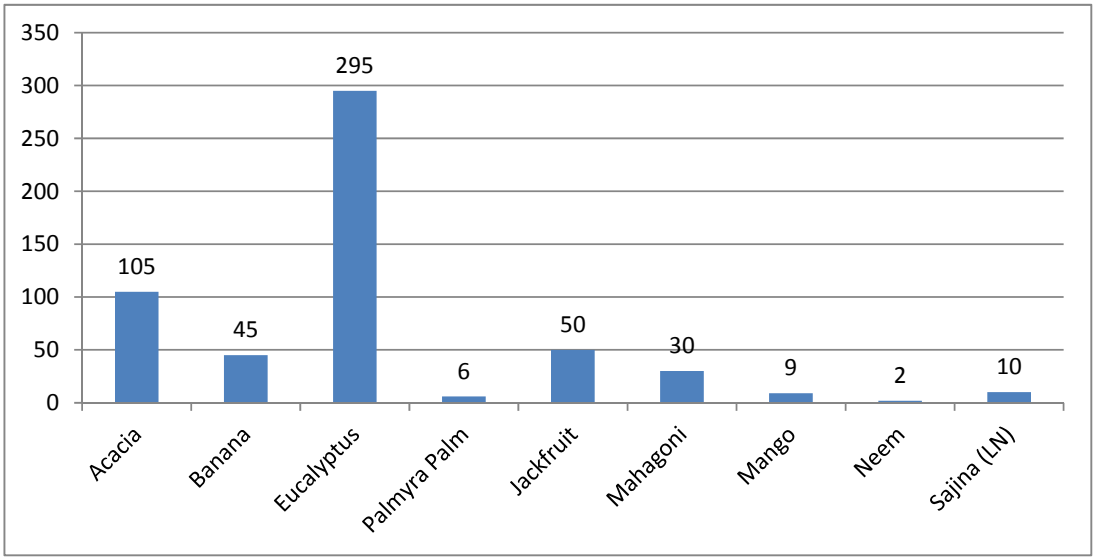


Figure 5.12: Frequencies of different major flora counted in three quadrats (100*100 m) in Dhunot Upazilla

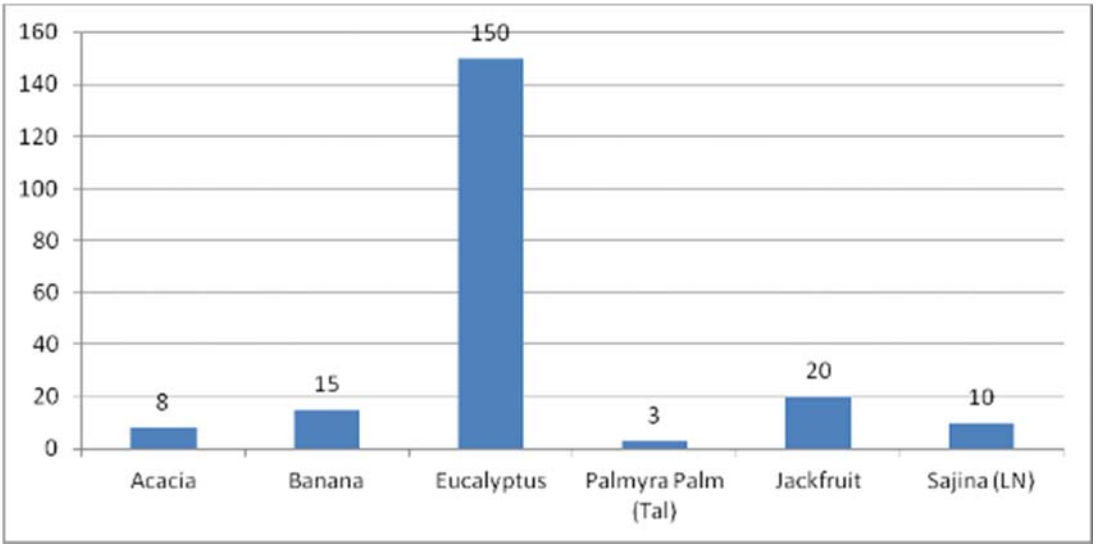


Figure 5.13: Frequencies of different major flora counted in one quadrat (100*100 m) in Sonatola Upazila

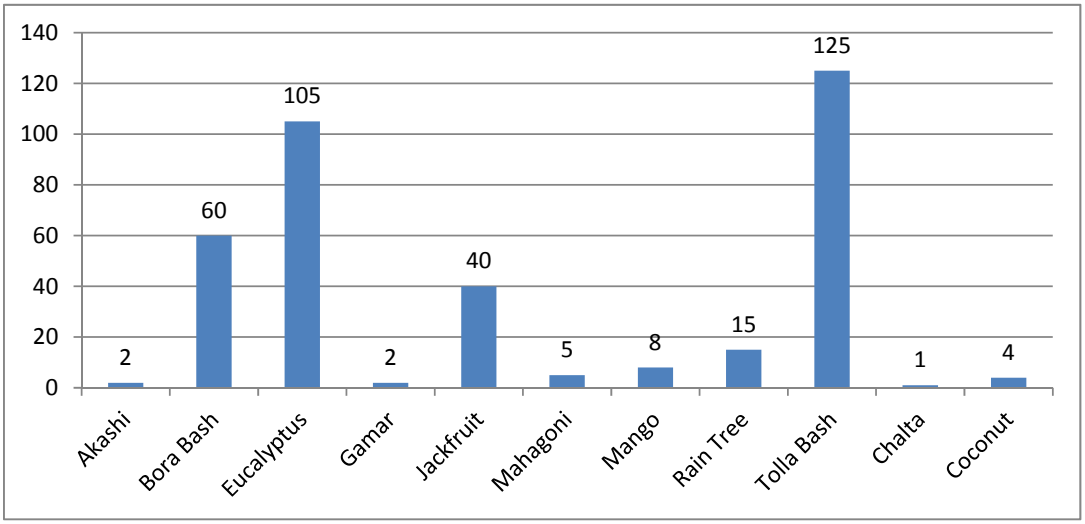


Figure 5.14: Frequencies of different major flora counted in two quadrats (100*100 m) in Shaghata Upazila

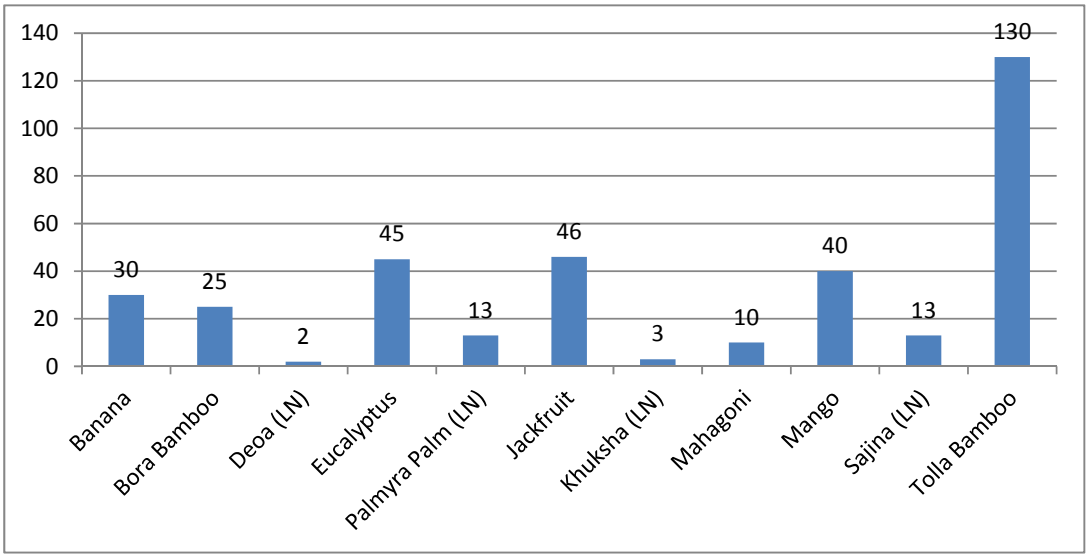


Figure 5.15: Frequencies of different major flora counted in two quadrats (100*100 m) in Fulchori Upazila

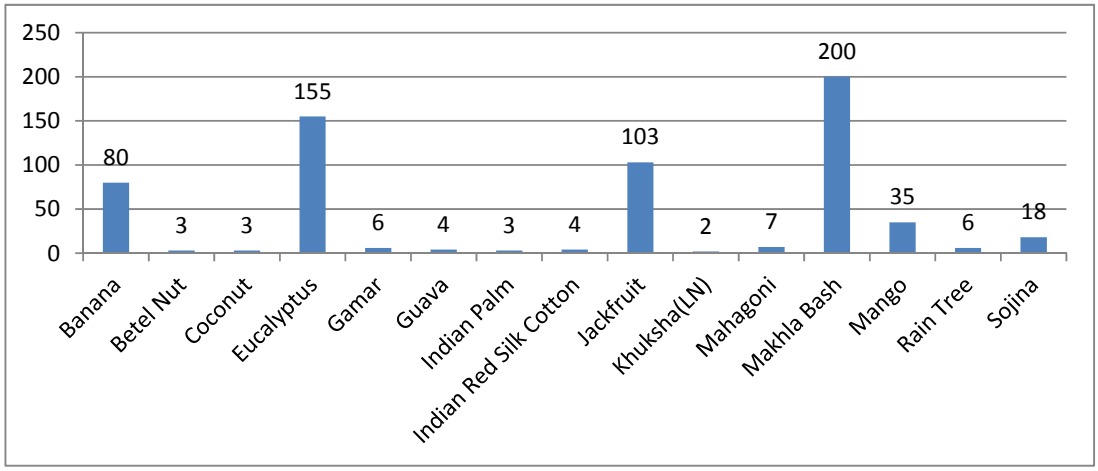


Figure 5.16: Frequencies of different major flora counted in four quadrats (100*100 m) in Gaibandha Sadar Upazila

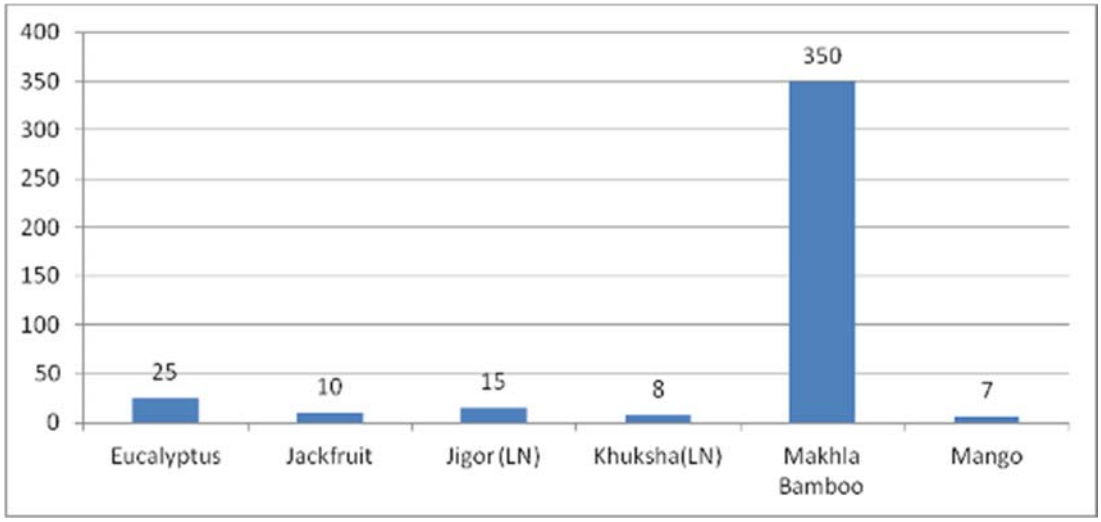


Figure 5.17: Frequencies of different major flora counted in one quadrat (100*100 m) in Sundarganj Upazila

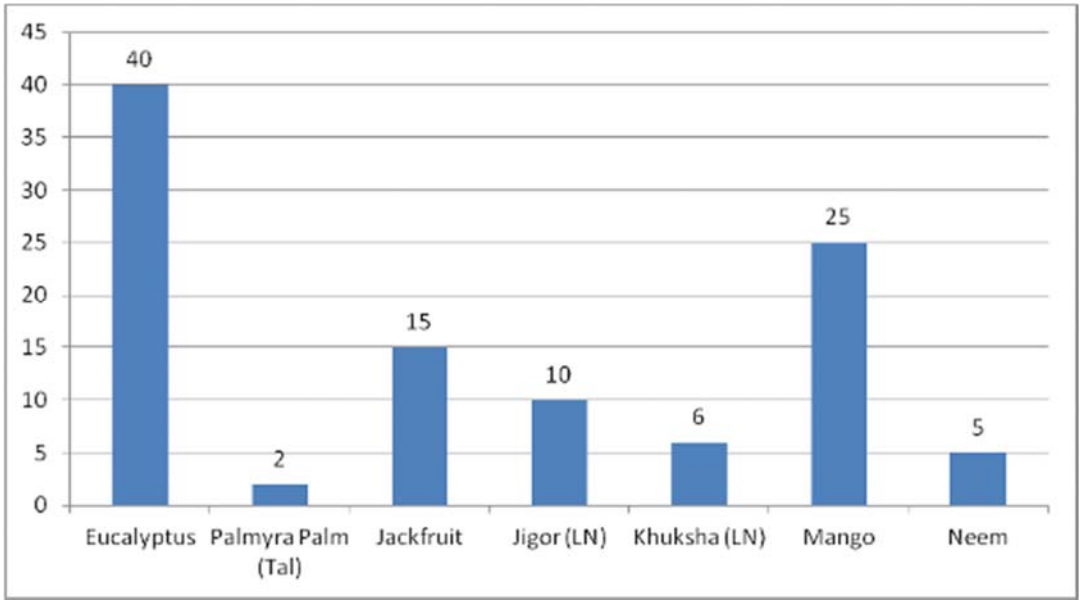


Figure 5.18: Frequencies of different major flora counted in one quadrat (100*100 m) in Chilmari Upazilla

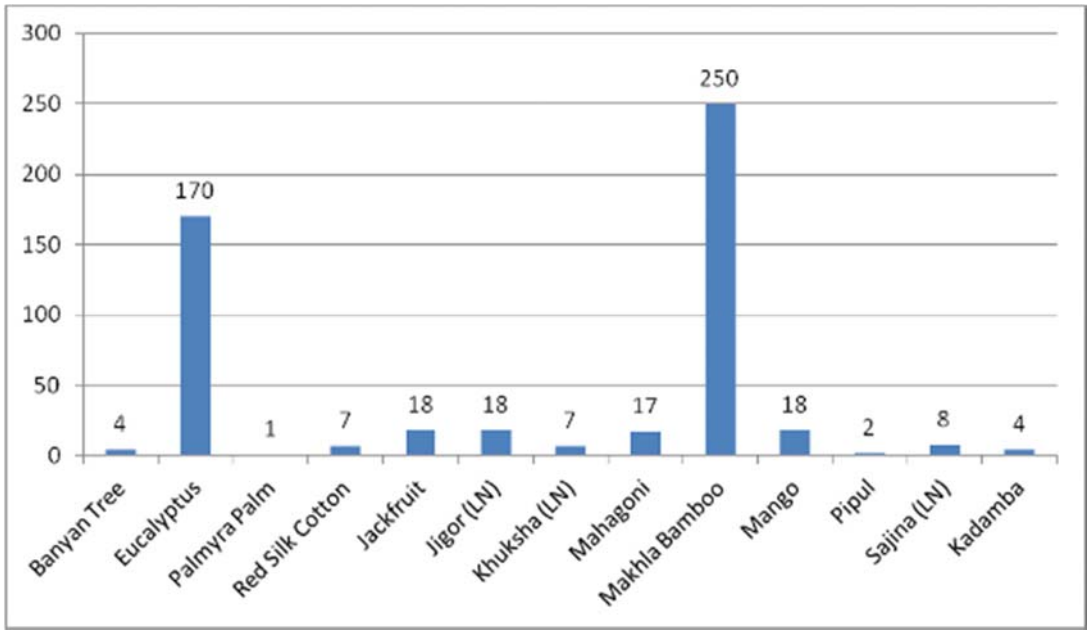


Figure 5.19: Frequencies of different major flora counted in two quadrats (100*100 m) in Ulipur Upazilla

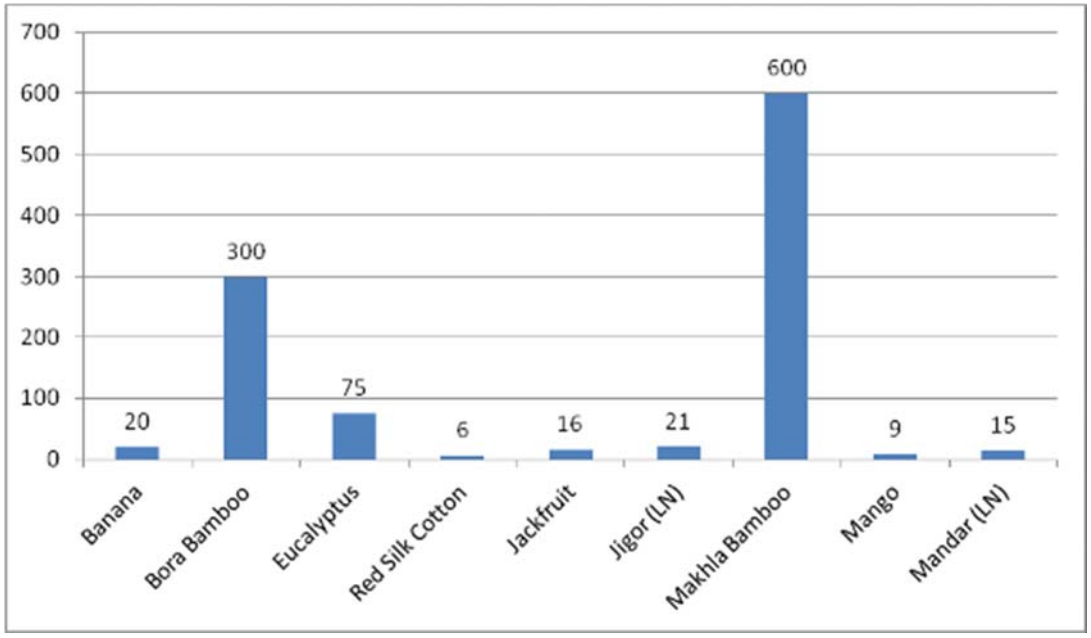


Figure 5.20: Frequencies of different major flora counted in two quadrats (100*100 m) in Kurigram Sadar Upazilla

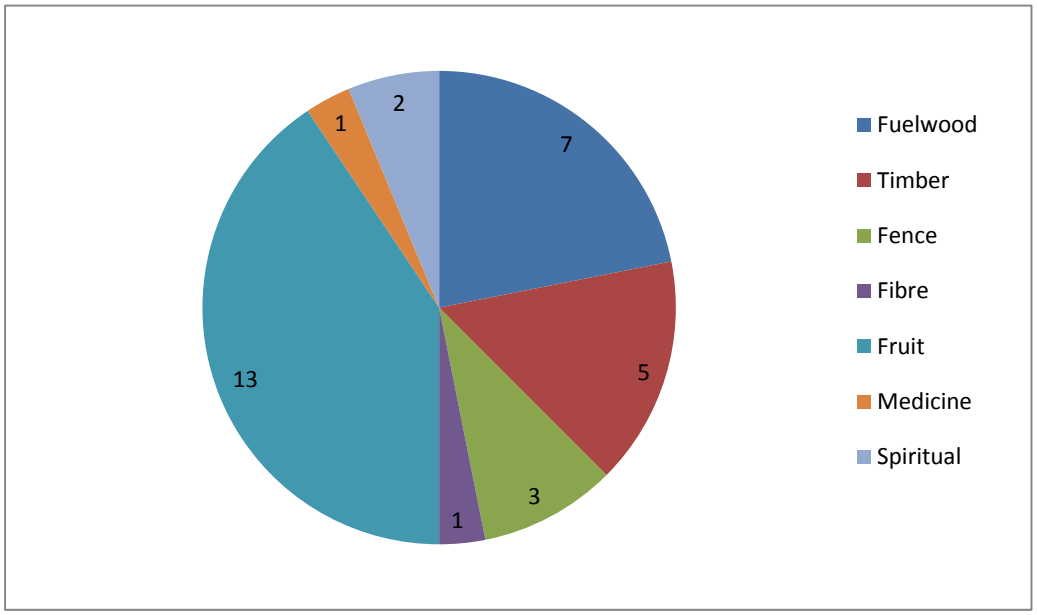


Figure 5.21: Principal uses of 33 major plants in the project influence area based on FGD

5.3.2. Aquatic Vegetation

The aquatic vegetation is mostly seasonal and is flourished when there is plenty of water during the wet season (see **Figure 5.22**). There is, however, some aquatic species like Hijal (*Barringtonia acutangula*) that are not seasonal and can survive during the dry

season as well. The common aquatic plants in the project influence area include Kachuripana (*Eichhornia crassipes*), Shada Shapla (*Nymphaea nouchali*), Panchuli (*Nymphoides indicum*), Singara (*Trapa bispinosa*) (Nishat *et al.* 1993, Nishat *et al.* 2002). Species like 'Kachuripana' grow well in the stable aquatic environment where water flow is less or absent. In the project influence area this species is very abundant in pond and lake. On the other hand, aquatic vegetation is absent in the mighty Jamuna-Brahmaputra River, but still there are some aquatic vegetation where water flow is less.

Figure 5.22: Aquatic Vegetation

5.3.3. Exotic Species

The two very common tree species in the project influence area are exotic species, viz. Acacia (*Acacia* spp.) and Eucalyptus (*Eucalyptus* spp.). These were introduced in the area and rapidly became popular, because these grow fast and can be harvested in several years. These are particularly popular in the charlands and riverbanks, because these areas are prone to erosion, so long-rotation trees are not preferred.

5.4. Wildlife

Diverse wildlife species, particularly birds, are known to occur in the project influence area. Based on the direct observation, FGD and secondary sources a total of 89 vertebrate wildlife species were identified that are commonly seen, including 7 amphibian, 11 reptile, 62 bird, and 9 mammal species (**Table 5.5**). The relative abundance shows that a total of 38 species are Very Common, 31 Common, 15 Uncommon, and 5 are Rare.

Table 5.5: List of Common Vertebrate Wildlife (Amphibians, Reptiles, Birds and Mammals) in the Project Influence Area (based on direct observation and FGD)

English Name	Scientific Name	Abundance Relative	Sirajganj Sadar	Kazipur	Sariakandi	Dhunot	Sonatola	Shaghata	Fulchori	Sundorganj	Gaibandha Sadar	Ulipur	Kurigram Sadar	Chilmari	IUCN Status	IUCN 2000
Amphibians																
Common Toad	*Duttaphrynus melanostictus*	V	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	LC	
Indian Bull Frog	*Hoplobatrachus tigerinus*	V	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	LC	
Common Tree Frog	*Polypedates leucomystax*	U	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	LC	
Ornate Microhylid Frog	*Microhyla ornata*	C	✓	✓					✓	✓	✓	✓	✓	✓	LC	VU
Leaping Frog	*Hylarana leptoglossa*	U	✓	✓	✓	✓						✓	✓	✓	LC	
Cricket Frog	*Fejervarya spp.*	V	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	LC	
Skipper Frog	*Euphlyctiscya nophlyctis*	V	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	LC	
Reptiles																
Yellow Monitor	*Varanus flavescens*	C	✓	✓		✓	✓	✓	✓	✓	✓	✓			LC	EN
Binocellate Cobra	*Naja naja*	R	✓	✓	✓										EN	EN
Peacock Softshell Turtle	*Nilssonia hurum*	R	✓	✓	✓	✓									VU	EN
Common	*Calotes*	V	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	LC	VU

English Name	Scientific Name	Abundance Relative	Sirajganj Sadar	Kazipur	Sariakandi	Dhunot	Sonatola	Shaghata	Fulchori	Sundorganj	Gaibandha Sadar	Ulipur	Kurigram Sadar	Chilmari	IUCN Status	IUCN 2000
Garden Lizard	*versicolor*															
Common Skink	*Eutropis carinata*	V	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	LC	VU
House Gecko	*Hemidactylus flaviviridis*	V	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Not Assessed	VU
Striped Keelback	*Amphiesma stolatatum*	V	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Not Assessed	
Checkered Keelback	*Xenochrophis piscator*	V	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Not Assessed	
Spotted Flapshell Turtle	*Lissemys punctata*	C	✓	✓	✓	✓	✓	✓	✓	✓					LC	VU
Bengal Monitor	*Varanus bengalensis*	U	✓	✓	✓	✓	✓	✓							LC	VU
Common Wolf Snake	*Lycodon aulicus*	C	✓	✓			✓		✓	✓	✓				LC	VU
Birds																
Bank Myna	*Acridotheres ginginianus*	V	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	LC	
Black Drongo	*Dicrurusmacrocercus*	V	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	LC	
Common kingfisher	*Alcedo atthis*	V	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	LC	
Lesser Goldenback	*Dinopium benghalense*	V	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	LC	
Lesser	*Dendrocygna*		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	LC	

English Name	Scientific Name	Abundance Relative	Sirajganj Sadar	Kazipur	Sariakandi	Dhunot	Sonatola	Shaghata	Fulchori	Sundorganj	Gaibandha Sadar	Ulipur	Kurigram Sadar	Chilmari	IUCN Status	IUCN 2000
Whistling Duck	*javanica*															
Little Black Comorant	*Phalacrocorax sulcirostris*	V	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	LC	
Little egret	*Egretta garzetta*	V	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	LC	
Oriental Magpie Robin	*Copsychus saularis*	V	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	LC	
Red-vented Bulbul	*Pycnonotus cafer*	V	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	LC	
Ruddy Shelduck	*Tadorna ferruginea*	V	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	LC	
Spot billed Duck	*Anas poecilorhyncha*	V	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	LC	
Spotted Dove	*Streptopelia chinensis*	V	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Not Assessed	
Striated Heron	*Butorides striata*	V	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	LC	
Wood Sandpiper	*Tringa glareola*	C	✓	✓				✓	✓	✓	✓				LC	
Fulvous Whistling Duck	*Dendrocygna bicolor*	C	✓	✓	✓	✓	✓	✓	✓	✓					LC	
Northern Pintail	*Anas acuta*	C	✓	✓	✓	✓	✓	✓	✓	✓					LC	
Gadwall	*Anas strepera*	C	✓	✓	✓	✓	✓	✓	✓	✓					LC	

English Name	Scientific Name	Abundance Relative	Sirajganj Sadar	Kazipur	Sariakandi	Dhunot	Sonatola	Shaghata	Fulchori	Sundorganj	Gaibandha Sadar	Ulipur	Kurigram Sadar	Chilmari	IUCN Status	IUCN 2000
Bar headed Goose	*Anse rindicus*	U	✓	✓	✓	✓	✓		✓	✓					LC	
Ferruginous Pochard	*Aythya nyroca*	C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	NT	
Red Crested Pochard	*Rhodonessa rufina*	V	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Not Assessed	
Common Shelduck	*Tadorna tadorna*	V	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	LC	
Greater Flameback	*Crysocolaptes lucidus*	V	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	LC	
Fuvous Breasted Woodpecker	*Dendrocopos macei*	V	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	LC	
Common Flameback	*Dinopium javanese*	V	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	LC	
Eurasian Wigeon	*Mareca penelope*	C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	LC	
Northern shoveler	*Spatula clypeata*	C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	LC	
Common Hoopoe	*Upupa epops*	U	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	LC	
Blue Throated Barbet	*Megalaima asiatica*	U	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	LC	
White Throated Kingfisher	*Halcyon smyrnensis*	V	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	LC	

English Name	Scientific Name	Abundance Relative	Sirajganj Sadar	Kazipur	Sariakandi	Dhunot	Sonatola	Shaghata	Fulchori	Sundorganj	Gaibandha Sadar	Ulipur	Kurigram Sadar	Chilmari	IUCN Status	IUCN 2000
Pied Kingfisher	*Megacery lelugubris*	C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	LC	
Blue Tailed Bee Eater	*Merops philippinus*	R	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	LC	
Asian Koel	*Eudynamys scolopaceus*	C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	LC	
Greater Coucal	*Centropus menbecki*	C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Not Assessed	
Eurasian Collard Dove	*Columba decaocto*	C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	LC	
Common Moorhen	*Gallinula chloropus*	U	✓	✓			✓	✓	✓	✓	✓				LC	
Purple Coot	*Porphyrio porphyrio*	V	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	LC	
Eurasian Coot	*Fulica atra*	V	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	LC	
Common Sandpiper	*Actitis hypoleucos*	C	✓	✓			✓	✓	✓	✓					LC	
Little Stint	*Calidris minuta*	U	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	LC	
Curlew Sandpiper	*Calidris ferruginea*	R						✓	✓	✓	✓				LC	
Bronze-winged Jacana	*Metopidius indicus*	C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	LC	
Pheasant-tailed Jacana	*Hydrophasianus chiurgus*	C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	LC	

English Name	Scientific Name	Abundance Relative	Sirajganj Sadar	Kazipur	Sariakandi	Dhunot	Sonatola	Shaghata	Fulchori	Sundorganj	Gaibandha Sadar	Ulipur	Kurigram Sadar	Chilmari	IUCN Status	IUCN 2000
River Lapwing	*Vanellus duvaucelii*	C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	NT	
Red-wattled Lapwing	*Moringa indica*	C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Not Assessed	
Common Black Headed Gull	*Larus ridibundus*	V	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	LC	
Whiskered Tern	*Chlidonias hybridus*	C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	LC	
Black Kite	*Milvus migrans*	C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	LC	
Brahminy Kite	*Haliastur Indus*	C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	LC	
Purple Heron	*Ardea purprea*	V	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	LC	
Indian Treepie	*Dendrocitta vagabunda*	V	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	LC	
Large-billed Crow	*Corvus macrohynchos*	V	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	LC	
Black-hooded Oriole	*Oriolus xanthornus*	V	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	LC	
House Sparrow	*Passer domesticus*	V	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	LC	
Purple Rumped Sunbird	*Leptocoma zeylonica*	U	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Not Assessed	
Purple	*Cinnyris*	U	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Not	

English Name	Scientific Name	Abundance Relative	Sirajganj Sadar	Kazipur	Sariakandi	Dhunot	Sonatola	Shaghata	Fulchori	Sundorganj	Gaibandha Sadar	Ulipur	Kurigram Sadar	Chilmari	IUCN Status	IUCN 2000
Sunbird	*asiaticus*														Assessed	
Zitting Cisticola	*Cisticola juncidis*	U	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	LC	
Eurasian Stone Chat	*Saxicola torquatus*	C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	LC	
Bluethroat	*Luscinia svecica*	C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	LC	
Bengal Bush Lark	*Mirafra assamica*	C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	LC	
Sand Lark	*Calandrella raytal*	R						✓	✓	✓	✓				LC	
Oriental Skylark	*Alauda gugula*	U	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	LC	
Paddyfield Pipit	*Anthus rufulus*	U	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	LC	
Citrine Wagtail	*Motacilla citreola*	C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	LC	
Mammals																
Ganges River Dolphin	*Platanistagan getica*	U	✓	✓	✓	✓	✓	✓	✓	✓					EN	EN
Golden Jackal	*Canis aureus*	V	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	LC	VU
Small Indian Mongoose	*Herpestes auropunctatus*	V	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Not Assessed	VU
Northern Palm Squirrel	*Funambulus pennantii*	C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	LC	
Greater	*Bandicota*	C	✓					✓	✓	✓	✓	✓	✓	✓	LC	

English Name	Scientific Name	Abundance Relative	Sirajganj Sadar	Kazipur	Sariakandi	Dhunot	Sonatola	Shaghata	Fulchori	Sundorganj	Gaibandha Sadar	Ulipur	Kurigram Sadar	Chilmari	IUCN Status	IUCN 2000
Bandicoot-rat	*indica*															
Asiatic long tailed climbing mouse	*Vandeleuria oleracea*	V	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	LC	
Jungle Cat	*Felis chaus*	U	✓						✓	✓	✓	✓	✓	✓	LC	
Greater Short Nosed Fruit Bat	*Cynopterus sphinx*	C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	LC	
Indian Flying Fox	*Pteropusgiganteus*	C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	LC	

[Legend: V - Very common, C - Common, U - Uncommon, and R - Rare; i.e. relative abundance as recorded in the project influence area]

Most of the wildlife species that were recorded in the project influence area were recorded in all Upazilas, but some species were recorded in a few Upazilas only. It is possible that all Upazilas have these species, but further surveys are required to confirm the Upazilla-wise records. Based on FGD in 12 Upazilas of the project influence area it was found that the relative diversities of vertebrate wildlife species vary across 12 Upazilas. The highest relative diversity was reported from Sariakandi Upazilla (see **Figure 5.23**).

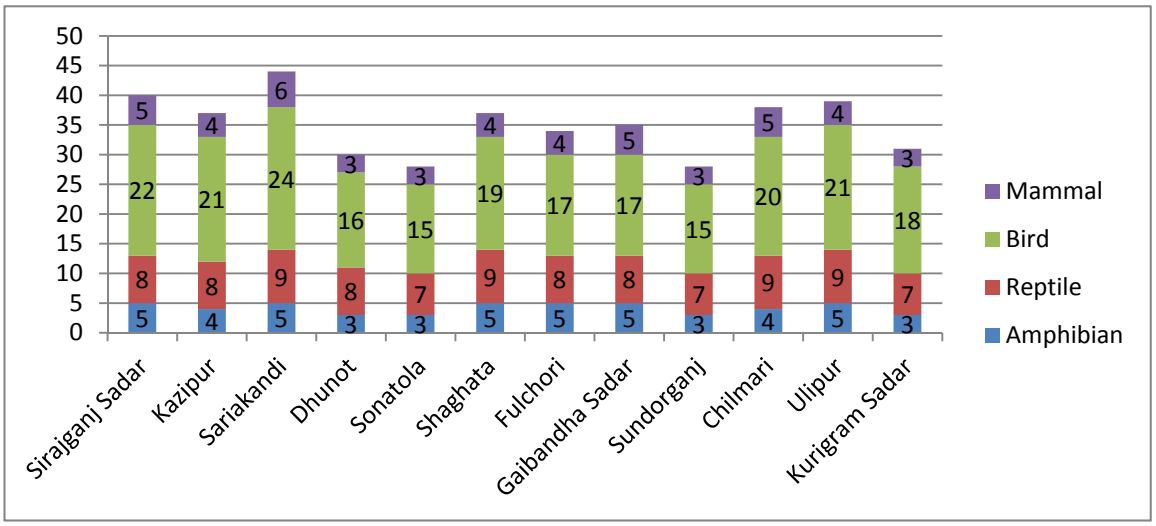


Figure 5.23: Relative Diversity of Common Vertebrate Species across 12 Upazilas of the Project Influence Area (based on FGD)

5.4.1. Mammals

The mammalian species diversity and density are relatively low in the project influence area, because a large proportion of the area is wetlands of some kind that are not suitable for terrestrial mammals. The mammals that occur in and around wetlands are common and widespread. A total of 25 species of mammal are known to occur in the project influence area (**Table 5.6**). The most notable is the Ganges River Dolphin that occurs all along Brahmaputra River, including the major tributaries, but there are some hotspots where it is more common (**Figure 5.2**) (CARINAM 2011, FHRC 2013). Discussions during the FGDs have revealed that the dolphin number is declining due to accidental death to fishing nets, human disturbance and pollution.

Other common mammals of the area are Small Indian Mongoose (Herpestes auropunctatus), Golden Jackal aureus), Indian Flying Fox (Pteropus giganteus), Jungle Cat (Felis chaus), Asian Palm Civet (Paradoxurushermaphroditus), and many species of rats and mice. Ganges River Dolphin (Platanista gangetica; global status: Endangered) is also abundant in some specific location. Some of the above-mentioned mammals occasionally hunt the domestic chicken and duck, and are often killed by angry villagers. Therefore, their population trends are showing the signs of decline.

Table 5.6: Mammals that are Known to Occur in the Project Influence Area (based on Primary and Secondary Information)

	Taxon and Scientific Name	English Name	Local Name	Status
	ORDER: RODENTIA Family: Sciuridae			
1	*Funambulus pennantii*	Northern Palm Squirrel	Dora Kathbirali	V
	Family: Muridae			
2	*Bandicota bengalensis*	Lesser Bandicoot-Rat	Dhari/Baro Idur	V
3	*Bandicota indica*	Greater Bandicoot-Rat	Dhari/Baro Idur	V
4	*Mus booduga*	Little Indian Field Mouse	Metho Idur	V
5	*Mus musculus*	Eastern House Mouse	Nengti Idur	V
6	*Rattus rattus*	House Rat	Idur	V
7	*Vandeleuria oleracea*	Asiatic Long-tailed Climbing Mouse	Gecho Idur	V
	ORDER: CARNIVORA Family: Viverridae			
8	*Paguma larvata*	Masked Palm Civet	Boishne Ula	U
9	*Paradoxurus hermaphroditus*	Asian Palm Civet	Gandhagakul, Nongar, Shairel, Hailla	C
10	*Viverra zibetha*	Large Indian Civet	Baro Bagdash, Huicha	C
11	*Viverricula indica*	Small Indian Civet	Choto Baghailla	C
	Family: Felidae			
12	*Felis chaus*	Jungle Cat	Ban Biral, Wap	V
13	*Felis viverrina*	Fishing Cat	Mecho Biral/Bagh, Baghailla, Dash Bagh	C (VU)
	Family: Herpestidae			
14	*Herpestes auropunctatus*	Small Indian Mongoose	Choto Benji, Nakul	V
15	*Herpestes edwardsii*	Indian Gray Mongoose	Baro Benji	C
	Family: Canidae			
16	*Canis aureus*	Golden Jackal	Shial, Shial Pandit, Feuwa	V
	ORDER: SORICOMORPHA Family: Soricidae			
17	*Suncus murinus*	Asian House Shrew	Chika, Chhucho	V
	ORDER: CHIROPTERA Family: Pteropodidae			
18	*Cynopterus sphinx*	Greater Short-nosed Fruit Bat	Kola Badur	V
19	*Pteropus giganteus*	Indian Flying Fox	Baro Badur	V
20	*Rousettus leschenaultia*	Leschenault's Rousette	Kola Badur	V
	Family: Megadermatidae			
21	*Megaderma lyra*	Greater False Vampire	-	C

	Taxon and Scientific Name	English Name	Local Name	Status
		Bat		
	Family: Vespertilionidae			
22	*Pipistrellus coromandra*	Indian Pipistrelle	Cham Badur, Chamchika	V
23	*Scotophilus heathi*	Greater Asiatic Yellow Bat	-	R
24	*Scotophilus kuhlii*	Lesser Asiatic Yellow Bat	-	R
	ORDER: CETE Family: Platanistidae			
25	*Platanista gangetica*	Ganges River Dolphin	Nadir Shushuk/Shishu, Hucchum	V (EN)

V: Very Common; C: Common; U: Uncommon; R: Rare; CR: Critically Endangered globally; EN: Endangered globally; VU: Vulnerable globally.

Ganges River Dolphin

The most notable species of the project influence area which is globally considered as threatened species. This species (**Figure5.24**) is available in Ganga-Brahmaputra River system. In project influence area the species is frequently found in some point of Sirajganj, Bogra and Kurigram. Snout is long thinned; belly is rounded with large flippers. This species uses its eyes to locate object though it has no lens. It cannot breathe in water and surface every 30-120 seconds for breathing. Female is larger than males. Female attain sexual maturity at the age of ten. The Ganges River Dolphin will breed in a similar way to other dolphins, which includes breeding during the beginning of the year, and remaining pregnant for an average of 10 – 12 months. The diet includes a variety of fish and invertebrates. Globally, the number of their population is ranged from 1200-1800.

FGD and Field survey were conducted to assess the distribution and status of Ganges River Dolphin. FGD was conducted during August-September and the vessel-based dolphin survey was conducted in November, 2014 as this is the period of minimum river discharge when dolphins are easiest to count within the project time. Survey was started from Sirajganj Hard Point, Sirajganj to Antarpara, Bogra. The survey was conducted within the priority area. 50 collinear transects of 1 km was established to cover river width and sampled the area as followed by Bashir *et al.* 2010. A motor boat with a constant speed between 6-9 km/hour was maintained in upstream and downstream direction following the deepest channel with a zig-zag pattern from bank to bank. A boat-based line-transect method as described by Smith & Reeves, 2000b and Kreb & Budiono, 2005 was adopted in which transects were sampled by five observers at a time with three Primary Observers stationed with different direction (right, left and front), one data recorder and one rear observer (observing 180^0 behind the survey vessel). Positions of observers were rotated every 30 minutes to avoid fatigue.

Figure 5.24: Ganges River Dolphin

At the time of each sighting, GPS location, time, and age category (e.g. adults, calves) of the individual was recorded. Survey track and location of dolphin was plotted in the GIS map. A dolphin group was defined as dolphins no more than 2 km apart, within an area of similar hydrological characteristics. Group sizes were evaluated with a best, high and low estimate of numbers to incorporate a degree of uncertainty. A low and best estimate of zero was used if the sighting was unconfirmed or if there was a possibility that the dolphin was following the vessel and might have already been counted. A 15 minute stoppage was made in areas of high dolphin abundance to make a more accurate group size estimate. All sightings were confirmed by a second observer. The observers took extreme care to eliminate repeated dolphin counts considering their spatio-temporal array and beak morphology (Mohan *et al*., 1997).

The survey was conducted dual times to get the accurate data on the abundance and group size of Ganges River dolphin. On first survey the vessel based dolphin survey was conducted towards upstream direction and on the second survey it was conducted towards downstream direction.

The entire 50 km of priority area was surveyed, though we started our survey from Sirajganj Hard Point which in outside of priority area. A total of 19 dolphins were encountered in the field survey considering their three groups.

A zone (Transect-3) from Kutubpur to Bhandarbari (24°48'16.80"N to 24°43'30.66"N and 89°35'54.53"E to 89°37'28.63"E) was found with high abundance of dolphin population which is 3 dolphins per km (see **Table 5.7, Figures 5.2** and **5.25**). About 64 percent of total dolphin population was encountered from this zone. On the other hand, dolphin population was very low in Transect-1 which is ranging from Shubgacha to Pachthakuri under Sirajganj District. In general, the encounter rate of Ganges River Dolphin in the project influence area is 0.38 dolphin per km.

Table 5.7: Distribution of Ganges River Dolphins in the Jamuna River

Location	GPS Cordinate	No. of Dolphin			Total	Transect Length (km)	Encounter Rate (dolphin/km)	Average Distance from proposed Alignment (km)
		Adults	Calves	Total				
Transect-1: Shubgacha to Pachthakuri (District: Sirajganj)	24.54406N-89.68383E	1	0	2	19	4	0.5	0.9
	24.54542-89.68214	1	0					
Transect-2: Meghai (District: Sirajganj)	24.66419N-89.65692E	1	0	5		4	1.25	1.2
	24.66142N-89.65692E	2	1					
	24.66419N-89.6575E	1	0					
Transect-3: Kutubpur to Bhandarbari (District: Bogra)	24.78267N-89.60917E	1	0	12		4	3	1.4
	24.785N-89.60775E	2	1					
	24.79718N-89.60211E	2	1					
	24.79983N-89.59967E	2	0					
	24.80092N-89.59917E	1	0					
	24.79826N-89.60109E	2	0					

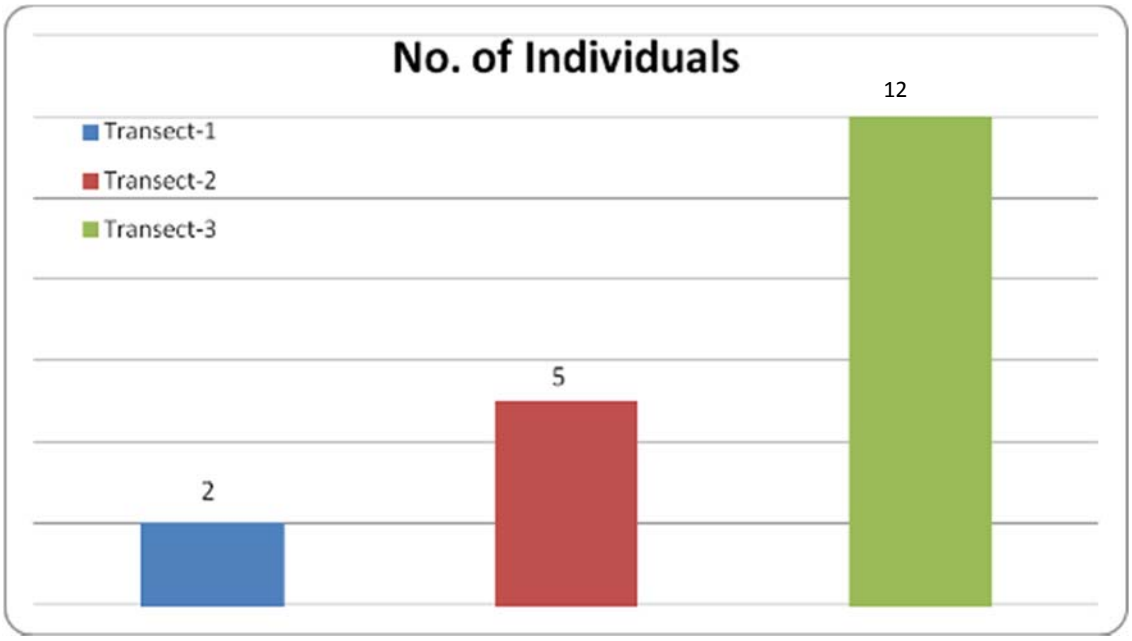


Figure 5.25: Relative Abundance of Ganges River Dolphin in Three Transects

5.4.2. Birds

Huge congregation of migratory winter birds can be seen during November-March in the floodplains of Brahmaputra River (see **Figure 5.26**). Winter birds from the Himalayas, Central Asian highlands and faraway places like Siberia move to relatively warm swampy lands in Bangladesh including the project influence area to escape the freezing cold, and feed on various animal and plant food that are abundant in the mudflats, sandflats, rice fields and other areas. Birds start arriving from early November and stay till March-April. An estimated 500,000 birds of about 150 species (mainly ducks, waders and warblers) travel to Bangladesh each winter.

Figure 5.26: Flock of Water Birds

A total of 255 species of bird are known to occur in the project influence area (see Table 5.8), of which a significant proportion is migratory winter birds. Some common migratory species include Ruddy Shelduck (Tadorna ferruginea), Northern Pintail (Anas acuta), Gadwall (Anas strepera), Common Sandpiper (Actitis hypoleucos), Wood Sandpiper (Tringa glareola), and Little Stint (Calidris minuta) (**Tables 5.8** and **5.9**). Wide variety of breeding resident birds also occur in the aquatic and terrestrial ecosystems of the project influence area, viz. Lesser Whistling Duck (Dendrocygna javanica), Little Egret (Egretta garzetta), Pied Kingfisher (Megaceryle lugubris), Sand Lark (Calandrella raytal), Zitting Cisticola (Cisticola juncidis), Black Drongo (Dicrurus macrocercus), Oriental Magpie Robin (Copsychus saularis), Red-vented Bulbul (Pycnonotus cafer), Spotted Dove (Streptopelia chinensis), Large-billed Crow (Corvus macrorhynchos) and House Sparrow (Passer domesticus), and Whiskered Tern (Chlidonias hybridus) (see **Figure 5.27**), (Source: transect data and Asian Waterbird Census 2014). The FGD in the project influence area recorded that all ducks and geese, whether winter visitor or breeding resident, were showing decling trend due to illegal hunting for meat.

Table 5.8: Birds of the Project influence area (based on primary and secondary information)

	Taxon and Scientific Name	English Name	Local Name	Status
	ORDER: GALLIFORMES Family: Phasianidae			
1	*Coturnix coturnix*	Common Quail	Botera	R, w
	ORDER: ANSERIFORMES Family: Dendrocygnidae			
2	*Dendrocygna bicolor*	Fulvous Whistling-duck	Baro Sarali Hans, Forali Hans	C, r
3	*Dendrocygna javanica*	Lesser Whistling-duck	Choto Sarali Hans, Shingali Hans	V, r
	Family: Anatidae			
4	*Anas acuta*	Northern Pintail	Lenja Hans	V, w
5	*Anas clypeata*	Northern Shoveler	Chamosthuti/ Kodailla/Pantamukhi Hans	V, w
6	*Anas crecca*	Common Teal	Patari/Sonadigheri/Peri Hans	V, w
7	*Anas Penelope*	Eurasian Wigeon	Lalshir/Dubrakhauri Hans	V, w
8	*Anas platyrhynchos*	Mallard	Boiragi/Nilshir Hans	C, w
9	*Anas poecilorhyncha*	Spot-billed Duck	Pati/Metey Hans, Metey Digheri	V, r
10	*Anas querquedula*	Garganey	Nairoli/Giria/Itaperi Hans	V, w

	Taxon and Scientific Name	English Name	Local Name	Status
11	*Anas strepera*	Gadwall	Piong Hans	V, w
12	*Anser anser*	Graylag Goose	Chaia/Kadombo Rajhans	U, w
13	*Anser indicus*	Bar-headed Goose	Kor Rajhans	U, w
14	*Aythya baeri*	Baer's Pochard	-	U (VU), w
15	*Aythya ferina*	Common Pochard	-	C, w
16	*Aythya fuligula*	Tufted Duck	Kali/Bamunia Hans	V, w
17	*Aythya nyroca*	Ferruginous Pochard	Bhuti Hans	C, w
18	*Netta rufina*	Red-crested Pochard	Moulvi/Rangamuri/Hero Hans	C, w
19	*Nettapus coromandelianus*	Cotton Pygmy-goose	Bejori/Bali/Alakadra Hans, Bherar Dhosh	C, r
20	*Sarkidiornis melanotos*	Comb Duck	Nakkua/Nakta/Bocha Hans	U, r
21	*Tadorna ferruginea*	Ruddy Shelduck	Lal Chokha	V, w
22	*Tadorna tadorna*	Common Shelduck	Shah Chokha	V, w
	ORDER: TURNICIFORMES Family: Turnicidae			
23	*Turnix suscitator*	Barred Buttonquail	Gulu, Nagor Batoi	C, r
24	*Turnix tanki*	Yellow-legged Buttonquail	-	R, w
	ORDER: PICIFORMES Family: Picidae			
25	*Celeus brachyurus*	Rufous Woodpecker	Lal Kaththokra	V, r
26	*Chrysocolaptes lucidus*	Greater Flameback	-	V, r
27	*Dendrocopos macei*	Fulvous-breasted Woodpecker	Jarad Kaththokra	V, r
28	*Dinopium benghalense*	Black-rumped Flameback	Sonali Kaththokra/Kathkhutalu/Kurailla	V, r
29	*Jynx torquilla*	Eurasian Wryneck	-	C, w
30	*Picus canus*	Gray-headed Woodpecker	Sabuj Kaththokra	C, r
31	*Picus chlorolophus*	Lesser Yellownape	-	U, r
31	*Picus xanthopygaeus*	Streak-throated Woodpecker	-	C, r
	Family: Megalaimidae			

	Taxon and Scientific Name	English Name	Local Name	Status
32	*Megalaima asiatica*	Blue-throated Barbet	Dhonia/Beghbou Basantabouri	V, r
33	*Megalaima haemacephala*	Coppersmith Barbet	Choto Basantabouri/Amtota	V, r
34	*Megalaima lineate*	Lineated Barbet	Baro/Gorkhod/Beghbou/Kutlush Basantabouri/Amtota	V, r
	ORDER: UPUPIFORMES Family: Upupidae			
35	*Upupa epops*	Common Hoopoe	Hudhud, Adud/Kup/Solaiman Pakhi, Mohonchura	V, w
	ORDER: CORACIIFORMES Family: Coraciidae			
36	*Coracias benghalensis*	Indian Roller	Nilkantha, Chhatkaia, Tauwa, Thormocha, Kewa	V, r
	Family: Alcedinidae			
37	*Alcedo atthis*	Common Kingfisher	Tit/Talghaira Machranga	V, r
	Family: Halcyonidae			
38	*Halcyon smyrnensis*	White-throated Kingfisher	Sadabuk Machranga	V, r
	Family: Cerylidae			
39	*Ceryle rudis*	Pied Kingfisher	Korikata/Sada Machranga	C, r
	Family: Meropidae			
40	*Merops orientalis*	Green Bee-eater	Suichora, Banshpati, Pok Khaori	V, r
41	*Merops philippinus*	Blue-tailed Bee-eater	-	V, s
	ORDER: CUCULIFORMES Family: Cuculidae			
42	*Cacomantis merulinus*	Plaintive Cuckoo	Sorgom	V, r
43	*Clamator jacobinus*	Pied Cuckoo	Papiya	V, s
44	*Cuculus micropterus*	Indian Cuckoo	Bou-kotha-kou	V, s
45	*Eudynamys scolopacea*	Asian Koel	Kokil, Kokil	V, r
46	*Hierococcyx varius*	Common Hawk Cuckoo	Chokhgelo	V, r

	Taxon and Scientific Name	English Name	Local Name	Status
	Family: Centropodidae			
47	*Centropus sinensis*	Greater Coucal	Baro Kanakukka/Kanakukhra/Kukka/Moukol/Harikuri	V, r
	ORDER: PSITTACIFORMES Family: Psittacidae			
48	*Psittacula krameri*	Rose-ringed Parakeet	Teya	V, r
49	*Psittacula roseate*	Blossom-headed Parakeet	Koiridi Teya	R?, r
	ORDER: APODIFORMES Family: Apodidae			
50	*Apus affinis*	House Swift	Chatok, Batashi	V, r
51	*Cypsiurus balasiensis*	Asian Palm Swift	Talchata, Talchorai, Nak-kati	V, r
	ORDER: STRIGIFORMES Family: Tytonidae			
52	*Tyto alba*	Barn Owl	Laxmi Pencha	V, r
	Family: Strigidae			
53	*Asio flammeus*	Short-eared Owl	-	R, w
54	*Athene brama*	Spotted Owlet	Khuruley Pencha	V, r
55	*Bubo coromandus*	Dusky Eagle Owl	-	R, r
56	*Glaucidium cuculoides*	Asian Barred Owlet	-	V, r
57	*Ketupa zeylonensis*	Brown Fish Owl	Bhutum /Hutum/Kudum Pencha	C, r
58	*Ninox scutulata*	Brown Hawk Owl	Ku/Kal Pencha, Ku-pokh	V, r
59	*Otus bakkamoena*	Collared Scops Owl	Nim Pencha, Nim-pokh	C, r
	Family: Caprimulgidae			
60	*Caprimulgus macrurus*	Large-tailed Nightjar	Banshkopani Ratchora/ Dinekana, Metey Pencha, Char Pencha	V, r
	Order: Columbiformes Family: Columbidae			
61	*Chalcophaps indica*	Emerald Dove	Sabuj/Bansh/Raj/Chaiar Ghughu	V, r

	Taxon and Scientific Name	English Name	Local Name	Status
62	*Columba livia*	Rock Pigeon	Jalali/Jongla Kobutar	V, r
63	*Ducula aenea*	Green Imperial Pigeon	Dhumkol, Haissol	U, r
64	*Streptopelia chinensis*	Spotted Dove	Tila/Boron/Pachori/Sit Ghughu/Dufy, Teddykol	V, r
65	*Streptopelia decaocto*	Eurasian Collared Dove	Mala/Doila/Dhola Ghughu	C, r
66	*Streptopelia orientalis*	Oriental Turtle Dove	Ram Ghughu	U, r
67	*Streptopelia tranquebarica*	Red Collared Dove	Ghot/Kot/Motor/Dol/ Penchi Ghughu	V, r
68	*Treron bicincta*	Orange-breasted Green Pigeon	-	C, r
69	*Treron curvirostra*	Thick-billed Green Pigeon	-	C, r
70	*Treron phoenicoptera*	Yellow-footed Green Pigeon	Lona Harial	V, r
71	*Treron pompadora*	Pompadour Green Pigeon	Choto Harial	V, r
	ORDER: GRUIFORMES Family: Rallidae			
72	*Amaurornis phoenicurus*	White-breasted Waterhen	Dahuk, Daike, Baro Duk, Chainda Dok	V, r
73	*Fulica atra*	Common Coot	Ramer Kora	V, w
74	*Gallicrex cinerea*	Watercock	Kora, Bon Kora	C, r
75	*Gallinula chloropus*	Common Moorhen	Jolmurgi, Donkui	V, r
76	*Porphyrio porphyrio*	Purple Swamphen	Kalim, Kaiem, Sia Kukhra, Buri	V, r
	ORDER: CICONIIFORMES Family: Scolopacidae			
77	*Actitis hypoleucos*	Common Sandpiper	Cha Pakhi	V, w
78	*Calidris minuta*	Little Stint	-	C, w
79	*Calidris ruficollis*	Red-necked Stint	-	V, w
80	*Calidris temminckii*	Temminck's Stint	-	U, w
81	*Gallinago gallinago*	Common Snipe	Metey Chaga, Kadakhucha	V, w
82	*Gallinago stenura*	Pintail Snipe	Chaga, Kadakhucha	V, w
83	*Limosa limosa*	Black-tailed Godwit	Jurali	V, w
84	*Numenius arquata*	Eurasian Curlew	Baro Gulinda, Ram	V, w

	Taxon and Scientific Name	English Name	Local Name	Status
			Chaga, Kodailla	
85	*Numenius phaeopus*	Whimbrel	Choto Gulinda, Ram Chaga, Kodailla	V, w
86	*Tringa erythropus*	Spotted Redshank	-	R, w
87	*Tringa nebularia*	Common Greenshank	Gotra	V, w
88	*Tringa ochropus*	Green Sandpiper	-	C, w
89	*Tringa stagnatilis*	Marsh Sandpiper	Piew	V, w
90	*Tringa tetanus*	Common Redshank	Motori	V, w
91	*Tringa glareola*	Wood Sandpiper	-	V, w
	Family: Rostratulidae			
92	*Rostratula benghalensis*	Greater Painted-snipe	Rongila/Kunal/Boiragi Chaga	C, r
	Family: Jacanidae			
93	*Hydrophasianus chirurgus*	Pheasant-tailed Jacana	Naew, Mewa, Jol Mayur	C, r
94	*Metopidius indicus*	Bronze-winged Jacana	Jolpipi, Pipi	V, r
	Family: Burhinidae			
95	*Burhinus oedicnemus*	Eurasian Thick-knee	Khorma, Hatrima, Bogudi	R, r
	Family: Charadriidae			
96	*Charadrius alexandrines*	Kentish Plover	-	R, w
97	*Charadrius dubius*	Little Ringed Plover	Choto Jiria	V, r/m
98	*Charadrius hiaticula*	Common Ringed Plover	-	R, v
99	*Charadrius leschenaultia*	Greater Sand Plover	-	C, w
100	*Charadrius mongolus*	Lesser Sand Plover	Titi Jiria	V, w
101	*Charadrius placidus*	Long-billed Plover	-	R, w
102	*Himantopus himantopus*	Black-winged Stilt	Raj Dhenga, Lal/Ram Thengi	U, w
103	*Pluvialis fulva*	Pacific Golden Plover	Murgi/Metey Batan, Koitori Chaga	V, w
104	*Vanellus cinereus*	Gray-headed Lapwing	Langoila Titi/Odda	C, w
105	*Vanellus duvaucelii*	River Lapwing	-	U, r
106	*Vanellus indicus*	Red-wattled Lapwing	Hot Tity, Bamon Badsha	V, r
107	*Vanellus malarbaricus*	Yellow-wattled Lapwing	-	U, r

	Taxon and Scientific Name	English Name	Local Name	Status
	Family: Glareolidae			
108	*Glareola lacteal*	Small Pratincole	Babui Batan	C, r
	Family: Laridae			
109	*Chlidonias hybridus*	Whiskered Tern	Phokdahori Gangchil/Panpaira	V, w
110	*Larus brunnicephalus*	Brown-headed Gull	Bodorkoitar, Gang Bodor	V, w
111	*Larus cachinnans*	Yellow-legged Gull	-	U, w
112	*Larus ichthyaetus*	Pallas's Gull	Baro Bodorkoitar	C, w
113	*Larus ridibundus*	Black-headed Gull	Gongakoitar	C, w
114	*Sterna acuticauda*	Black-bellied Tern	-	R, r
115	*Sterna albifrons*	Little Tern	Choto Gangchil	V, r/m
116	*Sterna aurantia*	River Tern	Machkhaikka Gangchil	R, r
	Family: Accipitridae			
117	*Accipiter badius*	Shikra	-	V, r
118	*Aquila clanga*	Greater Spotted Eagle	-	U (VU), w
119	*Aquila hastate*	Lesser Spotted Eagle	-	R (VU), r
120	*Butastur teesa*	White-eyed Buzzard	-	R, r
121	*Buteo buteo*	Common Buzzard	-	R, w
122	*Buteo rufinus*	Long-legged Buzzard	Idurmara Chil	U, w
123	*Circus aeruginosus*	Eurasian Marsh Harrier	Pan/Chita/Kuria Chil	V, w
124	*Circus melanoleucos*	Pied Harrier	Math Chil, Rakhal-bhulani	U, w
125	*Elanus caeruleus*	Black-shouldered Kite	Dhola/Ada Chil	C, r
126	*Gyps bengalensis*	White-rumped Vulture	Shakun	U (CR), r
127	*Gyps himalayensis*	Himalayan Griffon	-	R, w
128	*Haliastur Indus*	Brahminy Kite	Sankha/Lal Chil	V, r
129	*Hieraaetus pennatus*	Booted Eagle	Katua Chil	R, w
130	*Ichthyophaga ichthyaetus*	Gray-headed Fish Eagle	Bowli/Ukosh Eagle	C, r
131	*Milvus migrans*	Black Kite	Bhuban Chil	V, r
132	*Pandion haliaetus*	Osprey	Machmural	U, w
133	*Pernis ptilorhynchus*	Oriental Honey-buzzard	Madhu Chil, Madhubaj	C, r

	Taxon and Scientific Name	English Name	Local Name	Status
134	*Spilornis cheela*	Crested Serpent Eagle	Tila/Hadal/Dhumba Eagle, Shap Kori	V, r
135	*Spizaetus cirrhatus*	Changeable Hawk Eagle	-	C, r
	Family: Falconidae			
136	*Falco amurensis*	Amur Falcon	-	R, v
137	*Falco chicquera*	Red-necked Falcon	Turmoti Baj	U, r
138	*Falco peregrines*	Peregrine Falcon	Boheri Baj	U, w
139	*Falco tinnunculus*	Common Kestrel	Pokamara/Shapkhauri Baj	V, w
	Family: Podicipedidae			
140	*Podiceps cristatus*	Great Crested Grebe	Baro Duburi	U, w
141	*Tachybaptus ruficollis*	Little Grebe	Choto Duburi/Dubalu/Vurvuira/Charcheri, Taler Aati, Guda-holoi	V, r
	Family: Anhingidae			
142	*Anhinga melanogaster*	Oriental Darter	Shap-pakhi, Ragga, Goyar	U, r
	Family: Phalacrocoracidae			
143	*Phalacrocorax carbo*	Great Cormorant	Baro Pankouri, Goyal	C, r
144	*Phalacrocorax fuscicollis*	Indian Cormorant	-	U, r
145	*Phalacrocorax niger*	Little Cormorant	Choto Pankouri/Panikamur/ Kalkuch	V, r
	Family: Ardeidae			
146	*Ardea cinerea*	Gray Heron	Khaira/Pidali/Daing Bok	C, r
147	*Ardea purpurea*	Purple Heron	Oikka Bok	C, r
148	*Ardeola grayii*	Indian Pond Heron	Kana/Koch/Korchey/ Guzi Bok	V, r
149	*Bubulcus ibis*	Cattle Egret	Go Bok	V, r
150	*Butorides striatus*	Little Heron	Choto Bok	C, r
151	*Casmerodius albus*	Great Egret	Jaitha Bok	C, r
152	*Egretta garzetta*	Little Egret	Sada Bok	V, r
153	*Ixobrychus cinnamomeus*	Cinnamon Bittern	Nolchonga/Nolghonga/Rangi/Lal Bok	C, r

	Taxon and Scientific Name	English Name	Local Name	Status
154	*Ixobrychus sinensis*	Yellow Bittern	-	U, r
155	*Mesophoyx intermedia*	Intermediate Egret	-	C, r
156	*Nycticorax nycticorax*	Black-crowned Night Heron	Waak/Nishi/Raitta/Baichko Bok	C, r
	Family: Threskiornithidae			
157	*Threskiornis melanocephalus*	Black-headed Ibis	Kanchichora, Dhalbadani	C, w
	Family: Ciconiidae			
158	*Anastomus oscitans*	Asian Openbill	Shamuk Khol/Bhanga/Kecha/ Guza	C, r
159	*Ciconia episcopus*	Woolly-necked Stork	Manikjor	R, v
160	*Ciconia nigra*	Black Stork	Kalo Manikjor, Kalajang, Ramshalik	R, v
161	*Leptoptilos javanicus*	Lesser Adjutant	Modontak, Modonchor, Harong	U (VU), r
162	*Mycteria leucocephala*	Painted Stork	Sonajongha	R, w
	ORDER: PASSERIFORMES Family: Irenidae			
163	*Chloropsis aurifrons*	Golden-fronted Leafbird	Patabulbuli, Horbola, Sabujali	V, r
	Family: Laniidae			
164	*Lanius cristatus*	Brown Shrike	Badami Kosai	V, w
165	*Lanius schach*	Long-tailed Shrike	Dabra/Baghatiki/Chamoch Kosai	V, r
166	*Lanius tephronotus*	Gray-backed Shrike	-	C, w
	Family: Corvidae			
167	*Aegithina tiphia*	Common Iora	Fotikjal	V, r
168	*Artamus fuscus*	Ashy Woodswallow	Latora, Chalakchala, Kankata,	V, r
169	*Coracina macei*	Large Cuckooshrike	Gudhuka, Baro Kabashi	C, r
170	*Coracina melanoptera*	Black-headed Cuckooshrike	Kabashi	C, s
171	*Coracina melaschistos*	Black-winged Cuckooshrike	-	U, w
172	*Corvus macrorhynchos*	Large-billed Crow	Dar Kak/Kaia	V, r
173	*Corvus splendens*	House Crow	Pati Kak/Kaia	V, r

	Taxon and Scientific Name	English Name	Local Name	Status
174	*Dendrocitta vagabunda*	Rufous Treepie	Kutum, Harichacha, Taira	V, r
175	*Dicrurus aeneus*	Bronzed Drongo	-	V, r
176	*Dicrurus leucophaeus*	Ashy Drongo	-	C, w
177	*Dicrurus macrocercus*	Black Drongo	Kalo Fingey/Feichka/Fingira/Feskuna	V, r
178	*Hypothymis azurea*	Black-naped Monarch	-	C, r
179	*Oriolus oriolus*	Eurasian Golden Oriole	Beney-bou	U, w
180	*Oriolus xanthornus*	Black-hooded Oriole	Haldey Pakhi, Haludia	V, r
181	*Pericrocotus cinnamomeus*	Small Minivet	Teni Satsaheli	V, r
182	*Rhipidura albicollis*	White-throated Fantail	Lejnachani, Chakdoel	C, r
183	*Tephrodornis pondicerianus*	Common Woodshrike	Choto Dukka	V, r
184	*Terpsiphone paradise*	Asian Paradise-flycatcher	Laj Jhola, Dudhraj, Shapa, Shaheb Bulbuly	C, r
	Family: Muscicapidae			
185	*Copsychus saularis*	Oriental Magpie Robin	Doel, Doi Nachani, Deilla	V, r
186	*Culicicapa ceylonensis*	Gray-headed Canary Flycatcher	Futfuti Chotok	V, w
187	*Eumyias thalassina*	Verditer Flycatcher	-	C, w
188	*Ficedula parva*	Red-throated Flycatcher	Lalbuk Chotok	V, w
189	*Luscinia calliope*	Siberian Rubythroat	-	U, w
190	*Luscinia svecica*	Bluethroat	-	U, w
191	*Monticola solitaries*	Blue Rock Thrush	-	C, w
192	*Phoenicurus ochruros*	Black Redstart	Lal Girdi	C, w
193	*Saxicola leucura*	White-tailed Stonechat	-	R, w
194	*Saxicola torquata*	Common Stonechat	-	V, w
195	*Zoothera citrine*	Orange-headed Thrush	Dama, Metey Doel	C, r
	Family: Sturnidae			
196	*Acridotheres fuscus*	Jungle Myna	Jhuti Shalik, Tika Myna	V, r
197	*Acridotheres ginginianus*	Bank Myna	Gang Shalik	C, r

	Taxon and Scientific Name	English Name	Local Name	Status
198	*Acridotheres tristis*	Common Myna	Bhat Shalik/Aro/Towanay	V, r
199	*Sturnus contra*	Asian Pied Starling	Gobrey/Go/Chonda Shalik, Gohaia, Choni, Sharo, Chikra Aro	V, r
200	*Sturnus malabaricus*	Chestnut-tailed Starling	Kath Shalik	V, r
	Family: Certhiidae			
201	*Parus major*	Great Tit	Titpokh, Ramgangra	V, r
	Family: Hirundinidae			
202	*Hirundo daurica*	Red-rumped Swallow	-	C, w
203	*Hirundo rustica*	Barn Swallow	Ababil	V, w
204	*Riparia paludicola*	Plain Martin	-	C, r
205	*Riparia ripari*	Sand Martin	-	U, w
	Family: Pycnonotidae			
206	*Pycnonotus cafer*	Red-vented Bulbul	Bulbuli, Kuli	V, r
207	*Pycnonotus jocosus*	Red-whiskered Bulbul	Sipahi Bulbuli, Jhutkuli	V, r
	Family: Cisticolidae			
208	*Cisticola juncidis*	Zitting Cisticola	-	V, r
209	*Prinia gracilis*	Graceful Prinia	-	R, r
210	*Prinia hodgsonii*	Gray-breasted Prinia	-	C, r
211	*Prinia inornata*	Plain Prinia	-	C, r
	Family: Zosteropidae			
212	*Zosterops palpebrosus*	Oriental White-eye	Babunai	V, r
	Family: Sylviidae			
213	*Acrocephalus aedon*	Thick-billed Warbler	-	R, w
214	*Acrocephalus Agricola*	Paddyfield Warbler	-	C, w
215	*Acrocephalus dumetorum*	Blyth's Reed Warbler	-	V, w
216	*Acrocephalus stentoreus*	Clamorous Reed Warbler	Tikra	C, w
217	*Locustella certhiola*	Pallas's Warbler	-	U, w
218	*Locustella naevia*	Grasshopper Warbler	-	V, w

	Taxon and Scientific Name	English Name	Local Name	Status
219	*Malacocincla abbotti*	Abbott's Babbler	Bhadatuni	V, r
220	*Megalurus palustris*	Striated Grassbird	Takteki, Tiktikka	C, r
221	*Orthotomus sutorius*	Common Tailorbird	Tuntuni, Tula Tuni	V, r
222	*Phylloscopus affinis*	Tickell's Leaf Warbler	-	U, w
223	*Phylloscopus collybita*	Common Chiffchaff	-	C, w
224	*Phylloscopus fuscatus*	Dusky Warbler	-	C, w
225	*Phylloscopus inornatus*	Yellow-browed Warbler	-	V, w
226	*Phylloscopus reguloides*	Blyth's Leaf Warbler	-	C, w
227	*Phylloscopus trochiloides*	Greenish Warbler	-	V, w
228	*Timalia pileata*	Chestnut-capped Babbler	-	U, r
229	*Turdoides earlei*	Striated Babbler	Metho Satbhaila/Chatarey	C, r
230	*Turdoides striatus*	Jungle Babbler	Satbhaila, Satbhai, Satarey, Arakhaskhasi	V, r
	Family: Alaudidae			
231	*Alauda gulgula*	Oriental Skylark	-	V, r
232	*Calandrella raytal*	Sand Lark	Dhulcharai	V, r
233	*Eremopterix grisea*	Ashy-crowned Sparrow Lark	Dhulchata, Baluchata	U, r
234	*Mirafra assamica*	Rufous-winged Bushlark	Bharat	V, r
	Family: Nectariniidae			
235	*Dicaeum erythrorynchos*	Pale-billed Flowerpecker	Fuljhuri	V, r
236	*Nectarinia asiatica*	Purple Sunbird	Niltuni, Durgatuntuni	V, r
237	*Nectarinia zeylonica*	Purple-rumped Sunbird	Moutushi	C, r
	Family: Passeridae			
238	*Amandava amandava*	Red Avadavat	Moina Babui	R, r
239	*Anthus campestris*	Tawny Pipit	-	C, w
240	*Anthus hodgsoni*	Olive-backed Pipit	-	C, w
241	*Anthus richardi*	Richard's Pipit	-	C, w
242	*Anthus rufulus*	Paddyfield Pipit	-	V, r

	Taxon and Scientific Name	English Name	Local Name	Status
243	*Dendronanthus indicus*	Forest Wagtail	-	C, w
244	*Lonchura malabarica*	Indian Silverbill	-	U, r
245	*Lonchura Malacca*	Black-headed Munia	Kalomatha Munia	C, r
246	*Lonchura punctulata*	Scaly-breasted Munia	Tila Munia	V, r
247	*Motacilla alba*	White Wagtail	Choto Khonjan	V, w
248	*Motacilla cinerea*	Gray Wagtail	-	C, w
249	*Motacilla citreola*	Citrine Wagtail	-	C, w
250	*Motacilla flava*	Yellow Wagtail	-	C, w
251	*Motacilla maderaspatensis*	White-browed Wagtail	Baro Khonjan	V, r
252	*Passer domesticus*	House Sparrow	Charui, Peirga	V, r
253	*Ploceus benghalensis*	Black-breasted Weaver	-	U, r
254	*Ploceus manyar*	Streaked Weaver	Teli Babui	R, r
255	*Ploceus philippinus*	Baya Weaver	Babui, Baoi, Baloi, Bailla, Piara	V, r

V: very common; C: common; U: uncommon; R: rare; CR: critically endangered globally; EN: endangered globally; VU: vulnerable globally; r: resident (breeds in Bangladesh); w: winter visitor (does not breed in Bangladesh); s: summer visitor (breeds in Bangladesh); v: vagrant (does not normally breed in Bangladesh).

Table 5.9: Common Migratory Bird Species in the Project Influence Area

English Name	Scientific Name	Local Name	Habitat	IUCN RED LIST STATUS
Ruddy Shelduck	*Tadorna ferruginea*	Khoira Chokachoki	Terrestrial	Least Concern
Fulvous Whistling Duck	*Dendrocygna bicolor*	Raj Shorali	Aquatic/ Terrestrial	Least Concern
Western Yellow Wagtail	*Motacilla flava*	Holdey Khonjon	Aquatic/ Terrestrial	Least Concern
Wood Sandpiper	*Numenius glareola*	Bon Batan	Aquatic/ Terrestrial	Least Concern
Black Headed Ibis	*Threskiornis melanocephalus*	Kalomatha Kastachora	Terrestrial	Near Threatened
Brown Shrike	*Lanius cristatus*	Khoira Latora	Terrestrial	Least Concern
Common Sandpiper	*Actitis hypoleucos*	Pati Batan	Terrestrial	Least Concern
Common Tern	*Sterna hirundo*	Pati Panchil	Terrestrial	Least Concern
Fulvous Whistling Duck	*Dendrocygna bicolor*	Raj Shorali	Terrestrial	Least Concern
Grey Headed Lapwing	*Vanellus cinereus*	Matamatha Titi	Terrestrial	Least Concern
Indian River Tern	*Sterna aurantia*	Nodia Panchil	Terrestrial	Near Threatened
Comb Duck	*Sarkidiornis melanotos*	Nakta Hash	Terrestrial	Least Concern

Figure 5.27: Flock of Whiskered Tern - a common bird in the project influence area

5.4.3. Reptiles

Since most of the reptiles are moisture-loving species, the project influence area is the home of many reptiles of medium and small sizes. A total of 36 species of reptiles are known to occur in the area (**Table 5.10**).

Table 5.10: Reptiles that are Known to Occur in the Project Influence Area (based on primary and secondary information)

	Taxon and Scientific Name	English Name	Local Name	Status
	ORDER: TESTUDINEA Family: Bataguridae			
1	*Morenia petersi*	Yellow Turtle	-	U (VU)
2	*Pangshura tectum*	Indian Roofed Turtle	Kori/Hail Kasim/Kaitta	C
3	*Pangshura tentoria*	Median Roofed Turtle	-	U
	Family: Trionychidae			
4	*Aspideretes gangeticus*	Ganges Softshell Turtle	Kuchrong/Khalua Kasim	U (VU)
5	*Aspideretes hurum*	Peacock-marked Softshell Turtle	Dhum Kasim	C (VU)
6	*Chitra indica*	Narrow-headed Softshell Turtle	Sim Kasim	U (EN)

	Taxon and Scientific Name	English Name	Local Name	Status
7	*Lissemys punctata*	Spotted Flapshell Turtle	Patapori/Shundi Kasim	C
	ORDER: LACERTILIA Family: Agamidae			
8	*Calotes versicolor*	Common Garden Lizard	Raktachosa Girgiti	V
	Family: Gekkonidae			
9	*Hemidactylus brookii*	Brook's House Gecko	-	C
10	*Hemidactylus flaviviridis*	Yellow-bellied House Gecko	Goda Tiktiki	C
11	*Hemidactylus frenatus*	Common House Gecko	Haroil Tiktiki	V
	Family: Scincidae			
12	*Lygosoma albopunctata*	White-spotted Supple Skink	-	R?
13	*Lygosoma bowringii*	Bowring's Supple Skink	-	R
14	*Mabuya carinata*	Keeled Grass Skink	Anzoni, Lenzana	V
15	*Mabuya macularius*	Bronze Grass Skink	-	R
	Family: Varanidae			
16	*Varanus bengalensis*	Bengal Moniror	Hung Gui, Gui Shap	V
17	*Varanus flavescens*	Yellow Monitor	Sona Gui	U
	ORDER: SERPENTES Family: Typhlopidae			
18	*Ramphotyphlops braminus*	Common Blind Snake	-	U
19	*Typhlops diardii*	Diard's Blind Snake	Baro Dumukha/Sutanoli Shap	R
	Family: Boidae			
20	*Eryx conicus*	Common Sand Boa	Balu-bora Shap	R
	Family: Colubridae			
21	*Ahaetulla nasutus*	Common Vine Snake	Laodoga Shap	U
22	*Amphiesma stolatum*	Striped Keelback	Chiru Shap	C
23	*Atretium schistosum*	Olive Keelback	Maita Shap	V

	Taxon and Scientific Name	English Name	Local Name	Status
24	*Boiga trigonata*	Common Cat Snake	Phonimonosha Shap	U
25	*Chrysopelea ornata*	Ornate Flying Snake	Kalnigini/Urukku/Uranta Shap	U
26	*Dendrelaphis pictus*	Painted Bronzeback Tree Snake	Rangila Gecho Shap	U
27	*Enhydris enhydris*	Common Smooth Water Snake	Paina/Huria Shap	V
28	*Lycodon aulicus*	Common Wolf Snake	Gharginni Shap	V
29	*Ptyas mucosus*	Indian Rat Snake	Daraj/Dhaman Shap	C
30	*Xenochrophis piscator*	Checkered Keelback	Dhora Shap	V
	Family: Elapidae (all deadly venomous species)			
31	*Bungarus caeruleus*	Common Krait	Kal-keutey Shap	C
32	*Bungarus fasciatus*	Banded Krait	Shakini/Shonkhini/Akhainna Shap	U
33	*Naja kaouthia*	Monocled Cobra	Gokhra Shap	U
34	*Naja naja*	Spectacled Cobra	Khoia Gokhra Shap	C
	Family: Viperidae (all deadly venomous species)			
35	*Daboia russelii*	Russell's Viper	Chandra-bora/Ulu-bora Shap	U
	ORDER: CROCODYLIA Family: Crocodylidae			
36	*Gavialis gangeticus*	Gharial	Ghorial, Baishal, Ghot Kukir	R (CR)

V: very common; C: common; U: uncommon; R: rare; CR: critically endangered globally; EN: endangered globally; VU: vulnerable globally; EW: extinct in the wild.

Some common reptiles of the area are Common Garden Lizard (Calotes versicolor), Common Skink (Eutropis carinatus), Common House Gecko (Hemidactylusfrenatus), Checkered Keelback (Xenochrophis piscator), Binocellate Cobra (Naja naja), Peacock Softshell Turtle (Nilssonia hurum), Spotted Flapshell Turtle (Lissemys punctata) and Bengal Monitor (Varanus bengalensis) (Hasan et al. 2014). Common Garden Lizard and Common Skink were frequently sighted in the project influence area. On the other hand, Peacock Softshell Turtle and Spotted Flapshell Turtle are very rare in the project influence area. At the time of FGD people informed about the presence of turtles long time ago, and the turtles appear to be disappearing from the project site. Binocellate

Cobra (**Figure 5.28)** is the common reptile in the project influence area. Other than turtles, the lizards and snakes do not show any significant trend of decline. Description of two threatened reptiles, Peacock softshell turtle and gharial, is presented below.

Figure 5.28: Binocellate Cobra - a Common Reptilian the Project Influence Area

Peacock Softshell Turtle

The Peacock Softshell Turtle (*Nilssonia hurum*; global status: Vulnerable) has a distinctive soft-shell that is beautifully marked with dark olive green carapace reticulated with black (**Figure 5.29**). Carapace is also adorned with a narrow rim and numerous broken ridges. Its head is dark green to black with numerous yellow spot. They are oviparous and breeding activities take place in winter. Nesting takes place from December to March in chars. They inhabit in all major rivers of Bangladesh. They are currently rare in the project influence area.

Figure 5.29: Peacock Turtle

Gharial (Gavialis gangeticus)

The only large reptile in the area is the Gharial (*Gavialis gangeticus*) (**Figure 5.30**), which is extremely rare. It is a globally and nationally threatened species. Few decades ago it was a common species in the Ganges-Brahmaputra River System, but the population sharply declined due to the lack of food (fish), accidental killing by fishing nets and destruction of eggs by domestic dogs (Khan 1982). Today, it is one of the rarest species of wildlife in Bangladesh and there have been no report of its nesting since 1980s. It is possible that the individuals (mostly juvenile and young) that are rarely seen in the Ganges-Brahmaputra River System come from the neighbouring India and Nepal.

Gharial is categorized as 'Critically Endangered' according to IUCN Red List which means species is at high risk of extinction. After 2010 gharial was not recorded from the Jamuna-Brahmaputra river channel. In 2009 and 2010 gharial was encountered only two spot of Jamuna-Brahmaputra river channel (**Figure 5.31**) (CARINAM 2010). At the time of Dolphin Survey in project influence area, the team also searched for Gharials. But there was no evidence of the presence of this animal. Again at the time our Baseline survey during August and September several FGD was conducted and people confirmed that after 2011 they had not seen any Gharials in the Jamuna-Brahmaputra River. On the basis of these FGD and primary survey we can conclude that currently there are no Gharials in the project influence area.

Figure 5.30: Gharial- at its natural Habitat (Source- ARKIVE)

Figure 5.31: Distribution map of Gharials in 2010 (Source: CARINAM 2010)

5.4.4. Amphibians

The stagnant water bodies and the moist terrestrial areas offer vast habitats for amphibians. Therefore, the amphibians are very common in the project influence area. A total of 15 species are known to occur (**Table 5.11**). Among the amphibians, only the frogs and toads are found in the area. Some common species are Skipper Frog (Euphlyctis cyanophlyctis), Cricket Frog (Fejervarya spp.), Indian Bull Frog (Hoplobatrachus tigerinus), and Common Toad (Duttaphrynus melanostictus) (Hasan et al. 2014). See **Figure 5.32** for an amphibian species of the area. Since there is no notable threat to amphibians and there is no hunting for meat, none of the frog species show the trend of decline, which was recorded during the FGD.

Table 5.11: Amphibians that are Known to Occur in the Project Influence Area (based on primary and secondary information)

	Taxon and Scientific Name	English Name	Local Name	Status
	ORDER: ANURA Family: Bufonidae			
1	*Bufo stomaticus*	Marbled Toad	-	U
2	*Duttaphrynus melanostictus*	Common Toad	Kuno Bang	V
	Family: Dicroglossidae			
3	*Euphlyctis cyanophlyctis*	Skipper Frog	Mali Bang	V
4	*Fejervarya pierrei*	Pierre's Cricket Frog	Jhijhi Bang	C
5	*Fejervarya nepalensis*	Nepal Cricket Frog	Jhijhi Bang	V
6	*Fejervarya syhadrensis*	Syhadra Cricket Frog	Jhijhi Bang	C
7	*Fejervarya teraiensis*	Terai Cricket Frog	Jhijhi Bang	C
8	*Fejervarya asmati*	Asmat's Cricket Frog	Jhijhi Bang	V
9	*Hoplobatrachus tigerinus*	Indian Bull Frog	Sona/Kola/Bhawa Bang	V
	Family: Microhylidae			
10	*Microhyla ornata*	Ornate Microhylid Frog	-	V
11	*Microhyla mymensinghensis*	Mymensingh Microhylid Frog	-	C
	Family: Ranidae			
12	*Hylarana tytleri*	Leaping Frog	-	U
13	*Sylvirana taipehensis*	Two-striped Grass Frog	Kad Bang	U
	Family: Rhacophoridae			
14	*Polypedates leucomystax*	Asian Brown Tree Frog	Gecho Bang	C
15	*Polypedates maculatus*	Indian Tree Frog	Gecho Bang	V

V: very common; C: common; U: uncommon; R: rare; VU: vulnerable globally.

Figure 5.32: Cricket Frog - a Common Amphibian in the Project Influence Area

5.4.5. Terrestrial Invertebrates

Wide varieties of terrestrial invertebrates are known to occur in the project influence area as well as in entire Bangladesh, but there is no information on their diversity and abundance in the literature. The warm and humid climate of the country is favorable to lower organisms, especially the insect and spider fauna. The project influence area is similar to other areas of the country in terms of having diverse terrestrial invertebrate communities. Detailed invertebrate surveys were not carried out in the project influence area but a general assessment was made of invertebrate taxa in the area. A number of species of earthworms (eg, *Dendrobena* spp., *Apporectoda* spp., *Lumbricus* spp.) exist in the area. They play a vital role in maintaining the humus of the soil and help the nitrogen and oxygen to penetrate the soil through its holes. There are many species of grasshoppers (order: Orthoptera) that cause a lot of damage to the crops. Other common invertebrates include many species of butterflies, dragonflies, spiders and beetles.

5.4.6. Ecosystem Services

Ecosystem services are the benefits that the people harness from the ecosystems. These may be tangible or intangible. The tangible benefits are direct and possess some sort of physical entity, such as edibles, fiber, construction materials, etc. The intangible benefits are indirect and need a little thinking to perceive those, such as perennial stream flows, clean water, oxygen supply, climate regulations, microclimatic impacts, aesthetic values of the landscapes, etc. According to 'The Economics of Ecosystems and Biodiversity' (TEEB), ecosystem services can be divided into four categories, which are presented here under.

1. **Provisioning services**

These are mainlyproducts obtained from ecosystems. These products will include:

- food (including seafood and game), crops, wild foods, and spices
- raw materials (including lumber, skins, fuel wood, organic matter, fodder, and fertilizer)
- genetic resources (including crop improvement genes, and health care)
- water
- minerals (including diatomite)
- medicinal resources (including pharmaceuticals, chemical models, and test and assay organisms)
- energy (hydropower, biomass fuels)
- ornamental resources (including fashion, handicraft, jewelry, pets, worship, decoration and souvenirs like furs, feathers, ivory, orchids, butterflies, aquarium fish, shells, etc.)

Bangladesh context:

Under the Bangladesh context, a few of the examples of such provisioning services rendered by the ecosystems are as under. The water bodies such as rivers, haors, baors, beels, wetlands etc. produce fishes, crabs, shrimps, etc. The agro-eco systems provide the cereals, spices, jute, cotton, vegetables, fruits, etc.. The forest ecosystems provide timber, fuel-wood, game animals, bamboos, canes, poles, etc. which is the provisioning services of these ecosystems.

Project Context:

The major provisioning services that are provided by the ecosystems in the Project Influence Area (PIA) are:

- The agro-ecosystems (agricultural areas) provide rice, wheat, oil seeds, spices, fruits, jute, etc.
- The freshwater ecosystems provide clean ground water and surface water that are used for drinking and irrigation purposes. The water bodies such as the rivers, beels, ponds, wetland areas, etc. provide fishes, crabs, shrimps
- Raw materials obtained from this ecosystem inlcude bamboos, fruits, medicinal plants, timber and fuel-wood

2. **Regulating services**

Regulating services are the “benefits obtained from the regulation of ecosystem processes”. These include:

- carbon sequestration and climate regulation
- waste decomposition and detoxification

- purification of water and air
- pest and disease control

Bangladesh context:

The forest ecosystem in Bangladesh extended over 17 percent of the country transpires out huge quantities of water to the atmosphere. This water has a significant contribution in the rain fall at least on regional context. It is known that the North Western region of the country receive less rain fall than the South Eastern part of the country, which has some relation with the regional ecosystem variability, especially with respect to tree cover. The Barind tract of Bangladesh gets cooler during the winter months than the Chittagong area. In a small country like, this sort of climatic variability refers to the climate regulatory aspects of its ecosystem services.

Bangladesh in general, is tropical and receives a reasonable quantity of rain fall. These features of the ecosystems of the country facilitate waste treatment as the regulating services of its ecosystems.

Bangladesh is endowed with the world largest contiguous mangrove forest, the Sundarban. The cyclone that lashed over Chittagong (non-Sundarban) area on November 12, 1970 had a speed of 224 Km per hour and had a death toll of 0.5 million lives. Another cyclone 'SIDR', having a speed of 210 to 230 Km per hour, hit Sundarban first and then passed over the human habitations on November 15, 2007, had a death toll of 3363 numbers of human lives. The SEALS project (being implemented by the Forest Department) document has revealed that the intangible benefit of Sundarban, only with respect to the saving human lives, is about 8 billion euro. Sundarban as a "buffer zone" in the context of 'regulating services' of ecosystem is providing this intangible benefits from this given ecosystem.

Project Context:

In the project influence area the rural agricultural practices, in many locations have adopted agro-forestry, wherein tree species have been planted especially along the boundary of the agricultural plots. These trees through evapo-transpiration cause an impact on the climate regulation. Besides these the project influence area has large water bodies, which have some role on climate regulation at local level. The ecosystems in the project influence area have the biodegrading capability, which helps natural waste treatment. The flowing rivers in the project influence areas also help to remove the wastes downstream.

3. Support Services

Ecosystem services "that are necessary for the production of all other ecosystem services". These include services such as nutrient recycling, primary production and soil formation. These services make it possible for the ecosystems to provide services such as food supply, flood regulation and water purification.

Bangladesh context:

The nutrient cycling is a universal phenomenon for almost all of the natural ecosystems in Bangladesh. This prevails not only in hill forest but also in sal forest, fresh water

wetland forest, mangrove forest, etc. Besides these most of the water bodies (except Buriganga) this sort of nutrient cycling is there. Biologically Mediated Habitats such as mangroves (Sundarban, coastal afforestation areas,) fresh water forests, such as Ratargul reserved forest (in Sylhet district), Tamguar haor in Sunamgonj district, etc. provide the support services by providing breeding and nursery grounds for large fish population of variety of species.

Project Context:

The project influence area posses many small rivulets that connect the Brahmanputra river with inland beels, depressions that retain water especially during the dry periods. These water bodies will act as spawning grounds for the fish and act as migratory routes for the fish from river to floodplains.

Besides these the leaf chlorophyll in the project implementation area, through the process of photosynthesis continuously using the carbon dioxides from the air and releasing oxygen. This service of the existing ecosystems in the project influence area is maintaining the air quality. The organic matter in the upper layers of the soil is enhancing its water holding capacity of the existing ecosystems and thereby a better water regime. The roots of the aquatic plants of the existing ecosystems are holding the water pollutants and thereby enhancing and maintaining the quality of the surface water. In addition, the vegetation covers also somewhat regulate the natural hazards such as high windspeeds, erosion, etc. Some of beetles, especially 'lady bird beetle' commonly seen in the ecosystems of the project influence area, feed on many vegetable pests of which aphids are common.

4. Cultural services

Cultural services of ecosystems refer to nonmaterial benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experiences. These include:

- cultural (including use of nature as motif in books, film, painting, folklore, national symbols, architect, advertising, etc.)
- spiritual and historical (including use of nature for religious or heritage value or natural)
- recreational experiences(including ecotourism, outdoor sports, and recreation)
- science and education (including use of natural systems for school excursions, and scientific discovery)

Bangladesh context:

The Dublar Char ecosystem, under the Sundarban (Khulna), provides the ecosystem services which are of the type of "cultural services", by hosting a colorful Puja, which attracts a large number of tourists. Bangladesh has about 37 Protected Areas. Most of these attract tourists from the whole country, whereas Sundarban attract a sizable number of foreign tourists as well.

Project Context:

Jamuna and its charland ecosystem is a natural scenic spots with lot of recreational value. Charland ecosystem of project influence area plays an important role by allowing thousands of migratory birds to visit the ecosystem. This phenomenon enhances the biodiversity values of the ecosystem and enhances its eco-tourism values, which may even generate revenues. The other attraction in the project influence area is presence of globally endangered 'Ganges River Dolphin'.

5.5. Threats to Ecosystem

Both the terrestrial and aquatic ecosystems of the project influence area face formidable anthropogenic threats. Excessive and uncontrolled use of various agrochemicals is the biggest threat to the local ecosystems. Moreover, there are reports of disease outbreaks, human-wildlife conflict and pollution.

5.5.1. Use of Agrochemicals

In the terrestrial ecosystems of the project influence area, particularly in the agricultural lands, many pesticides, fertilizers (such as urea) and growth hormones are used indiscriminately in the agricultural fields. All these chemicals are incorporated to the food chain and are gradually deposited to the higher trophic level through biological magnification. As a consequence, not only the local wildlife, but also the humans are suffering from adverse effects of these agrochemicals.

5.5.2. Potential Vectors of Diseases

Many birds are known to serve as vectors of highly pathogenic H5N1 and some other contagious diseases that can be transmitted to humans with fatal consequences. On the other hand, Nipah Virus (NiH) is known to be carried by fruit bats and is transmitted to humans through the date juice or fruits, contaminated by bats, that are consumed by people. Moreover, anthrax outbreaks to cattle are occasionally reported. The germs can be transmitted through the wild animals that feed on the carcass of infected cattle.

5.5.3. Other Threats

In the project influence area there are many reports of human-wildlife conflict. People kill snakes, whether they are poisonous or not, because of the innate fear for snakes. Poisonous snakes (particularly cobras and kraits) are responsible of deaths of some people every year. Similarly, Golden Jackal, Jungle Cat and Common Palm Civet are killed by people due to the perception that these animals kill and eat a lot of domestic chicken and ducks. They do kill some, but more often they kill the rodents that are very harmful to crops.

The Ganges River Dolphin is often killed accidentally in the fishing nets, particularly in illegal gill nets (see **Figure 5.33**). The fat of the dolphin is believed to have the power to cure pain (which has no scientific basis), so there are people to buy dead dolphins. Even the meat is used as baits for large fish and crabs. Since it is rather difficult to purposely kill dolphins, and it is more gainful to catch fish than to kill dolphins, people usually do not kill dolphins purposely.

Figure 5.33: Ganges River Dolphin Accidentally Killed by Fishing net in Project Influence Area

6. Fish and Fisheries Baseline

6.1. Summary of the Fish and Fisheries Baseline

The Jamuna is an important source of fresh water fish in Bangladesh. In a braided river like Jamuna, fish favorable environment generally exists around the river banks, braided channels, scour hole, deep clear water, and near shallow chars. The river has about 220 km long embankment along the right bank and other structures such as Bangabandhu Bridge, hard points, spurs and revetments (hard and soft) which play an important role in shaping out the characteristics of different fish habitats dependent on the Jamuna river. Both capture and culture fisheries types exist in the area. Among capture fisheries habitats main river channels, natural and manmade *khals*, connected seasonal wetlands (*Beel*), associated flood plains, streams/creeks in riverine islands and embayments (*kole*) are important.

Total fish habitat area (in ha) of the project influence area is about 54,987 ha. Besides, about 56 ha culture ponds are found in the project influence area. Wetlands and *khals* at the country side and embayments in the charlands play a major role in sustaining the fish production of the Jamuna River. These habitats - most of which have been formed due to the complex hydro-morphological characteristics of the river - provide food and shelter grounds of fishes. Others rivers that exist in the project influence area are Bangali river, Ichamati river, Hurasagar river, Ghagot river, Manosh river, Alai river, Dhudkumar river and Teesta river which are connected either directly or through different *khals* with the Jamuna river forming a fish movement network in the entire area. The eddy counter-current system at the junction of two rivers (tributary and main river) is an ideal place for fish assemblages. The confluences are also the passageways for upstream fish migration. The project influence area also has numerous seasonal and perennial *beels*/wetlands, some of which are connected with these rivers through the internal *khal*/stream network. *Beels* act as feeding and breeding grounds for many riverine species. *Beels* generally have a residential fish population as well. Besides, a considerable amount of seasonal floodplain area exists within the project influence area.

The total fish production of the project influence area has been estimated as about 8,500 metric tons per year. The main river contributes the largest share of this production followed by floodplain, *beels* and *koles*. Fish production from *khals*/streams is insignificant as most of those are either dried up during peak dry season or remain closed by flood control structures. Hilsa constitutes about 27 percent of Jamuna fish catch. Other major species of fish catch in Jauma are major carps and cat fishes (about 1 percent each), and shrimps-prawns (4 percent). However, fish production of the Jamuna river has been declining continuously until recently. Fish production was decreasing because of increased fishing pressure and a decrease in the extent of floodplain habitats because of the construction of flood control, drainage and irrigation systems, and the consequent obstruction of movement of fry and fingerlings from rivers.

More than 3500 fishermen were identified during the catch assessment survey along the right bank. Fishing is one of the available livelihood options for most of the landless people of the project influence area. The people that become landless due to river bank

erosion losing their traditional income sources usually turn into fishermen. A total of about 1800 fishing crafts were found during catch assessment survey.

A huge number of stagnant water bodies in chars and river channels support habitats of rich fish biodiversity. Rahman and Akhter (2007) identified 156 fish species of which 89 are commercially important and 53 are rare in the river. Jamuna river is renowned for its high diversity of the small indigenous fish species (SIS). Large Hilsa is only available up to Sirajganj. Out of 54 threatened fishes of the country 29 were found in the project influence area during field investigation. A total of six principal carp spawn collecting sites exist along the Brahmaputra-Jamuna mainly on its right bank. Carp spawn collection has been decreasing remarkably over the last three decades. Other areas of conservation significance in the Jamuna river found during the field survey are Simlar kole, Mothiar kul/ Pachthakuri kole, Pukuria kole, Sariakandi kole, Boishakhi kole, Chunia para kole, Taltola kole and Kazlar kole. These areas are at a distance of 0.5-4 km from the project corridor. Besides, Department of Fisheries (DoF) has established several fish sanctuaries in the countryside.

The major migratory fish of the Jamuna include Carps, Cat fishes and Hilsa. Hilsa migrates into Jamuna during March-May from Bay of Bengal through the Meghna and the Padma rivers. Carp fishes migrate upstream and laterally to the inundated floodplains adjacent to the river channel in the late dry season or early rainy season in order to spawn in the nutrient-rich waters. The eggs and larvae of these species drift downstream and enter the floodplain with the floodwater, where they feed on the developed plankton. At the end of the rainy season, the adults and young migrate to the main river channel in order to avoid the harsh conditions of the floodplain during the dry season. The Brahmaputra stock of carp fishes is the largest stock in Bangladesh. Upstream migration of adult carps in the Jamuna/Brahmaputra River starts in March, coinciding with the gradual rise of water level. Spawning starts in May, with the onset of the southwest monsoon, and continues until the end of July. Connecting *khals* between main rivers and other water bodies are vital for maintaining successful fish migration during different seasons. Field survey has identified five migration routes of the priority area as follows: i) Jamuna to Icamoti river through Baliaghugri regulator; ii) Jamuna to Bangali river through Sariakandi fish pass; iii) Jamuna to Dauli beel to Bangali river through Antarpara regulator; iv) Jamuna to Manos river through proposed Kamalpur fish pass; and v) Jamuna to Bangali river via Kutubpur khal through proposed Kutubpur fish pass. Among these five, Sariakandi fish pass is now almost completely silted. Other four fish migration routes are partially obstructed due to the existing regulators/BRE. The BRE acts as barrier and has disconnected large area of floodplain from the main river – a phenomenon that has changed the natural ecosystems dependent on the river hydrology thus resulting in great loss of biodiversity and natural resources, as well as livelihood opportunities.

6.2. Jamuna River - A Suitable Habitat of Fresh Water Fishes

The Jamuna is a large braided river having a length of 260km in Bangladesh with an average width of 11.8km. The annual average flow is 20,000 m^3/sec with a maximum estimated discharge of 100,000 m^3/sec. The average flood water slope of the river is 7.5 cm/km and the average median size bed material is 0.20mm (CEGIS, 2009). It is an important source of fresh water fish in Bangladesh. Braided nature of the river provides

suitable fish habitat as the typical fish assemblage in a river requires a high variability of depth, flow velocity and substrates. The high species richness and diversity in braided rivers can be explained by small-scale habitat mosaics encompassing aquatic habitats as well as riverine forests (**Figure 6.1**), and by multiple sub-surface exchange areas (Tockner et. al., 2006). Braided channels were also known to provide more favorable shelter and nursing conditions for fish larvae and juveniles by mitigating high velocities during floods, by maintaining relatively shallow areas of flow, and by significant adjustments in the thermal region (Sukhodolov et. al., 2009).

Figure 6.1: Dense shrubs along the banks of the Jamuna river chars–preferred feeding ground for fish offsprings

The fish habitats of the Jamuna reflect a combination of sedimentology, depth and velocity associated with the organization of river bedforms and morphologies. Jamuna also has huge sediment loads coming from upstream. Its sediment has high organic contents which makes the river suitable for fishes (IWFM, 2012). The Jamuna has a severe bank erosion problem and the eroded banks and scour holes are also good habitats for the adult fishes. According to Sarkar and Bain, 2007 fish fauna of the Jamuna river prefer both erosional and depositional channel habitats with depths, substrates, and current velocity. In a braided river like Jamuna, fish favorable environment exists around the eroded bank, scour hole, deep clear water, near shallow sand bar and some other places. Average depth of the river ranges from 60 to 90 feet is common in rainy season and decreased to average 40 to 50 feet in dry season which is favored by large fishes. River water is always colder than the surrounding weather, so it supports suitable habitats for different fishes. All these make the Jamuna a unique habitat for fish regeneration.

The river has about 220 km long embankment along the right bank and other structures such as Bangabandhu Bridge, hard points, spurs and revetments (hard and soft) which play an important role in shaping out the characteristics of different fish habitats. However, for the construction of the different riverine structures the fish of the river decline day by day. Tsai and Ali (1985) carried out a study on open water carp fisheries

management. They recorded a decline in Padma, Brahmaputra and Upper Meghna stocks of major carps. According to them, the reasons for decline were construction of embankments, sedimentation and over fishing for Brahmaputra stock.

6.3. Fish Habitat

6.3.1. Type, Area and Distribution

Both capture and culture fisheries types are exist in the project influence area. Among capture fisheries habitats main river channels, natural and manmade *khals*, connected seasonal wetlands (*Beel*), associated flood plains, streams/creeks in riverine islands and embayments (*koles*) are important. Average depth of river channels, *khals*, *koles*, and *beels* is 10-15 metesr, 3-4 meters, 2-7 meters, and 1-4, meters, respectively. Total fish habitat of the project influence area is about 55,000 ha, of which 68 percent is in the rivers, followed by flood plain (21 percent), *beel* (6 percent) and *kole* (5 percent) as given the **Table 6.1** and **Figure 6.2**. *Beels* and *khals* at the country side and *koles* in the charlands play a major role in sustaining the fish production of the Jamuna River (**Figure 3.8**). These habitats facilitate food and shelter grounds of many riverine fishes. A total of 56 ha of culture ponds also exist in the project influence area. Upazila wise distribution of different fish habitats is given in **Table 6.2**.

Table 6.1: Fish Habitat in Project Influence Area (in ha)

Fisheries Type	Fish Habitat	Area (ha)		
		Priority Zone (50km)	Remaining Zone (132km)	Project Area (182km)
Capture	River	12652.91	24655.81	37308.72
	Canal (both natural and manmade khals)	91.30	89.00	180.30
	Beel	1289.00	2239.20	3528.20
	Flood plain	3917.50	7454.80	11372.30
	Embayment (Kole)	719.40	1823.00	2542.40
	Sub-total	18670.11	36261.81	54931.92
Culture	Pond	20.90	34.60	55.50
	Sub-total	20.90	34.60	55.50
Total		**18691.01**	**36296.41**	**54987.42**

Source: Field investigation, September 2014, IUCN

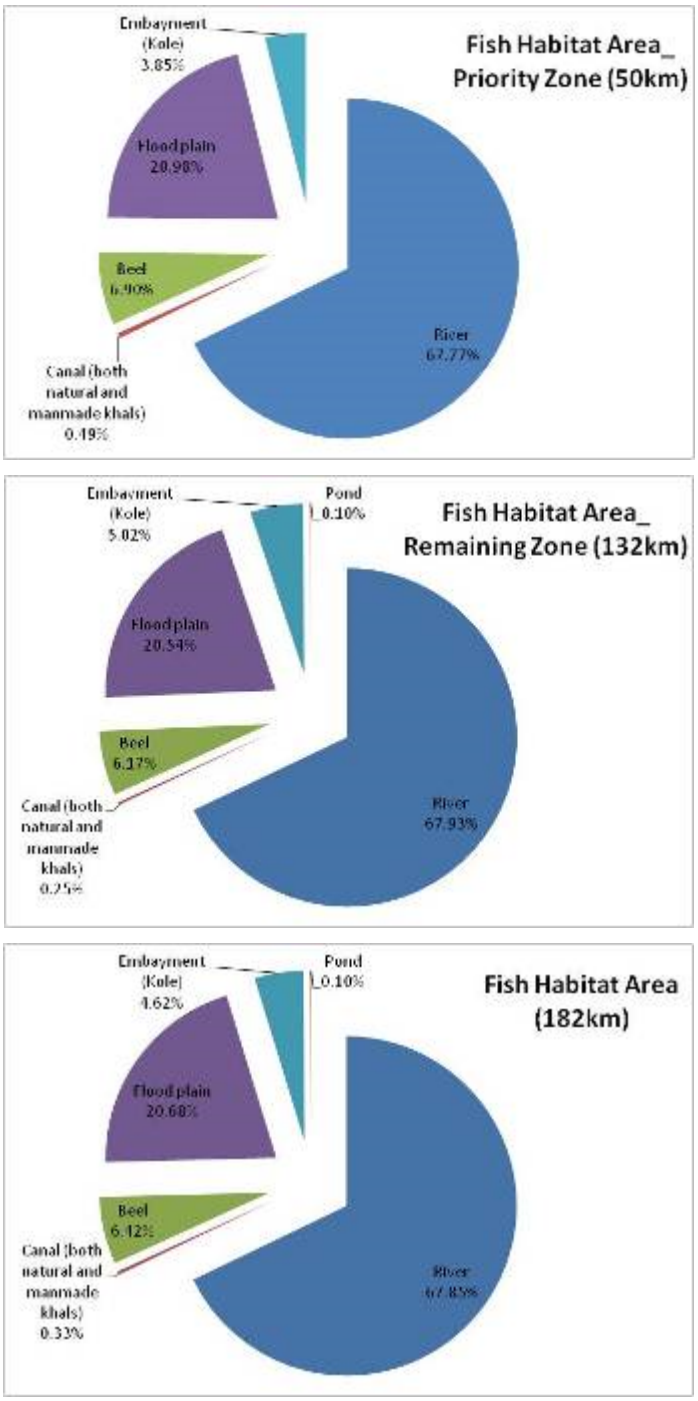


Figure 6.2: Fish Habitat Types of the P (percent of area)

Table 6.2: Upazila Wise Distribution of Fish Habitats within Project Influence Area

Zone	Upazila/District	Habitat type	Area (country side) ha	Area (river side) ha	Total area (ha)
Priority zone	All	River	1832.92	10676.50	12509.42
Remaining zone			6626.64	17500.34	24126.98
	Sub-total		8459.55	28176.84	36636.40
Priority zone	Sirajganj Sadar	Canal	-	0.60	0.60
		Beel	19.00	-	19.00
		Flood plain	44.30	-	44.30
		Embayment (Kole)	-	342.70	342.70
		Pond	3.60	1.00	4.60
		Total	**66.90**	**344.30**	**411.20**
	Kazipur, Sirajganj	Canal	52.90	-	52.90
		Beel	890.00	-	890.00
		Flood plain	2500.00	-	2500.00
		Embayment (Kole)	-	128.00	128.00
		Pond	3.70	1.20	4.90
		Total	**3446.60**	**129.20**	**3575.80**
	Dhunat, Bogra	Canal	20.00	-	20.00
		Beel	80.00	-	80.00
		Flood plain	312.50	10.00	322.50
		Embayment (Kole)	56.50	-	56.50
		Pond	3.30	2.30	5.60
		Total	**472.30**	**12.30**	**484.60**
	Sariakandi, Bogra	Canal	3.50	14.30	17.80
		Beel	300.00	-	300.00
		Flood plain	1050.70	-	1050.70
		Embayment (Kole)	-	192.20	192.20
		Pond	4.60	1.20	5.80

Zone	Upazila/District	Habitat type	Area (country side) ha	Area (river side) ha	Total area (ha)
		Total	**1358.80**	**207.70**	**1566.50**
	Sub total (priority zone)		**7177.52**	**11370.00**	**18547.52**
Remaining zone	Sonatola, Bogra	Canal	8.00	-	8.00
		Beel	4.00	-	4.00
		Flood plain	13.40	-	13.40
		Embayment (Kole)	-	12.00	12.00
		Pond	1.90	0.60	2.40
		Total	**27.30**	**12.60**	**39.80**
	Shaghata, Gaibandha	Canal	-	-	0.00
		Beel	10.20	-	10.20
		Flood plain	19.60	-	19.60
		Embayment (Kole)	184.00	-	184.00
		Pond	2.30	0.60	2.90
		Total	**216.10**	**0.60**	**216.70**
	Fulchari, Gaibandha	Canal	-	-	0.00
		Beel	60.00	-	60.00
		Flood plain	237.00	-	237.00
		Embayment (Kole)	-	40.10	40.10
		Pond	2.90	0.60	3.50
		Total	**299.90**	**40.70**	**340.60**
	Gaibandha Sadar	Canal	3.00	1.00	4.00
		Beel	600.00	-	600.00
		Flood plain	1933.20	-	1933.20
		Embayment (Kole)	-	105.10	105.10
		Pond	11.90	0.90	12.70
		Total	**2548.10**	**107.00**	**2655.00**
	Chilmari, Kurigram	Canal	54.00	-	54.00
		Beel	500.00	-	500.00

Zone	Upazila/District	Habitat type	Area (country side) ha	Area (river side) ha	Total area (ha)
		Flood plain	1437.60	-	1437.60
		Embayment (Kole)	-	148.30	148.30
		Pond	3.20	1.20	4.40
		Total	**1994.80**	**149.50**	**2144.30**
	Ulipur, Kurigram	Canal	11.00	-	11.00
		Beel	950.00	-	950.00
		Flood plain	3602.10	-	3602.10
		Embayment (Kole)	-	889.80	889.80
		Pond	3.40	0.70	4.20
		Total	**4566.50**	**890.50**	**5457.10**
	Kurigram Sadar	Canal	12.00	-	12.00
		Beel	115.00	-	115.00
		Flood plain	211.90	-	211.90
		Embayment (Kole)	-	443.70	443.70
		Pond	3.60	0.80	4.50
		Total	**342.50**	**444.50**	**787.10**
	Sub total (remaining zone)		**16621.84**	**19145.74**	**35767.58**
	Grand total		**23799.35**	**30515.74**	**54315.10**

Source: Field investigation, September 2014, IUCN

6.3.2. Fish habitat Characteristics of the Jamuna River

As descriebd earlier that different types of habitats exist in the Jamuna River most of which have been formed due to the complex hydro-morphological characteristics of the river. Each of those has an identical hydraulic profile for which fish community structure is different from one to another, those are: main channel, second level channel, third level channel, embayment (*kole*), charland channel, bankside and floodplain (in chars). A total of 149 chars were identified during the field investigation, of which 55 chars fall under priority area. Most of these chars and associated river channels form various *kole* (embayment) some of which are permanent in nature. **Figure 6.3** (IWFM, 2011) shows the sub-habitats of Jamuna river along the Sirajganj Sadar Upazila.

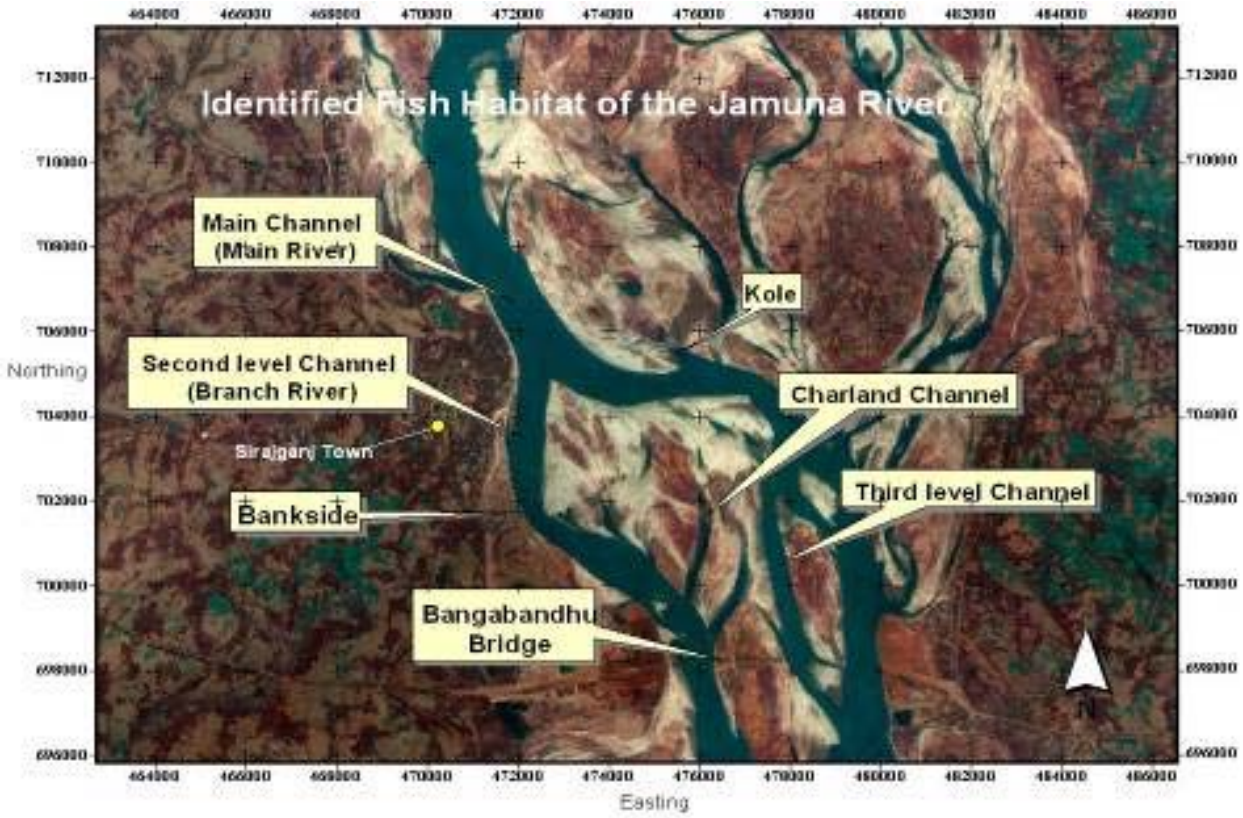


Figure 6.3: Different fish sub-habitats of the Jamuna River (Source: IWFM, 2011)

Hydraulic profile of these important fish sub-habitats of Jamuna river was also prepared during the same study and is furnished in **Table 6.3** below. Fish habitats of the priority zone as well as remaining zone of the Jamuna river has the same hydraulic profiling favored by different fishes.

Table 6.3: Hydraulic Profiling of Fish Sub-Habitats of the Jamuna River

Habitat Name	Average depth		Average Velocity		Substrate Profile	Cross section	Available fish species on preference basis	
	Dry Season	Wet Season	Dry Season	Wet Season			Young	Adult
Main Channel	> 60 feet	>90 feet	0.5 – 1.5 m/s	1.5 – 3 m/s	• In bottom clay and silty clay. • Sand in char land and submerged charland • Near eroded bank sand, silt and	• On the bank side of the main channel strep slope is observed. • And the slope is gently rising on the charland side. • River bed		Air, Baghair, Baus, Rita, Boal, Hilsa, Baspatari, Kajuli, Khorsholla, Ghaura, Rui, Katol, Pangas,

Habitat Name	Average depth		Average Velocity		Substrate Profile	Cross section	Available fish species on preference basis	
	Dry Season	Wet Season	Dry Season	Wet Season			Young	Adult
					clay are present.	containsa square hole, submerged sand bars, dunes etc. • Width more than one kilometer during wet season		Chitol, Poa, Chingri, Bailla
Second level Channel	30 – 40 feet	60 feet	0.75 – 1.25 m/s	1.25 – 2.5 m/s	• In bottom clay and silty clay as well as sand is also present are some places. • Sand in char land and submerged charland • Near eroded bank sand is mainly present.	• In the second level channel, the slope is not very sharp. • Near char land, the slope gently increases. • Contain less scour hole and dunes. • Very few submerged charland. • Width is near about one kilometer during the wet season		Kajuli, Air, Baghair, Hilsa, Rita, Ghaura, Khorsholla, Baus, Boal, Pangas, Rui, Katol, Bata
Third level Channel	10 – 30 feet	30-50 feet	0.75 – 1.25 m/s	1.25 – 2.5 m/s	• In bottom clay and silty clay. • Sand in char land and submerged charland • Near eroded bank only sand and very little silt is present.	• Slope is gentle in both sides. • No sand dunes. • Very often scour hole. • No charland inside the channel. • Very few or no submerged charland. • Width is less than one kilometer during the wet		Kajuli, Khorsholla, Baus, Air, Baghair, Boal, Chela, Boal, Pasgas, Carp, Mrigel, Matichata, Gungunia

Habitat Name	Average depth		Average Velocity		Substrate Profile	Cross section	Available fish species on preference basis	
	Dry Season	Wet Season	Dry Season	Wet Season			Young	Adult
						season		
Embayment (Kole)	5 – 10 feet	30-40 feet	0 – 0.5 m/s Some time Stagnant	0.5 – 1.5 m/s	• Clay and silt around the embayment and sand deposited at the mouth of the embayment. • Vegetation is available. • People cultivate paddy, corn, ground nut, etc. on the side of the employment which makes an ideal habitat for fish.	• Slope is gentle. • Almost round shape and one side is connected with the main channel with a narrow neck. • Almost similar with sea lagoon. • No scour hole, no submerged or normal Charland. But dune may present.	Kajuli, Carp, Hilsha, Feka, Bailla, Chanda, Chikasi	Puti, Piali, Chingri, Gulsha Khorsholla, Bacha, Fesha
Charland Channel	1 – 3 feet	3-6 feet	0 – 0.5 m/s Some time Stagnant	0.5 – 1.5 m/s	• Mostly sandy clay and fine sand. • Often contain vegetation. • Some time char land people cultivate paddy on its bank.	• Narrow channel. Off take from main river, flowing through the charland up to few hundred meters to one kilometer. • Not very deep. • No scour hole, no submerged or normal charland, no dune. • Usually used for navigation inside the charland	Piali, Gulsha, Chela, Chikasi	Kajuli, Chingri, Bailla, Kora Puti
Bankside	1 – 10	30-60	0.75 – 1.25 m/s	1.25 –	• Beside bank Clay,	• Mainly eroded and almost strep	Air, Baghair,	Bailla, Rita, Baim,

Habitat Name	Average depth		Average Velocity		Substrate Profile	Cross section	Available fish species on preference basis	
	Dry Season	Wet Season	Dry Season	Wet Season			Young	Adult
	feet	feet		2.5 m/s	silt, silty clay, sandy clay, clay is present. And it depends on the type of the bank soil. • Vegetation found with the eroded pile of soil.	bank. • Deep scour hole found near the bank. • Erosion formed band.	Khorsholla, Kayakata	Ghira, Baus, Kajuli, Bacha, Fesa, Gulsha
Flood plain (in Chars)	1- 3 feet	3-8 feet	0 – 0.25 m/s Some time Stagnant	0.5 – 1m/s	• Clay and silt are main, but silty clay, sandy clay and after sand is present. • People cultivate paddy, Jute, Dhaincha etc. at the side of the embayment which makes an ideal habitat for fish.	• Look like a pond or pool. • Almost closed, during wet season a small narrow channel connected with pool. • Not very deep and doesn't contain any deep scour hole, sand bars etc.	Gulsha, Small Carp, Bailla	Chikasi, Kora puti, Piali, Chingri, Kajuli

6.3.3. Characteristics of Other Fish Habitats of the Project Influence Area

The eddy counter-current system at the confluence of Jamuna with its tributaries is an ideal place for fish assemblages. Bangali river, Ichamati river, Hurasagar river, Ghagot river, Manosh river, Alai river, Dhudkumar river and Teesta river which are connected either directly or through different canals with the Jamuna river forming a fish movement network in the entire project influence area. Boruah and Biswas (2002) recorded 77 fish species from the confluences of these tributaries of the Upper Brahmaputra river. The confluences are also the passageways for upstream fish migration.

The project influence area also has numerous seasonal and perennial *beels*/wetlands, some of which are connected with these rivers through the internal stream networks. Beels of the Brahmaputra basin are weed infested shallow water bodies temporarily or permanently connected with the main river. Beels act as feeding and breeding grounds for

many riverine species. However, beels do have a residential fish population. Besides, a considerable amount of seasonal floodplains exist within the project influence area which remain inundated for 1-4 months/year with average depth of 0.3 to 1 m. Aquaculture practice were found comparatively less frequent in the project influence area than other parts of the country, mostly because of recurrent flooding. Around 50 percent of the ponds found derelict in the project influence area. Location of different fish habitats and their profile generated during field investigation is furnished in **Table 6.4** and **Annex E**.

Table 6.4: Names and Location of Different Fish Habitats of the Projecct Influence Area

Upazila/District	Habitat type	Name/Number
Sirajganj Sadar	Canal (natural and manmade)	WAPDA Khal, Doi Vanger khal, Baliaghugri khal, Bahuka khal
	Beel/floodplain	Aminpur beel, Joynagar beel, Charkhada, Chatiantolir beel, Ghuria beel, CNB Beel
	Embayment (Kole)	Simla kole, Mothiar kul - Pachthakuri, Balutia-Moshamara
	Pond	62 no.
Kazipur, Sirajganj	Canal (natural and manmade)	Halot khal, Meghai khad
	Beel/floodplain	Paikartoli beel, Chalita danga beel, Vhut baria beel, Kachihara beel, Pagol kandi beel
	Embayment (Kole)	
	Pond	88 no.
Dhunat, Bogra	Canal (natural and manmade)/river	Manos river, Madhob Danga, Shimul bari khal
	Beel/floodplain	Jagiar beel, Bera danger beel, Houra khali beel
	Embayment (Kole)	Pukuria, Sariakandi, Shamol bari, Baniajan, Adhanagar, Boishakhi, Chunia para
	Pond	99 no.
Sariakandi, Bogra	Canal (natural and manmade)	Kata khal, Kuripara canal, Shalukar canal, Char bati canal
	Beel/floodplain	Dauli beel, Vakir beel, Bera beel, Dikdar beel, Dighol kandi beel, Satbilla beel, Kalaihata beel, Burungir beel, Gojariar beel
	Embayment (Kole)	Antarpara kole, Nich Kola, Khurda boloi, Maiz bari, Taltola, Kazlar kole, Gobindapur, Nolcia, Beragram, Holdia
	Pond	95 no.
Sonatola, Bogra	Beel/floodplain	Saluka beel
	Embayment	

Upazila/District	Habitat type	Name/Number
	(Kole)	
	Pond	18 no.
Shaghata, Gaibandha	Beel/floodplain	Kharkhara, Charagata, Ghoridaho, Kachur beel, Beel bosta, Vagir beel, Napiter beel
	Embayment (Kole)	Hatbari, Pansi para, Shaghata, Kachuar kole, Bashhata, Shatilla
	Pond	46 no.
Fulchari, Gaibandha	Canal (natural and manmade)/River	Ghaghot river, Alai river, Gopaldoba
	Beel/floodplain	Singrai beel, Gauchulki beel, Khathuria beel, Kabilpur beel, Gun bhuri, Ratanpur beel
	Embayment (Kole)	Khazjani Kole, Coach khali kole
	Pond	67 no.
Gaibandha Sadar	Canal (natural and manmade)	Kamarjani khal, Dara/Canal
	Beel/floodplain	Vela goa beel, Pakhimara beel, Puiya gara beel, Purbo Baroboldia beel, Gidari beel
	Embayment (Kole)	Uttar gidari kole, Gorain kole, Kalaibari, Khazjani, Gidari, Khana bari, Kamarjani, Koraibari, Matikhola
	Pond	261 no.
Chilmari, Kurigram	Canal (natural and manmade)/River	Sorai river, Gidari canal, Antarpur canal
	Beel/floodplain	Chang mari beel, Nakhali beel, Baharer beel, Hasar dala beel, Mohisalar beel, Magurar beel, Shol dukri, Kodal daho beel, Kalir pati, Rajar ghat, Ranigonj (Domer hat), Khaye ghat, Hagritola beel, Koyar beel
	Embayment (Kole)	Agabor kole, Horipur-1, Horipur-2, Hasher beel kole, Bahattor kole, Haser vita kole, Kachkole, Kolapani, Badhdhara, Uttarowari, Bongram
Ulipur, Kurigram	Beel/floodplain	Anantapur beel, Paglir kuri, Nayantapur, Chirokhaoya dola, Malchar par, Kosulla, Singramari, Kossa, Darki mari beel, Chokchoka beel
	Embayment (Kole)	Jolanger kuthi, Anatapur kole, Kolakata, Gujimari
	Pond	51 no.
Kurigram Sadar	Canal (natural and manmade)	Girai nodi/Khal
	Beel/floodplain	Ponchasar beel, Jobber munsher beel, Amluddi

Upazila/District	Habitat type	Name/Number
		hazir beel, Kazol daho, Dubba churi, Gagla beel, Sarisui beel, Dolarpar beel, Sonalir khuthi beel, Hodir beel, Koi ghuri, Duba churi, Kazol daho, Pachgaciar chora, Misti parar beel
	Embayment (Kole)	Gobindopur, Perbotti pur, Vushakuthi, Sarkerpara vanga, Prothom alo kole, Bangar dola kole, Kath giri kole, Pocha kata kole, Shantiar kole, Rolakata kole, Narayanpur kole, Astoasi kole, Jhumkar kole
	Pond	50 no.

Source: Field Investigation, IUCN Bangladesh, 2014.

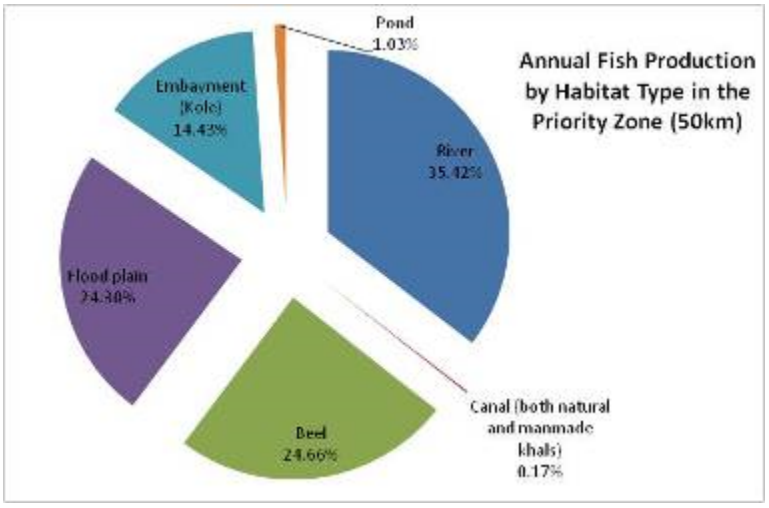
6.4. Fish Production

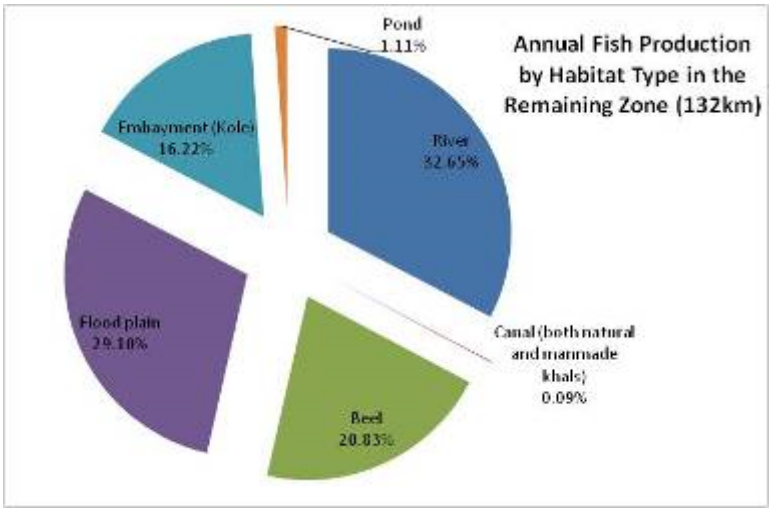
Annual total fish production of the project influence area has been estimated as about 8500 metric ton of which river contributes the largest share (34 percent) followed by floodplain (27 percent), beel (22 percent), kole (16 percent) and pond culture (01 percent) (**Table 6.5**, **Figure 6.4**). Fish production from canals/streams is insignificant as most of those are either dried up during peak dry season or remain closed by flood control structures. Unlike other areas of the country, bulk of the fish production comes from open water or capture fisheries sources as opposed to fish cultures.

Table 6.5: Annual Fish Production of Project Influence Area

Fisheries Type	Fish Habitat	Annual Production (tonnes)		
		Priority Zone (50km)	Remaining Zone (132km)	Project Area (182km)
Capture	River	1138.76	1725.91	2864.67
	Canal (both natural and manmade khals)	5.48	4.94	10.41
	Beel	792.74	1101.22	1893.96
	Flood plain	781.29	1538.67	2319.96
	Embayment (Kole)	463.84	857.52	1321.36
	Sub-total	3182.10	5228.25	8410.36
Culture	Pond	32.98	58.58	91.56
	Sub-total	32.98	58.58	91.56
Total		**3215.08**	**5286.83**	**8501.92**

Source: Field investigation, September 2014, IUCN





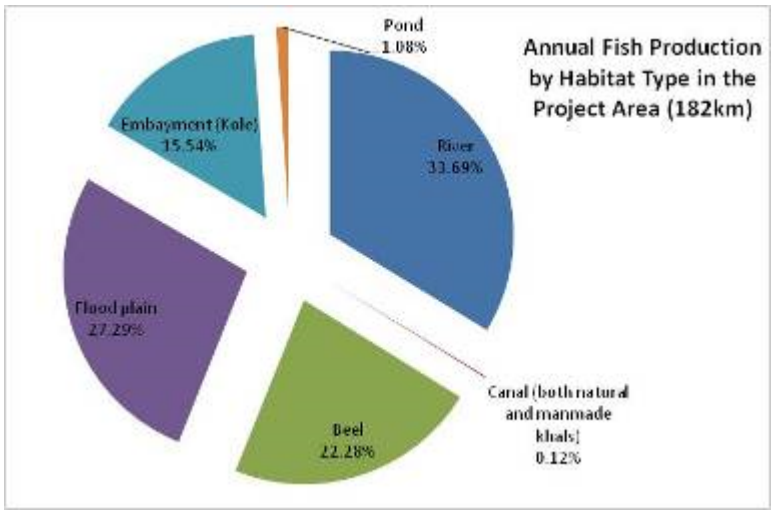
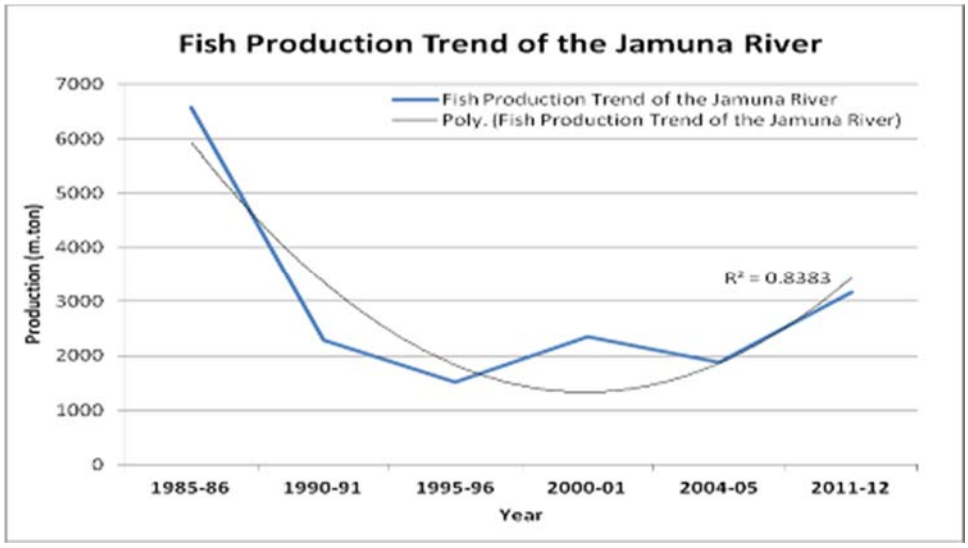
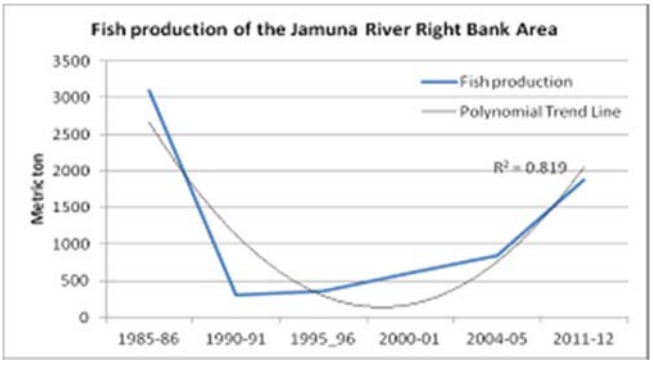
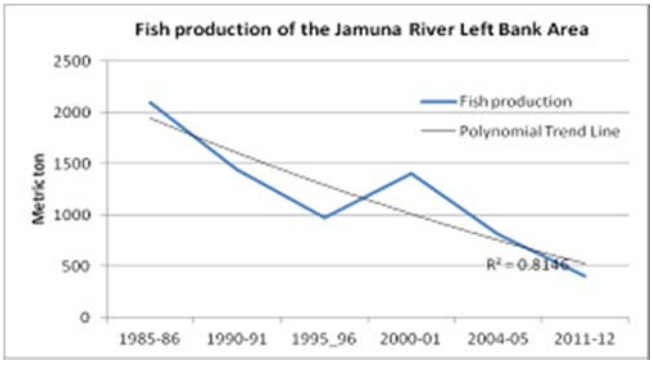


Figure 6.4: Fish Production (%) by Habitat Type

The fish production of the Jamuna river has been declining continuously until recently (trend analysis of the FRSS time series data 1984-2012). Annual total fish production decreased approximately 3,200 tonnes in 30 years. A sharp decline of fish production took place during the 80s, a trend that continued until the year 2004-05. After that in last few years fish production has been improving. More specifically, increasing trend of fish production has been found along the bank of Sirajganj, Gaibandha and Kurigram districts, whereas it has decreased in Bogra. On the other hand, fish production along the left bank is consistently declining since early 80s. Fish production was decreasing because of increased fishing pressure and a decrease in the extent of floodplain habitats caused by the construction of flood control, drainage and irrigation systems, and the consequent obstruction of fry and fingerlings from rivers. Further declines of fish production are anticipated when all the planned water control projects are completed. Increasing trend of fish production in recent times can be attributed to the enforcement of fisheries regulations by DOF, banning fishing during breeding season, improving resources management and establishing sanctuaries. **Figure 6.5** shows polynomial trend analysis of the Jamuna river fish production.







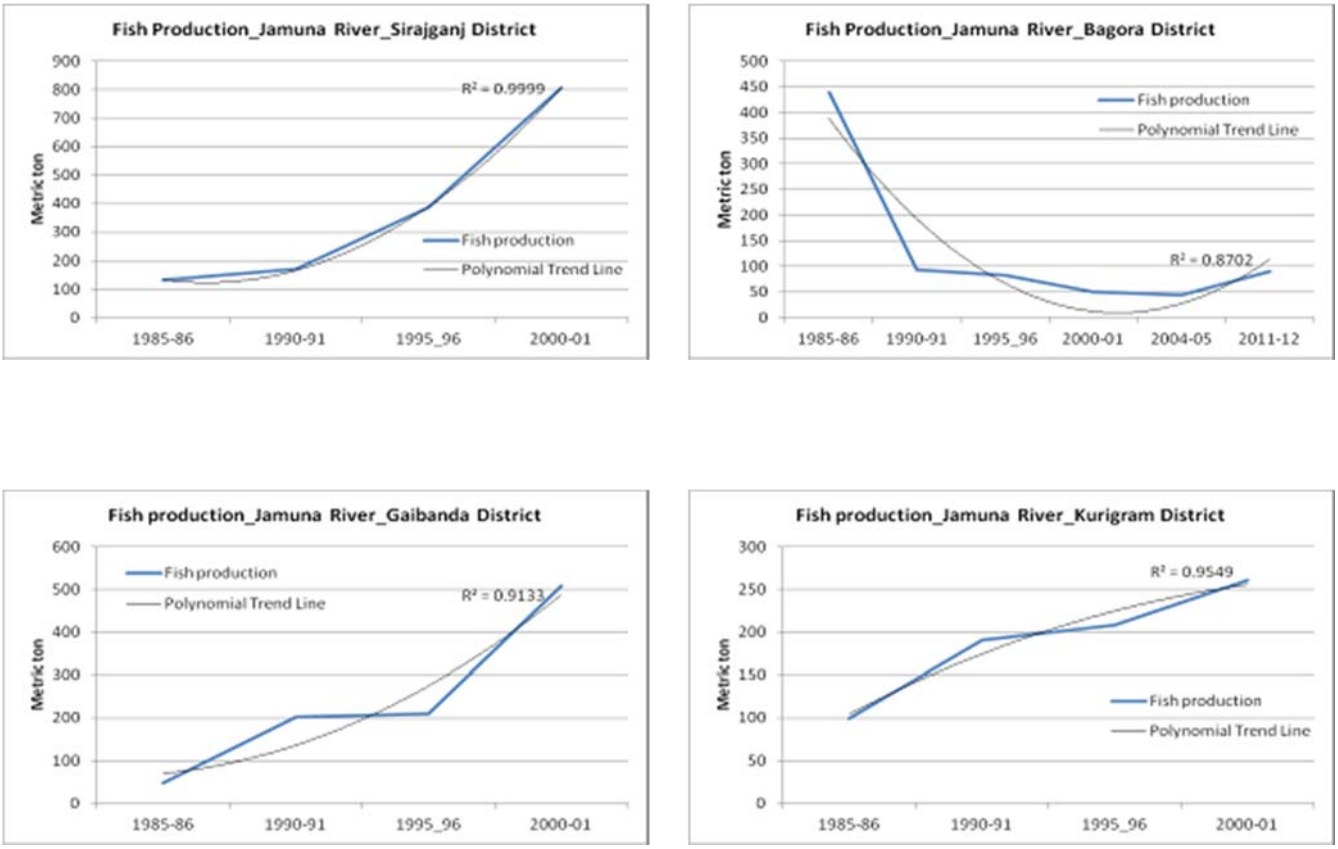


Figure 6.5: Fish Production Trend of the Jamuna River (FRSS, DoF 1984-2012)

Among the upazilas at the right bank of the Jamuna river, Kazipur of Sirajganj, Sonatala and Sariakandi of Bogra are the most productive zone due to good connectivity between the main river and its floodplains. According to Lasne et al., 2007; Leigh et al., 2010 and Arthington & Balcombe, 2011 the single most important factor for the persistence of the fish assemblage in an isolated wetland is the flow connection between the wetland and a main stream.Upazila wise fish production by habitat types is furnished in **Table 6.6**.

Table 6.6: Annual Fish Production Status of Project Influence Area

Zone	Upazila/District	Habitat type	Production (tonnes)
Priority zone	All	River	1138.76
Remaining zone			1725.91
	Sub-total		2864.67

Zone	Upazila/District	Habitat type	Production (tonnes)
Priority zone	Sirajgang Sadar	Canal	0.04
		Beel	11.69
		Flood plain	6.65
		Embayment (Kole)	222.76
		Pond	6.90
		Total	**248.02**
	Kazipur, Sirajgang	Canal	3.17
		Beel	547.35
		Flood plain	500.00
		Embayment (Kole)	81.92
		Pond	7.84
		Total	**1140.28**
	Dhunat, Bogra	Canal	1.20
		Beel	49.20
		Flood plain	64.50
		Embayment (Kole)	36.16
		Pond	8.96
		Total	**160.02**
	Sariakandi, Bogra	Canal	1.07
		Beel	184.50
		Flood plain	210.14
		Embayment (Kole)	123.01
		Pond	9.28
		Total	**528.00**
	Sub total (priority zone)		**3215.08**
Remaining zone	Sonatola, Bogra	Canal	0.48
		Beel	2.46
		Flood plain	2.68
		Embayment (Kole)	7.68
		Pond	3.84
		Total	**17.14**
	Shaghata, Gaibandha	Canal	0.00
		Beel	6.24

Zone	Upazila/District	Habitat type	Production (tonnes)
		Flood plain	4.02
		Embayment (Kole)	112.24
		Pond	4.93
		Total	**127.43**
	Fulchari, Gaibandha	Canal	0.00
		Beel	36.72
		Flood plain	48.59
		Embayment (Kole)	24.46
		Pond	5.95
		Total	**115.72**
	Gaibandha Sadar	Canal	0.22
		Beel	367.20
		Flood plain	396.31
		Embayment (Kole)	64.11
		Pond	21.59
		Total	**849.43**
	Chilmari, Kurigram	Canal	2.97
		Beel	220.00
		Flood plain	297.58
		Embayment (Kole)	64.96
		Pond	7.48
		Total	**592.99**
	Ulipur, Kurigram	Canal	0.61
		Beel	418.00
		Flood plain	745.63
		Embayment (Kole)	389.73
		Pond	7.14
		Total	**1561.11**
	Kurigram Sadar	Canal	0.66
		Beel	50.60
		Flood plain	43.86
		Embayment (Kole)	194.34

Zone	Upazila/District	Habitat type	Production (tonnes)
		Pond	7.65
		Total	**297.11**
	Sub total (remaining zone)		**5286.83**
	Grand total		**8501.92**

Source: Field investigation, September 2014, IUCN

6.5. Fishing Effort

6.5.1. Number of fishermen

More than 3500 fishermen were found during the catch assessment survey along the right bank. Fishing is one of the available livelihood options for most of the landless people of the project influence area. The people that become landless due to river bank erosion thus losing their traditional earning sources usually turn into fishermen. Hence, overall catch per fisher is declining due partly to the growth in the number of fishing efforts.

6.5.2. Fishing pattern

The pattern of fishing along the right bank is found similar to the Padma river with a major peak in the pre-monsoon season (April-July) and a second peak in the post-monsoon season (October-December). This largely coincides with the migratory movements of many fish species, particularly amongst the hilsa, catfishes and cyprinids. Catfishes and major carps are much prominent in Jamuna. Major carps are also key indicators of the Jamuna river system. They were originally a dominant group in the river and floodplain eco-system. They are amongst the most highly regarded of the fish species with respect to commercial value and also for aquaculture.

6.5.3. Fishing gears and crafts

An attempt has been made to investigate the fishing gears available in the project influence area during catch assessment survey. Detail information on the gears specification was also collected in this respect. **Table 6.7** and **Figure 6.6** summarize target fishes and catch per unit effort (CPUE) of different types of fishing gears used in open water fishing. Gill net, long line and cast net got the highest CPUE (2-2.71 kg/hr/gear).

Table 6.7: Fishing gear efficiency

Fisheries Type	Fishing Gears	Target Fish Species	Fish catch per unit effort (Kg/hr/gear)
Capture	Gill net (Phasi jal)	Hilsa and Large Cat fishes (Boal, Rita, Aire, Bagaire)	2.71
	Seine Net/ Ber jal (Kazoli jal)	Kazoli and Mixed SIS*(Baila, Chingri, Poa, Bata, Pabda)	0.13
	Current jal (Mono filament net)	Mixed Small Indigenous Species (SIS) (Tengra, Puti, Chela, Bashpata, Bele)	0.32

Fisheries Type	Fishing Gears	Target Fish Species	Fish catch per unit effort (Kg/hr/gear)
	Lift net (Vesal Jal)	Kazoli and Mixed SIS	0.13
	Push net	Mixed SIS	0.13
	Cast net	Mixed SIS	2.00
	Moi Jal	Mixed SIS	0.13
	Trap (Doair chai)	Mixed SIS	0.13
	Angling	Boal, Chital,Taki,Baim	0.81
	Long line	Boal, Chital,Aire, Guji	2.71

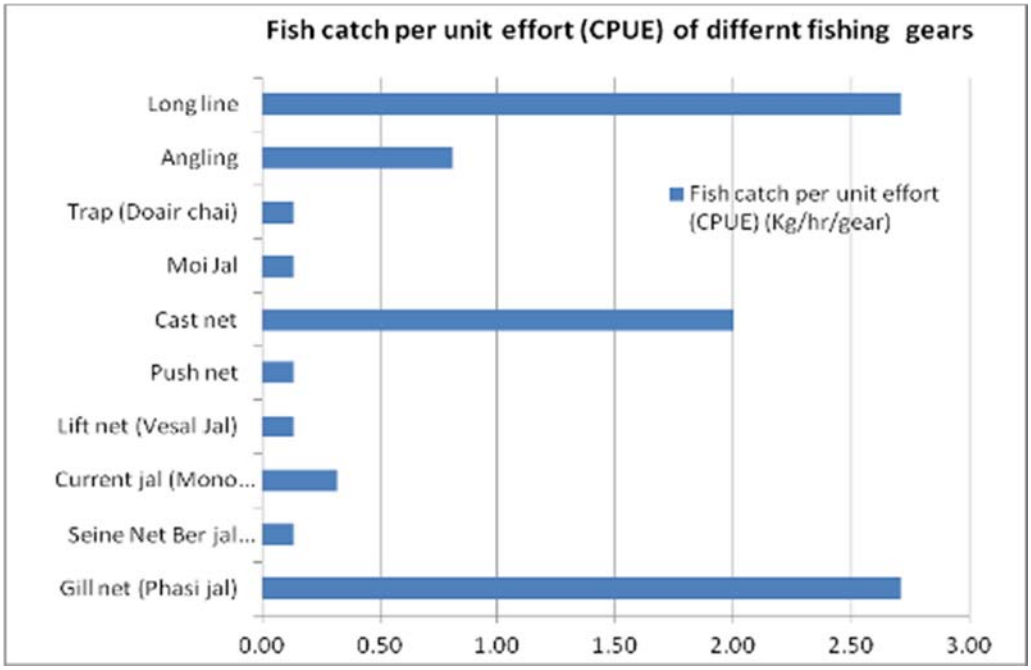


Figure 6.6: CPUE of the different fishing gears

A total of about 1800 fishing crafts were found during catch assessment survey. Some fishing gears like gill nets (for hilsa catch) and seine nets (for mixed fishes) need multiple fishermen for operation. Pictorial view of the fishing crafts and gears are given in the **Figure 6.7**. Operational specification of different fishing gears are furnished in the **Table 6.8**.

Figure 6.7: Different types of fishing gears and crafts of the project influence area

Table 6.8: Fishing gears and their operational specification

Fishing gears	Total no. of gear	Mesh size (inch)	Length (m)	Fishing depth (m)	Fishermen engaged per gear	Average duration/ haul (hr)	Average no. of haul/day
Gill net (Phasi jal)	30	12-14	365-950	14-22	8-12	2.5 – 3	3
Seine Net/ Ber jal (Kazoli jal)	55	0.25	90-275	9-15	7-12	2-2.5	3-6
Current jal (Mono filament net)	76	1-2	55-140	0.70-1.83	1-2	3-12	1-2
Lift net (Vesal Jal)	14	0.25-1	4.60-7.31	-	1-2	0.083-0.25	36-144
Push net	8	0.25-0.5	-	-	1	0.033-0.07	15-40
Cast net	16	0.5-1	-	-	1	0.07-0.17	10-30
Moi Jal	6	0.25-1	15-24	5-10	2-4	1.5-3	2-5
Trap (Doair chai)	25	-	-	-	1	3-12	1-2

6.5.4. Fishing Season

Hilsa and carps are the dominant species of the Jamuna River. The first hilsa fishing season starts in June (15th) and continue up to August (15th). Second Hilsa fishing season starts in September (15th) and continue up to October (15th). Rest of the time fishermen

are mainly engaged in other fishing. Fishing using Ber jal (Kazli jal) continue for seven months (November –May). Different fishing traps are generally used by the fishermen during dry season months. The seasonality of major fishing types in different habitats are furnished in **Table 6.9**. Fishing season as per gears operated for hilsa fishing is furnished in **Table 6.10**.

Table 6.9: Fishing Seasonality of Different Habitats

Habitat	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
River	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
Canal				✔	✔	✔	✔	✔	✔	✔	✔	
Floodplain				✔	✔	✔	✔	✔	✔	✔		
Embayment (Kole)	✔	✔	✔	✔						✔	✔	✔
Beel	✔	✔	✔	✔						✔	✔	✔

Table 6.10: Crafts and Gears Used for Hilsa Fishing

Type of Net	Local Name	Craft used	Nos. crew	Operation Season	Fishing type
Set gill net	Gara jal	Kosa	6-8	Nov-Feb	Gilling & Selective
	Dhara jal	Kosha	4-6	May-Oct	Gilling & Selective
	Daba jal	Kosha	4-6	May-Oct	Gilling & Selective
	Bundhi jal	Dingi	10-15	Jan-May	Gilling & Pocket Selective
Drift gill net	Current jal	Dingi/kosha	2-4	Year round	Gilling & Selective
	Gulti jal	Chandi	8-10	May-Oct	Pocketing
	Kona jal	Chandi	8-10	May-Oct	Gilling & Pocketing
Clap net	Shangla jal	Dingi/kosha	2	Aug-Oct	Trapping
	Kharki jal	Kharki	2	Aug-Oct	Trapping
Seine	Jagat ber	Chandi	40-50	Jan-May	Encircling
	Ber jal	Chandi	30-40	Jan-May	Encircling
Lift net	Khara/Bhesal	Dingi	1-2	Jan-May	Lifting

6.6. Fish Biodiversity

Huge number of stagnant water bodies in chars and river channels support a habitat of rich fish biodiversity. Rahman and Akhter (2007) identified 156 fish species of which 89 are commercially important and 53 are rare in the river. Thousands of fishermen are dependent on this river. FAP 17 (1995) carried out a catch assessment survey in Jamuna and Padma rivers during March 1993 - February 1994. The study classified the fish species according to their preference of habitat namely riverine, migratory and floodplain resident. The study identified 68 fish species for Jamuna, out of which 22 were riverine,

18 migratory, and 28 floodplain resident. Catches from Jamuna accounted 60 percent of riverine species, whereas migratory and floodplain resident fish species were equally abundant on the Jamuna comprising 13 percent. Hilsa was the dominant species occupied 31 percent of the catch. The study noted that the number of floodplain species found in the catch during winter highlights the importance of the extensive areas of these large rivers as shelter during a critical period in the hydrological cycle when the area of perennial water on the floodplain is at a minimum. Jamuna river is renowned for its high diversity of the small indigenous fish species (SIS). Some of the fishes like Piyali (Joya) are only now available in Jamuna and its adjacent floodplain (**Figure 6.8**). Large Hilsa is only available up to Sirajganj. A list of abundant species found during the catch assessment survey and determined through FGD in the project influence area is furnished in **Table 6.11**.

Figure 6.8: Small Indigenous Species (SIS) of the Jamuna River

Table 6.11: Indicative Fish Species Diversity of Different Habitats and their Breeding Period

A=Absent; P=Present

Scientific Name	Local Name	Common Name	Habitat Type			
			River	Khal	Wet land	Breeding Period
Labeo rohita	Rui	Rohu	P	P	P	April- August
Catla catla	Catla	Katla	P	P	P	June-July
Cyprinus carpio	Carpu		A	A	P	June-July
Labeo calbasu	Calbaus	Black Rui	P	P	P	During monsoon
Labeo gonius	Gonia/Goni		P	P	P	April- August

Scientific Name	Local Name	Common Name	Habitat Type			
			River	Khal	Wet land	Breeding Period
Labeo bata	Bata	Bata Labeo	P	P	P	Between June and October
L.boga	Bhangon	Boga Labeo	P	P	A	April-July
L .boggut		Boggut Labeo	P	P	A	
L. nandina	Nandil	Nandi Labeo	P	P	A	
Cirrhinus mrigala	Mrigal	Mrigal	P	P	P	May-July
C. reba	Raik, Lachu	Reba	P	P	A	May-July
Crossocheilus latius	-	Gangetic Latia	P	A	A	Not known
Channa. punctatus	Taki	Spotted Snakehead	P	P	P	April-June
C. orientalis	Cheng/Teli taki	Asiatic Snakehead	P	P	P	April-June
C. striatus	Shol	Snakehead Murrel	P	P	P	Almost through the year
C. marulius	Gajar	Giant Snakehead	P	P	P	April-June
Mystus vitatus	Tangra	Striped dwarf Catfish	P	P	P	During monsoon
M. tengara	Bajari tengra	Tengara Mystusa and Pearl catfish	P	P	P	During rainy season
M. bleekeri	Tengra	Day's Mystus	P	P	P	May-June
M. cavasius	Gulsa tengra	Gangetic Mystus	P	A	A	Data is not available
Lepidosephalus guntea	Gutum	Guntea Loach	P	P	P	April-July
Acanthocobitis botia	Balichata, beelturi	Zipper/ sand loach	P	A	A	Data is not available
Somileptes gongota	Cheng/Gutum	Gongota Loach	P	P	P	Data is not available
Heteropneutes fossilis	Shing	Stinging catfish	A	A	P	June-December
Clarias batrachus	Magur	Walking catfish	A	A	P	May-July
Amblypharyngodon mola	Mola	Indian Carplet	P	P	P	May- October
Osteobrama cotio	Dhala	Cotio	P	P	P	June-September
Anabas testudineus	Koi	Climbing parch	A	A	P	June-July
Chanda baculis	Chanda	Himalayan glassy perchlet	P	P	P	During monsoon
C. nama	Nama chanda	Elongate glassy perchlet	P	P	A	March-October

Scientific Name	Local Name	Common Name	Habitat Type			
			River	Khal	Wet land	Breeding Period
Pseudambassis ranga	Ranga chanda	Indian glassy fish	P	P	A	During monsoon
Colisa fasciata	Khalisa	Striped Gourami	P	P	P	During monsoon
Colisa lalia	Baicha	Dwarf gourami	P	P	P	During monsoon
Colisa chuna	Chuna kalisha	Honey gourami	P	P	P	During monsoon
Chela cachius	Chap chela	Silver hatchet chela	P	P	P	April –May
C. laubuca	Lauboka	Indian grass barb	P	P	P	During monsoon
Gudusia chapra	Chapila	Indian river shad	P	P	P	During monsoon
Chitala chitala	Citol	Humped Feather back	P	P	p	June-July
Notopterus notoperus	Foi	Grey- Feather back	P	P	p	May-June
Ompok pabda	Modhu pabda	Pabdah Catfish	P	A	A	June –Mid August
Ompok bimaculatus	Kani/ Boali pabda	Indian butter-catfish	P	P	P	June –Mid August
Xenentodon cancila	Kakila	Freshwater Garfish	P	P	P	During monsoon
Glosoglobius guris	Baila	Tank Gobi	P	P	P	May -October
Brchygobius nunus	Nona Baila	Golden banded goby	P	A	A	Not known
Apocryptes bato	Chaoya baila	Goby	P	A	A	Not known
Tenualosa ilisha	Ilish	River hilsha	P	P	A	January-February
Aspidoparia jaya	Jaya	Piali	P	A	A	Winter and monsoon
Esomus danricus	Darkina	Flying Barb	P	P	P	August-October
Puntius cholo	Chala puti	Chola barb	P	P	P	May –October (Pick August)
P. conchonius	Kanchon puti	Red barb	P	P	P	May –October (Pick August)
P.guganio	Mola puti	Glass barb	P	P	P	May –October (Pick August)
P.sarana	Sarputi	Olive Barb	P	P	P	May –October (Pick August)
P. sophori	Jat puti	Soft fin Barb	P	P	P	May –October (Pick August)
P.terio	Teri puti	One spot Barb	P	P	P	May –October (Pick August)

Scientific Name	Local Name	Common Name	Habitat Type			
			River	Khal	Wet land	Breeding Period
P.ticto	Tit puti	Ticto Barb	P	P	P	
Rasbora rasbora	Leuzza darkina	Gangetic Scissortail Rasbora	P	P	A	
Raiamas bola	Bol	Indian trout	P	P	A	Early monsoon(April-May)
Salmostoma bacaila	Chela	Laagre Razorbelly Minnow	P	P	P	April-August
Salmophasa. phulo	Ful chala	Fine Scaled razor Belly Minnow	P	P	P	April-October
Securicula gora	Ghora chela	Gora-chela	P	P	P	April-August
Botia dario	Beti	Necktie Loach	P	P	P	During monsoon
Mystus aor	Aor	Long whishkeper Cat fish	P	P	A	Monsoon(June)
M. seenghala	Guizza ayer	Gaint river catfish	P	P	A	Early monsoon (June)
Rita rita	Rita/Eta	Rita	P	P	P	During monsoon (Peak: July-August)
Nangra nangra	Gang tengra	Kosi Nangra	P	A	A	During monsoon
Goganga viridescens	Gang tengra	Huddah tengra	P	P	A	Not known
Gagata youssoufi	Gang tengra	Gangatic gagata	P	A	A	During monsoon
Bagarius bagarius	Bagha aore	GangeticGoonch & Devil catfish	P	P	A	April-July
Hemibagrus menoda	Gang magur	Menoda catfish	P	P	A	April - August
Wallago attu	Boal	Fresh water shark	P	P	P	June- August
Ailia coila	Kajoli	Gangetic Aila	P	P	A	July-September
Clupisoma garua	Gharua	Garua Bacha	P	P	A	March-August
Clupisoma naziri	Muri Bacha	Indus Garua	P	P	A	
Eutropiichthys vacha	Bacha	Batchwa bacha	P	P	A	June-September
Pseudeutropius atherinoides	Batashi	Indian Potasi	P	A	A	Mid May-Mid July
Gagata cenia	Cenia	Indian Gagata	P	A	A	

Scientific Name	Local Name	Common Name	Habitat Type			
			River	Khal	Wet land	Breeding Period
Chaca chaca	Cheka	Squarehead Chaka	P	A	A	During monsoon
Monopterus cuchia	Kuicha	Cuchia/Gangetic mudEel	P	P	P	
Nandas nandas	Meni	Mud perch	P	P	P	April - September
Rhinomugil corsula	Corsula	Corsula Mullet	P	P	A	Apri-July
Macrognathus aculeatus	Tara baim	Lesser spinyeel	A	P	P	During monsoon
Macrognathus pancalus	Baim	Striped Spinyeel	A	P	P	Between May and August
Mastacembalus armatus	Sal baim	Tire-track Spinyeel	P	P	P	June- July and November
Tetraodon cutcutia	Potka	Ocellated Pufferfish	P	P	P	During monsoon
Macrobrachium rosenbargii	Golda chingri	Fresh water/ Giant river prawn	P	P	P	April
M. villosimanus	Dimua icha	Dimua river prawn	P	P	P	June-July
Labio calbasu	Calbaus	Black Rui	P	P	P	June-July
Tenualosa ilisha	Ilish	Hilsa	P	P	A	Feb-Mar and October
Aspidoparia jaya	Piyali	Jaya	P	P	P	June-July

Based on literature review, FGD and Catch Assessment Survey during field Investigation, August-September, 2014) N=89

6.7. Species of Conservation Significance

A total of 260 species of fishes were found in the northwestern region of the country of which 143 belonged to small fishes (Fresh Water Fishes of Bangladesh, 2005). More than 41 species of small fishes are on the verge of vulnerability now. These include: Shankha, Fansha, four varieties of Puti, Khayera, Pabda, Panikoi, Bancha, Milon, Yellow Tengra, Bele, Ganges Pangas fish, Bheda fish, Piyali, and Bou fish. Based on the red list (2000), species of conservation significance in the Jamuna is given in **Table 6.12**. Out of 54 threatened fishes of the country 29 were found in the project influence area during field investigation.

Table 6.12: List of Species of Conservation Significance

Scientific name	Local name	Common name	CR	EN	VU
Labeo calbasu	Kalbasu	Black Rohu		✔	
L. gonius	Gonia	Kuria Labeo		✔	

Scientific name	Local name	Common name	CR	EN	VU
L. boga	Bangon bata	Boga Labeo	✔		
L. nandina	Nandil	Nandi Labeo	✔		
Cirrhinus reba	Raik, Vagna	Reba			✔
Chela laubuca	Lauboka	Indian grass barb		✔	
Puntius ticto	Tit puti	Ticto barb			✔
P. sarana	Sar puti	Olive barb	✔		
Ompok bimaculatus	Kani pabda	Indian Butter Catfish		✔	
Ompok pabda	Modhu pabda	Pabdah Catfish		✔	
Ompok pabo	Pabda	Pabo Catfish		✔	
Clupisoma garua	Gharua	Garua Bacha	✔		
Eutropiichthys vacha	Bacha	Batchwa bacha	✔		
Bagarius bagarius	Bagghair	Gangetic Goonch	✔		
Chaca chaca	Cheka	Indian Chaka		✔	
Rita rita	Rita	Rita	✔		
Mystus aor	Aor	Long whishkeper Cat fish			✔
M. seenghala	Guizza Ayer	Gaint river catfish		✔	
Monoptenus cuchia	Kuicha	Cuchia			✔
Chanda nama	Nama Chanda	Elonget Glass-perchlet			✔
Pseudambassis ranga	Ranga chanda	Indian Glassy fish			✔
Nandas nandas	Meni	Mud perch			✔
Botia dario	Rani	Necktie Loach		✔	
Channa marulis	Gajar	Giant snakehead			✔
C. gachua	Cheng	Asiatic snakehead			✔
Macrognathus aculatus	Tara baim	Lesser –spiny eel			✔
Mastacembalus armatus	Sal baim	Tire-track Spinyeel		✔	
Notopterus notopterus	Foli	Grey-Featherback			✔
Chitala chitala	Chital	Humped Featherback		✔	

CR= Critical Endangered , EN= Endangered, UV =Vulnerable

6.8. Area of Conservation Significance

FAP 2 (1991) identified 6 principal carp spawn collecting sites along the Brahmaputra-Jamuna mainly on its right bank (**Figure 6.9**).

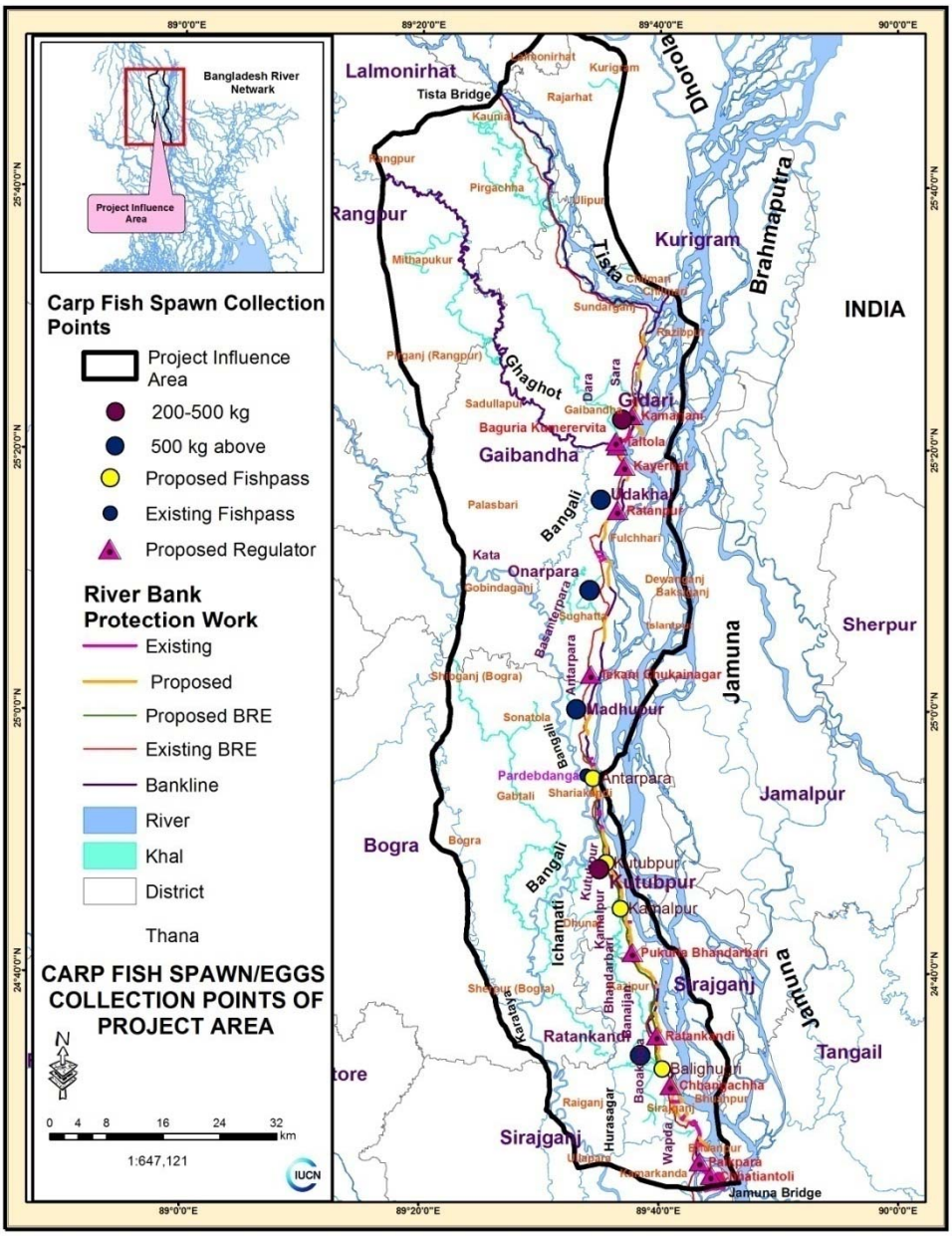


Figure 6.9: Carp Spawn Collection Points of the Jamuna River

Important carp spawn/egg collection stations are Ratankandi, Madhupur, Anterpur, Udakhal, Kutubpur, and Gidari. River areas adjacent to these spawn/egg collection stations are considered as carp breeding grounds of the Jamuna river. Carp spawn collection has been decreasing remarkably over the last three decades (**Figure 6.10**). In

the year 2012, total 1514 kg egg/spawn was collected from different breeding spots of the Jamuna river (FRSS, 2012). Spawn/egg collection status of the year 2012 is given in **Table 6.13**.

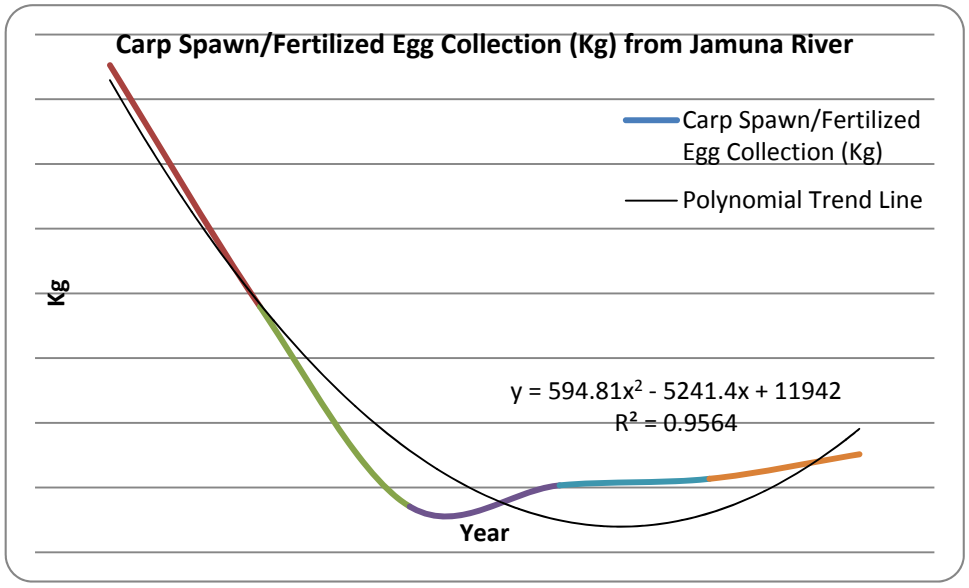


Figure 6.10: Carp Spawn Collection Trend of the Jamuna River

Table 6.13: Carp Spawn/Fertilized Egg Collection from Jamuna River in 2012 (FRSS, 2012)

Location	Collection Center	River	Frequency of Spawning Time	Quantity of Spawn / Fertilized Egg Caught (kg)	Price BTK per kg
Kazipur (Sirajganj)	Singrabari, Khudbandi	Jamuna	1	80	1,650
Sirajganj	Vatpiary, Puthiabari,Char Malsapara	Jamuna	2	175	1,600
Shajadpur (Sirajganj)	Enayatpur,Sonatali,Hat pachil, Bharakola	Jamuna	1	24	4,000
Chauhali (Sirajganj)	Khashpukuria	Jamuna	2	800	1,200
Belkuchi (Sirajganj)	Khidramati,Delua,Thak urpara, Jangalia	Jamuna	3	120	2,000
Sariakand (Bogra)	Devdango to Sbanbairdo	Jamuna	2	215	1,200
Bera (Pabna)	Goghunathpur	Jamuna	3	215	3,500

Note: All the above locations, except Bera, are located in PIA.

The project influence area has some embayments (Kole) and perennial beels which serve as feeding grounds and provide shelter during over wintering period. Important water bodies mentioned by the fishermen during FGD and field investigation are given in **Table 6.14**.

Table 6.14: Areas of Conservation Significance (Field Investigation)

Name of fish habitat	Area (in ha) and Location	Distance from Embankment
Simlar kole	2.67 ha; Baliaghugri, Sirajganj;	4 km east from proposed Baliaghugri regulator
Mothiar kul/ Pachthakuri kole	3.34 ha; Baliaghugri, Sirajgong;	1.25 km north-east from proposed Baliaghugri regulator
Pukuria kole	6.68 ha; Pukuria, Dhunat, Bogra;	0.75 km east from proposed Pukuria – Vanderbari regulator
Sariakandi kole	0.67 ha; Bogra	0.5 km east from proposed embankment
Boishakhi kole	5.34 ha; Dhunat, Bogra;	1 km east from existing Shamolbaria spur
Chunia para kole	40.08 ha; Dhunat, Bogra;	0.5 km east from proposed Kamalpur regulator
Taltola kole	66.80 ha; Sariakandi, Bogra;	4km east from Sariakandi fish pass, Bogra
Kazlar kole	10.69 ha; Sariakandi, Bogra ;	2 km east from the proposed embankment

Department of Fisheries (DoF) has established some fish sanctuaries in the project influence area with the help of local fishing communities to promote sustainable harvesting. The objective of the sanctuaries is to avoid fishing in these sanctuaries during spawning periods. These sanctities have no legal status. **Table 6.15** showing a list of existing fish sanctuaries established by the DoF. **Figure 6.11** shows fish sanctuaries of the project influence area established by DoF. Most of these sanctuaries are not well managed.

Table 6.15: Existing Fish Sanctuaries of the Project Influence Area (Source: DoF)

Name of Sanctuary	Location				Distance from River Bank line (km)	Water body Name	Geo-location	
	Mouza	Union	Upazila	District			Latitude	Longitude
Fakirpasha	Somnarayan	Nazimkhan	Rajarhat	Kurigram	Tista -2.44 Dhorala-12.43 Brahmaputra-17.07	Fakirpasha beel	25°44'1.92"N	89°33'2.00"E
Koteshar	Khitab Khan	Gharialdanga	Rajarhat	Kurigram	Tista -0.99 Dhorala-14.56 Brahmaputra-21.26	Koteshar beel	25°45'27.58"N	89°31'2.07"E
Gharildanga	Nafadanga	Rajarhat	Rajarhat	Kurigram	Tista -3.96 Dhorala-11.50 Brahmaputra-18.87	Gharildanga	25°45'54.99"N	89°32'51.72"E
Mashankura	Baman Sardar	Annadanagar	Pirgachha	Rangpur	Tista -6.94 Brahmaputra-26.02	Mashankura Mora nodi	25°41'34.59"N	89°26'24.54"E
Harudanga	Adam	Chhaola	Pirgachha	Rangpur	Tista -1.40 Brahmaputra-20.56	Harudanga beel	25°38'56.97"N	89°29'43.27"E
Tulshidanga	Janak Inathpur	Latifpur	Mithapukur	Rangpur	Ghaghot -8.96 Tista-23.32 Brahmaputra-38.49	Tulshidanga beel	25°34'43.70"N	89°17'52.21"E
Kafri khal	Majhgram	Bara Hazratpur	Mithapukur	Rangpur	Ghaghot -6.54 Tista-20.23 Brahmaputra-34.30	Kafri khal	25°32'18.51"N	89°20'18.69"E
Chokchoka	Baldi Bathan	Bara Hazratpur	Mithapukur	Rangpur	Ghaghot -6.46 Tista-20.86 Brahmaputra-35.69	Chokchoka	25°33'29.17"N	89°19'36.29"E
Meshta	Meshta	Sanerhat	Pirgang	Rangpur	Ghaghot -12.05	Meshta	25°28'55.49"N	89°19'28.58"E

Name of Sanctuary	Location				Distance from River Bank line (km)	Water body Name	Geo-location	
	Mouza	Union	Upazila	District			Latitude	Longitude
					Tista-27.51			
					Jamuna-32.85			
Atrai beel	Hasaner Para	Bara Hazratpur	Pirgang	Rangpur	Ghaghot -9.29	Atrai beel	25°30'2.30"N	89°21'2.38"E
					Tista-22.37			
					Jamuna-31.02			
Serudanga	Bhagabatipur	Mirzapur	Mithapukur	Rangpur	Ghaghot -7.63	Serudanga	25°30'33.15"N	89°22'0.20"E
					Tista-20.71			
					Jamuna-28.94			
Borobila	Osmanpur	Pirgang	Pirgang	Rangpur	Ghaghot -11.42	Borobila	25°23'47.65"N	89°20'1.60"E
					Jamuna-30.47			
Ghagot river	Kholabari	Ballamjhar	Gaibandha	Gaibandha	Ghaghot -1.63	Ghagot river	25°19'56.52"N	89°31'30.99"E
					Jamuna-8.51			
Konai Brahmaputra kol	Beja Telkupi	Fazlupur	Fulchhari	Gaibandha	Jamuna -2.27	Konai Brahmaputra kol	25°14'7.45"N	89°38'5.02"E
					Bangali-7.13			
Talaijan Kalapani	Kalpani	Bonarpara	Sughatta	Gaibandha	Jamuna -5.92	Talaijan Kalapani	25° 8'24.81"N	89°32'41.66"E
					Bangali-4.24			
Nizkakra	Sekher Kola	Sekher Kola	Gabtali	Bogra	Jamuna -18.00	Nizkakra beel	24°54'0.93"N	89°23'50.56"E
					Bangali-15.59			
Mohicharan	Ganiarkandi	Digdair	Sonartala	Bogra	Jamuna -8.91	Mohicharan beel	24°56'5.14"N	89°28'43.95"E
					Bangali-6.64			
Bangali	Fulbari	Fulbari	Sariakandi	Bogra	Jamuna -1.42	Bangali river	24°51'7.46"N	89°34'11.60"E
					Bangali-0.58			

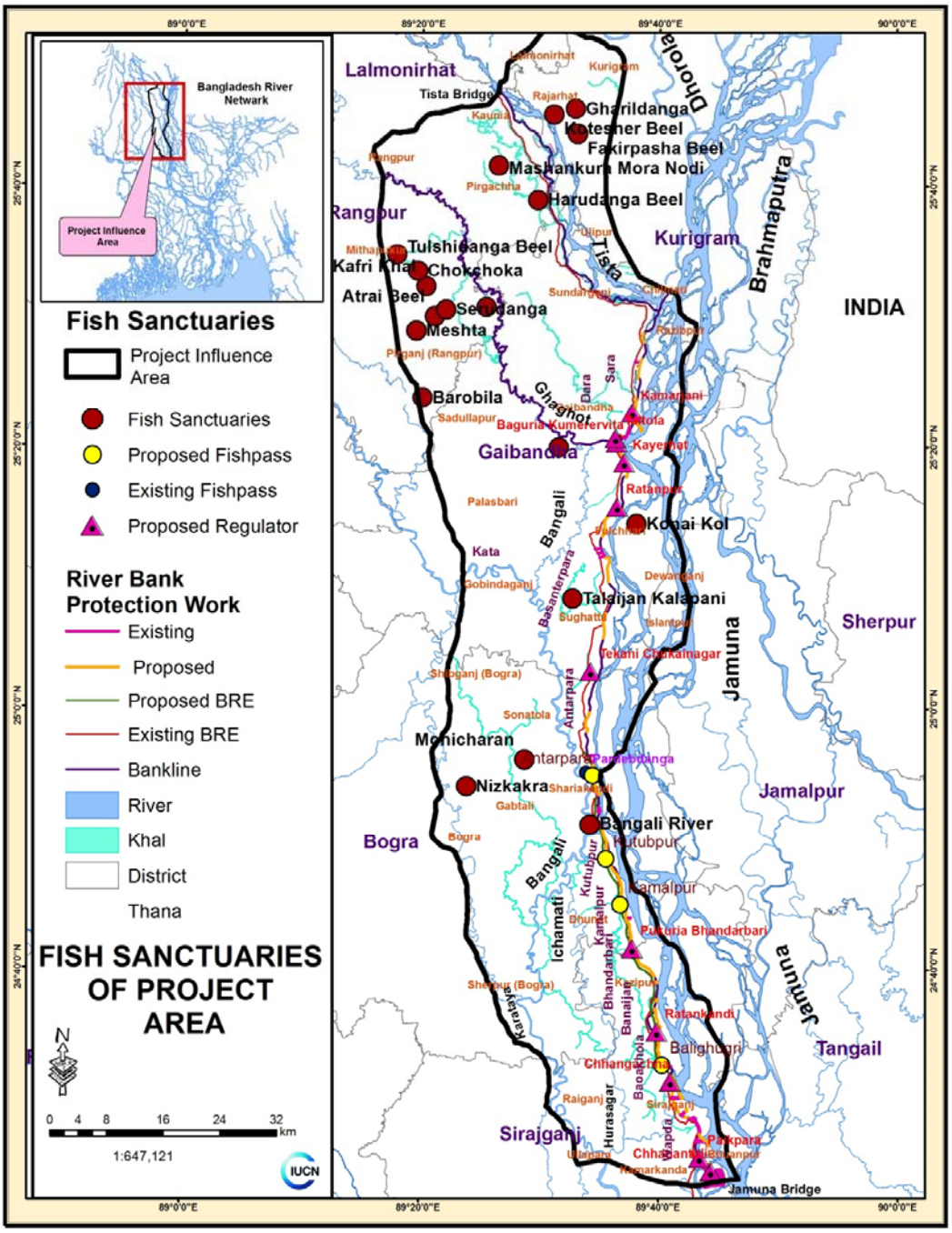


Figure 6.11: Location of the Fish Sanctuaries in Project Influence Area

6.9. Fish Migration

Some species of fish remain confined to the riverine water, some species migrate from flood plain to the river mostly for breeding, and again some species migrate to the upper reaches during monsoon season. On the basis of the fish behavior, mainly related to migration and reproduction, the fish species of the Jamuna river can be divided in two

groups: "whitefish" and "blackfish" (Sao-Leang and Dom Saveun, 1955). "Blackfish" species are able to tolerate the de-oxygenated water conditions of dry season floodplain water-bodies and may spend most of their lives in a single water-body. These include species such as snakeheads (Channidae), catfish (Heteropneustidae) and climbing perch (Anabas testudineus). "Whitefish" migrate upstream and laterally to the inundated floodplains adjacent to the river channel in the late dry season or early rainy season in order to spawn in the nutrient-rich waters. The eggs and larvae of these species are drifting downstream and are entering the floodplain with the floodwater, where they feed on the developed plankton. At the end of the rainy season, the adults and young of the year escape/migrate to the main river channel in order to avoid the harsh conditions of the floodplain during the dry season. Migration cycle of the floodplain dependent fishes is shown in **Figure 6.12**.

Migration and spawning of the major carp in Bangladesh was first studied by Tsai and Ali in 1983-85 (Tsai & Ali, 1986). They found that the major carp in Bangladesh were comprised of three stocks: the Brahmaputra stock, Padma stock and the Upper Meghna stock. The Brahmaputra stock is the largest stock in Bangladesh, and its spawning grounds are located in the Southern tributaries of the Brahmaputra river in the Assam Hills and Letha Range, Assam, India (Alikhuni, 1957 and Jhingran, 1991). Upstream migration of adult major carps in the Jamuna/Brahmaputra River starts in March, coinciding with the gradual rise of water level. Spawning starts in May, with the onset of the Southwest monsoon, and continues until the end of July (Azadi, 1985, Shaha and Haque, 1976 and Tsai and Ali, 1986).

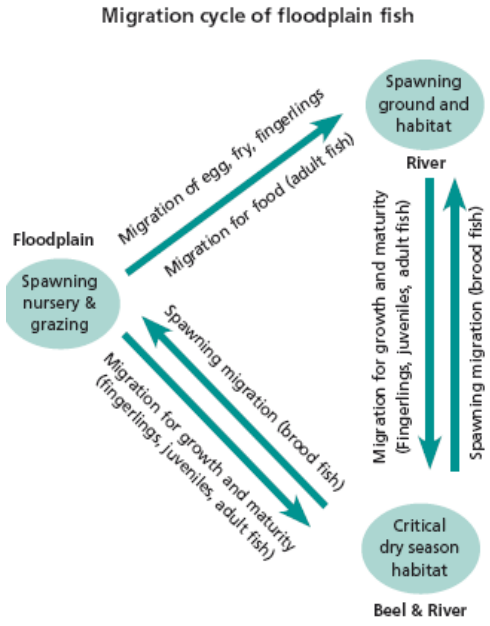


Figure 6.12: Migration pattern of the floodplain fishes of the project influence area

Connecting canals between main rivers and other water bodies are vital for maintaining successful fish migration at different seasons. Field survey has identified five migration routes (**Figure 6.13**) of the priority area are as follows:

- Jamuna to Icamoti river through Baliaghugri regulator
- Jamuna to Bangali river through Sariakandi fish pass
- Jamuna to Dauli beel to Bangali river through Antarpara regulator
- Jamuna to Manos river through proposed Kamalpur fish pass
- Jamuna to Bangali river via Kutubpur khal through proposed Kutubpur fish pass

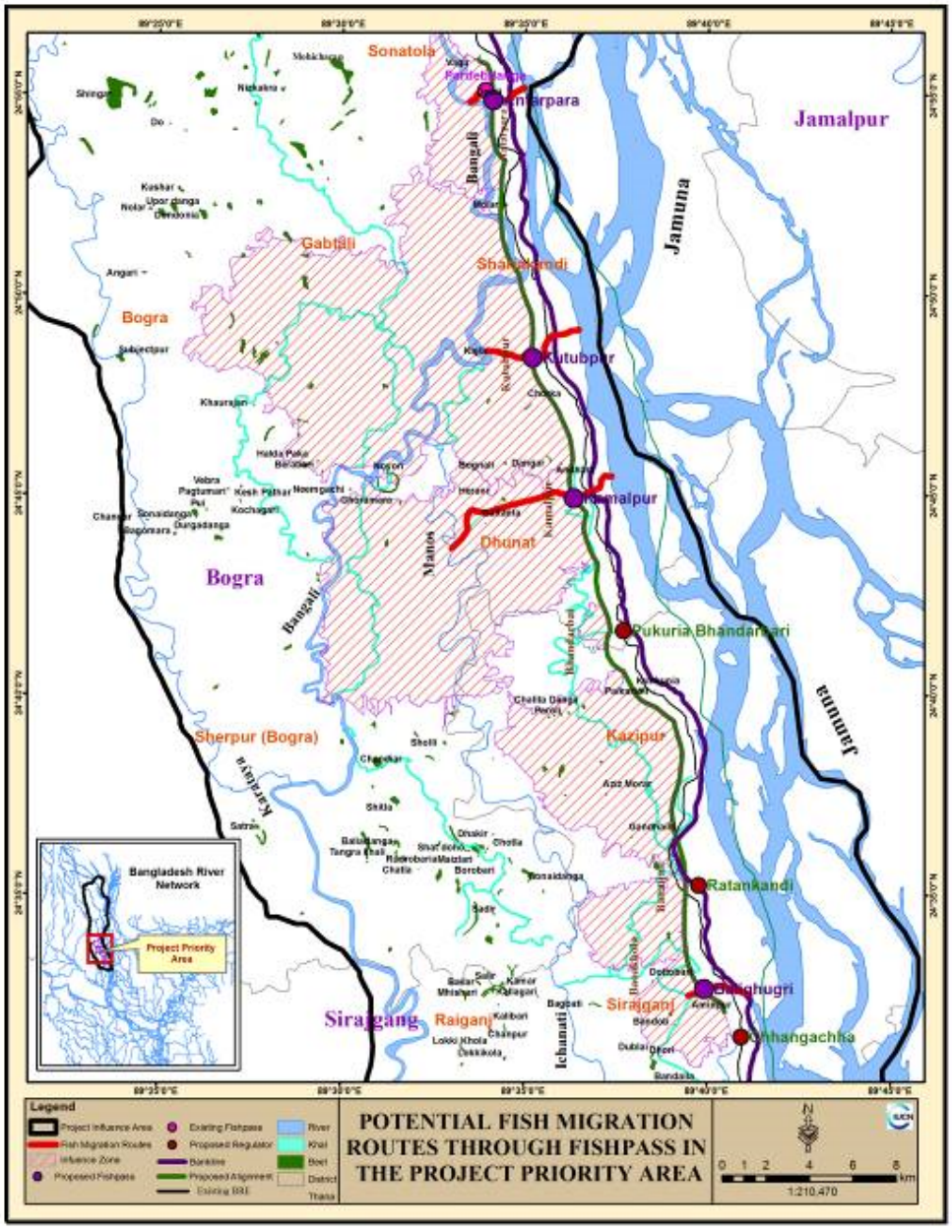


Figure 6.13: Potential Fish Migration Routes through Fishpass in the Priority Area

Among these five, Sariakandi fish pass was built in late 90s to facilitate fingerlings migration into the Bangali river and its adjacent floodplain, which is now almost silted

(**Figure 6.14**). Other four fish migration routes are partially obstructed due to the existing regulators/BRE. The regulator had built for only irrigation purpose and not suitable for fingerlings migration into the the floodplain. Basically water velocity and depth are the two controlling factors for effective fish migration through water control structure. Most of the connected khals/streams in the project influence area are either silted or discontinued in different places which hinder fish migration. Present condition of the khals/canals of the study is furnished in the **Table 6.16**.

Figure 6.14: Sariakandi Fish Pass (3 September 2014)

Table 6.16: Present Condition of Khals of Project Influence Area and Potential Fish Migration Routes

Upazila	Name of Khal	Problem	Location related to the existing/ proposed structures
Sirajgang Sadar	Doi Vanger khal	• No connectivity to the countryside. • No existence at the time of consultation as it merged into the Jamuna river	Proposed Baliaghuri regulator
	Balia ghugri khal (Jamuna – Ichamoti River)	Connectivity has been blocked in between Jamuna & Ichamoti River due to the BRE.	Proposed Baliaghuri regulator
	Banaijan Khal (Jamuna-Ichamoti River)	• Need excavation to reduce sedimented condition. • Connectivity with	Proposed Ratankandi Box Culvert-1

Upazila	Name of Khal	Problem	Location related to the existing/ proposed structures
		the Jamuna was destroyed by the BRE.	
	Baoikhola Khal (Jamuna-Ichamoti River)	• Need excavation to reduce sedimented condition. • Connectivity with the Jamuna was destroyed by the BRE.	Proposed Ratankandi Box Culvert-2
	Bahuka khal (Jamuna-Ichamoti River)	Flow was interrupted due to the existing embankment and artificially sedimented by the local people.	A regulator should be Constructed (according to the public opinion)
Kazipur	Halot khal (Jamuna-Ichamoti River)	Flow was interrupted due to the existing ring dam	
Dhunat	Madhob Danga (Jamuna – Beradanga Beel)	Need connectivity to the Jaguria Beel	Proposed Pukuria Vandarbari Regulator
	Shimul bari khal (Jamuna- Jagiar Beel)	• Connectivity with Jamuna was destroyed due to spur • Several Areas were occupied by the local powerful people.	Shimulbari Spur
Sariakandi	Kata khal (Bangali River-Dewli beel)	Need re-excavation for connectivity in between Bangali River and Dewli Beel.	Proposed Anterpara Regulator
	Kutubpur Khal (Jamuna river-Manos River)	• Need Connectivity with Manos river • Need re-excavation	Proposed Kutubpur Regulator
Fulchari Gaibandha	Gopaldoba khal (Beside Jamuna River)	This Khal was almost merged into the Jamuna River except 6 ha of existing khal on the riverside.	Existing Katlamari regulator
Sadar, Gaibandha	Kamarjani khal	Need connection with the Brahmaputra River for	Proposed Kamarjani Regulator

Upazila	Name of Khal	Problem	Location related to the existing/ proposed structures
		drainage	
Chilmari Upazila, Kurigram	Gidari khal	Water logged khal due to no connection with the Brahmaputra River	Proposed Chilmari Regulator
	Anantapur khal (Brahmaputra- several beels such as Magura Beel)	During Rainy season, the adjacent Beels are flooded due to overflow as there is no flow control regulator.	Proposed Bamni Regulator
Sadar, Kurigram	Girai nadi/Khal (Brahmaputra-Dharla)	Need re-excavation	Existing Tenganmari Sarkarpara Regulator.

Timing of fish migration:

- 15 March - Broodstock starts migration towards upstream
- 15 April to 30 May - Most of the matured broods complete either partial or full breeding i.e.eggs/spawn, so need connectivity with the adjacent floodplains to facilitate drifting downstream migration.
- 01 to 30 July - Most of the fingerlings enter into the floodplains. After that, only lately recruited spawn/eggs drifted down to the floodplain.
- 15 September to 30 October - Adults and young fishes migrate to the main river channel.

Criteria for fish migration studied by the IWFM, 2011 revealed that flow velocity and water depth play a major role. Depth and velocity preference are also different from species to species. Charts for depth and velocity preference of different kind and age of fishes are furnished in **Figure 6.15**. Most the connected canals of the project influence area are either silted or encroached and sometime disconnected from its original water source. Hence, the required flow and depth for movement of fishes are not found in almost all the canals. It can be stated that the following threshold value should be maintained in identified migration routes to sustain fish biodiversity.

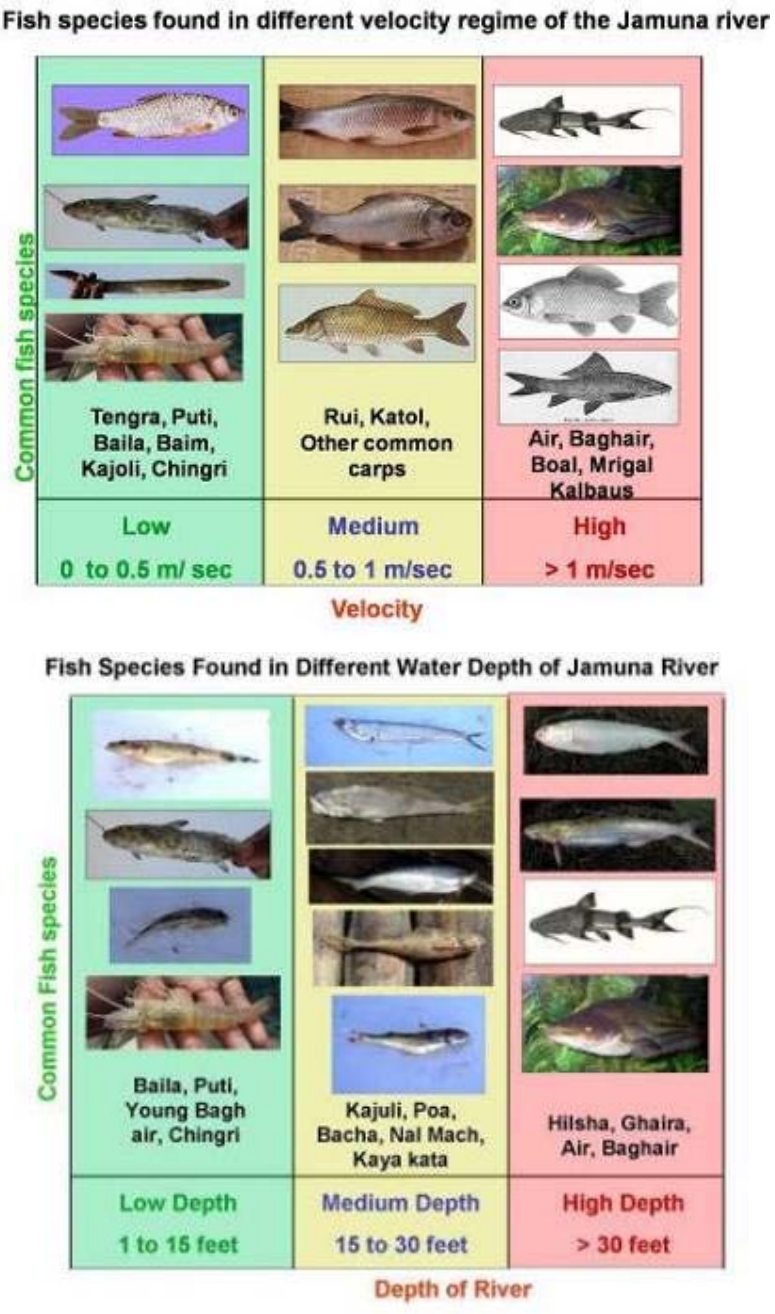


Figure 6.15: Depth and Velocity Preference for Fish (IWFM, 2011)

Other kind of fish migration in Jamua is longitudinal fish migration of hilsa, an anadromous fish species. Hilsa migrates from Bay of Benal to Meghana – Padama – Jamuna river system for spawning and breeding. Besides the these rivers, hilsa were also abundant in other rivers such as Kanafuly, Feni, Surma, Kusiara, that directly drains to Bay of Benal (Ahsanullah, 1964, Quereshi, 1968, Haldar et.al. 1992). Hilsa migrates into Jamuna duringMarch-May from Bay of Bengal through the Meghna and the Padma. The range of migration of hilsa in the Brahmaputra River was up to Tezpur, Assam province of India. Migration pattern of the Hilsa fish at different season is furnished in the

Figure 6.16. It is evident from different sources, that the condition that avails for Hilsa migration is fulfilled the biological requirement (water depth, water flow, velocity, water quality etc.) of other riverine catfishes and carps. During the last decades, a major change in the abundance and distribution of hilsa in the inland waters of Bangladesh has occurred.

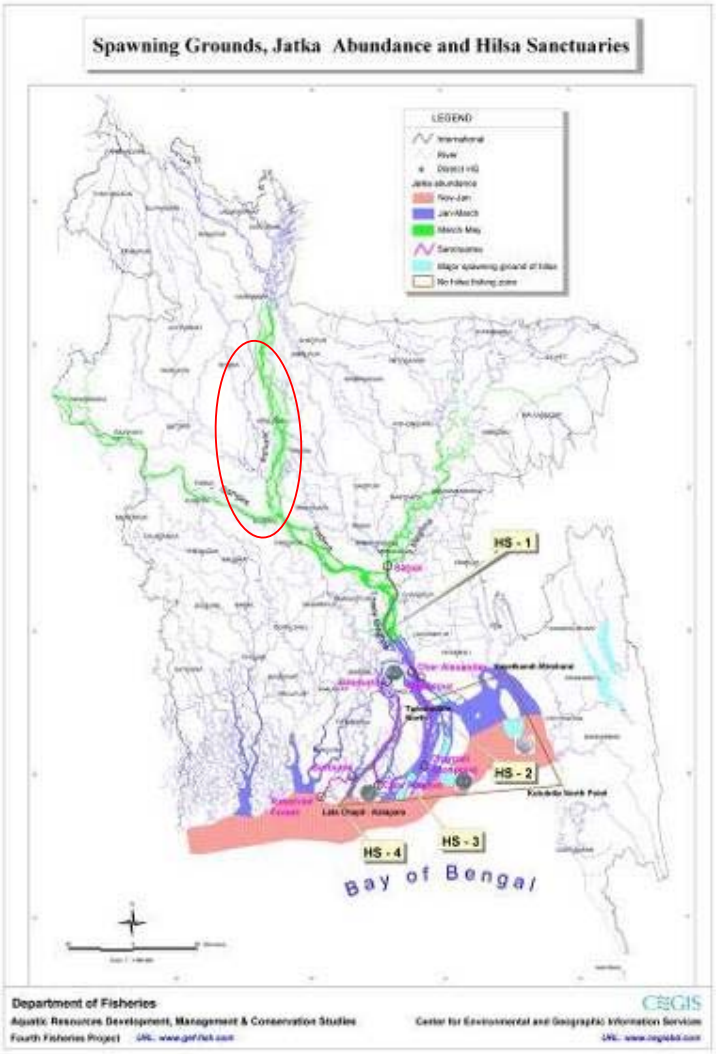


Figure 6.16: Movement of Jatka (Hilsa juvenile) into the Jamuna River (source: FFP, DoF/CEGIS)

6.10. Fish Catch Composition

Hilsa occupied only 27 percent of Jamuna catch. Whereas, miscellaneous fishes comprise the highest 67 percent, major carps 1 percent, cat fishes <1 percent, and shrimps-prawns 4 percent (**Figure 6.17**). Among the principal rivers, considerable amount of major carps (Rui, Catla, Mrigal) production is coming from Jamuna. Other carps (Ghania, Kalbasu, Kalia) production is the lowest in this river. Catfish (Rita, Boal, Pangas, Silon, Aor, Bacha) production is also the highest in Jamuna. Snake head (Shol, Gazar, Taki) production is almost nil in the Jamuna. Live fishes (Koi, Singhi, Magur) are only available in canals and creeks of the Jamuna river. Small shrimps are available in almost all rivers, whereas big shrimp production is found comparatively higher than other rivers.

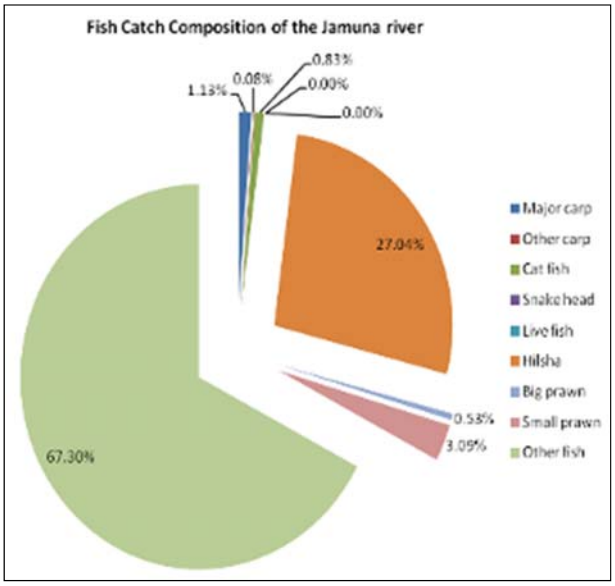


Figure 6.17: Fish catch composition (%) of the Jamuna River (FRSS, 2012)

6.11. Aquatic Invertebrates

In freshwater biology, benthos are referred to the organisms at the bottom of freshwater bodies of water, such as lakes, rivers, and streams. These are the organisms which live on, in, or near the benthic zone. Most organisms in the benthic zone are scavengers or detritivores. Different types of Zoobenthos and Phytobenthos exist in the aquatic part of the project influence area. Insect larvae constitute the most numerous and diverse zoobenthos group. Daphnia, Cypris, Cyclops and several copepods are important zooplankters in freshwater and are food of many fish and other crustaceans.

According to a survey of the Department of Zoology, Rajshahi University, the rivers in Bangladesh once thrived with thousands of species of zooplankton and zoobenthos. The number of species has dwindled to 19 species of Rotifer, 12 species of Cladocera and 11 species of Copepoda. Many other indigenous species of plankton, beneficial insects and water worms have become extinct or on the way to extinction (Bhuiyan et. al. 2008). During an earlier study, 11 species of Crustacea (Arthropoda) and Gastropoda (Mollusca) were recorded in the Padma river (. Crustaceans included four species: Macrobrachium rosenbergii, M. malcolmsonei and Cancer sp. which are present throughout the year and breed during December-February; and, M. lamarrei which also is present throughout the year and breeds during April-June. Two species of mollusks were collected (Pila globosa and Unio sp.); these species are present throughout the year and breed during April-June. Among non-fin fishes 36 percent were arthropods, 18 percent, mollusks and 45 percent chordates.

Crustaceans are predominantly aquatic; the class Crustacea includes the crabs, shrimps, lobsters, barnacles, water fleas, fish lice, hermit crabs.. The project influence area supports many important freshwater crabs. Of them Paratelphusa lamelliforns is commonly used as food.

During a benthos study of the Fourth Fisheries Project (Willoughby et. al., 2004) a checklist of common benthos indicator was preparedfor the fresh water rivers in Bangladesh; indicator species are shown in Figure **6.18**.

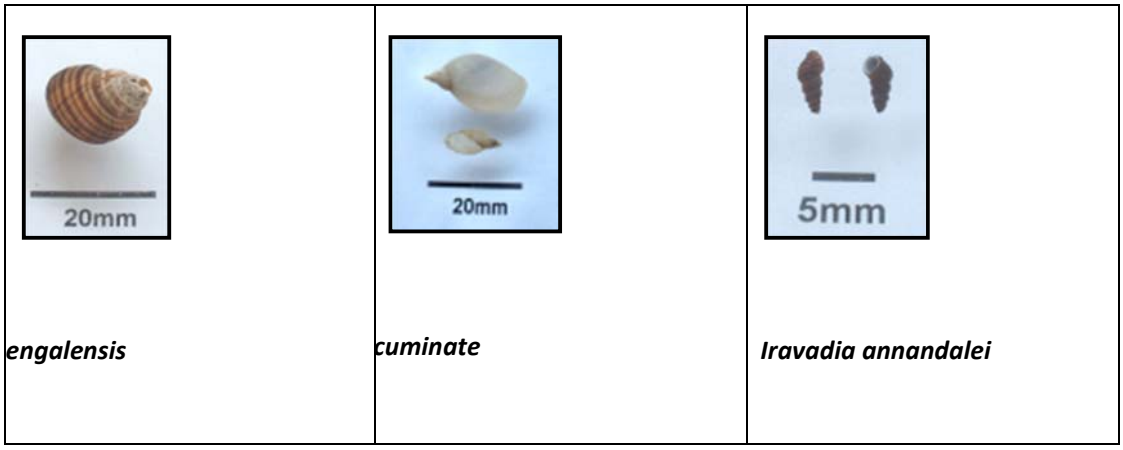


Figure 6.18: Benthos indicator species for fresh water bodies in Bangladesh

These freshwater invertebrates play several important roles in freshwater ecosystem. They are instrumental in cleaning excess living and non-living organic material from freshwater systems, a service that contributes to the overall quality of the freshwater resource. Detritivores that feed on decaying organic matter speed up the decomposition process, maintaining the nutrient load in the freshwater resource. Freshwater mussels filter the water on a microscopic level, removing algae, bacteria, and other microorganisms. Water quality degradation adversely impacts the health of aquatic communities including fish and invertebrates. As a result, benthic freshwater invertebrate communities are valuable indicators of water quality.

7. Social Profile of Project Influence Area

This Chapter presents the social profile of the entire project influence area and also provides detailed socio-economic conditions of the priority reach.

7.1. Soial Profile of Project Area of Influence

7.1.1. Demographic Structure

Bangladesh is a highly populated country and its reflection is present in the northern districts. The population of Kurigram was 1.79 million in 2001. The population density was 780 per sq-km. Among nine the Raumari upazilla of this district had the highest population while the Char Razibpur upazilla had the lowest.[7] On the other hand, Gaibandha had a population of 2.48 million in 2001. The density of population was 981 per sq-km. Among seven, the Gobindaganj upazila had the highest and Fulchari had the lowest population (Census of Agriculture and Economic Census of 2001 & 2003)[8]. The population of Sirajganj in the census of 2011 is 3 million with a density of 1290 per sq-km. Of nine upazilla, Shajadpur had the highest and Kamarkanda had the lowest population. Bogra district had a population of 3.4 million in 2001 with a density of 1173. Bogra Sadar had the highest population and Dhupchanchia had the lowest population.

7.1.2. Administrative Structure

District Administration

Each district is headed by a Deputy Commissioner. District administration is a part of the central administration controlled from the capital Dhaka. The Deputy Commissioner at the district administration is supported by three Additional Deputy Commissioners assigned to general administration, revenue and education, besides an additional district magistrate. Police administration is headed by a Superintendent of Police directly controlled from the capital Dhaka. The Deputy Commissioner holds a very wide range of responsibility which would be as many as sixty plus. It includes revenue management, land administration, district and executive magistracy, public order and safety, law and order, government treasury, licensing and others.

Each district has a tier of sub-district or upazilla. Each sub-district has also full fledged police administration. Below the sub-district there is union which in turn consists of mauza and revenue village. In terms of number of sub-district Bogra has the highest (12) while Gaibandha has the lowest (7). The number of union is also highest in Bogra district (108) and it is lowest in Kurigram district. Mauza or revenue village is a unit comprising the description of agricultural holdings which provide the basis for revenue collection. See **Table 7.1** for details.

[7] BBS (2011), *Census of Agriculture 2008, Kurigram Series*, Ministry of Planning, GOB.
[8] BBS (2011,) *Census of Agriculture 2008, Gaibandha Series*, Ministry of Planning, GOB; BBS(2007), *Census of Agriculture and Economic Census of 2001 & 2003, Zila Series Gaibandha*, Ministry of Planning, GOB.

Table 7.1: Details of Administrative Units in Project Influence Area

District	Upazilla or Sub-District	Union	Mauza or Revenue Villages	Villages
Kurigram	9	72	639	1,907
Gaibandha	7	83	1,093	1,244
Bogra	12	108	1,672	2,706
Sirajganj	9	82	1,300	2,006

At the district and sub-district level different governmental offices related to different ministries, directorate and department are located. To ensure law and order there is police department along with para-military force. Related to agriculture and food a number of offices are present – agricultural extension, fishery, livestock and others. The responsibility of communication and engineering lies in the hand of roads and highways, telecommunication and others. For health and education there are specific offices. Schools and hospitals fall within the purview of these offices. Besides, there is the department of forestry, human resource development and others. Each office at the district level is headed by a district officer, while a coordination body is there headed by the Deputy Commissioner to integrate the activities. Similarly the Upazilla Nirbahi Officer or the Sub-district Executive Officer coordinates the activities of different offices while each office headed by its respective officer. There are several NGOs functioning in the four districts engaged in health, education, environment, women's empowerment and livelihood sectors. Micro-credit institutions are important segment of this part[9].

Local Government

Multi tier local government is an important component of the administrative structure and the British administration introduced single tier local body in 1870 through the introduction of a law called Bengal *Chaukidari Ain*. However, in course of time single tier got elevated to multi tier. At the district level the district council became the representative body, however, municipality is headed by a chairman. With the introduction of sub-district or *upazilla* another local body came into existence called *upazilla parishad* headed by a chairman. Below this level there is union *parishad* at the village level which is the lowest tier of local body structure[10].

Union *Parishad* consists of 14 persons who are entrusted with executing official responsibility including a chairman, nine councilors, three women councilors and a secretary. Structurally this local body consists of nine wards each is represented by an elected councilor irrespective of sex. However, for each three wards one woman councilor is elected. It is a coordinating and executive body. There are 13 standing committees with specific responsibility (e.g., infrastructure development, education or health). There is a coordination body comprising the chairman, councilors, government and non-government staff working at the union level. The activities of the government

[9] BBS (2014), *Statistical Pocketbook Bangladesh 2013*, Ministry of Planning, GOB. and the governmental portal.
[10] BBS (2014), *Statistical Pocketbook Bangladesh 2013*, Ministry of Planning, GOB. and the governmental portal

and non-government organizations are coordinated and facilitated at the union level through this entity and generally 10 to 15 villages constitutes a union (the following figure an Union *Parishad* viewed from outside).

7.1.3. Economy and Occupation Pattern

These four districts are predominantly agricultural although Bogra district is slightly different. In Kurigram district about 59 percent households are engaged in farming activities producing varieties' of crops. According to governmental account non-agricultural activities in Kurigram district is in a developing stage. According to government account the non-farm activities in Gaibandha district is also not significant. In Bogra agriculture and livestock sectors play a vital role in economy although it is considered as the industrial city of North Bengal. About 27 percent of all establishments are located in urban areas of Bogra. Sirajganj is also predominantly agricultural and more than 52 percent households are engaged in agriculture.

Following table has shown the traditional economic activities in non-agricultural sector, because in all four districts the majority of entrepreneurs are engaged in wholesale and retail trade. In Gaibandha 60 percent of non-agricultural enterprises are engaged in wholesale and retail trade. Less than one percent of enterprises represent the modern type, namely bank, insurance and financial establishments[11].

Table 7.2: Details of Economic Activities in Project influence area

Districts	Traditional (Wholesale and Retail) as % of Total Establsihments	Modern (Bank, Insurance and Financial Institutions) as % of Total Establishments
Kurigram	58	0.67
Gaibandha	60	0.69
Bogra	53	0.65
Sirajganj	51	0.37

In terms of occupation of the four districts agricultural labour is found to be the most common one which represents 20 percent of the occupation. About 12 percent are engaged in cultivation. Construction workers comprise more than 12 percent while transport sector absorbs 8 percent of the households. About 7 percent households are engaged in industrial work, about 6 percent are engaged trade and business while salaried jobs absorbed about 5 percent[12]. At the macro level Bangladesh is slowly changing, its garment sector now absorbs 3 million workers of whom 80 percent are women. Similarly construction and service sector is also gradually expanding, the scenario of four districts share these features to a certain extent.

[11] Information of this section are derived from : BBS (2011), *District Statistics 2011, Sirajganj*, Ministry of Planning, GOB, BBS (2011), *District Statistics 2011, Bogra*, Ministry of Planning, GOB, BBS (2007), *Economic Census 2001 & 2003, Zila Series, Zila: Gaibandha*, Ministry of Planning, GOB, BBS (2007), *Economic Census 2001 & 2003, Zila Series, Zila: Kurigram*, Ministry of Planning, GOB, BBS (2011), *Census of Agriculture 2008, Zila Series Gaibandha*, Ministry of Planning, GOB, BBS (2011), *Census of Agriculture 2008, Zila Series Kurigram*, Ministry of Planning, GOB.

[12] Derived from the data of Social Assessment of RBIP, 2014.

7.1.4. Education

Educational campaign is a major development initiative in Bangladesh. Introducing universal primary education is a major effort in this regard. Enrolment rate has increased although drop out rate is also high. Child labor is a major reason for drop out rate at the primary and secondary level. Besides, parents cannot afford educational cost for a long period. About 37 percent of the people who are 5 years or more than that are still illiterate or can sign names, cannot read. About 51 percent has been found who are currently enrolled or enrolled in the past and yet to pass school final examination. About 8 percent respective population has passed school final or the college final examination. Less than 1 percent has been found who have the certificate of tertiary level completion such as Bachelors or Masters degree.[13]

7.1.5. Urbanization

Among the four districts the scale of urbanization is higher in Bogra district. It has got 12 municipalities which is higher than the other three districts. Urban population is 0.59 million. Sirajganj has six municipalities with 0.32 million urban population. Gaibandha has three municipalities with 0.19 million people. Kurigram has three municipalities with 0.27 million urban population. Above municipalities provide facilities to the dweller such as access to electricity and sewer system, but their coverage is still limited. However, among the four towns the Bogra town is most bustling than other three with the presence of offices, banks and insurance. Hotel establishment is also better in Bogra town. High rise building will be found in Bogra town not in others. There are colleges and hospitals in these places. In all four districts the office of Deputy Commissioner and other line ministries are located. However, recreational facilities are not many, fast food shops are more noticeable in Bogra town than other places. Compated to Dhaka or Chittagong the level of urbanization is still much lower even in Bogra let alone the other three. Urbanization is not evenly taking place in Bangladesh, thus significant difference will be noticed between the metropolitan areas like Dhaka, Chittagong or Khulna and the distrct headquarters like Bogra, Sirajganj or Gaibandha.

7.1.6. Norms, Values and Local Institution

Being an agriculturally predominant area the traditional institution still predominate the northern districts. Nuclear, joint and extended families furnish the basic units of the society. In the villages nuclear families surpass the other types in terms of proportion because of the splitting of land. Joint land ownership is a precondition for the existence of joint families where the budget is commonly shared. More than 80 percent families are of nuclear type[14] . However, the presence of extended families where intense social interactions among the kin take place is still prevailing in the rural and urban areas. In both Muslim and Hindu tradition relatives are placed at a high esteem. Showing respect to the elder is a part of social tradition, however market economy norms sometimes clash with the function of long cherished social tradition. Impoverishment of economic condition is also encouraging the nuclearization of families. The relevance of lineage or *gushti* is on decline and social cohesion is functioning under pressure to some extent. However, the effect of lineage is manifested in political conflict or in other tension ridden situations. Political factionalism is on rise in rural areas, particularly in the distribution of

[13] Derived from the data of Social Assessment of RBIP, 2014.
[14] Derived from the data of Social Assessment of RBIP, 2014. ; Also see Aziz KMA, *Kinship in Bangladesh*, ICDDRB, and Key Informant Interviews.

favor among the poor households. In the distribution of Social Safety Net benefits the effect of political factionalism will be noticed. *Salish* or traditional village arbitration bodies are still functioning but its scope is becoming reduced. The role of the local body such as Union *Parishad* is increasing in the dispute resolution in the countryside. Formal political linkage of the local bodies is also on increase in the recent time. Festivals are important part of the life of the society. Among the Muslims two major festivals are *Idl Fitr* and *Idl Azha*. Since the society is predominantly Muslim these festivals are observed pompously. Among the Hindus *Durga puja* is a major religious festival and plenty of *mandap* are installed. There is Bengali festival called *naba barsha* or welcoming Bengali calendar participated by Hindu Muslim alike.

7.1.7. Monga and Vulnerability

Jotedari or semi-feudal agrarian structure impeded the development of modern agriculture in the northern region for a long period. Following the partition of India, absentee landlordism emerged in the northern districts slowing down the growth of agricultural technology with a consequence of limited employment opportunity. The areas where traditional agricultural system prevailed in certain months of the year particularly during the pre-harvest time scale of unemployment used to rise very high. In local language it came to be known as mara kartik (dead autumn). Poor agricultural workers are forced to starve. It is narrated in the following manner, "Monga is a seasonal food insecurity in ecologically vulnerable and economically weak parts of north-western Bangladesh, primarily caused by an employment and income deficit before aman rice is harvested. It mainly affects those rural poor, who have an undiversified income that is directly or indirectly based on agriculture."[15] However, concerted efforts are now being made with a focus on the monga areas to create self-employment opportunities for those deprived of employment opportunities. By providing micro-credit and livelihood training this attempt is made.

7.1.8. Historical Places

The history of these districts is quite old and several entities and aspects have acquired significances in the mind of the people and society with a fair amount of imprint on their memories. The Mahasthangarh of Bogra boasts its ancientness being the capital of Pundranagara during the 4th to 8th century BC. There are Islamic relics that attract the attention of tourists. The Kherua mosques, tomb of Shah Sultan Balkhi, Parshuram's palace are a few historical sites in Bogra. Sirajganj district has also got a few important archeological sites historically prominent. These are also related to the names of saints, sacred places like temple or the building used by some renowned poet. Rabindranath Tagore used to use Kuthi Bari at Shahjadpur as his office cum residence, there is a homestead of mythical figure Behula, Shiva temple and the tomb and mosque of Khawja Pir Saheb of Enayetpur. Gaibandha district includes the house of Naldanga Zamindar along with its Shiva Linga made of black basalt, Vrisa Mandir of white stone and a large pond, Mosque of Shah Sultan Gazi at Mirer Bagan. Temples, zamindar's or lord's house or mosque drew attention of the tourists at Kurigram which include three domed mosque at the village Majider Par of Bhurangamari, image of Kali at Dasherhat, images of

[15] Zug S. (2006), 'Monga – Seasonal Food Insecurity in Bangladesh – Bringing the Information Together' in *Journal of Social Studies*, No 111, July- Sept., p-2.

Mangal Chandi, Kamakkha Devi, Laksmi and Sattanarayan in front of the Bhetarbandh Zamindar Bari[16].

7.1.9. Erosion and Migration

The people who live on the right bank of the mighty river Jamuna have been suffering from the curse of erosion for several years under the effect of a westward shifting river which has severely affected their livelihood opportunities posing threat to life. The information and data presented in this section will also reveal the dimensions of this threat and insecurity while the following figure presents graphical evidence (see **Figure 7.1**). The proposed project will entail four districts of the northern region which includes Sirajganj, Bogra, Gaibandha and Kurigram while the first leg will prioritize the area lying in the Sirajganj and Bogra Districts.

Figure 7.1: River Bank Erosion along Jamuna

Major threats to these people emanate from river erosion and selected reflection in the following description would reveal the nature and depth of this threat. River erosion and the subsequent displacement is almost a regular phenomenon on the right bank of Jamuna. The range of vulnerabilities to the lives of these people is really wide what will be chronicled in this brief but a few are devastating leaving little opportunities to escape or recoup from the destruction. It is now commonly believed that each day thousands of people throng into the capital and a substantial section are the victims of such erosion. Since transport has improved than the past such mobility has become easier. Unfortunately many of them end up in the state of squatters.

Almost half of the affected households have experienced the lesson of shifting at some points of their life/household cycle. On the other hand, 51.6 percent never shifted who may be regarded as the old residents of this area. About 41.3 percent shifted in their life/household cycle 1 to 5 times. Similarly 5.9 percent shifted six to ten times. There are 0.3 percent households who experienced this bitterness for more than 21 times. River

[16] The account of this section is drawn from the following: BBS (2011), *District Statistics 2011, Sirajganj*, Ministry of Planning, GOB, BBS (2011), *District Statistics 2011, Bogra*, Ministry of Planning, GOB, *amardesh.com/zila_kurigram.php, amardesh.com/zila_gaibandha.ph*

erosion and displacement have depleted their resources and infused extreme vulnerability contributing to the process of impoverishment.

The phenomenon of displacement and displacement is a part of the life for people who live on the right bank of Jamuna. Earlier table gave idea about its scale and the above table establishes the causes. River erosion is the prime factor behind displacement is no longer a hypothetical statement, if the above table is analyzed. About 97 percent affirms this cause that is erosion has led to their displacement where they used to live (**Table 7.3**).

Table 7.3: Reasons of Displacement

Reasons	Percent (N=1687)
Displaced by River Erosion	96.91
Commercial Opportunity	0.36
Land Scarcity	2.43
Socio-Political Conflict	0.12
Family Problem	0.18
Total	100

Source: Priority Area Survey

7.1.10. Socioeconomic Perspective

Sirajganj is predominantly an agricultural area and Bogra has slightly larger non-agricultural base. However, the scale of industrialization or urbanization cannot be compared with metropolitan areas. Thus villages and rural society constitute the core of its entity. Over the years its traditional agriculture has undergone changes with the introduction of Green Revolution technology. Changes in the agrarian society took place at the structural and technological levels. Although agriculture is the mainstay of its economy, Sirajganj earned fame for its handloom industry which produces *saree*, *lungi* and other clothes. In the late seventeenth and early eighteenth century it was commercially an important place. However, being faced with steep competition particularly from the clothes produced in the mill its business has been affected leading to shutdown of many handloom units. Many of them took loan from the banks but being failed to repay went bankrupt. Another commodity is popular of both districts is the cow milk and sweet food such as curd. Large milk manufacturers of the country gather milk from this district for retail sale in the large cities of the country. On the other hand Bogra has larger presence of banks and other financial institutions[17]. Bogra town is larger than Sirajganj and vegetable cultivation is also widespread in this district[18].

Sirajganj was a sub-division and elevated to a district in 1984 and Bogra was all along a full-fledged district. In both places people are mostly day laborers engaged in agricultural and non-agricultural activities and the respective proportion would be more than 28 percent[19]. In non-agriculture sector the wholesale and retail business constitute more than half of the functional enterprises and still there is no textile, garments, steel and

[17] Key Informant Interviews
[18]Sirajganj municipality population: 158913 (BBS 2014, Statistical Pocketbook Bangladesh 2013, GOB); Bogra Sadar population: 400983 (BBS 2014, Statistical Pocket book Bangladesh 2013, GOB)
[19] Household Survey, 2014, RBIP

engineering industry in both districts, in Bogra district the presence of rice mill is noteworthy[20]. About 15 percent households of the district are engaged in different services which are related to the enterprises carrying out different small and medium scale business. Some are alsoengaged in non-governmental organizations. Less than 1 percent of the enterprises are related to modern sector such as banking, insurance and financial institutions[21]. Roughly 11 percent households would be found in agriculture and about 15 percent households are engaged in business of different kinds. Transport sector comprising, rickshaw, van, and buses also absorb 8 percent of the households.

Nuclear family is the predominant form among different family types. With the decrease of the size of the agricultural holding and splitting of the households owing to the process of inheritance the nuclearization of families is taking place[22]. The proportion of joint family (where budget and kitchen are shared) is decreasing because of the fact landlessness has increased. The role of the extended family is present to some extent where the kinship interaction is noticeable, psychological attachment apparent with mutual support. Corporate spirit or neighborly relationship does not function intensely nowadays since individualization and market norms has intruded in a gradual manner, lineage relationship becomes relevant more at the time of election while political factionalism has emerged to a perceivable extent. The role of the union parishad in the rural power structure is visible more than the traditional *samaj* or *salish*. The effect of globalization on rural culture is becoming distinct in terms of dress code, language and others. The process of migration has also increased generating effect both on economy and culture. Sirajganj town is the victim of river erosion and the socioeconomic development of the area has been affected by this process.

7.1.11. Gender

Traditionally patriarchy predominates over the gender relation in rural Bangladesh. As a result women's position in family and society, role in division of labor, mobility or economic condition have been shaped in a particular manner. Compared to the male, the women enjoy lower status in family and society, engaged in household chores and their movement remains restricted to the home and around. However, in the last few decades the situation is gradually changing owing to macro-economic development (more than 2 million women in garment factories) and different development programs (micro-credit and self-employment of NGO, universal primary education, girls student stipend, gender awareness campaign among many). Women in the villages of these four Upazila are found to be engaged in different types of livelihood activities. Involvement with new activities led increased mobility of the women. More than 60 percent women interviewed in this respect reported that their mobility is not restricted to home. Homestead agriculture or livestock raising are some of the new activities. Involvement with livelihood activities has brought income and increased their control on cash, it has contributed to the consolidation of position in family and economic empowerment. In relation to mobility it is found that market related mobility has increased. However, more frequently they can visit to relative house and when necessary to the hospitals. Similarly women's reproductive health rights are also better reflected and they can take pregnancy decision by themselves. However, there are certain social ills still affect them which include eve

[20] BBS (2013), District Statistics 2011, Sirajganj and Bogra, Ministry of Planning, GOB
[21] BBS (2013), District Statistics 2011, Sirajganj and Bogra Ministry of Planning, GOB
[22] Key Informant Interview.

teasing, dowry and early marriage. It means complete emancipation of the women from the curse of patriarchal exploitation is still incomplete.

7.2. Socio-economic Conditions in Priority Reach

7.2.1. Administrative Units and Set Up

The priority area belongs to four Upazila namely, Kazipur, Sirajganj Sadar, Sariakandi and Dhunat. All four Upazila include municipality, indicating the progress of urbanization to a certain extent. There are 846 villages in the area. See **Table 7.4** for information on municipalities, unions, mauzas, and villages in the area.

Table 7.4: Number of Upazillas, Municipaliiesy, Unions, Mauzas and Villages in Sirajganj District

Upazilla	Municipality	Union	Mauza	Village
Kazipur	1	9	108	172
Sirajganj Sadar	1	15	187	294
Dhunat	1	10	90	207
Sariakandi	1	12	100	173
Total	4	46	485	846

7.2.2. Demography

Population size is varying in different Upazila. Highest population is found in Sirajganj Sadar Upazila which 555 thousands. It is lowest in Sariakandi Upazila which 271 thousand. In two upazila Kazipur and Dhunat, the male is lower than female, it is same in Sariakandi Upazila and in Sirajganj Sadar it is higher. See **Table 7.5** for some salient data on demography.

Table 7.5: Population, Male Female Distribution and Other Relevant Information

Upazilla	Population			Sex Ratio (M/F)	Average Size of Household	Density per sq km
	Male	Female	Total			
Kazipur	135,000	140,000	275,000	97	3.94	835
Sirajganj Sadar	279,000	276,000	555,000	101	4.38	1,734
Dhunat	143,000	149,000	292,000	96	3.90	1,180
Sariakandi	135,000	136,000	271,000	100	3.58	663

Source: BBS (2013), District Statistics 2011, Sirajganj and Bogra, Ministry of Planning, GOB; BBS (2013), District Statistics 2011, Sirajganj and Bogra Ministry of Planning, GOB.

Average household size is less than 4 in three Upazilas while it is much higher than 4 in Sirajganj Sadar Upazila. Sirajganj is highly dense in terms of population with 1734 persons per sq km. The Bangladesh average is 1203 persons per km, which means that the density is much higher in Sirajganj Sadar. One major reason for this is the migration of river erosion victims into this Upazila from other areas, with the expectation of job

opportunity erosion victims assemble here. Already the population density of Bangladesh is very high compared to most countries of the world[23]. Present population density in four Upazila indicates how much pressure is there on resources. See **Figure 7.2** for population density in the area.

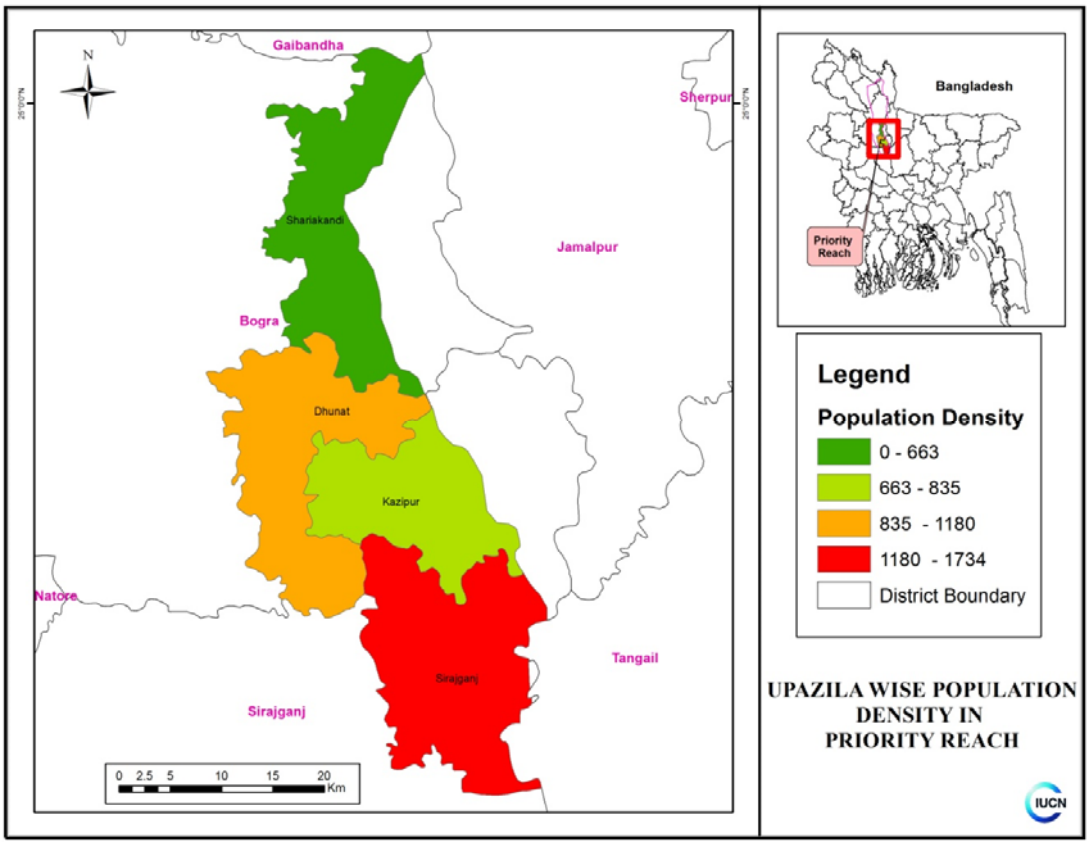


Figure 7.2: Population Density in Project Influence Area

In all four Upazila population has increased over the years. Continuous increase of population is the most common feature here. The simple growth rate is found higher than the national average which 1.2 at present, the corresponding rate is much higher in four upazila and much higher in Sirajganj Sadar which is mostly for migration from the adjoining areas (see **Table 7.6**).

Table 7.6: Population in Different Years in Four Upazila of Priority Area

Upazilla	1981	2001	2011	Annual Growth Rate 1981-2011
Kazipur	214,000	267,000	275,000	1.53
Sirajganj Sadar	340,000	484,000	555,000	3.32
Dhunat	213,000	271,000	292,000	1.95

[23] Information of this section is gathered from: *data.worldbank.org/indicator/EN.POP.DNST;* BBS (2013), District Statistics 2011, Sirajganj and Bogra, Ministry of Planning, GOB.

Upazilla	1981	2001	2011	Annual Growth Rate 1981-2011
Sariakandi	199,000	240,000	271,000	1.89

Source: BBS (2013), District Statistics 2011, Sirajganj and Bogra, Ministry of Planning, GOB; BBS (2013), District Statistics 2011, Sirajganj and Bogra Ministry of Planning, GOB.

7.2.3. Income and Poverty

Occupation largely determines one's income level apart from other linkages (e.g., gift, donation or remittance although occasional). As it is transpired earlier that agriculture is the mainstay of their economic pursuit. In the context of agriculture, non-crop sector (e.g., chicken rearing, cow fattening or aquaculture) has developed in the recent time but it could absorb a bulk of households and the expansion of micro-credit has a large role to play in this regard. In non-agriculture transport, hotels or shops provide employment opportunities but mill or factory could not make any substantial headway. In **Table 7.7** brief idea may be gathered on what kind of occupations these people are engaged with.

Table 7.7: Occupations of the Surveyed Household Head

Occupation	Percent (N=3369)
Day laborer(agri/non-agri)	28.32
Service	15.49
Business	14.49
Agriculture	10.69
Rickshaw/van puller	7.06
Old/retired/children	6.53
Carpenter	4.36
Remittance/migrants	1.75
Fisherman	1.60
Housewife/unemployed	1.40
Others	8.31
Total	100

Others: Handloom owner, handloom worker, business, carpenter, blacksmith, tailor, teacher, driver, mason, physician, folk healer, boatman, rent out house, crop intermediary, livestock seller, poultry seller, fodder seller, milk seller. Source: Priority Area Survey.

It is found that 28.32 percent presently pursue the job of wage laborer either in agriculture or non-agriculture. It is a job that requires little technical competence, physical capacity is more important in this regard or the capacity for doing hard labor. Service is the present occupation, such reported by 15.49 percent, however, the corresponding level of the service may be ascertained if it is considered that very few household heads reported to possess tertiary educational qualification (discussed in a later table), in other words they are perhaps engaged with the job of low level support staff. Business is reported by 14.49 percent which include grocery business and others. There is 10.69 percent household heads that pursue agriculture or cultivation. Why the proportion of the people pursuing agriculture is limited, the answer would be found in the fact that they have

minimum agricultural land and the expanding non-agricultural sector at present also encourage many of them to switch over to different jobs. Rickshaw and van puller is found 7.06 percent which is related to low skill job.

More than 4 percent are found who are carpenter, it may be uniqueness of local tradition. Remittance or migration is nowadays gaining ground and 1.75 percent heads have reported it as their occupation. There are fishermen or housewives among the household heads who represent more than 1 percent as individual category among the total household heads. It is found 8.31 percent are clubbed together into the category of 'other', it may be noted all the individual proportions which are individually less than 1 percent are included here.

The income situation and poverty/vulnerability condition is reviewed through a survey among the households who are directly related to the priority area. Apart from income the land ownership and possession is also reviewed among the same households to assess their access to resource in a predominantly agricultural society. In addition their exposure to river erosion and its effect is also reviewed to understand the process of their vulnerability to natural disaster. It starts with income which is significant as a proxy indicator of socioeconomic situation. It reflects on the standard of living, economic capacity and the adequacy of livelihood activities.

There is a direct relevance of the income level in the assessment of poverty condition of a household. Poverty line is also expressed in terms of money although it fluctuates because of inflation. The income range what are used in this table are divided into three slabs, the lowest range is TK ≤5000, it may be assumed that for a household of 4 people income of this range is hardly enough to ensure necessary subsistence, in other words, those who do not have such income may be called poor. About 32 percent households are found whose monthly income represents this category. However, 40.3 percent earn monthly income which is TK ≥7500 (**Table 7.8**). Above amount is not large, may be enough to ensure subsistence need. From the national estimate we know that about 30 percent people are below the moderate poverty line at present.

Table 7.8: Monthly Income of the Households in Priority Area

Monthly income range (TK)	Percentage (N=3443)
≤5000	31.9
5001-7500	27.7
≥7501	40.3
Total	100.0

Source: Priority Area Survey.

In a composite manner the socioeconomic condition of the surveyed households are expressed in **Table 7.9**, in which the vulnerability status is measured. The definition used to explain vulnerability is the following: (female-headed or elderly headed (>60yrs) or HH income < Tk6367/monthly or landless). Using these criteria more than 80 percent households are found in this category. Relevant situation indicates not only inadequate income is the feature of these households many are headed by elderly or women or mere landless.

Table 7.9: Vulnerability Status of the Households in Priority Area

Vulnerable Status	Percent (N=3443)
No	19.1
Yes	80.9
Total	100.0

Source: Priority Area Survey.

The presence of large scale vulnerability owes to a number of factors. Continuous exposure to erosion has weakened their economic condition which is accompanied by affected agricultural production apart from limited employment opportunities. Mere manual labor based work could not generate enough income to overcome vulnerable situation. High vulnerability may create a poverty situation, from that view point this is an important issue.

Land is an important wealth in an agricultural society because it provides livelihood opportunities apart from constituting an important basis for social status. Surveyed households are found to control land through legal ownership, possession and renting practices. **Table 7.10** provides information on the extent of land control used for the purpose of dwelling either by ownership or possession. A number of interesting features have surfaced in this regard. First of all the amount of land used for dwelling is small. About 81 percent have placed control over 1 to 10 decimal of land for the purpose of dwelling, above amount include both own and those accessed through other means (khas and rented). Another 12.8 percent control 11 to 20 decimal of land. There are very few among the surveyed households with large amount of dwelling land. The corresponding scenario changes sharply in the next column when own land of dwelling is reviewed. As high as 55 percent do not own land for the purpose of dwelling because they live on other's land - either khas or rented. 31.7 percent own 1 to 10 decimal of land while 9.8 percent own 11 to 20 decimal of land. It means more than half of the affected households are absolutely landless in terms of dwelling land.

Table 7.10: Possession and Ownership of Dwelling Land in Priority Area

Land Size (decimal)	Own+Khas+Others (Percent) (N=3440)	Own (Percent) (N=3442)
0	1.3	55.0
1-10	81.1	31.7
11-20	12.8	9.8
21-50	4.0	3.1
51-100	0.5	0.2
101-250	0.2	0.1
≥251	0	0
Total	100.0	100.0

Source: Priority Area Survey.

With regard to possession and ownership of commercial land different scenario has emerged further. Almost none of them either possess or own any land for this purpose. It is not unlikely over the years they have lost land to river. **Table 7.11** shows how little amount of land they have even for commercial activities.

Table 7.11: Possession and Ownership of Commercial Land of Households in Priority Area

Land Size (decimal)	Own+Khas+Others (Percent) (N=3435)	Own (percent) (N=3443)
0	98.7	99.7
1-50	1.0	0.3
Total	99.8	100.0

Source: Priority Area Survey.

Almost 90 percent reported not to even own cultivable land (**Table 7.12**). It means these people need to depend on market to procure the articles of subsistence, such as rice or vegetable. In the project vicinity the community members do not own cultivable land much, however, in the countryside of Bangladesh including the Upazila of the priority area about 69 percent rural households are absolutely landless at present[24]. Occupational distribution shown in an earlier table also revealed, small proportion of household heads pursue cultivation as an occupation.

Table 7.12: Possession and Ownership of Cultivable Land of the Households

Land Size (decimal)	Own+Khas+Others (Percent) (N=3441)	Own (percent) (N=3442)
0	88.8	89.2
1-50	5.9	5.8
51-100	2.4	2.2
101-250	2.0	1.9
251-500	0.8	0.7
≥501	0.2	0.2
Total	99.9	100.0

Source: Priority Area Survey.

Table 7.13 presents a consolidated land ownership scenario. Different observations that have been made above on the possession and ownership of land are more compositely presented here. Neither possession nor ownership of land exists on a significant scale. Possession includes both own, khas and rented land. On average 7.55 decimal land is

[24]Raihan S., et. al. (2009), *Access to Land and Other Natural Resources by the Rural Poor: The Case of Bangladesh,* South Asian Network on Economic Modeling (SANEM), Department of Economics, University of Dhaka, Bangladesh,

there for dwelling purpose, of what 4.46 is own and the rest is either khas or rented. The amount of commercial land is negligible. In a land scarce condition in and around priority areas, the victims of erosion do not have usual scope of procuring land. Average amount of cultivable land under possession is 10.17 decimal, of this amount 9.76 decimal is own, it means small amount of cultivable land is gathered from khas or other sources. With regard to dwelling land the importance of khas and others are found important while cultivable land is gathered from ownership although the amount is meager.

Table 7.13: Possession and Ownership of Average Dwelling, Commercial and cultivable Land of the Households in Priority Area

Categories	Regular	
	Own+Khas+Others (Dec.)	Own (Dec.)
Dwelling	7.55	4.46
Commercial	0.04	0.02
Cultivable	10.17	9.76

Source: Priority Area Survey.

7.2.4. Education

The situation related to education has been analyzed using the household survey data. It is found that about 50 percent of the surveyed household heads never attended school (**Table 7.14**). It is a situation which is an effect of the past when governmental and NGO efforts to popularize education was not so vigorous. At present enrollment rate at the primary level has gone up significantly although dropout rate could not be contained well. In the third table of this section we would focus light on side of infrastructure though which one can assess what new strides are made towards attaining a bright educational goal. More than a quarter in the table reported to have attended primary school, little more than 10 percent attended secondary school. Less than 6 percent passed SSC examination, 4 percent passed HSC examination and only 2.8 percent passed tertiary level education.

Table 7.14: Educational Qualification of the Household Head

Educational Qualification	Percent (N=3363)
None	49.7
Primary	27.0
Secondary school, vocational (VI-X)	10.8
SSC & equivalent	5.7
HSC	4.0
Tertiary (bachelor, master's, equivalent)	2.8
Total	100.0

Source: Priority Area Survey.

In **Table 7.15**, gender segregation with regard to literacy is presented. Two issues are notable, the traditional male advantage in terms of literacy and the widespread illiteracy. In a relative sense Sirajganj Sadar is ahead of three other Upazila in terms of overall literacy rate, Dhunat lags most than the other three. In all four Upazila male are ahead of female in attaining literacy, for example, 40.7 percent male who are more than 7 years old are literate while it is 34.4 percent in the same Upazila, the corresponding situation is same for other Upazila.

Table 7.15: Male and Female Literacy at the Upazilla Level in 2011

Upazilla	Male	Female	Both
Kazipur	40.7	34.4	37.5
Sirajganj Sadar	50.1	45.8	48.0
Dhunat	38.3	33.1	35.6
Sariakandi	40.6	33.4	36.9

Source: Priority Area Survey.

It is noted above that presently concerted efforts are made to spread literacy both by the government and the non-government agencies. Universalization of primary education is also legislated. In this regard institutions to promote primary education have been established. In **Table 7.16** some evidences in this regard is presented.

Table 7.16: Schools to Promote Primary Education in Four Upazilas

Upazilla	Government Primary		Registered Primary		Private Primary		Kindergarten		NGO school	
	No of School	S/T ratio	No of School	S/T ratio	No of School	S/T ratio	No of School	S/T ratio	No of School	S/T ratio
Kazipur	108	32	110	39	18	41	16	20	23	30
Sirajganj Sadar	151	53	86	65	5	40	38	20	4	29
Dhunat	96	29	98	32	6	30	35	16	48	29
Sariakandi	83	45	78	62	4	39	6	26	83	30

Source: Priority Area Survey.

In **Table 7.16**, number and types of schools in four project Upazilas is shown. Primary schools are run under different management. There is government primary school, registered school which receive subvention from the government, privately run primary school, kindergarten school with a special focus on provisioning English language skill, and the primary schools run by different non-governmental organization (NGO). In the context of Bangladesh the role of NGO is significant because they have introduced innovative measure to popularize education particularly among the poor children bringing adjustment with their conveniences in terms of time and teaching style. Government primary schools are present on a larger scale in Kazipur and Sirajganj Sadar, although the teacher student ratio is 53 in Sirajganj Sadar because of the fact that it is peri-urban area with higher concentration of people. Registered primary school is highest in Kazipur

Upazila. Private primary school are fewer in number bringing home a fact it does not attract attention of the people who can invest money. Kindergarten schools are relatively costlier than the other types of schools. Student teacher ratio is relatively better in the privately run primary schools.

7.2.5. Public Health

There are different diseases that mark the morbidity pattern of the people living in these four Upazila. The most common disease that is reported by the respondents is fever, which may be caused for various reasons, by contracting cold, inflammation or as symptoms of other diseases. Cold is also reported by about 57 percent, which is mostly a seasonal bout. Headache is also a complaint lodged by 36.04 percent. It is also an independent disease as well as a consequence. About 10 percent reported gastric/ulcer often related to the use of spice and excessive oil in cooking. Diarrhea was reported by 7.18 percent, once it was more common, now has been reduced owing to health campaign. The other diseases include anemia, eye problem and others. See **Table 7.17** for the prevalence of different diseases in the area,

Table 7.17: Morbidity Pattern in Four Upazilas

Diseases	Percent of People Reported N=641
Fever	82.22
Cold	56.79
Headache	36.04
Gastric/Ulcer	9.83
Colic pain	9.83
Diarrhea	7.18
Anemia	3.43
Eye problem	3.12
Pneumonia	2.65
Jaundice	2.50

Source: Priority Area Survey.

Health seeking behavior is an important part of how disease is dealt with. Medical pluralism marks the prevailing phenomenon. Allopathic treatment is the most common although taken from different sources. For example, 46.30 percent took treatment from Upazila health complex, 16.24 percent received treatment from union health center while 17.52 percent received it from district hospital (see **Table 7.18**). This also implies the combination of modern and traditional treatment. For example, 36.04 percent also received treatment from village doctor which may include folk healer or quack. Treatment is also sought from the drug store attendants who are trained healers; such phenomenon is also seen in other parts of the country.

Table 7.18: Health Seeking Behavior in Four Upazilas

Places where Treatment is Sought	Percent Reported N=702
Union health Center	16.24
Community clinic	12.54
Upazila health complex	46.30
District hospital	17.52
NGO clinic/hospital	3.13
Pharmacy	23.22
Homeopathy	0.71
Village doctor	36.04

Source: Priority Area Survey.

Maternal mortality is a major public health concern. With the improvement of public health situation the maternal mortality is often reduced. One of the major causes of maternal mortality is the traditional delivery practices which mean senior female members of the family or traditional birth attendant assist the delivery of the pregnant women at home. There a number of disadvantages when delivery of a pregnant women takes place at home. The condition provided by a hospital particularly from the point of sterilization cannot be provided at home, which leads to casualty of mother and newly born. The serious of the condition of the pregnant women cannot also be ascertained due to lack of modern equipment. Although at present traditional birth attendant is provided with short training and delivery kit but it cannot reduce the risk substantially. Often it is found that at a critical condition the pregnant woman is removed to hospital. **Table 7.19** shows that about 71 percent delivery is carried out by the birth attendants that are not trained.

Table 7.19: Background of Persons Assistingucting Delivery of Pregnant Women

Person Conducting Delivery	Percent of Deliveries
Governmentdoctor	7.50
Private doctor	4.06
Government health workers	2.66
NGO health professional	0.16
FWV/FWC	0.47
Trained Traditional Birth Attendant	9.69
Traditional Birth Attendant	70.94
Villagedoctor	0.78
Others	3.75

Source: Priority Area Survey.

7.2.6. Water Supply and Sanitation

Water is an important element in every day's living. It is used for different purposes, as for the purpose of drinking, it is also used for the cleaning and washing. Water could be a serious threat for life if it is polluted by the presence of microbiological organism. The issue of water borne disease and mortality is well known. All of the households interviewed for this purpose reported that they use tube well to fetch water for drinking. Tube well draws water from a certain depth below the surface and the general assumption is it is safe for health.

Household chores are another purpose that requires water. It includes cooking, washing utensils and clothes and cleaning house. Safe water is extremely necessary for cooking and washing. For house cleaning one may use water which may not as safe as the one used for drinking. However, 99.1 percent respondents reported that they use tube well water for the purpose of household chores (see **Table 7.20**).

Table 7.20: Sources of Water for Household Chores

Sources	Percent (N=679)
Tube well	99.1
Pond	0.6
River	0.3
Rain water	-
Other	-
Total	100

Source: Priority Area Survey.

In the recent time the presence of arsenic in ground has caused a grave concern among the public health officials since it is hazardous for health. The water of tube well has been affected by arsenic and the government has taken special measure to provide source of drinking water free of arsenic. The tube well with arsenic water has been sealed by the public health department and in new spot it has been sunk. 80.6 percent respondents reported that the water of their tube well is arsenic free. However, 7.1 percent are found to use arsenic contaminated water which is posing threat to health condition, and about 12.4 percent respondents do not know about arsenic contamination (see **Table 7.21**).

Table 7.21: Presence of Arsenic in Drinking Water

Presence of arsenic	Percent (N=679)
Arsenic free	80.6
Not arsenic free	7.1
Not known	12.4
Total	100

Source: Priority Area Survey.

Human excreta are a source of different contagious diseases. Fowl and flies carry microorganism from human excreta and spread into the food eaten by human being. Thus the use of sanitary latrine is very important to prevent the spread of contagious diseases such as diarrhea, typhoid, jaundice and others. About 58 percent respondents reported the use of sanitary latrine in the priority areas a huge section do not use such provision. It

means health risk is quite significant in the priority areas. Moreover 1.55 percent still use open space for defecation. It is expression of poverty as well as lack of awareness. See **Table 7.22** for data on latrines used in the area.

Table 7.22: Types of Latrine Used

Types of Latrine Used	Percent (N=645)
Sanitary	57.83
Non-sanitary	40.62
Open place	1.55
Total	100

Source: Priority Area Survey.

7.2.7. Electricity

Electricity is an important utility for a household. Its necessity is manifold. It gives comfort and convenience. It depends on one's capacity whether that person would get access to electricity provided electricity in that particular area. In all four upazila electricity is available including the villages. A number of findings of this report indicated tight economic condition of the households living in the project influence area. As shown in **Table 7.23**, more than three quarter do not have access to electricity.

Table 7.23: Access to Electricity

Access to Electricity	Percent (N=679)
Yes	24.6
No	75.4
Total	100

Source: Priority Area Survey.

The number of bulbs used by different households is found to vary. It is related to the number of room the house has got and the need. It may be assumed that the house with several rooms would need several bulbs, and it may be related to the economic condition of a household. More than fifty percent households use one or two bulbs, indicating the size of house is small or the number of rooms is not many (**Table 7.24**).

Table 7.24: Number of Lighting Bulbs Used

Number of Bulbs	Percent N=169
One	30.8
Two	24.9
Three	17.8
Four	7.7
Five or more	18.8

Source: Priority Area Survey.

7.2.8. Transport and Communication

In the last few years roads and communication has developed in Bangladesh. Back in late 1980's roads and highways were not developed in the northern districts but gradually connectivity has increased. With the construction of Bangabandhu bridge further impetus has been created. Highways have been widened, internal roads have been constructed, villages have been connected with the center and markets. However, annual flood is a major threat to the maintenance of these roads in the northern districts. All Upazila are connected with the district town through public bus and because of increased business activity and administrative purposes people often travel the district headquarter. Many also travel to capital Dhaka when needed.

Among four Upazila Sirajganj Sadar is having greater length of roads relative to other three Upazila (see **Table 7.25**). More significant is the fact that Sirajganj Sadar has got railway communication only. The metal covered roads are also highest in Sirajganj Sadar. Kazipur and Sariakandi Upazila have got lesser length of metal covered roads. Earthen roads are of different length in different Upazila, it is highest in Sirajganj Sadar while lowest in Kazipur.

Table 7.25: Roads and Railways (kilometers)

Upazilla	Railway	Metalled Road	Semi-metalled Road	Earthen Road
Kazipur	0	87	3	294
Sirajganj Sadar	22	122	9	518
Dhunat	0	93	10	478
Sariakandi	0	86	9	406

Source: Priority Area Survey.

People's mobility has increased in rural areas. In the peri-urban area like Sirajganj Sadar it is also high. For various reasons people's mobility has increased, both for business and employment. As a result the number of transports has also increased. Since Sirajganj Sadar is located beside Sirajganj town the number of rickshaws, cycle van and other motorized vehicles is also higher than other three places. The predominance of manually operated vehicles such as rickshaw and cycle van is notable. In rural Bangladesh locally innovated transport vehicles like nosimon (shallow engine generally used for small scale irrigation is fitted into a small van to carry goods) plies over the road, although restriction is put over its movement. See **Table 7.26** for the number of vehicles in various Upazilas of the project influence area.

Table 7.26: Types of Vehicles - Registered and Non-registered

Upazila	Rickshaw	Cycle Van	Three Wheeler	Small Hauler and other Vehicles
Kazipur	115	188	125	25
Sirajganj Sadar	6746	633	2007	185
Dhunat	122	172	80	160
Sariakandi	75	730	25	99

Source: Priority Area Survey.

7.2.9. Chars

In four Upazila there are more than fifty chars (shoals) in the priority area, which are locally known as *chars*, built through continuous siltation of the place in the riverbed where it is raised. The people who live in the land-scarce countryside take the opportunity to shift to newly arisen *char* and often it leads to severe conflict between the contending parties with the consequence of bloody casualties. The people who earlier lost land to river owing to erosion place a larger claim although it was always a contested claim since the land documents of the lost land in the river do not provide clear indication of proprietorship. Sometimes land barons with political muscle lay claims on such chars backed by a band of armed members. Above conflicting situation negatively influence the lives of the char people which is true in this context also. Livelihood pattern shows they subsist on minimum income and the major occupations are found fishing, boat riding and cultivation

Commercial investment did not take place here because the longevity of these chars is always uncertain. People live in different types of houses which include mostly thatched houses, tin sheds and semi-concrete ones. Literacy rate among the adults is very poor while among the children participation rate at the primary schools is increasing although limited number of primary schools has hindered the process. There is no community clinic because of very limited health investment and countryside is the last resort of receiving treatment. Drinking water is fetched from hand tube well while unsealed pit latrine is commonly found for the purpose of defecation. Most people in these *char* live around subsistence level poverty line and hunger is not reported. Agriculture has got certain cropping pattern because of the large scale presence of sands, facilitating the cultivation of groundnut and fodder for cow. Paddy cultivation is noticeable in some *char* particularly the ones existing for a longer period of time. Transport is mainly bi-cycle and foot. Electricity is almost absent and kerosene lamps provide light. Cooking fuel is mainly wood.

8. Agriculture in the Project Influence Area

This Chapter presents the agricultural baseline of the project influence area. The data and information provided in this Chpater has been obtained during the field investigations as well as from the secondary resources.

8.1. Overview

Bangladesh is situated in the north of the Bay of Bengal and is predominantly low lying. The alluvial plains of the delta are formed by the Ganges, the Brahmaputra and the Meghna rivers. The economy of the country is primarily dependent on agriculture. About 71 percent[25] of the total population lived in rural areas and are directly or indirectly engaged in a wide range of agricultural activities. The contribution of agriculture to GDP growth was 33 percent in 1980-81, 25 percent in 2000-2001 and 21 percent in 2005-2006.[26] The latest Household Income and Expenditure Survey (HIES), 2010 reported 17.6 percent of the country's population currently lives in extreme poverty -- defined as those people whose total expenditure is equal to the food poverty line (the cost of a basket of goods amounting to the consumption of 2,100 Kcal per person day). More food production is needed to improve the livelihoods of people who are still lying below poverty level (25 million or more), which directly related with flood control measure in west bank of Brahmaputra/Jamuna river. No major townships except Sirajganj have been established in the project influence area due to its vulnerably to river erosion and as such the areas/populations are mostly rural, so around 70 percent population dependent upon agriculture farming. The share of agriculture in annual family income of rural households lived in west bank of Jamuna is 82 percent and small business only 8 percent[27]. So their livelihoods are practically agriculture based which is under threat of breaching of embankment almost in every year (flood damage of crops), river erosion, sand deposit and opening of new watershed that washed-away fertile crop lands.

The construction of river embankments to protect agricultural land from seasonal flooding/inundation is a common and continuous phenomenon of the country. Usually the silty alluvium deposit caused by flooding is brought under cultivation within 2-3 years. The natural course of soil formation process makes the soil cultivable as of char land but productivity depends upon the types and ratio of sand, silt and clay with pH level and organic matter contents. The soil may barren for certain time but not forever or long time.The floodplain areas are traditionally fertile land with alluvium deposit but generally less productive due to depth of flood water level during the monsoon. Before construction of embankment in 1960 the traditional crops grown in the area are broadcast aman rice[28] (low yield potentials 1.0 – 10.5 t/ha during productive year), Aus rice also with low yield and local aman rice that was mostly vulnerable to flood damage. Some other crops like grass pea, corn, gram pulse, chili, and sugarcane were the crops in the dry season. The farmers were very poor and under threat of migration from their locality due to lack of

[25] http://www.tradingeconomics.com/bangladesh/rural-population-percent-of-total-population-wb-data.html
[26] Updating Poverty Maps of Bangladesh, The World Bank, Bangladesh Bureau of Statistics, World Food Program, 2009
[27] Annual Report 2013-14, Second Crop Diversification Project, DAE, Khamarbari, Dhaka
[28] Deepwater paddy cultivated in low land with more than 180 cm water depth during monsoon, Transplanted aman rice cultivated in medium land during monsoon and aus rice either broadcast or transplant cultivated during pre-monsoon season (Mar-June)

livelihood support. After construction of embankment the scenario of crops and cropping and the livelihoods of people started to change. The flood plain areas became productive by started to produce good local aman rice reducing the areas of broadcasted deep-water aman rice. The dry land crops like vegetables and oilseeds started to occupy the areas of corn/gram pulse and sugarcane. In 80's major crops were early aus rice, jute, deep-water aman rice, gram pulse, corn, mustard, rabi pulses, rabi groundnut and sugarcane. Transplanted aman rice is sometimes planted on silty alluvium or silty soils as the floodwater recedes, and boro paddy is grown locally in depressions, usually using traditional irrigation devices or hand pumps. There were ample surface water and groundwater resources, but they are difficult to exploit for irrigation except by small-scale traditional devices or hand pumps because of shifting river channels and changing land qualities. At present the farmers are mostly cultivating High Yielding Varieties (HYV) of Transplanted Aman and HYV Boro rice instead of local low yield potential varieties, Aus[29] almost wiped out from the area. Among the popular crops now farmers have adopted boro rice, Aman rice, Maize, potato, mustard, chili, wheat, jute, and vegetables. The yield of rice has increased from 1.5 – 2.0 t/ha to 3.5 – 6.0 t/ha. Similarly the production per unit area of other popular crops potentially increased.

The area is still under threat of river breach the embankment during the monsoon that damages transplanted aman crop fully or partially. The breaching not only floods the crops, but also damages the fertility of the agriculture lands by depositing river sand. The proposed embankment would certainly restrict the occasional floods and sand cover of crop land and farmers would have good yield of transplantedaman (T. Aman) rice regularly which is presently irregular and governed by flood. It is expected that the proposed construction of embankment would not only increase the area of T. Aman cultivation but also increase the yield levels of T. Aman by 10-15 percent as the farmers would invest more when they ensure about no flood damage.

8.2. Soil and Agriculture Resources in the Influenced Area of RBIP

8.2.1. Land Types

Land type is classified based on water depth of inundation during the monsoon season due to normal flooding. High land is classified as land which remains above flood level during the monsoon flood, medium high land flooded up to 90 cm, medium low land flooded up to 180 cm, low land flooded up to 300 cm and very low land flooded more than 300 cm during flood season. The majority of the cultivable land in the west bank of Jamuna/Brahmaputra river composed of medium high land (44 percent) followed by high land (24 percent), medium low land (20 percent), low land (8 percent) and very low land (4 percent)[30]. Details of land types are presented in **Table 8.1**.

[29] Three types of rice is grown in the country: Aus rice either transplanted or broadcast cultivated in pre-monsoon period (Mar to June); Aman rice either transplanted or broadcast in monsoon period (July to Oct); and Boro rice cultivated in dry/winter season (Nov to Feb).

[30] High Land: Land which is above normal flood level; Medium High Land: Land which normally is flooded up to about 90 cm deep during the flood season; Medium Low Land: Land which normally is flooded up to between 90 cm and 180 cm deep during the flood season; Low Land: Land which normally is flooded up to between 180 cm and 300 cm deep during the flood season; Very Low Land: Land which normally is flooded deeper than 300 cm during the flood season

Table 8.1: Land Type of the Project Influence Area

Land Type	Depth of Inundation during Monsoon (cm)	Area (ha)	Percent of Total Area
High Land	Above normal flood level	62,250	23
Medium High Land	Up to 90 cm deep	116,246	43
Medium Low Land	90 to 180	52,477	20
Low Land	180 to 300	21,314	8
Very Low Land	More than 300	16,180	6
Total		268,467	100

The area is characterized by presence of large numbers of chars (raised riverbeds surrounded by water) with an area of more than 25000 ha with poor soils especially the new ones, however comparatively older chars are productive in respect of cultivating dry land crops (sweet potato, sesame, mustard, groundnut, rabi vegetables, melons and recently maize) and livestock raising/grazing.

8.2.2. Soil Resources

The area included within the RBIP does not greatly vary in terms of Agro-ecological characteristics. The west bank of Brahmaputra/Jamuna River starting from north (Kurigram district) to south (Sirajganj district) has wide range of environmental conditions. Soil diversity in the project influence area occurs not only at regions, but at Upazila and even at village levels. The diversity of crop production and yield level is greatly influenced by land types, seasonal flood water levels and soil textures.

The agro-ecological regions and sub-regions of the country are differentiated mainly on physiographic, soil and surface flooding characteristics and the crop suitability assessments for each unit take into account agro-climatic factors in only a generalized way. Thirty agro-ecological regions and 88 sub-regions have been identified for the country based on physiography, soils, land levels in relation to flooding and agro-climatology. The present RBIP area comprises of three agro-ecological regions[31]:

- Active Teesta Flood Plain (AEZ – 2)
- Karatoya-Bangali Floodplain (AEZ – 4), and
- Active Brahmaputra-Jamuna Flood plain (AEZ-7)

The distribution of agro-ecological regions in the project influence area and their general soil characteristics is presented in **Table 8.2**. The map in **Figure 8.1** shows the presence of AEZs with its extent and locations.

[31] The statement is supported by clause 9, page #191 of UNDP/FAO publication (book): Agroecological Regions of Bangladesh; written by H. Brammer et al 1988.

Table 8.2: Agro-ecological Zones in Project Districts

Agro-ecological Region	General Soil Type/Texture	AEZ area (ha)	Area (%)	Land type in percentage				
				High Land	Medium High Land	Medium Low Land	Low Land	Homestead and Water
Active Teesta Flood Plain	Non-calcareous grey floodplains; Loamy + Sandy	83,644	13	2	72			26
Karatoya-Bangali Floodplain	Non-calcareous grey/dark grey floodplains; Loamy + clayey	257,158	39	23	44	14	1	14
Active Brahmaputra-Jamuna Flood plain	Non-calcareous grey floodplains; Loamy+Sandy	319,001	48	5	37	20	8	30
All		659,803	100	12	44	15	4	23

8.2.3. Soil Characteristics of the Project Influence Area

The soils of the areas are mostly non-calcareous alluvium and non-calcareous gray floodplain. Soil texture is classifies as loamy plus sandy in AEZ 2 and 7 while loamy plus clayey in AEZ 4. Complex mixtures of sandy and silty alluvium occupy most char land, but there are some developed grey silty soils on older areas of alluvium, especially along the west coast of the Brahmaputra/JamunaRiver. However large areas of sand may be deposited in high flood years, especially in the north (Kurigram). The region has an irregular relief of broad and narrow ridges and depressions, interrupted by cut-off channels and active channels. Both the outline and relief of char formation are liable to change each flood season due to bank erosion by shifting channels and to deposition of irregular thickness of new alluvium. Local differences in elevation are mainly 2-5 meters.

According to the tested sample of the soil, the result showed that the availability of ample surface water and ground water resources make the area highly productive when crop are to be grown by lifting water either by LLP or STW. The top soils are mostly neutral to acidic (pH 5.5 to 7.0) and lower layer silt deposits neutral to moderately alkaline (pH 7 to 8). The organic matter contains are low (about 1.5 percent), especially in sandy soils. However the soils in project influence areas are largely suitable for rice and other cereals, jute, oilseeds, and pulses.

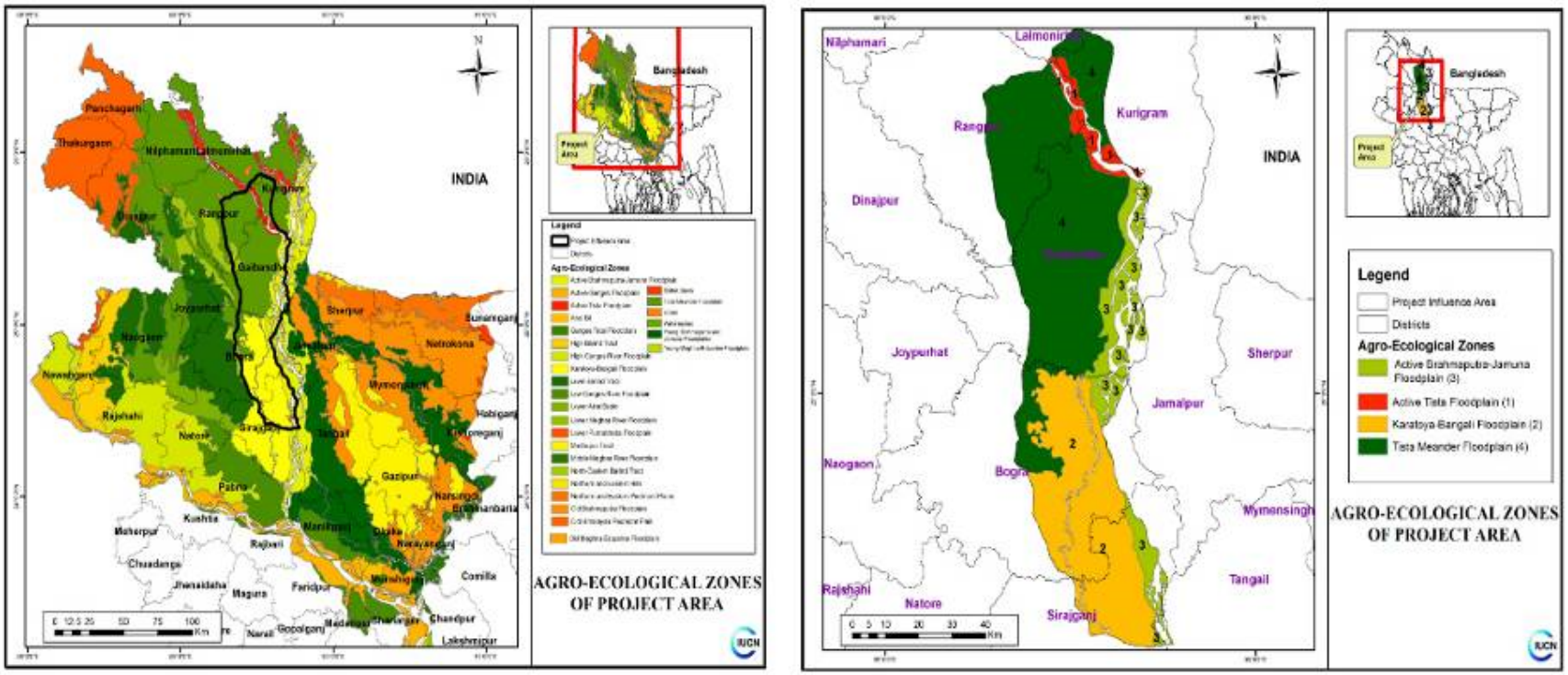


Figure 8.1: Agro-ecological Zones

8.3. Flood Prone Area and Crop Damage

The field investigation was made immediately after the flood (Aug-Sep 2014) in the west bank of Jamuna/Brahmaputra river, so the researcher had opportunity to collect the area of transplanted aman rice fully damaged by current flood from each of the Upazilas starting from SirajganjSadar to Kurigram Sadar. It is roughly about 40,000 ha, which could be treated as flood prone areas in the west zone of the Jamuna River.

The landscaping of project influence area is not quite different from other areas of the country only the area is rich in natural channels and narrow ridges due to high intensity of several big rivers. The area faces seasonal floods once in two years on average as reported by local people and especially in northern parts (upper region of Gaibandha and Kurigram) there is threat of sand-sediment that damaged the area for year round crop production for several years. Other crop production constraints include river-erosion, siltation of canals and other water channels that caused drainage congestion, and unusual drought in some years caused low production of aus and aman rice, and all types of dry land crops like mustard, potato, sugarcane, chili, gram/corn, pulses and other oilseeds.

8.4. Crops and Cropping Patterns of the Project Influence Area

Before construction of embankment in 1960's the predominant crop was deepwater rice in the floodplains during monsoon, and transplanted aman rice in ridges and comparatively upland areas that produced very low yield (1.0 to 1.5 t/ha). In the dry/winter season the crops were gram/corn, pulses especially grass pea, groundnut, mustard, and sesame. Most of the land in floodplains remain fallow in monsoon due to flood damage that seeded by grass pea (the poor man's crop). As a result people were very poor due to low productivity of land resources.

The cropping pattern is the sequence of crops grown in a particular plot in a particular year considering three cropping seasons. The country has three cropping seasons like a) Kharif II (monsoon: roughly July to Oct), b) Rabi (dry/winter season: roughly Nov to Feb) and c) Kharif I (pre-monsoon: roughly March to June). The cropping pattern is not a static system rather dynamic and varies from year to year, plot to plot, location to location depends upon weather and market price of crop products. The major cropping patters in the project influence area as reported by DAE are presented in **Table 8.3** below by land types and cropping seasons; **Figure 8.2** shows the cropping pattern in the project influence area. The predominant cropping pattern in the project influence area is Boro rice – Fallow – Transplanted aman rice that covers 36 percent of the net cropped area. Other dominant pattern is Boro – Fallow – Fallow and Mustard – Boro – Transplanted aman rice/Fallow pattern. Wheat, maize and jute are also common crops found in the area during transect/farm walk.

Table 8.3: Major Cropping Pattern of the project influence area by land types

Land Type	Cropping Season			Area Coverage (ha)	Percent of Net Cropped Area
	Kharif I (Mar - June)	Kharif II (Jul - Oct	Rabi (Nov - Feb)		
High land (F0)	Vegetable	Fallow	Vegetable	2094	0.86
	Fallow	Fallow	Maize	930	0.38
	Jute	Fallow	Maize	3306	1.36
	Jute	Fallow	Chili	4500	1.85

Land Type	Cropping Season			Area Coverage (ha)	Percent of Net Cropped Area
	Kharif I (Mar - June)	Kharif II (Jul - Oct	Rabi (Nov - Feb)		
	Jute	Fallow	Pulses	3704	1.52
	Aus rice	Fallow	Chili	2054	0.84
	Sugarcane		Chili	1700	0.70
	Fallow	Fallow	Gram/Corn	2315	0.95
Sub-Total				**20603**	**8.46**
Medium High Land (F1)	Fallow	T. Aman	Boro	122546	50.33
	Jute	T. Aman	Maize	3743	1.54
	Boro	T. Aman	Potato	3350	1.38
	Jute	T. Aman	Vegetable	2980	1.22
	Fallow	T. Aman	Gram/Corn	2835	1.16
	Jute	T. Aman	Boro rice	7633	3.13
	Jute	T. Aman	Wheat	5050	2.07
	Boro	T. Aman	Mustard	15092	6.20
	Fallow	T. Aman	Wheat	5532	2.27
	Maize	T. Aman	Potato	1400	0.58
	Jute	T. Aman	Potato	1120	0.46
	Vegetable	Vegetable	Boro	1500	0.62
Sub-Total				**172781**	70.96
Medium Low Land (F2)	Fallow	T. Aman	Pulses	5226	2.15
	Jute	Fallow	Maize	5340	2.19
	Jute	Fallow	Mustard	2350	0.97
	Jute	Fallow	Pulses	6530	2.68
	T. Aus	T. Aman	Boro	7055	2.90
Sub-Total				**26501**	**10.88**
Low Land (F3)	Fallow	Fallow	Maize	3490	**1.43**
	Fallow	Fallow	Peanut	1970	**0.81**
Very Low Land (F4)	Fallow	Fallow	Boro	13627	**5.60**
Total				**235482**	**96.72**
Other Minor Cropping Patterns				7986	3.28
Grand Total				**243468**	**100**

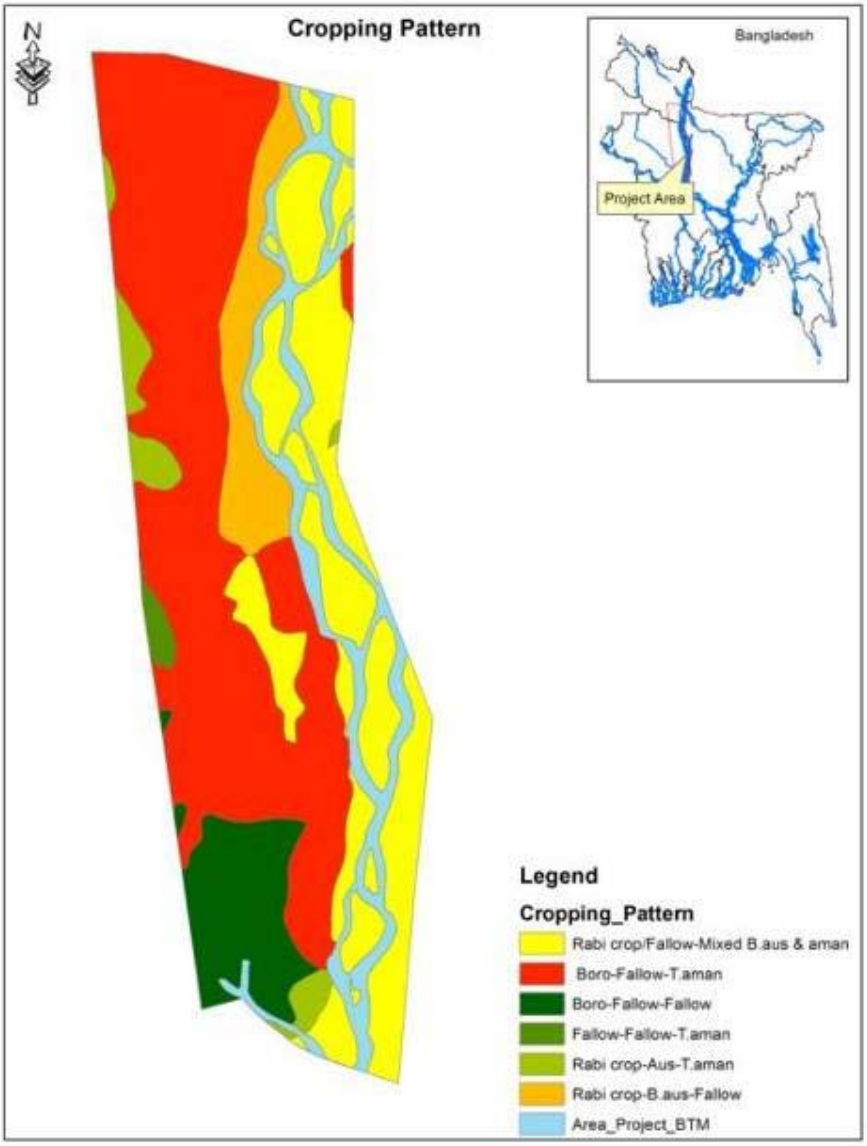


Figure 8.2: Cropping Pattern in the Area

8.4.1. Land Use Intensity and Cropping Intensity

The land use intensity (74 percent) is calculated based on the available cultivable land against the total area of the project influence area (the areas of Upazilas adjacent to the west bank of Brahmaputra/Jamuna is considered as influenced area of the project). It indicates that 74 percent of the land area is suitable for agricultural cultivation and the rest areas are being used for other purposes (settlements, rivers/water bodies, roads).The cropping intensity (211 percent) is the percentage of total cropped area against net cropped area, which found fairly higher than the country's average[32] (190 percent). Of the net cropped area 70 percent is double cropped, 21 percent triple cropped and only 9 percent single cropped area (**Table 8.4**). The data indicates higher agricultural

[32]Krishi diary 2014 published by Agriculture Information Service, DAE, Khamarbari, Dhaka.

productivity of the area. But still there is room for further improvement in production by increasing area of T. Aman during monsoon.

Table 8.4: Land Use and Cropping Intensity in the Project Influence Area (2013-14)

Land Type		Land Area (ha)					
	Total project area	Total Cultivable land	Single cropped area	Double cropped area	Triple cropped area	Net cropped area (NCA)	Total Cropped Area
High land			3,245	17,358		20,603	37,961
Medium high land				130,913	41,868	172,781	387,430
Medium low land				19,446	7,055	26,501	60,057
Low land			5,460			5,460	5,460
Very low land			13,627			13,627	13,627
Total	342,326	253,006	22,332	167,717	48,923	238,972	504,535
Coverage of NCA by percent			9	70	21	100	
Cropping Intensity (percent)		211					
Land use intensity (percent)		74					

8.5. Crop Economics

The average yield level of major crops growing in the concerned Upazilas was plotted in the following table 8.6. The yields of crops were estimated by arranging FGD sessions with 10-12 selected potential farmers through SAAO (Sub Assistant Agricultural Officer) of DAE in several locations of each of the Upazilas.

In all locations farmers are invariably growing HYVs in case of boro rice, T. Aman rice and other dry land crops including maize, wheat, oilseeds and vegetables. As reported by the respondents they are harvesting fairly good yields per unit area in case of rice (boro and T. Aman), wheat, maize, tomato, and potato (**Table 8.5**). These yields of crops will be used to estimate the production loss/gain in the area due to re-construction of proposed embankment.

Table 8.5: Economic Analysis of Major Crops Grown in RBIP Area

Crop	Yield t/ha	Production Cost (BDT/ha)	Gross Income (BTK/ha)	Net Income (DTK/ha)
Boro rice	5.87	78268	104,620	26,352
T. Aman rice	3.91	48072	73,290	25,217
Wheat	3.11	42608	66,134	23,527
Maize	8.74	74100	101,406	36,568
Jute	2.82	50388	102,629	52,241
Mustard	0.82	16302	30,566	14,264

Crop	Yield t/ha	Production Cost (BDT/ha)	Gross Income (BTK/ha)	Net Income (DTK/ha)
Tomato	44.46	211185	444,600	233,415
Potato	17.78	109298	143,569	34,271
Chili	0.00	100406	192,660	92,255
Pointed gourd	0.00	155610	555,750	188,214

Source: In-depth interview

The production costs of different crops in the locality as reported by the farmers are shown in **Table 8.5** by crops. The cost is found comparatively higher with vegetable crops followed by boro rice, maize and other crops, which passively related with the input use during growing period that directly corresponds to the financial base of the producers. Gross incomes of crops under cultivation by the local farmers are also plotted in **Table 8.5**. The gross income of crops largely varies with the market price and yields. In gross income from same crop varies with locations, which is more pronounced in case of perishable vegetables. Higher net incomes of crops per unit area are found from tomato and pointed gourd. Considering economic return maize is found better than wheat while rice showed marginal rate of return. The scenarios of crop economics in project influence areas are not unlikely to other areas of the country.

8.6. Irrigation Coverage

Traditionally people used to put irrigation water to potato, and chilies in dry season by using hand pumps or other local devices. Cultivation of boro rice in dry/winter season using river/canal and underground water through Low Lift Pimp (LLP), Shallow Tube Well (STW) and Deep Tube Well (DTW) started in 1960,s during green revolution and extends to other crops like wheat, potato, oilseeds in 70s. In mid 80s irrigated area expanded rapidly when installation of LLP, STW and DTW put under private ownership. Rice production increased by three folds due to use of technology and input especially irrigation to boro rice.

The project influence area is fairly good in coverage of area under irrigation. The area under irrigation with types of pumps used is shown in the following table by collecting information from local Department of Agricultural Extension (DAE) offices. The mean irrigated area in dry season is observed 71 percent with variation among districts (table). Coverage is high (64 percent) with Shallow Tube Well (STW) followed by Deep Tube Well (6 percent) and Low Lift Pump only 1 percent (**Table 8.6**).

Table 8.6: Irrigation Coverage by Type of Pumps and their Numbers in RBIP Area

District	Irrigated Area (ha)	Net Cropped Area (ha)	Coverage of Irrigated Area of Net Cropped Area by Irrigation Pumps (%)			
			DTW	STW	LLP	Total
Sirajganj	25,965	48,294	12	42	0.16	54
Bogra	32,434	43,875	2	69	2.48	74
Gaibandha	67,622	88,352	7	69	1.18	77
Kurigram	47,630	62,956	4	71	0.54	76

District	Irrigated Area (ha)	Net Cropped Area (ha)	Coverage of Irrigated Area of Net Cropped Area by Irrigation Pumps (%)			
			DTW	STW	LLP	Total
All	173,651	243,477	6	64	1.05	71

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

The existing numbers of irrigation equipment being usied in the concerned Upazilas with command area per unit of pump (i.e. efficiency) is calculated based on secondary data. The command area per DTW in the project influence area ranges from 20 to 25 ha, for STW, 1.2 to 3.5 ha and for LLP, 2.5 to 10.5 ha (see **Table 8.7**).

Table 8.7: Irrigation Pumps being Used in the RBIP Areas

District	DTW		STW		LLP		Total	
	Qty	Command Area per Unit (ha)	Qty	Command Area per Unit (ha)	Qty	Command Area per Unit (ha)	Qty	Command Area per Unit (ha)
Sirajganj	226	25	16,891	1.20	28	2.68	17,145	1.51
Bogra	47	20	22,158	1.37	86	12.67	22,291	1.46
Gaibandha	241	25	24,758	2.45	122	8.56	25,121	2.69
Kurigram	129	20	12,511	3.58	32	10.53	12,672	3.76
All	643	24	76,318	2.04	268	9.50	77,229	2.25

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

8.7. Agricultural Inputs

The farmers in the project influence area are using large amount of chemical fertilizers as of other areas of the country. The rate of fertilizer use per ha generally varies from farm to farm based on fertility status of plot and financial base of the producers. The major chemical fertilizers used in the area are Urea, TSP, MoP and Gypsum. Urea is widely used in boro rice, potato, maize, jute and other crops. 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. Pesticides are used as granular and liquid form in different doses varies from farmer to farmer. It was hard to collect the actual amount used per unit area of crop land, so the cost per unit area of land for pesticides collected and shown in **Table 8.8**.

Table 8.8: Rate of Fertilizer/Pesticides Used for Major Crops (2013-14)

Name of the Crop	Fertilizer Used (Kg/ha)				Pesticide Used (BDT/ha)			
	Urea	TSP	MoP	Gypsum	Insecticide	Fungicide	Herbicide	Total
HYV Boro Rice	268	132	132	60	1647	2620	2133	6400
HYV T. Aman Rice	183	126	81	49	455	530	1123	2108
Jute	248	33	123		2620		449	3069
Maize	469	139	139	75	1796			1796

Name of the Crop	Fertilizer Used (Kg/ha)				Pesticide Used (BDT/ha)			
	Urea	TSP	MoP	Gypsum	Insecticide	Fungicide	Herbicide	Total
Wheat	268	136	66	117	1029	1123	1123	3275
Potato	254	67	124	60	1684	1684	748	4117
Mustard	62	40	32	13	1123			1123
Chilies	472	281	206	56	4865		1347	6212

Source: FGD in project influence area in Sep 2014

Table 8.9 shows the actual amount of chemical fertilizers used in the Upazilas in the project influence area for RBIP. The data was collected from Upazila Agriculture Office of each of the Upazila.

Table 8.9: Chemical Fertilizer Used in Project influence area in 2013-14

Name of Fertilizer	Total Amount Used (MT)	Percent of Total Use
Urea	78,982	59
TSP	15,777	12
DAP	14,152	11
MOP	15,363	11
NPKS	1,125	1
Gypsum	4,715	4
Zinc sulfate	1,997	1
Mag. Sulfate	1,194	1
Boric	653	0
Total	133,958	100

Source: Upazila Agriculture Office of DAE in Project influence area

Use of chemical fertilizer in crops increased rapidly in 80s after introduction of hybrids/high yield varities (HYVs) in rice (boro, aman and aus). Vegetable production in the country increased by several folds during past three decades with the introduction of hybrids and HYVs that resulted increased use of fertilizers too. Massive agriculture extension works motivated the farmers in using chemical fertilizers in cereals, oilseeds, fruit crops and all sorts of vegetables. Consumption of chemical fertilizers also increased with extension of maize cultivation in 90s.

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Annex A. Chainage Wise Observations in the Priority Area (Ecological/Social Features)

Chainage	Key Environmental and Social Features	Name of the Key Places	Distance from right of way (km)
Sirajganj sadar (20.00 - 27.20 km)	Beel	1.Aminpur, 2.Joynagar, 3.Charkhada,	**1.** 1 km south from proposed Balia ghugri regulator , **2.** 3 km south from proposed Balia ghugri regulator, **3.** 4 km south from proposed Balia ghugri regulator
	Khal/Canal	1. WAPDA Khal ,2. Doi Vanger khal, 3. Balia ghugri khal 4. Bahuka khal	1.adjacent to existing alignment 2. 3 km north-east from simla spur 3. adjacent to proposed Balia ghugri regulator (on north side) 4. adjacent to existing alignment
	Char	1.Simla , 2. Kharoya, 3. Khas para, 4. Par Simla, 5. Noya para, 6. Dumber char, 7. Jhumkal char,	1. 4 km east from proposed Balia ghugri regulator, 2. 6 km east from proposed Balia ghugri regulator, 3. 7 km north-east from proposed Balia ghugri regulator,4. 3 km north-east from proposed Balia ghugri regulator, 5. 5 km north-east from proposed Balia ghugri regulator, 6. 2 km north east from proposed Balia ghugri regulator, 7. 7 km north from proposed Balia ghugri regulator
	Char (Important for winter bird)	1.Jhumkal char, 2.Khas para, 3. Kharoya	1. 7 km north from proposed Balia ghugri regulator, 2. 7 km north-east from proposed Balia ghugri regulator,3. 6 km east from proposed Balia ghugri regulator
	Kole (Embayment)	1.Simla, 2.Mothiar kul – Pachthakuri,3. Balutia-Moshamara	1. 5 km east from proposed Balia ghugri regulator, 2. 1.25 km east-north from proposed Balia ghugri regulator, 3. 0.5 km east from proposed Balia ghugri regulator
	Breeding ground	Banaijan khal	0.5 km east from proposed Ratankandi culvert-1
	College	Kuchkabari	Adjacent to the new alignment
	Bazar	1. Ratankandi,2. Bahuka	1. 0.1 km south from proposed Ratankandi culvert-1, 2. 0.3 km south from proposed alignment
	School	Bahuka	0.2 km south from proposed alignment
Kazipur, Bogra (27.20 - 40.13 km)	Beel	1.Kachihara, 2.Pagol kandi	1. 15 km west from Dhekuria hat 2. 14 km west from Suvhgaccha
	Khal	1.Chalita danga 2.Paikartoli, 3. Banaijan 4.Baoitara	1. adjacent to existing alignment 2. adjacent to existing alignment 3. adjacent to existing alignment 4. adjacent to existing alignment

Chainage	Key Environmental and Social Features	Name of the Key Places	Distance from right of way (km)
	Char	1. Megai, 2.Manikpotol, 3.Fultola, 4.Shimultola,5. Saouthtola 6. Polashpur, 7.Char kazipur,8.Masuakandi, 9.Maijbari fulchar, 10.Bhurungi	1. 1km north-east from 1 no. Meghai spur 2. 1.5km east from 1 no. Meghai spur 3. 2km east from 1 no. Meghai spur 4. 2 km east from 1 no. Meghai spur 5. 2km North from 1 no. Meghai spur 6. 1km east from 2 no. Meghai spur 7. 3km east from 2 no. Meghai spur 8. 1km north from 3 no. Meghai spur 9. 3km east from 1 no. Meghai spur 10. 3km east from 3 no. Meghai spur
	Char (Important for winter bird)	**1**.Maijbari, **2.** Fultola, **3.** Char Kajipur **4.** Bhurungi	**1.** 3km east from 1 no. Meghai spur **2.** 2km east from 1 no. Meghai spur **3.** 3km east from 2 no. Meghai spur **4.** 3km east from 3 no. Meghai spur
	Kole (Embayment)	**1.**Vutir diar, **2.** Khudbandi, **3.** Meghai, **4.** Dhakuria	**1.** 2 east from proposed Ratankandi culvert-1 **2.**3 north from proposed Ratankandi culvert-1 **3.** 4 north from proposed Ratankandi culvert-1 **4 .** 6north from proposed Ratankandi culvert-1
	Union Parishad	Meghai, Kazipur	Adjacent to the new alignment
	Mosque (2 nos.)	Meghai, Kazipur	Adjacent to the new alignment
	Temple	Meghai, Kazipur	On the new alignment
	Public Health Center	Meghai, Kazipur	Adjacent to the new alignment
	Bazar	Dhekuria ,Meghai, Kazipur	adjacent to existing alignment
		Hatkhola, Changaccha, Kazipur	adjacent to existing alignment
	Boat Ghat	Meghai, Kazipur	adjacent to existing alignment
		Khutbandhi,Meghai, Kazipur	adjacent to existing alignment
		Dhekuria,Meghai, Kazipur	adjacent to existing alignment
Dhunat , Bogra (40.13 - 46.850 km)	Beel	1.Jagiar beel/ Vander bari, 2. Bera danger beel, 3.Houra khali beel	1. adjacent to proposed Pukuria-Vanderbari regulator 2. 1.5 km east from proposed Pukuria-Vanderbari regulator 3. 5 km north from Shimulbari spur
	Khal	1.Madhob Danga , 2.Shimul bari khal	1. 1 km east from proposed Pukuria-Vanderbari regulator 2. adjacent to existing Shimulbari spur
	Char land	1.Maiz bari, 2.Vanger bari, 3.New sariakandi, 4.Pukuria, 5.Boroikandi, 6.Baniajan, 7.Koiya	1.3 km east from proposed Pukuria- Vanderbari regulator,2. 2 km east from Pukuria- Vanderbari regulator, 3. 3 km north-east from Pukuria- Vanderbari regulator,4.

Chainage	Key Environmental and Social Features	Name of the Key Places	Distance from right of way (km)
		gari, 8.Atai, 9.Sohora, 10.Boishaki, 11.Adhanagor, 12.Fuljhur,13. Mollik para, 14.Shree pur, 15.Agura maizbari, 16.Dhakuria, 17.Boyan char ,18.Majhira, 19.Shanbandha, 20.Promitibari, 21.Noi khola	on east side of Pukuria- Vanderbari regulator, 5. on east side of Pukuria- Vanderbari regulator , 6. on east side of Pukuria- Vanderbari regulator, 7. on east side of Pukuria- Vanderbari regulator , 8. on east side of Pukuria- Vanderbari regulator, 9. on east side of Pukuria- Vanderbari regulator,10. 1 km east from Shimul baria spur,11. 1 km east from Shamol bari spur,12. 2 km east-south from Shamolbari spur,13. 3 km east-south from Shamol bari spur, 14. 3.5 km east-south from Shamol bari spur,15. 4 km east-south from Shamol bari spur,16. 5 km east-south from Shamol bari spur,17. 3 km east from proposed proposed kamalpur regulator, 18.4 km east from proposed kamalpur regilator, 19. 5 km east from proposed kamalpur regulator, 20. 6 km north from proposed kamalpur regulator,21. 6.5 km north from proposed kamalpur regulator
	Char (Important for winter bird)	1.New sariakandi, 2.Shreepur, 3.Dhakuria, 4.Promitibari, 5.Noi khola, 6.Shanbandha	1. 3 km north-east from proposed Pukuria- Vanderbari regulator,2. 3 km east-south from Shamol bari spur, 3. 5 km east-south from Shamol bari spur, 4. 6 km north from proposed kamalpur regulator,5. 6.5 km north from proposed kamalpur regulator,6. 5 km east from proposed kamalpur regulator
	Mosque	Bhanderbari, Dhunat	Adjacent to the new alignment
	School	Chuniapara, Dhunat	Adjacent to the new alignment
	Union Parishad	Baluhata, Bhandarbari, Dhunot	Adjacent to the new alignment
Sariakandi (46.850 – 70.00 km)	Beel	1.Deuli, 2.Vakir, 3.Bera, 4. Digdar	1. 0.1 km west-north from proposed anterpara regulator, 2. 1 km north-west from proposed anterpara regulator, 3.4 km north-west from proposed anterpara regulator, 4. 2 km north- west from hasnapara
	Khal	Kata khal	0.5 km west north-west from proposed Anterpara regulator
	Kole (Embayment)	1.Antarpara, 2.Nichkola, 3.Khurda Boloi, 4. Maiz bari	1.2 km east from proposed anterpara regulator, 2. 0.75 north from Hasnapara,3. 0.5 km east from Hasnapara, 4. 2 km east from

Chainage	Key Environmental and Social Features	Name of the Key Places	Distance from right of way (km)
			proposed kutubpur regulator
	Char	1.Kuripara, 2.Khapur par, 3.Antarpara, 4. Kazla, 5. Ghager char, 6. Diga para, 7. Chokorthinatha, 8. Konnobari, 9.Kormoja, 10. Housherpur, 11.Sujatpur, 12. Bauliapara, 13.Banupur, 14. Dhorbon, 15. Pakuria char,16.Jamtoil, 17.Manik, 18. Nobboi, 19. Barabajbari, 20.Indurmara, 21.Hasnapara, 22.Dakat mara, 23.Chanpara,	1. east to proposed Antarpara regulator , 2. east to proposed Antarpara regulator ,3. east to proposed Antarpara regulator ,4. east to proposed Antarpara regulator ,5. east to proposed Antarpara regulator ,6. 1 km east-north from Hasnapara, 7. 3 km east-north from Hasnapara,8. 4 km east-north from Hasnapara,9. 2 km north from Hasnapara,10. 1.5 km north from Hasnapara,11. 3 km north from Hasnapara,12. 4 km north from Hasnapara,13. 2 km east from Hasnapara,14. 1 km east south from Hasnapara,15. west to Shalukar char,16. west to Shalukar char,17. north to Shalukar char,18. north-east to Shalukar char,19. east to Shalukar char,20. south to Shalukar char,21. east-south to Shalukar char,22. east-south to Shalukar char,23. east-south to Shalukar char
	Char (Important for winter bird)	1.Konnobari, 2.Bauliapara	**1.** 4 km east-north from Hasnapara, **2.** 4 km north from Hasnapara
	Breeding ground	1. Kutubpur khal, 2. Vagir beel	**1.**0.5 km west from proposed kutubpur regulator, **2.**0.3 km north-west from proposed Anterpara regulator
	Fish pass	Perdevdanga, kutubpur	0.1 km west from proposed alignment
	School	Perdevdanga, kutubpur	Adjacent to new alignment
	Mosque	Hasnapara, Hatsherpur	Adjacent to new alignment
	Grave yard	Antarpara	0.25 km west from proposed Anterpara regulator

Annex B. Air Quality and Noise Measurement Spots

River Bank Improvement Program (RBIP)

Environmental Study

Priority Zone (50 km)

Place	Upazila/Union	District
1.Sariakandi HP	Sariakandi	Bogra
2.Singrabari	Kajipur	Sirajganj
3.Ratankandi	Ratankandi	Sirajganj

Reaming Zone

1. Baoitara	Saidabad	Sirajganj
2.Jumarbari	Gaibanda Sadar	Gaibanda
3.Bharatkhali	Saghatta	Gaibanda
4.Anantapur	Ulipur	Kurigram

Annex C. Survey Sheets for Ecological Study

River Bank Improvement Program
Environmental Study

Focused Group Discussion (Ecological Survey)

SL. No.	Date:	Time:
Vill:	Mouza:	Union:
P.S.:	District:	No. of Participant:
GPS:		Photo:

Trees

Species Name	Use	Species Name	Use	Species Name	Use

Shrubs & Herbs

Species Name	Use	Species Name	Use	Species Name	Use

Wildlife

Species Name	Hunting/Poaching	Species Name	Hunting/Poaching	Species Name	Hunting/Poaching

Use : 1=food; 2=timber; 3=fuel; 4=medicinal; 5=fiber/thatching; 6=others
Hunting/Poaching: Y=Yes, N=No

Ecological Survey

Plot No.:	Date:	Time:
Vill:	Mouza:	Union:
P.S.:	District:	
GPS:		Photo:

Landform Pattern
Landform Element

ALP= Alluvial Plain FLO=Floodplain

100=Plain	101=Sandy Plain	102=Limestone Plain
103=Drainage Depression	104=Stream Channel	105=Flood out
106= Lake	107= Swamp	

Crop cover

0= Nil	1= 1-25%	2= <50%	3= 51%-100%

Crop characteristics

Surface Soil Texture

Sand	Loamy Sand	Clayey Sand
Sandy loam	Clay loam	Silty loam
Loam	Sandy Clay Loam	Silty Clay Loam
Peat	Clay	

Wild Animal Composition

Species Name	Microhabitat	Niche

Floral Species composition

Species Name	Adult		Juvenile	Comments
	Total	Avg. Height	Total	

Canopy Coverage

Wet land information

Types	Month (Wet)	Month (Dry)	Types	Month (Wet)	Month (Dry)
Permanent canal			Seasonal canal		
Permanent lakes			Seasonal/intermittent lakes		
Seasonal/intermittent ponds			Irrigated land and irrigation channels		
Riverine floodplains			Permanent pond		

GPS Location of Sensitive Receptor

Environmental Receptor	N	E
Hospital		
College		
School		
Madrasa		
Mosque		
Graveyard		
Prayer Place		

Questionnaire for homestead vegetation survey

HHH Name:			Village:		
Sample No.		GPS Reading:	N:	E:	Date:
Homestead size (Decimal):			% of homestead covered with woods:		

Species Name	Total Number		Avg. Height (m) of Adult	Utilization	*Economic Value (Tk.)*		Ecological value	Flood susceptibility	% of total Coverage of species
	Adult	*Juvenile*			*Annual*	*Harvest Value*			

[1] Utilization : 1=food; 2=timber; 3=fuel; 4=medicinal; 5=fiber/thatching; 6=others
[1] Ecological value : 1=for wildlife; 2= for avi-fauna; 3=for micro ecosystem
[1] Flood susceptibility : 1=highly susceptible; 2=susceptible; 3=resistant

Questionnaire for homestead wildlife survey

HHH Name:				Village:			
Sample No.		GPS Reading:	N:	E:		Date:	
Homestead size (Decimal):				% of homestead covered with woods:			

Species name	Habitat[1]	Food habit[2]	Breeding time (month)	Status[3]	Migration status[4]

[1] Habitat : 1=homestead forest; 2=flood plain; 3=wetland; 4=river
[2] Food habit : 1=herbivore; 2=carnivore; 3=both
[3] Status : 1=very common; 2=common ; 3=rare; 4-very rare
[4] Migration status : 1=local; 2=local migratory; 3=migratory

Annex D. Fisheries Catch Assessment Survey Sheets

Field Researcher: *Habitat Name:* *Survey date:*

Annex 1

Fisheries Catch Assessment Survey Sheet

Baseline Survey of the Jamuna RBIP Project

IUCN Bangladesh Country Office

Date:	Sample no.	Location:	GPS Reading: N	E

Time	Riverbank distance	Meteorological setting @time of sampling	Gear Description	Craft Description	Duration of Haul	Total no. of haul/sample
		Sunshine:	Name & Type:	Name:		
		Part of day:	Mesh:	Length:		
		Wind speed:	Materials:	Fishermen no.:		
		Flow (m/s):	Length:	Made of:		
		Lunar date:	Depth of fishing:	Mechanized/non-mechanized:		
		Water quality:	Target species:	Type of boat (Commercial/non-commercial):		

Catch composition		Species list	Abundance (Count)	Total Length (L∞) S: 1-10	Body weight (gm) S: 1-10	Specimen Details					Catch (Kg/haul)	Tot catch (kg)
Fish	%					Photo ID	Morphology	Egg	Age	Sex		

Additional Comment/Constraints:	Research Assistant:	Signature:

Signature:

Field Researcher: *Habitat Name:* *Survey date:*

Annex 2: Fisheries Baseline Checklist

Vill: **Mouza:** **Union:** **Upazila:** **District:** **BWDB Circle:** **BWDB Division:**

Background Water bodies: *Name: Alphabetic, Area: in Ha/% of area/Ana, Length: in km, Depth/Inundation depth: in Meter, Flood Duration: in Months, Production: metric ton*

Problem/Issue	Fishing Effort	Habitat Type	Water Quality	Avg. Production	Production Trend (+/-) and Reason	List of Gears	% of gears	List of Habitat Name	Present					Past (15-20 yrs back)				
									Area	Length	Width	Depth	Duration	Area	Length	Width	Depth	Duration
Capture Fisheries: 1. 2. 3.	a. Total No. of fisher HHs: b. %/No. of CFHHs:	River																
Culture Fisheries: 4. 5. 6.	c. %/No. of SFHHS: d. No. of Days spend annually in fishing by CFHHs: SFHHs:	Beel (Leased/non leased)																
Indiscriminate Fishing Activities: 7. 8. 9.	e. Hrs/Day spend in fishing by CFHHs: SFHHs:	Khal																
		Floodplain																
		Mangrove area																
		Fish pond																
		Baor																
		Ghers																

Signature:

Field Researcher: ***Habitat Name:*** ***Survey date:***

Fish Migration				Fish Biodiversity		Species List					Species Composition				
						River	Khal	Beel	Pond	Other	Group	River	Khal	Beel	Pond
Previous Migration Status				Fish diversity status (Poor/Moderate/Rich) /%							Major carp				
											Exotic carp				
											Other carp				
											Catfish				
											Snakehead				
Present Obstacle to fish migration:	1. 2. 3.			Reasons of increase or decrease	1. 2. 3. 4. 5.						Live fish				
											Other fish				
											Shrimp/prawn				
											Hilsa/Bombay duck/Indian salmon				
											Pomfret				
Important breeding, feeding and over wintering ground											Jew fish				
											Sea cat fish				
											Shark/Skates/ Rays				
											Rui				
											Catla				
Horizontal Migration pattern	Species: 1. 2. 3. 4. 5.	Season (Months):	Routes:	Significant areas	1. 2. 3.						Mrigal				
											Koi				
											Sarputi				
											Large shrimp				
											Small shrimp				
Vertical Migration Pattern	Species: 1. 2. 3. 4. 5.	Season (Months):	Habitats :	Species of Conservation Significance	Rare:						Silver carp				
											Carpio				
											Grass carp				
											Tengera				
					Unavailable:						Chapila				
											Others				

Signature:

Field Researcher: *Habitat Name:* *Survey date:*

Post Harvest Activities		Fishermen Lifestyle	
Fish edible quality:		Socio-economic Status of subsistence level fishermen:	
Source of pollution in each habitat:		Socio-economic Status of Commercial fishermen:	
Seasonal vulnerability:		Other conflict (with muscle men/ agriculture/ other sector/laws):	
Ice factory (Number, location and name):		Fishermen community structure (Traditional/Caste/Religion)	
Landing center, whole sale market, other district markets, etc.:		Traditional fishermen vulnerability (Occupation change/others):	
Storage facility (number, location and name):		Existing Fisheries Management	
Fish market (Number, location and name):		Fishermen Community Based Organizations (FCBOs):	
Marketing problems:		WMOs activity:	
Fish diseases (Name, Host species, Season, Syndrome, Reason, etc.):		Fishing right on existing fish habitats (Deprived/Ltd. access/Full access):	
Other backward and forward linkages (Number, location and name):		Leasing system:	
Transport facility (Mode of fish transportation, cost, other involvements)		Enforcement of fisheries regulation (Weak/strong):	
Dry fish industries (Number, location and name):		Department of Fisheries (DoF) activity:	
Others information:		NGOs activities:	

Note: 1. Major Carp - Rui, Catla, Mrigal, 2. Exotic Carp - Silver Carp, Common Carp, Mirror Carp, Grass Carp, 3. Other Carp - Ghania, Kalbasu, Kalia, 4. Cat Fish - Rita, Boal, Pangas, Silon, Aor, Bacha, 5. Snake Head - Shol, Gazar, Taki, 6. Live Fish - Koi, Singhi, Magur, 7. Other Fish - Includes all other fishes except those mentioned above.
Marine: Hilsa/Illish, Bombay Duck (*Harpondon nehereus*), Indian Salmon (*Polydactylus indicus*), Pomfret (*Rup_Hail_Foli Chanda*), Jew Fish (*Poa, Lambu, Kalabatina* etc.), Sea Cat Fish (*Tachysurus spp.*), Sharks, Skates & Rays, Other Marine Fish.

Beels: Rui (Labeo rohita), Catla (Catla catla), Mrigal (Cirrhinus mrigala), Kalbasu (Labeo calbasu), Gonia (Labeo gonius), Boal (Wallago attu), Air (Mystus aor / Mystus seenghala), Shol/Gazar (Channa spp.), Chital/Phali (Notopterus chitala / N. notopterus), Koi (Anabas testudineus), Singi/Magur (Heteropneustes fossilis /Clarias batrachus), Sarpunti (Puntius sarana), Large Shrimp (Macrobrachium rosenbergii /M. malcomsonii), Small Shrimp, Silver Carp (Hypophthalmichthys molitrix), Carpio (Cyprinus carpio), Grass Crap (Ctenopharyngodon idellus), Pabda (Ompok pabda), Punti (Puntius spp.), Tengra (Mystus spp.), Baim (Mastacembelus spp.), Chapila (Gudusia chapra), Others.

Pond: Rui (Labeo rohita), Catla (Catla catla), Mrigal (Cirrhinus mrigala), Kalbasu (Labeo calbasu), Mixed Carp, Silver Carp (Hypophthalmichthys molotrix), Grass Carp(Ctenopharyngodon idellus), Mirror Carp (Cyprinus carpio var. specularis), Tilapia (Oreochromis mossambicus / O. niloticus), Shrimp, Aor (Mystus aor / Mystus seenghala), Boal (Wallago attu), Shol/Gazar & Taki (Channa spp.), Chital/Phali (Notopterus chitala / N. notopterus), Koi (Anabas testudineus), Singi/Magur (Heteropneustes fossilis / Clarias batrachus), Sarpunti (Puntius sarana), Thai Sarpunti (Puntius goniconotus), Punti (Puntius spp.), Others.

Signature:

Annex E. Location and specification of different fish habitats and chars

Sirajgang Sadar Upazila

Water body type	Country side (Name/ No.)	River side (Name/No.)	Specification
River		Jamuna	
	Ichhamoti		
Beel/ Wetlands	Aminpur beel		0.80 ha
	Joynagar beel		20 ha
	Charkhada		0.80 ha
	Chatiantolir beel		13.36 ha
	Ghuria beel		6.68 ha
	CNB Beel		2.67 ha
Khal/Canal	WAPDA Khal		
	Doi Vanger khal		
	Balia ghugri khal		
	Bahuka khal		
Kole (Embayment)		Simla	2.97 ha
		Mothiar kul - achthakuri	3.34 ha
	Balutia- Moshamara		334.01 ha
Pond	52 nos.	10 nos.	3.51 ha

Sl no.	Name of Char	Location (From proposed Baliaghugri regulator)
1	Simla	4 km east
2	Kharoya	6 km east
3	Khas para	7 km north-east
4	Par Simla	3 km north-east
5	Noya para	5 km north-east
6	Dumber char	2 km north east
7	Jhumkal char	7 km north

Kazipur Upazila, Sirajgang

Water body type	Country side (Name/No.)	River side (Name/No.)
River		Jamuna
Beel/ Wetlands	Paikartoli beel	
	Chalita danga beel	
	Vhut baria beel	
	Kachihara beel	
	Pagol kandi beel	
Khal/Canal	Halot khal	
	Meghai khal	
Kole		Vutir diar

Water body type	Country side (Name/No.)	River side (Name/No.)
		Khudbandi
		Meghai
		Dhakuria
Pond	70 nos.	18 nos.
Sl no.	**Name of Char**	**Location**
1	Saouthtola	1km east from 2 no. Meghai spur
2	Megai	1km north-east from 1 no. Meghai spur
3	Manikpotol	1.5 km east from 1 no. Meghai spur
4	Fultola	2 km east from 1 no. Meghai spur
5	Shimultola	1.75 km east from 1 no. Meghai spur
6	Polashpur	2 km north from 1 no. Meghai spur
7	Char Kazipur	3 km east from 2 no. Meghai spur
8	Masuakandi	1 km north from 3 no. Meghai spur
9	Maijbari fulchar	3 km east from 1 no. Meghai spur
10	Bhurungi	3 km east from 3 no. Meghai spur

Dhunat upazila, Bogra

Water body type	Country side (Name/No.)	River side (Name/No.)	Specification
River	Manos river		8.75 ha
Beel/ Wetlands		Jagiar beel/ Vander bari	10 ha
	Bera danger beel		200 ha
	Houra khali beel		112.5 ha
Khal/Canal	Madhob Danga		8 ha
	Shimul bari khal		12 ha
		Pukuria	8.02 ha

Water body type	Country side (Name/No.)	River side (Name/No.)	Specification
Kole (Embayment)		Sariakandi	0.67 ha
		Shamol bari	1.07 ha
		Baniajan	0.67 ha
		Adhanagar	0.67 ha
		Boishakhi	5.34 ha
		Chunia para	40.08 ha
Pond	59	40	5.61 ha

	Name of Char	Location
1	Maiz bari	3 km east From proposed Pukuria- Vanderbari regulator
2	Vanger bari	2 km east From proposed Pukuria- Vanderbari regulator
3	New sariakandi	3 km north-east From proposed Pukuria- Vanderbari regulator
4	Pukuria	East to proposed Pukuria- Vanderbari regulator
5	Boroikandi	East to proposed Pukuria Vanderbari regulator
6	Baniajan	East to proposed Pukuria Vanderbari regulator
7	Koiya gari	East to proposed Pukuria Vanderbari regulator
8	Atai	East to proposed Pukuria Vanderbari regulator
9	Sohora	East to proposed Pukuria Vanderbari regulator
10	Boishaki	1 km E from Shimul baria spur
11	Adhanagor	1 km East from Shamol bari spur
12	Fuljhur	2 km E-S from Shamol bari spur
13	Mollik para	3 km E-S from Shamol bari spur
14	Shree pur	3 km E-S from Shamol bari spur
15	Agura maizbari	4 km E-S from Shamol bari spur
16	Dhakuria	5 km E-S from Shamol bari spur

	Name of Char	Location
17	Boyan char	3 km E from chuniapara regulator
18	Majhira	4 km E from chuniapara
19	Shanbandha	5 km E from chuniapara
20	Promitibari	6 km N from chuniapara
21	Noi khola	6 km N from chuniapara

Sariakandi Upazila, Bogra

Water body type	Country side (Name/No.)	River side (Name/No.)	Specification
River		Jamuna	
		Bangali	
Beel/ Wetlands	Dauli beel		1 km long (50 ha)
	Vakir beel		60 ha
	Bera beel		100 ha
	Dikdar beel		2 km N- W from Hasnapara , 30
	Dighol kandi beel		40.08 ha
	Satbilla beel		293.93 ha (5 km long)
	Kalaihata beel		26.72 ha
	Burungir beel		20 ha
	Gojariar beel		60 ha
Khal/ Canal	Kata khal		1 km long (3.50 ha)
		Kuripara canal	derived from Jamuna and directed to shalukar char , 4 ha
		Shalukar canal	derived from Jamuna and directed to shalukar char,5.25 ha
		Char bati canal	derived from Jamuna and directed to shalukar char, 5 ha
Kole (Embayment)	Antarpara kole		E to Antarpara regulator (4.01 ha)
	Nich Kola		0.75 km N- from Hasnapara (8.01 ha)
	Khurda boloi		0.5 km E- from Hasnapara (6.68 ha)

Water body type	Country side (Name/No.)	River side (Name/No.)	Specification
	Maiz bari		5952.02 ha
	taltola		66.80 ha
	Kazlar kole		10.69 ha
	Gobindapur		7 ha
	Nolcia		5.5 ha
	Beragram		10 ha
	Holdia		14 ha
Pond	75 nos.	20 nos.	5.38 ha

	Name of Char	Location/ Feature
1	Kuripara	E to proposed Antarpara regulator
2	Khapur para	E to proposed Antarpara regulator
3	Antarpara	E to proposed Antarpara regulator
4	Kazla	E to proposed Antarpara regulator
5	Ghager char	E to proposed Antarpara regulator
6	Diga para	1 km E-N from Hasnapara
7	Chokorthinatha	3 km E-N from Hasnapara
8	Konnobari	4 km E-N from Hasnapara
9	Kormoja	2 km N from Hasnapara
10	Housherpur	1.5 km N from Hasnapara
11	Sujatpur	3 km N from Hasnapara
12	Bauliapara	4 km N from Hasnapara
13	Banupur	2 km E from Hasnapara
14	Dhorbon	1 km E- S from Hasnapara
15	Pakuria char	W to Shalukar char
16	Jamtoil	W to Shalukar char
17	Manik	N to Shalukar char
18	Nobboi	N-E to Shalukar char
19	Barabajbari	E to Shalukar char
20	Indurmara	S to Shalukar char

	Name of Char	Location/ Feature
21	Hasnapara	E-S to Shalukar char
22	Dakat mara	E-S to Shalukar char
23	Chanpara	E-S to Shalukar char
24	Gobindapur	7 km N-E from Kundupara
25	Nolcia	4 km N-E from Kundupara
26	Fazilpur	6 km E from Kundupara
27	Joyantirpara	4 km E from Kundupara

Sonatola Upazila, Bogra

Water body type	Country side (Name/No.)	River side (Name/No.)	Specification
Beel/ Wetlands	Saluka beel		13.36 ha, perennial, average water depth= 15 feet
Pond	16	2	0.87 ha

Sl no.	Name of Char	Location/ Feature
1	Khabilla	5 km S-E from Pakulla,Bogra
2	Boro vanga	10 km E from Pakulla
3	Shollia	8 kmS- E from Pakulla
4	Auchar	10 kmS- E from Pakulla
5	Patil char	11 km S-E from Pakulla

Shaghata Upazila, Gaibandha

Water body type	Country side (Name/No.)	River side (Name/No.)	Specification
River		Jamuna	
Beel/ Wetlands	Kharkhara		0.5 km W from shaghata sluice gate,5 ha, Seasonal, water depth 8 feet

Water body type	Country side (Name/No.)	River side (Name/No.)	Specification
	Charagata		1.5 km W from shaghata sluice gate, 6 ha, Perennial, water depth 20 feet
	Ghoridaho		3 km W from shaghata sluice gate,3 ha, Perennial, water depth 15 feet
	Kachur beel		W to Kachuar regulator, 2.01 ha, perennial, culture
	Beel bosta		0.5 km S from Kachuar regulator, 2 ha, perennial, culture
	Vagir beel		0.81 ha , S-E of nilkhuthi village , Bhorot khali union , Shaghata, Gaibandha
	Napiter beel		0.81 ha
Kole (Embayment)		Hatbari	5 km N-E from shaghata sluice gate, 4 ha
		Pansi para	5 km N from shaghata sluice gate, 10 ha
		Shaghata	1 km E from shaghata sluice gate, 14 ha
		Kachuar kole	300 m W from shaghata sluice gate,50 ha, Perennial, water depth (R=25 feet, D=12 feet
		Bashhata	0.5 km E from putimari,0.40 ha
		Shatilla	2 km S- E from putimari, ,2.67 ha
Pond	40 nos.	6 nos.	2.79 ha

Sl no.	Name of Char	Location / Feature
1	Hatbari	3 km E from shaghata sluice gate
2	Delabari	6 km E from shaghata sluice gate
3	Jamira	8 km E from shaghata sluice gate
4	Batoner char	1 km E from Putimari
5	Shatilar char	2 km E from Putimari

Fulchari Upazila, Gaibandha

Water body type	Country side (Name/No.)	River side (Name/No.)	Specification
		Brahmaputra	
River	Ghaghot	Ghaghot	
	Alai	Alai	
Beel/ Wetlands	Singrai beel		N-E to Catlamari sluice gate, 80.16 ha,Perennial, water depth(R= 15 feet, D= 5 feet)
	Gauchulki beel		N-W to Catlamari sluice gate, 20.16 ha,Seasonal, water depth(R= 7 feet, D= 0 feet)
	Khathuria beel		N-E to Ratanpur sluice gate, 26.72 ha,Perennial, water depth(R= 15 feet, D= 7.5feet)
	Kabilpur beel		4 km S from from proposed kanchipara regulator,30 ha
	Gun bhuri		5.5 km S from from proposed kanchipara regulator
	Ratanpur beel		5.5 km S from from proposed kanchipara regulator
Canal		Gopaldoba	6.01 ha, 1 km east from catlamari regulator(2v)
Kole (Embayment)		Khazjani Kole	0.5 km E from Hardanga Char, 26.73 ha,Perennial, water depth (R=30 feet, D=15 feet
		Coach khali kole	1.5 km N from Hardanga Char, 13.36 ha, Perennial, water depth (R=25.5 feet, D=7.5 feet
Pond	55 nos.	12 nos.	3.53 ha

Sl no.	Name of Char	Location / Feature
1	Khatia mari	6 km S-E from proposed kanchipara regulator
2	Haro danga	3 km S from proposed kanchipara regulator
3	Satar danga	1.5 km E-N from proposed kanchipara regulator
4	Kauya para	3 km E from proposed kanchipara regulator

Sl no.	Name of Char	Location / Feature
5	Kuch khali	1 km E from proposed kanchipara regulator
6	Jora bari	1.5 km E-S from proposed kanchipara regulator
7	Kabilpur	1.5 km E-S from proposed kanchipara regulator
8	Fazlur pur	3 km E-S from proposed kanchipara regulator
9	Kalosona	6 km S from proposed kanchipara regulator
10	Chomohan	4 km S from proposed kanchipara regulator
11	Krishnomoni	4.5 km S from proposed kanchipara regulator
12	Zira bari	10 km E from proposed kanchipara regulator
13	Khazjani	1.5 km E from Hardanga Char
14	Kauyabada	5 km E-N from Hardanga Char
15	Rahamatpur	4 km E-N from Hardanga Char
16	Satarkandi char	5 km E from Hardanga Char

Sadar, Gaibandha

Water body type	Country side (Name/No.)	River side (Name/No.)	Specification
River	Ghaghot		
	Manos River		
		Brammaputra	
Floodplain/ Wetlands	Vela goa beel		0.25 km W from Baguria point ,two parts divided by WAPDA badh, 9.35 ha, Seasonal, water depth(R= 15 feet)
	Pakhimara beel		Adjacent to existing 8 vent regulator,1002.02 ha, Seasonal, Water depth =7 feet
	Puiya gara beel		Adjacent to proposed taltola regulator,240.49 ha, seasonal , water depth = 6 feet
	Purbo Baroboldia beel		Adjacent to(N-W) Proposed Kamarjani regulator, 280.57ha, Perennial , Average water depth = 7.5 feet
	Gidari beel		2.5 km S-W from

Water body type	Country side (Name/No.)	River side (Name/No.)	Specification
			Proposed Kamarjani regulator, 400.81ha, Perennial , Average water depth = 9 feet
Canal	Kamarjani khal		Along the WAPDA badh
		Dara/Canal	Brammaputra to WAPDA badh
Kole (Embayment)		Uttar gidari kole	10 km N from Hardanga Baguria point, 1.07 ha,Perennial, water depth (R=30 feet, D=10.5 feet
		Gorain kole	1.20 ha, Perennial, water depth (R=30 feet, D=12 feet
		Kalaibari	8 km E-S from first grown of Anarar chora,5.34 ha, Perennial, water depth (R=30 feet, D=12 feet, Fish culture practiced
		Khazjani	10 km E-S from first grown of Anarar chora, 3.34 ha, Perennial, water depth (R=25 feet, D=10 feet, Fish culture practiced
		Gidari	2 km N-W from first grown of Anarar chora,6.68 ha, perennial, water depth (R=22.5 feet, D=7.5 feet
		Khana bari	4 km E-Nfromproposed Kamarjani regulator, 9.35ha, Perennial , Average water depth = 12 feet
		Kamarjani	2 km E from proposed Kamarjani regulator, 3.34 ha, Perennial , Average water depth = 10 feet
		Koraibari	2 km E-N from Proposed Kamarjani regulator, 8.02 ha, Perennial , Average water depth = 11 feet
		Matikhola	7 km S- E from Proposed Kamarjani regulator, 66.80 ha, Perennial , Average water depth = 12 feet
Pond	244 nos.	17 nos.	13.74 ha

Sl no.	Name of Char	Location / Feature
1	Raidas bari	2 km N from Baguria point

Sl no.	Name of Char	Location / Feature
2	Faliar gob	3 km E from Baguria point
3	Kalai bari	4 km E from Baguria point
4	Khas jani	5 km E from Baguria point
5	Patdiara	6 km E from Baguria point
6	Kundarpara	7 km E from Baguria point
7	Batkamari	9 km E from Baguria point
8	Fazlur pur	3 km E-S from proposed kanchipara regulator
9	Kalosona	6 km S from proposed kanchipara regulator
10	Chomohan	4 km S from proposed kanchipara regulator
11	Krishnomoni	4.5 km S from proposed kanchipara regulator
12	Zira bari	10 km E from proposed kanchipara regulator
13	Khazjani	1.5 km E from Hardanga Char
14	Kauyabada	5 km E-N from Hardanga Char
15	Rahamatpur	4 km E-N from Hardanga Char
16	Satarkandi char	5 km E from Hardanga Char
17	Folar cock	3 km E- N from first grown of Anarar chora
18	Sayedpur	5 km E- N from first grown of Anarar chora
19.	Satarkangi	10 km E from first grown of Anarar chora
20	Khazjani	10 km E- N from first grown of Anarar chora
21	Kalaibari	7 km E from first growen of Anarar chora
22	Aijaz bari	2 km E from first growen of Anarar chora
23	Khamarjani	6 km E from Proposed Kamarjani regulator
24	Karaibari	5 km E-S from proposed Kamarjani regulator
25	Batkamari	9 km E-S from Proposed Kamarjani regulator
26	Kandolpara	25 km E-S from proposed Kamarjani regulator
27	Kolmu	18 km E-S from proposed Kamarjani regulator
28	Puran char	8 km E-N from

Sl no.	Name of Char	Location / Feature
		proposed Kamarjani regulator
29	Sidhai	25 km E from proposed Kamarjani regulator

Chilmari Upazila, Kurigram

Water body type	Country side (Name/No.)	River side (Name/No.)	Specification
River	Sorai river	Sorai river	Brammaputra to shreepur
Beel/ Wetlands	Chang mari beel		713, Seasonal, water depth(R= 9 feet)
	Nakhali beel		713 ,Seasonal, water depth(R= 7 feet)
	Baharer beel		3 km N from Horichiri ghat (12 vent) regulator, 80.16ha, Perennial , Average water depth = 10 feet,
	Hasar dala beel		5 km N from Horichiri ghat (12 vent) regulator, Seasonal , Average water depth = 7 feet
	Mohisalar beel		N to Horichiri ghat (12 vent) regulator,, 13.36ha, Seasonal , Average water depth = 8 feet
	Magurar beel		1 km N fromkachkol (10 vent) regulator,160.32 ha, Seasonal Average water depth = 7 feet
	Shol dukri		2 km W from Kachkole regulator,120.24 ha
	Kodal daho beel		2.5 km N from Kachkole regulator
	Kalir pati		4 km W from Kachkole regulator
	Rajar ghat		4 km W from Kachkole regulator
	Ranigonj (Domer hat)		6km W from Kachkole regulator
	Khaye ghat		7 km W from Kachkole regulator
	Hagritola beel		80.16 ha
	Koyar beel		601.21 ha
Khal/Canal	Gidari canal		20 km long (28 ha)

Water body type	Country side (Name/No.)	River side (Name/No.)	Specification
	Antarpur canal		8 km long (12 ha)
Kole (Embayment)		Agabor kole	E to Horichorighat regulator, 2.67 ha, Perennial, Average water depth= 12 feet
		Horipur-1	2 km S to Horichorighat regulator, Seasonal, Average water depth= 8 feet
		Horipur-2	3 km W to Horichorighat regulator, Perennial, Average water depth= 10 feet
		Hasher beel kole	4.01 ha, Seasonal, water depth = 15 feet
		Bahattor kole	5 km E from kachkol (10 vent) regulator, 20.04 ha, Perennial, Average water depth = 30 feet
		Haser vita kole	3 km E from kachkol (10 vent) regulator, Perennial, 3.21 ha, average water depth = 18 feet
		Kachkole	0.5 km s from simultola/Magurar regulator, Perennial, average water depth=15 feet
		Kolapani	1.5 km E from simultola/Magurar regulator, Perennial, 1.34 ha, avrage water depth= 9 feet
		Badhdhara	5 km E from simultola/Magurar regulator , Perennial, 4.01 ha,Average water depth= 15 feet
		Uttarowari	5 km E-N from simultola/Magurar regulator , Perennial
		Bongram	100.20 ha, perennial, Average water depth=30 ha

Sl no.	Name of Char	Location / Feature
1	Gorghoti char	2 km E from Shimultola regulator
2	Chutarmari	20 km S from Shimultola regulator
3	Bagdhara badh	8 km S from Shimultola regulator
4	Nauer char	8 km S from Shimultola regulator
5	Boro vitar char	7 km W-S from Sarkerpara regulator

Sl no.	Name of Char	Location / Feature
6	Bongram char	8 km E-N from Sarkerpara regulator
7	Damar char	1 km S-W from Horichorighat regulator
8	Char horipur	3 km S-W from Horichorighat regulator
9	Nil char	8 km S-W from Horichorighat regulator

Ulipur , Kurigram

Water body type	Country side (Name/No.)	River side (Name/No.)	Specification
River		Brahmaputra	
		Sorai	
Beel/ Wetlands	Anantapur beel		7 km W from proposed Anantapur regulator, perennial
	Paglir kuri		4 km W-S from proposed Anantapur regulator, perennial
	Nayantapur		8 km W-N from proposed Anantapur regulator, perennial
	Chirokhaoya dola		4 km S from proposed anantapur regulator, perennial
	Malchar par		7 km S from proposed Anantapur regulator, perennial
	Kosulla		Adjacent to regulator, 1.5 km long, 500 m wide, Seasonal (3 month), water depth=9.5 feet
	Singramari		1 km N-W from regulator, seasonal (4 month), water depth=10.5 feet
	Kossa		3 km N-W from regulator, seasonal (5 months),15 feet
	Darki mari beel		1.5 km N from regulator, 4 km long, 3 km wide, perennial,water depth=14 feet
	Chokchoka beel		5 km N from regulator, 5 km long, 4 km wide, perennial
		Jolanger kuthi	2 km E from Anantapur regulator,48.09

Water body type	Country side (Name/No.)	River side (Name/No.)	Specification
Kole (Embayment)			ha,
		Anatapur kole	100 m E from Anantapur regulator , 320.65 ha, Perennial, Average water depth=30 feet
		Kolakata	4 km E-N from Anantapur regulator , 480.97 ha, Perennial, Average water depth=30 feet
		Gujimari	2 km E from Anantapur regulator , 40.08 ha, Perennial, Average water depth=30 feet
Pond	38 nos.	13 nos.	2.68 ha

Sl no.	Name of Char	Location / Feature
1	Anantapur char	100 m E from Anantapur regulator
2	Gujimari	1 km E from Anantapur regulator
3	uttar gujimari	2 km N from Anantapur regulator
4	Dakkhin gujimari	km S from Anantapur regulator
5	Sukherbati	25 km S from Anantapur regulator
6	Char Bagua	20 km S from Anantapur regulator
7	Parar char	7 km east from Balaijan regulator
8	Kaziar char	8 km E from Anantapur regulator
9	Durga pur	14 km E from Anantapur regulator

Sadar, Kurigram

Water body type	Country side (Name/No.)	River side (Name/No.)	Specification
River		Brahmaputra	
		Dhudkumor	
Beel/ Wetlands	Ponchasar beel		0.75 km W from Aragikodomtola regulator ,2.40 ha,Perennial, water depth=10 feet, fish culture practiced

Water body type	Country side (Name/No.)	River side (Name/No.)	Specification
	Jobber munsher beel		1 km W from Aragiodomtola regulator, Perennial, water depth=10.5 feet
	Amluddi hazir beel		2 km W from Aragikodom regulator, water depth=12 feet
	Kazol daho		2 km W from Khama Rasulpur regulator
	Dubba churi		2.5 km N-W from Khama Rasulpur regulator
	Gagla beel		1 km W from Existing Tangormarir patar regulator,40.08 ha, perennial, average water depth=9 feet
	Sarisui beel		1.5 km N from Existing Tangormarir patar regulator,60.12 ha, perennial, average water depth=16 feet
	Dolarpar beel		1.5 km N-W from Existing Tangormarir patar regulator,80.16 ha, seasonal, average water depth=8 feet
	Sonalir khuthi beel		1.5 km W from Existing Tangormarir patar regulator,10.69 ha, Seasonal, average water depth=10 feet
	Hodir beel		3 km W-N from Existing Tangormarir patar regulator,20.04 ha,Perennial, average water depth=15 feet
	Koi ghuri		4.5 km N-W from Tangormarir patar regulator
	Duba churi		7 km S-W from Tangormarir patar regulator, 8.02 ha, water depth=5 feet
	kazol daho		9 km S-W from Tangormarir patar regulator, 13.36 ha, seasonal, water depth= 6 feet
	Pachgaciar chora		5 km W from Tangormarir patar regulator,80.16ha, perennial, water depth=20 feet
	Misti parar beel		1 km N-W from Tangormarir patar regulator,2 ha, perennial, water depth = 10 feet
Khal/Canal	Girai nodi/Khal		1 km west from khama Rasulpur,4.8 ha,4

Water body type	Country side (Name/No.)	River side (Name/No.)	Specification
			km long
Kole (Embayment)		Gobindopur	2 km E from Aragikodomtola regulator,80.16 ha, perennial, Water depth=15 feet
		Perbotti pur	3 km E from Aragikodomtola regulator,140.28 ha, perennial, Water depth=18 feet
		Vushakuthi	2 ha, perennial, Water depth=10 feet
		Sarkerpara vanga	0.5 km N from Tangormarir patar regulator,40.08 ha, perennial, Water depth=14 feet
		Prothom alo kole	2 km E-S from Tangormarir patar regulator, 12.04 ha
		Bangar dola kole	1.5 km E-N from Tangormarir patar regulator, 10.69 ha
		Kath giri kole	2.5 km N from Tangormarir patar regulator , 10.69 ha
		Pocha kata kole	5 km N from Tangormarir patar regulator , 9.35 ha
		Shantiar kole	2.5 km E from Tangormarir patar regulator , 13.36 ha
		Rolakata kole	4 km E-N from Tangormarir patar regulator , 9.35 ha
		Narayanpur kole	8 km E from Tangormarir patar regulator , 133.60 ha, perennial
		Astoasi kole	7 km E-N from Tangormarir patar regulator , 13.36 ha, perennial
		Jhumkar kole	6 km E from Tangormarir patar regulator ,12.02 ha
Pond	47 nos.	3 nos.	2.43 ha

Sl no.	Name of Char	Location / Feature
1	Prothom alo	2 km E-S from Tangormarir patar regulator, 12.04 ha
2	Bangar dola	1.5 km E-N from Tangormarir patar regulator, 10.69 ha

Sl no.	Name of Char	Location / Feature
3	Kath giri	2.5 km N from Tangormarir patar regulator , 10.69 ha
4	Pocha kata	5 km N from Tangormarir patar regulator , 9.35 ha
5	Shantiar	2.5 km E from Tangormarir patar regulator , 13.36 ha
6	Rolakata	4 km E-N from Tangormarir patar regulator , 9.35 ha
7	Narayanpur	8 km E from Tangormarir patar regulator , 133.60 ha, perennial
8	Astoasi	7 km E-N from Tangormarir patar regulator , 13.36 ha, perennial
9	Jhumkar	6 km E from Tangormarir patar regulator ,12.02 ha
10	Raulia char	Adjacent and E to Tangormarir patar regulator
11	Char Rasulpur	1.5 km E from Tangormarir patar regulator
12	Majher char	3 km E from Tangormarir patar regulator
13	Catlar char	1.5 km E-N from Tangormarir patar regulator
14	Fakirere char	2 km E-N from Tangormarir patar regulator
15	Kathgirir char	2.5 km N from Tangormarir patar regulator
16	Motherganj char	4 km N from Tangormarir patar regulator
17	Barobisha	3 km E-N from Tangormarir patar regulator
18	Khaser char	3.5 kmE-S from Tangormarir patar regulator
19.	Balduba	3 km E-S from Tangormarir patar regulator
20	Porar char	4.5 km E-S from Tangormarir patar regulator
21	Mirgamari char	6 km W from Tangormarir patar regulator

** N=north, S= South, E= East, W=West