Bangladesh – India Friendship Power Company (Pvt.) Limited
(A joint Venture of NTPC Ltd and BPDB)

Monitoring of Environment Parameters and Implementation of Environmental Management Plan during pre-construction and construction period along with Engineering Activities for Site Development of Khulna 2X660 MW Maitree Super Thermal Power Plant




Fourth Quarter Monitoring Report of Third Year (2017)

Monitoring Period: November 2016- January 2017

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Abbreviations and Acronyms

AECL	Adroit Environment Consultants Ltd
AAS	Atomic Absorption Spectrophotometer
BIFPCL	Bangladesh-India Friendship Power Company (Pvt.) Limited
BOD	Biochemical Oxygen Demand
BPDB	Bangladesh Power Development Board
BCSIR	Bangladesh Council of Scientific and Industrial Research
BUET-BRTC	Bangladesh University of Engineering and Technology- Bureau of Research, Testing and Consultation
CEGIS	Center for Environmental and Geographic Information Services
COD	Chemical Oxygen Demand
CPUE	Catch per Unit Effort
DCR	Duplicate Carbon Receipt
DO	Dissolved Oxygen
DoE	Department of Environment
DPHE	Department of Public Health Engineering
dBH	Diameter at Breast Height
EC	Electrical Conductivity
ECR	Environment Conservation Rules
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EPC	Engineering Procurement Construction
FGD	Focus Group Discussion
FGD	Flue Gas Desulfurization
FSR	Fisheries Species Richness
GoB	Government of Bangladesh
GIS	Geographic Information System
GPS	Global Positioning System
GW	Ground Water
HS	Household Survey
ISO	International Organization for Standardization
IUCN	International Union for Conservation of Nature
IFC	International Finance Corporation

Kg	Kilogram
KII	Key Informants Interview
MoPEMR	Ministry of Power, Energy and Mineral Resources
MW	Mega Watt
NTPC	National Thermal Power Corporation
OHSAS	Occupational Health and Safety Management Systems
PCU	Passenger Car Unit
PGCB	Power Grid Company of Bangladesh Ltd
PMU	Project Management Unit
PRA	Participatory Rural Appraisal
PWD	Public Works Department
QMR	Quarterly Monitoring Report
RRA	Rapid Rural Appraisal
RS	Remote Sensing
SRDI	Soil Resources Development Institute
SRF	Sundarbans Reserve Forest
TDS	Total Dissolved Solid
TH	Total Hardness
ToR	Terms of References
TSS	Total Suspended Solid
USEPA	United States Environmental Protection Agency
VOC	Volatile Organic Compounds

Unit

dB	Decible
ppm	parts per million
ppt	parts per thousand
hr	Hour
Kg	Kilogram
Km	Kilometer
KW	Killo Watt
m	Meter
mg	Milligram
ton/year	Ton Per Year
MW	Mega Watt
Nm	Normal Meter
s	Seconds
KV	Kilo Volt

Unit Conversion Table

General Units

1 meter = 3.2808 feet

1 kilometer = 0.62137 mile

1 kilogram = 2.20 pound

1 metric ton = 1000 kg

1 square mile = 640 acres = 2.590 km^2

1 hectare = 10^{-2} km^2 = 2.471 acres

1 pascal = 1 N/m^2= 0.01 millibar

1 liter = 0.001 cubic meter

1°C = 274.15^0 K=33.8° F

1 mg/m^3 = 1 µg /L

1 mg/L ≈1 g/m^3≈1 ppm (w/w)

Energy Unit

1 KWh = 3412 Btu

1MW=1000KW=10^6 W

1 KWh = 3.6 x 10^6 J

1 kWh = 859.85 kcal

1 horsepower = 746 W

1 GWyr = 8.76 x 10^9 kWh

Glossary

Aman:	Group of rice varieties grown in the monsoon season and harvested in the post-monsoon season. This is generally transplanted at the beginning of monsoon from July-August and harvested in November-Dec. Mostly rain-fed, supplemental irrigation needed in places during dry spell.
Aus:	Group of rice varieties sown in the pre-monsoon season and harvested in the monsoon season. These are broadcasted/transplanted during March-April and harvested during June-July. Generally rain-fed, irrigation needed for HYV T. Aus.
B:	When preceding a crop means broadcast (B. Aus)
Bazar:	Market
Beel:	A saucer-shaped natural depression, which generally retains water throughout the year and in some cases seasonally connected to the river system.
Boro:	A group of rice varieties sown and transplanted in winter and harvested at the end of the pre-monsoon season. These are mostly HYV and fully irrigated, planted in December-January and harvested before the onset of monsoon in April- May.
Haat:	Market place where market exchanges are carried out either once, twice or thrice a week, however not every day.
Gear/Jaal:	Different types of fishing net to catch fish from the water bodies.
Kutcha:	A house made of locally available materials with earthen floor, commonly used in the rural areas.
Khal:	A drainage channel usually small, sometimes man-made. The channel through which the water flows. These may or may not be perennial.
Kharif:	Pre-monsoon and monsoon growing season. Cropping season linked to monsoon between March-October, often divided into kharif-1 (March-June) and kharif-2 (July-October).
Perennial Khal:	Water available in the khal all the year round.
Pacca:	Well constructedbuilding using modern masonry materials.
Rabi:	Dry agricultural crop growing season; mainly used for the cool winter season between November and February.
Seasonal Khal:	Water not available in the khal all the year round.
T. *Aman*:	When preceding a crop means transplanted (T. Aman).
Upazila:	Upazila is an administrative subdivision of a District.

Executive Summary

This is the Twelve (12th) Quarterly (**4th** quarter of the **3rd** year) Environmental and Social monitoring report covering status of different environmental and social parameters including environmental compliance related monitoring in regard to EMP of ongoing pre-construction activities. The report represents the period from November 2016 to January 2017 and accordingly CEGIS has carried out the monitoring activities in January 2017 comprising of the monitoring of implementation of Environmental Management Plan (EMP) and Environmental Compliance with the environmental parameters such as ambient air quality, noise level, water quality, Land resource condition, Agricultural resources monitoring, fisheries resources monitoring which covers fish habitats, migration and production, social environment monitoring, ecosystem monitoring and Sundarbans forest health monitoring.The status of environmental compliance in regard to the EMP (provided in the EIA) summarizes the assessment of the effectiveness of the recommended mitigation measures and also to identify any further requirement for additional mitigation measures or remedial action associated with pre-construction of the Project. In regard to the Project progress it revealed that the land development for the BIFPCL's site (Block A) has been completed under pre-construction phase. Construction of the embankments, slope protection works and the main access road from Babur Bari to the Plant site are also completed. Site office has been moved to South west corner of the project boundary. All the bridges and culverts have been constructed of the access road. In this quarter, the environmental due diligence covers: the Environmental Management System and Action Plan, Occupational Health and safety, workers' wellbeing, Biodiversity and Sustainable Management of Natural Resources. The monitoring study found that BIFPCL has been complying with the EMP as suggested in the EIA report. However, as per the EMP approved by DoE and being the Environmental Monitoring Consultant of the Project, CEGIS makes a few Site Specific Measure(s) that should be complied for ensuring environmental and social safeguarding of the Project, such as, demarcation of traffic way and taking precautionary measures like using proper signs in local language; and sediment fences/traps need to be maintained to prevent sediment wash load to Maidara river; stockpile of construction materials should be placed at a safe distance from river bank; sufficient waste disposal bins need to be placed at the labour shed, and working area.

Moreover, in the recent monitoring period, the HR policy was found developed as the management of site specific EHS programme have been stablished; Occupational Health and Safety Policies; establishment of the grievance redress mechanism; Emergency preparedness and response plan; fire prevention, protection and control plan; stakeholder engagement plan etc. were found finalized and incorporated for the next phase of the project. Site specific fire and safety officer have also been appointed. However, proper documentation of any accident/incident or any health hazard risk issues needs to be recorded; preventive measures for near miss accidental events and any unforeseeable injury, illness, or damage shall be adopted; an officer responsible for enforcing and monitoring safety procedure shall be appointed; Site specific ESMP have been prepared by the EPC contractors; Safety training program for the Project personnel and labour force shall be arranged.

Air quality monitoring inferred that the wind flowed from North-Northwest to South-Southeast direction. The weather can be characterized by gentle wind flow, low air temperature, sunny and cloudless sky. This time the concentration of all the ambient air quality monitoring parameters (**SO_2, NO_x, $PM_{2.5}$, PM_{10}, CO and O_3**) were found within the standard limit. However, newly developed land for industrial activities along the Passur River, loading-unloading activities and cement industries can be described as the known sources of $PM_{2.5}$, PM_{10} and SPM in this area. Other pollutants may generate from the commonly known sources like the local vehicles (human hauler/ Nosimon) and were observed while working beside the roads, the monitoring spot in or around the project area & Sundarbans and engines of trawler, barges, ship etc.

In the study area, noise generation sources can mainly be divided into two types; one is natural and another one is anthropogenic. Natural sources of noise generation are birds' chirping, stormy wind, wave breaking on the shoreline, howling of leaves and so on. On the other hand traffic mobilization, industrial activities, vessels movement within the rivers and local vehicles are the salient sources of anthropogenic noise. However, in this monitoring season; the observed noise value (**Figure 2.2** and **Table 2.3**) did not cross the Bangladesh standard noise limit in any point; even in some points the noise level was much lower than the standard value.

In the recent monitoring period of January, 2017 water samples were collected from the preselected 18 locations (15 locations for surface water and 3 locations for ground water analysis). Accordingly, the samples have been submitted to DPHE and BCSIR for laboratory analysis of the preselected parameters. This monitoring report contains laboratory reports of the last monitoring study (October, 2016) and in-situ monitoring results of this quarter (**4th** quarter of **3rd** year). However, similar to the earlier year, spatial and seasonal variations is still present for the analyzed parameters. But the analyzed results of all parameters were found within the standard limit set by **ECR' 1997** for surface water and were found to be minimal or similar in concentrations compared to the results previous seasons.

Soil samples were collected to prepare a baseline during the monitoring years (2013-14 to 2015-16) of Rampal power plant project. Fifteen soil samples were collected from five different locations at three depths (0-15 cm, 15-30 cm and 30-45 cm) to observe soil fertility/nutrient status and inherent heavy metal contamination. Every year these samples were collected twice (dry and wet season) to monitor the seasonal variation. However, Soil salinity (EC) and soil reaction (pH) control most of the changes of elements in the coastal region. From the analysed data, it has been observed that overall EC decreased while pH increased in the study area. It might be an impact of polder of that locality. In terms of organic matter concentration of the soil, increasing pattern was found in two locations (Baranpara and Chakghona) while decreasing pattern was found in three locations (Basherhula, Chunkuri-2 and Kapalirmet). Macro and micro nutrients of the soil showed the similar pattern. In terms of heavy metal concentration, Cadmium was found only once (dry season of 2014-15) in three years of monitoring period. On the other hand, maximum concentration of lead was found in Kapalirmet (47.12 ppm/W); dry season of 2014-15), which is within the range. As a result, a concrete trend analysis is very difficult in terms of soil nutrient and heavy metal aspect.

Fisheries resources have been monitored at the same locations for seven sampling sites as of earlier quarter monitoring. Habitat uses were observed changing yearly (as compare to the year of 2014-2015 and of 2015-2016) and mainly due to biophysical changes i.e. tidal

effect, seasonal variability, food availability and also fisheries resource management practices. Moreover, through analyzing the type of habitat uses by different ages of different fish species (based on the length-based community structure model) two types of habitats have been found as i) Grazing and spawning ground, mainly for Paissa, ii) Nursing ground mainly inherited by fries of Bagda, Bairagi Chela, Chali Chingri and Khayra Chela. Shannon-Weiner index was also observed varrying between 4th quarter of 2016-17 with that of 2014-15 and 2015-16. The highest index has been found at Akram Point and Maidara (0.90). On the contrary, lowest evenness has been found at Harbaria (0.6). Maximum FSR was recorded in Sheola Khal at Chandpai (n=7), while very low FSR is recorded at Chalna Point, Mongla Point and Akram Point (n=2). Fries and juveniles for fin fish were widely distributed among the upper stretches of the Passur River. Among these Bagda fish was more widely distributed among the sampling sites. Moreover, fry fish of Chali Chingri, Khoira Chela, Baisakhi and Cheng were found at Chalna Point and Maidara-Passur Confluence. Moreover, brood female fishes of Paissa have been observed at Akram Point and Harbaria sampling sites in this quarter. Fish species like Gulsha Tengra and Chela showed the maximum abundance among the migratory fish species. Moreover, three species like Poma and Khayra Chela showed long range of distribution. No stocking has been observed in this monitoring, because the farms were being prepared for the re-stocking. For this reason, no growth rate and mortality rate could be calculated.

The highest productivity has been found in Sheola Khal at Chandpai, and lowest in the Mongla Point, Maidara and Chalna Point because of the abundance of fries, mainly of Bagda, Bairagi Chela, Chali Chingri and Khayra Chela, which are not considered as the cultured. Moreover, lower productivity was observed in this fourth quarter monitoring of 2016-17 as compared to that in fourth quarter of 2014-15 and 2015-16. Net Jal was found most common and frequently used gear in the upper reaches. Likewise, Charpata Jal in middle reach and Baro Khepla Jal in lower reach of the Passur River System. Furthermore, the highest total catch has been observed in Sheola khal at Chandpai and lowest in the Mongla Point, Maidara and Chalna Point in this monitoring phase. No fish production, except from Gher at Kapasdanga, has been found from Shrimp/fish farm (Gher) in this quarter (January).

Plant health, vegetation canopy status, bird habitat, butterfly occurrences, dolphin and plankton occurrence in river water have been monitored for this monitoring season. Plant heath showed an improved trend than previously monitored data. Overall canopy status of studied homestead vegetation was found increasing than the same monitoring tier in January 2016 due to well growth of mangrove trees like *Excoecaria agallocha* and foliage expansion of planted saplings in Borni, Kalekarber and Chalkghona sites. Out of 8 wetlands, occurrence of migratory bird have been informed from only 2 sites and local migratory has been informed from only 3 sites. This denotes the declining trend of migratory bird occurrence and changes of land use caused against this status. No local bird nest have observed from any of the monitoring sites. Occurrence of butterfly species is recorded 3 species from three locations except Rajnagar site. Dolphins have been sighted at Passur River and Dhangmari khal and most of which are centered inside the Maidara River and Dhangmari khal. Beside this, Ganges River Dolphin was also found at Passur River near Karamjal with more occurrence than previous season.

From the last twelve monitoring season, it was found that the seedling density, pneumatophore, crab hole, canopy cover, leaf area index (m^2 leaf area/m^2 ground area) and

Tree carbon stock changed periodically, although there has been some seasonal effect. However, based on above indicators, the forest health condition at Akram point was found unsuitable. This may be due to the physiographic location of this plot, which was found facing high environmental stress. The Akram point is situated at the confluence of Shibsa and Passur River. Therefore, during tidal inflow the forest floor carried large amount of soil sediment than other locations monitored under this study. Here, the forest is experiencing retrogation process where the climax species are started decaying. Hence, this area is sensitive in terms of disturbance. Therefore, the monitoring should be continued to know the dynamism of mangrove attributes which are very much interlinked with each other as well as with the environment and more monitoring site should delineate as control site to compare any potential impact due to coal transportation and transshipment along the Passur River.

Data on crop area, crop production and crop damage were collected from the selected five mauzas for the year of 2013-14 to 2015-16. In addition, agricultural data (2014-15) also collected from the local DAE offices to know the existing situation of agricultural practices in the study area. Total crop production was 288,667 tons in the study area, of which the Batiaghata, Dacope, Rampal and Mongla upazila were 91,019 tons, 129,165 tons, 42,197 tons and 26,286 tons respectively. Among five sample plots, Kapalirmet and Chakgona sites, no agricultural activities was observed during 2014-15 and 2015-16 due to the adverse impacts of salinity. Highest production (2.4 tons) was found in the monitoring agricultural plot-2 (Chunkuri-2), because only HYV Aman was cultivated in Chunkuri-2 plot in 2013-14 and the lowest production (0.99 tons) was obtained in monitoring plot-5 (Basherhula) in 2015-16 in the three consecutive year of monitoring. It was also observed that the crop production slightly decreased from the year 2013-14 and increased over the year 2014-15 in all the monitoring plots, except in Kapalirmet and Chakgona. Crop damage was observed in monitoring plot-2(Chunkuri-2) and monitoring plot-5(Basherhula) in the year of 2014-15. Crop damaged areas were about 0.33 ha and 0.17 ha respectively in 204-15. A total 0.52 tons of crop was damaged in 0.50 ha of plots. It is also mentioned that the plot owner gave plot (0.07 ha out of 0.14ha) voluntarily for the construction of cyclone shelter at Chakgona mauza. Though the monitoring plots are in the coastal area and observed seasonal variation of soil nutrient and heavy metal, yet the soil quality is suitable for crop production.

In this recent monitoring period, it was found from the social environmental monitoring that the compensation process has been completed and BIFPCL got the clearance on land issue from Bagerhat DC prior to the civil construction works. However, some contradictory cases on compensation issues has not been solved yet because the obligations of legal documents/papers of land ownership. Numbers of resettled households were found decreased from 18 to 10 due to lack of earning options and securities of accommodation as no legal document of allotted have been provided yet. However, the labor and working conditions was found improving with time though it is mandatory to maintain the international standard. It will be improved and all the suggested EMPs will be followed in construction phase by the EPC contractor who will be obliged to maintain it. For mitigating dust flow, plantation of tree and grass should be continued after bounding the area with concrete wall. In construction phase the authority will have to finish the works before night time (6 pm to 7 am) so that the community cannot be disturbed. About 3,198 people received health facilities from the health camping of the project authority during last six months (Jul-Dec, 2016) which shows a progressive figure from the early of its establishment. As the number of patients is increased successively, the authority is able to arrange sufficient medicine for all.

1 Introduction

1.1 Background

1. The proposed Plant is a joint venture project of Bangladesh Power Development Board (BPDB) and National Thermal Power Corporation (NTPC) Ltd., India as per the contract signed in January, 2012 and run by Bangladesh-India Friendship Power Company pvt. Ltd. (BIFPCL).

2. The proposed coal based thermal power Plant is a Red category project as per ECA, 1995 and the subsequent rules ECR, 1997, and therefore, needs Site Clearance Certificate (SCC) and Environmental Clearance Certificate (ECC) from Department of Environment (DoE), Bangladesh. To that end, BPDB engaged Center for Environmental and Geographic Information Services (CEGIS) as independent public trust for conducting Initial Environmental Examination (IEE) and Environmental Impact Assessment (EIA) studies under a Contract signed on 13thJuly, 2010 between BPDB and CEGIS.

3. Accordingly, CEGIS has conducted detailed EIA study in mid-2013 encompassing a rational study area which is also ecologically very important by virtue of the existence of the world's largest single tract of Mangrove Forest, the Sundarbans with remarkable biodiversity in this area. As per the scope of EIA study, a detailed Environmental Management Plan (EMP) has been developed suggesting mitigation, enhancement, contingency, and compensation measures that shall duly be implemented during project pre-construction, construction and operation phase in order to minimize the negative impacts considered to be generated by the power plant associated activities.

4. Successful implementation of the EMP depends on regular monitoring of the selective indicators at specified locations. Therefore, an independent environmental monitoring team has been proposed and moreover, compliance monitoring has been suggested mandatory for this Project due to the presence of the Sundarbans. It has also been recommended that the environmental monitoring officer/agency should monitor the EMP implementation and submit a quarterly report to the concerned department.

5. Subsequently, BIFPCL has initiated a study on monitoring environmental and social parameters and implementation of EMP during pre-construction and construction phases of the proposed Thermal Power Plant to safeguard the environment of the Sundarbans Mangrove Forest and the surrounding communities. CEGIS has been engaged for carrying out the study since early 2014 and continued till early 2017 over a time span of three (3) years.

6. This study report is aimed at understanding the baseline condition and a plausible description of the recommended environmental and social parameters of the study area as described in the EIA study for Power Plant. It has also provided a complete scenario of environmental compliance status during pre-construction phase along with engineering activities of the **4th quarter of 3rd year** for the proposed ***2×660 MW Moitree Super Thermal Power Project*** being constructed at Rampal, Bagerhat.

7. The location of the proposed project encompasses Sapmari Katakhali and Kaigar Daskati Mauza of Rajnagar Union under Rampal Upazila of Bagerhat district (**Map 1.1**). The Power Plant lies in between latitude 22˚37'0''N to 22 ˚34'30''N and longitude 89˚32'0''E to

89˚34'5''E and is about 23 km south from the Khulna City and 14 km in the north-west direction from the nearest tip of the Sundarbans. Location of the study area and their relative distance from various World heritage sites are presented in **Map 1.1**. The study area includes: i) area covering 10 km radius from the Plant location, ii) 10 km strip from both bank of Passur and Sibsa rivers starting from the Plant site to Hiron point (**Map 1.2**).

8. According to the contract, the results of all the monitoring study have been reported quarterly to BIFPCL through a monitoring report for each quarter. Eventually, BIFPCL submitted all these reports to DoE and Forest Department. All monitoring reports were regularly uploaded in BIFPCL website. CEGIS has so far submitted eleven (11) monitoring reports on quarterly basis. The current document constitutes **12th** monitoring report i.e. monitoring activities of the **4th** quarter of **3rd** year. The field study has been carried out in January 2017 covering all the monitoring parameters and at pre-selected monitoring locations which has helped to improve and further upgrade the environmental monitoring database till today.

1.2 Objectives

9. The overall objective is to monitor the environmental parameters and implementation of Environmental Management Plan (EMP) during pre-construction and construction phases of the installation of the Power Plant.

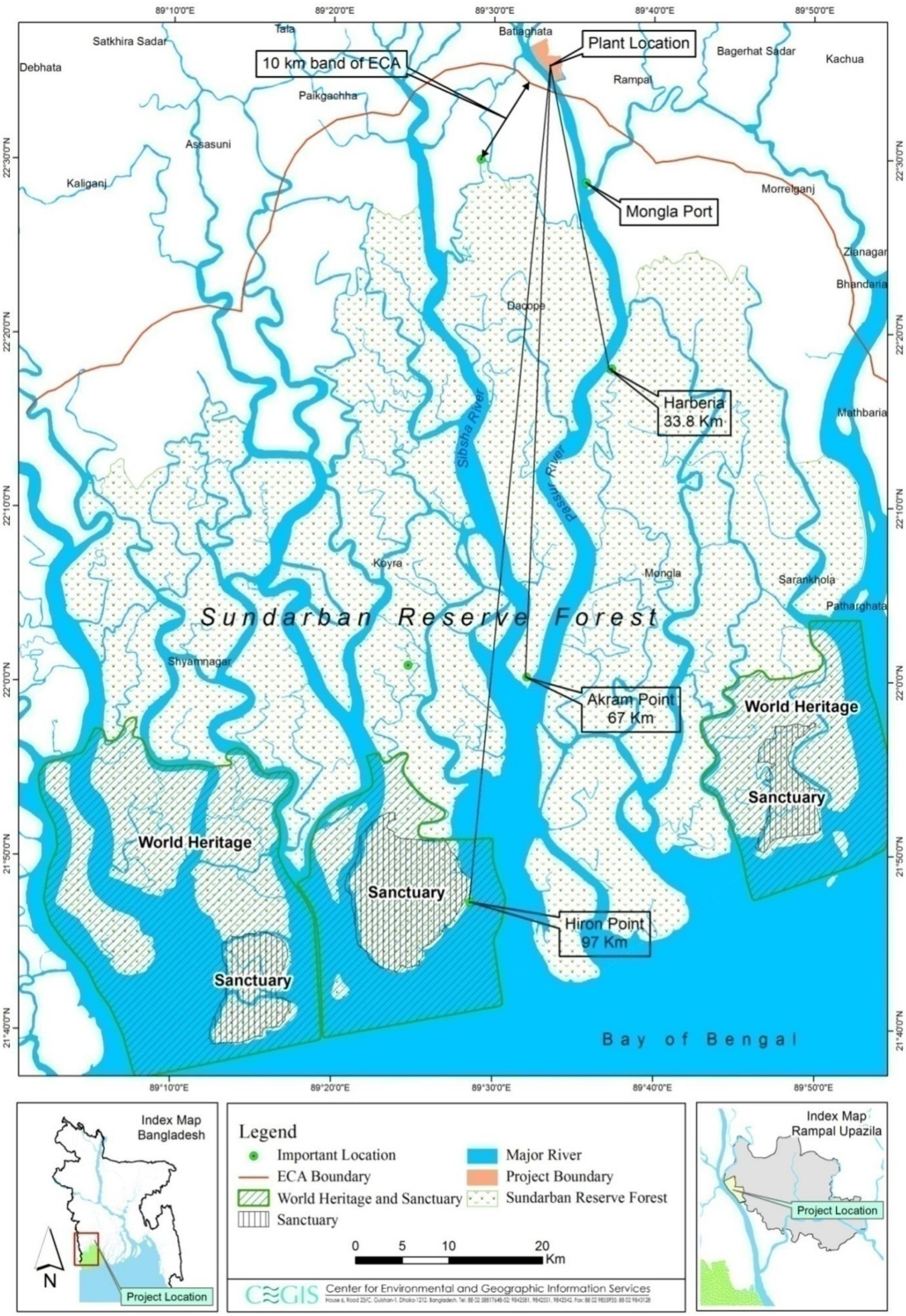
10. The aim of the quarterly monitoring is to monitor the ambient state of environment that will be considered as the baseline and will later be compared with the environmental condition in future when the Power Plant will be in operation phase. The monitoring activities also include monitoring of environmental compliance of the Power Plant's pre-construction activities.

1.3 Criteria for Selection of Monitoring sites/locations

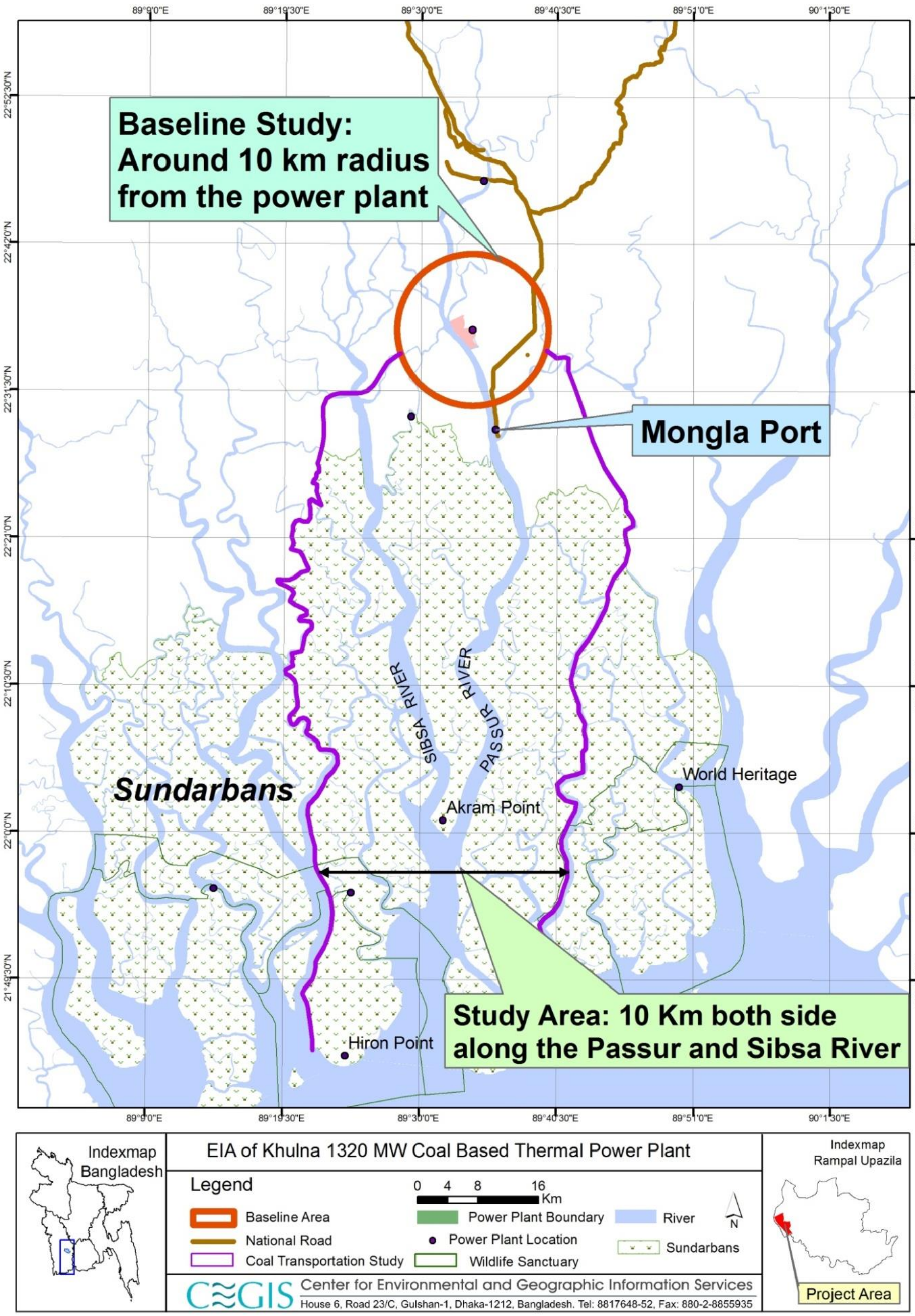
11. The monitoring sites have been selected considering the sensitive receptors and the ambience likely to be impacted from the Project related activities.

- Monitoring locations for ambient air quality were selected considering the wind direction, sensitive receptors in the vicinity of the Project etc. Site selection for monitoring of ambient noise condition also considers the same as for air quality.
- Sites for ambient water quality were selected by considering the water sources likely to be impacted/ polluted by both the natural and anthropogenic sources.
- Monitoring sites of fisheries resources covers the fish habitats, biodiversity, migration and production zones likely to be impacted.
- Monitoring locations of ecosystem and biodiversity have been selected considering the induced impacts of the Project.
- Monitoring locations of soil and land resources likely to be impacted by the project activities.
- Monitoring of social environment i.e. the PAPs (project affected peoples) and the changes of socio-economic parameters.

- Sundarbans Reserve Forest (SRF) health Monitoring locations have been selected considering the potential access routes for Power Plant which may have impacts on Sundarbans Reserve Forest.
- Monitoring of EMP status in and around the project area.



Map 1.1: Location Map of the Rampal Coal Based Thermal Power Plant



Map 1.2: Area under the Interest of Environmental and Socio-economic Monitoring

1.4 Main stakeholders

Forest Department

12. The monitoring of the study area includes some locations in Sundarbans that needs to comply with the conditions set out by the DoE in the approval of EIA report. Hence, permission from the Forest Department is necessary to carry out monitoring activities in the Sundarbans.

13. The Forest Department has issued the permission of carrying out monitoring activities in the Sundarbans under certain conditions that include keeping close communication with Forest Department, submitting the monitoring report to Forest Department and including the following activities in the monitoring study:

- Inclusion of soil scientist and a botanist in the monitoring team,
- Monitoring of regeneration, ingrowths (seedlings), diseases and pests (if necessary, to carry out laboratory analysis),
- Monitoring of soil nutrients (macro, micro) and heavy metals,
- Monitoring of floral diversity, species richness and dominancy,
- Measurement of carbon at above and below ground level,
- Assessment of impact on canopy cover, leaves phenology, flowers behaviour, pneumatophore and crab hole conditions.

14. The monitoring team has been formed as per the requirements of the Forest Department. BIFPCL also forwarded each copy of the earlier quarterly monitoring report to the Chief Conservator of Forest, Bangladesh Forest Department, Agargaon, Dhaka and Conservator of Forest, Khulna Circle, Boyra, Khulna. Similarly, this monitoring report (4th quarter, 3rd Year) will also be forwarded to the Forest Department.

Department of Environment (DoE)

15. The monitoring plan, including indicators, location and schedule, has been prepared incorporating the suggestion(s) of the Department of Environment. Before initiating the monitoring study, a discussion meeting was held with experts of DoE to finalize the monitoring plan at CEGIS office.

16. The BIFPCL forwards the monitoring reports and data to the DoE regularly. The monitoring report are also being presented to the Environmental Clearance Committee of the DoE during the renewal of the site clearance. In each monitoring visit a representative from the local DoE have also been accompanying the monitoring team.

Bangladesh India Friendship Power Company (Pvt.) Limited (BIFPCL)

17. Bangladesh India Friendship Power Company (Pvt.) Limited (BIFPCL) is the Project proponent. The monitoring plan has been prepared based on the conditions set by DoE which have been suggested in the EIA study. During field survey for baseline study, official(s) from BIFPCL has been assisting the study team from the beginning of the study. In addition, BIFPCL is implementing the environmental management plan (EMP) for ensuring environmental and social safeguarding of the project.

Bangladesh Power Development Board (BPDB)

18. BPDB is the main promoter of BIFPCL and is giving lateral support the BIFPCL in every phase (pre-construction, construction and operation) of the Rampal Power Plant. In addition, BPDB is also ensuring the environmental compliance monitoring of different stages of the Power Plant construction.

Local Community

19. The Project Affected Peoples (PAPs) were included in the monitoring of social environment. The changes on important socio-economic parameters were examined based on the Focus Group Discussions (FGDs) and informal discussions with local people at different locations surrounding the project area as stated in the monitoring reports.

1.5 Study Scopes

20. In this study, the Physical, Biological aspect has been monitored on quarterly basis and the quarterly monitoring report is furnished in the subsequent chapters as such,

- Physical aspects would cover air quality, noise level, water quality and land resources;
- Biological environment include fisheries resources, ecological resources, Sundarbans Reserve Forest (SRF) health conditions ;
- Environmental compliance monitoring includes Monitoring of Environmental and Social Management System Action Plan Implementation, Monitoring of labour and working conditions, Monitoring of community health, safety and security and Monitoring of biodiversity and sustainable management of living natural resources.

21. However, all the significant aspects of physical environment, Biological Environment, Social Environment and implementation of EMP status monitoring have been included in the following chapters of the monitoring report.

2 Physical Environment

22. A number of physical environmental parameters including air quality, noise level, water quality, land resources are monitored quarterly as per the monitoring schedule to establish a baseline.

2.1 Air Quality

23. In this monitoring period (**4th** quarter of **3rd** year), the ambient air quality has been observed at the pre-selected (Eleven) 11 locations. .

2.1.1 Methodology

24. The monitoring plan in the EIA has covered five (5) major air pollutants i.e., **Particulate Matters ($PM_{2.5}$, PM_{10}, SPM), SO_X, NO_X, CO** and **O_3 which** are expected to emit from the proposed Power Plant related activities and taken under consideration in this monitoring report too. The sites have been selected based on a number of criteria e.g., the sensitivity of the receptors, project activities like coal-carrying vessel movement, transshipment point etc.; wind direction and atmospheric stability class. Moreover, the potential location of air pollution has been projected on the basis of model generated pollutant dispersion scenario. U.S. EPA approved regulatory air quality software 0 has been used to determine the maximum ground level concentration of potential pollutants which may be dispersed from the Power Plant activities. A comprehensive discussion on the ambient air quality has been reported in the following sections. All the parameters were monitored for eight (8) hours and the data has been analyzed by taken into consideration the eight (8) hours concentration.

Method of Sampling and Laboratory Testing

25. Respirable Dust Sampler (Model-Envirotech India APM-460BL) and Fine Particulate Sampler (Model-Envirotech India APM-550) have been used to collect the air samples. The $PM_{2.5}$, PM_{10}, and SPM have been tested by gravimetric method. The concentration of SO_x has been tested by West-Gaeke method. Likewise the NO_2 has been tested by Jacob and Hochheiser method. In addition, CO and Ozone (O_3) was measured by Metravi CO-10 and Tongdy O3 Monitor respectively.

Monitoring locations

26. Ambient air quality of the study area has been monitored in the same locations as monitored in the earlier quarters. The locations of the air quality monitoring points have been shown in **Map 2.1**. The details of the monitoring plan have been provided in the **Table 2.1.**

Pollution sources at Project area

27. The major pollution sources currently contributing to the ambient air pollution along the Passur River in between the Project site and Mongla Port area are the existing infrastructures (i.e., cement and petroleum industries) and other pollution sources (i.e., marine vessels and residential sources) are listed in **Table A.2** of Appendix **IV.**

Pollution sources in the Sundarbans

28. Mostly river traffic of Mongla Port travelling across the Sundarbans are the sources of Suspended Particulate Matter (SPM), Oxides of Sulphur (SO_2), Oxides of Nitrogen (NOx) and Green House Gas (GHGs).

29. An inventory of the existing emission types and sources in the study area have been provided in **Table A.2** of **Appendix IV**.

Table 2.1: Air Quality Monitoring Plan

Sl no	Monitoring Indicators	Locations	GPS Points	Frequency	Methods/Tools/Techniques
1	Particulate Matter ($PM_{2.5}$, PM_{10}, SPM) SO_X, NO_X, CO and O_3	South West corner of the Project boundary	89°33'34.5"E 22°34'33.8"N	Quarterly	In situ field measurement conducted with the facilities of outsourced laboratory. **Method of testing $PM_{2.5}$:** Gravimetric **Method of testing PM_{10}:** USEPA (1997) Method 201 or 201A (as appropriate) **Method of testing SO_X:** USEPA (2000) Method 6 or 6A or 6B or ISO (1998) Method 11632 (as appropriate) **Method of testing NO_X:** USEPA (2000) Method 7 or 7A or 7B or 7C or 7D or ISO (1993) Method 10396 (as appropriate).
2		Proposed township area near Chimney location, Mauza: Sapmari Katakhali	89°32'3.8"E 22°36'32.5"N		
3		North West corner of the Project boundary (Kaigar Daskati)	89°33'51.8"E 22°36'1.06"N		
4		Barni, Gaurambha union (4km North East from the chimney location)	89°34'37.7"E 22°38'51.8"N		
5		Chunkuri-2, Bajua Union (4km South West from the chimney location)	89°34'01.1"E 22°32'3.3"N		
6		Pankhali, Dacope, (4km North West from the Chimney location)	89°31'24.2"E 22°36'6.7"N		
7		Mongla Port Area	89°35'50.4"E 22°28'24.8"N		
8		Harbaria, Sundarbans	89°35'34.2"E 22°17'43.1"N		
9		Akram point, Sundarbans	89°30'54.1"E 22° '23.50"N		
10		Hiron Point, Sundarbans	89°27'53.2"E 21°46'27.60"N		
11		Khulna city near Khan Jahan Ali Bridge	89°35'35.5"E 22°46'36.8"N		

Map 2.1: Air Quality Monitoring Locations

2.1.2 Status of air quality

30. Air quality is expressed in terms of standards set forth for public health and welfare protection (against decreased visibility and damage to human health, animals, crops, other vegetation etc.). All the recognized and practiced current standards are listed below in **table -2.2**. Units of measurement for the standards are parts per million (ppm) by volume, and micrograms per cubic meter of air (µg/m^3).

Table 2.2: Air Pollutants Emission Standards

Pollutant		Averaging Time	IFC/WB Standard	Bangladesh (DoE) Standard for ambient Air (ECR 2005)
Carbon Monoxide (CO)		1 hour	-	40 mg/m^3
		8 hours	10 mg/m^3	10 mg/m^3
Nitrogen Dioxide (NO_2)		1 hour	200 µg/m^3	-
		Annual	40 µg/m^3	100 µg/m^3
Ozone (O_3)		8 hours	100 µg/m^3	157 µg/m^3
		1 hour	-	235 µg/m^3
Particle Pollution (PM)	$PM_{2.5}$	24 hours	75 µg/m^3 (Interim Terget-1)	65 µg/m^3
	PM_{10}	24 hours	150 µg/m^3 (Interim Terget-1)	150 µg/m^3
	SPM	8 hours	-	200 µg/m^3
Sulphur Dioxide (SO_2)		24 hours	125 µg/m^3 (Interim target-1)	365 µg/m^3

Particulate Matter ($PM_{2.5}$, PM_{10} and SPM)

31. The values of $PM_{2.5}$ and PM_{10} have been found within the standard limit at each location. Among those locations, maximum concentration of $PM_{2.5}$ and PM_{10} was found 38.7 µg/m^3 and 145.9 µg/m^3 at Chlna bazar and Khulna city near Khan Jahan Ali Bridge comparatively. Similarly, SPM concentration have been recorded higher at Chalna Bazar comparing to the other locations and may be due to the intervention of large number of two-stroke human hauler, small engine boats and the anthropogenic activities. The SPM values were ranged in between 115.7 µg/m^3 and 194.6 µg/m^3 in and around the eproject area. In addition, cement industries and road traffic may also be considered as other source of the particulate matters of the study area. However, all the recorded data (monitored for 8 hrs) are given in **Table A.1** in **Appendix IV.**

Sulphur Dioxide (SO_2)

32. Concentration of Sulphur dioxide (SO_2) in the ambient air is found within the Bangladesh standard limit of 365 µg/m^3. The highest value (18.9 µg/m$^{3)}$ was recorded at bajua union in Dacope upazilla. However, SO_2 values in and around the Project ranged between 9.5 µg/m^3 and 18.9 µg/m^3 which are the lowest among all the monitored data recorded in the same season. Likewise, SO_2 concentration in the Sundarbans reserve forest

area were found to be within the ECR' 97 standard and ranged in between 8.4 µg/m^3 to 13.5 µg/m^3.

Nitrogen Dioxide (NO_2)

33. The eight hours observed concentration of SO_2 in ambient air of the Sundarbans area ranged in between 12.7 µg/m^3 to 15.9 µg/m^3 while in Project site and its adjoining areas, the values were found comparatively similar to the recorded values of the previous season and within the Bangladesh standard limit of 100 µg/m^3. The highest value (19.3 µg/m^3) was recorded at Gaurambha, Rampal site. The monitoring results are shown in **Table A.1**in **Appendix IV.**

Carbon Monoxide (CO)

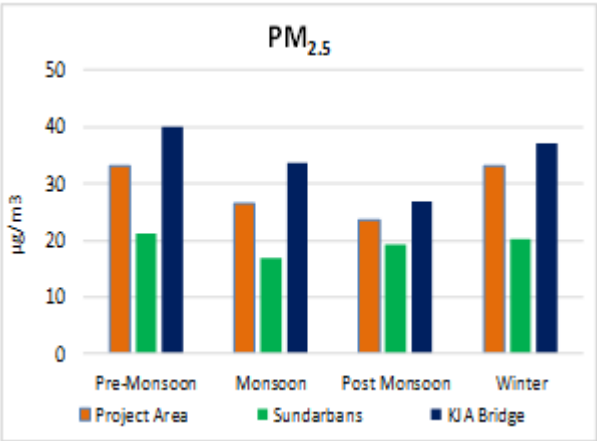
34. The observed concentration of CO at the monitored locations were found lower than the standard values imposed by ECR'97 and ranged in between 31 µg/m^3 to 66 µg/m^3 in and around Project area, 43 µg/m^3 to 67 µg/m^3 in Sudarbans area comparatively. The possible causes for the CO concentration could be the movement of numerous types of vehicles in roads and boats in the river. The values are found very insignificant in the context of national standard (10,000 µg/m^3 for 8 hours).

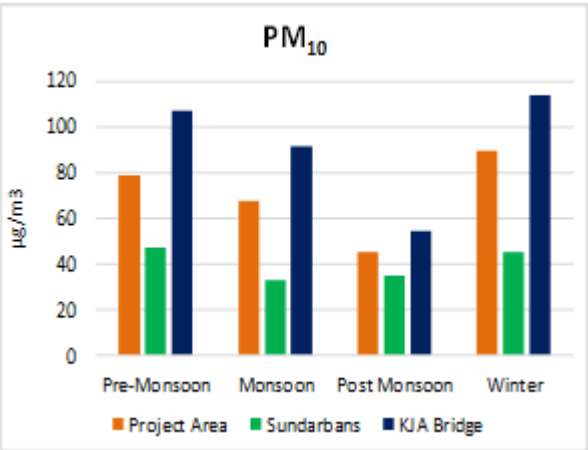
Ozone (O_3)

35. Similarly, results of O_3 both in the Sundarbans and Project area are lower (1 - 5 µg/m^3) than the Bangladesh standards of 157 µg/m^3 for 8 hours. In this recent monitoring study the maximum concentration was found in South-west corner of the project area and at Khulna city near Khan Jahan Ali Bridge. Ground-level or "bad" ozone is not emitted directly into the air, but is created by chemical reactions between oxides of nitrogen (NOx) and volatile organic compounds (VOC) in the presence of sunlight.

2.1.3 Findings

36. All the air pollutant data satisfactorily comply with the national standards and showed a modest condition of the ambient air. The observed values did not indicate any harm to the local atmosphere. (**Figure 2.1**).





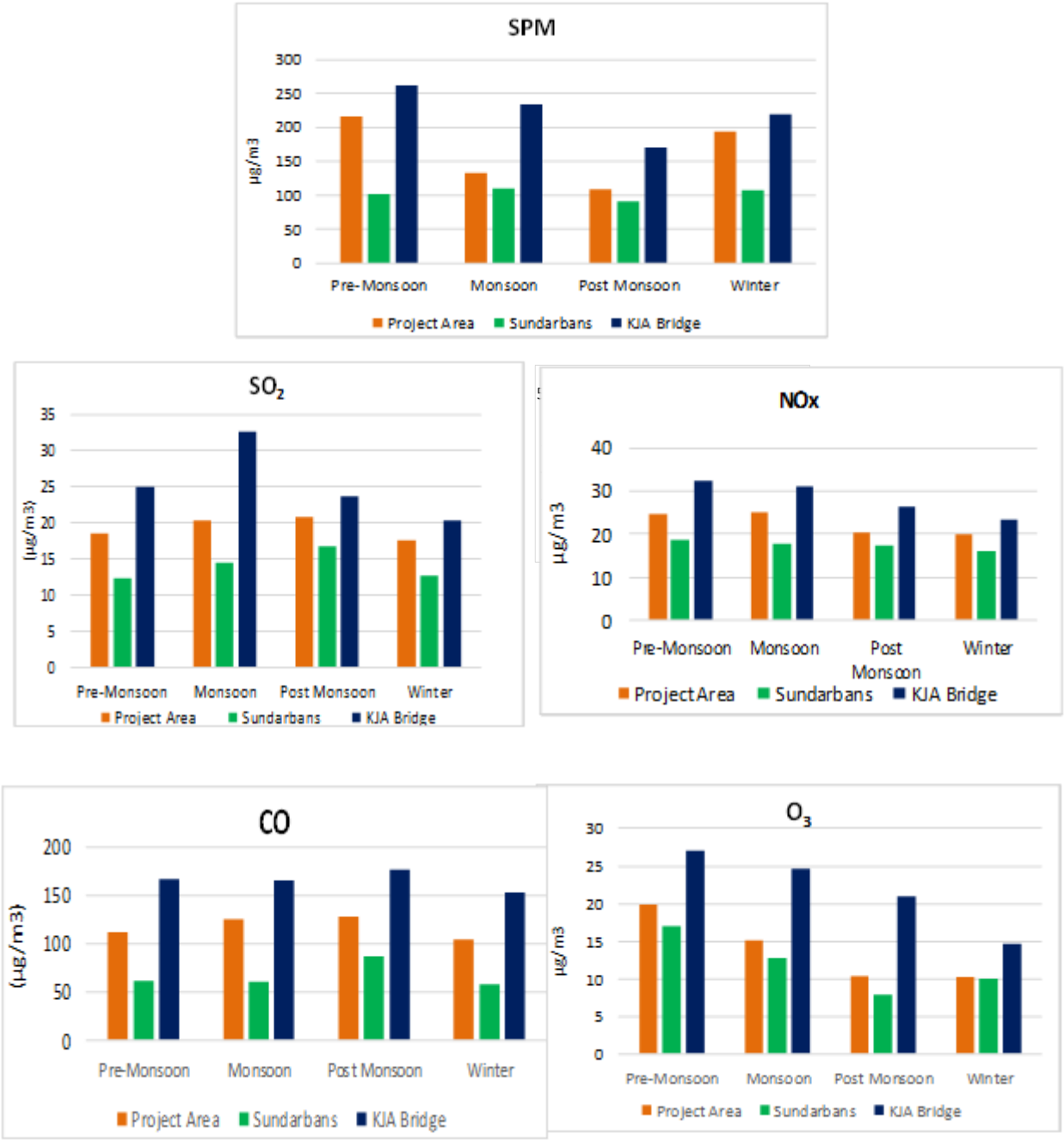


Figure 2.1: location wise Seasonal variations of the Air pollutants collected during the monitoring years

Summary of the air quality monitoring

37. Air quality monitoring inferred that the wind flowed from North-Northwest to South-Southeast direction. The weather can be characterized by gentle wind flow, low air temperature, sunny and cloudless sky. This time the concentration of all the ambient air quality monitoring parameters (SO2, NOx, PM2.5, PM10, CO and O3) were found within the standard limit. However, newly developed land for industrial activities along the Passur River, loading-unloading activities and cement industries can be described as the known sources of PM2.5, PM10 and SPM in this area. Other pollutants may generate from the commonly known sources like the local vehicles (human hauler/ Nosimon) and were observed while working beside the roads, the monitoring spot in or around the project area & Sundarbans and engines of trawler, barges, ship etc.

2.2 Noise

38. Noise is the sound that is not desired by the perceiver, because it is unpleasant, loud, or interferes with hearing. By extension, in experimental sciences, "noise" refers to any random fluctuations of noise level data that makes more difficult the perception of an expected signal. From a physics standpoint, noise is indistinguishable from sound as both are vibrations through a medium, like air or water. In general point of view, noise is the chaotic feeling of sound where many sound waves are mixed and difficult to distinguish a single signal.

39. Noise is described by a weighted sound intensity (or level), which represents sound heard by the human ear and is measured in units called decibels (dBA). Noise is recorded through Noise Level (Sound Pressure Level) Meter for a certain period of time for determining the ambient noise level in the study area.

40. Noise levels have been monitored during 2014 (March, July, October), 2015 (January, April, July, October), 2016 (January, April, July and October) and 2017 (January). Ambient noise levels have been monitored quarterly at eleven (11) locations during this session.

41. In this **4th quarter** monitoring of **3rd year**, the noise level has been recorded at winter period.

42. The noise is generated from the common sources i.e., the rural vehicles (human hauler/ Nosimon, auto-rickshaw); whereas in case of the monitoring spot in or around the waterways, the sources are trawler, ship, sometimes waves breaking against the shore, etc. Barges, trawlers and ships are found plying over the waterway during this season.

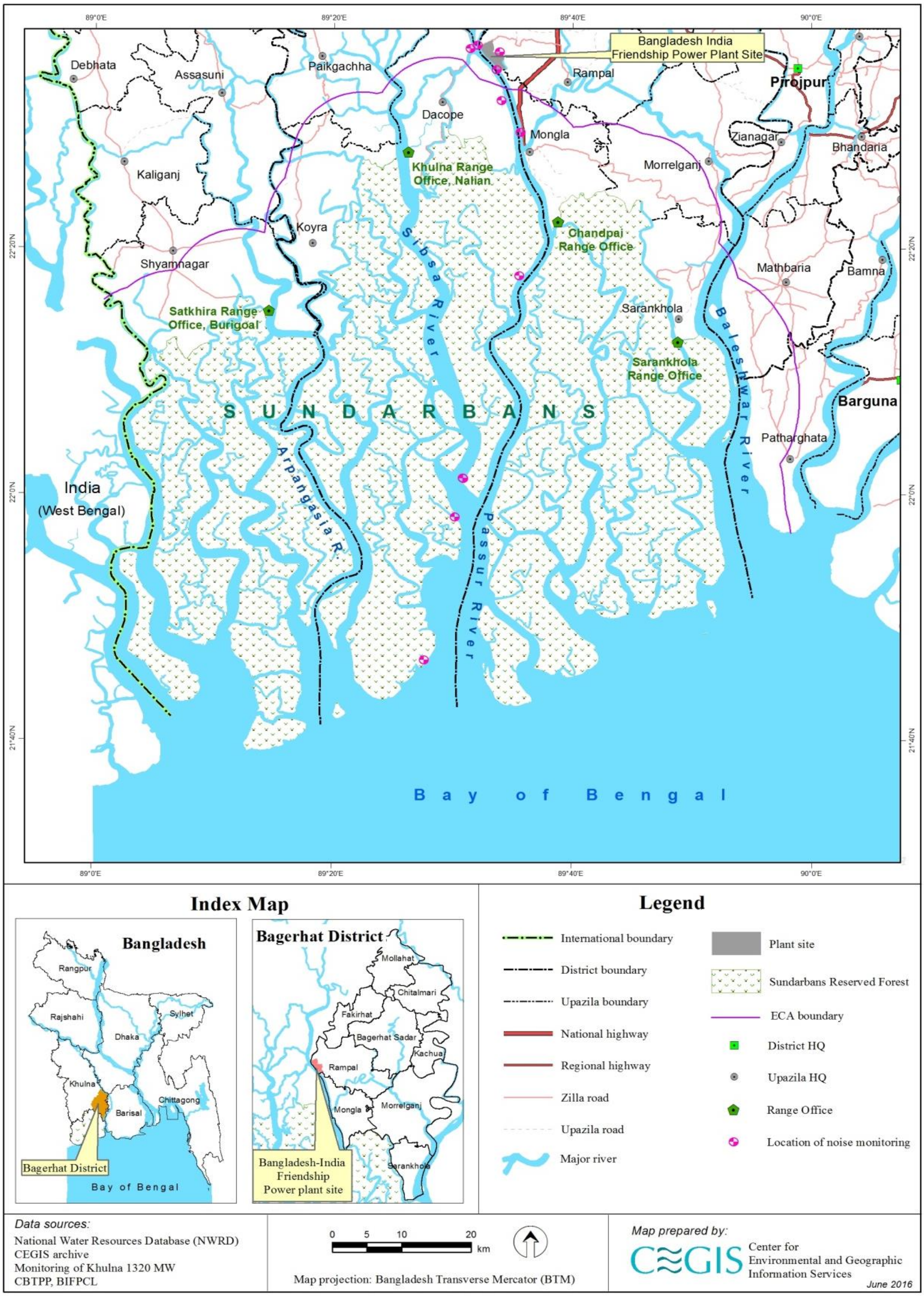
2.2.1 Methodology

43. Noise level has been measured thrice in a day (morning, afternoon and evening) at Eleven (11) locations. Each time noise level is recorded using portable noise level meter for a five minutes time span with a 30 seconds interval. Depending on the site condition and acoustic environment, the noise meter is set up and calibrated following the instruction manual. All the data are collected in Leq, L10 and L90 dBA values.

Locations of Noise level Monitoring

44. There are eleven (11) locations for the noise level monitoring of which three locations are inside the Sundarbans, six locations are in and around the Project site, one is at Khan Jahan Ali Bridge on Rupsha River and one is at Mongla Port (**Map 2.2**).

Photo 2.1: Professional conducting an ambient noise acquisition survey in Harbaria, Sundarbans



Map 2.2: Noise Level Monitoring Locations

2.2.2 Status of Noise

45. The brief summary of Noise level data is appended in the **Table 2.3**; but the detailed field Noise level data is attached to the **Table no. C1, C2** and **C3** in the **Appendix IV**. Ambient noise data have been recorded at the following places:

Dacope Upazila Parishad

46. The monitoring location is at Chalna Bazar [Pankhali, Dacope (4km North West from the Chimney location); 89.5234°E, 22.6046°N] which is a commercial area. According to the Environmental Conservation Rules (ECR) 1997, noise level standard for commercial area at day time is 70dB (A). The noise level has been recorded as 59.29 dB which is below the Bangladesh standard (**Table 2.3**).

47. The significant noise sources at this place are road traffic and crowd. The road traffics are mostly from locally made engine van (locally called Nosimon), motor bike, easy bike (battery operated tri-cycle), etc.

North- West (NW) corner of the Project area

48. The North West (NW) corner of the Project area [89.5334°E, 22.6093°N] is under Kaigar Daskati mauza of Gaurambha union. The monitoring location is near a Gucchha gram (a cluster village built by the Government for the landless and homeless people). This area is residential and the standard is 55dB (A) at day time (ECR, 1997). This time, the average day time noise level has been recorded as 44.52 dB which is far below (10.96dB) than that of last monitoring season (55.48 dB) and also lower (10.48 dB) than the standard value.

Chunkuri-2, Bajua

49. This area [4km South West from the chimney location, 89.5669°E, 22.5342°N] is residential and the standard is 55dB (A) at day time (ECR, 1997). During this time (Jan, 2017), it is found to be 55.31 dB which is 0.31 dB higher than the day time standard value.

50. The noise sources are rural road traffic and crowd. The road traffics are mostly locally made engine van (called as Nosimon), motorcycle, bicycle, van, etc.

South West corner of the Project area

51. The South West corner of the Project area [89.5601°E, 22.5761°N] is in Maidara Khal of Rajnagar union. During this time (Jan, 2017), the noise level was found to be 45.19 dB. This area is residential area and the standard is 55dB (A) at day time (ECR, 1997). The noise level is found much lower (9.81 dB) than the standard value (55 dB). It was 48.51dB during the last monitoring period. Frequent movement of water vessels over the Moidara Khal is one of the main reasons of noise generation.

Proposed township area of the Project

52. The proposed township area, Sapmari [89.5644°E, 22.6005°N] of the Power Plant is located at the middle of the eastern portion of the Project area. This area is residential and the standard is 55dB (A) at day time (ECR, 1997). In this monitoring period, sound level was found to be 42.62dB which was not much far from the last (43.69 dB) monitoring season but much lower (12.38 dB) than the day time standard limit.

Barni, Gaurambha

53. This area [4km North East from the chimney location; 89.5772°E, 22.6477°N] is both residential and commercial and the standard for a mixed zone is 60dB (A) at day time (ECR, 1997). The noise level was found as 49.05 dB during this monitoring season which was 10.95 dB lower than the standard value.

Khan Jahan Ali Bridge, Khulna

54. The monitoring location is close to the toll booth of Khan Jahan Ali Bridge, Khulna [89.5935°E, 22.7779°N]. This area is considered as commercial due to activities around the bridge side and the standard for the commercial area is 70dB (A) at day time (ECR, 1997). The average noise level was found 55.57 dB which was far below (14.43 dB) than the standard of day time. The highway traffic was the main source of noise. The highest noise level has been recorded both in the mid-day and evening due to higher traffic load.

Mongla Port area

55. The monitoring location [89.5936°E, 22.4916°N] is at Khulna-Mongla highway, 200m northward from the main entrance of the Mongla Port area. The area is industrial and the standard for the industrial area is 75dB (A) at day time (ECR, 1997). The average day time noise level was 48.95 dB which was 26.05 dB lower than the standard value.

56. The sources of noise were mostly road traffic (heavy vehicles, light vehicles, Nosimon, etc.) and noise from Mongla Port activities (crane, ships, etc.).

Harbaria, Sundarbans

57. Harbaria area of the Sundarbans is very critical considering the richness of biodiversity. The area is important navigation route for Mongla Port Area. Most of the sea going vessels were used to anchor at this site for operation. The area is under silent class of noise standard and standard of ambient at day time is 50 dB (A) (ECR, 1997). The noise level ismeasured41.18 dB in this monitoring period at 100m inside the forest on the right bank of the Passur River [89.5926°E, 22.2968°N] to avoid the disturbance of noise from wave breaking against the shore and was found lower (8.82 dB) than day time standard value.

58. Distant ship movement, running engines of anchored ships, wind, birds, wave and wind action on tree leaves were the main sources of noise.

Akram point, Sundarbans

59. Akram Point of the Sundarbans is another biodiversity hot spot in the Sundarbans. This area was selected for anchorage point of coal carrying mother vessel for the Power Plant. This area is also under the silent class where the ambient day time noise standard is 50 dB (A). The monitoring location [89.5152°E, 22.0219°N] is at the left bank of the Sibsa River. Noise was recorded as 100m inside the forest from the river bank to avoid noise from wave breaking. The average day time ambient noise level during this monitoring (38.08 dB) which was much lower (11.92 dB) than the standard value. Birds' chirping, stormy wind, wave and tree leaves were the main sources of noise here

Hiron Point, Sundarbans

60. This noise sampling location [89.4614°E, 21.7755°N] falls under the demarcated area of World Heritage Site. Noise level was measured at the western bank of Passur river mouth and eastern side of the Sundarbans South Sanctuary. This location is highly important as the

Mother vessels enter into the Passur river adjacent to this point. However, the river is roughly 5-6 km wide between two banks at the confluence point. Noise level was recorded as 42.29 dB during this monitoring season. This is the place where sound level shows less fluctuation and always remains lower than the standard values except July-2014 (51.29 dB). Sound of sea shore, wind blow, creeping of birds and small mechanized sea going boat might be responsible for the present noise level.

Table 2.3: Summary of the ambient noise recorded in consecutive eleven (12th) Quarter monitoring sessions in 2014, 2015, 2016 & 2017

Sl No.	Location	QM1 Mar-14	QM2 Jul-14	QM3 Oct-14	QM4 Jan-15	QM5 Apr-15	QM6 Jul-15	QM7 Oct-15	QM8 Jan-16	QM9 Apr-16	QM10 July-16	QM11 Oct-16	QM12 Jan-17	Std*
1	Chalna, Dacope	68.13	52.87	54.63	53.28	57.08	49.77	65.12	66.07	65.08	52.42	65.51	59.29	70
2	NW Corner of the Project area	51.89	NM	41.92	35.25	44.67	41.56	41.94	50.96	50.79	52.65	55.48	44.52	55
3	Chunkuri-2, Bajua	57.76	52.55	51.39	49.29	47.05	40.66	47.43	53.62	44.49	53.4	51.55	55.31	55
4	SW corner of the project area	49.2	47.6	45.95	36.03	43.58	43.75	42.7	60.44	54.50	65.37	48.51	45.19	55
5	Proposed Township area(Sapmari), project site	48.75	46.68	41.92	41.47	41.47	46.75	50.52	53.77	53.37	55.79	43.69	42.62	55
6	Barni, Gaurambha	58.84	49.95	49.78	43.6	54.17	46.18	55.16	59.16	53.97	56.75	54.91	49.05	60
7	Khan Jahan Ali Bridge, Khulna	71.7	60.8	66.28	61.72	73.45	52.82	64.25	68.45	65.85	63.77	60.95	55.57	70
8	Mongla Port area	61.24	53.84	60.5	38.69	48.15	39.61	47.01	52.7	49.88	52.86	49.86	48.95	75
9	Harbaria, Sundarbans	40.88	56.13	55.3	34.38	65.37	35.03	50.75	45.2	44.55	52.9	55.33	41.18	50
10	Akram Point, Sundarbans	40.94	47.9	43.98	34.32	54.86	NM	49.6	42.95	42.95	47.96	41.77	38.08	50
11	**Hiron Point, Sundarbans**	38.63	51.29	47.98	37.37	47.84	NM	46.06	NM	43.11	NM	44.38	42.29	50

*Note: All values are in decibels (dBA), QM- Quarter Monitoring, NM – Not Monitored, *Std- Standard as defined in National Noise Control Rules 2006*

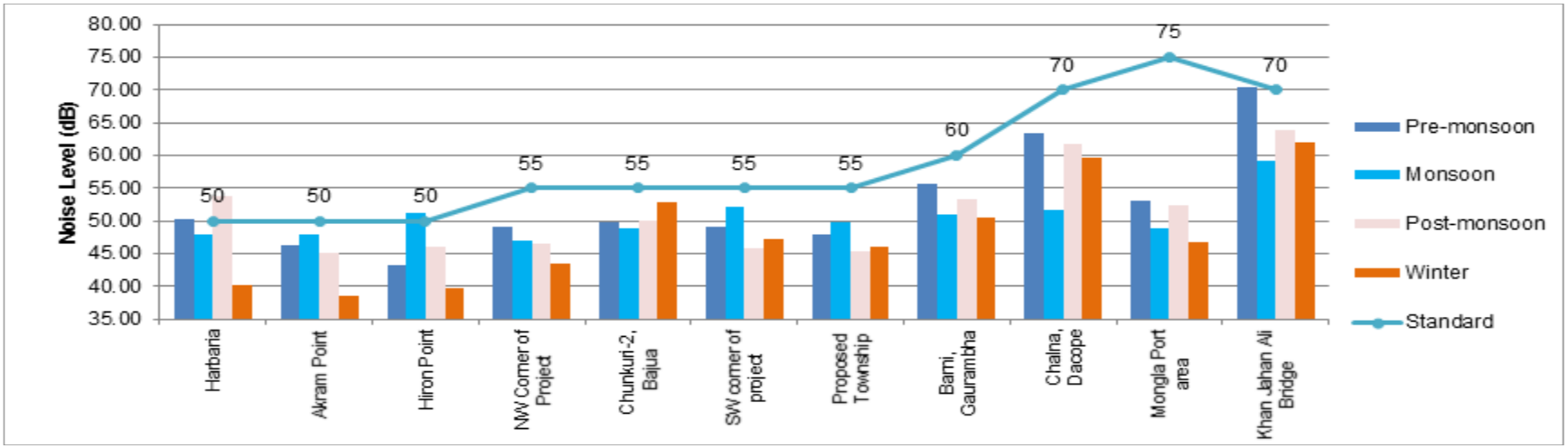


Figure 2.2: Seasonal variation of Noise level at different location

2.2.3 Findings

61. In the study area, noise generation sources can mainly be divided into two types; one is natural and another one is anthropogenic. Natural sources are birds' chirping, stormy wind, wave breaking on the shoreline and howling of leaves and so on. On the other hand traffic mobilization, industrial activities, vessels movement within the rivers and local vehicles are the salient sources of anthropogenic noise. However, in this monitoring season; the observed noise value (**Figure 2.2 and Table 2.3**) did not cross the Bangladesh standard noise limit in any point; even in some points the noise level was much lower than the standard value.

62. In the course of total twelve monitoring seasons, it was found that the noise level of eight locations exceeded the Bangladesh standard for their corresponding standard value in different monitoring seasons. These were NW corner of the Project area (Oct-2016), Chunkuri-2 (Mar-2014 & Jan-2017), SW corner of the Project area (Jan-2016 & July-2016), Proposed Township area (July-2016), Khan Jahan Ali Bridge (Mar-2014), Harbaria (July-2014, Oct-2014, Apr-2015, Oct-15, July-2016 & Oct-2016), Akram Point of Sundarbans (Apr-2015) and Hiron point of Sundarbans (July-2014). It was observed that the noise level of Harbaria crossed the standard value in five seasons among the twelve monitoring seasons which was 41.67% of its monitoring number. On the other hand, it was found that noise level at three locations namely Chalna under Dacope upazila, Barni (Gaurambha), and Mongla Port area had never cross the Bangladesh standard limit.

2.3 Water Quality

63. A detail description of the current water quality status of Passur-Sibsa river system has been updated in this section. The entire monitoring activities and analyzing methodologies has been adopted following both the national and international guidelines. A systematic sampling design has also been adopted in order to emphasize the multiple lines of evidence of the water quality. This report includes in-situ water quality data collected during the **4th quarter** of **3rd year** (**12th program, January 2017**) and the available laboratory data obtained up to **October, 2016**.

64. The water quality monitoring activities include surface water and ground water at the respective locations. A number of identical parameters were chosen to understand the quality of the water for community use, aquatic life, and the Sundarbans forest ecosystem.

65. The samples collected for the **11th** monitoring program (**October, 2016**) have been analyzed for the specific parameters which is available in this report and the data of the recently collected samples (January, 2017) will be available and discussed in the summary Monitoring report as the laboratory analysis is under progress.

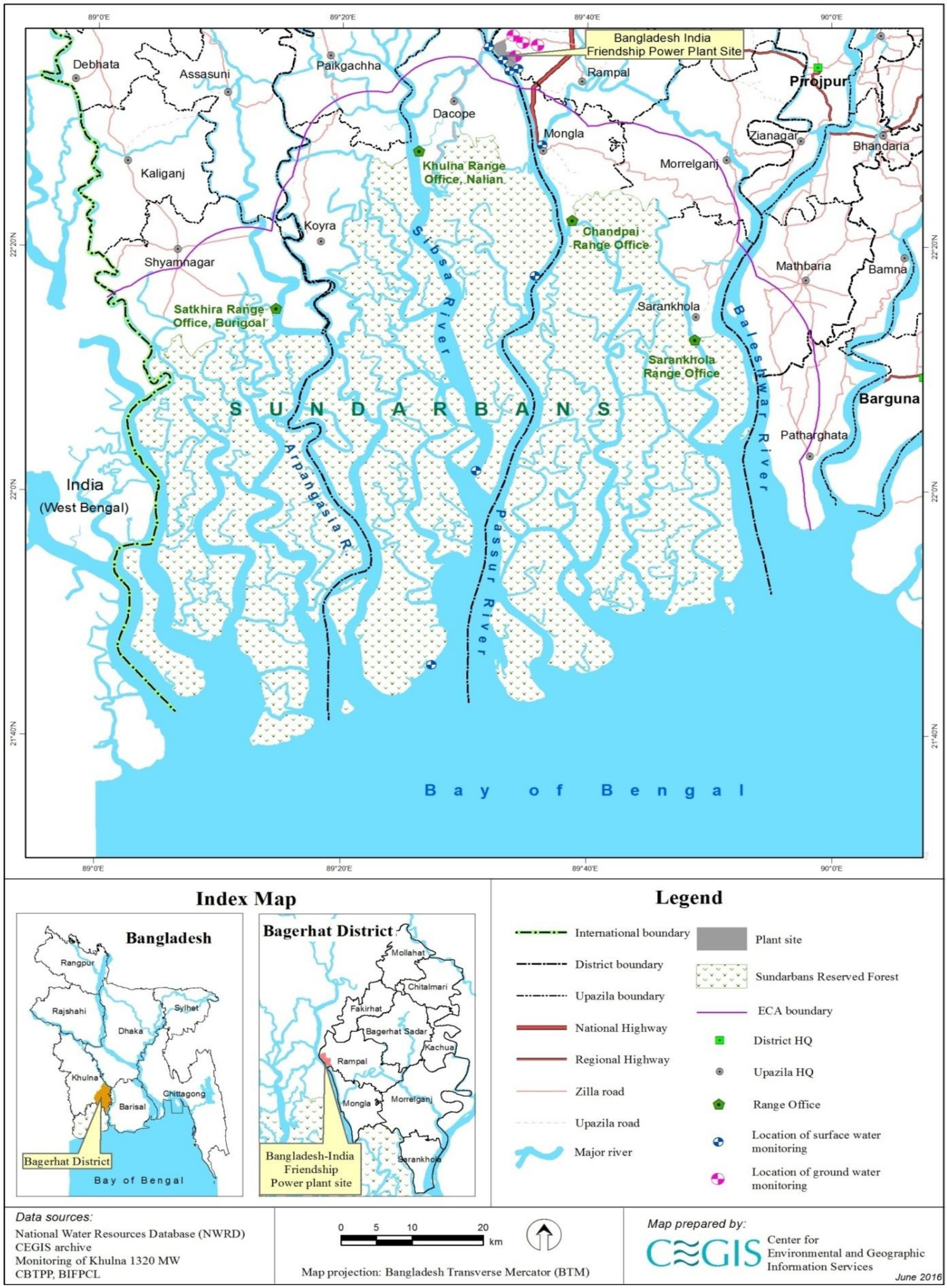
2.3.1 Methodology

66. Monitoring of water quality directly depends on selection of water quality parameters, sampling locations, sampling frequency, evaluation criteria etc. Standard practices have been followed to analyze the water quality. Both the surface and ground water quality have been assessed to examine the water quality status in and around the Power Plant and the Sundarbans. The monitoring results have not only been presented but also been compared with the national standards (ECR, 1997 and all amendments).

67. The samples have been collected from Eighteen (18) preselected sites (15 locations for surface water along Passur River, Sibsa River, Maidara River, near the plant site, and three locations for groundwater around the study area) for 12th monitoring program as shown in the **Map 2.3**. These sampling locations were preliminarily selected at inception stage and finalized during the 1st monitoring study. The details of the monitoring plan (selected water quality parameters, sampling locations, and frequency of sampling at each location) for surface water is shown in **Table 2.4** and for groundwater in **Table 2.5.**

Table 2.4: Surface Water Quality Monitoring Parameters, Locations and Plan

Sl no	Monitoring Indicators	Locations	GPS (Decimal Degree)		Frequency	Methods/Tools/ Techniques
			Easting	Northing		
1	pH, Temperature, Salinity, DO, BOD_5, TDS, TH, TSS, COD, Nitrate, Sulphate, Phosphate, Arsenic, Lead, Mercury, Oil & Grease	Left Bank of Passur River at 100m u/s of North West corner from the Project boundary	22.604167˚N	89.527222˚E	Quarterly	In-situ measurement (pH, Temperature, Salinity, DO and BOD_5) and Laboratory analysis (TDS, TH, TSS, COD, Nitrate, Sulphate, Phosphate, Arsenic, Lead, Mercury, Oil & Grease)
2		Middle of Passur River at 100m u/s of North West corner from the Project boundary	22.607222˚N	89.528889˚E		
3		Right Bank of Passur River at 100m u/s of North West corner from the Project boundary	22.609361˚N	89.531417˚E		
4		Left Bank of Passur River at Project site-Jetty	22.584833˚N	89.543583˚E		
5		Middle of Passur River at Project site-Jetty	22.587667˚N	89.546472˚E		
6		Right Bank of Passur River at Project site-Jetty	22.589333˚N	89.548222˚E		
7		Left Bank of Passur River at South West corner from the Project boundary	22.572889˚N	89.552583˚E		
8		Middle of Passur River at South West corner from the Project boundary	22.574611˚N	89.557500˚E		
9		Right Bank of Passur River at South West corner from the Project boundary	22.575667˚N	89.559861˚E		
10		Maidara river at the South East corner of the project at Ichamoti-Maidara confluence	22.600639˚N	89.565611˚E		
11		Maidara river near proposed Township area	22.577472˚N	89.569250˚E		
12		Passur river at Passur – Ghasiakhali confluence	22.473861˚N	89.602361˚E		
13		Passur river at Harbaria of Sundarbans	22.295250˚N	89.593139˚E		
14		Passur river at Akram Point of Sundarbans				
15		Passur river at Hiron point of Sundarbans				



Map 2.3: Surface water and Groundwater Quality Monitoring Locations

Table 2.5: Groundwater Quality Monitoring Parameters, Locations and Plan

Sl no	Monitoring Indicators	Locations	GPS (Decimal Degree)		Frequency	Methods/Tools/ Techniques
			Easting	Northing		
1	pH, Temperature, Salinity, DO, COD, As, Hg, Pb, TH, TDS, TSS, Nitrate, Sulphate, Phosphate	Near Proposed Township Area of the Project	22.594167˚N	89.566139˚E	Quarterly (April, July, October, January)	In-situ measurement and Laboratory analysis
2		Rajnagar	22.612528˚N	89.576056˚E		
3		Kalekarber	22.609306˚N	89.596278˚E		
4		Kapasdanga	22.622528˚N	89.563000˚E		

Sampling Procedure

68. The standard sampling procedure has been followed for both surface and groundwater sampling to reduce the probability of error. Each sample is tagged at the time of sampling.

Photo 2.2: Professional is collecting water samples at mongla-Passur confluence

Surface Water Sampling Procedure

69. The study area is highly influenced by tidal variation. Hence, temporal and spatial variations of tides were considered significantly in sampling procedure. Surface water samples were collected during the low tides or relative slag period after the low tide. Samples were taken 50 m away from the riverbank and at a depth of 6 cm below the river surface, whereas for oil and grease, samples were collected from the river surface. The individual sampling bottle was rinsed with respective water samples before storing. Acidified sampling bottles were used for heavy metal (As, Pb, Hg) analysis and wrinkle bottles were used for BOD_5 measurement. All the samples were preserved as per standard practices.

Groundwater Sampling Procedure

70. Groundwater availability depends on the recharge factor of aquifer, seasonal variation in water table, excessive water extraction from nearby agricultural field. Groundwater samples were collected from hand operated tube wells after 5-7 minutes of water extraction. Each sampling bottle was rinsed with respective water samples before storing. Acidified sampling bottles were used for heavy metal (As, Pb, Hg) analysis and were preserved following standard practices.

Photo 2.3: Professional is taking reading of water parameter

Parameters tested for water quality

71. Water quality parameters have been selected on the basis of tentative potential impacts generated during pre-construction, construction and operation phases of the Power Plant Project. Only five parameters namely pH, temperature, salinity, DO and BOD_5 have been tested while conducting the monitoring study and the rest of the preselected parameters are analyzed in the laboratories.

Surface Water Quality Parameters

72. The selected parameters for surface water quality includes Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Heavy Metals (As, Pb, Hg), pH, Salinity, Nitrate (NO_3), Total Dissolve Solids (TDS), Total Suspended Solids (TSS), Total Hardness (TH), Turbidity, Temperature and Oil and Grease. The main parameters are grouped into following four categories:

- Physical and aggregate properties i.e. pH, Temperature, Salinity, Hardness, TDS, TS, Turbidity, Oil & Grease
- Inorganic non-metallic constituents i.e., DO, NO_3^-, PO_4^{3-} and SO_4^{2-}
- Aggregate organic constituents i.e. BOD, COD
- Heavy metals i.e. As, Pb and Hg

Groundwater Quality Parameters

73. The parameters for ground water quality includes Dissolved Oxygen (DO), Chemical Oxygen Demand (COD), Heavy Metals (As, Pb, Hg), pH, Salinity, Hardness, Nitrate (NO3), Total Dissolve Solids (TDS), Total Hardness (TH) and Temperature.

Water quality analysis procedure

74. The collected samples of selected water quality parameters were analyzed as per the procedure of American Public Health Association (APHA) standard. The analysis procedures along with the standards have been appended in **Table 2.6.**

Table 2.6: Testing Methodology of Water Quality Parameter

Parameters	Methods/Measuring Tools	Unit	BD Standard (ECR 1997)
Temperature	Thermometer	$^{\circ}C$	20 - 30
pH	Microprocessor pH meter	-	6.5-8.5
TDS	TDS meter (Multimeter)	ppm	1000
TSS	Drying and Filtration	ppm	10
Salinity	Salinity Refractometer (Master- S/MillM Cal. No. 2493, ATAGO)	ppt	-
DO	Dissolved Oxygen meter DO-5509	ppm or mg/l	6
BOD_5	5-Day BOD Test at 20^0C	ppm or mg/l	50 (SW)
COD	Closed Reflux Method	ppm or mg/l	200 (SW), 4.0 (GW)
Total Hardness (as $CaCO_3$)	Titrimetric	ppm or mg/l	200-500
Ortho-Phosphate (PO_4^{3-})	UV-VIS Spectrophotometers	ppm	6

Parameters	Methods/Measuring Tools	Unit	BD Standard (ECR 1997)
Nitrate (NO_3^-)	UV-VIS Spectrophotometers	ppm or mg/l	10
SO_4^{2-}	UV-VIS Spectrophotometers	ppm or mg/l	400
Oil and Grease	Liquid-liquid extraction with hexane, treatment with silica gel and gravimetric determination	ppm or mg/l	10 (SW)
Arsenic (As)	Atomic Absorption Spectrophotometers–Hydride Vapor Generating (AAS-HVG)	ppm or mg/l	0.05
Lead (Pb)	Atomic Absorption Spectrophotometers–Graphite Furnace (AAS-GF)	ppm or mg/l	0.05
Mercury (Hg)	Mercury Analyzer	ppm or mg/l	0.001

2.3.2 Status of the surface water quality

In-situ tested parameters

(a) pH

75. During this period of monitoring pH values ranged in between 7.2 to 8.9 among the monitoring sites. The highest value was found in Right Bank of Passur River at South West corner from the Project boundary while the lowest value was observed in Passur River at Passur-Ghasiakhali confluence. The results show close conformity among the monitoring results of the same period of previous years.

76. pH values of pre-monsoon and monsoon seasons were found to be comparatively lower than post-monsoon and winter seasons. During post monsoon and winter seasons, river water level normally goes down because of less rainfall and less water flow from u/s (upstream) of Passur-Sibsa RS and as a result, pH values becomes higher than pre-monsoon and monsoon seasons as reported by others (Rahman et al., 2013). Fluctuations in pH values during different season of the year can be attributed to factors like removal of CO_2 by photosynthesis through bicarbonate degradation, dilution of waste with fresh water, reduction in salinity and temperature, and decomposition of organic matter (Rajasegar, 2003).

77. No significant pH differences have been observed except spatial variation in the river water. Seasonal variations in pH concentrations among the selected monitoring locations during first, second and third year quarterly monitoring of Passur-Sibsa RS are presented in **Figure-2.3** and all the observed dataset are attached in **Table B.1** of **Appendix- IV.**

(b) Temperature

78. Recent monitoring results of temperature show close conformity with the previously monitored values in the same season of 1st and 2nd year. The latest values varied from 21.4^{0}C to 23.1^{0}C among the monitored locations. During all the monitoring period maximum temperature is found in July 2014 which seemed to be slightly higher than the standard limit set by environmental conservation rules (ECR), 1997 and may be due to the temperature rise in the month of June & July (Summer Season). But all the observed values are found to be within the BD standard (20°C-30°C).

79. The surface water temperature largely depends on daily weather condition (Bartram J et al., 1996). According to the seasonal weather pattern of Bangladesh the temperature

drops to a minimum level during winter which is also applicable for the water temperature and thus it differs largely than the others season's data. However, the average temperature in all the other seasons is seen to be very similar with each other. No significant spatial variation had been observed during the monitoring periods. The measured temperature values of selected monitoring locations during quarterly monitoring of first and second year are presented in **Figure-2.4** and all the observed dataset are attached in **Table B.2** of **Appendix- IV**

(c) Salinity

80. The observed salinity values varied from 3.6 ppt to 21.4 ppt during this monitoring period and the maximum value was observed at Hiron point in Sundarbans while salinity level has been found much lower in the upstream at Right Bank of Passur River at 100m u/s of North West corner from the Project boundary than the downstream of the PS river system.

81. However, the observed results values were found nearly similar for the same seasons in the previous years. The highest average values are found in pre-monsoon season of the previous years. Water salinity data at the selected sampling stations of Passur-Sibsa RS of eleven consecutive periods are presented in **Figure: 2.5** and all the observed dataset are attached in **Table B.3** of **Appendix- IV.**

(d) Dissolved Oxygen

82. Among all the monitored locations DO concentrations were found to be ranged in between 5.9 mg/L to 6.8 mg/L. The maximum concentration was found at Hiron point in Sundarbans while the lowest amount was recorded at Middle of Passur River at Project site-Jetty, Right Bank of Passur River at Project site-Jetty and Passur River at Passur-Ghasiakhali confluence respectively. It may be mentioned that the Maximum concentrations were observed during monsoon and post monsoon than the other seasons. These higher values of DO in the monitoring stations could be due to DO enriched inland freshwater input through the river. Seasonal variations of DO at the monitoring sites of Passur-Sibsa RS are shown in **Figure: 2.6;** all the observed dataset are attached in **Table B.4** of **Appendix- IV**.

(e) Biochemical Oxygen Demand (BOD_5)

83. The BOD_5 values ranged from 1.8 to 2.2 mg/L. Maximum value of BOD_5 was observed at Middle Passur River at Project site-Jetty while the lowest (1.8 mg/L) value is observed at Maidara river of the South East corner of the Project at Ichamoti-Maidara confluence and at Left Bank of Passur River at 100m u/s of North West corner from the Project boundary. However all the values are found to be within the standard limit as stated in the ECR' 1997 and in IFC standard.

84. It is also evident from the figure that the highest average value has been recorded in Passur-Mongla confluence during monsoon season because of the river receives huge amount of organic load and agricultural runoff from the adjacent areas. Thus, BOD_5 has been found higher during summer season than monsoon and the least during winter. The water temperature normally goes down in winter season than those of pre-monsoon, monsoon and post monsoon seasons, which in turn decreases the bacterial and microbial activities and contributes a low level of BOD_5.

85. The measured BOD_5 values at different monitoring locations during the monitoring of Passur-Sibsa RS are presented in **Figure: 2.7** and all the observed dataset are attached in **Table B.5 of Appendix- IV.**

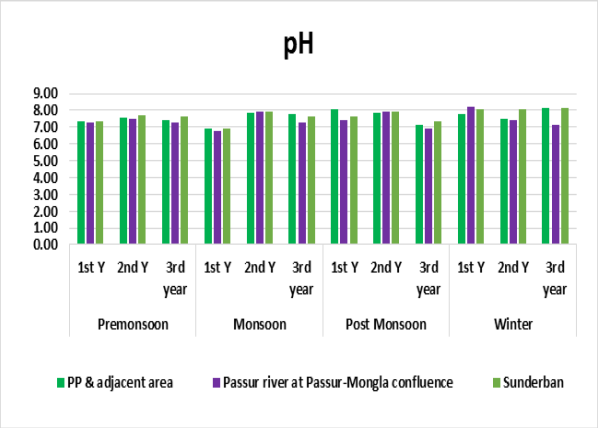


Figure 2.3: Variations in average pH values in sampling spots for the consecutive seasons

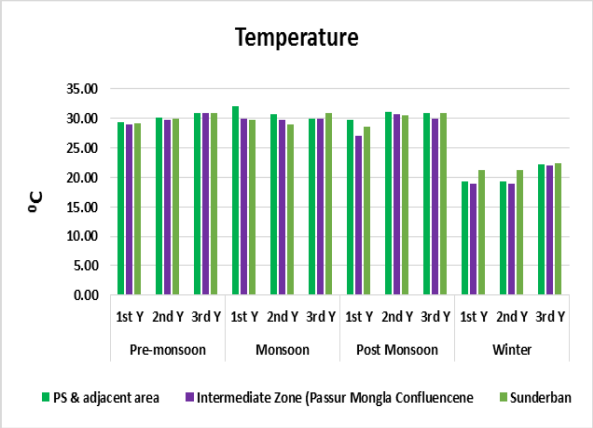


Figure 2.4: Variations in average temperature values in sampling spots for the consecutive seasons

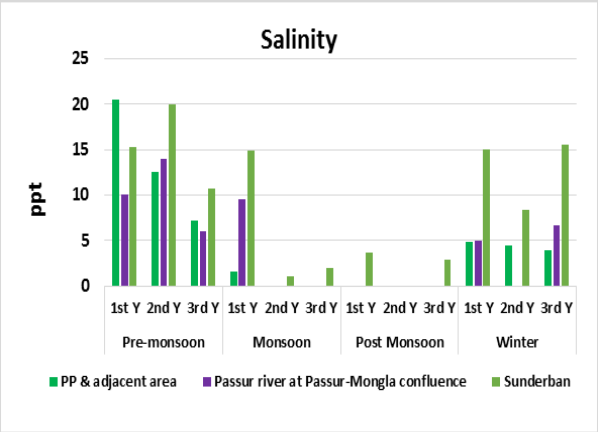


Figure 2.5: Variations in average salinity values in sampling spots for the consecutive seasons

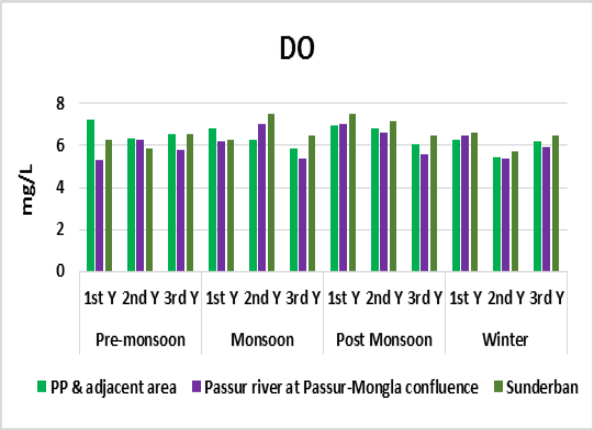


Figure 2.6: Variations in average DO values in sampling spots for the consecutive seasons

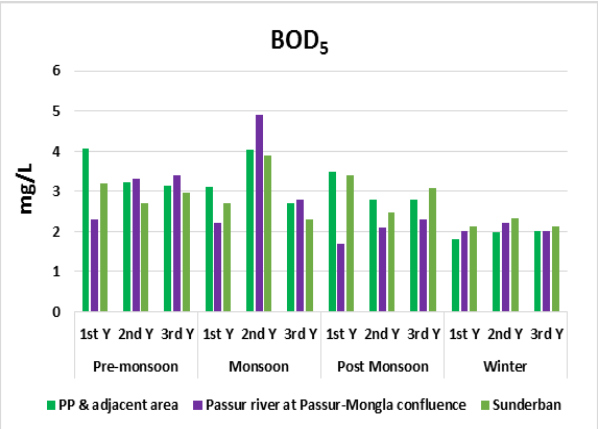


Figure 2.7: Variations in average BOD_5 values in sampling spots for the consecutive seasons

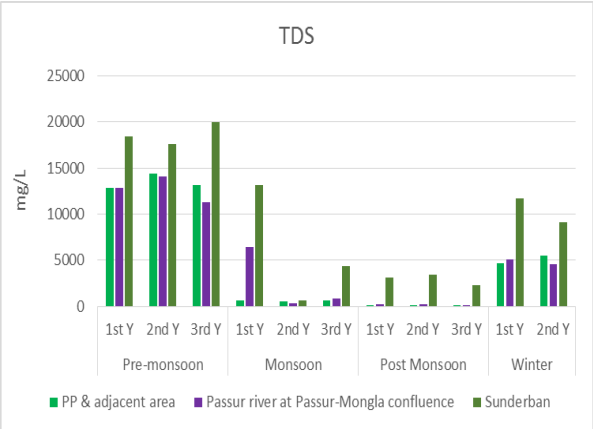


Figure 2.8: Variations in average TDS values in sampling spots for the consecutive seasons

Laboratory tested parameters

(a) Total Dissolved Solids (TDS), Total Hardness (TH) and Total Suspended Solids (TSS)

86. The observed values of TDS vary from 106 mg/L to 4120 mg/L which shows a little proximity to that of the previously obtained data of the same season of 2014 and in 2015. The lowest value was found in Middle of Passur River at 100m u/s of North West corner from the Project boundary while the highest value was observed at Hiron point in Sundarbans. This may be due to the sea water and the erosion-accretion process of the river.

87. In most of the observed locations, the TDS concentrations seem to be lower in monsoon and post monsoon period and higher in pre-monsoon and winter season. A Significant spatial variation is found, which could be due to the sea water and the erosion-accretion process of the river. Sediment load in Passur River is relatively higher as it is located in the south western part of Bangladesh. TDS mainly indicates the presence of various kinds of minerals like ammonia, nitrite, nitrate, phosphate, alkalis, some acids, sulphates and metallic ions etc. which comprise both colloidal and dissolved solids in water (*Tareq M S et al., 2013*).

88. The highest and lowest concentration of Total Hardness were found 810 mg/L and 190 mg/L and observed at the Right bank of Passur River at 100m u/s of North West corner from the Project boundary and at Passur River at HIron point in Sundarbans respectively. During the rainy season, the hardness in all monitoring stations in Passur River were found to be lower whereas it was found remarkably higher in pre-monsoon season. in general cases the hardness is found to be higher in monsoon season but in Passur River it is found higher in pre monsoon season due to the saline water intrusion to the upstream in this season (***Rahman et al., 2013***).

89. TSS includes solid materials of organic and inorganic in origins which are suspended in water. In Passur and Sibsa Rivers system the suspended matters generally contain sand, clay, silt and loam. However, during the 11th monitoring period the TSS concentrations varied from 16 mg/L to 41 mg/L among the monitoring locations. The highest value was found at Passur River at Akram point of Sundarbans while the lowest valu is found in Right Bank of Passur River at South West corner from the Project boundary. TSS values in every spots were found to be within the standard limit (150 mg/L) suggested for Bangladesh) but were found lower than in post-monsoon season comparing to the other values recorded in the previous season of the monitoring years.

90. The values were found to be relatively higher in pre-monsoon season than those of monsoon. During dry season (pre-monsoon and winter season) the TSS value increases, probably due to less freshwater flow, urban runoff, industrial wastes, bank erosion, bottom feeders (such as carp), algae growth or wastewater discharges. The TDS, TH and TSS of Passur River in pre-monsoon, monsoon, post-monsoon and winter seasons at different monitoring locations are presented in **Figure: 2.8, 2.9** and **2.10** respectively and all the observed dataset are attached in **Table B.8, B.9 and B.10** respectively of **Appendix- IV.**

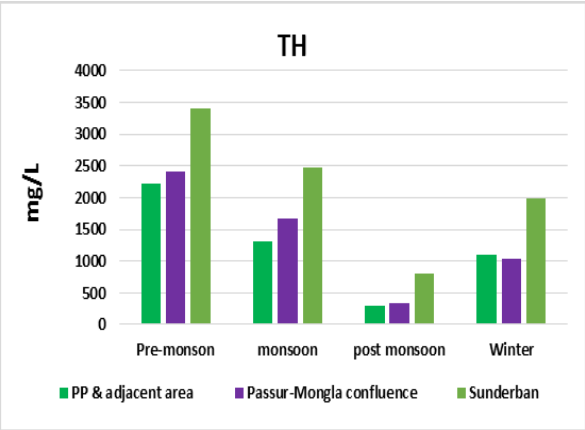


Figure 2.9: Variations in average TH values in sampling spots for the consecutive seasons

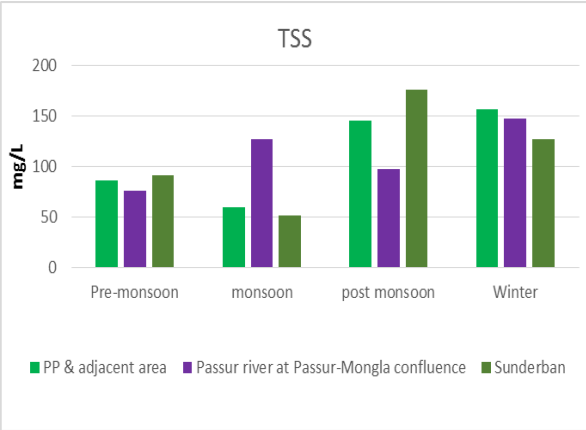


Figure 2.10: Variations in average TSS values in sampling spots for the consecutive seasons

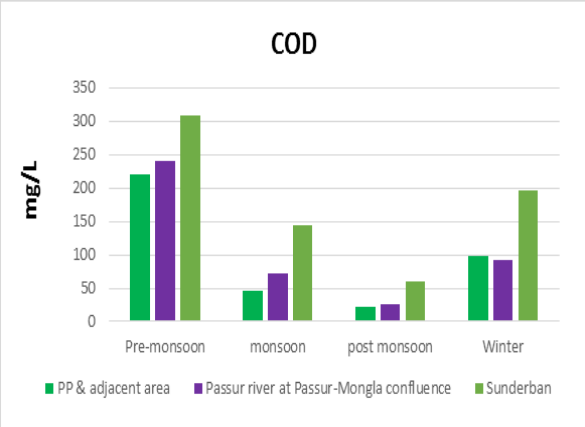


Figure 2.11: Variations in average COD values in sampling spots for the consecutive seasons

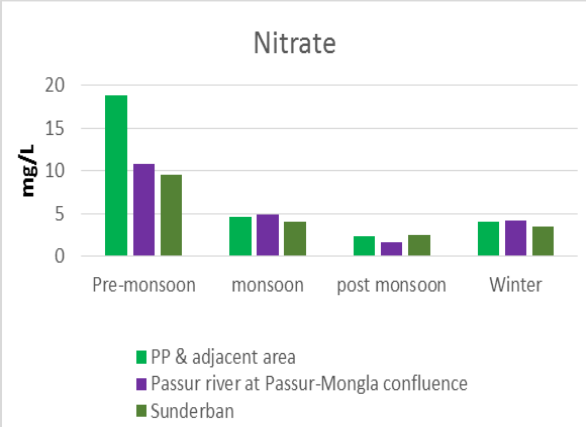


Figure 2.12: Variations in average Nitrate values in sampling spots for the consecutive seasons

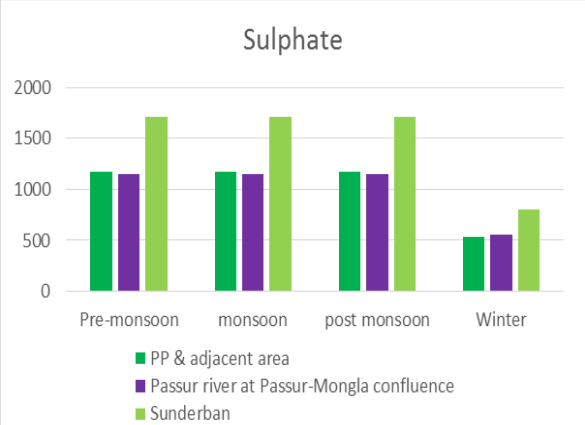


Figure 2.13: Variations in average Sulphate values in sampling spots for the consecutive seasons

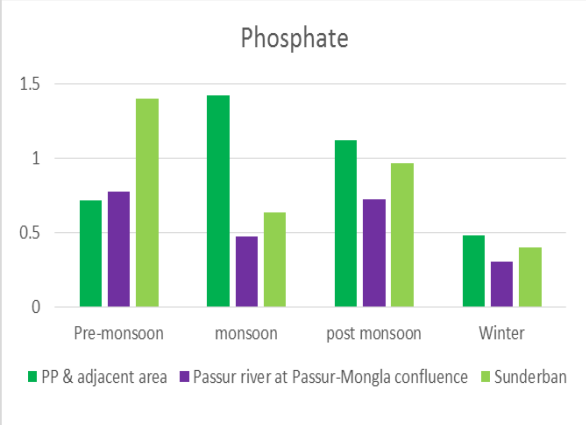


Figure 2.14: Variations in average Phosphate values in sampling spots for the consecutive seasons

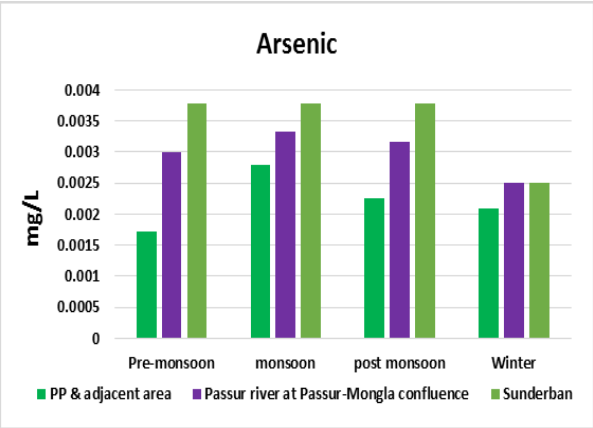


Figure 2.15: Variations in average Arsenic values in sampling spots for the consecutive seasons

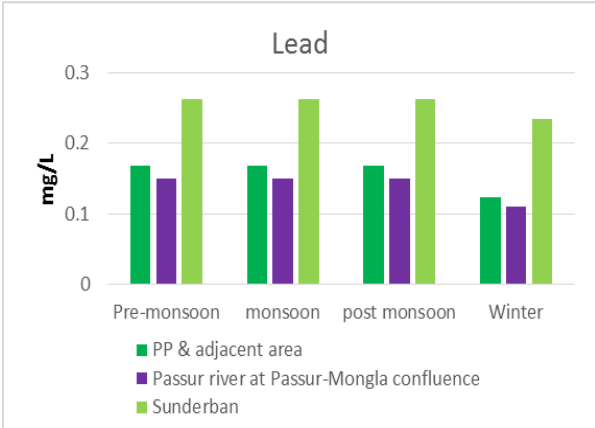


Figure 2.16: Variations in average Pb values in sampling spots for the consecutive seasons

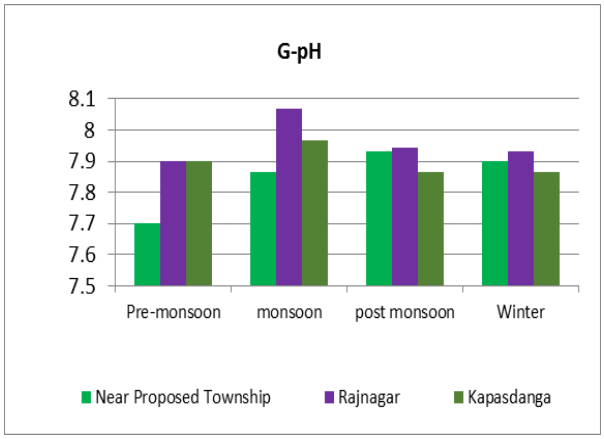


Figure 2.17: Variations in average G-pH values in sampling spots for the consecutive seasons

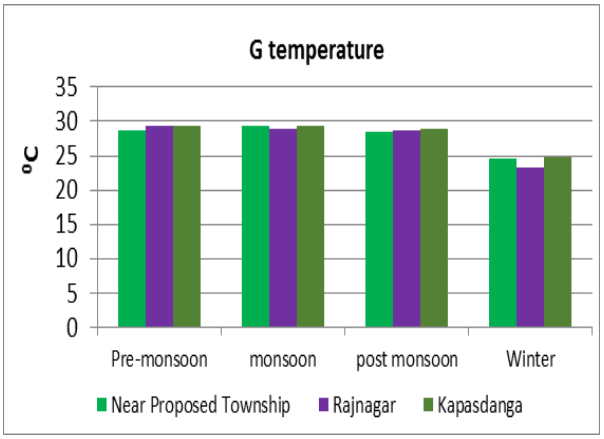


Figure 2.18: Variations in average G-Temperature values in sampling spots for the consecutive seasons

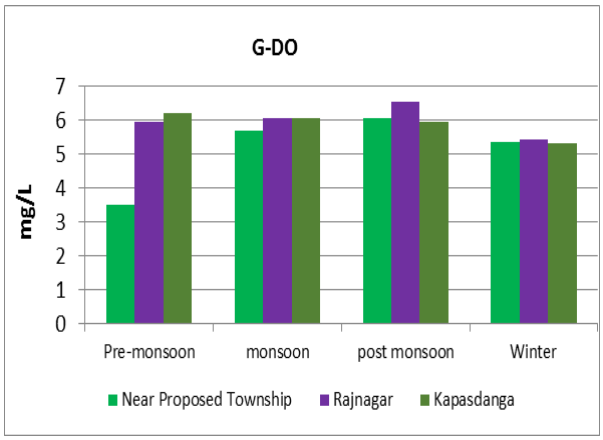


Figure 2.19: Variations in average G-DO values in sampling spots for the consecutive seasons

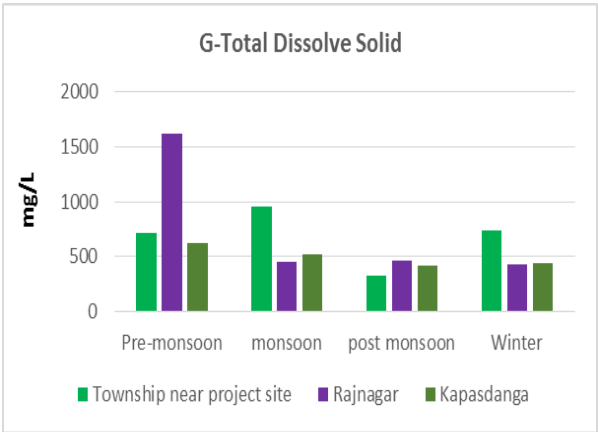


Figure 2.20: Variations in average G-TDS values in sampling spots for the consecutive seasons

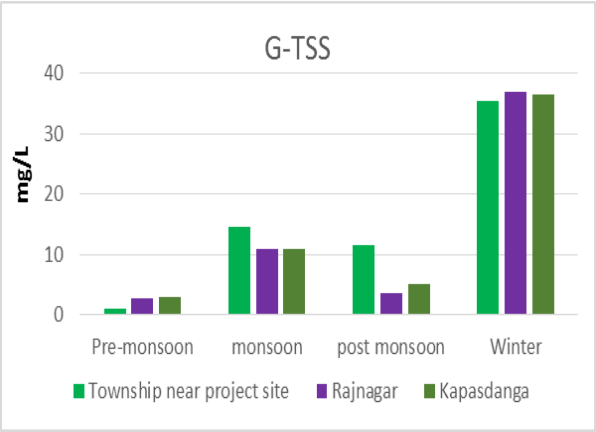


Figure 2.21: Variations in average G-TSS values in sampling spots for the consecutive seasons

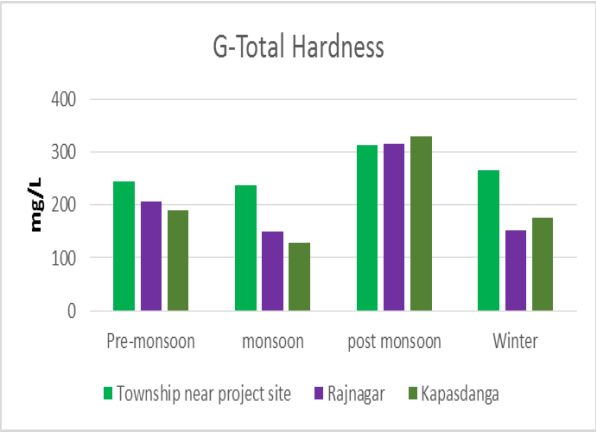


Figure 2.22: Variations in average G-TH values in sampling spots for the consecutive seasons

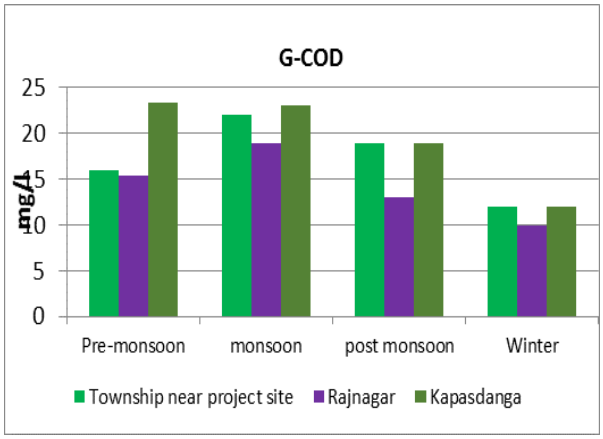


Figure 2.23: Variations in average G-COD values in sampling spots for the consecutive seasons

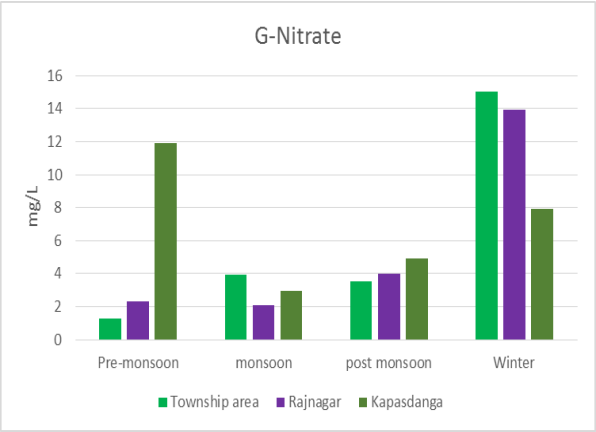


Figure 2.24: Variations in average G-Nitrate values in sampling spots for the consecutive seasons

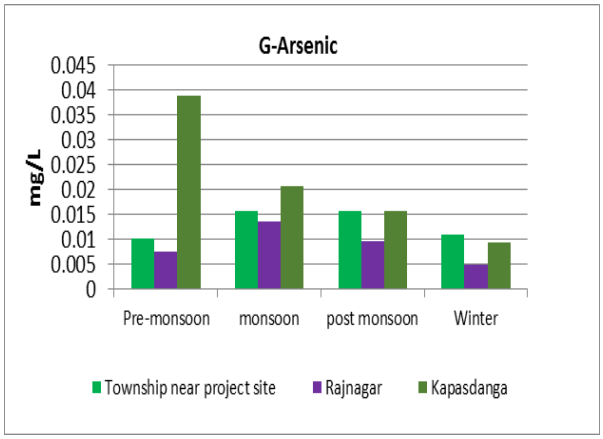


Figure 2.25: Variations in average G-Arsenic values in sampling spots for the consecutive seasons

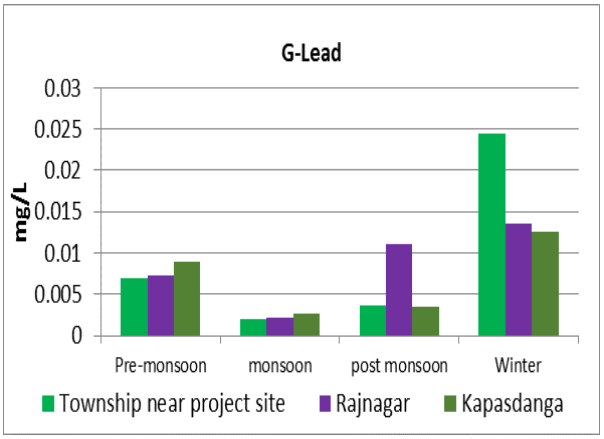


Figure 2.26: Variations in average G-Lead values in sampling spots for the consecutive seasons

(b) Chemical Oxygen Demand

91. COD is an indicator of organic pollution, which is caused by the inflow of domestic, livestock and industrial waste that contains elevated levels of organic pollutants (***Ayati, 2003***). Generally, values of COD found higher in Passur-Sibsa RS as it has been recorded to receive high amount of organic matter from the Sundarbans forest area and from Sundarbans adjacent community.

92. The observed values of COD varied from 8 mg/L to 68 mg/L in the last monitoring period among all the spots. The highest amount was found at Passur River at Akram point of Sundarbans. Maidara River near proposed township area and may be due to the dumping of wastes from the ships and detritous from Sundarbans. However, high values of COD indicate high levels of organic pollution in the river water (Sivasubramanium, 1999). Moreover, a large scale industrial activity is taking place along the left bank of Passur River from Chalna to Harbaria, which might also contribute to the high concentration of COD.

93. The COD concentrations of pre-monsoon and winter seasons (dry) were found higher than monsoon and post-monsoon seasons. In monsoon, higher discharge diluted the COD load in the river which in turn reduces COD concentration in post monsoon. The observed dataset are shown in **Figure: 2.11** and all the observed dataset are attached in **Table B.6 of Appendix- IV.**

(c) Nitrate, Sulphate and Phosphate

94. Among the monitoring locations, the nitrate values vary from 0.2 mg/L to 0.76 mg/L. The maximum value of nitrate (0.76 mg/L) was recorded at Left Bank of Passur River at Project site-Jetty. This may be due to the runoff from the jetty area and chemical bilge water from numerous ships and fishing boats. While on the other hand the lowest value (0.2 mg/L) was recorded at Left Bank of Passur River at South West corner from the Project boundary. The results obtained from all the monitoring locations from of last monitoring period were found within the standard concentration stated in ECR'1997. However, the highest values were found in pre-monsoon season of 1st quarter of 2nd year, which may be due to the higher amount of surface and groundwater runoff, dissolution of nitrogen-rich geological deposits, and biological degradation of organic matter (*Spencer, 1975; Kinne, 1984; Gleick, 1993; Wetzel, 2001; Rabalais, 2002*).

95. Naturally, SO_4^{2-} concentration is higher in sea water as well as in river in coastal region due to the tidal behavior of the respective water bodies. The monitored dataset reveals this general fact i.e., the SO_4^{2-} concentration of Passur-Sibsa RS increases in the direction of upstream to downstream. The highest value (320 mg/L) of sulphate was found Passur River of Hiron point in Sindarbans while the lowest was found at Middle of Passur River at 100m u/s of North West corner from the Project boundary (3 mg/L). However, all the observed dataset of Sulphate (SO_4^{2-}) found within the standard limit (400 mg/L) specified in ECR, 1997. Comparatively lower concentration of SO_4^{2-} in monsoon and post monsoon seasons could be due to the dilution effect of upstream fresh water. However, the obtained results found to be much lower than the previous season of the monitoring years.

96. The values of PO_4^{2-} were found to be ranged in between 1.16 mg/L to 9.08 mg/L and found slightly higher to that of the results of the post-monsoon period in the previous years. The highest value was found at Passur River at Akram point of Sundarbans. This could be due to the excessive discharge of bilge water from numerous ships and fishing boats, agricultural and industrial runoff. However, all the observed values are found to be within the

standard limit (6 mg/L) specified for surface water. The recorded low phosphates value during dry seasons could be attributed to the limited flow of freshwater from upstream, high salinity and utilization of phosphate by phytoplankton (***Senthilkumar et al., 2002; Rajasegar, 2003***) but agricultural fields as fertilizers and phosphates used in households as detergents may be other sources of inorganic phosphates during the season (***Tiwari and Nair, 1993***).

97. The observed NO_3^{2-}, SO_4^{2-} and PO_4^{2-} concentrations at different monitoring locations of five consecutive monitoring periods are presented in **Figure: 2.12, 2.13** and in **2.14** and all the observed dataset are attached in **Table B.11, B.12 and B.13** respectively o**f Appendix- IV**.

(d) Heavy Metals

98. The observed dataset of Arsenic (As) concentrations demonstrated conformity among all the spots which vary from 0.002 mg/L to 0.003 mg/L. In pre-monsoon season subsurface flow from groundwater to river might increase the concentration of As (Arsenic) in the river water. In monsoon, lower concentration of As is recorded. It might be due the dilution effect in river water caused by surface runoff.

99. Heavy metal (Pb) dissolved in water is very harmful to aquatic organisms; due to bioaccumulation, it increases in body tissue of organisms (***Rompas, 2010***). It is also evident that organic fertilizer, which comes from lime and compost fertilizers, can contain heavy metal, e.g., NPK fertilizer (phosphate fertilizers containing Pyromorphite- $Pb_5(PO_4)^3$ (***Zhu et. al., 2004***) which may results in higher amount of Pb concentration in river water in winter season. During the last monitoring period, the lowest concentration of Pb (0.005 mg/L) was found at Right Bank of Passur River at Project site-Jetty and the highest value (0.151 mg/L) was found in Passur River at Hiron point of Sundarbans. This may be due to the dumping of bilge water from large ships and other water vessels.

100. The values of Hg (Mercury) showed a continuous consistency among all the spots in all the seasons. The values never exceeded 0.0002 mg/L. All observed data found to be within the Bangladesh standard limit set by the environmental Conservation rule, 1997, Bangladesh. During the last monitoring period the value was found less than 0.00015 mg/L at all the locations.

101. The observed As, Pb concentrations at different monitoring locations of the consecutive monitoring periods are presented in **Figure: 2.15** and in **2.16** and all the observed dataset are attached in **Table B.14, B.15 and B.16** respectively of **Appendix- IV**.

(e) Oil and Grease

102. In order to measure the concentration of oil and grease in Passur River, samples have been taken from four locations during low tide from the surface layer. The analysis has been conducted through standard testing method of APHA. The concentration of oil and grease are presented in **Table-B.7** of **Appendix-IV**.

103. During pre-monsoon, monsoon and post monsoon periods, the concentration of oil and grease has been found less than 5 mg/L and all of the monitoring results are fully in conformity with the Standard of ECR 1997. Passur and Sibsa river system were found contained high concentration of oil and grease in winter period in 2014, which may be due to accidental oil spill occurred on the 9th December, 2014. An amount of 350,000 liters

(***Philips, 2014***) of furnace oil has been spilled in the river which spread over a 350 km2 area (***Welle, 2014***). During the last monitoring period, the concentrations of oil and grease varied from <5 mg/L to 10.14 mg/L and were found to be equal or within the standard limits for inland surface water, 10 mg/L (ECR, 1997) in all the spots. Maximum concentration was found in Passur River at Hiron point of Sundarbans This higher concentration may be due to oil spillage and other organic residues discharges from large number of marine vessels in the location; oil discharge from the fishing boats and other anthropogenic activities might contribute to this higher amount of oil and grease concentration in the site.

2.3.3 Status of the Groundwater quality

In-situ tested parameters

a) pH and Temperature

104. The values of groundwater pH and temperature at observed locations are found fully complied with the drinking water quality standards as specified in ECR, 1997. The pH values of 12th monitoring program were found to be varied from 7.5 to 8.1 while temperature was found to be ranged in between 24°C and 25.1°C (**Table 5.15).** The recorded pH values were always found slightly alkaline in all the spots in all the season. No significant difference and negative health effect have been observed by the monitoring team. Similarly, no significant variation has been recorded in groundwater temperature over the monitoring period. Both the results of pH and Temperature were found more or less consistent with all the previously obtained data. The twelve (12) consecutive monitoring results of pH and temperatures of selected locations are presented in **Figure**: **2.17** and **2.18** and all the observed dataset are attached in **Table B.17** of **Appendix- IV**

b) Salinity and Dissolved Oxygen

105. Salinity is a common parameter in order to determine the ground water quality for drinking and irrigation purpose. However, groundwater is found to have 0 ppt of salinity in all the consecutive monitoring seasons.

106. The observed values of dissolved oxygen are ranged in between 4.8 mg/L and 4.5 mg/L and found in Rajnagar and in township area respectively. all the observed data were found within the BD standard (6.0 mg/L) set by ECR, 1997. Higher DO values makes water tastier but cause corrosion to the supply pipe.

107. Twelve (12) consecutive monitoring results of salinity and DO of selected locations are presented in **Figure: 2.19** and all the observed dataset are attached in **Table B.18** of **Appendix- IV**.

Laboratory tested parameters

(a) TDS, TSS and TH

108. During the 11th monitoring period TDS values were found within the standard limit (1000 mg/L). Though the Highest value (636 mg/L) was recorded in Karpashdanga which never exceed the limit while the lowest value (382 mg/L) was recorded in Rajnagar. The TDS concentration was found to be within than the BD standard (ECR, 1997)

109. Total Suspended Solids (TSS), also known as non-filterable residue, are those solids (minerals and organic material) that remain trapped on a 1.2 µm filter (U.S.EPA, 1998). Among all the monitoring season the values were found much higher in monsoon season

which could be due to the subsurface runoff from nearby area. In all the monitoring locations the concentration found varied in between 4 mg/L to 7 mg/L which presents an ideal condition and fully in conformity with the BD drinking water standards (**ECR, 1997**).

110. TH concentrations of the three monitored spots vary from 175 mg/L to 295 mg/L. The maximum value was found in rajnagar while the lowest value was found in Township area. The monitored values were found to be within the standard limit (200-500 mg/L) set by the ECR 1997. However, no incidents of weathering of Ca^{2+} bearing minerals or excessive application of lime is found during the monitoring period which could cause a higher concentration of TH. Groundwater TDS, TSS and TH value of eleven (11) consecutive monitoring periods in all the monitoring location are presented in **Figure 2.20, Figure 2.21** and **Figure 2.22** and all the observed dataset are attached in **table B.19** and **B.20** of **Appendix- IV**.

(b) Chemical Oxygen Demand

111. The Bangladesh standard for COD in drinking water is 4.0 mg/L. However, all the monitored data from the tube wells found to be equal with the standard limit. COD concentrations found similar in all the monitoring locaions. Such COD value is likely to be generated from anthropogenic sources such as percolation from landfill leachates and/ or industrial effluents.

112. The COD concentrations of all the monitoring locations with seasonal variation are presented in **Figure: 2.23**.and all the observed dataset are attached in **Table B.21** of **Appendix- IV**.

(c) Nitrate, Sulphate and Phosphate

113. Nitrate values were found to be varied from 6.1 mg/L to 10.16 mg/L and also found within the standard limit (10 mg/L) as specified in ECR, 1997. However, Maximum values are observed in winter season in 4th monitoring program (i.e. 1st year 4th quarter). Again the value is found higher in pre-monsoon in Rajnagar which might be due to the excessive fertilizer use in the nearby agricultural field..

114. SO_4^{2-} and PO_4^{2-} concentrations monitoring of Passur-Sibsa RS have been included in this study since 2nd monitoring report (i.e. **1st** year **2nd** quarter). Sulphate concentrations were found same (1 mg/L) in all the monitoring locations. On the other hand, the values of PO_4^{2-} are within the standard limit (6 mg/L) and ranged between 0.167 mg/L to 0.67 mg/L. Among all the monitoring period the recorded data were found maximum in the monsoon period.. The observed ground water NO_3^-, SO_4^{2-} and PO_4^{2-} concentrations are presented in **Figure 2.24** and all the observed dataset are attached in **Table B.22** of **Appendix- IV.**

(d) Arsenic (As), Lead (Pb) and Mercury (Hg)

115. As per Bangladesh Standard (ECR, 1997), the maximum acceptable concentration of Arsenic in groundwater is 0.05 mg/L. Among all the monitoring locations, the As concentration ranged between 0.011 and 0.023 mg/L which is completely within the BD permissible standard limit (ECR, 1997). The maximum value was found in Rownship area and the lowest value was recorded in Rajnagar. It can be concluded that the ground water sources are considered as suitable for the drinking purpose.

116. The Hg concentrations were found much lower than the detectable limit (<0.00015 mg/L) in all the consecutive periods.

117. During the 11th monitoring period the values of Pb concentration were found similar at all the monitoring locations.

118. The observed values of As, Pb and Hg in all the monitored locations are presented in **Figure 2.25** and **2.26** and all the observed dataset are attached in **Table B.23** of **Appendix-IV**.

119. Summary of the water quality monitoring

120. In the recent monitoring period of January, 2017 water samples were collected from the preselected 18 locations (15 locations for surface water and 3 locations for ground water analysis). Accordingly, the samples have been submitted to DPHE and BCSIR for laboratory analysis of the preselected parameters. This monitoring report contains laboratory reports of the last monitoring study (October, 2016) and in-situ monitoring results of this quarter (4th quarter of 3rd year). However, similar to the earlier year, spatial and seasonal variations is still present for the analyzed parameters. But the analyzed results of all parameters were found within the standard limit set by ECR' 1997 for surface water and were found to be minimal or similar in concentrations compared to the results previous seasons.

2.4 Land Resources

2.4.1 Methodology

Monitoring Indicators

121. Monitoring of land resources has been scheduled twice a year as per the contract. Monitoring of the selected indicators is very crucial for land resources in the study area. Land use, soil fertility/nutrient status, soil contamination with heavy metals, soil salinity and physical quality of soil are the major monitoring indicators for land resources. It is assumed that during the operation phase of the power plant ash may be deposited on the surrounding agriculture land. .

Sampling Frequency

122. Soil samples have been collected twice a year such as April for dry season and October for wet season of last three consecutive years 2013-2014, 2014-15 and 2015- 2016 respectively.

Location

123. Five mauzas within the 10 km radius of the power plant have been selected for monitoring of plot use, soil fertility/nutrient status, soil contamination with heavy metals and soil salinity. The selected mauzas are Baranpara (E-89°30′59.1″, N-22°37′57.0″) of Batiaghata upazila, Chunkuri-2(E-89°32′20.0″, N-22°34′51.0″) of Dacope Upazila, Kapalirmet (E-89°36′8.8″, N-22°32′18.9″) of Mongla upazila, Chakgona(E-89°34′25.3″,N-22°34′18.3″) of Rampal upazila and Basherhula(E-89°34′25.0″, N-22°36′14.0″) of Rampal upazila under Khulna and Bagerhat district. Locations of collected soil samples are presented in Table **E.1 of Appendix IV and Map 2.4.1.**

2.4.2 Process of soil samples collection

Plot selection

124. Monitoring plots have been selected before initiation of the monitoring through group discussion, especially with the plot owners and specific experts such as Upazila Agriculture Officers of Batiaghata, Dacope, Rampal and Mongla of Khulna and Bagerhat districts and Senior Scientific Officer of Soil Resource Development Institute (SRDI), Khulna Office. All the selected areas are medium high (F_1) land, which normally get flooded up to the depth of 30-90 cm and remain inundated continuously for more than two weeks to few months during the flood season. Main emphasis of plot selection is given to the potential locations ash, SOx and NOx, emitted from the Plant, may be deposited during dry/ wet season.

Soil samples collection

125. Soil samples have been collected from five locations at three depths (0-10 cm, 10-20 cm and 20-30 cm) inside the monitoring area in the month of April and October, 2014, 2015 and 2016 for the year of 2013-14, 2014-15 and 2015-16 respectively. Some basic indicators have been selected to evaluate the base condition of the adjacent area of the Rampal power plant. Besides, continuous monitoring of that area gives an opportunity to observe the seasonal change of the indicators of that specific locality. The selected indicators are soil reaction(pH), soil salinity (EC), Organic Matter (OM), base cations-Ca, Mg, K and Na, status of macro nutrients (N, P and S), status of micro nutrients (B, Fe, Mn and Zn) and presence of heavy metals (Pb and Cd).

Laboratory analysis

126. Collected soil samples were tested from SRDI, Dhaka. Monitoring results of soil quality for different years are presented below.

2.4.3 Status of soil quality in monitoring land

127. The analyzed result of dry and wet season of the year 2013-14, 2014-15 and 2015-16 are compared in this final monitoring report. Seasonal variation of these indicators is described below according to their location. The parameter considered for earlier monitoring will be same in this quarter as well. The result of the dry and wet season of 2013-14, 2014-15 and 2015-16 year has been provided in the **Figure 2.27-2.42** and in Table **E.2 of Appendix IV.**

128. In general monitoring study area comprises under the Agro-Ecological Zone, AEZ 13: Ganges Tidal Floodplain (BARC, 2012). So, the analysis report of soils of monitoring land is compared to the physico-chemical properties of soils of AEZ 13 to understand the variation of the soil fertility status. Generally, organic matter content of the soil is low in the coastal regions of Bangladesh. Thus in addition to salinity, plant nutrients in soils affect plant growth (S.A. Haque, 2006). Some basic characteristics of AEZ 13 are PH: (4.5-8.4), OM(%): (1.0-3.4%), N(%): (0.091-0.18%), P: (<5.25-10.5) (µg/gm), K: (0.181-0.36 (meq/100g), S: (15.1-30.0) (µg/gm), Ca: (4.51-7.5) (meq/100g), Mg: (0.751-1.5) (meq/100g), Zn: (0.451-1.35) (µg/gm), B: (0.31-0.6) (µg/gm) , Mo: (0.226-0.30) (µg/gm). The soil qualities for different years are presented in the following paragraphs.

Monitoring Plot (Baranpara)

129. It has been observed that salinity has increased in both seasons (wet and dry) of 2014-15 10.1 (ds/m)-dry and 5.56 (ds/m)-wet than that of 2013-14 9.6 (ds/m)-dry and wet 5.8 (ds/m)-wet among the three layers. This may be due to lack of water source connectivity of Baranpara. As a polder area, most of the openings of this locality are confined, so natural flow of water is disrupted. Natural precipitation can dissolve a portion of salt particles, but this is not sufficient in terms of lowering the overall salinity of a vast area. The present study also found the similar pattern. Soil salinity tremendously reduced 2.23-4.32(ds/m) and 3.25-6.48(ds/m) in dry and wet season of 2015-16 at all layer over both dry and wet season of 2013-14 and 2014-15 due to repeated flushing of land by rain water and there was no scope to inundation by saline water. It is also noted that amount of base cations (except Mg) has increased Ca: 31.50 (meq/100g)-dry and 14.75 (meq/100g)-wet season gives highest value among the three layers in 2014-15. Amount of Mg might be suppressed by Ca intrusion as both of them are divalent cations. On the other hand, amount of base cations has increased Ca: 15.12(meq/100g), K: 0.69 (meq/100g), Mg: 2.58(meq/100g) and S: 212.18(µg/gm in dry season of 2015-16 over wet season of 2014-15. Amount of Base cations has decreased Ca: 11.96(meq/100g), K: 0.60 (meq/100g), Mg: 1.92(meq/100g) and S: 222.75(µg/gm) in wet season of 2015-16 over dry season of 2015-16.

130. Due to top soil erosion, organic matter content drops in wet season (1.27%) than dry season (3.1%) of 2013-14. In 2014-15, owner of the land introduced fish and crab culture. To prepare the land for aquaculture he cut off the top soil, which drastically lowers the organic matter. After the wet season a portion of organic matter is replenished by sedimentation. But, organic matter content has increased (1.35%) in dry this dry season over wet season of 2014-15. Organic matter content has decreased in wet season than dry season of 2015-16. Basic nutrients (N: 0.06%, P: 4.60 (meq/100g), K: 0.57 (meq/100g) and S: 210.0 (µg/gm) also follow the similar trend of organic matter in wet season of 2014-15 than wet season of 2013-14. Basic Nutrients, N:0.06%,P:4.82(meq/100g),K:0.61(meq/100g). In the dry season of 2015-16, the basic nutrients (N: 0.08%, P: 5.33 (meq/100g), K: 0.69 (meq/100g) and S: 212.18 (µg/gm) also follow the similar trend of organic matter. In the wet season of 2015-16, the basic nutrients (N: 0.06%, P: 4.82 (meq/100g), K: 0.61 (meq/100g) and S: 222.75 (µg/gm) also follow the similar trend of organic matter.

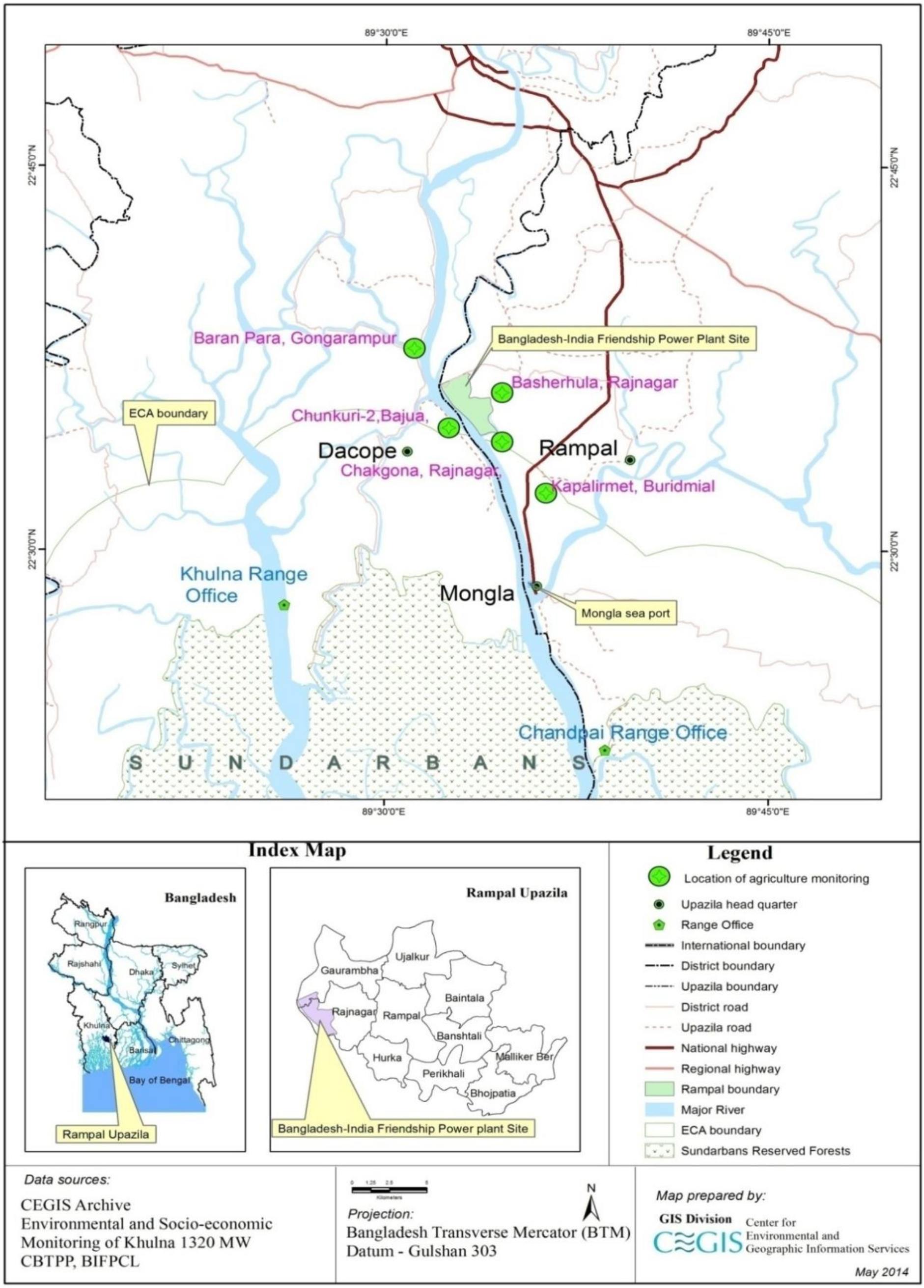
131. Micro nutrients (Fe, Mn, B, Na and Zn) in soil are also analyzed for baseline data. It has been noted that all these elements Fe: 78.25 (µg/gm), Mn: 6.89 (µg/gm), B: 2.11 (µg/gm) and Na: 4.76 (meq/100g) and Zn: 2.47 (µg/gm) show an increasing pattern in wet season of 2014-15. It might be due to increased salinity, which cannot be removed properly by rainwater. It has also been found that all the micronutrients decreased in wet season than that of dry season, which may be an after effect of leaching and percolation in wet season. Na has also decreased by this process. Micro nutrient such as B: 2.05 (µg/gm) and Na: 4.43(meq/100g) and Zn: 1.82 (µg/gm) show a decreasing pattern in dry season of 2015-16 over wet season of 2014-15 whereas Fe: 42.96(µg/gm), Mn: 11.90 (µg/gm) shows increasing trend. Micro nutrients Fe: 28.65 (µg/gm), Mn: 5.90 (µg/gm), B: 1.02 (µg/gm) and Na: 5.07 (meq/100g) and Zn: 1.62 (µg/gm) show an increasing pattern in wet season of 2015-16 is presented in **Table E.2 of Appendix IV.**

132. There is a trace of heavy metal observed in dry and wet season in all the monitoring land and three consecutive year. The concentration level of Pb was observed in both the dry

and wet season of 2013-14, 2014-15 and 2015-16 whereas Cd level is only observed in the dry season of 2014-15 in this monitoring land. The analytical results of soil were verified with India/Austria Guidelines for agricultural soil [mgkg-1/(µg/gm)/ppm-dry weights] to know the Maximum Acceptable Concentrations (MAC) level of collected soil samples. This is due to there was no huge research conducted on heavy metals in Bangladesh. Limited research work had been conducted on heavy metals. So, there was no sufficient information available related to permissible limit/maximum acceptable concentration of heavy metals in our country. So, there was no standard setting for heavy metal by our scientist for our country context. Concentration of Pb in the leachate is not exceeded the permissible limit of Indian/Austria Guidelines for agricultural soil standard. By comparing the heavy metals analysis data, Pb belongs to not polluted category (Awashthi, 2000) and (Kabata-Pendias, A. and H.Pendias, 1992) is presented in Table **E.3** of **Appendix IV.**

Monitoring Plot-2 (Chunkuri-2)

133. Salinity level has slightly increased 13.05 (ds/m)-dry and 8.20 (ds/m)-wet in both seasons of 2014-15 than 2013-14 {11.2 (ds/m)--dry and 5.6 (ds/m)—wet}. Salinity level slightly decreased 5.44-6.15 (ds/m)-in wet season of 2015-16 over that of the dry season of 2015-16. Polder areas are generally confined area with very limited water source connectivity. As a result natural flow of water is disrupted. Precipitation can dissolve a portion of salt particles, but this is not sufficient in terms of lowering the overall salinity. This was due to there was no saline water intrusion in the monitoring land. On the other hand, amount of base cations (except Mg) are also increases in similar pattern. Amount of Mg: 6.34 (meq/100g)–dry and 3.13 (meq/100g)-wet might be suppressed by Ca intrusion as both of them are divalent cations. Salinity level has decreased 5.74-6.92(ds/m) in the dry season of 2015-16 in all layers over both dry and wet season of 2013-14 and 2014-15. Amount of base cations (except Mg) are also increases in the dry season of 2015-16 over wet season of 2014-15. Amount of Mg: 2.52(meq/100g) has decreased in wet season over the dry season of 2015-16. Organic matter content has increased (1.75% -wet; 2014-15) than wet season of (1.4%: 2013-14) in Chunkuri-2. Beyond Aman season, the sampling area is mostly used as a grazing land. Crop residue and animal wastes helped to improve the organic matter content in soil. New sedimentation also contributed in this process. Amount of organic matter content has increased (1.66-1.98%) in the dry season of 2015-16 over wet season of 2014-15. Amount of organic matter content has decreased (1.55-1.70%) in the wet season of 2015-16 over dry season of 2015-16.



Map 2.4: Land Resource Monitoring Locations

134. Basic nutrients (N: 0.09%, P: 6.89 (µg/gm), K: 0.79 (meq/100g) and S: 500.0 (µg/gm)) also follow the similar trend of organic matter in wet season of 2014-15 over 2013-14. The amount of basic nutrients (N: 0.11%, P: 8.05 (µg/gm), K: 0.86 (meq/100g) and S: 511.0 (µg/gm)) also follow the similar trend of organic matter in dry season of 2015-16 over wet season of 2014-15. Basic nutrients (N: 0.09%, P: 6.90 (µg/gm), K: 0.77 (meq/100g) and S: 273.38 (µg/gm)) also follow the similar trend of organic matter in wet season of 2015-16 over dry season of 2015-16.

135. Micro nutrients Fe: 91.20 (µg/gm), Mn: 8.29 (µg/gm), B: 1.52 (µg/gm), Na: 8.16 (meq/100g), Zn: 5.32 (µg/gm) show an increasing pattern in wet season of 2014-15 over wet season of 2013-14. It might be due to increasing salinity, which cannot be removed properly by rainwater. It has been found that all the micronutrients decreased in wet season than that of dry season, which could be an after-effect of leaching and percolation in wet season in 2014-15. Na+ has also decreased this process. Fe: 71.73 (µg/gm), Mn: 11.21 (µg/gm), B: 1.88 (µg/gm), show an increasing pattern in dry season of 2015-16 over wet season of 2014-15. However, Na: 7.11 (meq/100g) and Zn: 2.09 (µg/gm) shows a decreasing trend over wet season of 2014-15. Micro nutrients Fe: 76.44 (µg/gm), Mn: 7.00 (µg/gm), B: 1.39 (µg/gm), Na: 6.03 (meq/100g), Zn: 2.80 (µg/gm) show a decreasing pattern in wet season of 2015-16 over dry season of 2015-16 is presented in **Table E.2 of Appendix IV.**

136. There is a trace of heavy metal observed in dry and wet season in all the monitoring land and three consecutive year. The concentration level of Pb was observed in both the dry and wet season of 2013-14, 2014-15 and 2015-16 whereas Cd level is only observed in the dry season of 2014-15 in this monitoring land. By comparing the heavy metals analysis data, Pb belongs to not polluted category in Table **E.3** of **Appendix IV**.

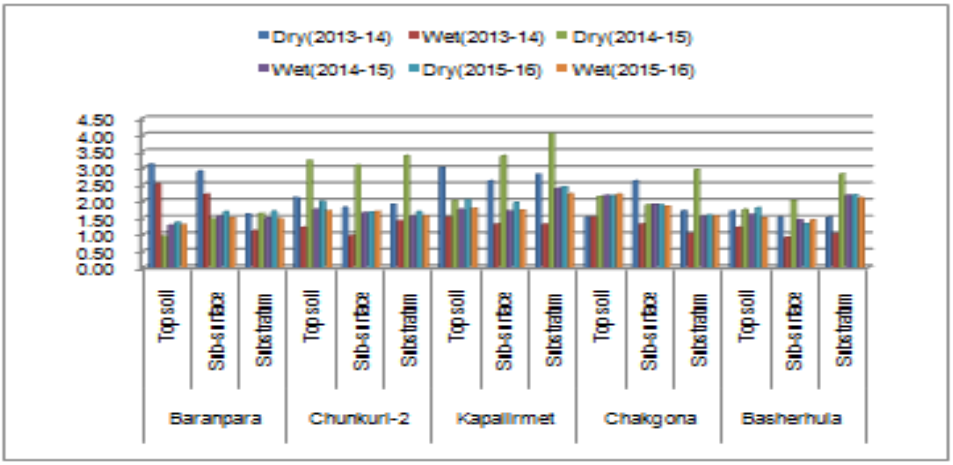


Figure 2.27: OM concentration of the sampling sites around Project consecutive year-3)

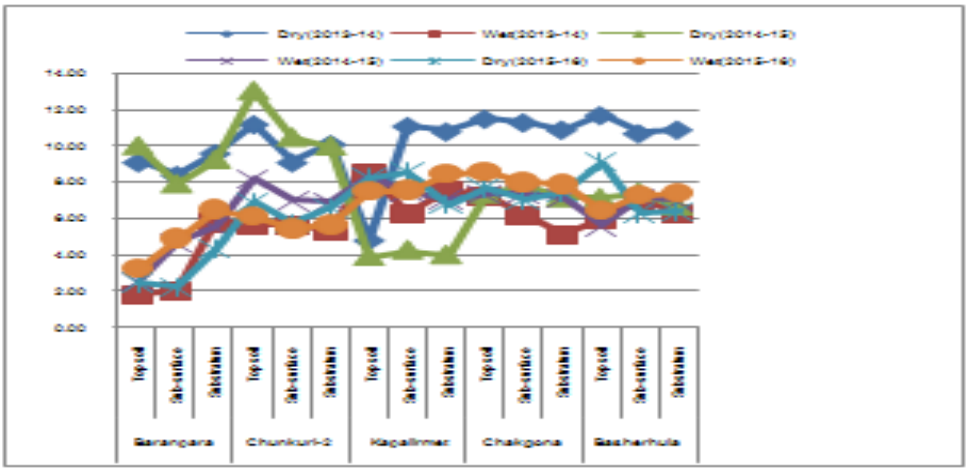


Figure 2.28: EC concentration of the sampling sites around Project (consecutive year-3)

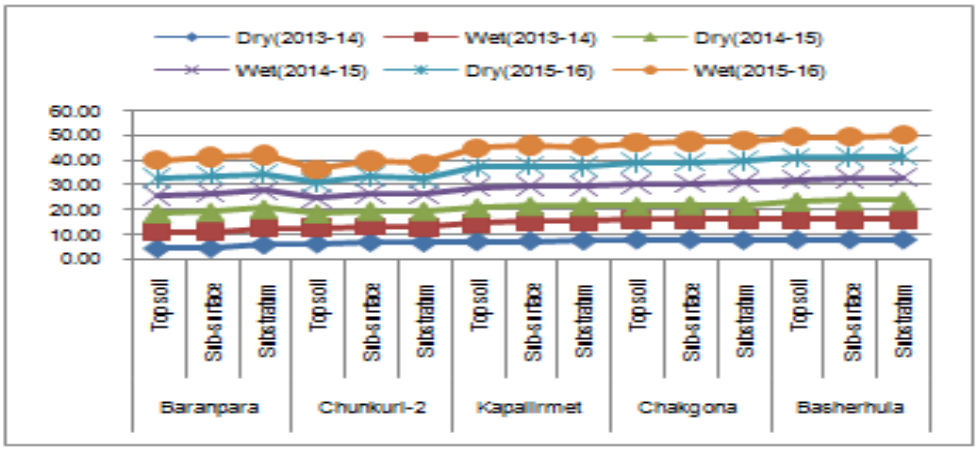


Figure 2.29: pH of the sampling sites around Project (consecutive year-3)

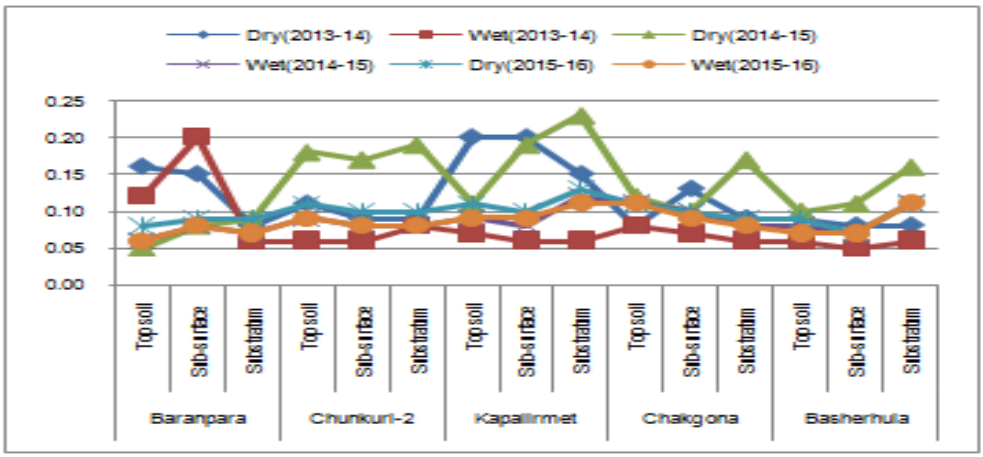


Figure 2.30: Nitrogen concentration of the sampling sites around Project (consecutive year-3)

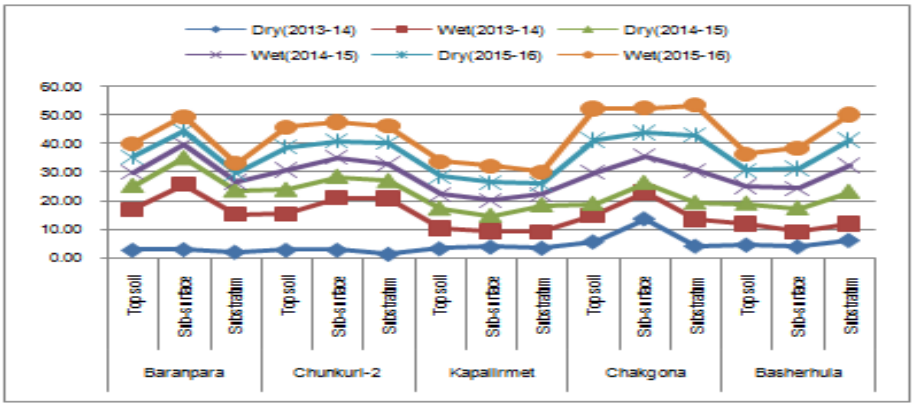


Figure 2.31: Phosphorus concentration of the sampling sites around Project (consecutive year-3)

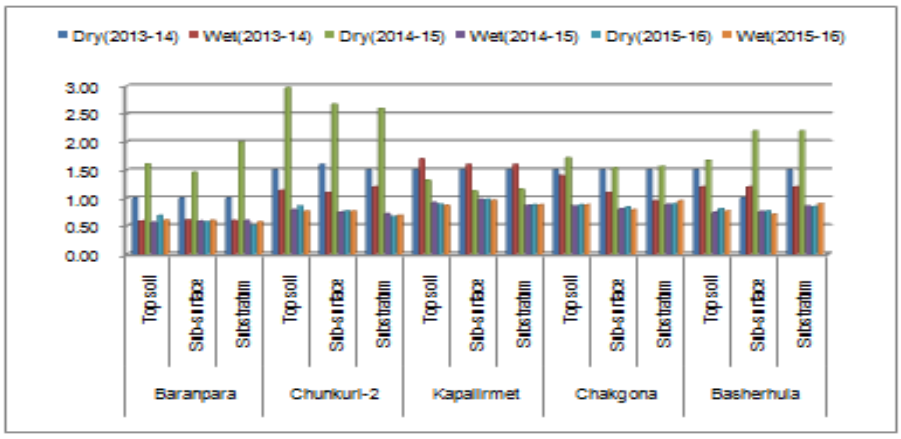


Figure 2.32: Potassium concentration of the sampling sites around Project (consecutive year-3)

Monitoring Plot-3 (Kapalirmet)

137. As regards, soil salinity in coastal belt, the general trend is that it increases in dry season. But in Kapalirmet this scenario is quite opposite. Soil salinity in wet season, 8.29 (ds/m), is almost double than that of dry season 4.26 (ds/m) of 2014-15. Golbunia Khal and Gona River flooded the area including our sampling site. Besides, pH (8.0) is also found higher in wet season than those of dry season (7.3). It could be an impact of shrimp culture in this zone. Aman is the only crop of Kapalirmet but its practice is very limited. People used to store saline water for shrimp cultivation and as a consequence base cation presence did not change significantly. The Ca2+, Mg2+ and K+ level are found almost similar in both seasons of first year (2013-2014) but in second year (2014-15) the concentrations decreases in wet season Ca:17.20 (meq/100g), Mg: 3.94 (meq/100), K: 0.98 (meq/100g) than that of dry season Ca:27.13 (meq/100g, Mg:6.25 (meq/100g), K:1.32 (meq/100g) in 2014-15. It has also been observed that concentration of S2+ has decreased in wet season of 2013-14, but has increased again in wet season of 2014-15. So, this might be due to replacement of base cations by S2+ at that time. Na is also decreased by this process. Consequently the base cations Ca: 16.88 (meq/100g, Mg: 4.12(meq/100g), K: 0.89 (meq/100g) has decreased in 2015-16 over wet season of 2014-15. Soil erosion is a common feature of coastal area. As a result, organic matter could also be eroded due to

erosion. It has been observed that the overall organic matter content is increased (2.38%) in wet season 2014-15 than that of 2013-14(1.5%). Basic nutrients (N:0.12%, P:5.01 (µg/gm) and S: 655.0 (µg/gm) also follow the similar trend of organic matter.The overall organic matter content (1.95-2.42%) has increased in dry season of 2015-16 over the wet season of 2014-15. The organic matter content observed decreasing in all the layer than dry season of 2015-16. N: 0.13%, P: 6.21 (µg/gm) and S: 764.07 (µg/gm) also follow the similar trend of organic matter in the dry season of 2014-15. N: 0.09%, P: 4.12 (µg/gm) (µg/gm) also follow the similar trend of organic matter the dry season of 2014-15 and 2015-16, except in S status where it tends to upward the the dry season of 2015-16. .

138. The salinity level has decreased in all layer but increases in sub-surface layer 8.60(ds/m) in the dry season of 2015-16. The salinity level has decreased in all layer but increases in sub-surface layer 8.50 (ds/m) in the wet season over the dry season of 2015-16. On the other hand, pH level has increased in top and sub-surface layer than that wet season of 2014-15. pH level increases in all layer, except in top soil 7.8 (ds/m) in wet season over the dry season of 2015-16.

139. As regards micro nutrients, most of the elements show an increasing trend in wet season than those of dry seasons of 2013-14, 2014-15 and 2015-16, which might be after effect of salinity. Among the micro nutrients, B and Zn tends to downwards in all layers in wet season of 2015-16 over dry season of 2015-16 is presented in **Table E.2 of Appendix IV.**

140. However, concentration of Pb did not show similar pattern in last two years. Its concentration in 2013-14 increases in wet season but it decreased to almost one-fourth in dry season of 2014-15. Cd could be totally washed-out by rain water in wet season. Pb and Cd were within the critical limit. Cd concentration only observed in the dry season of 2014-15. Pb concentration observed in all layers of the monitoring land in the dry and wet season of 2015-16 and the highest was observed in sub-surface layer 10.03 (µg/gm) in dry season as well as 10.14 wet season respectively. Pb concentration belongs to not polluted category is presented in Table **E.3** of **Appendix IV.**

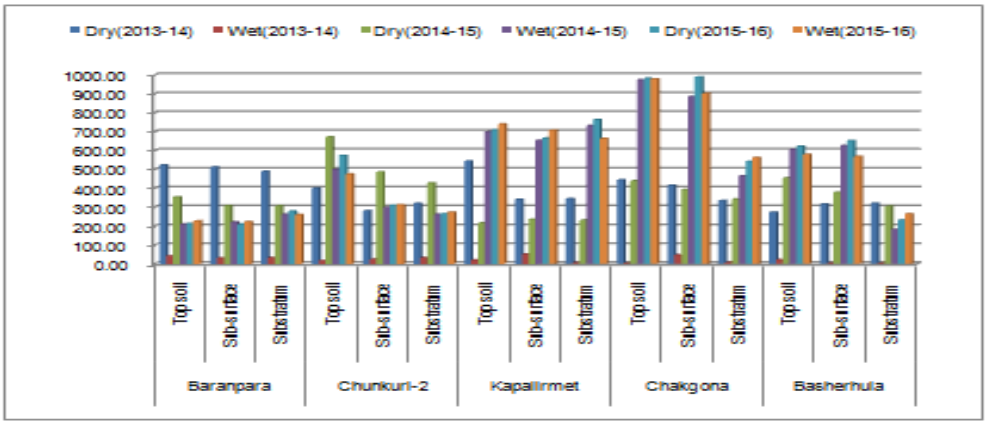


Figure 2.33: Sulphur concentration of the sampling sites around Project (consecutive year-3)

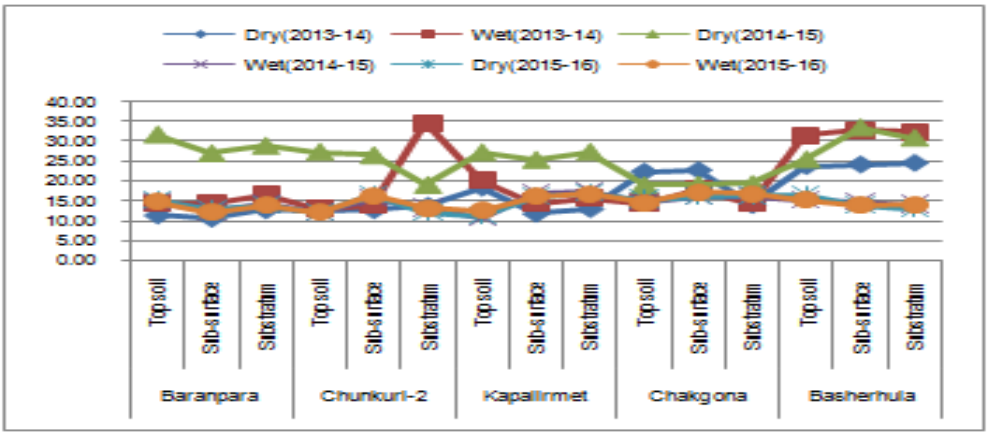


Figure 2.34: Calcium concentration of the sampling sites around Project (consecutive year-3)

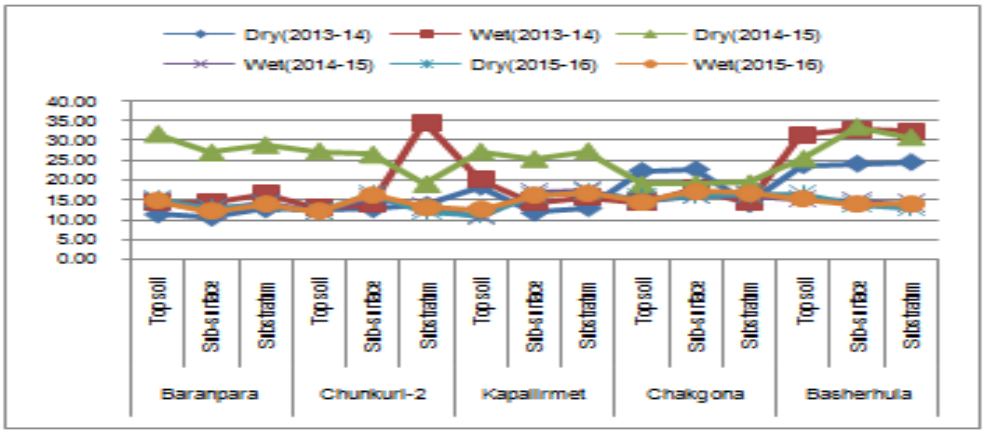


Figure 2.35: Magnesium concentration of the sampling sites around Project (consecutitive year-3)

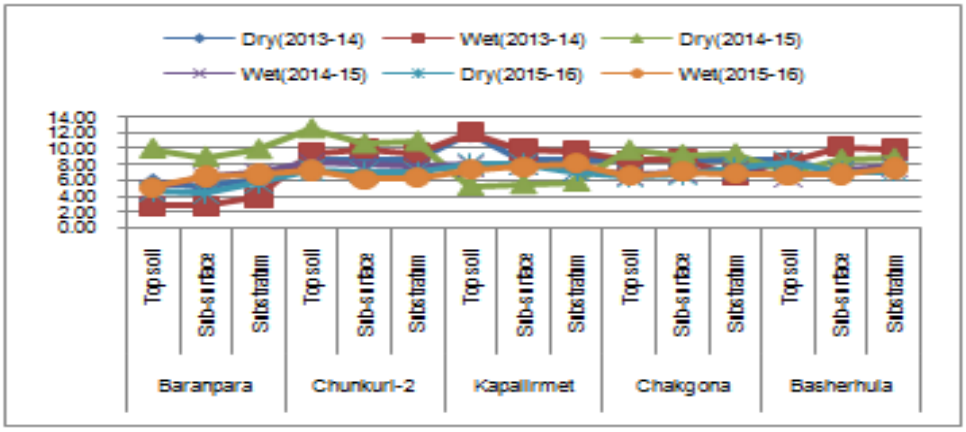


Figure 2.36: Sodium concentration of the sampling sites Project (consecutive year-3)

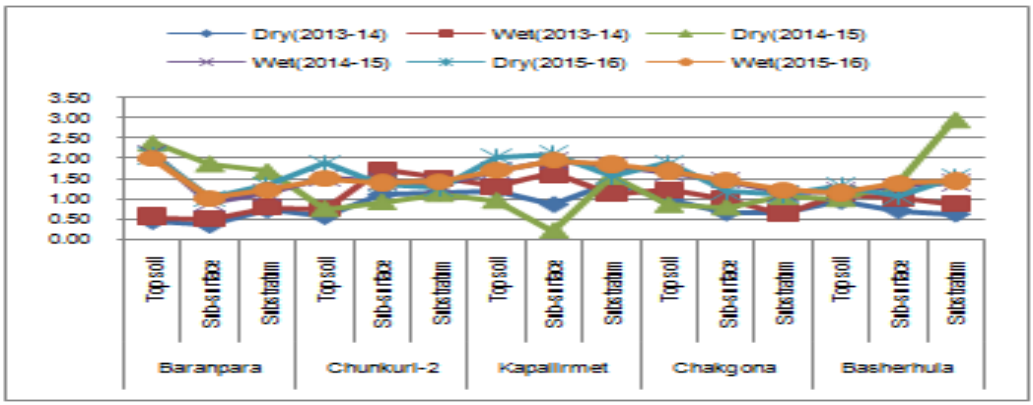


Figure 2.37: Boron concentration of the sampling sites around Project (consecutive year-3)

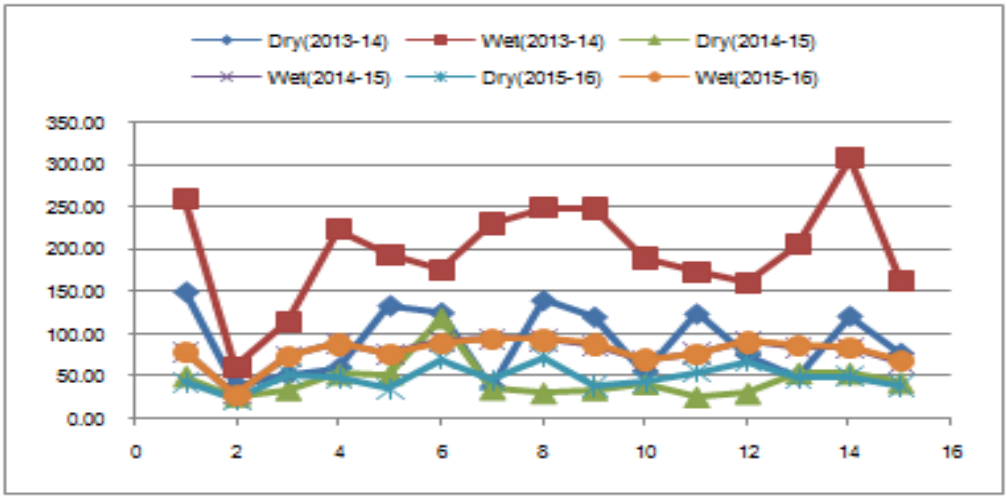


Figure 2.38: Iron concentration of the sampling sites around Project (consecutive year-3)

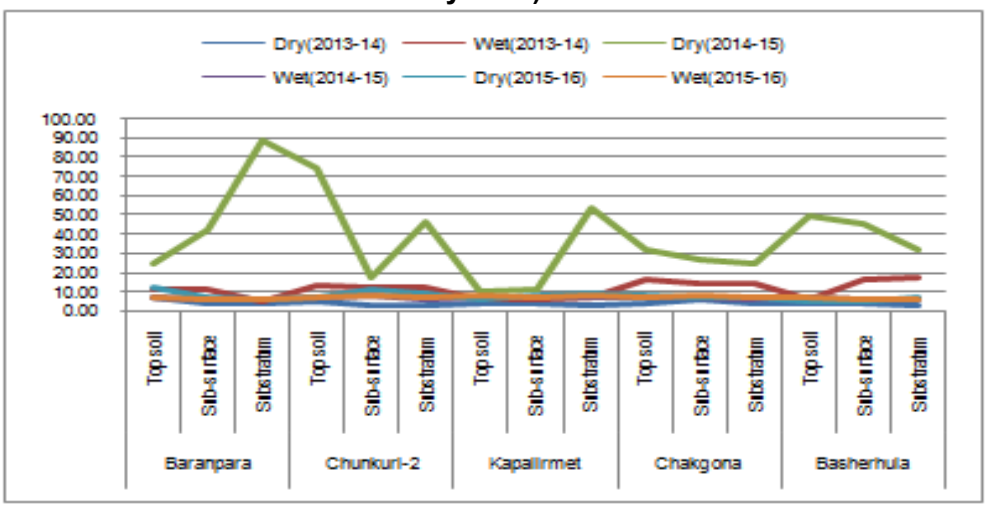


Figure 2.39: Manganese concentration of the sampling sites around Project (consecutive year-3)

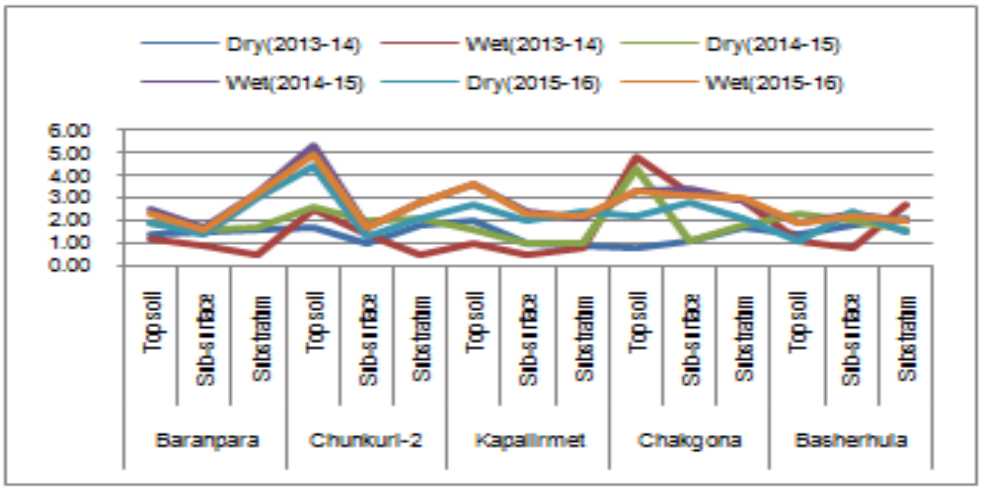


Figure 2.40: Zinc concentration of the sampling sites around Project (consecutive year-3)

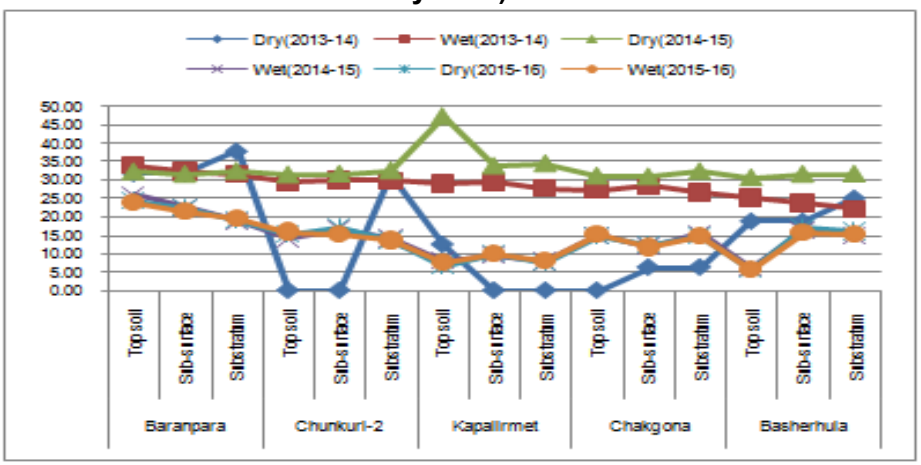


Figure 2.41: Lead concentration of the sampling sites around Project (consecutive year-3)

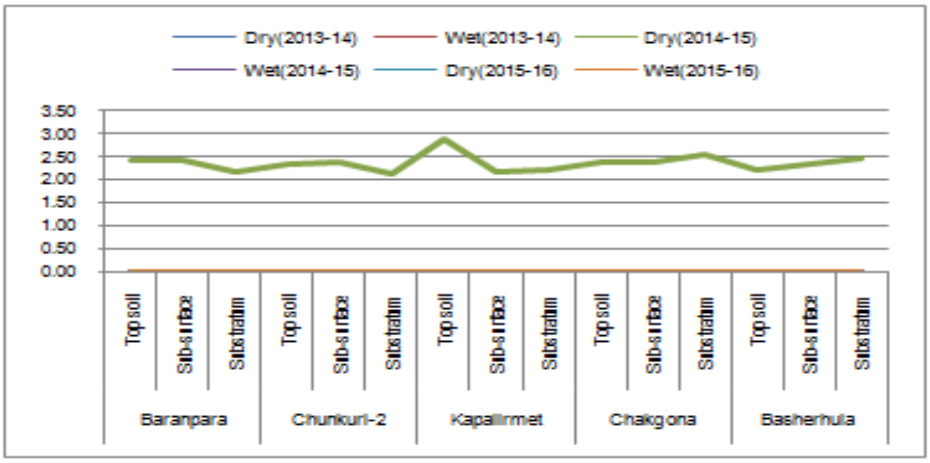


Figure 2.42: Cadmium concentration of the sampling sites around Project (consecutive year-3)

Monitoring Plot-4 (Chakgona)

141. Salinity and pH plays a vital role for the distribution of elements in Chakgona. In 2013-14, EC 7.38 (ds/m) dropped in wet season than dry season 7.81 (ds/m) but pH has been almost same. As a result, most of the cations show a decreasing trend in wet season. But EC content has been almost similar in both seasons of 2014-15 and pH (8.9) is found to be higher in wet season of 2014-15, which helped to move up the cation concentrations. Maidara River flooded the sampling area and as a result salinity has not changed that much in wet season. The most significant rise is found in case of sulphur 975 µg/gm, which is found 440 µg/gm in dry season. Other elements are found to be in a decreasing trend. This scenario indicates that sulphur replaced other cation from the exchange sites of clay.

142. The salinity level has increased 7.02-7.67(ds/m) in the dry season of 2015-16 over dry and wet season of 2014-15 and the pH level was almost same. The salinity level has slightly increased in all layer 7.99-8.56(ds/m) and pH level slightly decreased 8.3-8.4 in the wet season of 2015-16 over the dry season of 2015-16.

143. The highest sulphur level was 990.48 µg/gm in the dry season of 2015-16 which was higher than both dry and wet season of 2014-15. The lowest sulphur level ovserved in562.60 µg/gm in the wet season of 2015-16 which was higher than both dry and wet season of 2013-14 and 2014-15.

144. Organic matter shows an increasing trend (2.17%) in wet season of 2014-15 at Chakgona over wet season (1.5%) of 2013-14, which might be due to stagnant water, limited crop production and grazing practice. Basic nutrients N: 0.11%, P: 11.26 (µg/gm) and K:0.89 (meq/100g) also followed the similar trend of organic matter. As organic matter and pH increases there is a possibility of formation of chelates. As a result, most of the micro nutrients show a decreasing pattern in second year. Organic matter shows a decreasing trend (2.15%) in the dry season of 2015-16 over the wet season of 2014-15. Organic matter shows a decreasing trend (1.55%) in the wet season of 2015-16 over the dry season of 2015-16. N: 0.09%, P: 8.27 (µg/gm) and K: 0.84(meq/100g) also followed the similar trend of organic matter. N: 0.08%, P: 10.46 (µg/gm) and K: 0.79(meq/100g) also followed the similar trend of organic matter is presented in **Table E.2 of Appendix IV.**

145. In wet season of 2013-14, presence of Pb concentration is found in soil. In 2014-15 trace of Pb was found in both seasons. Moreover, as most of the Pb has possibly washed out in rainy season, concentration is found much lower in wet season than dry season. On the other hand, Cd might be completely washed out in wet season. Pb and Cd have been within the critical limit. In dry season of 2015-16, the concentration of Pb has been found in the monitoring land in all layers. It was also observed that comparing the Pb level in the dry season of 2015-16, was decreased in dry season over wet season of 2014-15. Pb level in wet season of 2015-16, was decresed in all level, except in top soil15.26 (µg/gm) where Pb level increased over dry season of 2015-16. Cd level only observed in dry season of 2014-15. Comparing the heavy metals data, Pb concentration belongs to not polluted category is presented in **Table E.3** of **Appendix IV**.

Monitoring Plot-5 (Basherhula)

146. Level of EC dropped in dry season 6.3 (ds/m) from that of wet season 7.16 (ds/m) in 2014-15 over 2013-14. On the other hand, pH shows the opposite trend. Although EC indicates that overall salinity is decreased in wet season but Na and Ca concentration increased at that time. But there is a possibility of increase in base cation due to high pH (8.3-8.7). But most of the elements show a decreasing trend at that time, except S and Fe in

the dry seson of 2015-16. The overall situation indicates that there is a possibility of replacing other elements by S and Fe from exchange sites of clay. This area is flooded by Passur River and Basherhula Khal in rainy season. EC level slightly decreased 6.41(ds/m) in top soil and and pH tends to decresd in all layer in wet season of 2015-16 over dry season of 2015-16.

147. Overall organic matter content (2.17%) increased in wet season of 2014-15 year than that of 2013-14. Every year's sedimentation could have contributed to this. But dry season content of organic matter is generally higher than wet season due to top soil erosion. Basic nutrients N: 0.11%, P: 9.12 (µg/gm) and K: 0.86 (meq/100g) also followed the similar trend of organic matter. Organic matter content (2.09%) increased in wet season of 201-16 year than that of dry season of 2015-16. N: 0.07% and K: 0.77 (meq/100g) also followed the similar trend of organic matter. P: 8.90 (µg/gm) level increased in wet season of 2015-16 overthe dry season of 2015-16.

148. Micro nutrients Fe: 85.08 (µg/gm), Mn: 6.50 (µg/gm), B: 1.40 (µg/gm), Na: 7.68 (meq/100g), Zn: 2.27 (µg/gm) show an increasing pattern in 2014-15. It could be due to new sedimentation, which is not removed properly by rainwater. It has also been found that all the micronutrients decreased in wet season than that of dry season, which could be an after effect of leaching and percolation in wet season. Fe: 87.22 (µg/gm), Mn: 6.55 (µg/gm), B: 1.44 (µg/gm), Na: 7.14 (meq/100g), Zn: 2.27 (µg/gm) show an increasing pattern in wet season of 2015-16 is presented in Table **E.2** of **Appendix IV**.

149. Concentration of Pb did not show similar pattern in last two years. In 2014-15 its concentration increased in wet season but in 2014-15, it decreased to almost one-forth than that of dry season. Cd level only observed in dry season of 2014-15. Cd might be totally washed out by rain water in wet season in 2014-15. Pb and Cd are within the critical limit. It was observed in dry and wet season of 2015-16, Pb level is not plluted category is presented in **Table E.3 of Appendix IV.**

150. According to the **Figure 2.4.17**, the order of the trace and heavy metals mean concentrations in soils in dry seaon (mean ± STD) was : trace metal like Fe (80.8 ± 40.8)> Mn(4.0 ± 1.3)>Zn(1.4 ±0.42) and heavy metal like Pb(14.7 ± 14.0)> Cd (0.0 ± 0.0) in 2013-14. In 2014-15, trace metal like Fe (44.0 ± 23.1)> Mn (25.4 ± 17.6)>Zn (1.9 ±0.81) and heavy metal like Pb(30.8 ± 4.1)> Cd (2.4 ± 0.18). In 2015-16, trace metal like Fe (44.0 ± 23.1)> Mn (25.4 ± 17.6)>Zn (1.9 ±0.81) and heavy metal like Pb(30.8 ± 4.1)> Cd (2.4 ± 0.18). It is noted that, heavy metal Cd is observed only in the dry season of 2014-15. However, the high values of Fe, Mn, Zn, Pb and Cd might be due to the uses of execissive fertilizers and biomass in the agricultural land. Mean concentration of trace and heavy metals of the dry season is presented in Figure 2.43 and **Table E.3** of **Appendix IV.**

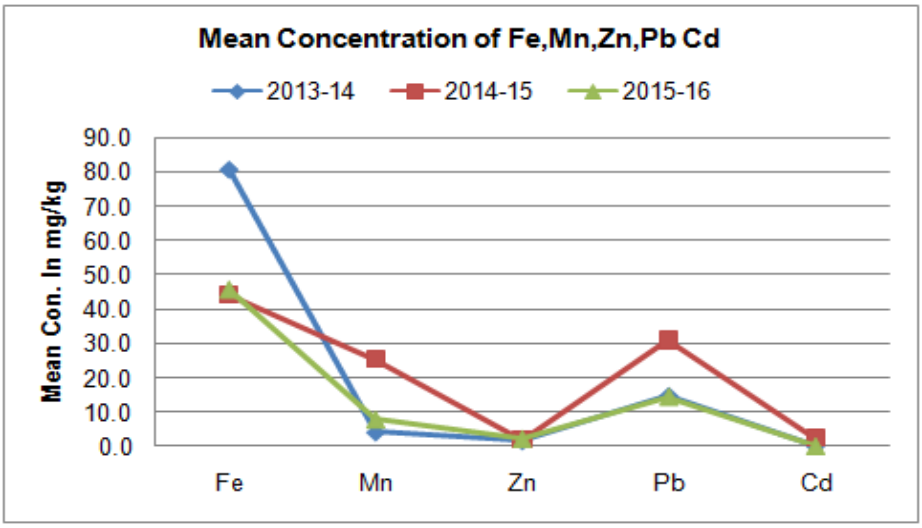


Figure 2.43: Mean Concentration of the Trace and Heavy Metals in Soil Samples of Three Consecutive Year (Dry Season)

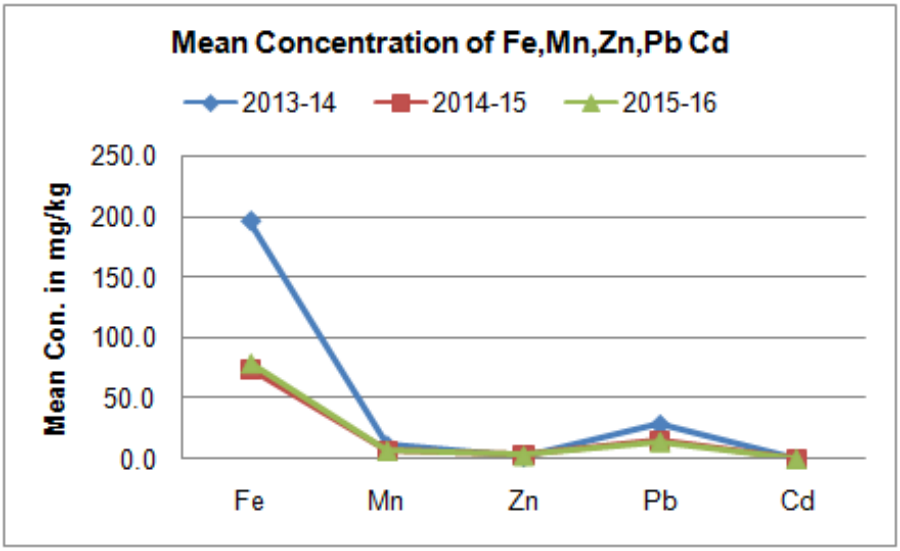


Figure 2.44: Mean Concentration of the Trace and Heavy Metals in Soil Samples of Three Consecutive Year (Wet Season)

151. It was observed from the **Figure 2.44,** the order of the metals mean concentrations in soils in wet seaon (mean ± STD): trace metal like Fe (196.6 ± 61.1)> Mn (11.1± 4.02)>Zn (1.7 ± 1.28) and heavy metal like Pb (28.3 ± 3.1)>Cd (0.0 ± 0.0) in 2013-14.

152. In 2014-15, trace metal like: Fe (74.3 ± 16.3)> Mn (6.7 ± 0.72)>Zn (2.7 ±0.95) and heavy metal like Pb (14.5 ± 5.4)> Cd (0.0 ± 0.0). In 2015-16, trace metal like Fe (79.33 ± 16.3)> Mn (6.85 ± 0.68)>Zn (2.70 ±0.88) and heavy metal like Pb (14.24 ± 5.1)> Cd (0.0 ± 0.0). During extremely wet season the rain water and in some cases river water fills its course and come out and covers the agricultural land for one to two months, which also be the cause of the increase of the concentration of the metals under this monitoring study. Mean concentration of trace and heavy metals of the wet season is presented in **Figure 2.4.18 and Table E.3 of Appendix IV**.

Summary of the soil quality monitoring

153. Though the sampling areas are medium high land, all are situated within a polder area. Another special characteristic of the area are frequent tidal waves, which makes some significant changes in pH and EC of the area. Salinity (EC) and pH control most of the changes of elements in this region. Being a coastal zone of Bangladesh, the southern region receives large amount of sediments every year. Besides, the sampling zone is inherently sulphur rich. Organic matter content is increasing due to practice of single cropping pattern and new sediment deposition every year in the monitoring lands. Though the monitoring plots are in the coastal area, yet the soil quality is not bad for crop production.

3 Biological Environment

154. Biological resources include all living organism within an ecosystem which interact with one another as well as with the physical environment. The biological resources around the project site were categorized into four major groups and monitored quarterly and halh yearly with the aim to establish baseline conditions to compare with the probable impact of proposed project in place. These groups include fisheries resources, ecological resources, Sundarbans Reserve Forest (SRF) and agricultural resources.

3.1 Fisheries Resources

Fisheries Resources

155. Fisheries resources were monitored quarterly in a year. Monitoring of all four quarters of 2014-15 and of 2015-16 and first, second and third quarter of 2016-17 were completed and reported earlier. This chapter contains the outcome of this 4thquarter monitoring of 2016-17 along with the comparisons with the earlier eleven (11) quarters.

Location of Monitoring Sites

156. The monitoring activities were carried out at ten pre-selected locations of which seven (7) are capture fish habitat and three (3) are shrimp/fish farms. The capture sampling sites were selected based on the fishing availability of upstream, middle stream and downstream of Passur River system. Shrimp/fish farms were selected based on the direct impacted area of Plant site. The sampling sites are detailed in **Table 3.1**

Table 3.1: The Sampling Locations for monitoring of Fisheries Resources

Site	Capture Habitat Location	Sl	Culture Habitat Location
A	Akram Point	1	Bhekatkhali Khal, Rajnagar
B	Haldikhali	2	Kapasdanga-Muralia
C	Harbaria	3	Chunkuri-2
D	Chandpai		
E	Mongla Port		
F	Maidara		
G	Chalna Point, Batiaghata		

Selection of Parameters

157. In the fisheries monitoring, five major components were selected according to TOR, such as, fish habitat status, fish migration, fish diversity, shrimp/fish farm practices and fish production. Fish habitat status was monitored through investigating habitat suitability index in view of habitat classification based on length frequencies of different fish species and sensitivity of fish diversity and survival success of different life stages of fish to abiotic factors (water quality, bed material, hydrological condition, morphological aspects and biotic factors (food cover).Fish migration status was monitored through assessing migratory fish species diversity, migration pattern, migration purpose, period and extent of migration etc. Species evenness, species richness and community structure were investigated for monitoring fish

diversity. Shrimp/fish farm practice was monitored by viewing stocking pattern, growth rate and mortality rate. Fish production monitoring was divided into capture and shrimp/fish farm production.

3.1.1 Methodology

Fish Habitat Status

158. Fish habitat status was monitored through determination of Habitat Suitability Index (HSI) by applying numerical habitat model based on the habitat classification and sensitivity of fish diversity and survival success of different life stages of fish to abiotic and biotic factors. Fish habitat classification was analyzed by calculating Ecludean Distance among sampling sties. Moreover, the similarities in species composition among the sites were analyzed using the Jaccard index (JI) for estimating the extent of similarity between pairs of data sets. Basic life requirements for fish community are given in **Table D.1 of Appendix IV**.

Fish Migration

159. Migratory species were identified by analyzing the common species found in the catch assessment survey from the sampling sites based on IUCN list.

Fish Diversity

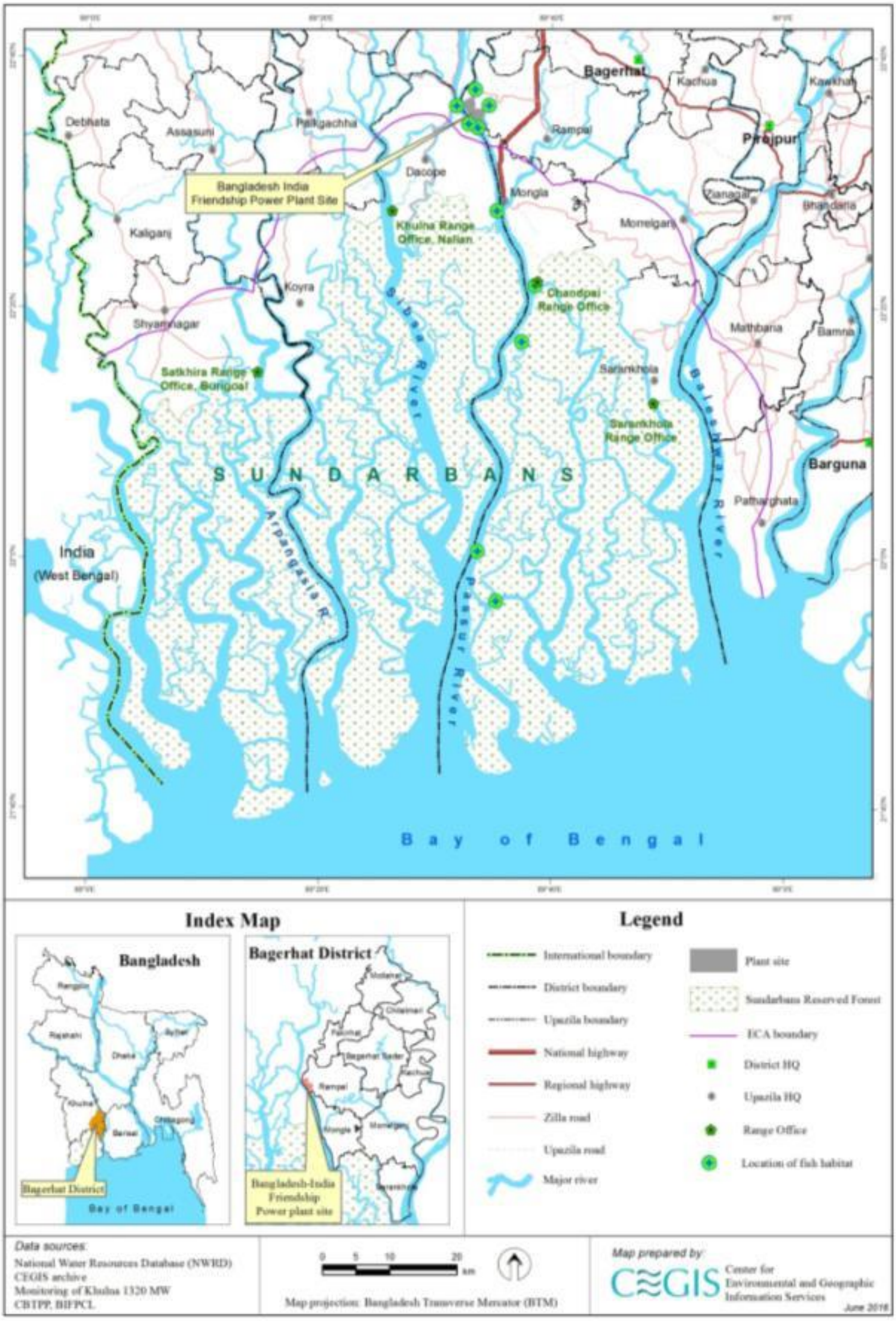
160. Fish diversity was surveyed by Catch per Unit Effort (CPUE) method. The fish individuals were counted according to the length of each species from the samples. Diversity was estimated by analyzing Shannon-Weiner Index ranges from 0 to 1. Fish species richness (FSR) was analyzed using the Simpson's Index that generates two types of values. The first one includes values from 0 to 1 expressing normalization scores for species richness status and the second one includes values from one (01) to values equal to the total number of species found in the sample which suggests that how many species are dominant in this fish community. Fish community structure has also been analyzed through counting the length-wise fish individuals.

Fish-Shrimp Culture Practice

161. For monitoring shrimp/fish farm, three farms within the direct impact zone of the proposed Power Plant were surveyed. Stocking pattern of the shrimp/fish farm is the major issue for successful production, because of having natural genetic resources from the wild source of the Passur River System. Moreover, mortality rate should be minimized for getting more economical output from the farms. So, stocking pattern and mortality rate and its causes were surveyed intensively.

Fish Production

162. Fish production for riverine fish was surveyed through CPUE. The information on the species-wise production of shrimp/fish farm was collected from the selected farms for the last catch.



Map 3.1: Fisheries Resources Monitoring Locations

Status of monitoring

163. Followed by the first, second and third quarter monitoring of the third year, fourth quarter monitoring was conducted during the period of 03 to 12 January, 2017.

Fish Habitat Status

164. Fish habitat status has also varied in the view of habitat classification and habitat use pattern of different life stages of different fish species.

Habitat Classification

165. Habitat classification was analyzed by using the length-wise distribution of different fish species in the sampling sites. The length of different life stages of fish species were identified and collected from literature. Linkage distance was then calculated with the similarity in distribution. The entire stretch of the Passur River System consists of three major behavioral habitats. The sampling sites were classified (shown in the **Figure 3.1**) on the basis of abundance of different life stages of fish species in those habitats.

166. During 1st monitoring (April, 2014) fish habitat had been classified as the grazing ground (Akram Point and Harbaria), grazing and breeding ground (Haldikhali and confluence of the Passur river at Chalna Point) as well as spawning and nursery ground (Sheola khal at Chandpai, Passur River at Mongla Point and Maidara River). In the second quarter monitoring (June – July 2014) two habitats – i) grazing ground, ii) spawning and nursery ground were identified. However, during third quarter monitoring in the month of October 2014 the similarity of size group distribution of fish species among the habitats were found to be shifted to some extent. In fourth monitoring phase in the month of January 2015 three habitats – i) grazing ground, ii) grazing and breeding ground; and iii) spawning, nursery and grazing ground were identified. During the 1st quarter (April, 2015) of the second year three habitats – i) grazing ground, ii) nursery ground; and iii) spawning and nursery were identified. During the 2ndquarter monitoring of 2nd year (October, 2015) two habitats were identified as: i) grazing and breeding ground and ii) spawning and nursery ground. During the 3rd quarter monitoring of 2nd year (October, 2015) such three habitats as i) grazing ground, ii) nursery ground and iii) growing and feeding were identified. During the 4th quarter monitoring of 2nd year (January, 2015) two major habitats – i) nursery and feeding ground and ii) feeding and growing ground were identified. During the 1st quarter monitoring of 3rd year (April, 2016) two major habitats – i) spawning and nursery ground and ii) feeding and growing ground were identified. During the 2nd quarter monitoring of 3rd year (July, 2016) two major habitats – i) nursery ground and ii) feeding and breeding ground were identified. During the 3rd quarter monitoring of 3rd year (October, 2016) two major habitats – i) Breeding and spawning ground, mainly for Hilsha and Poma; and ii) feeding and grazing ground were identified.

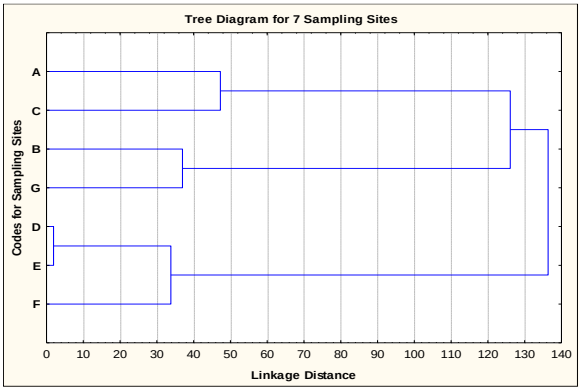
During the 4th quarter monitoring of 3rd year (January, 2017) two major habitats – i) Grazing and spawning ground, mainly for Paissa; and ii) Nursing groundwere identified as shown in the **Figure-3.1**

Grazing and Spawning Ground:

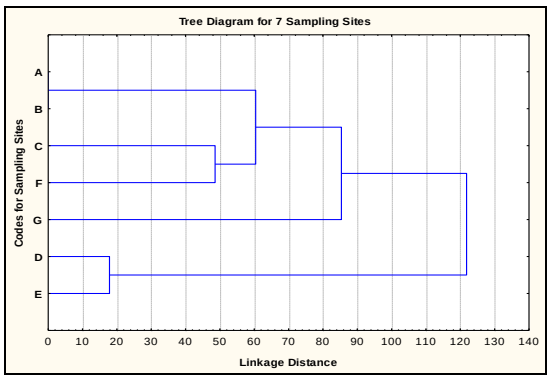
167. Among the sampling sites, Akram Point (A) and Harbaria khal(C) were identified as the grazing and spawning ground for abundance of both the juvenile and broodfish.

Nursing Ground:

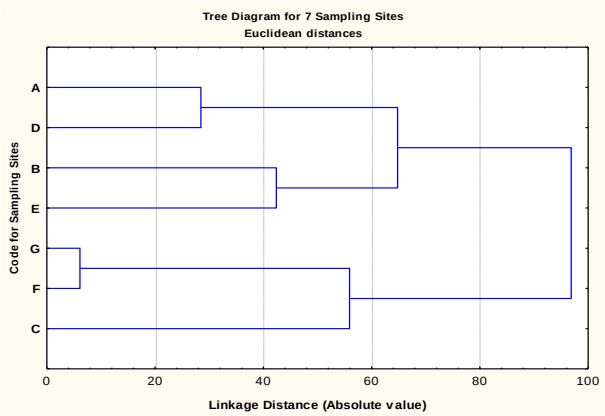
168. Among the sampling sites, mainly the Mongla-Passure Confluence (E), Maidara-Passur Confluence (F) and Chalna Point (G) were identified as the nursing ground mainly used by Bagda, Bairagi Chela, Chali Chingri and Khayra Chela.



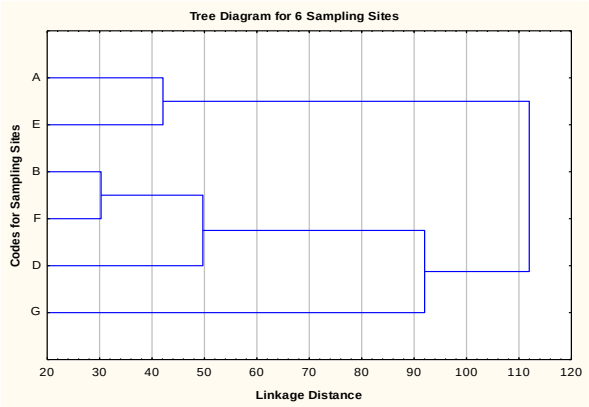
1st Monitoring, April, 2014



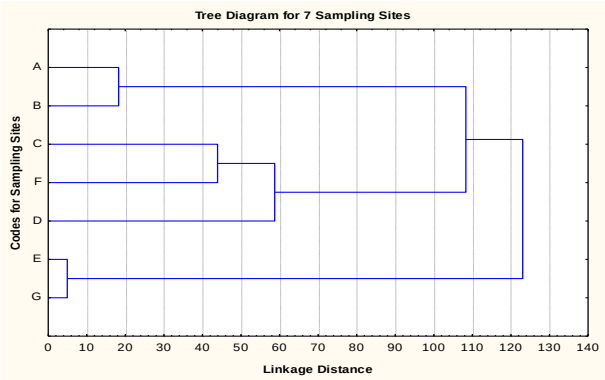
2nd Monitoring, July 2014



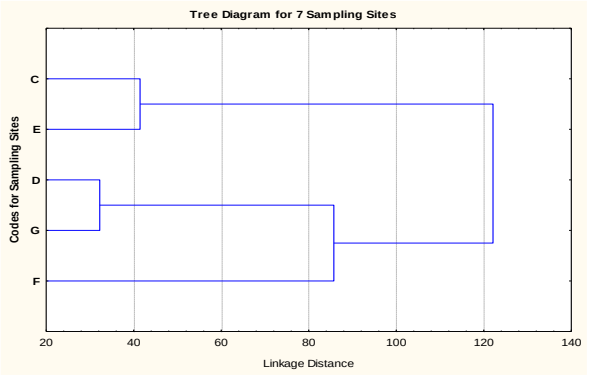
3rd Monitoring, October, 2014



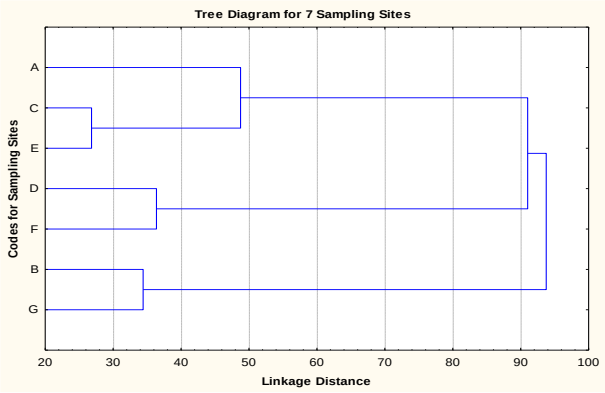
4th Monitoring, January 2015

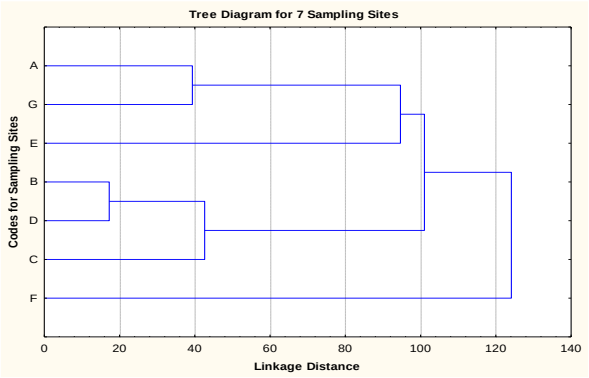


5th Monitoring, April, 2015

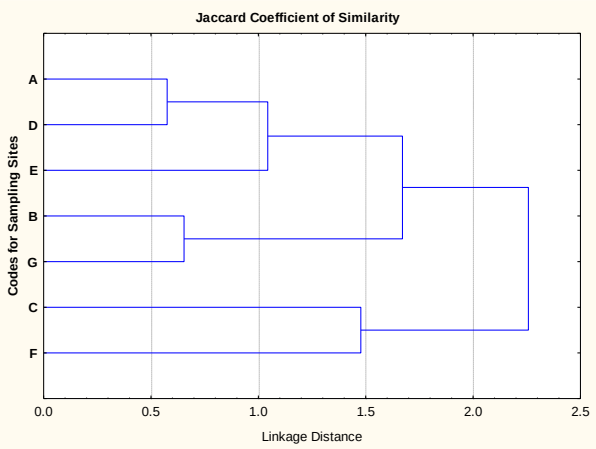


6th Monitoring, August, 2015

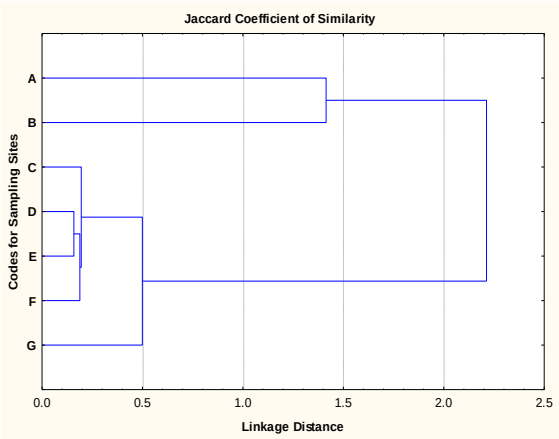


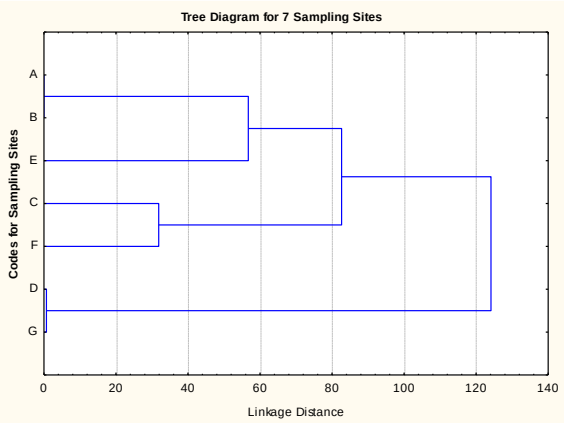


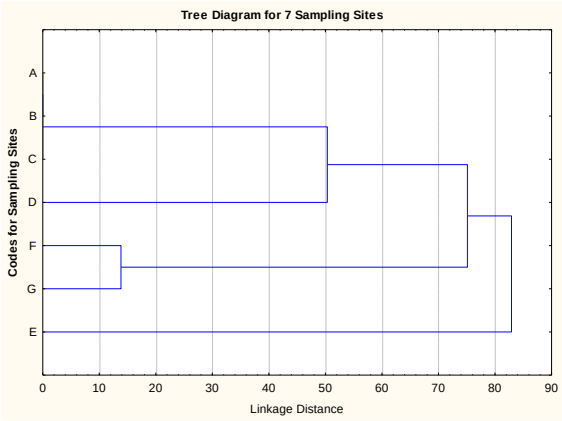
7th Monitoring, October, 2015



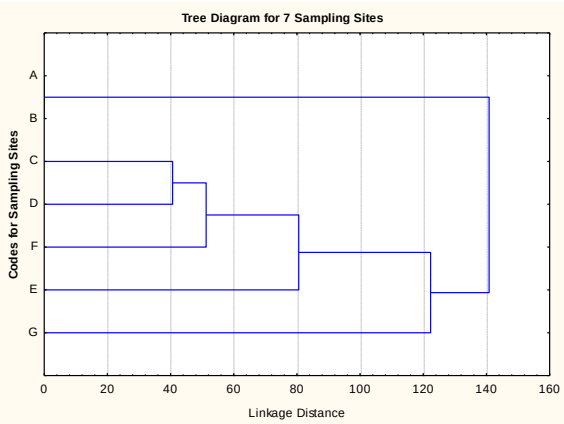
8th Monitoring, January, 2016



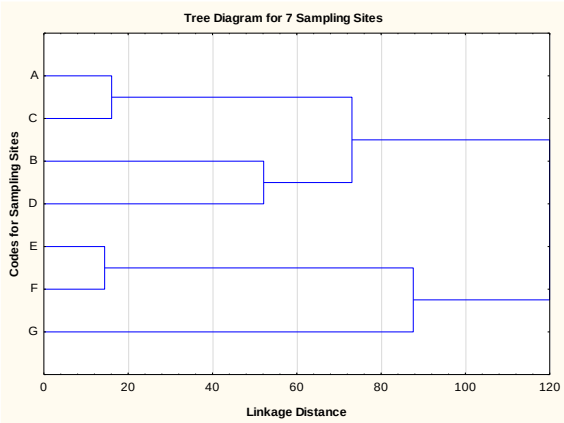




9th Monitoring, April, 2016



10th Monitoring, July, 2016



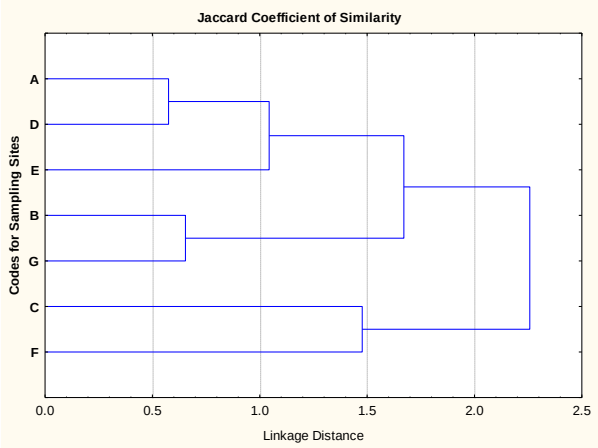
11th Monitoring, October, 2016

12th Monitoring, January, 2017

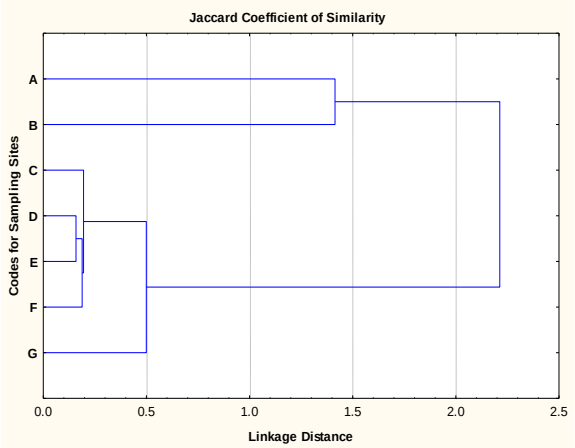
(Note: Life stage is identified through length measurement of the fish individuals)

Figure 3.1: Habitat Classification on the basis of Different Life Stages of Fish Species

169. The dendogram analyses the distances among the JI (Jaccard Coefficient Index) indices which are opposite to the JI values. It was found that the length-wise distribution relationship varies not only with four quarter but also with year to year. In thisfourth quarter of the third monitoring year, the JI value between C and D sampling sites was the highest (Figure 3.1.2) which indicates the maximum similarity in species occurrence between these two sites out of seven (7) sampling sites.



1st Monitoring, April, 2014



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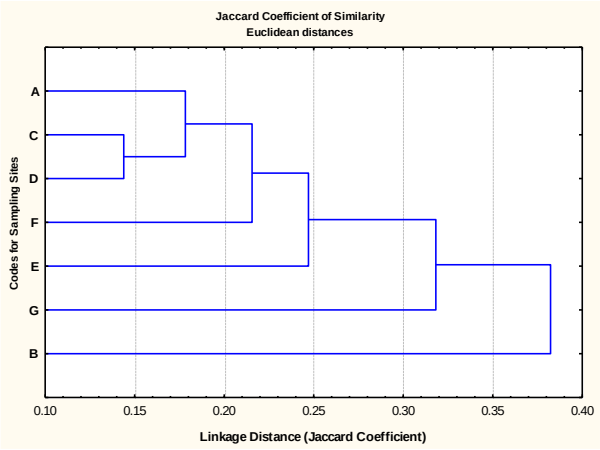
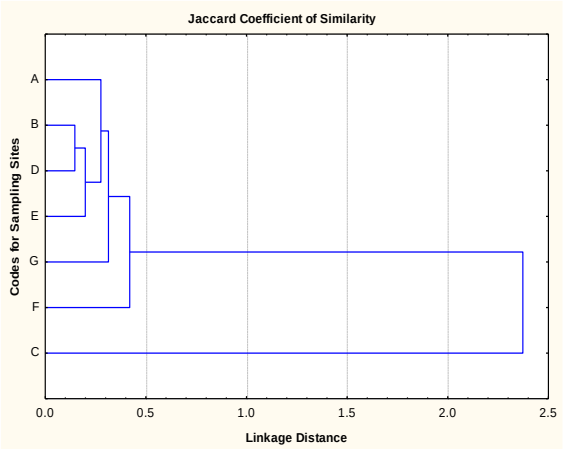
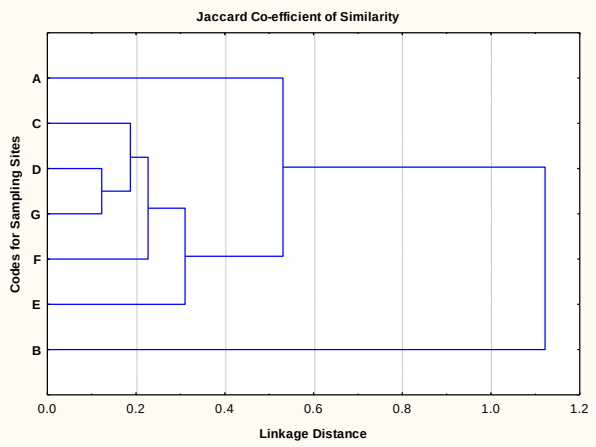


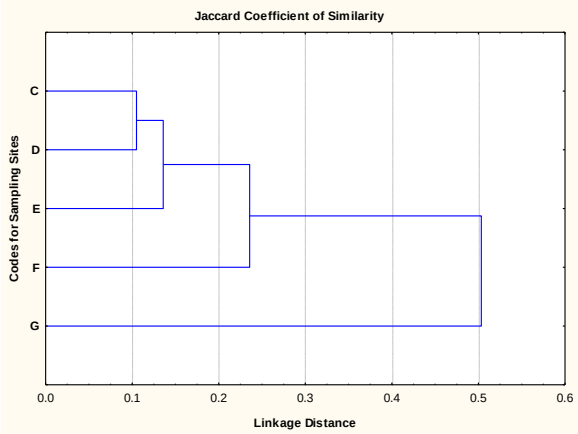
3rd Monitoring, October, 2014



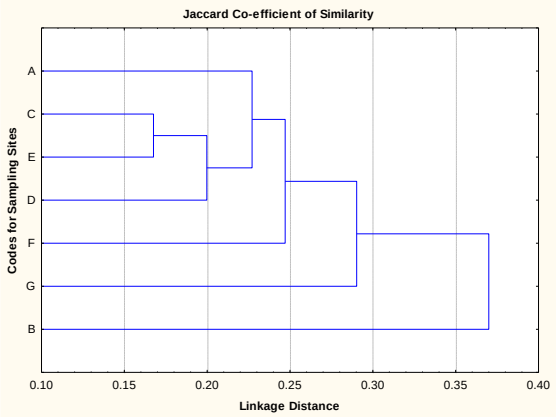
4th Monitoring, January 2015



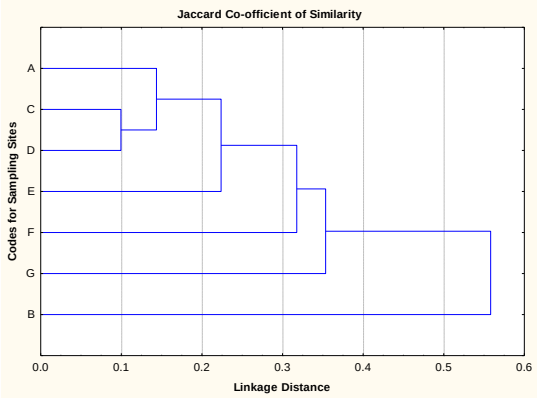
5th Monitoring, April, 2015



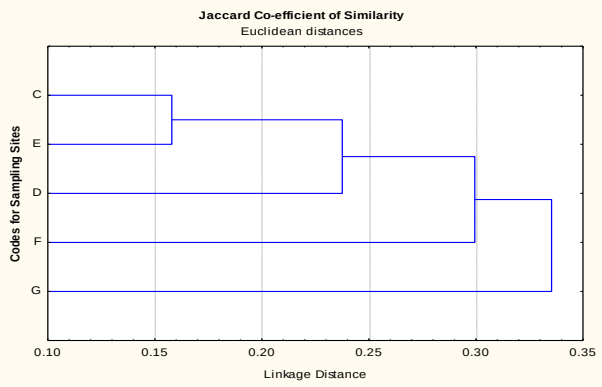
6th Monitoring, August, 2015



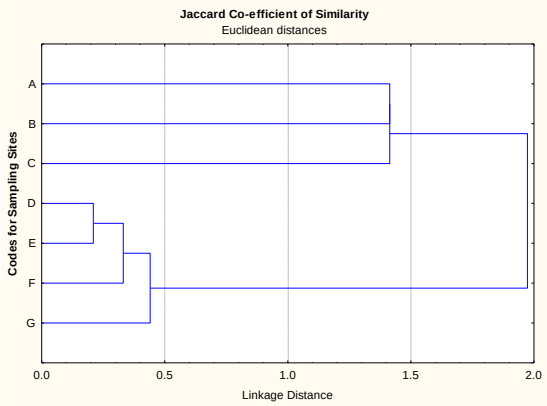
7th Monitoring, October, 2015



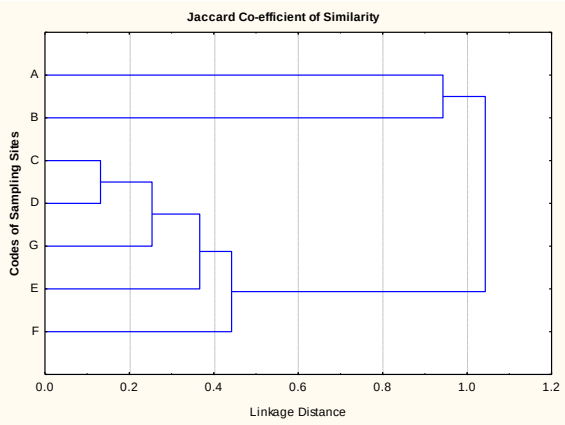
8th Monitoring, January, 2016



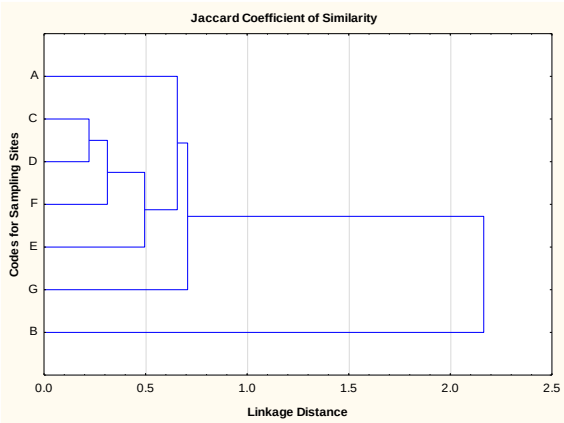
9th Monitoring, April, 2016



10th Monitoring, July, 2016



11th Monitoring, October, 2016



12th Monitoring, January, 2017

Figure 3.2: Dendogram Showing Similarity in Binary Species Composition in seven sampling sites

Habitat Suitability Index (HSI)

170. Habitat Suitability Index (HSI) was determined for the year of 2014-15 and 2015-16 considering the exposure to water quality and the production performance of different fish species. Production performance was measured through considering length-structured production assessment model (E. L. Cadima, 2003). Suitability analysis was conducted by applying Iyengar and Sudarshan (1982) developed model. All data was normalized through using UNDP developed normalization equation (UNDP, 2006).

In the first year of monitoring, Sheola khal at Chandpai was found as the most suitable habitat for fish species among Passur River System. Sheola khal has also been identified as the most suitable in second year which is followed by Harbaria, Akram Point, Haldikhali, Mongla Point, Maidara and Chalna Point (**Table 3.2**).

Table 3.2: Habitat Suitability Index (HSI) for selected spot in the study area

Sampling Sites	Location	HSI* (2014-2015)	HSI (2015-2016)	HSI (2016-2017)
A	Akram Point	0.334	0.56	
B	Haldikhali	0.408	0.54	
C	Harbaria	0.226	0.64	
D	Chandpai	0.520	0.72	
E	Mongla Port	0.321	0.43	
F	Maidara	0.224	0.25	
G	Botiaghata, Chalna Point	0.218	0.32	

**HSI value is calculated on the basis of life requirement and length-age structured population dynamics model*

Note: The HSI will be calculated on the basis of one year monitoring data

Fish Diversity

Shannon-Weiner Index

171. In the fourth and final quarter monitoring of third year (2016-17), species evenness also varies among the sampling sites. Highest Shannon-Weiner index was found at Akram Point and Maidara (0.90) indicating most evenly distributed fish species. On the contrary, lowest evenness was found at Harbaria (0.6) (shown in the **Table 3.3**). It has also been found that both the number of fish species found in in-situ catch and the evenness of their distribution within the sampling sites show high variation with the changing seasonal and yearly bio-physical conditions. Moreover, more varied evenness scenarios were found in downstream than in upstream. Highest deviation, for example, was found in case of catch in down stream of the Passur river system (Akram Point, Haldikhali and Harbaria) and lowest in case of catch in upstream (Mongla Point, Maidara and Chalna Point).

Fish Species Richness (FSR)

172. Fish species richness was identified through Simpson's Index 1 . Considerable difference is noticed in the fish species richness (FSR) in different habitat classes (**Table 3.4** and **Figure-3.3**).

173. In this monitoring phase, species richness varies withthe sampling sites. Maximum FSR was obtained in Sheola Khal at Chandpai (n=7), while very low FSR was recorded at Chalna Point, Mongla Point and Akram Point (n=2). Different scenarios of richness were found in this quarter in comparison to the previous monitoring years. Among habitats in upstream portions of the Passur River, Mongla Port was home to a rich assemblage of Bagda and Chali Chingri; Maidara River at Baro Durgapurwas of Bairagi, Bele, Cheng and Darkina; and Chalna Point was of Bagda and Chali Chingri. Among the habitats in down stream portions, Chandpai was rich in Aswene Bele, Chela, Golda, Gulsha Tengra, Mutkura, Paissa and Potka; Harbaria was in Khoira Chela and Gagra Tengra, Akram Point in Paissa and Gagra Tengra.

1Simpson's index is a method to calculate the community characteristics of fish in a particular habitat. It is mainly used to know about the species richness of a particular habitat to tell how many species are rich in their abundance. The value of this index ranges from 0 to 1. There is other kind of value which is described in the methodology section. The second value is mainly used tomeasure the species richness in the sampling sites.

Table 3.3: Site Wise Species Diversity using Shannon–Weiner Index

Site	Species No													Shannon-Weiner Index*												
	1st QM	2nd QM	3rd QM	4th QM	5th QM	6th QM	7th QM	8th QM	9th QM	10th QM	11th QM	12th QM	Mean± STD	1st QM	2nd QM	3rd QM	4th QM	5th QM	6th QM	7th QM	8th QM	9th QM	10th QM	11th QM	12th QM	Mean± STD
A	33	0	13	7	3	0	10	15	0	0	1	2	7±10	0.5	0	0.7	0.6	1	-	0.6	0.4	0	0	0	0.9	0.42±0.37
B	12	0	24	14	0	0	11	3	0	0	1	0	5±8	0.9	0	0.6	0.4	0	-	0.6	0.6	0	0	0	0	0.27±0.33
C	2	12	9	0	11	26	18	24	17	0	23	10	13±9	0.3	0.77	0.4	0	0.8	0.6	0.5	0.7	0.6	0	0.6	0.6	0.48±0.26
D	12	22	15	26	27	24	20	25	8	19	32	27	21±7	0.3	0.78	0.7	0.5	0.7	0.7	0.5	0.7	0.6	0.6	0.6	0.8	0.62±0.14
E	7	13	10	11	6	16	9	9	15	12	5	4	10±4	0.4	0.6	0.8	0.8	0.2	0.7	0.9	0.4	0.7	0.5	0.7	0.7	0.60±0.20
F	3	13	6	4	10	8	14	6	7	5	7	12	8±4	0.8	0.77	0.5	0.6	0.7	0.4	0.8	0.7	0.8	0.7	0.9	0.9	0.71±0.15
G	6	3	5	7	18	3	8	6	6	4	12	3	7±4	0.7	0.82	0.7	0.7	0.2	1	0.7	0.8	0.6	0.9	0.2	0.7	0.66±0.23
Mean	11	9	12	10	11	11	13	13	8	6	12	8		0.55	0.53	0.64	0.50	0.48	0.68	0.64	0.61	0.45	0.37	0.43	0.65	
STDEV	11	8	6	8	9	11	5	9	7	7	12	9		0.24	0.37	0.14	0.25	0.37	0.21	0.13	0.14	0.32	0.37	0.36	0.32	

**According to Shannon-Weiner Index, 0-0.30: Low diversity/equally distribution (VH); 0.31-0.50: Moderate Diversity (M); 0.51-0.80: High Diversity (HD) and 0.80-1.0: Very High Diversity (VHD)*

Table 3.4: Site wise Rich Species Number

Site	Location	No. of Rich Species												
		2014-2015				2015-2016				2016-2017				Mean± STD
		1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th	
A	Akram Point	4	0	4	3	3	-	3	2	0	0	1	2	2±2
B	Haldikhali	7	0	4	2	0	-	3	2	0	0	1	0	2±2
C	Harbaria	1	5	2	0	4	4	3	6	4	0	4	2	3±2
D	Chandpai	2	2	5	4	5	8	3	7	4	6	3	7	5±2
E	Mongla Point	1	10	4	5	3	6	4	2	4	7	3	2	4±2
F	Maidara at Baro Durgapur	3	6	2	2	4	2	4	2	3	2	3	3	3±1
G	Botiaghata, Chalna	3	3	2	3	1	3	3	4	2	4	1	2	3±1
Mean± STD		3±2	4±4	3±1	3±2	3±2	5±2	3±0	4±2	2±2	3±3	2±1	3±2	

Rupchanda in 1stQuarter of 1st Year

Chela in 2nd Quarter of 1st Year

Phesa, Chela, Hilsa, Gagla Tengra

Harina Chingri

Fish Species at 3rd Quarter Monitoring of 1st Year 2014-15

Amadi Chela

Banspata

Fish Species in Upstream of Passur River at 4th Quarter Monitoring of 1st Year 2014-15

Adult Poma in Chalna Point

Fry of Bagda at Chalna Point

Meth and Gagra Tengra

Gagra Tengra

Fish species found in 1st quarter of the second monitoring year (2015-16)

Mutkure and Paissa

Khorsula

Menu

Vetki

Fish species found in 2nd quarter of the second monitoring year (2015-16)

Gulsha Tengra, Bele, Aswine Bele and Paissa

Gangania

Telcupa

Golda

Kain Magur

A Mix of Culture and Capture Fishes

Fish species found in 3rd quarter of the second monitoring year (2015-16)

Tau Paissa

Bele

Horina Chingri

Gulsha and Gagra Tengra

Jaba

Female Gulsha Tengra

Fry Fishes

Chata Bele

Fish species found in 4th quarter of the second monitoring year (2015-16)

Kain Magur

Banspata, Vetki, Koidda and Poma

Fish species found in 1st quarter of the 3rd monitoring year (2016-17)

Poma and Tapsi

Tapsi

Fish species found in 2nd quarter of the 3rd monitoring year (2016-17)

Miscellaneous Fish Species

Hilsha

Tapse

Poma and Tapse

Fish species found in 3rd quarter of the 3rd monitoring year (2016-17)

Catch Sample

Juvenile of Kain Magur

Khayra Chela

Jevenile of Pangas

Brood Paissa

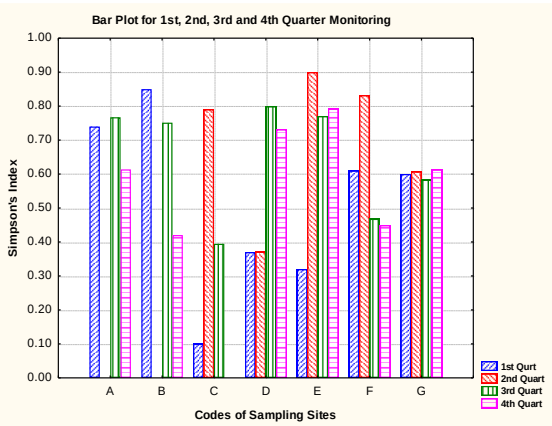
Paissa and Gagra Tengra

Aswene Bele, Daitna, Tapse and Chitra

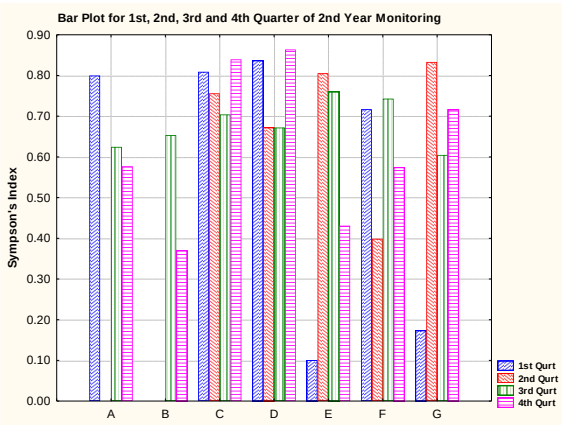
Dry Fish of Khayra Chela

Fish species found in 4th quarter of the 3rd monitoring year (2016-17)

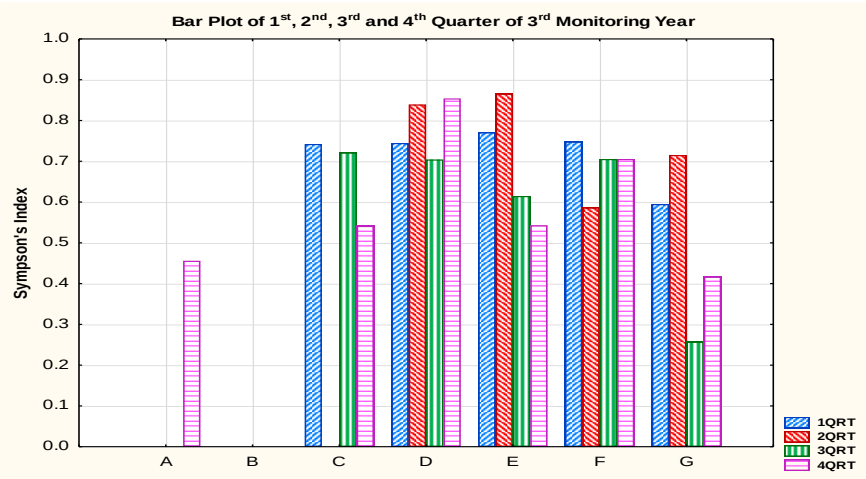
Photo 3.1: Length-wise distribution of fish species



2014-2015



2015-2016



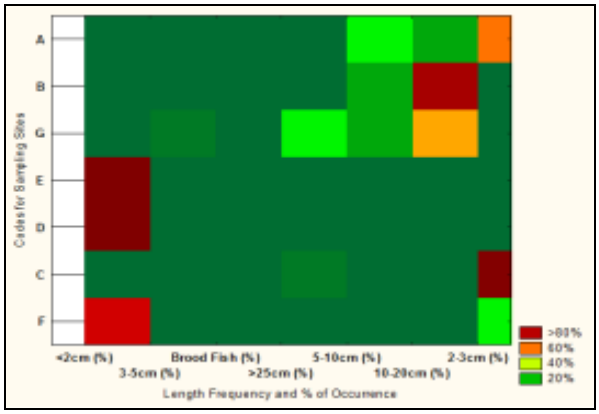
2016-2017

(FSR is identified though Simpson's Index)

Figure 3.3: Site-wise fish species richness (FSR) in the Passur River System.

Fish Community Structure

174. Fish community structure was analyzed through counting the length-wise fish individuals (Photo 3.1). The following Table D.2 and D.3 of Appendix IV and Figure 3. 4 for fourth quarter of third monitoring year show that fries and juveniles for fin fish were widely being distributed among the upper stretches of the Passur River. Among these Bagda fish wasmore widely being distributed among the sampling sites. Moreover, fries fish of Chali Chingri, Khoira Chela, Baisakhi and Cheng were found at Chalna Point and Maidara-Passur Confluence. Moreover, brood female fishes of Paissa were observed at Akram Pointand Harbaria sampling sites in this quarter.



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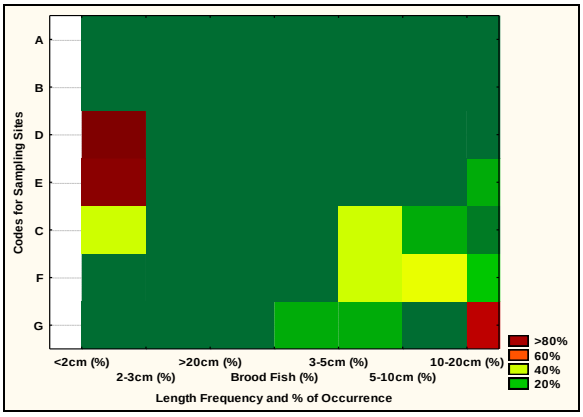
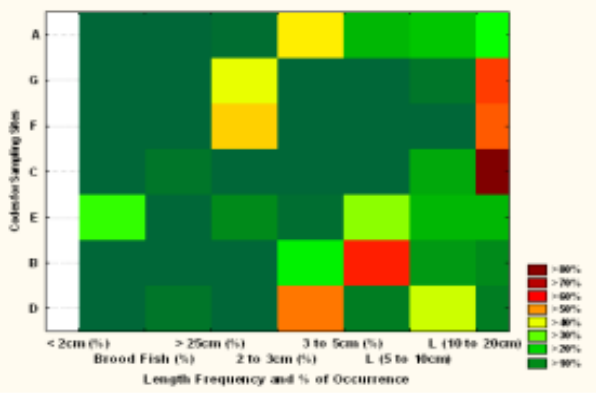
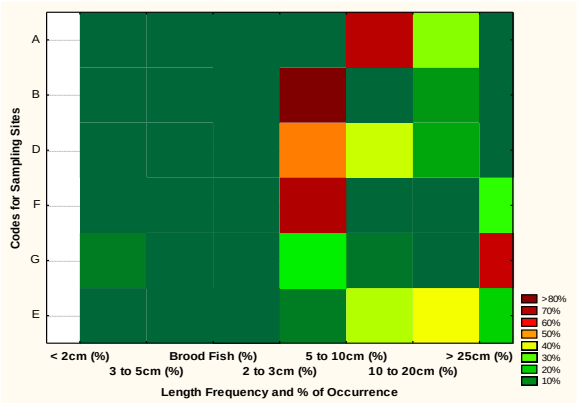


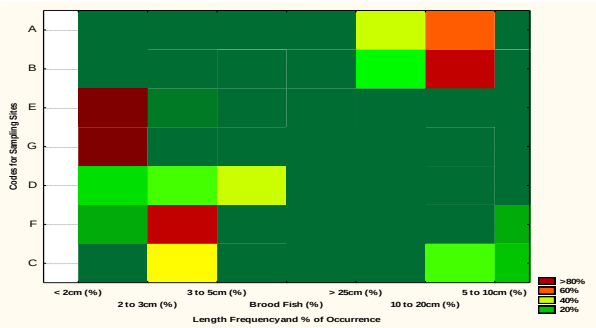
2nd Monitoring, July 2014



3rd Monitoring, October, 2014



4th Monitoring, January 2015



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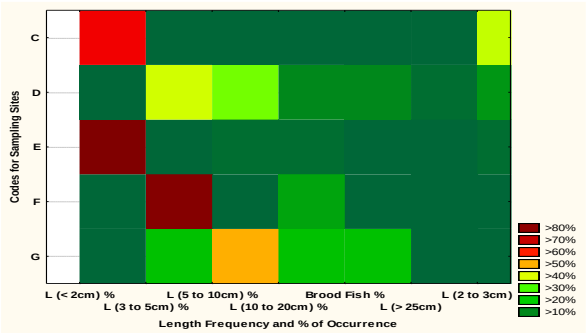
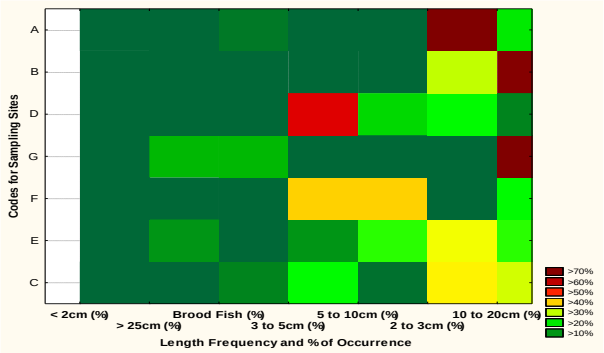
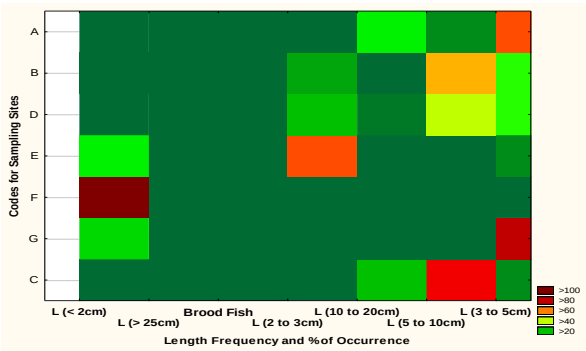


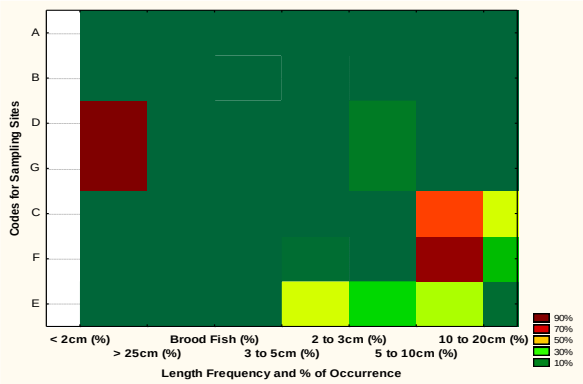
6th Monitoring, August, 2015



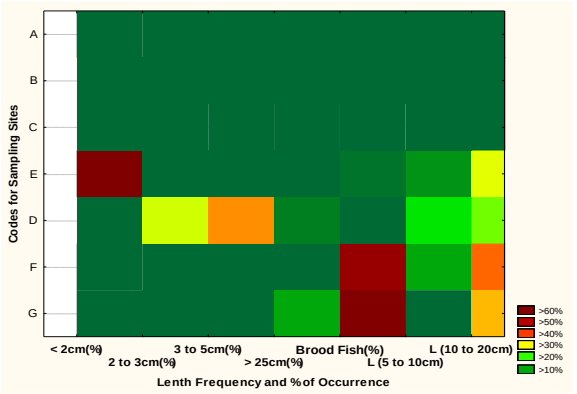
7th Monitoring, October, 2015



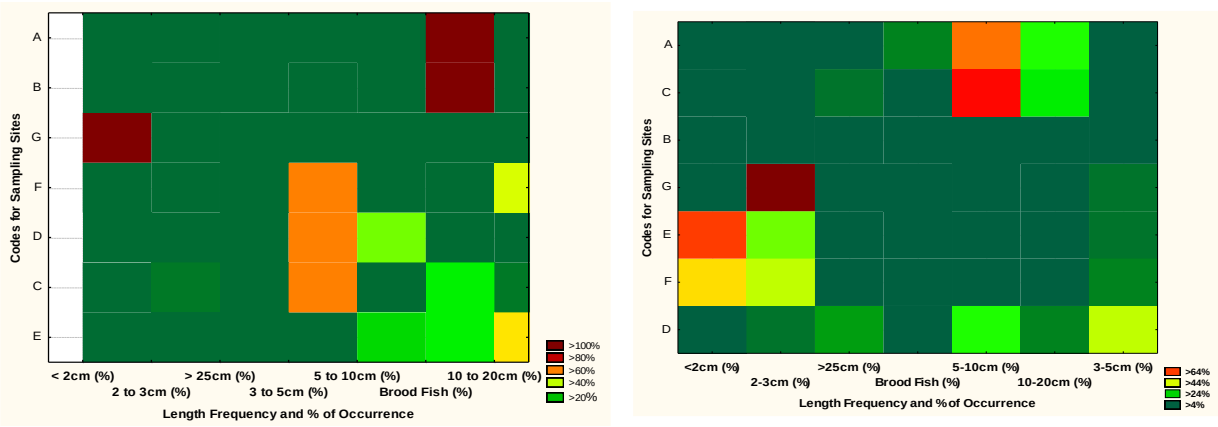
8th Monitoring, January, 2016



9th Monitoring, April, 2016



10th Monitoring, July, 2016



11th Monitoring, October, 2016 12th Monitoring, January, 2017

Figure 3.4: Habitat Distribution of Different Life Stages of Fish Species

Note: N.B.: Colour ranges from deepest green to deepest red. 0-4.99% Occurrence signifies Deepest Green; 5-9.99%-Shaded Green; 11-14.99%-Normal Green; 15-19.99%-Light Green; 20-24.99%; 25-29.99%-Lightest Green; 30-34.99%; 35-39.99%; 40-44.99; 45-49.99; 50-54.99-Light Magenta; 55-59.99-Deep Magenta; 60-64.99%; 65-69.99%; 70-74.99%; 75-79.99%-Light Red; 80-84.99%-Deep Red; 85-89.99%; 90-94.99%; 95-100%-Deepest Red

Fish Migration

Migratory Species Diversity

175. Migratory species were identified by analyzing the common species available in the regular catch from the sampling sites. Fish species like Gulsha Tengra and Chela attains the maximum abundance among the migratory fish species observed in fourth quarter of third monitoring year. The relative abundance of the migratory species is give below in the **Figure-3.5**

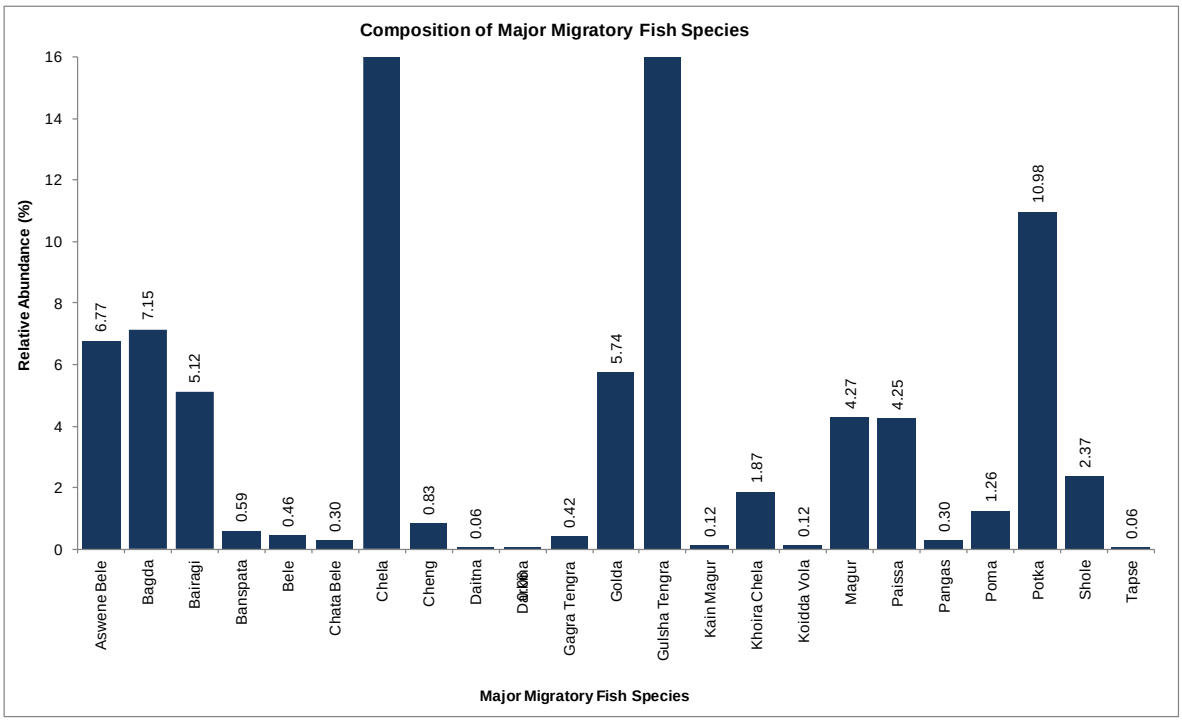


Figure 3.5: Relative abundance of major migratory fish species in sampling sites

Migration Extent, Time and Purpose

176. Major fish species showed interesting pattern in distribution for exploiting different purposes mentioned in the following table all along the sampling sites. Three (3) fish species were found common in most of the sites. These species, also, Poma and Khayra Chela, were observed indicating long range of distribution (Table D.4 of Appendix IV).

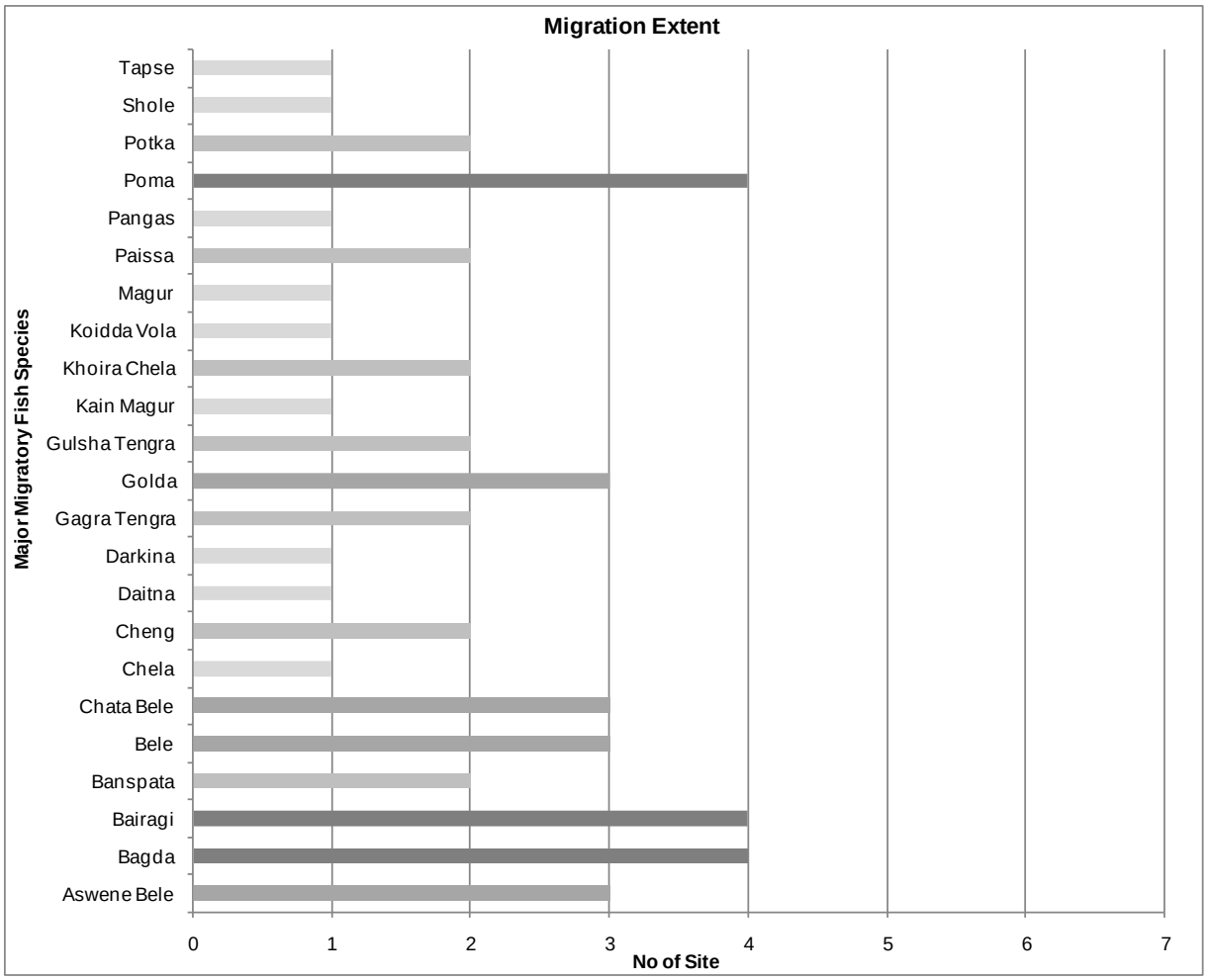


Figure 3.6: Migration extent of major migratory fish species in sampling sites

Shrimp/Fish Farm

177. Three farms situated in the direct impact zone of Power Plant were surveyed for monitoring shrimp/fish farm. Stocking pattern of the shrimp/fish farm is one of the major issues for successful production because of having natural genetic resources from the wild source of the Passur River System. Moreover, maximization of growth rate and minimization of mortality rate should be ensured for getting more economical output from the farms. So, stocking pattern, growth rate and mortality rate and its causes were surveyed intensively.

Stocking Pattern

178. No stocking was observed in this monitoring, because the farms were being prepared for the re-stocking.

Shrimp/Fish Growth Rate and Mortality

179. During the fourth quarter of third monitoring year, no growth rate and mortality ratecould be calculated (**Table 3.5**).

Table 3.5: Growth Rate and Mortality of Fish/Shrimp

Gher No.	1st QM		2nd QM		3rd QM		4th QM		5th QM		6th QM		7th QM		8th QM		9th QM		10th QM		11th QM		12th QM	
	Growth Rate (cm/day)	Mortality (%)	Growth Rate (cm/day)	Mortality (%)	Growth Rate (cm/day)	Mortality (%)	Growth Rate (cm/day)	Mortality (%)	Growth Rate (cm/day)	Mortality (%)	Growth Rate (cm/day)	Mortality (%)	Growth Rate (cm/day)	Mortality (%)	Growth Rate (cm/day)	Mortality (%)	Growth Rate (cm/day)	Mortality (%)	Growth Rate (cm/day)	Mortality (%)	Growth Rate (cm/day)	Mortality (%)	Growth Rate (cm/day)	Mortality (%)
1	0.3	15-20	0.2	40	0.25	50	-	-	-	30	0.18	25	0.20	60	-	-	-	-	0.2	20	0.20	60	-	-
2	0.3	30-35	0.3	94	0.25	10	-	-	-	-	0.14	20	0.15	100	-	-	0.21	15	0.3	40	0.25	50	-	-
3	0.2	25-30	0.2	25	0.20	65	-	-	-	10	0.15	50	0.25	20	-	-	0.17	30	0.15	30	0.20	30	-	-

Source: CEGIS Field Survey, 2014, 2015& 2016

Fish Production

Capture Fish Production

180. In fourth quarter monitoring of the third year, the highest productivity was found in Sheola khal at Chandpai (**Table 3.6**). The lowest productivity was found in the Mongla Point, Maidara and Chalna Point. Because allthe fry fishes are not considered as catch.

181. The present study revealed that the highest catch susceptibility was found in case of Charpata Jal (56.25 kg/haul) (**Table 3.6**). The following table also expresses that Net Jal was most frequently used in all upper reaches in Passur River System. Charpata Jal was commonly used in middle reach and Baro Khepla Jal in lower reach of the Passur River. Moreover, the highest total catch was observed in Sheola khal at Chandpai and lowest in the Mongla Point, Maidara and Chalna Point in this monitoring phase (**Table-3.7**).

Table 3.6: Total Catch in Different Gears in the Sampling Sites

Sl. No	Site	Habitat	Gear Name/Type	Haul Duration (hr)	No of Haul	kg/haul
A	Akram Point	Kukilmoni Khal	Baro Khepla Jal	1.5	30	0.067
B	Haldikhali	Haldekhali Khal	0	0	0	0
C	Harbaria	Harbaria Khal	Baro Khepla Jal	1.5	15	0
D	Chandpai	Sheola Khal	Charpata Jal	24	2	56.25
E	Mongla Point	Passur River	Net Jal	5	1	0**
F	Maidara	Maidara River	Net Jal	10	2	0**
G	Chalna Point	Passur River	Net Jal	2	1	0**

Source: Catch assessment survey, CEGIS (2016-17)

*** Weight of Fry is not considered for catch assessment*

Table 3.7: Total Catch in the Sampling Sites

Sampling Site	Total Catch (kg)												
	1st QM	2nd QM	3rd QM	4th QM	5th QM	6th QM	7th QM	8th QM	9th QM	10th QM	11th QM	12th QM	Mean± STD
A	28	0	3	28.7	6	0	20	276.2	0	0	10	2	31.16±78
B	65	0	1	3.3	0	0	10	12.8	0	0	4	0	8.01±18
C	1,559	0.5	8	8.7	1.05	0.33	19.5	173.6	2.8	0	2.6	10	148.84±447
D	0	12	3	30	10.5	5.08	10.75	189	0	12	18	56	28.82±53
E	0	0.6	5	0	0.5	0.4	0.6	7.8	5	7.5	2.6	0	2.50±3
F	0	1.2	13	3.7	1.5	0.7	0.8	0	1.5	0.8	0.5	0	1.97±3.6
G	0	1.6	4	0.7	2.9	0.83	0.825	70	1	0.8	0.1	0	6.90±20
Mean± STD	236±584	2.27±4.3	5.29±4	10.73±13	3.21±3.79	1.05±1.8	8.93±8.56	104±109	1.46±1.9	2.98±4.7	5.33±6.3	9.75±21	

**Average Weight 0.15kg/mud crab and average weight 0.6 kg/mud eel*

*** Weight of Fry is not considered for catch assessment*

Culture Fish Production

182. The present study on shrimp/fish farm in the fourth quarter monitoring of 3rd year phase showed that the fish production was found only in the Gher of Kapasdanga (Table D.5 in Appendix IV).

Photo 3.2: Fishing gears and crafts use in fishing at sampling sites

3.2 Ecosystem Monitoring

3.2.1 Monitoring of Ecosystem and Biodiversity

183. Ecological indicators for terrestrial and aquatic ecosystems have been selected by prior anticipation of probable impacts on ecological resources in different phases of the proposed project.

184. Composition and diversity of flora is important for vegetation study which indicates vegetation structure of an area. Plant health is directly related with biomass productivity. Plant health of an area may change for changing of different environmental parameters like temperature, composition of gaseous components, soil salinity, humidity and nutrients, air particulate dust etc. Plant diseases and proportion of healthy/ unhealthy plant is needed to observe for ensuring plant health condition.

185. Canopy status of terrestrial vegetation indicates plant health and biomass properties of an area. Vegetation canopy structure may be change for change of plant growth rate due to soil properties change, plant physiological disorders due to change of climatic parameters or even for different human interventions. To monitor vegetation canopy status of the study area, canopy cover has been followed in different time intervals.

186. Lichens often grow on trees and shrubs, absorbing nutrients from the atmosphere. Because lichens are very sensitive to air pollution, particularly to sulfur dioxide, fluoride, and ammonia, their presence or absence is an indicator of homestead forest health. The acidity of a tree's bark can also affect lichen abundance. Presence of lichen coverage on homestead trees would be a bio indicator for monitoring air quality standard of the study area.

187. Among the terrestrial faunal community, Bird is an important class that is sensitive to their habitat condition. Changes of environmental parameters, landuse and vegetation composition directly impact on bird's habitat of a locality. Broadly, two types of bird are found in an area; local and migratory. To observe local bird habitat suitability, number of bird nest and nesting bird species can be a good indicator. Numbers of wetlands where migratory birds come in each migration season have also been considered to observing migratory bird habitat suitability of the area.

188. Butterfly monitoring is an important means of measuring change in the environment as well as state habitats for biodiversity. Insects are by far the most species rich group of animals, representing major portions of terrestrial biodiversity. Contrary to most other groups of insects, butterflies are well visible and mostly sensitive to changes of environmental parameters like air temperature, gaseous components etc.

189. In the respects of aquatic ecosystems, dolphin is an ecological indicator which indicates water quality as well as aquatic habitat suitability. This aquatic mammal is still present all the river systems of the study area. Any changes of water quality and river bed siltation may change dolphin occurrence in a river system. So, dolphin occurrence is needed to monitor for this study.

Rationales for selection of indicators

190. Indicators for terrestrial and aquatic ecosystems have been selected by prior anticipation of probable impacts on ecological resources in different phases of the proposed project.

191. Plant composition and diversity is important for vegetation study which indicates vegetation structure of an area. Plant health is directly related with biomass productivity. Plant health of an area may change for changing of different environmental parameters like temperature, composition of gaseous components, soil salinity, humidity and nutrients, air particulate dust etc. Hence, plant diseases and proportion of healthy/ unhealthy plant is needed to observe the plant health condition.

192. Canopy status of terrestrial vegetation indicates plant health and biomass properties of an area. Vegetation canopy structure may be change for change of plant growth rate due to soil properties change, plant physiological disorders due to change of climatic parameters or even for different human interventions.

193. Lichens often grow on trees and shrubs, absorbing nutrients from the atmosphere. Because lichens are very sensitive to air pollution, particularly to sulfur dioxide, fluoride, and ammonia, hence their presence or absence is an indicator of homestead forest health. The acidity of a tree's bark can also affect lichen abundance. Presence of lichen coverage on homestead trees barks would be a bio indicator for monitoring air quality standard of the study area.

194. Bird is important group in terrestrial faunal community that is sensitive to their habitat condition. Changes of environmental parameters, landuse and vegetation composition directly impact on bird's habitat of a locality. Broadly, two types of bird are found in an area; local and migratory. To observe local bird habitat suitability, number of bird nest and nesting bird species can be a good indicator. Numbers of wetlands where migratory birds come yearly have been considered to observe migratory bird habitat suitability.

195. Monitoring butterfly is an important means of measuring change in the environment as well as stating habitats for biodiversity. Insects are by far the most species rich group of animals, representing over 50% of terrestrial biodiversity. Contrary to most other groups of insects, butterflies are well visible and mostly sensitive to changes of environmental parameters.

196. Benthos and planktons play an important role as a food and oxygen source for various aquatic biota. Phytoplankton also has a great contribution to ensure primary productivity of aquatic ecosystems. Good water quality is essential to support healthy benthic and plankton communities. Changes of any water quality parameter can impact on benthic and planktonic composition and population.

197. Dolphin is another ecological indicator which indicates water quality as well as aquatic habitat suitability of an aquatic system. This aquatic mammal is still present all the river systems of the study area. Any changes of water quality and river bed siltation may change dolphin occurrence in a river system. So, dolphin occurrence is need to monitor.

198. Invasion of alien species may come with coal vessel from other countries. Alien species may be harmful to aquatic ecosystem if they are highly aggressive in succession or

reproduction. So, alien invasion will need to be regular observation during plant operation phase.

199. From the above discussion, following indicators have been selected to identify the impacts for proposed power plant.

Terrestrial Ecosystems

a) Plant Species composition and diversity

b) Plant health

c) Vegetation canopy
d) Lichen
e) Bird habitats
f) Butterfly occurrence

Aquatic Ecosystems

a) Benthos
b) Planktons

Dolphin

Terrestrial ecosystem

200. Terrestrial ecosystem supports most of the floral and faunal communities which are directly related to the environmental parameters like temperatures, air quality, sunlight, soil nutrients etc. In the study area, homesteads occupy maximum portions of terrestrial ecosystems. As such, observation on different indicators of selected homestead vegetation and dweller wildlife will be helpful to know the ecological impacts for the proposed project.

Description of the selected homestead

201. The homestead in Rajnagar is located at 2.5 km. east from upper North-east boundary of the project site. This is situated inside the damp area as numerous small swamps exist inside and surround the homesteads. Water retention capacity of surface soil of this homestead is very low and for this reason very little number of grasses and other herbs are present. Land elevation of selected homestead at Kalekarber village is comparatively flood free. This is located at about 1.8 km. east from Middle-east boundary of the project. Chalkghona village is located about 0.5 km south from south-east boundary of the project. The selected homestead of this village is close to Maidara River to it's north side and saline water shrimp farms to its south periphery. Presence of shallow ditches and peripheral waterbodies support to grow staple coverage of saline tolerant plant species. Borni village is located at about 3.0 km north from north-east boundary. Sampled homestead at Borni is situated at the middle part of the village. This homestead is also dominated by planted tree species and soil condition is similar to Rajnagar site. Vegetation of this homestead have been severely been damaged by past Cyclone Aila.

Species Composition of selected homestead vegetation

Homestead at Rajnagar

202. Among the trees, Gewa *(Excoecaria agallocha)* is dominating among all trees. Moist and saline soil favors luxurious succession of this mangrove plant in homestead vegetation.

Beside this, Safeda *(Manilkara zapota)* and Boroi *(Zizyphus sp)* are the two species of fruit yielding trees. Monocots including Narikel *(Cocos nucifera)* and Khejur *(Phoenix sylvestris)* occupied the top canopy of the vegetation. In addition three Bola *(Hibiscus tiliaceus)* and one Sundari (*Heritiera fomes)* also found to exist. The homestead very few grasses or undergrowth vegetation.

Homestead at Kalekar Ber dighi

203. Narikel (Cocos nucifera) and Khejur *(Phoenix sylvestris)* occupies the top canopy. Aam (Mangifera indica), Safeda (Manilkara zapota), Peyara (Psidium guajava) and Boroi (Zizyphus sp) are common trees height about 3-5 m. Rendi Koroi *(Albizia saman)* and Raj Koroi *(A. richardiana)* are timber trees those are occupied top canopy height more than 10m. Beside this, Bakul (Mimusops elengii) and few number of Kola (Musa sp) are found on these homestead platforms. Among the creepers and herbs, Swarnalata *(Cuscuta reflexa)* and Durba *(Cynodon sp)* are found.

Homestead at Chalkghona

204. Similar to the above homesteads, in the selected homestead at Chalkghona, Narikel is the dominating tree species as well as occupying the top canopy. As the homestead is near the peripheries of river and shrimp gher, soil salinity supports luxurious growth of mangrove plant Gewa (Excoecaria agallocha). This homestead has two shallow ditches which contain brackish water throughout the year and 2 Gol *(Nipa fruticans)* bushes are existing there. Most of the medium size trees like Safeda *(Manilkara zapota),* Aam *(Mangifera indica),* Peyara *(Psidium guajava)*, Papay *(Carica papaya)* etc are fruit bearing trees. Beside this, some ornamental plants also exist.

Homestead at Barni

205. This homestead contains 21 tree species. Except Narikel *(Cocos nucifera),* Khejur *(Phoenix sylvestris)* and Taal *(Borassus flabellifer)*, most of trees are young in age. The devastating cyclone Aila caused huge damge to the tree species. Then the house owner planted many timber and fruit yielding trees throughout the home yard.

a. Vegetation canopy status

206. Cocos nucifera occupied top canopy of all the studied homestead vegetation. Phoenix sylvestris is prevalent as second top layer followed by Excoecharia agallocha. Most of the fruit yielding trees like Manilkara zapota, Mangifera indica possess upper bole of canopy layer. Lower bole are occupied by small fruit yielding trees like Psidium guajava, Musa sp. Very few grass species and undergrowth vegetation were followed at studied homesteads.

Estimated Canopy cover in homestead vegetation of sampling sites

207. Vegetation Canopy status is slightly decrease from the last monitoring period in all the monitoring locations. In Rajnagar site, canopy cover reduced highest compare to last monitoring season (October 2016). This happened due to seasonal change of leaf density and a staple amount of canopy occupies by Excoecaria agallocha (Gewa) tree that show deciduous nature in winter. Comparing with the same season in last monitoring year (Jan 2016), canopy cover improved all locations except Rajnagar. Well growth of mangrove trees like Excoecaria agallocha and foliage expansion of planted saplings in Borni, Kalekarber and Chalkghona sites contribute behind this improvement. Canopy coverage of the studied homesteads has been represented in following **table 3.8**

Table 3.8: Vegetation Canopy Cover in different studied homesteads

Location	% of canopy Coverage										
	Apr 2014	Jun 2014	Oct 2014	Jan 2015	Apr 2015	Aug 2015	Oct 2015	Jan 2016	Jul 2016	Oct 2016	Jan 2016
Rajnagar	NS	19	19	17	20	20	20	20	21	23	19
Borni	NS	26	18	18	12	14	20	20	25	25	23
Kalekarber	NS	20	24	25	23	24	24	22	24	26	25
Chalkghona	NS	13	24	22	17	21	21	20	21	27	26

Note: NS = Not Surveyed

b. Lichen cover

208. This indicator has not observed in this monitoring tier.

Bird Habitat

Local birds and their nesting behavior

209. Numerous local bird species are supported in the study area. Homestead vegetation are the prime habitat for local birds. Existence of vast shrimp farms as well as canals and rivers also favor good number of water dependent bird species in this area. Most of the birds are nesting on tall trees of homesteads. Cocos nucifera and Excoecharia agallocha followed top priority for nesting. Small bird like Tailor bird, prefer small bushy shrubs. Although, birds do not follow any local boundaries, a clear conception on available bird species have been gathered through discussions with studied homestead owners as well as physical observation.

Migratory birds and their habitats

210. Migratory and local migratory winter birds are followed at large shrimp gher along the study area. According to local people and physical observation, Common Coot, Common Snipe, Black Winged Stilt, Bar Headed Goose, Red Crested Pochard, Ruddy Shellduck, etc are common winter visitor of this area. In addition, local Ruddy Breasted Crake, Common Sandpper, Great Egret, Pond Heron, Little Cormorant are also found at most of the monitoring wetlands of the study area.

211. Borocharar Gher and Chotocharar Gher are in top abundance of migratory birds which have been informed during recent field visit. According to local knowledgeable persons, population of migratory birds are reducing day by day from these wetlands for illegal hunting, re-starting shrimp culture within short intervals from shrimp harvesting in past year and indiscriminate use of pesticides in agriculture field and shrimp ghers.

212. Following table show the presence of migratory birds at the important wetlands inside the study area.

Table 3.9: Presence of migratory birds at different wetland inside the study area

Wetland Name	Wetland type	Approximate distance from project Boundary (Km.)	Presence of Birds					
			Jan 2015		Jan 2016		Jan 2017	
			LM	M	LM	M	LM	M
Choto Charargher	Saline Water Shrimp Farm	0.10	Y	N	Y	Y	Y	Y
Boro Charargher	‘’	0.10	Y	Y	Y	Y	Y	Y

Wetland Name	Wetland type	Approximate distance from project Boundary (Km.)	Presence of Birds					
			Jan 2015		Jan 2016		Jan 2017	
			LM	M	LM	M	LM	M
Putimari Gher	‘’	1.10	Y	N	N	N	N	N
Golbunia Gher	‘’	0.1	Y	Y	Y	N	N	N
Shukariar Gher	‘’	1.25	Y	N	N	N	N	N
Koigar Daskati Gher	‘’	0.25	N	N	Y	N	Y	N
Badyamari Gher	‘’	1.00	N	N	Y	N	N	N
Chalkghonar Beel	‘’	1.50	Y	N	N	N	N	N

Note: ‘LM’=Local Migratory, ‘M’=Migratory, ‘Y’=Yes

Source: Field Monitoring, January 2015, January 2016 and January 201

Bird species and number of Bird nests in sampling sites

213. No bird nest was observed from any site of the monitoring location during this monitoring period. Following table represent the bird nest monitoring datasheet over the monitoring periods.

Table 3.10: Bird nest monitoring datasheet

Bird Name	No. of Bird Nest observed																																							
	Apr 2014				Jun 2014				Oct 2014				Jan 2015				Apr 2015				Aug 2015				Oct 2015				Jan 2016				Jul 2016				Jan 2017			
	R	B	K	C	R	B	K	C	R	B	K	C	R	B	K	C	R	B	K	C	R	B	K	C	R	B	K	C	R	B	K	C	R	B	K	C	R	B	K	C
Little Cormorant	NS	-	NS	-	12	-	-		-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	NS	NS	NS	NS	10	-	-	1	-	-	-	-
Little Egret	NS	-	NS	1	4	-	-		-	-	-	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-	-	-	NS	NS	NS	NS	5	-	-	1	-	-	-	-
Asian Pied Starling	NS	1	NS	-	-	-	-	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	NS	NS	NS	NS	-	-	-	-	-	-	-	-
Tailor Bird	NS	-	NS	1		-	-		-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	NS	NS	NS	NS	-	-	-	-	-	-	-	-
Spotted Dove	NS	-	NS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	NS	NS	NS	NS	-	-	-	-	-	-	-	-
Great Egret	NS		NS																										NS	NS	NS	NS	3	-	-	-	-	-	-	-

a. Butterfly occurrence

214. A total of 32 butterflies species have been recorded from studied sites during last different monitoring tiers. Of which Common crow, Common Emigrant, Common Rose, Grass yellow, Peacock Pansy etc are followed most of the homesteads in most of the monitoring season. 3 species of butterflies have been observed in this monitoring tier (Jan 2017) from Borni, Kalekarber and Chalkgona sites. Evening Brown and Peacock Pansy are most abundant species.

Photo 3.3: Peacock Pansy (Junonia almanac) is the most common butterfly in the study site (Photo taken from studied homestead at Borni)

Aquatic Ecosystem Monitoring

215. Rivers, canals, ponds and saline water shrimp farms are main wetland forms in the study area. Of which, river bear the flowing/ lotic and ponds bear the stagnant/lentic water systems. Canals of this area have merged with shrimp farms. Shrimp farms extend a large proportion of total watershed of the study area those are intervene by human. Therefore, canals are not a actual flowing or stagnant water system

a. Monitoring Locations

216. Passur is the only external river beside the project area which maintains connectivity with all flowing water systems of the study area. On the other hand, Maidara River including two branches (Sailtakhali and Ichamoti) exists as internal river system. Hence, status of benthos, planktons and aquatic mammals (Dolphin) in different locations of the study area has been monitored.

b. Dolphin Occurrence

Dolphin migration route in study area

217. Two dolphin species (Ganges River Dolphin and Irrawaddi Dolphin) travel throughout the Passur river for whole of the year. The Ganges river dolphin migrates from estuary regions to upstream connected rivers like Rupsha and Madhumoti. Though Irrawardi Dolphin is mostly habituated in estuary regions of Bangladesh, but this aquatic mammal is also sighted in Passur river. Ganges Dolphins also roam through Maidara River mainly during high tide. Siltation and narrowing of upstream branches is limiting the length of migration area of this river day by day.

Table 3.11: Occurrences of Butterflies in the study area

ommon Name	Scientific Name	Time and locations for Occurrence of Butterfly species																																			
		Jun 2014				Oct 2014				Jan 2015				Apr 2015				Aug 2015				Oct 2015				Jan 2016				Oct 2016				Jan 2017			
		R	B	K	C	R	B	K	C	R	B	K	C	R	B	K	C	R	B	K	C	R	B	K	C	R	B	K	C	R	B	K	C	R	B	K	C
Common Albatross	*Appias albina*																					*	*	* * *	* *											*	
Blue Tiger	*Tirumala hamata*						* *	*																*							* *						
Lime Butterfly	*Papilio demoleus*				*				*		*		*												*		* *										
Chocolate Argus	*Junonia hedonia*	*		*						*																											
Common albatross	*Appias albina*															*																					
Common Cerulean	*Jamides celeno*							*																													
Common Crow	*Euploea core*	*		*	*	*	*		*				*		*							*	*	*	*												
Common Emigrant	*Catopsilia pomona*					*	*	* *	*		*	*																									
Common Gull	*Cepora nerissa*						*																														
Common Leopard	*Papilo phalantha*						*	*																													
Common palmfly	*Elymnias hypermnestra*						*	*			*		*		*									*	*		*					*					
Common Pierrot	*Castalius rosimon*						*		*			*															*					*	*				
Common Rose	*Pachliopta aristolochiae*								*					*				*					*	*			*										
Common Sailor	*Neptis hylas*													*																							
Dainty Grass-blue	*Zizula hylax*						*	*												*	*		*	* *				*		*	*						

ommon Name	Scientific Name	Time and locations for Occurrence of Butterfly species																																					
		Jun 2014				Oct 2014				Jan 2015				Apr 2015				Aug 2015				Oct 2015				Jan 2016				Oct 2016				Jan 2017			
		R	B	K	C	R	B	K	C	R	B	K	C	R	B	K	C	R	B	K	C	R	B	K	C	R	B	K	C	R	B	K	C	R	B	K	C
Danaid Eggfly	*Hypolimnas misippus*											*																									
Evening Brown	*Melanitis leda*				*						*		*			* * *													*					*	* *	*
Foscus Swallowtail	*Papilio fuscus*																																				
Grey Pansy	*Junonia atlites*						*											*												*							
Indian sunbeam	*Curetis thetis*								*						*																						
Lemon Pansy	*Junonia lemonius*						*					*																									
Mangrove Jewel	*Hypochrysops epicurus*		*		* *																																
Stripped Tiger	*Danaus genutia*					*		*															* *		*												
Orchard Swallowtail	*Papilio aegeus*	*	* *													*																					
Pale Grass Blue	*Pseudozizeeria maha*														* *	* *																					
Three spot Grass Yellow	*Eurema blanda*					*	* *		*																												
Peacock pansy	*Junonia almana*						* *								*								* * *		*		*				* *				* *		
Rice Swift	*Borbo cinnara*						* *	*	* *				*																								
Small Grass-yellow	*Eurema smilax*		* *									*			*	* *		* *		* *	*					*	* *	*	*		* *	* *	* *				
Spotted Pea-blue	*Euchrysops cnejus*																																				
Swamp Tiger	*Danaus*												*			*																					

ommon Name	Scientific Name	Time and locations for Occurrence of Butterfly species																																			
		Jun 2014				Oct 2014				Jan 2015				Apr 2015				Aug 2015				Oct 2015				Jan 2016				Oct 2016				Jan 2017			
		R	B	K	C	R	B	K	C	R	B	K	C	R	B	K	C	R	B	K	C	R	B	K	C	R	B	K	C	R	B	K	C	R	B	K	C
	affinis																																				
Common Red Eye	*Matapa aria*																							*				*									

Source: CEGIS Monitoring (2014-2017)

Note: R = Rajnagar, B = Barni, K = Kalekarber C= Chakgona, NS = Not Surveyed, '-'= Not Found

*Butterfly occurrence: *= Low, **=Moderate, ***=High*

Dolphin occurrence in Passur River

218. A total of 16 km length of Passur River surround the project area (From Chalna to Mongla) have been transact by boat for observed dolphin occurrence . A total of 3 Ganges River Dolphins were recorded at different locations of the surveyed transect. All of which are diving and occurrence concentrated at the confluence points of the river (**Map: 3.2).**

219. Another short survey was conducted Karomjal, Harbaria and Akram Point while passing the river. Both at Karamjal and Harbaria, evidence of Ganges Dolphin was found. However, the survey result is included in Table: **3.11**.

Dolphin occurrence in Maidara River

220. Occurrences of Dolphin also have observed inside Maidara and Ichamoti River in parallel survey with Passur River at project site during flood tide. 6 individuals of Ganges dolphin sighted at Maidara-Ichamoti confluence point and one sighted near Maidara-Passur confluence point.

Dolphin occurrence in Dhangmari Khall

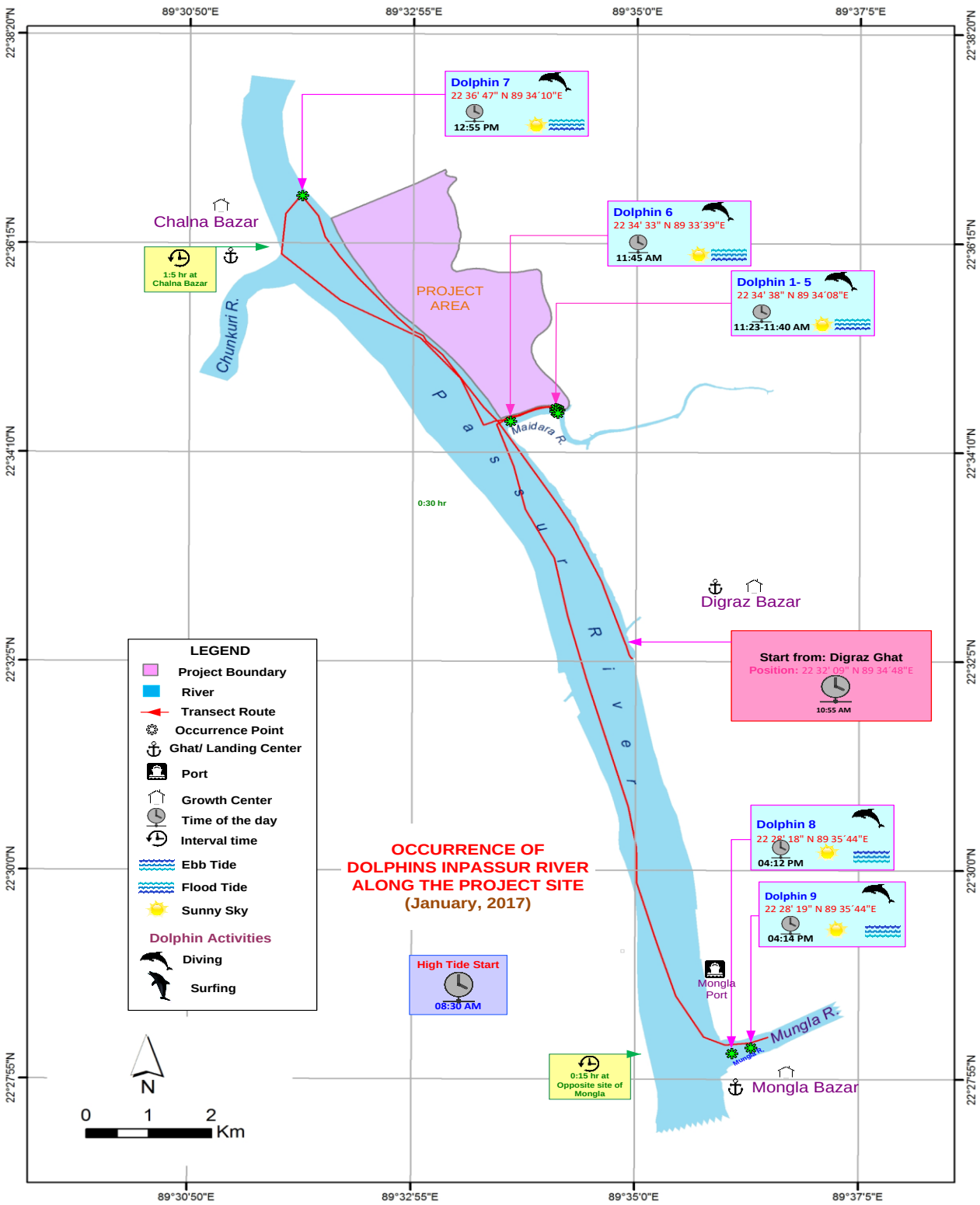
221. Dolphin also surveyed at the Dhangmari Khal Wildlife Sanctuary. Total transect length was 7x2km from Dhangmari-Passur confluence to Gagramari Patrol Post of Forest Department. 15 dolphins occurrences were recorded from this survey. Of which, 4 individuals have found at river confluence point in front of Gagramari Patrol Post and the average encounter rate of 0.55/km/hr.

Photo 3.4: Dolphin signs in Maidara River

Table 3.12: Occurrences of Butterflies in the study area

Location of River systems	Occurrence Status																					
	Apr 2014		Jun 2014		Oct 2014		Jan 2015		Apr 2015		Aug 2015		Oct 2015		Oct 2015		Jul 2016		Oct 2016		Jan 2017	
	F T	N T	FT	NT	FT	NT	F T	NT	FT	NT	F T	N T	F T	N T	FT	NT	F T	N T	F T	N T	F T	N T
Passur River Near Project Site	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	NS	Y	Y	Y	Y	Y	N	Y	Y	Y
Karamjal	NS	NS	NS	N	NS	Y	Y	Y	N	N	NS	Y	NS	Y	Y	N	Y	NS	Y	Y	Y	Y
Harbaria	NS	NS	NS	N	NS	Y	Y	N	N	N	N	N	Y	NS	Y	N	Y	Y	Y	NS	N	N
Akram Point	NS	NS	NS	N	NS	N	NS	Y	Y	Y	NS	NS	N	Y	Y	NS	NS	NS	N	N	NS	NS
Moidara River	Y	N	N	N	Y	Y	Y	N	Y	N	Y	N	NS	Y	N	Y	Y	NS	NS	Y	N	Y

222. Bangladesh's government declared the three new wildlife sanctuaries at Sundarbans in Jan. 29, 2012 establishing them in part to protect freshwater dolphins in the Sundarbans, the world's largest mangrove ecosystem. The sanctuaries will serve for the survival of the last two species of freshwater dolphins in Asia: the Ganges River dolphin and the Irrawaddy dolphin.



Map 3.2: Occurrence of Dolphin at Passur and Maidara River along the project site (January 2017)

c. *Status of planktons in river systems*

223. Plankton sample was collected from 7 different locations of Passur, Shibsa and Sutarkhali rivers during different tidal conditions in July 2016. 5 types of zooplanktones have been identified and highest density counted at Passur River project jetty site. Cyclops, Rotifer and Protozoans are common in 5 sites, whereas are recorded from Passur-Mungla rivers confluence point and Shibsa River water at Akram point. Detail plankton species association is presented in Table below.

Table 3.13: Plankton species composition and abundance of the study area

Location	Tidal Condition	Species	No. of Species Count	Total Plankton count (No./m3)
Mongla-Passur River confluence	High tide	Rotifer	1	8,050
		Cyclops	2	
		Diaptomus	3	
		Daphnia	1	
Passur river at Koromjol	Neap tide	Protozoa	2	2,625
		Roifer	3	
Passur River at Harbaria	High tide	Protozoan	2	1,665
		Diaptomus	1	
Sibsha River at Akram Point Full tide	High tide	Protozoan	2	9,350
		Rotifer	3	
		Cyclops	7	
		Diaptomus	5	
		Moina	5	
Chunkuri River at Sutiakhali	Neap tide	Cyclops	3	2,130
Passur River at Project Jetty	Full tide	Protozoan	1	16,800
		Rotifer	2	
		Cyclops	4	
		Diaptomus	1	
Maidara Ichamoti River confluence	Full tide	Protozoa	4	12,360
		Rotifer	1	
		Cyclops	1	

Source: CEGIS Field Survey, July 2016 (Sample analyzed from Department of Zoology, University of Dhaka)

3.3 Sundarbans Forest Health

224. CEGIS team is periodically monitoring Sundarbans forest health to oversee the probable impacts of Rampal Thermal Coal Power Plant Project under implementation. This monitoring program will also support in determining the status, trend and changes in the indicators of the forest condition. The Sundarbans forest health is being monitored quarterly as per monitoring schedule and so far, twelve (12) surveys have been conducted at five locations, namely Sutarkhali, Karamjal, Harbaria, Akram point and Hiron point. The overall monitoring indicators observed in twelve monitoring schedules broadly include plant growth, tree regeneration, tree crown condition, tree damage, lichen communities, plant diversity, soil chemistry, and plant physiology.

3.3.1 Methodology

Indicators Selected for Third Year Fourth Quarter

225. Monitoring frequency for different indicators has been determined considering efficiency in time, cost and applicability. The indicators observed in this tier are as follows:

- Seedling Regeneration
- Pneumatophores
- Crab hole density
- Canopy cover
- Leaf Area Index
- Tree Carbon
- Soil properties

Forest Health Monitoring Location

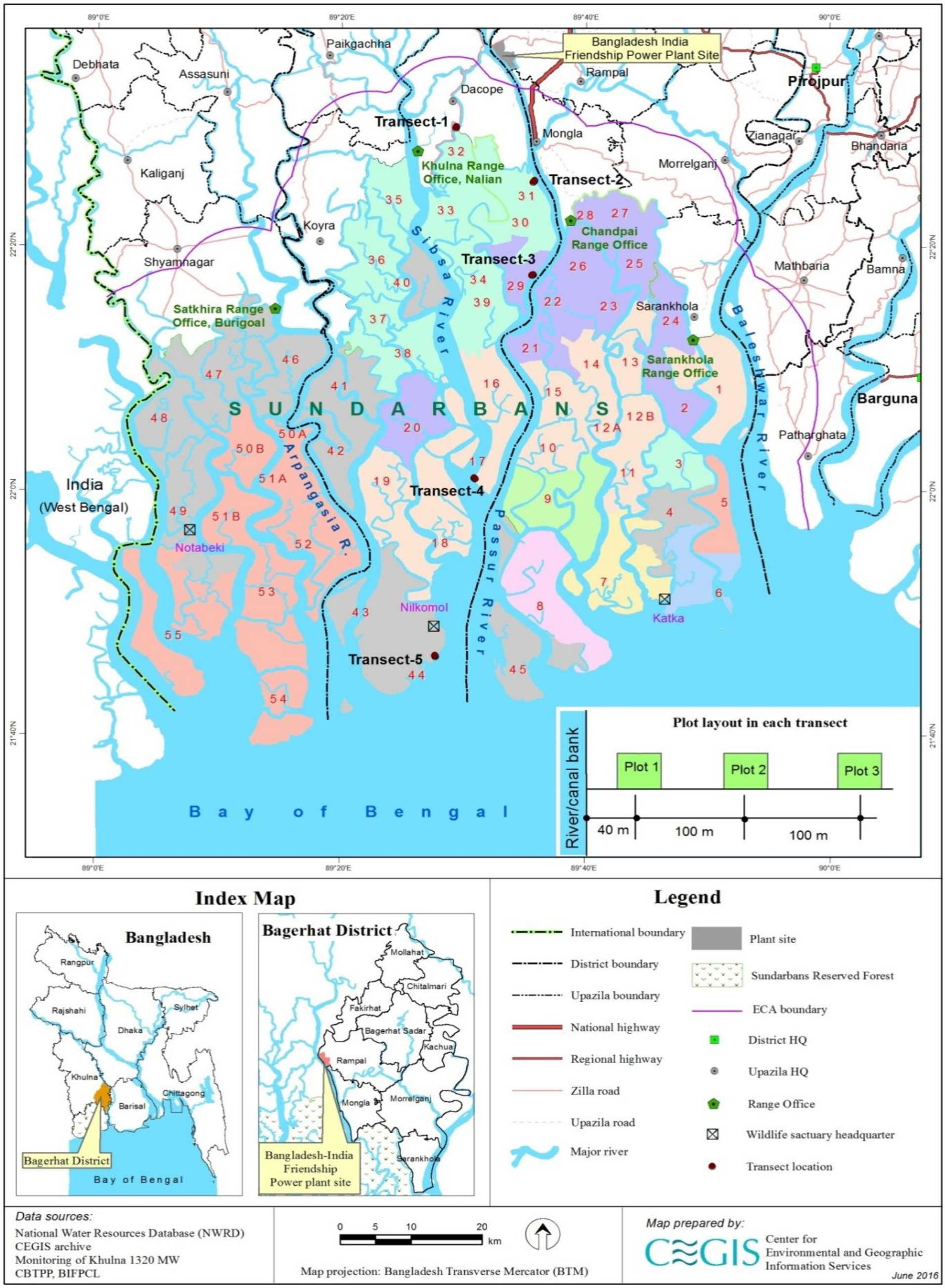
226. To set up permanent sample plots five sites have been selected on the basis of the survey conducted from April 3 to April 6, 2014 (**Map 3.3**). Among those, four sites are along the Passur River at Karamjal, Harbaria, Akram point and Hiron point, and the fifth one is near Sutarkhali forest office (**Table 3.14**). The sites have been selected considering the distance from the proposed Project site, coal transportation route, protection of the permanent sample plots, and vegetation types.

Sampling Design of Permanent Sample Plots (PSPs)

227. In each site, a transect line has been laid out perpendicular to river or canal bank. Along the transect line three circular nested subplots of 12.62 m radius have been laid out at 100 m intervals in order to capture the maximum tree species (**Figure 3.7**). Because of the variation in species composition in SRF, observation plots have been laid out from the coast, river or canal side to landward zone (forest proper side). The location of the first subplot is 40 m away from ecotone (riverside) to inner ward of forest in order to save the subplot from river bank erosion. Each subplot is again subdivided into four quadrates for the ease of data detection and recording (**Figure 3.8**).

Table 3.14: General Description of Permanent Sampling Plots (PSPs)

Transect	Plot	Range	Compartment No.	GPS ± (m)		Soil Description	Plot Location Notes
				Latitude (N)	Longitude (E)		
1. Sutar khali	1	Khulna	32	22.49815	89.48752	Hard Clay	Just opposite from Sutar Khali Forest Station and 40 m SW from Sutar Khali canal
	2	Khulna	32	22.49733	89.48711	Hard Clay	Just opposite from Sutar Khali Forest Station and 140 m SW from Sutar Khali canal
	3	Khulna	32	22.49655	89.48664	Hard Clay	Just opposite from Sutar Khali Forest Station and 240 m SW from Sutar Khali canal
2. Karamjal	1	Chandpai	31	22.42531	89.59439	Hard Clay	Plot centre 40 m west from Passur river
	2	Chandpai	31	22.42521	89.59341	Hard Clay	Plot centre 140 m west from Passur river
	3	Chandpai	31	22.42261	89.59254	Hard Clay	Plot centre 240 m west from Passur river
3. Harbaria	1	Chandpai	29	22.2061	89.5924	Hard Clay	40 m west from passure river
	2	Chandpai	29	22.29624	89.59179	Hard Clay	140 m west from passure river
	3	Chandpai	29	22.2962	89.5908	Muddy	240 m west from passure river
4. Akram Point	1	Khulna	17	22.01953	89.51291	Hard Clay	40 M east from shibsha river
	2	Khulna	17	22.01873	89.51344	Clayee	140 M east from shibsha river
	3	Khulna	17	22.01805	89.51408	Hard Clay	240 M east from shibsha river
5. Hiron Point	1	Khulna	44	22.77535	89.46104	Sandy	350m east from Gogari canal
	2	Khulna	44	21.91667	89.23333	Sandy	40m north from Bay of Bengal
	3	Khulna	44	22.18333	89.50000	Hard Clay	648m south east from Shibsa river



Map 3.3: Location Map of Sundarbans Forest Health Monitoring Plots (PSPs)

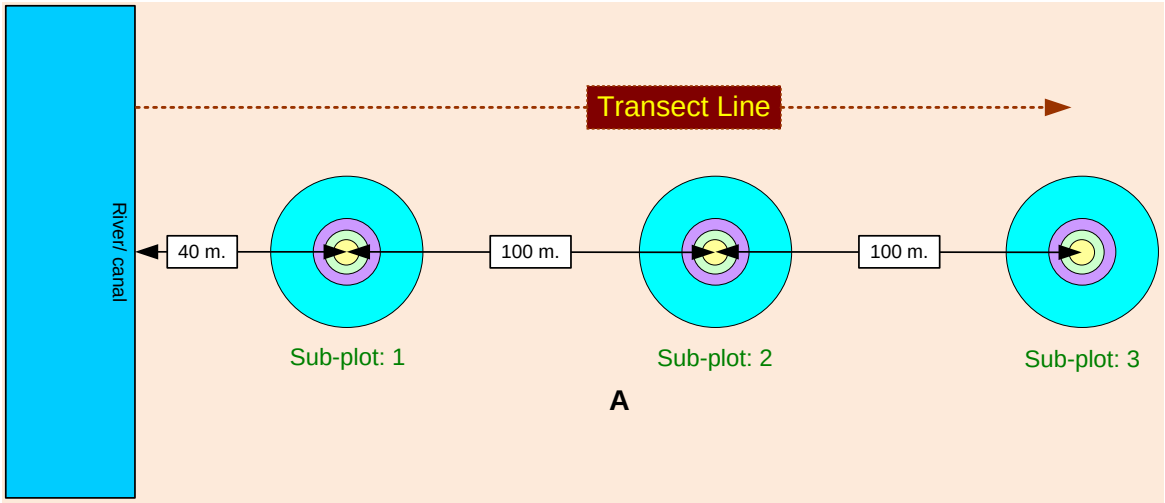


Figure 3.7: Layout of the subplots and transect line perpendicular from ecotone (river or canal bank)

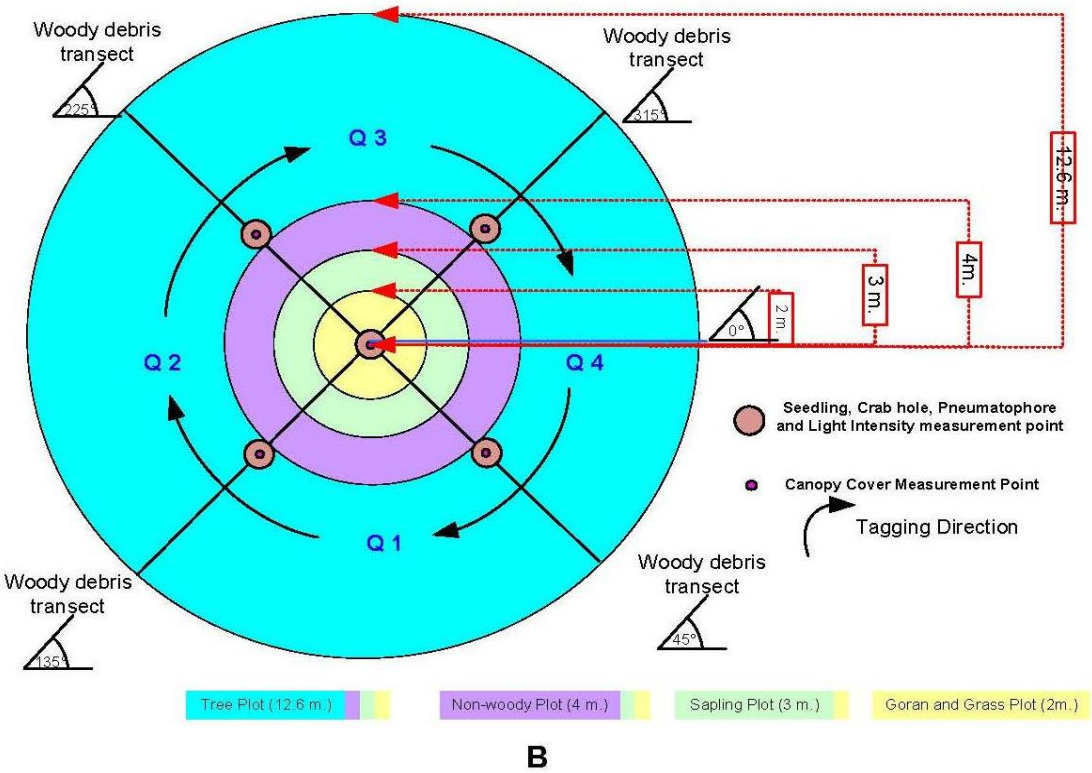


Figure 3.8: Layout of the survey activities in each subplot

Forest Health Survey

(a) Trees

228. The tag number of trees (DBH ≥ 5cm and lean angle greater than 45º) is monitored and rewritten if any new tree is found within 12.62 m radius circle of the Permanent Sample Plot (PSP). In the same monitoring period a map showing the location of all trees (tag number) is developed to ease the next data collection (**Photo 3.6**). The tree height and diameter are also taken by the surveyor (**Photo 3.7** & **Photo 3.8**).

Photo 3.5: Team Member recording and cross checking data in the field sheet

Photo 3.6: Team member measuring height of trees in the subplot

Photo 3.7: Surveyor measuring the DBH of trees in the subplot

(b) Sapling and seedling

229. Saplings (DBH < 5 cm and height 1.37 m) and seedlings (height < 1.37 m) have been assessed within 3m and 2m radius circle, respectively in each PSP. Seedlings have been counted species wise, and their status of living have also been recorded (**Photo 3.9**). For saplings, species name and DBH have been recorded along with the living status (**Photo 3.10**).

Photo 3.8: Team member counting the seedlings in the subplot

Photo 3.9: Surveyor measuring the DBH of saplings in the subplot

(c) Pneumatophores

230. The total number of living pneumatophores has been recorded within a circular area of 1 m radius centring each of the five points of all the subplots. The first point has been laid out in the centre of each subplot and other four have been in the midpoint of the four woody debris transects that are facing at 45°, 135°, 225° and 315° (**Photo 3.11**).

(d) Crab hole

231. Crab plays an important role in mangrove ecosystems such as decomposing litter fall thereby increasing fertility. In order to work out the crab density, usually crab hole abundance is monitored. For this purpose, the crab holes have been counted within an area of 1 m radius circle in each subplot's centre and in the midpoint of four woody debris transect (**Photo 3.12).**

(e) Canopy Cover

232. Percentage (%) of canopy cover has been estimated by a spherical densiometer, a gridded convex mirror that provides a simple and inexpensive approach of measuring canopy cover. The densiometer has been held at a distance of 30–40 cm from the body and at an elbow height so that head is not visible in the mirror (**Photo 3.13**). After levelling the instrument using the level bubble, the dots, which are not occupied by canopy, are systematically counted. In each subplot, the meter readings have been taken at five points facing north, south, east, and west direction including the centre point of the subplot. The canopy cover has been calculated by taking the average of these five readings.

(f) Leaf Area Index

233. Leaf Area Index (LAI) is a key structural characteristic of forest ecosystems because of the role of green leaves in controlling many biological and physical processes in plant canopies.It influences net canopy photosynthesis. Light absorption by the forest canopy can be used to estimate leaf area index (**Photo 3.14**). In this monitoring report, LAI is calculated as follows:

Leaf Area Index (LAI) = $\log_e (I/I_o)/-K$ m^2leaf area /m^2area of ground

(Where, I = Under Canopy Light Intensity, I_o = Open Canopy Light Intensity and K is Canopy light extension coefficient i.e., 0.5)

Photo 3.10: Team member taking canopy cover using Densiometer

(g) Tree Carbon

Tree Biomass Density

234. Aboveground biomass of all living tree species (DBH ≥ 5cm) were estimated by using Chave, et al., (2005) allomatric equation as yet site and species specific allomatric model is not available. Komiyama et al., (2008) equation was used to estimate below ground biomass if species specific biomass equations are unavailable.

– AGB (kg) = $\rho \times \exp(-1.349 + 1.980 \ln(dbh) + 0.207 \times (\ln(dbh))^2 - 0.0281(\ln(dbh))^3$

– BGB (kg) = $0.199 \times (\rho)^{0.899} \times (dbh)^{2.22}$

235. Where, ABG = above ground biomass; BGD = belowground biomass; DBH = diameter at breast height

236. Total tree biomass density (Mg/ ha) = Tree (ABG + BGB)

237. Total tree carbon density (Mg/ha) = Total tree biomass density X 0.5

(h) Soil sampling

238. The soil sampling was carried out in second year final quarter (winter period) and the soil properties data after being analyzed has been incorporated in this tier (**Photo 3.15**).

239. An open face split auger (1m long) has been used to pull out one meter long soil core. Soil core has been taken around the centre of the each plot. From the 100 cm soil core, a 5 cm long subsample has been taken from the middle point of 0-15, 15-30, 30-50 and 50-100 cm intervals for bulk density, soil pH, salinity, soil nutrients (Ca, Mg, Al , K, N and P) and organic carbon assessment (Kuaffman, and Donato, 2012).

Photo 3.11: CEGIS Professionals scaling out the soil sample

Bulk Density:

240. Bulk density has been measured according to Maynard and Curran, 2007. Collected samples have been oven-dried at 105°C until constant weight by using an air flow oven (Wisd, WOF-W305, Korea). The oven-dried samples have been weighted and the corresponding volume of core has been measured and bulk density (BD) of the soil sample has been calculated with the following equation:

Bulk Density (BD) = Wt105°C/Vcore

Vcore = πDcore^2Lcore/4

Where, Wt105°C is the weight of oven dried soil, Vcore is the volume of the core, Dcore is the inner diameter of the core and Lcore is the length of the core.

Soil Salinity (EC):

241. Soil Salinity (EC) has been measured according to Mostara and Roy, 2008. 1:2 ratio of soil and water (w/v) extraction has been followed to determine soil EC. 10 g of soil has been added with 20 ml of distilled water in a 250 ml Erlenmeyer flask. This mixture has been shaken on a reciprocating shaker for 1 hour and was filtered through Whatman No-1 filter paper. EC of the filtrated extraction has been measured by using an EC meter (Neomet EC-470L, istek Inc, Korea)

Soil pH:

242. Soil pH has been measured according to Miller and Kissel, 2010. 1:2 ratio of soil and water (w/v) extraction has been followed to determine soil pH. 10 g of soil has been added with 20 ml of distilled water in a 250 ml Erlenmeyer flask. The mixture has been shaken on a reciprocating shaker for 30 min and allowed the slurry to settle for 30 min. pH of the slurry has been measured by a pH meter (Hach, sension3, USA).

Total Organic Carbon:

243. Loss of ignition (LOI) method has been followed to measure organic carbon in soil sample (Allen et al., 1974). One gram of soil has been taken in a pre-weighted porcelain cup and oven-dried at 105 °C for 24 hours. The oven-dried sample has then been placed in digital Muffle furnace (WiseTherm F, Wisd, Korea) at 450 °C for four hours. After ignition the

sample has then been placed in desiccators to allow it to room temperature and weight it again to calculate the loss of ignition (LOI%) using the following formula

LOI% = (Wt105 °C – Wt450 °C)/Wt105 °C

244. Where, Wt105 °C is the weight of soil at 105 °C and Wt450 °C is the weight of soil at 450 °C.

245. The LOI% is usually accounted as organic matter percentage. A total of 50% of LOI% or ash free mass has been considered as the C content in the sample (Allen, 1989). However, the LOI or organic matter can be converted to organic carbon according to Nelson and Sommers, 1996 by using a universal conversion factor 1.724 (Van Bemmelen factor) based on the assumption that organic matter contains 58% organic C (i.e., Organic C% = Organic matter (%)/l.724)

Soil Total Kjeldahl Nitrogen:

246. Soil Total Kjeldahl Nitrogen has been measured according to Baethgen and Alley (1989). The digestion of soil sample has been carried out with concentrated H_2SO_4 catalyst mixture (100:10:1 of K_2SO_4:$CuSO_4$:Se) (Bremner and Mulvaney, 1982) in a block digester (VELP DK-6, VELP Scientifica) and diluted the digest with distilled water to a final volume of 100 ml. The Nitrogen concentration of the digest has been then analyzed colorimetrically using UV-VIS Spectrophotometer (Hitachi U-2910, Japan). 5.5 ml working buffer solution (0.1M Na_2HPO_4, 5% Na-K tartrate, 5.4% NaOH), 4 ml Na Salicylate-Na nitroprusside solution (15% - 0.03%), 2 ml Na hypochlorite solution have been added to 1 ml of aliquots. Absorbance of the sample has been then measured at 650 nm wavelength after 45 minutes.

Soil Total Phosphorus:

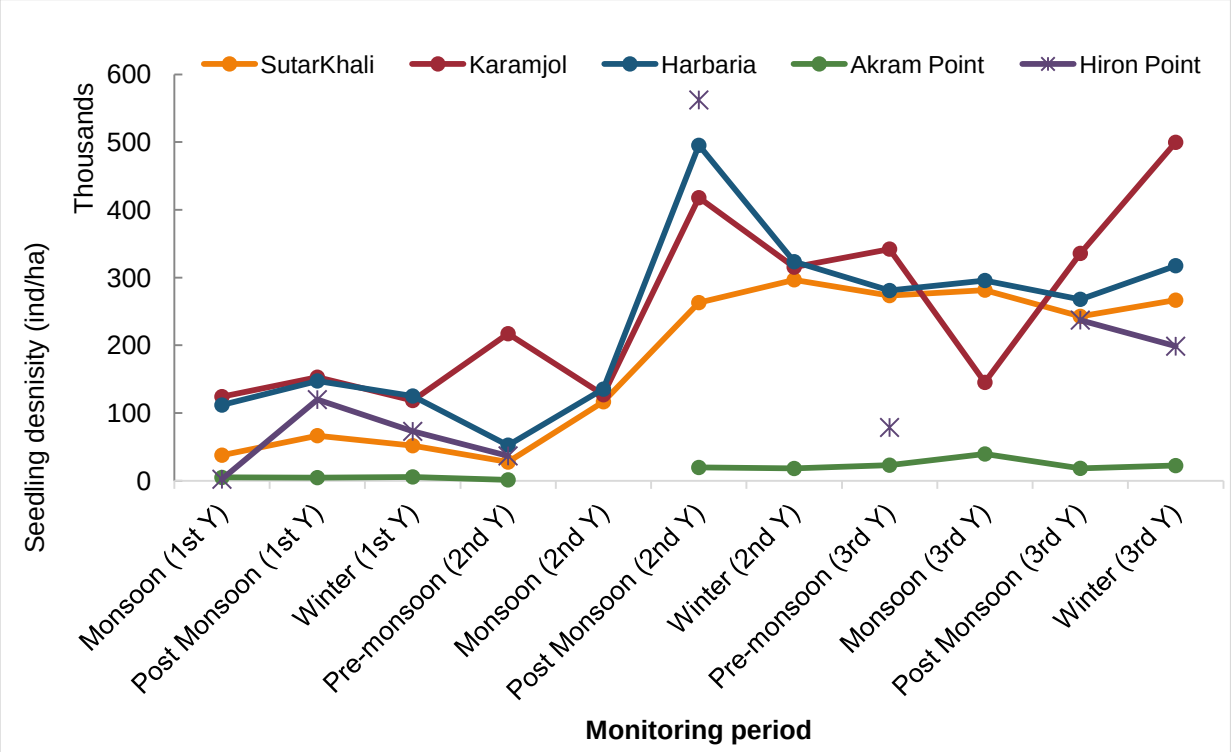
247. Total Phosphorus in soil has been measured according to Olsen and Sommers (1982). The digestion of soil sample has been carried out with concentrated HNO_3 and 60% Perchloric acid ($HClO_4$). The digest has been then diluted to a final volume of 100 ml with distilled water. 10 ml of Ammonium Paramolybdate-Vanadate reagent was added in 2 ml of sample aliquots and diluted the solution to 25 ml with distilled water. The Phosphorus concentration has been then analyzed colorimetrically with UV-VIS Spectrophotometer (Hitachi U-2910, Japan) at 470 nm wavelength after 20 minutes of sample preparation.

3.3.2 Status of monitoring of SRF Health

Seedling

248. From last twelve monitoring, it is found that number of seedlings per hectare is increasing almost all the monitoring locations except Akram point (**Figure 3.3.3**). The graph has also shown that higher number of seedlings is being found during monsoon to post-monsoon period whereas the number decreases during winter to pre-monsoon period. However, in this monitoring tier (winter 3Y), seedlings density at Karamjal is seen to be increased. The recruitment of new seedlings depends on regeneration and survival rate. These two indicators also depend on canopy cover, soil chemistry (pH, salinity, organic matter etc.). Seedlings usually die at an early stage in natural forest due to competition for nutrients as well as light intensity. Other than the silvicultural competition, the seedlings at Akram point also face natural stresses due to their location being very much closer to the sea. In the Sundarbans, most of the mangroves' seeds disperse during the rainy season and go up to forest floor. In this relation, seedlings are usually found more after the rainy season (monsoon to post monsoon) than in other seasons. It is to be noted that seedling density at

Hiron point during monsoon 2nd and 3rd year, winter 2nd year and at Akram point during monsoon 2nd year was not monitored.

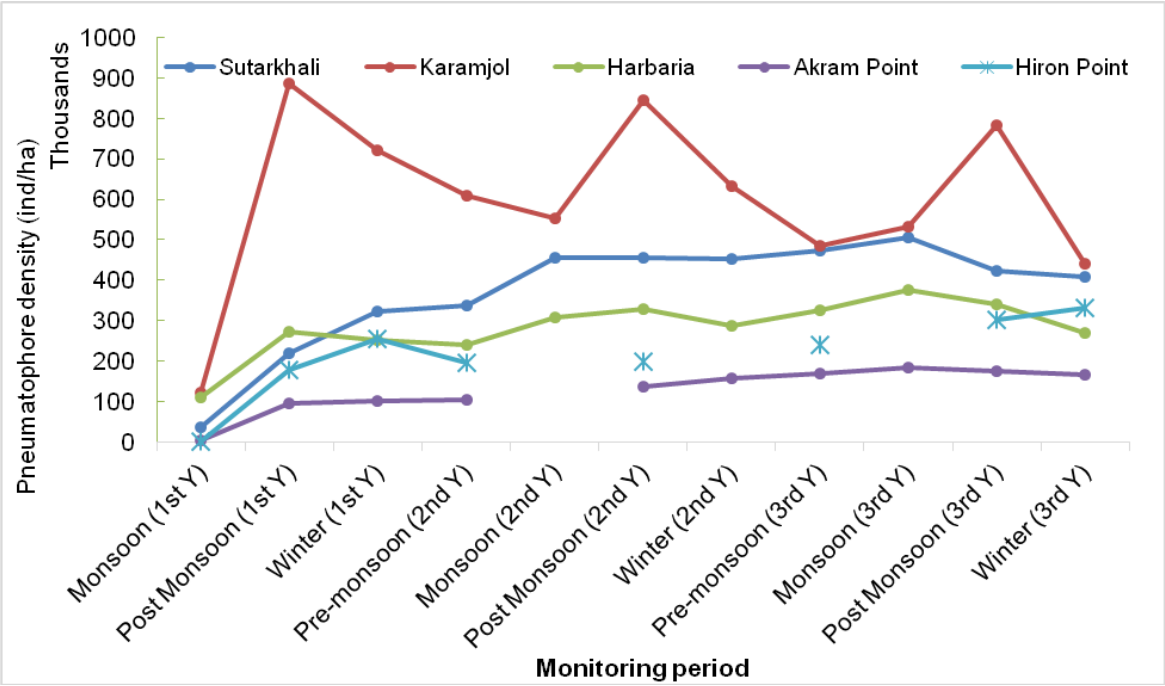


(Seedlings density was not monitored at Akram Point during Monsoon 2nd Year)

Figure 3.9: Mean (±95%CI) seedlings density among the quarterly surveys in five PSPs

Pneumatophores

249. Like seedlings, pneumatophores density also changes due to seasonal variability (Figure 3.10). Pneumatophores usually dry up and die during dry season. Hence, the number of pneumatophores per hectare is found comparatively higher in post-monsoon period. However, among five monitoring sites, the mean pneumatophores density is found lower in Akram point due to floristic composition. From the species composition inventory, it is found that this monitoring site is mainly dominated by Gewa (*Exoecaria agallocha*) species. On the contrary, Karamjal is mainly dominated by Baen (*Avicennia officinalis*) tree and it has numerous tender pneumatophores considering to others. The number of pneumatophores may also vary due to the elevation of the forest floor from the mean sea level (MSL). The major function of pneumatophores is to exchange gas into the atmosphere during tidal inundation. Hence, the highly elevated plot with less effect of inundation may have lesser number of pneumatophores. It is to be noted that pneumatophore density at Hiron point during monsoon 2nd and 3rd year, winter 2nd year and at Akram point during monsoon 2nd year was not monitored.

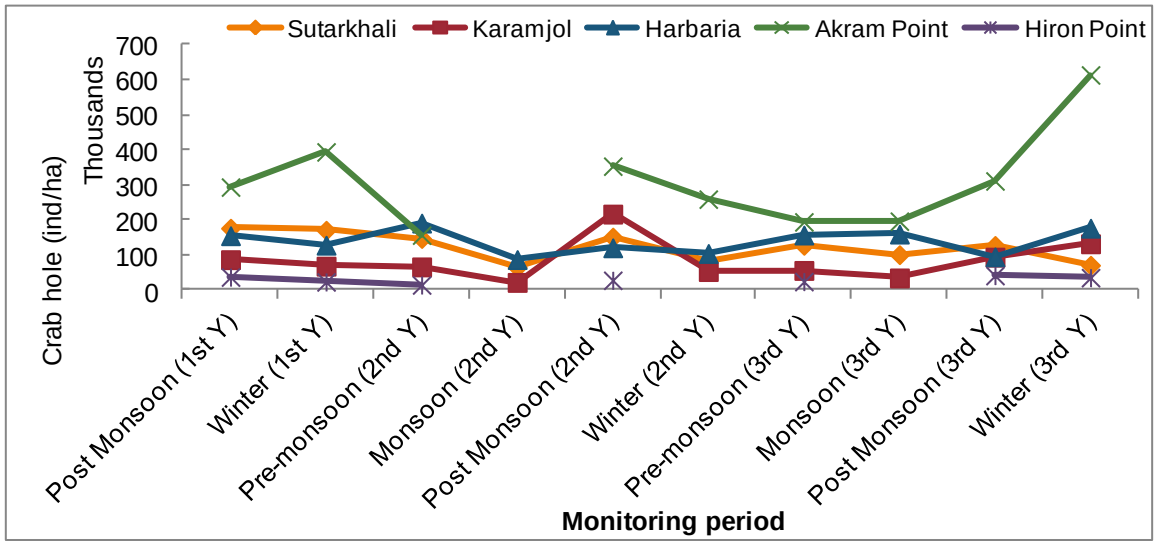


(Pneumatophores density was not monitored at Akram Point during Monsoon 2nd Year)

Figure 3.10: Mean Pneumatophores Density among the quarterly surveys in five PSPs

Crab hole

250. The crab hole density, the indicator of availability of crab in a site, has been found the highest at Akram point among the five monitoring sites **(Figure 3.11**). This may be due to sandy forest floor at Akram point because they love to drag hole on that particular habitat. From figure, it is difficult to predict the relationship of crab hole with seasonal variability. This may be due to the nature of mangrove (evergreen forest) forest floor. Although mangroves are marshy land, there are differences in terms of area in dry period (winter) and wet period (monsoon) which shows some influences on crab hole abundance. It is to be noted that crab hole density at Hiron point during monsoon 2nd and 3rd year, winter 2nd year and at Akram point during monsoon 2nd year was not monitored.

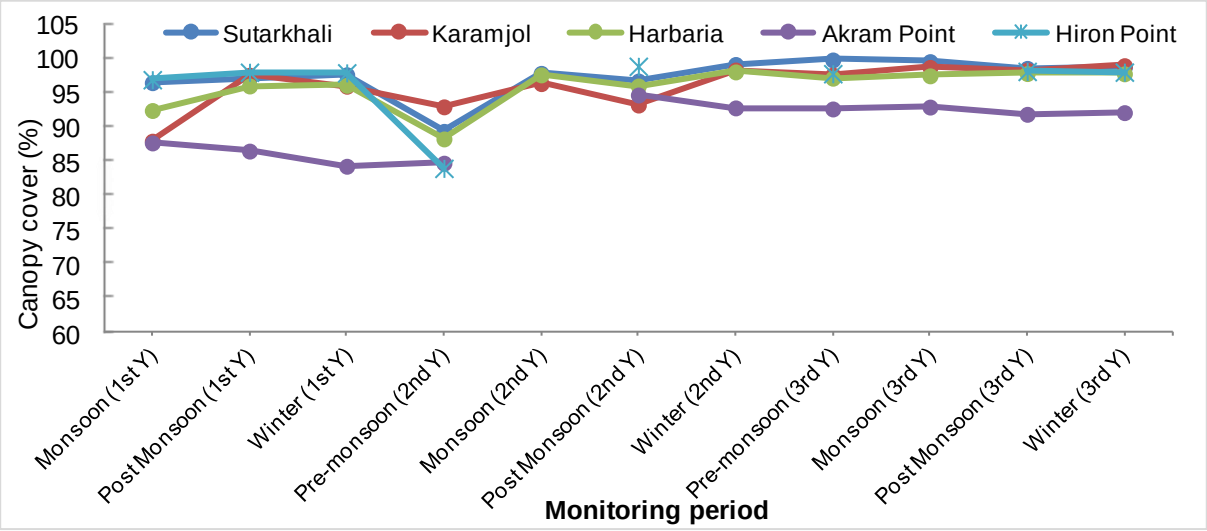


(Crab hole density was not monitored at Akram Point during Monsoon 2nd Year)

Figure 3.11: Mean crab hole density among the quarterly surveys in five PSPs

Canopy cover

251. In the monitoring plots, the canopy cover percentages have not varied significantly. From the first year to second year pre-monsoon, the highest canopy cover percentages are observed during monsoon to post monsoon which started decreasing during winter and is found the lowest in pre-monsoon period. However, from monsoon second year to winter third year, it is found that the canopy cover percentages are similar among the monitoring sites (**Figure 3.12**). Since greater than 60% of the canopy coverage in a site is treated as healthy, all the locations of the monitoring sites are in good shape. It is to be noted that canopy cover at Hiron point during monsoon 2nd and 3rd year, winter 2nd year and at Akram point during monsoon 2nd year was not monitored.

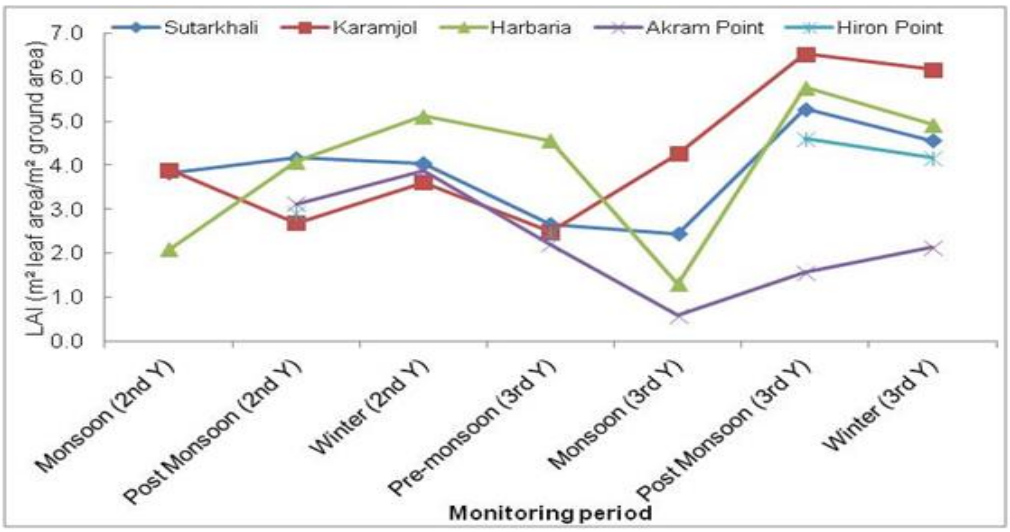


(Canopy cover was not monitored at Akram Point during Monsoon 2nd Year)

Figure 3.12: Mean canopy cover (%) among the quarterly surveys in five PSPs

Leaf Area Index (LAI)

252. The LAI influences daily rate of net canopy photosynthesis which results in exchange of atmospheric CO2. The minimum the ratio of under canopy to open canopy light intensity value indicates the maximum the LAI. Hence, the maximum the net canopy photosynthesis. From Figure 3.3.7, it is found that the LAI has increased in all monitoring locations from previous results. This is a sign of good health of forest. However, at Akram point like other indicators the LAI is much lower due to high under canopy light intensity. It is to be noted that LAI at Hiron point during monsoon 2nd and 3rd year, winter 2nd year and at Akram point during monsoon 2nd year was not monitored.



(LAI was not monitored at Akram Point during Monsoon 2nd Year)

Figure 3.13: Leaf Area Index (m^2 leaf area /m^2 ground area) among the quarterly surveys in five PSPs

Tree Carbon

253. Like other indicators of forest health, ecosystem carbon stocks is very much important. Mangrove ecosystem sequestrates greater amount of carbon than other forest due to high root shoot ration and huge organic matter. Here, in this monitoring report total carbon sequestration only for living trees (above and below ground) per hectare among five locations has been compared to see the periodic changes. From figure 3.14, it is seen that tree carbon is increasing periodically due to increasing of tree diameter and recruitment of new trees. However, this increasing pattern is not same in all monitoring locations and tiers. This change happen due to dying or decaying rate of trees. From last three years monitoring, it is found high tree mortality at Akram point compared to other. In In third year pre-monsoon period, high rate of illegal felling (reported in 9th Monitoring report) was observed at Hiron point, which has negative effect on carbon stocks.

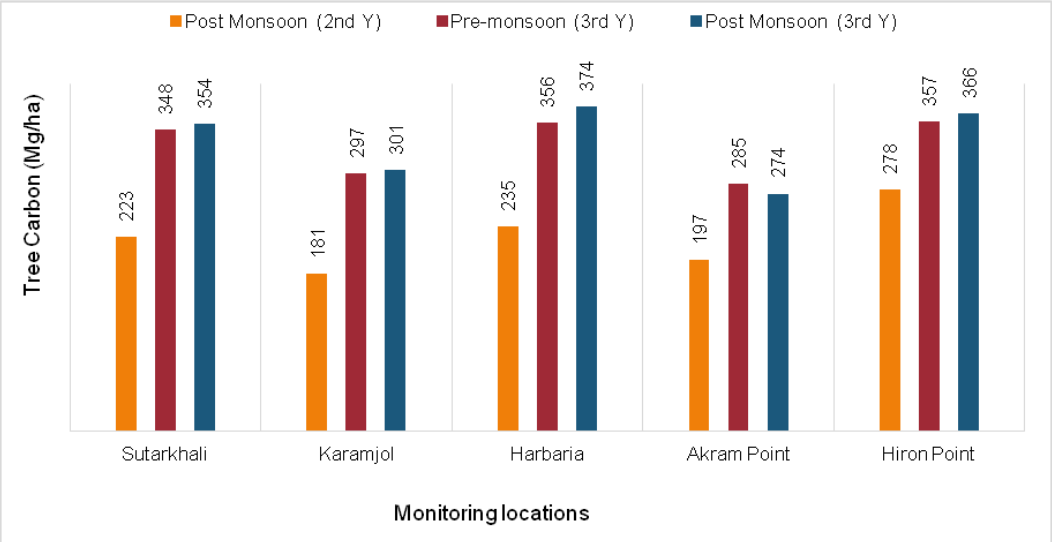


Figure 3.14: Tree Carbon (Mg/ha) among the quarterly surveys in five PSPs

Soil properties

254. The soil properties were analysed using samples collected in third year third quarter (post-monsoon period) from the monitoring sites. The mean bulk density, Soil pH, soil salinity (EC), OC%, N and P contain across the five monitoring sites were given in table 3.15. There is not found significant changes of mean soil properties among the monitoring sites except N and P concentration. Lower bulk density indicates that the site have more organic matter. According to this fact the Harbaria site's soil contained more organic matter, less compact, and more porous. Soil salinity has been found highest in Karamjol Point (6.53 ms cm-1), while this figure is lowest in Hiron Point (3.19 ms cm^{-1}, Table 3.15). The OC% has been observed almost similar figure in all monitoring locations except Hiron point which represents lower amount of OC (1.88%). The N concentration was found similar in Karamjol, Harbaria and Akram Point (Table 3.15). Lowest N concentration has been observed at Sutar Khali site (Table 3.15). The P content is also found lowest in Hiron point. The Hiron point shows poor concentration of soil properties because of the location's high elevation compared to others and results in lower litter decomposition.

Table 3.15: Mean soil properties among the four monitoring sites in SRF

Soil depth (cm)	Soil parameters					
	Bulk density (g cm^{-3})	Soil pH	Soil Salinity (EC) ms cm^{-1}	OC %	N(mg g^{-1})	P (mg g^{-1})
Sutar Khali						
0-15	1.10	7.25	1.76	1.72	0.41	0.83
15-30	1.15	7.37	3.13	2.32	0.73	1.46
30-50	1.22	7.74	3.91	2.15	0.75	1.50
50-100	1.21	7.61	5.04	2.45	0.67	1.33
0-100	**1.17**	**7.49**	**3.46**	**2.16**	**0.64**	**1.28**
Karamjol						
0-15	1.07	7.27	4.47	2.46	1.04	2.08
15-30	1.10	7.32	7.18	2.88	1.06	2.11
30-50	1.17	7.43	7.31	2.81	0.90	1.80
50-100	1.22	7.49	7.17	2.95	0.77	1.54
0-100	**1.14**	**7.38**	**6.53**	**2.77**	**0.94**	**1.88**
Harbaria						
0-15	1.00	7.49	1.84	2.72	1.14	2.28
15-30	1.00	7.45	2.74	2.75	1.08	2.17
30-50	1.11	7.34	4.59	2.73	1.09	2.18
50-100	1.18	7.31	6.71	2.86	0.95	1.90
0-100	**1.07**	**7.40**	**3.97**	**2.77**	**1.07**	**2.13**
Akram Point						
0-15	1.17	7.44	3.05	2.34	1.08	2.17
15-30	1.14	7.19	4.25	2.83	1.14	2.28
30-50	1.15	7.34	5.24	3.36	0.98	1.97
50-100	1.24	7.13	5.76	2.78	0.93	1.87
0-100	**1.18**	**7.28**	**4.58**	**2.83**	**1.03**	**2.07**
Hiron Point						

Soil depth (cm)	Soil parameters					
	Bulk density (g cm^{-3})	Soil pH	Soil Salinity (EC) ms cm^{-1}	OC %	N(mg g^{-1})	P (mg g^{-1})
0-15	1.18	6.99	2.90	1.63	0.66	1.33
15-30	1.17	6.87	1.84	1.61	0.61	1.21
30-50	1.22	6.90	2.79	2.07	0.77	1.54
50-100	1.27	7.31	5.24	2.23	0.74	1.49
0-100	**1.21**	**7.02**	**3.19**	**1.88**	**0.70**	**1.39**

3.3.3 Findings

255. From the last eleven monitoring, it can be predicted in terms of seedling density, pneumatophore, crab hole, canopy cover and leaf area index (m^2 leaf area/m^2 ground area) that the forest condition is showing positive changes periodically, although there has some seasonal effect. However, the Akram point is situated at the confluence of Shibsa and Passur River. Therefore, during tidal inflow the forest floor carry large amount of sediment than other locations. Here, the forest is experiencing retrogation process where the climax species are started decaying. Hence, this area is sensitive in terms of disturbance. Therefore, the monitoring should be continued to know the dynamism of mangrove attributes which are very much interlinked with each other as well as with the environment and more monitoring site should delineate as control site to compare any potential impact due to coal transportation and transshipment along the Passur River.

3.4 Agriculture Resources

256. Monitoring of agriculture resources has been scheduled twice a year as per the contract. Accordingly, a survey has been conducted in April and October 2014, 2015 and 2016 for the year of 2013-14, 2014-15 and 2015-16 respectively. In addition, as per suggestion of Department of Environment (DoE), present agricultural practices and status of crop production are incorporated in this report to provide an idea of the present agricultural scenario in the monitoring area. For this reason, Upazila wise secondary data of 2014-15 has been collected from the local Department of Agriculture Extension (DAE) offices. The consultation session with the DAE officials is appended to this report. It is mentioned that various crops like HYV Aus, Local Aman, HYV Aman, HYV Boro, Local Boro, summer and winter vegetables, Pulses, Potato, Spices, Sesame and Water melon etc. are cultivated inthe study area. However, in the sample plots only Aman was found to be cultivated. As such data on Aman crops were collected through field visit, while data on other crops were collected from secondary sources.

3.4.1 Methodology

Monitoring Indicators

257. The major monitoring indicators for agriculture sector are major crop area, crop production and crop damage.

Sampling Method

258. During field visit, extensive consultations/group discussions have been held with local people to know the use of inputs, present cropping patterns by land type, crop damage due to drainage congestion/water logging, salinity or other natural calamities induced impacts as

well as management practices and crop production in the selected locations of the monitoring area.

Frequency

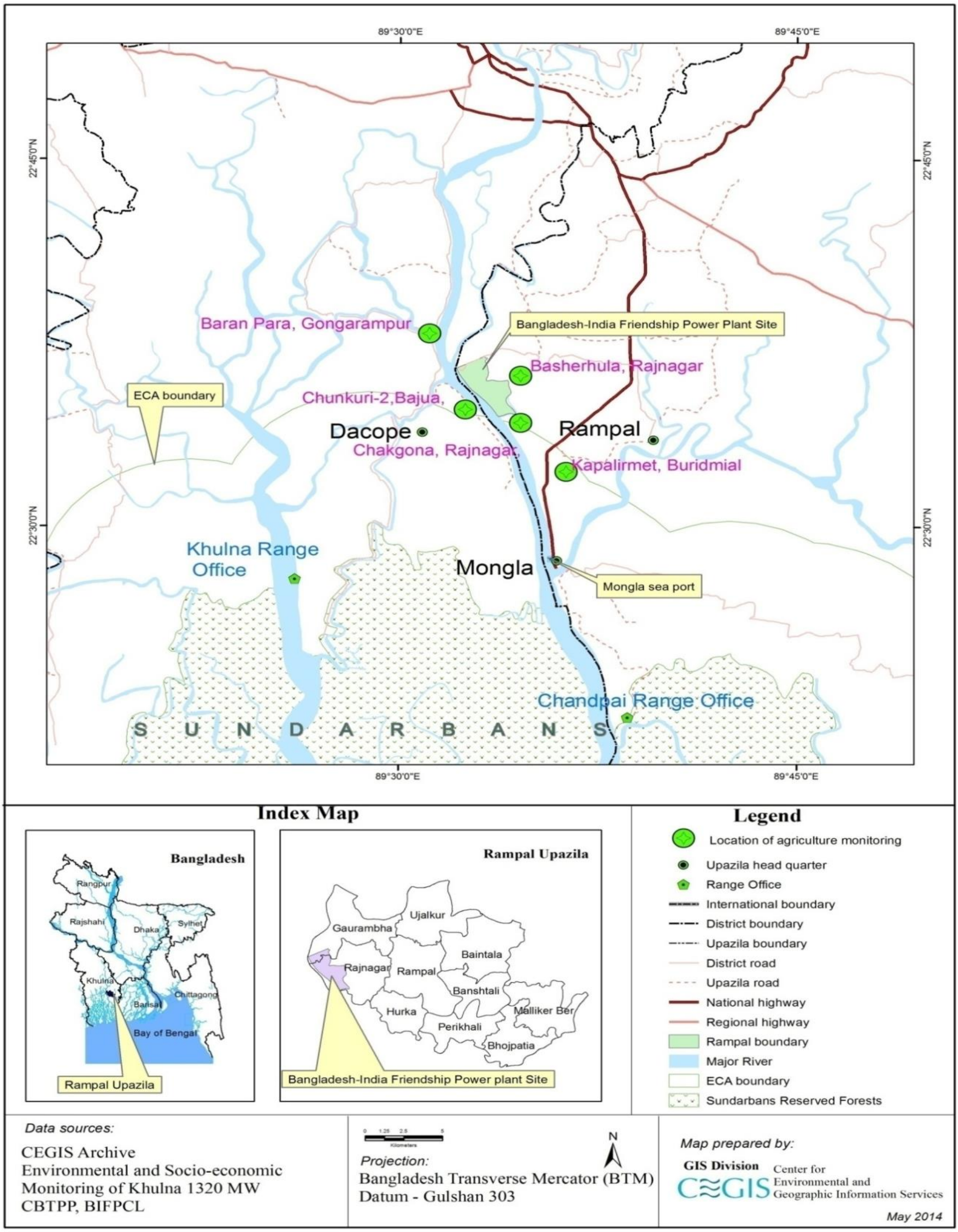
259. Land use, major crops area, major crop production and damages are monitored quarterly in a year. Data related to the cropping season of 2013-14, 2014-15 and 2015-16 were collected in April and October, 2014, 2015 and 2016 through field visit. The farmers of the monitoring plot stated that, they are harvesting their Aman crops during end November to early December. As such crop production and damage data have been collected during the field visit in April, 2014, 2015 and 2016 for the year of 2013-14, 2014-15 and 2015-16 respectively.

Location

260. The study area covers about 10km radius. However, for agricultural data collection five samples plots were selected on random basis within the study area. The same mauzas have been selected for land resources as well as agricultural resources monitoring. Locations of the agriculture monitoring plots are presented in **Map 3.4**

3.4.2 Description of the Selected Agriculture Plot for Monitoring

261. Detailed information of the selected plot for agriculture monitoring is presented in Table **E.1 of Appendix IV.**



Map 3.4: Agriculture Resources Monitoring Locations

3.4.3 Upazila Wise Cropping Pattern of the Monitoring Area for the Period of 2014-15

262. The monitoring area (10km radius) comprises four upazilas namely Batiaghata, Dacope, Rampal and Mongla under Khulna and Bagerhat districts. According to the secondary information of local DAE offices, dominant cropping pattern is Fallow-Local Aman-Fallow which occupies 95.3% of NCA at Mongla upazlia of Bagerhat district. Next dominant cropping pattern is Fallow–HYV Aman-Fallow which covers 81.5% of the NCA at Dacope upazila of Khulna district. Detailed cropping pattern of the monitoring study area is presented in **Table E.4** of **Appendix IV**.

3.4.4 Upazila Wise Cropped Area, Yield and Crop Production for the Period of 2014-15

263. Total cropped area is 79,676 ha, of which 33,612 ha, 23,394 ha, 11,200 ha, 11,470 ha are in the Batiaghata, Dacope, Rampal and Mongla upazila respectively for the year of 2014-15. According to the local DAE, total crop production is 288,667 tons, of which 91,019 tons, 129,165 tons, 42,197 tons and 26,286 tons are produced in the Batiaghata, Dacope, Rampal and Mongla upazila respectively. Among the crop production, the highest (68%) production of Local Aman crops is at Mongla upazila of Bagerhat district. The next highest (41%) crop production is of HYV Boro crops at Dacope upazila under Khulna district. Detailed cropped area, yield and crop production of the monitoring study area are presented in **Table E.5 of Appendix IV.**

3.4.5 Present Cropping Patterns of Monitoring Plots

264. Detailed data on the last three years of cropping pattern have been obtained through extensive discussion with the plot owners. Based on the discussion, the plot based cropping patterns have been identified for the year 2013ropping pattern data has been collected in October, 2014 and October, 2015 for the year of 2014-15 and 2015-16. Detailed cropping pattern are presented in Table **E.6 of Appendix IV.** The cropping patterns for different years are presented in the following paragraphs.

Agriculture Plot-1(Baranpara)

265. This plot is located at Baranpara and the size of the plot is about 0.4 ha. Farmer of the plot cultivated Local Aman (Kumragur) in Kharif-II season during the 1st Monitoring year (2013-14). Chemical fertilizer and liquid pesticides was used in the plot for crop production. Rice straw and Bajua grass were mixed to improve the soil fertility level. In the year 2014-15(2nd Monitoring year), the plot owner cultivated HYV Aman (BRRI dhan 30) in the Kharif-II season. Pest like Stem borer and Leaf roller infestation has been observed in this plot. Chemical fertilizer and pesticides have been used. The rates of chemical fertilizers as used in this plot were: Urea: Not applied, MP: 11.2kg/plot and DAP: 37kg/plot. To protect crop from pest infestation, granular pesticide Virtako 40WG was applied @ 500gm/plot.

266. In the Kharif-II season of 2015-16(3rd Monitoring year), HYV Aman (BR23) has been cultivated. Chemical fertilizer and liquid pesticide have been used. Pest like Stem borer and Leaf roller infestation has been observed in this plot. Chemical fertilizer used in this plot included Urea: 15.0 kg/plot, TSP: Not applied and MP: 5.0kg/plot. To protect crop from pest infestation, granular pesticide Virtako has been applied @ 500gm/plot. Due to the application of pesticide, the pest infestation reduced significantly. So, no crop damage was found in this plot. Detailed cropping pattern is shown in Table **E.6 of Appendix IV.**

Agriculture Plot-2(Chunkuri-2)

267. This monitoring plot is located at Chunkuri-2 and the size of the plot is about 0.93 ha. Farmer of the plot was practicing HYV Aman (BR23) in Kharif-II season in the 1st Monitoring year (2013-14). Chemical fertilizer and liquid pesticides was used in the plot. Rice straw and Bajua grass were mixed to improve the soil fertility level. In 2014-15(2nd Monitoring year), farmer of this plot cultivated Local Aman (Benapole) due to the high market price of local variety than HYV Aman. Stem borer infestation has been observed in this plot. Chemical fertilizer and pesticides have been used in the plot. The rates of chemical fertilizer and pesticides as used in this plot were; Urea: 125 kg/plot, TSP: 42kg/plot and MP: 20kg/plot. To protect crop from pest infestation, liquid pesticide Karate 2.5 EC has been applied @700ml/plot.

268. Farmer of the plot has been practicing Baran in Kharif-II season of 2015-16(3rd Monitoring year) due to its high market price for being a local variety than HYV Aman as well as its saline tolerance capacity. Chemical fertilizer and liquid pesticides have been used in the plot. Stem borer infestation has been observed in this plot. Chemical fertilizers used in this plot include Urea: 42 kg/plot, TSP: 7kg/plot and MP: 3.5 kg/plot. To protect crop from pest infestation, liquid pesticide Karate 2.5 EC has been applied @500ml/plot. Infestation of stem borer has been checked due to pesticides application. So, no crop damage was observed this year. Detailed cropping pattern is shown in **Table E.6 of Appendix IV.**

Agriculture Plot-3 (Kapalirmet)

269. This monitoring plot is located at Kapalirmet and the size of the plot is about 0.14 ha. Farmer of the plot has practiced Local Aman (Chapsail) in Kharif-II season in the 1st Monitoring year (2013-14).Chemical fertilizer and liquid pesticides have been used. In Kharif-I and Rabi season, farmers are used to culture shrimp in this plot every year. In 2014-15(2nd Monitoring year), this plot has remained fallow due to salinity. Shrimp gher owners of this area have been practicing to let saline water from Ghona River enter in the plots every year for shrimp culture. There has been no scope to drain/wash out saline water from this area. On the other hand, inadequate rainfall has occurred in this year. Farmers of this locality informed that many of them have cultivated T. Aman crops in their plots. But most of the crops have been damaged due to saline water. However, shrimp/fish has been cultured in this plot in the Kharif-II season of 2014-15. Due to this, farmers have not grown Aman crops in this Kharif-II season while they were expecting to cultivate Aman in the upcoming Kharif-II season.

270. But the situation has not been in the farmers' favor as expected. In the 3rd year of monitoring (2015-16), farmers of this locality opined that Bangladesh Water Development Board (BWDB) decided to commence the re-excavation of the Ghona River. They removed all the obstacles to facilitate the re-excavation of the Golbunia khal mouth. For this reason, water enters into the settlement areas including their cultivated plots. The whole area has been inundated by saline water. As a result farmers of the locality could not cultivate crops and cultured shrimp. Many of the farmers cultivated crops in their plot in this adverse situation, but all crops were damaged by river water and rain water as well. Detailed cropping pattern is presented in Table E.6 of Appendix IV.

Agriculture Plot-4 (Chakgona)

271. This monitoring plot is located at Chakgona and the size of the plot is about 0.28 ha. Farmer of the plot is cultivated Local Aman (Chapsail) in Kharif-II season of 1st Monitoring year (2013-14). In Kharif-I and Rabi season shrimp was cultured in this plot every year, but this year there is no shrimp culture in this particular piece of plot. Chemical fertilizer and liquid pesticides are being used in the plot. Due to adverse situation of salinity, the plot has not been suitable for crop cultivation in Kharif-II season of the 2nd Monitoring year of 2014-15, while farmers were expecting to cultivate Aman in the upcoming Kharif-II season.

272. Unfortunately, salinity contamination continued thereafter. So, he could not cultivate crops in his plot in Kharif-II season of 2015-16(3rd Monitoring year). It is also mentioned that plot owner has given part of the plot (0.07 ha out of 0.14ha) voluntarily for the construction of cyclone shelter at Chakgona mouza. Detailed cropping pattern is presented in **Table E.6 of Appendix IV.**

Agriculture Plot-5 (Basherhula)

273. This monitoring plot is located in Basherhula and the size of the plot is about 0.47 ha. Farmer of the plot has cultivated Local Aman (Benapole) in Karif-II season of the 1st Monitoring year (2013-14). Chemical fertilizer and liquid pesticides are being used in the plot. In the succeeding year of 2014-15 (2nd year), the farmer of this monitoring plot cultivated Local Aman variety (Chapsail). Pest like Stem borer infestation has been observed in his plot. Chemical fertilizer and pesticides are being used in the plot. Chemical fertilizers used in this plot were Urea: 5kg/plot, TSP: 15kg/plot and MP: 10kg/plot. To protect crop from pest infestation liquid pesticide (Karate 2.5 EC) applied @500ml/plot.

274. Farmer of the plot cultivated Local Aman (Baran) in Karif-II season of 2015-16(3rd Monitoring year). Noteworthy, the Baran rice is a salt tolerant variety. Chemical fertilizer and liquid pesticides are being used in the plot. Pest like Stem borer infestation has been observed in this plot. Only Urea was applied in his plot at the rate of 30kg/plot. To protect crop from pest infestation, liquid pesticide (Karate) applied @500ml/plot. As a result, crop was protected from stem borer infestation and there was no crop damage found in this plot. Detailed cropping pattern is shown in Table **E.6 of Appendix IV.**

3.4.6 Crop Production in Monitoring Plots

275. The highest production (2.4 tons) has been observed in the monitoring agriculture plot-2 (Chunkuri-2) because only HYV Aman is cultivated in this plot and lowest production (0.2 ton) has been observed in monitoring plot-3(Kapalirmet), while in other plots local Aman has also been cultivated in 2013-14. Of these monitoring agricultural plots, farmers of Chakgona and Kapalirmet could not cultivate crops in 2014-15. The highest production (1.4 tons) has been observed in monitoring plot-1(Baranpara) due to HYV Aman crop cultivation and the lowest (0.57 tons) has been observed in monitoring plot- 5 (Basherhula) in 2014-15. The monitoring plots (Kapalirmet and Chakgona) have remained fallow this year (2015-16) due to the adverse impacts of salinity. The highest production (1.9 tons) has been obtained in monitoring plot-2 (Chunkuri-2) and the lowest production (0.99 tons) has been obtained in monitoring plot-5 (Basherhula) in the year of 2015-16. It has also been observed that the crop production has slightly decreased from the year 2013-14 and increased over the year 2014-15 in all the monitoring plots, except in Kapalirmet and Chakgona. Detailed information

on crop production in the monitoring plots is presented in Figure 3.4.3 and **Table E.7** of **Appendix IV.**

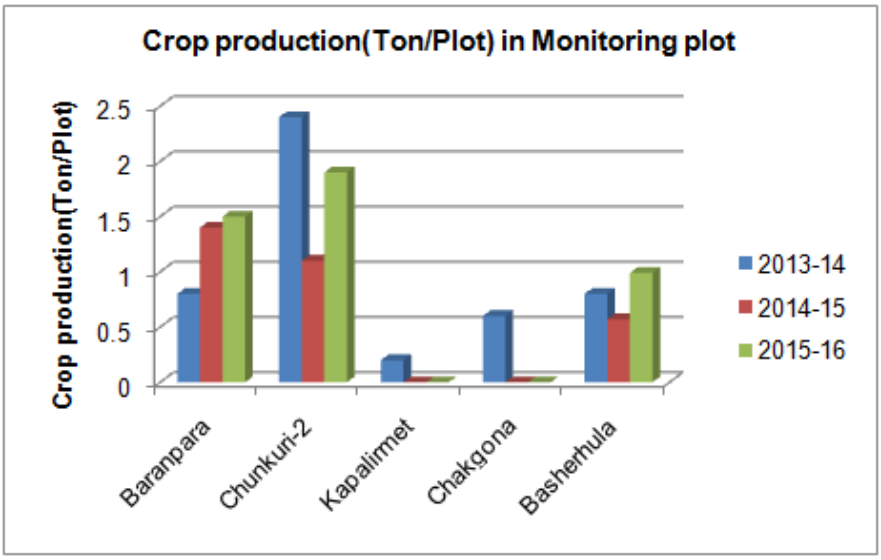


Figure 3.15: Crop Production in the Monitoring Agriculture Lands for the Last Three Consecutive Years

3.4.7 Crop Damage in Monitoring Plots

276. No crop damage has been observed in any monitoring plot in the year 2013-14. The owners of plot-1 (Baranpara), plot-2 (Chunkuri-2) and plot-5 (Basherhula) was cultivated HYV and Local Aman crops in the Kharif-II season of 2014-15. The rest of the plots (Kapalirmet and Chakgona) remained fallow due to the adverse impacts of salinity in 2014-15 and 2015-16. Crop damage was observed in monitoring plot-2(Chunkuri-2) and monitoring plot-5(Basherhula) in the year of 2014-15. Crop damage areas are about 0.33 ha and about 0.17 ha respectively this year. This was happened due to pest infestation in these two plots. Leaf roller was observed in monitoring plot-2. Stem borer, Rice hispa and Rat were observed in the plot-5. A total 0.52 tons of crop has been damaged 0.50 ha of plots (monitoring plot-2 and monitoring plot-5). Similar to the year 2013-14, no crop damage has been observed in any monitoring plots in 2015-2016. Detailed crop damage information is presented in Table **E.8 of Appendix IV.**

Summary of the agriculture resources monitoring

277. Crop production is an indicator of the fertility and productivity of a piece of land from the agricultural point of view. Crop production varies from plot to plot and due to different crop variety, fertility status, access to other inputs and management practices of the plot. For this reason, the production levels of the plots are not the same. Total cropped area is 79,676 ha, of which 33,612 ha, 23,394 ha, 11,200 ha, 11,470 ha are in the Batiaghata, Dacope, Rampal and Mongla upazila respectively for the year of 2014-15 in the monitoring area. Total crop production is 288,667 tons, of which 91,019 tons, 129,165 tons, 42,197 tons and 26,286 tons are produced in the Batiaghata, Dacope, Rampal and Mongla upazila respectively. Among the crop production, the highest (68%) production of Local Aman crops is at Mongla upazila of Bagerhat district. The next highest (41%) crop production is of HYV Boro crops at Dacope upazila under Khulna district.

278. Though the monitoring plots are in the coastal area, yet the soil quality is not bad for crop production in the all the monitoring plots, except the monitoring plots of Kapalirmet and Chakgona. Kapalirmet and Chakgona remained fallow due to the adverse impacts of salinity in 2014-15 and 2015-16. The highest production (2.4 tons) has been observed in the monitoring agriculture plot-2 (Chunkuri-2) because only HYV Aman is cultivated in this plot and lowest production (0.2 ton) has been observed in monitoring plot-3(Kapalirmet), while in other plots local Aman has also been cultivated in 2013-14. Of these monitoring agricultural plots, farmers of Chakgona and Kapalirmet could not cultivate crops in 2014-15. The highest production (1.4 tons) has been observed in monitoring plot-1(Baranpara) due to HYV Aman crop cultivation and the lowest (0.57 tons) has been observed in monitoring plot- 5 (Basherhula) in 2014-15.

279. The monitoring plots (Kapalirmet and Chakgona) have remained fallow this year (2015-16) due to the adverse impacts of salinity. The highest production (1.9 tons) has been obtained in monitoring plot-2 (Chunkuri-2) and the lowest production (0.99 tons) has been obtained in monitoring plot-5 (Basherhula) in the year of 2015-16. It has also been observed that the crop production has slightly decreased from the year 2013-14 and increased over the year 2014-15 in all the monitoring plots, except in Kapalirmet and Chakgona. Crop damage was observed in monitoring plot-2(Chunkuri-2) and monitoring plot-5(Basherhula) in the year of 2014-15. Crop damage areas are about 0.33 ha and about 0.17 ha respectively this year. This was happened due to pest infestation in these two plots. Leaf roller was observed in monitoring plot-2. Stem borer, Rice hispa and Rat were observed in the plot-5. A total 0.52 tons of crop has been damaged 0.50 ha of plots (monitoring plot-2-Chunkuri-2 and monitoring plot-5-Basherhula). It is also mentioned that plot owner has given part of the plot (0.07 ha out of 0.14ha) voluntarily for the construction of cyclone shelter at Chakgona mouza.

4 Social Environment

4.1 Socio-economic Condition and Social Safeguard

280. Socio economic monitoring of this phase is intended to investigate the change (either improvement or deterioration) in identified socio-economic indicators/parameters with reference to the previous monitoring results and to recommend for further improvement in pre-construction and construction activities. The socio-economic indicators changed slowly over time so those were assessed twice in a year as successive six months regular interval (1st and 3rd quarters in each year). However, due to contractual obligation this phase report is prepared within three months interval of previous phase. Therefore, findings of socio-economic condition have been updated according to the findings of short conversation with local people and project proponent. Changes over last three month and future plan with way out of upcoming construction activities were discussed during conversation

4.1.1 Methodology

281. The important and project associated indicators are identified for monitoring and changes on those parameters/indicators only are examined in this phase with reference to its earlier condition. For doing so, feedback on changes over last three months with relevant recommendation and future plan of upcoming construction works were discussed with project affected people and the proponent as well.

282. A KII was conducted with AGM of Project proponent (BIFPCL) and field level information was taken over phone by conversation with some of listed participants of previous monitoring. Though no intervention was conducted over last three months, field survey was not obligatory thereby. Also, according to contract agreement two field surveys were conducted in 1st and 3rd quarter of each monitoring year. The mouzas, conducted FGDs and Informal Discussions for previous monitoring of socio-economic indicators were identified in the following map (**Map: 4.1**).

4.1.2 Exploration of Monitoring Parameters

Compensation

283. The compensation process is about to close except some contradictory cases where legal documents/papers of land ownership are not been submitted yet. The Government of Bangladesh has acquired the land through DC office, Bagerhat on behalf of BPDB (Bangladesh Power Development Board).

284. As per the rule of Bangladesh Government, people do not have legal documents of land will not be eligible for expected compensation or other administrative supports. The lessees are also not eligible to get compensation or any types of assistance, however in some cases they have been compensated or assisted as per the guideline of Donor agencies.

285. Local people of the study area who leased the land in acquired area for fish farming are expecting support from Project authority so that at least a single member of those families can play role to income restoration. They expect that if a member of those families can get the trainings according to their ability (provided by the project authority) and involved in related activities in the project site, they can easily help to restore the family income. Also,

some of the affected households wish for using unused land in the acquired area (which is owned by Bangladesh Power Development Board) for arranging some savings in a certain period. They urge support from BIFPCL to create a pathway of communication with respective authority so that they can farm fish on that unused land before starting the development works which will somehow help to restore their livelihood for a certain period.

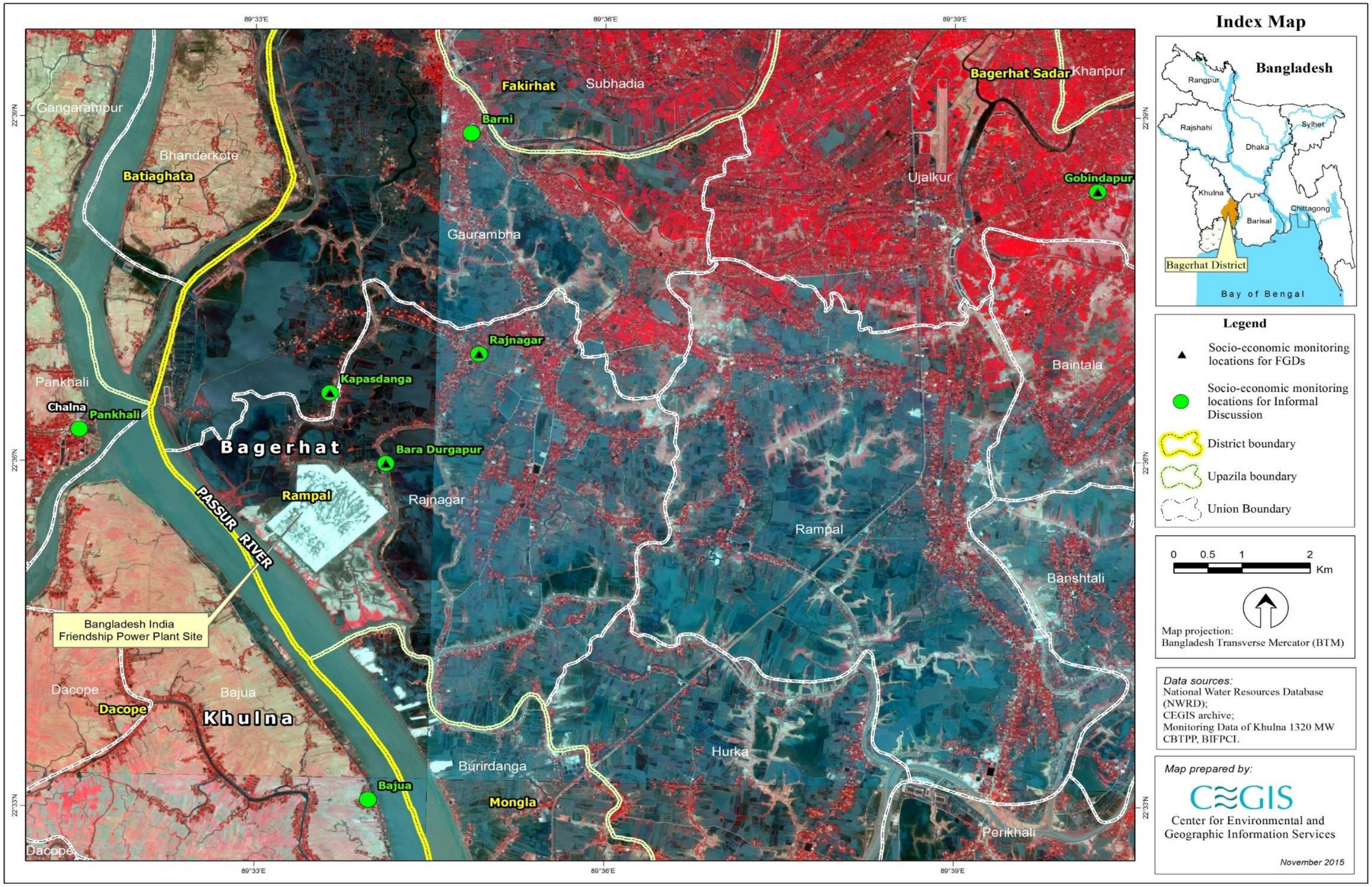
Resettlement/Rehabilitation

286. Numbers of resettled households have been decreased over last 3 years from Foyla Cluster Village due to having insufficient livelihood option according to their skill. It is observed that 8 allotters (out of 18) already left the cluster village over last 3 years due to lack of income generating options and some social harassment. The existing resettled people are somehow trying to cope with the surrounding features of that cluster village but they are worried because they do not get the legal papers of allotted land yet. Therefore, they are frightened of eviction from their present residence at any time.

287. The list of such indirectly affected people by the Project has been collected from Bagerhat DC office. BPDB already appointed a social consultant for validating the status of those households and for preparing Livelihood restoration Plan (LRP) for them, which in under process. Following that LRP, labors can be recruited in construction and post-construction activity of phase -1 also. However, draft LRP have been submitted and BPDB will take further necessary actions as per the final LRP.

288. In terms of rehabilitation issue, the resettled population urged to the project authority to get them involve in Project related activities which is suitable and possible to do by them. They are willing to take trainings if it can be helpful to develop their skill however they are not much efficient to pay for those trainings. Even they also requested for transport allowance including in labor wage, as they stayed far away from the Project site.

289. For income restoration purposes, Project authority have ran two trainings (sewing and computer literacy) to develop technical skill of project affected people so that they can easily compete in contemporary challenging occupations. The reaction of those trainings is good among the local people. However, they stated that the actual implementation sectors of those trainings have already saturated. Therefore, people urges that it would be better if the project authority can introduce such trainings (rode welding, wall painting, driving, security guards etc.) which will be relevant with the livelihood in that area in near future or the authority itself can be able to utilize those trainees in it project purposes.



Map 4.1: Socio-Economic Environment Monitoring Location

Project Related Employment Generation

290. The BIFPCL authority is willing to recruit local labors according to their area of expertise. They also appreciated the proposal for introducing skill development trainings (rode welding, driving, wall painting, security guard etc.) to the project affected people and recruit them in the project site in construction and post-construction phase activities according to their availability and capability.

291. The present construction works (those are mostly in technical types) were supervised by contractual contractors and hence a negligible scope of local affected people was found to be involved in these activities. However, the project authority stated that in construction phase activities about 2000-3000 employment opportunity will be generated of which 70% will consist for unskilled and semi-skilled labors. They also stated that they can train the local people to get that opportunity, if possible. The EPC contractor has already been appointed and will implement the construction works. However the EPC contractor shall utilize local unskilled & semi-skilled labors according to the availability and their job suitability.

Labor and Working conditions

292. A few labors were using temporary labor sheds because no major works have been done over last six months at the Project site as the works of pre-construction phase is almost over. A vast number of labors will be recruited during implementation of construction works when the facilities for labors will be more improved by the EPC contractor ensuring adequate accommodation facilities using standard materials, safe drinking water, hygienic sanitation and proper medical facilities (Source: BIFPCL Authority).

293. Some toilets have been found in the project site which were prepared in pre-construction phase but not sufficient for the arrangement of construction phase. The proportion of 1 toilet for each 12 labors should be ensured for the labors. Water treatment plant and a deep tube well has been installed in the Project site for supplying safe drinking and cooking water for the people staying in the project site during pre-construction phase. The capacity of the RO Plant is 5000 L/hr. which will cater the safe drinking water requirement of the entire workforce during the construction phase.

294. A cistern was prepared for meeting up the demand of water for bathing and other domestic activities but it may not be sufficient for meeting up the demand of migrated labors in construction phase. New cisterns should be constructed linking with the source of surface water and these cisterns should be maintained properly.

295. It has been observed that the labor and their working conditions have been gradually improving since early 2014 to up to 2016. A prayer room is situated within the compound and some labor sheds are modified than that was at the beginning. The project authority stated that the living condition of labor shall be improved as per the standard industrial practices when the EPC contractor shall mobilize the construction activitiesof the main power Plant

296. The labour and working condition is improving gradually and it will be improved more in construction phase after recruiting the EPC contractor. The contractor should follow international standard for ensuring accommodation, sanitation, drinking water and health safety issues for labors.

Photo 4.1: Toilet at Labor Shed area

Photo 4.2: Water tank at Labor Shed area for domestic use

Community Health Safety and Security

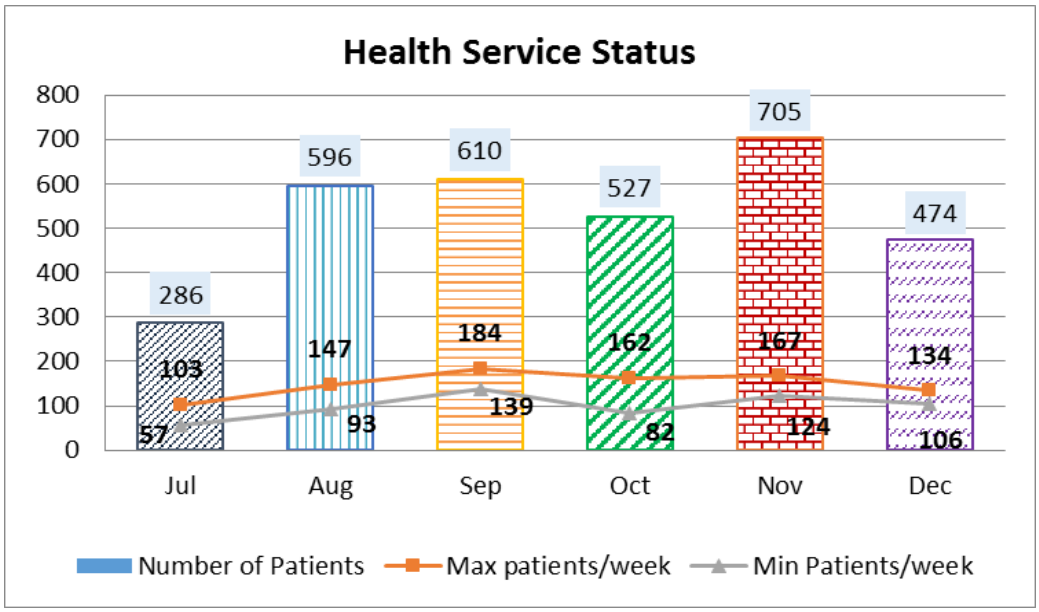
297. People opined that problem of dust, generated from the Project area is mitigated in many extents. The boundary wall of the project surroundings might play an important role to reduce dust flow in the project surroundings. Moreover, the project authority had planned for tree plantation in the project area at the beginning of land development phase and following it they have already planted 14,000 (fruit, wooden and medicinal) trees of which about 10,300 are still alive. In addition, about 4,000 *Golpata* have also been planted in the project site which are also alive. These trees will be helpful to balance environmental components and to ensure health safety and security in the Project and study area. For ensuring safety and security, watch towers have also been constructed to the surroundings of the project boundary. Under the condition no. 51 of DoE a MoU was signed on 24/02/2015 for implementation of afforestation program. In this regard the project authority has planned to plant 2- 3 lacs of saplings in and around the project area.

298. During construction phase, the environment may be degraded through noise and dust pollution which will negatively impact to the community health safety issue. However, that can be mitigated through boundary wall, plantation of trees to the peripheral of the project area, restriction on heavy construction works during quiet time (6 pm to 7 am) etc. Moreover, the grievance redress mechanism has already been prepared.

Activities under Corporate Social Responsibilities

299. Free medical service is being continued and getting familiar to local people. The coverage area of this service is expanding day by day. This free service is provided in the Project site on every Tuesday from 10:00 am up to the last service recipient. This service has been provided from a separate compartment in the project site with an equipped institutional arrangement. It found 2 shelves for keeping medicines and instruments, a separate check-up room for keeping privacy, a bed with oxygen support and 3 supporting staffs etc. in this medical compartment. Medical facilities will need to be improved as necessary during the construction phase while probability of different accidental events can be increased. This medical facility is now increased to twice in a week.

300. Medical facilities of burn injury, orthopedics, electrocution, chemical toxicity or poisoning and shock treatment are also need to be available during implementation of construction activities. Because labors can be injured by those hazards which need emergency response to minimize physical damages.



Source: Field visit to Medical Center at Project area, CEGIS, 2016

Figure 4.1: Record of health service recipients under CSR program

301. From the record it was found that 3,198 people had received health services in the last six months (from July 2016 to December 2016). The highest recipients were in November-2016 and the lowest was in July-2016 (**Figure: 4.1**). The above figure also showed the maximum and minimum recipients/week on monthly basis.

302. Among the recipients all are community members (except 25 working labors in the project site) in which female are still dominated in number compared to male and this gap is increasing day by day. Female recipient stated that they are getting conscious about health and treatment; and they get quality service for their critical diseases from project site's medical camp. In addition, a properly equipped medical center shall be developed with a provision of Ambulace service for ensuring the first aid faicility at the Project Site during construction phase.

303. Overall the local people and the service recipients are satisfied by receiving existing opportunities. But, the facilities should have more expanded in construction phase when the number of labors will be drastically increased and risky construction works will be running on.

5 Environmental Compliance

5.1 Introduction

304. The Project is now at the end of site development stage. The land development activities of the Project area are about to be completed. Project site especially the first phase is encircled by boundary wall and slope protection works. The construction of pre-fabricated building (recently has been moved to the south-east corner of the project area), RO plant, bridge of the approach road have been completed. The Power Plant approach road starting from Babur Bari of Khulna Mongla Road is at the finishing stage; land leveling, other infrastructures, tree plantation activities etc. have been progressing. However, there are some environmental compliance measures as suggested in the environmental management plan of EIA should be at place during the project lifetime.

305. The environmental compliance monitoring that includes monitoring of EMP implementation is based on physical observation and assessment by the monitoring team. A comprehensive diligence checklist has been developed to monitor the environmental compliance of different components e.g., Environmental and Social Management System and Action Plan; Labor and Working Condition; Community Health, Safety and Security; Biodiversity and Sustainable Management of Living Natural Resources.

306. The aim of the checklists is to check the diligence and effectiveness of the measures. The checklists are produced as Compliance Data Sheet that contains both quantitative and qualitative data. The details of the compliance checklist are attached in **Appendix I**. The **Table 5.1, 5.2, 5.3** and **5.4** present summary of the findings of the environmental compliance monitoring.

Table 5.1: Monitoring of Environmental and Social Management System Action Plan Implementation

Sl no	Potential Impacts	EMP measures as proposed in the EIA	Actual condition/ Measures already Implemented	Recommended Action	Compliance Status
1	Generation of Noise within the BIFPCL's Plant premises	• Conduct noise survey around and inside the site boundary • Reducing Noise and Vibrations to country's ambient standards, and also occupational health and safety standards • Introducing vehicle speed limit and speed limit monitoring system • Green plantation around the Project boundary • Switching off/ throttling down of machines/equipment/ generators which are not in use	• CEGIS is carrying out noise survey in ambient environment under environmental monitoring study. • BFD has initiated green plantation as a depository work of BIFPCL. • Switching off/throttling down of machines/equipment/ generators which are passing idle period.	• Create awareness among the labour for using noise muffler at construction site. • Stop working of the heavy noise generating equipment operators (e.g. stone/brick crusher) during 6:00 pm-8:00 am. • Supply sufficient ear plugs for the labours at the construction site.	Being Complied
2	Dust Generation from land development activities and other construction works	• Conducting dust monitoring and visual inspection around the site boundary • No use of earthen and undeveloped roads by vehicles related to the Project use • Installation of water spraying system to control fugitive dusts • Introducing vehicle speed limit and speed limit monitoring system • If yes, do they monitor vehicle speed regularly? • Construction of boundary wall	• CEGIS is quarterly monitoring the dust generated from land development activities and other construction works. • Construction of boundary wall for the main Plant is completed. • Preparing the road alignment for construction of paved road. • Dust generation is minimal in Monsoon season	• The project authority should include vehicular sprinkler for using during the period (Whole year) • Demarcate traffic way and enforce that all the vehicles are using the demarcated ways only. • Vehicle speed limit indicator should be introduced maintained. • Spray water along the road and roadside to suppress dust generation. • Clearing the bushes just before starting the construction works.	Being Complied and will be complied as and when needed
3	Water Quality	• Fencing the construction site • Arrangement of runoff drainage for reducing any water logging	• Construction of boundary wall for the main Plant is completed • Rainfall runoff discharge to	• Stockpile of construction material should be placed at a safe distance from drainage	Being Complied

Sl no	Potential Impacts	EMP measures as proposed in the EIA	Actual condition/ Measures already Implemented	Recommended Action	Compliance Status
		• Location of backfilling stockpile in safe area and protected from wind and rain action • No storing of backfilling materials/spoil stored on river bank/slope • No disposal of waste and wastewater to river or canal.	nearby river through temporary drainage network at some places has been developed. • Onsite sanitation facilities has been developed at the labour sheds as well as the working places.	network; • The solid kitchen waste should be disposed off on designated places.	
4	Waste Management System	• Provision of onsite waste management system	• Conventional way of waste collection and disposal system at Plant office and kitchen has been initiated. • Kitchen waste was recorded scattered around the labour colony.	• Sufficient waste disposal bin/s with labelling should be installed at labour shed, and working area before starting of the main construction works. • Proper training should be given to the labours for waste collection and management.	Being complied
5	Compensation and Resettlement	• Prepare Proper resettlement action plan and compensation plan if the Project needs any land acquisition addressing compensation, restoration, livelihood, living standards etc. based on proper socio economic studies • Resettlement of the PAPs • Cash for compensation of land (CCL) before resettlement • formal agreement with the affected people prior to migration/resettlement • Sufficient standing crop compensation • Compensation for movable structures? • Retention of salvageable materials? • Compensation for loss of trading income? • one time moving assistance	• Compensation has been given to the rightful owners of the land as per the laws of Bangladesh e.g., Acquisition and Requisition of Immovable Property Ordinance, 1982 • Compensation made by local DC office • Local DC office facilitates unauthorized occupants of the acquired land to get home in the Government's shelter homes or cluster villages • BIFPCL gives priority to affected people in Project related employment • List of 136 people indirectly affected was given by the DC office, Bagerhat.	• Initiatives should be taken for resettlement of the people who do not own the land but have been dependent on it for their livelihoods; • To meet the international standard and guideline of the funding agencies, necessary measures have to be undertaken. • The proponent should take initiatives to engage the PAPs during construction stages according to their skills and capabilities.	In the process of Compliance

Sl no	Potential Impacts	EMP measures as proposed in the EIA	Actual condition/ Measures already Implemented	Recommended Action	Compliance Status
		• grant to cover loss of regular wage income • Has a resettlement plan been developed which includes compensation, restoration, livelihood, living standards etc. based on proper socio economic studies? • Human provide/ take extra care/caution for the disadvantaged/ vulnerable group/s (i.e. women, children, ethnic minorities, indigenous people etc.) • Provision of monitoring the compensation and resettlement process	• Consultant has been appointed by BPDB for preparation of Livelihood Restoration plan (LRP). • Draft LRP report has been submitted.		
6	Livelihood and living condition	• Does the Project pose any threat to the livelihood/living standards of the local people? If yes, are adequate steps taken to reduce the impacts? • Has the company developed any policy, which prioritizes the local labourers in employment opportunities? • Is there any possibility that large vehicle related to the Project will cause traffic induced disturbance/s to the local dwellers? • If yes, are there any mitigation steps taken to decrease the disturbance/s? • Has the road network been developed after the Project being proposed and during the construction phase? • Are there separate water and sanitation facilities for the construction workers in the Project area?	• Recruited a social officer who is responsible for maintaining social liaison; • Engagement of Human Resources consultant for preparing HR policies, Labour recruitment Policies, Manpower • set up etc.; • At present around 40 labours are working directly or indirectly in the project. • Provision of first aid is present; • Medical unit capable of dealing emergency like injury, accident, etc. already set up.	• Monitoring the status regularly • Awareness program and grievance redress mechanism should be adopted in formal way • Accidental log sheet or injury log book should be put into display • Improve the sanitary facilities for the labours who are employed directly or indirectly for this project related activities. • Training to the Bouali, part-time fishermen, small boatman, Mauali of Sundarbans as future labor force.	In the process of Compliance
7	Green House	• Use of efficient generator in the	• Informing the bidders for EPC	• Prepare checklist on	To be

Sl no	Potential Impacts	EMP measures as proposed in the EIA	Actual condition/ Measures already Implemented	Recommended Action	Compliance Status
	Gas Controlling Measures	construction activities; • Regular maintenance of vehicles, generator and machinery in accordance with manufacturer's specifications; • Use of approved pollution control devices fitted in the equipment and machineries; • Switching off and throttling down the machines/equipment/generators, which are not in use.	of main Plants about measures to be followed; • Making IFC guidelines, EIA approval of DoE, and EMP of the EIA, etc. as a part of the bid document.	equipment and their condition owned by the contractors; • GHG inventory checklist might be mandatory for the EPC contractors. • Use low GHG emission machineries and CDM during main Plant construction.	complied during construction and operation stage.

Table 5.2: Monitoring of Labor and Working Condition

Sl no	Potential Impacts	EMP measures as proposed in the EIA	Actual measures already Implemented	Recommended Action	Compliance Status
1	Working Conditions and Management of Worker Relationship	• Preparation of Human Resources Policies and Procedures for Direct workers; • Defined Working condition and Terms of Employment for direct worker; • Sustainably equivalent terms and condition for migrant workers; • Compliance to national law of forming workers' organization; • No discrimination and equal opportunity for all; • Measures for diminishing past discrimination; • Grievance Redress Mechanism.	• Engaged HR consultant to prepare relevant policies; • recruited Environment, Occupation and Health Safety officer; • No discrimination has been recorded. • Women are recorded as worker in this project • ERP and ESMS is under finalization.	• The proposed EMP measures should be addressed in the HR policies; • Follow the national labour law 2006 and guideline of ILO. • Local workers would be given priority for non-technical jobs. • Formal mechanism of grievance redress should be established. • Motivational and training works should be introduced regularly.	Compliance action initiated and in the process compliance.
2	Protecting Workforce	• The client will not employ children in any manner that is economically exploitative, or is likely to be hazardous or to interfere with the child's	• Ensured no child labour employment • Ensured no forced labour • First Aid support to the labours during any accident	• The HR policy should cover child labour policy and Labour Law 2006 and all other amendments; • Proper documentation of	Being complied

Sl no	Potential Impacts	EMP measures as proposed in the EIA	Actual measures already Implemented	Recommended Action	Compliance Status
		education, or to be harmful to the child health or physical, mental, spiritual, moral, or social development. • No Forced Labour	• Immediate first aid medical treatment has been given to about 25 numbers of labour	contract with the worker is required, which includes working hour, wage, and benefit and emphasise to recruit the local labours • BIFPCL should pay the bill for any accidental event of the workers.	
3	Safety at site	• Installation/Construction of Safety Fence around the Project area; • Use of Personnel Protective Equipment's (i.e. safety vest, safety goggles, ear plug, safety shoes, gloves, dust mask, etc.); • Safety trainings for workers (i.e. fire control, working at height, working in heat, first aid etc.); • Practice of Tool box meeting, safety talks • Safe Storage of Hazardous Chemicals (e.g. fuel, flammable chemical, toxic chemicals, etc.); • Maintaining Material Safety Data Sheet (MSDS); • Provision of Health care facilities such as doctor, hospital etc. available at/nearby the plant construction site; • Availability of First Aid at work place; • Preparation and Follow of Emergency Response Plan; • Adequate fire precautions in place (e. g., fire extinguishers, escape routes etc.); • Documentation and reporting of	• Construction of boundary wall; • Encouraged labour and Project personnel to use appropriate PPEs; • Safety Policy of DoE and IFC, Safety measures proposed in EIA report have been incorporated in the bid document of main Plant to aware the potential bidders; • Included the EHS plan in the tender documents for the EPC contractor. • Preparation of emergency response plan in association with the EPC contractor. • Safety manual has been prepared. • EPC contractor submitted the site specific SHE plan. • In this winter period, only some finishing works (slope protection activities) are going on. • Fire safety mock drill is being conducted at some regular intervals. •	• Appointment of site specific EHS Officer of proponent and also contractors/sub-contractors is urgently required before EPC contractor take over the site. • Signboard must be kept into proper places. • Use of local language and picture so that the worker could aware. • 5 minute awareness speech would be deliberated to the workers at every morning • All electric distribution lines at project site required to be fixed as safe and tidy • Emergency contact number, personnel's, equipment and facilities should be developed before starting of the work of EPC contractor.	Being complied

Sl no	Potential Impacts	EMP measures as proposed in the EIA	Actual measures already Implemented	Recommended Action	Compliance Status
		occupational accidents, diseases, and incidents; • Policies and procedures for managing and monitoring the performance of third party employers in relation to OHS.			
4	Occupational Health and Safety Procedure	• Provision of complete EHS division in the Human Resources Planning/ Organogram • Preparation of Safety Policy to be adopted during Plant operation	• Engagement of HR consultant to develop HR policy and Organogram; • Medical aid, fire extinguisher, PPE are provided; • Worker's shed and sanitation facilities have been developed at construction site; • Onsite medical facilities have been continuing. • EPC contractor already prepared the site-specific Environmental Health & Safety plan, which is under finalization.	• Develop a complete EHS division in the HR Management; • Regular training, awareness, motivational and mock drill should be arranged at this pre-construction phase; • OHS procedure should also be followed by all workers including the labor from sub-contractors. Appointment of EHS Officer is recommended to expedite the EHS and OHS plan/procedure at project site • Insurance system may be introduced	EHS & OHS policy in line with World Bank standard formulated and Health and Safety manual prepared.
5	Workers Well Being	• Provision of Welfare facilities for Worker/Labor such as, timely bonuses, salaries, sick leaves, vacations etc.; • Routine medical check-up and emergency medical care for the sick and injured; • Appointment of a leader amongst the labor group, who will look into workers' well-being.	• Engagement of HR consultant to develop HR policy and Organogram; • Health care & information, canteen, restrooms, accommodation, water supply are facilitated by the proponents. • Grievance register are being initiated for the worker.	• The workers well-being should be protected in the HR policy • Freedom of Association, Rights & scope of bargaining and tripartite consultation should be open for the workers. • Development and formal procedure for grievance redress mechanisms	Being Complied

Table 5.3: Monitoring of Community Health, Safety and Security

Sl no	Potential Impacts	Proposed EMP	Actual measures already Implemented	Recommended Action	Compliance Status
1	Disturbance to nearby community due to dust from newly developed land and Noise from construction activities	• Construction of boundary wall around the Project area; • Installation of water spraying system to control dusts; • Conducting dust monitoring and visual inspection around the site boundary; • Adoption of Noise management plan.	• Construction of boundary wall around the Project area already completed; • No dust control systems were recorded but monsoon season and bushy grass limited dust emission in the land development areas. • Grievance redressal mechanism is under finalization.	• Regular communication with the local community • Prepare a register for receiving any grievance from the community • Low noise generating vehicles and equipment should be used by the EPC contractor	Being complied
2	Grievance of local people	• Availability and operation of Grievance Redress Mechanism; • Maintaining open communication channel with the local community.	• A Social officer has been recruited to maintain close relation with nearby community; • Regular monitoring has been conducted to identify the grievance of the nearby communities ; • National level stakeholder consultation has been conducted.	• Grievance Redress Mechanism is to be finalized early; • Establish a system to receive the grievance, and to take appropriate measures to redress it; • Regular local level consultation is necessary for impact monitoring as well as updating the local communities	Being complied
3	Risk of breaching Community Safety	• Construction of boundary wall/safety fence around the Project area; • Practicing Risk Assessment and Evaluation Process; • Practicing safe management for hazardous materials which may pose threat to the community; • Availability and operation of Emergency Response Plan; • Maintaining open communication channel with the local community;	• Construction of boundary wall around the Project area; • Incorporating safety policies to be followed in the bid documents for the appointment of EPC contractors; • Preparing a safety checklist to be followed during selection of construction contractors; • Maintaining a good	• Assign responsibility of enforcing and monitoring safety procedure to an officer. • Aware labours and all employees about the safety procedure and health check-up. • The EPC contractors should prepare site specific ESMPs;	BIFPCL agrees to comply all the measures during construction stage

Sl no	Potential Impacts	Proposed EMP	Actual measures already Implemented	Recommended Action	Compliance Status
		• Training and instruction to the security personnel about their behaviour and communication with the local people; • Aware the security personnel about the right of the community people.	communication with local community; • Negotiation with local DC office and Bangladesh Ansar and VDP (who are responsible for security). • The project proponent has engaged the local governments and communities for improving their livelihood status	• Arrange a safety training program for Project personnel and labours; • Training and instruction to the security personnel about their behaviour and communication with the local people; • Aware the security personnel about safeguarding environment and community.	
4	Community Health Risk	• Provision of providing health service facilities to community if the Project poses any health risk like sexually transmitted disease, contract disease, vector-borne diseases; • Implement all pollution mitigation measures to ensure safeguarding to community.	• Established a medical unit (consisting medical officer, medical assistant, office assistant) at Plant site; • Arranging weekly health service program (medical consultation and free medicine) for the local community; • Provided health services to around 1706 people from October 2016 to December 2016.	• The proponent should train the migrated labour regarding the local culture and customs • Health check-up must be done to the migrant labours • The proponent may arrange consultation meeting with the local communities • The proponent may introduce the business development services (BDS) support to the local communities as CSR activities	Being Complied
5	Youth Employment (Local)	• Providing training/awareness program for the local youth to let them aware about the required qualification to get involved in the Project related activities	• Informal sitting with the community • Regular training workshop on tailoring and computer has been organized by the proponents • The proponents have already	• Initiate awareness program for the local youth to let them aware about the required qualification to get involved in the Project related activities; • Assign job responsibilities	Will be complied during construction stage

Sl no	Potential Impacts	Proposed EMP	Actual measures already Implemented	Recommended Action	Compliance Status
			taken few initiatives to encourage local students through awarding them.	based on skills and previous experience.	
6	Public Communication, Consultation and Awareness	• Arranging public communication/consultation meeting; • Sharing of Project information with local people; • Organizing environmental and social awareness programs/meetings.	• Informal sitting with the community; • Display Project related information on a display board at Project site; • Regular public consultation meetings are taken places at different level; • Advertisement of this power plant was broadcasted • Publishing Project related discussion/article in different print media.	• Continue the dissemination workshop in Dhaka and Khulna to aware the community, civil society, environmentalists about the environmental safeguarding measures considered in basic design.	Being Complied

Table 5.4: Monitoring of Biodiversity and Sustainable Management of Living Natural Resources

Sl no	Potential Impacts	EMP measures as proposed in the EIA	Actual condition/ Measures already Implemented	Recommended Action	Compliance Status
1	Runoff (contain mostly sediment load) from newly developed land falls into nearby river and channel would cause deterioration of aquatic ecosystem.	• Installation of proper runoff drains; • Use of sediment fences, traps and basins for trapping the sediment, if required.	• Temporary installation of runoff drains; • Construction of sediment traps is mentioned in the Bid documents to instruct the bidders; • Develop temporary drainage network inside the Project boundary. • The connectivity of Maidara River is being maintained.	• The proponent has to ensure a good drainage system in before commencing the construction works by the EPC contractor. • The proponent needs to monitor that connectivity of the free flow of Maidara River.	Will be complied during the construction stage
2	Disturbance to nearby ecosystem	• No cutting/ felling of trees along the river bank;	• No cutting/ felling of trees occurred along the river bank;	• Using of light shade (directed downwards) around the	Being Complied

Sl no	Potential Impacts	EMP measures as proposed in the EIA	Actual condition/ Measures already Implemented	Recommended Action	Compliance Status
	due to different construction activities	• Implementation of onsite waste and air quality management plan; • Limiting soil extraction activities within the defined area; • Limiting the vegetation clearance and base stripping process within the Project boundary; • Safety fence around the construction site; • Limiting the use of night light; • Using shade (directed downwards) around the outdoor lights; • Provision of cut-off time to switch off unnecessary lights at night; • Initiate Green plantation; • No plantation of non-native species; • Retaining top soil for future habitat restoration; • No degradation of critical habitat?	• Limiting soil extraction activities within the defined area; • Limiting the vegetation clearance and base stripping process within the Project boundary; • Construction of Boundary wall; • Installation of few numbers of night light; • Provision of cut-off time to switch off unnecessary lights at night; • Selection of local plant species for green plantation; • No degradation of the habitat out site the power plant area	outdoor lights; • Regular monitoring of the trees planted around the Project site. • Bird sheds can be developed at the green belt areas or on the bank slope. • Eco-friendly development must be incorporated during the construction activities. • The pollution prevention technologies should be introduced before the commencement of this project +	
3	Disturbance to river, inter-tidal areas and wet lands	• No encroachment of inter-tidal flood plain area; • No disturbance to Dolphin community; • Monitoring of Ecosystem Health and Monitoring of Sundarbans Forest Health; • If required, embankment should be constructed considering a setback distance from river/canal bank; • Slope protection work along the Maidara River should be completed on an urgent basis before rainy	• Monitoring of forest health and ecosystem health in Sundarbans and around the Project site are being carried out by CEGIS; • Maintaining significant setback distance from Passur river to the Project site; • Completion of slope protection work; • Revising the drawing of embankment/slope protection works along the Maidara River for keeping necessary setback distance from Maidara River.	• BIFPCL may take initiatives to excavate the silted reach of Maidara River near proposed township area to facilitate proper functioning of the River for maintaining tidal flow dynamics. • Proponent may have taken the initiatives in policy level for not to development the adjacent wetland area of MSTPP into industrial or commercial area.	Being Complied

Sl no	Potential Impacts	EMP measures as proposed in the EIA	Actual condition/ Measures already Implemented	Recommended Action	Compliance Status
		season come, and; • BIFPCL may take initiatives of excavating of silted reach of Maidara river near proposed township area to facilitate proper functioning of River for maintaining tidal flow dynamics	• The stream flow of Maidara River near access road has been opened.		

5.2 Compliance to Conditions of DoE

Sl no	Condition of DoE	Compliance	Remarks
1	This EIA Report is approved only for 1320 MW Khulna Coal Based Power Plant. Any expansion or extension of this Power Plant will require obtaining further Environmental Clearance with additional EIA Study.	Not applicable now	***BPDB will comply with the condition prior to initiation of any expansion or extension***
2	The Coal Specification and Power Plant technology should be maintained as per EIA report. In case any change in design the proponent must obtain consent from DoE.	The Coal Specification and Power Plant technology will be maintained as per EIA report. In case of any change in Plant design and coal specification the proponent is to obtain consent from DoE.	***To be Complied as and when required***
3	Project Proponent may undertake activities for land development and infrastructural development of the Project.	BIFPCL has started land and infrastructure development activities.	***Being Complied***
4	Project Proponent may open L/C (Letter of Credit) for importing machineries for the Project which shall also include machineries relating to waste treatment plant and other pollution control devices.	BIFPCL will open L/C after finalizing the EPC contractor.	***will be Complied as and when required***
5	The activity under Proposed Khulna 1320 MW Coal based Thermal Power Plant Construction and operation shall not release any pollutant that affect human health or will have damaging impact on the environment or natural resources.	BIFPCL engaged CEGIS for monitoring pre-construction and construction activities for examining environmental impacts. No damaging impact on the environment or natural resources impact has been reported yet. All necessary measures have already been incorporated in the technical specification of main plant EPC package as per DoE stipulations. Pollution control measures have widely been covered in technical specification like effluent treatment plant, ESP, FGD etc.	***Complied at present and will be complied at Construction and Operation phase***
6	Proper and adequate mitigation measures shall be ensured throughout preparation, construction and operation period of the proposed Khulna 1320 MW Coal based Thermal Power Plant Project activities.	BIFPCL is also monitoring the mitigation measures adopted through an environmental consultant CEGIS. At present preliminary site preparation (pre-construction) activities are going on. Mitigation measures appropriate at this stage have been taken. Proper and adequate mitigation measures have widely been covered in Technical Specification. MP prepared & monitoring is being done for pre-construction period.	***Complied at present and will be complied at Construction and Operation phase***
7	Any heritage sight, ecologically critical area, and other	There is no religious, archaeological place in and around the site.	***Complied at present and***

Sl no	Condition of DoE	Compliance	Remarks
	environmentally, religious and archaeologically sensitive places shall be kept protected during Project construction phase.	The pre-construction activities has been carried out ensuring safeguarding to Sundarbans and ECA	***will be complied at Construction phase***
8	Environment friendly construction and development practices shall be followed that minimize loss of habitats and fish breeding, feeding & nursery sites.	The pre-construction activity is being carried out keeping all the mitigation measures in order.	***Being Complied***
9	Construction works shall be restricted to daytime hours so as to avoid/mitigate the disturbance of local lives as well as implementation schedules of the works shall be notified in advance to nearby residents.	The Project site and the present activities are limited to day time only. BIFPCL is keeping close communication with local people to receive the grievance.	***Being Complied***
10	Proper and adequate sanitation facilities shall be ensured in labor camps throughout the proposed Project period.	At present the Plant is in preliminary site preparation (pre-construction) phase. Adequate sanitation facilities have been provided for this stage. Provisions in line with this condition have been included in Clause no 2.5 of Special Condition of Contract (SCC) and in Health & safety manual. BIFPCL will ensure the same when work for Main Plant construction work starts.	***Being Complied***
11	In order to control noise pollution, vehicles & equipment shall undergo regular maintenance; working during sensitive hours and locating machinery close to sensitive receptor shall be avoided.	All vehicle & equipment used at site are under regular maintenance. Working during sensitive hours and locating machinery close to sensitive receptor are being avoided. Provisions in line with this condition have been included Clause no 14.11 of SCC and in Health & Safety Manual.	***Being Complied***
12	No solid waste can be burnt in the Project area. An environment friendly solid waste management should be in place during the whole period of the Project in the field.	At present the Plant is in preliminary site preparation (pre-construction) phase. No solid waste is burnt. Provisions in line with this condition have been included in Clause No 14.9 of SCC. Solid Waste Management system has been prepared (Section-V, B12, Part 9 of Technical Specification)	***Being Complied***
13	Proper and adequate on-site precautionary measures and safety measures shall be ensured so that no habitat of any flora and fauna would be endangered or destructed.	Pre-construction activities are being taken up with adequate on-site precautionary measures and safety measures to safeguard flora and fauna. Safety manual prepared and it is part of EPC contract document.	***Being Complied***
14	All the required mitigation measures suggested in the EIA report along with the emergency response plan are to be strictly implemented and kept operative / functioning on a continuous basis.	At present the Plant is in preliminary site preparation (pre-construction) phase. BIFPCL has appointed a paramedical staff and visiting Doctor is also made available for regular health checkup of the workers.	***Being Complied***

Sl no	Condition of DoE	Compliance	Remarks
		Villagers of surrounding areas also availing the health facilities. Emergency response plan shall be strictly implemented and kept operative/ functioning on a continuous basis.	
15	To control dust, spraying of water over the earthen materials should be carried out from time to time.	Water is sprayed in the area around the premises of site office to control dust. A boundary wall around the Plant has been constructed to control dustwithin the project boundary.	***Being Complied***
16	Storage area for soils and other construction materials shall be carefully selected to avoid disturbance of the natural drainage.	Construction materials have been stocked and piled far away from river bank and other natural water bodies.	***Being Complied***
17	Adequate considerations should be given to facilitate drainage system for runoff water from rain/tidal surge.	Run off drainage are being constructedas required at this stage. Adequate drainage shall be ensured during construction and operation phase of the Plant.	***Being Complied***
18	Adequate facilities should be ensured for silt trap to avoid clogging of drain/canal/water bodies	Run off/ storm water drainage system shall have silt trap.	***Being Complied***
19	The entire coal handling system should be designed as an enclosed (and not only covered) conveyor system. There should be integrated dust control system with dust extraction and bag filters at unloading areas and at each transfer points on the conveyor system.	Entire coal handling system have been designed as an enclosed conveyor system as per DoE requirement. Integrated dust control system with dust extraction system / bag filter and dust suppression system at crusher house, unloading points, transfer points has been specified in the technical specification of Main Plant EPC contract package.Refer Section V, B4 of Technical Specification.	***Complied***
20	Coal Plant should have high-efficiency bag filter for arresting dust emissions.	Integrated dust control system with dust extraction system / bag filter and dust suppression system at crusher house, unloading points, transfer points has been specified in the technical specification of EPC contract package and will be implemented accordingly. Refer Section V, B4 of Technical Specification (Clause no B4.3.1.4).	***Compliance action initiated***
21	Col should be stored in a covered storage yard.	All these stipulations have been included in the technical specification of Main Plant EPC contract package, Section V, B4 of Technical Specification (Clause No B4.3.1.6).	***Compliance action initiated***
22	The entire coal stockyard should be covered with water sprinkler provided with automated moisture sensor to control self-combustion.	All these stipulations have been included in the technical specification of Main Plant EPC contract package, Section V, B4 of Technical	***Compliance action initiated***

Sl no	Condition of DoE	Compliance	Remarks
		Specification.	
23	100% utilization of fly ash and bottom ash should be planned and implemented throughout the operation of the Plant. There should only be a provision of small ash dyke that will not exceed 25 (twenty five) acres of land to store residual ash.	100% utilization of fly ash has been planned and shall be implemented throughout the operation of the plant.Only 25 acres area has been allocated to store residual ash. EOI has been received in this regards from nearby Cement Plants.	***Complied at present and Will be Complied throughout Operation phase***
24	Integrated dry ash handling, loading, unloading and transportation system should be established.	Integrated dry ash handling, loading, unloading and transportation system will be established.Provisions in line with this has been included in Technical Specification of main plant EPC contract package (Section V, Chapter B4).	***Compliance action initiated***
25	There should be adequate and properly sized and designed dry ash silo with appropriate conveyor system.	Adequate and properly sized dry ash silo with appropriate conveying system have been specified in technical specification of main plant EPC contract package (Section V, Chapter B4).	***Compliance action initiated***
26	Bottom ash should be extracted, crashed and stored in silos for utilization with proper collection and conveyor system.	Bottom ash shall be extracted, crushed and stored in silos for utilization with proper collection and conveying system. The procedures have been included in the technical Specification of EPC contract package.(Section V, Chapter B4).	***Compliance action initiated***
27	Resettlement and rehabilitation of the displaced population (including those who do not own land) should be done properly.	Land has been acquired by GoB. Resettlement and rehabilitation action was taken as per the law of the Bangladesh. However, BPDB has already written to Ministry for suitable resettlement and rehabilitation as per DoE requirement.	***Compliance action initiated***
28	Resettlement plan should be properly implemented and people should be adequately compensated.	-do-	***Compliance action initiated***
29	Construction material should be properly disposed off after construction work is over.	At present the Plant is in preliminary site preparation (pre-construction) phase. Construction wastes are being reused at this stage.Solid Waste Management system has been prepared keeping the provisions in line with this (Section-V, B12, and Part 9 of Technical Specification).	***Complied at present and Will be Complied during and after Construction Phase***
30	As described in the report environmental monitoring should be strictly followed and monitoring report should be shared with DoE to ensure the environmental management properly.	BIFPCL has engaged CEGIS for environmental monitoring in February 2014. From then on, each quarterly monitoring report has been submitted regularly, based on study conducted for that period, to be shared with DoE, which are available at BIFPCL web page also.	***Being Complied***
31	All activities (pre-construction,	BIFPCL has adopted all of the EMP	***Being***

Sl no	Condition of DoE	Compliance	Remarks
	construction and post-construction stage) should be implemented according to EMP clearly listed in the EIA report.	applicable at this stage. CEGIS, as an environmental consultant of BIFPCL is monitoring implementation of EMP. BIFPCL is taking all possible actions based on EMP monitoring report.	***Complied***
32	A third party/independent monitoring bodies excluding JVC/BPDB should be engaged immediately for monitoring of all activities during pre-construction, construction and operation phases as per monitoring plan of EIA report and monitoring report must be submitted to Bagerhat District Office, Khulna Divisional Office and Headquarters of the Department of Environment simultaneously.	CEGIS, as an independent monitoring body has been engaged by BIFPCL as environmental consultant since February 2014. From then on, CEGIS has been conducting the monitoring programs quarterly and producing monitoring reports on regular basis which are submitted by CEGIS to BIFPCL for onward submission to the Bagerhat District Office, Khulna Divisional Office and Headquarters of the Department of Environment as directed by DoE.	***Being Complied***
33	Regular monitoring of the susceptible places of Sundarbans for protecting ecosystem, biodiversity and forest coverage should be made using latest high resolution image for keeping ambient environment.	The Monitoring activities of CEGIS included this part. The monitoring report contains analysis of biodiversity and forest coverage. However, in addition to this, Forest Department has also suggested some survey & analysis which have also been monitored and reported by CEGIS through the quarterly compliance monitoring report.	***Being Complied***
34	Air, water, soil, biological and social data should be monitored regularly with a network monitoring system with a view to assess the natural quality of the Sundarbans and other fragile ecosystem and report of monitoring results should be submitted to Bagerhat District Office, Khulna Divisional Office and Headquarters of the Department of Environment simultaneously.	The network monitoring system will be installed as a part of the project construction for online monitoring when the Plant will be in operation. All these stipulations have been included in the technical specification of Main Plant EPC contract package.(Section-V, Clause No B0 6.19.13.2 and Clause No. B0 6.19.13.5).	***Compliance action initiated***
35	There should be regularly disclosure of the report through workshops and websites and responses should be taken care accordingly.	All the reports are available on website of BIFPCL (www.bifpcl.com). CEGIS is regularly carrying out public consultation. The progress of the monitoring is regularly discussed in monthly Project implementation monitoring meeting in presence of PGCB, LGED, Bangladesh Army, BPDB, CEGIS, etc. The same is being reviewed by the Project Steering Committee, Chaired by the Secretary, Power Division, MoPEMR, and Government of Bangladesh.	***Being Complied***
36	Online air and water quality monitoring system should be made functional throughout the	The online monitoring system will be installed when the Plant will be in operation phase and will continue	***Compliance action initiated***

Sl no	Condition of DoE	Compliance	Remarks
	life of the Plant.	throughout the life time of the Plant. All these stipulations have been included in the technical specification of Main Plant EPC contract package.(Section-V, Clause No B0 6.19.13.2 and Clause No. B0 6.19.13.5).	
37	Management Information System (MIS) are to be developed for this coal based Power Plant. The scope of MIS services will obviously include representing the real time monitored data especially environmental parameters displaying at Bagerhat District Office, Khulna Divisional Office and Headquarters of the Department of Environment, BPDB and other concern agencies/Ministries. The MIS should be web based for accessing every individual to show the real time monitored records.	The MIS will be prepared before commissioning of the Plant. The consultant for developing MIS will be engaged at least one year earlier. Specification for elaborate MIS system is already included in EPC contract document.Technical Specification like DDCMIS, DDCS, PADO System, HART system, Plant MMS, Information management security system etc. have been included.	***Compliance action initiated***
38	JVC should provide all sort of logistics support to DoE and other relevant agencies for monitoring environment related items/events.	BIFPCL is ready to provide all sort of logistic support as and when required by DoE and other relevant agencies for monitoring of Plant construction activities and environmental items/events.	***Being complied***
39	No ground water should be allowed to use for plant purposes.	No ground water has been used so far for Plant purposes. The Plant has been designed considering use of surface water only.	***Complied at this stage and will be complied during operation phase***
40	Conduct stakeholder meetings on regular basis for better performance of the Project as a whole.	At present the Plant is in pre-construction phase. BIFPCL has appointed a social worker who regularly visits nearby community to consult with the local people. Besides, CEGIS, appointed by the Project authority as environmental monitoring consultant, is carrying out consultation with local people.The progress / review of the project is regularly discussed in monthly project implementation monitoring meeting in presence of PGCB, LGED, Bangladesh Army, BPDB, CEGIS, etc. The same is being reviewed by the project steering committee, chaired by the Secretary, Power Division.	***Being Complied***
41	Additional Environmental baseline data to be collected as suggested	In February 2014, CEGIS has been engaged for preparing Detail	***Being Complied***

Sl no	Condition of DoE	Compliance	Remarks
	in the EIA report and conveyed to DoE and other concern authorities.	Environmental Baseline. CEGIS has submitted annual monitoring report along with reports of quarterly monitoring containing latest baseline data to BIFPCL for further dissemination to DoE and other concerned authorities.	
42	The Environmental Management Plan under the EIA study shall strictly be implemented and kept functioning on a continuous basis.	BIFPCL has been implementing all the EMP measures phase by phase as suggested in EIA report and by DoE which is regularly monitored by CEGIS.	***Being Complied***
43	The Project authority shall submit a detail work plan with time schedule of development activities at least 7 (seven) days ahead of the work commences in the field to the Bagerhat District Office, Khulna Divisional Office and Headquarters of the Department of Environment simultaneously.	At present the Plant is in preliminary site preparation (pre-construction) phase.BIFPCL shall submit detail work plan seven (7) days before the start of Main Plant Works.	***Agreed to Comply***
44	Environmental Monitoring Reports according to specific format specified in the EIA Report shall be made available simultaneously to DoE Bagerhat District Office, Khulna Divisional Office and Headquarters on a monthly basis during the construction period of the Project.	Environmental Monitoring Reports as per specific format provided in the EIA Report shall be made available by BIFPCL simultaneously to DoE Bagerhat District Office, Khulna Divisional Office and Headquarters on a monthly basis during the construction period of the Project.	***being complied***
45	The following records must be kept in respect if any samples required to be collected for the purpose of environmental monitoring activities: (a) the date(s) on which the sample was taken; (b) the time(s) at which the sample was collected; (c) the point at which the sample was taken; and (d) the name of the person who collected the sample.	The Monitoring report of CEGIS keeps all the records as suggested.	***Being Complied***
46	The results of any monitoring required to be conducted under this EIA report must be recorded.	CEGIS is recording all the monitoring data and submitting to BIFPCL through proper documentation. The report is being shared with DoE on regular basis.	***Being Complied***
47	In case of any emergency, the following information shall be immediately be reported to Bagerhat District Office, Khulna Divisional Office and Headquarters of the Department of Environment (DoE) simultaneously	So far no such emergency has occurred. Emergency Reporting/ Emergency response plan have been prepared. Health and safety management manual have been prepared and it is a part of technical specification.BIFPCL would establish a proper mechanism for recording	***Compliance action initiated and Will be complied as and when required***

Sl no	Condition of DoE	Compliance	Remarks
	a) Nature of incident (oil spill, fire, accident. Collision, land slide, etc.) b) Personnel affected (injured, missing, fatalities, etc.) c) Emergency support available and its location (standby transport, medical facilities, etc.) d) Weather conditions e) Current operations (abandoning the site, fire fighting, etc.)	such incident as suggested, when main plant construction activities start.	
48	The Project authority or its employees must notify the department of Environment of incidents causing or threatening material harm to the environment as soon as practicable after the person becomes aware of the incident.	So far no such incident has occurred. BIFPCL would establish a proper mechanism for recording such incident as suggestedand notify the department of Environment of incidents causing or threatening material harm to the environment as soon as practicable after the person becomes aware of the incident. Health and safety management manual has been prepared and CEGIS is monitoring EMP.	***Will be complied as and when required***
49	All pollution incidents shall be reported immediately and simultaneously to the Bagerhat District Office, Khulna Divisional Office and Headquarters of the Department of Environment (DoE) in Dhaka.	So far no such incident has been happened. BIFPCL would establish a proper mechanism for recording such incident as suggested. CEGIS has been engaged to record such incident during pre-construction and construction period	***Will be complied as and when required***
50	Appropriate permission would require to be obtained from the Forest Department in favour of cutting/felling on any plant/tree/sapling forested by any individual or government before doing such type of activity.	There will be no need of cutting/felling down of any trees. However, in future, if any such case would arise, BIFPCL would seek for appropriate permission as suggested	***Will be Complied as and when necessary***
51	Re-vegetation and re-plantation under green belt activities shall be undertaken in consultation with the Forest Department according to those mentioned in the EIA report.	An MoU signed with Forest Dept., Bangladesh on 24.02.2015 for implementation of Afforestation Programme. Initial target is planting of 2 lac saplings in 3 years. By this time, they have already planted about 14000 nos. of saplings of different species.	***Being Complied***
52	Climate Change impacts and maximum storm surge height shall have to consider at the design and construction phase.	The level (elevation) of the land and earthen embankment has been fixed considering the climate change impact and maximum storm surge height.	***Being Complied***
53	A separate EIA/morphological study shall have to be conducted for coal transportation and river	Mongla Port Authority (MPA) is the Implementing Agency for dredging. Coal transportation will be done	***Being Complied***

Sl no	Condition of DoE	Compliance	Remarks
	dredging to develop sound environmental management plan towards conservation of ecosystem and biodiversity.	through the existing maritime route, which is Mongla port controlled waterways. M/s IWM has already completed the EIA study for the dredging activity and submitted the report to MPA. A separate EIA study for coal transportation is being conducted by M/s CEGIS as per approved ToR of DoE. Inception Report for the said study has been submitted to BIFPCL.	
54	A full-fledged institutional setup for EHS and CSR must be put in place before operation of the Power Plant.	A full-fledged institutional setup for EHS activities shall be in place before operation of the Plant (Project). Meanwhile, a number of CSR activities are ongoing at Project site, like free medical facilities and medicines, free potable water supply to the local people. BIFPCL has appointed a social worker to collect relevant social data. Health and Safety manual has been prepared.	***Being complied***
55	The Project authority shall extend active cooperation to DoE officials to facilitate their visit to the site as and when necessary.	BIFPCL is extending its all cooperation to DoE	***Being Complied***
56	Violation of any of the above conditions shall render this approval void.	Noted by BIFPCL	-
57	Any injunction on this Project from the Honourable Supreme Court/High Court Division shall render this approval void.	Noted by BIFPCL	-
58	Without installation of 275 Meter Height Chimney, Effluent Treatment Plant (ETP), Waste Water Treatment Plant (WWTP), Settling Pond, Desalinization Plant, API Oil Water Separator, High Efficiency Electro Static Precipitator (ESP), 'closed-loop' Flue Gas Desulfurization (FGD), Low NOx Burner, online air and water quality monitoring system and other pollution control equipment and obtaining Environmental Clearance Certificate, the proponent shall not start operation of the Project.	At present the Plant is in pre-construction phase. The functional technical specification of the main Plant includes 275 Meter high Chimney, Effluent Treatment Plant (ETP), Waste Water Treatment Plant (WWTP), Setting Pond, Desalinization Plant, API, Oil Water Separator, High Efficiency Electro Static Precipitator (ESP), 'closed-loop' Flue Gas Desulfurization (FGD), Low NOx Burner, online air and water quality monitoring systematic for preventing pollution. All these stipulations have been included in the technical specification of Main Plant EPC contract package.	***Compliance action initiated and will be complied before starting operation of the Project***
59	This EIA Approval has been issued with the approval of the appropriate authority.	BPDB and BIFPCL are thankful to DoE.	-

References

"Assessing the oil spill's impact on Bangladesh's Sundarbans forest". Deutsche Welle. December 17, 2014.

Awashthi, S.K. 2000. Prevention of Food Adulteration Act No. 37 of 1954. Central and State rules as amended for 1999(3rd ed.).New Delhi: Ashoka Law House.

Badran M (2001) Dissolved oxygen, chlorophyll a and nutrient seasonal cycles in waters of the Gulf of Aqaba, Red Sea. Aquat Ecosys Health Manag 4(2):139–150.

BARC (Bangladesh Agricultural Research Council). 2012. Fertilizer Recommendation Guide, Bangladesh Agricultural Research Council, Farmgate, Dhaka.

Bartram J and Balance R (1996), Water Quality Monitoring - A Practical Guide to the Design and Implementation of Freshwater Quality Studies and Monitoring Programmes, UNEP/WHO, Chapter 2.

CEGIS. (2013). Environmental Impact Assessment of 2X (500-660) MW Coal Based Thermal Plant to be Constructed at the Location of Khulna (p. 456). Bangladesh.

Chave J, Andalo C, Brown S, Cairns M. A., Chambers, J. Q., Eamus D et al (2005) Tree allometry and improved estimation of carbon stocks and balance in tropical forests. Oecologia 145: 87–99

Donato, D.C., Kauffman, J.B., Stidham, M.A. (2009) Protocols for measuring and reporting carbon stocks in mangrove forests. Unpublished report prepared for the workshops on Global Climate Change and Carbon Financing: Opportunities for Bangladesh. Dhaka, Bangladesh, 28, October–9 November 2009.

Eckman, J.E., (1979) Small-scale patterns and processes in a soft-substratum intertidal community. J. Mar. Res.37:437–457.

Eckman, J.E., (1983) Hydrodynamic processes affecting benthic recruitment. Limnol. Oceanogr. 28: 241–257

Gleick, P.H. (Ed.), 1993. Water in Crisis: A Guide to the World Fresh Water Resources. Oxford University Press, New York

Goldman, S. 2005. Information theory. Dover, New York.

Harmon, M. E. and J. Sexton (1996). Guidelines for measurements of woody detritus in forest ecosystems. U. S. LTER Publication No. 20.

Heath, R.C., 1989. Basic Ground-Water Hydrology. U.S. Geological Survey Water-Supply Paper 2220, 84p.

Hossain, M., Siddique , M. R. H., Bose, A., Limon, S.H., Chowdhury, M.R. K., • Saha, S. (2012) Allometry, above-ground biomass and nutrient distribution in Ceriops decandra (Griffith) Ding Hou dominated forest types of the Sundarbans mangrove forest, Bangladesh. Wetlands Ecol Manage DOI 10.1007/s11273-012-9274-2

Kabata-Pendias, A. and H.Pendias, 1992. Trace Elements in Soils and Plants, 2nd ed. CRC press, Boca Raton, 365pp

Kauffman, J.B. and Donato, D.C. (2012) Protocols for the measurement, monitoring and reporting of structure, biomass and carbon stocks in mangrove forests. Working Paper 86. CIFOR, Bogor, Indonesia.

Kinne, O. (Ed.), 1984. Marine Ecology. John Wiley and Sons, London

Komiyama A, Ong JE, Poungparn S (2008) Allometry, biomass, and productivity of mangrove forests: A review. Aquat Bot 89:128–137

Kabata-Pendias, A. and H.Pendias, 1992. Trace Elements in Soils and Plants, 2nd ed. CRC press, Boca Raton, 365pp

M. H. Rahman and H. Ishiga, “Arsenic pollution in soil and groundwater of Bangladesh,” in Proceedings of the International Conference on Energy and Environment, vol. 2, pp. 1626–1632, 2003.

M. M. Rahman, B. K. Mandal, T. Roy Chowdhury et al., “Arsenic groundwater contamination and sufferings of people in North 24-Parganas, one of the nine arsenic affected districts of West Bengal, India,” Journal of Environmental Science and Health A: Toxic/Hazardous Substances and Environmental Engineering, vol. 38, no. 1, pp. 25–59, 2003. View at Publisher · View at Google Scholar · View at Scopus

MacArthur, R.H. & MacArthur, J.W. (1961) On bird species diversity. Ecology, **42:** 594**–**598.

Margalef, R. (1958) “Information theory in ecology,” General Systems Yearbook, vol. 3, pp. 36–71,

Moore, P.D. & Chapman, S.B. (Ed.) (1986) Methods in Plant Ecology. Blackwell Scientific Publications. 581.5 MET

Nelson D., 2002; Natural Variations in the Composition of Groundwater; Groundwater Foundation Annual Meeting; Oregon Department of Human Services Springfield, Oregon; oages 1-8.

Odum, E. P. (1971) Fundamentals of Ecology, WB Saunders, Philadelphia, Pa, USA, 1971.

Pearson T, Walker S, Brown S (2005) Sourcebook for land use, land-use changes Forestry Projects. Report from BioCF and Winrock International. Available at: http://www.winrock.org/ecosystems/tools.asp?

Phillips, Tom (13 December 2014). "Fears for rare wildlife as oil 'catastrophe' strikes Bangladesh". The Daily Telegraph. Retrieved 15 December 2014.

Pielou, E.C. (1969) an Introduction to Mathematical Ecology. John Wiley & Sons, Inc., New York, 286 pp.

Rabalais, N.N., 2002. Nitrogen in aquatic ecosystems. Ambio 31, 102–112.

Rahman M M., Rahman M T., Rahman M S., Rahman F., Ahmed J U., Shakera B., Halim M A., 2013; Water quality of the largest mangrove forest; Canadian Chemical Transactions; Volume, Issue 2., Page 141-156.

Rahman, M. M. (2012) Relationship between carbon storage, vegetation type and salinity in Sundarbans Reserved Forest. M. Sc. Thesis. Forestry and Wood Technology Discipline, Khulna University, Khulna-9208, Bangladesh.

Rajasegar, M. 2003. Physico-chemical characteristics of the Vellar estuary in relation to shrimp farming. J. Environ. Biol. 24: 95-101.

Rajasegar, M., 2003. Physico-chemical characteristics of the Vellar estuary in relation to shrimp farming. J.Environ. Biol., 24, 95-101.

Raman S M B, Sarder L, Rahaman M S, Ghosh A K, Biswas S K, Siraj S S, Huq K A, Hasanuzzaman A F M and Islam S S (2013), Nutrient dynamics in the Sundarbans mangrove estuarine system of Bangladesh under different weather and tidal cycle, Ecological process, springer, page 5.

Rompas, R. M. (2010). Marine Toxicology. Indonesian Marine Council. Jakarta.

S. A. Haque, 2006. Review article, salinity problems and crop production in coastal regions of Bangladesh. Department of Soil Science, Bangladesh Agricultural University, Mymensingh, Bangladesh. Pak. J. Bot., 38(5): 1359-1365.

Schnitzer SA, DeWalt SJ, Chave J (2006) Censusing and measuring lianas: A quantitative comparison of the common methods. Biotropica 38(5): 581-591

Senthilkumar, S., P. Santhanam and P. Perumal 2002. Diversity of phytoplankton in Vellar estuary, southeast coast of India. In: Proc. 5th Indian Fisheries Forum (Eds. S. Ayyappan, J.K. Jena and M. Mohan Joseph). Published by AFSIB, Mangalore and AeA, Bhubanewar, India. pp. 245-248

Shukla, S.R. and Chandel, S. P. (1980) Plant ecology. 4th Edn. S. Chandel and Co. Ramnagar, New Delhi –110055. 197

Sivasubramanium R (1999). Water quality of river Periyar (River Suruliyar) in Tamil Nadu. In: Mishra SR (Ed.). Limnological Research in India. Daya publishing house, Delhi

Skilleter, G.A., Warren, S. (2000) Effects of habitat modification in mangroves on the structure of mollusc and crab assemblages Journal of Experimental Marine Biology and Ecology, 244: 107–129

Spencer, C., 1975. The micronutrient elements. In: Riley, J.P., Skirrow, G. (Eds.), Chemical Oceanography, vol. II, seconded. Academic Press, London

Sukumar, R., Dattaraja, H. S., Suresh H. S. et al. 1992. “Long-term monitoring of vegetation in a tropical deciduous forest in Mudumalai, southern India,” Current Science, 62:608–616,

Tareq M S., Rahaman S M., Rikta Y S., Islam S M N., Sultana M S 2013; Seasonal Variations in Water Quality of the Ganges and Brahmaputra River, Bangladesh; Jahangirnagar University Environmental Bulletin, Vol.2; pages (71-82)

Warren, J.H., (1990) Role of burrows as refuges from subtidal predators of temperate mangrove crabs. Mar. Ecol. Prog. Ser. 67:295–299

Weiss R (1970) The solubility of nitrogen, oxygen and argon in water and seawater. Deep Sea Res Oceanogr Abstr 17(4):721–735

Wetzel, R.G., 2001. Limnology, 3rd ed. Academic Press

WHO (World Health Organization), Guidelines for drinking water quality, 2nd Edition; 1993.

WHO, The International Network to Promote Household Water Treatment and Safe Storage. 2007

Zhu Y G., Chen, S. B., & Yang, J. C., 2004; Effects of Soil Amendments on Lead Uptake by Two Vegetable Crops from a Lead-Contaminated Soil from Anhui, China. Environ Int., 30(3), 351-356. http://dx.doi.org/10.1016/j.envint.2003.

Appendix I: Checklist of Monitoring Environmental Compliances

Table A: Checklist of Monitoring for ESMP Implementation (During Pre-Construction and Land Development)

Sl no	Potential Impacts	Proposed EMP	Actual Implementation	Recommended Action	Compliance Status
1	Generation of Noise within the BIFPCL's Plant premises	• Conduct noise survey around and inside the site boundary • Reducing Noise and Vibrations to country's ambient standards, and occupational health and safety standards • Introducing vehicle speed limit and speed limit monitoring system • Green Plantation around the Project boundary • Switching off/ throttling down of machines/equipment's/generators which are not in use			
2	Dust Generation from Land development activities and other construction works	• Conducting dust monitoring and visual inspection around the site boundary • No use of earthen and undeveloped roads by vehicles related to the Project use • Installation of water spraying system to control fugitive dusts • Introducing vehicle speed limit and speed limit monitoring system • If yes, do they monitor vehicle speed regularly?			
3	Water Quality	• Fencing the construction site by drum sheet or Tarjja of any other fencing • Arrangement of runoff drainage for reducing any water logging • Location of backfilling stockpile in safe area and protected from wind and rain action • No storing of backfilling materials/spoil stored on river bank/slope • No disposal of waste and waste water to river or canal.			

Sl no	Potential Impacts	Proposed EMP	Actual Implementation	Recommended Action	Compliance Status
4	Waste Management System	• Provision of onsite waste management system			
5	Compensation and Resettlement	• Prepare Proper resettlement action plant and compensation plan if the Project needs any land acquisition addressing compensation, restoration, livelihood, living standards etc. based on proper socio economic studies • Resettlement of the PAPs • cash for compensation of land (CCL) before resettlement • formal agreement with the affected people prior to migration/resettlement • Sufficient standing crop compensation • Compensation for shift able structures? • Retention of salvageable materials? • Compensation for loss of trading income? • one time moving assistance • grant to cover loss of regular wage income • Has a resettlement plan been developed which includes compensation, restoration, livelihood, living standards etc. based on proper socio economic studies? • Provide/take extra care/caution for the disadvantaged/vulnerable group(s) (i.e. women, children, ethnic minorities, indigenous people etc.) • Provision of monitoring the compensation and resettlement process			
6	Livelihood and living	• Does the Project pose any threat to the livelihood/living standards of the local people? • If yes, are adequate steps taken to reduce the impacts? • Has the company developed any policy which prioritizes the local labourers in employment opportunities? • Is there any possibility that large vehicle related to the Project will cause traffic induced disturbance/s to the local dwellers?			

Sl no	Potential Impacts	Proposed EMP	Actual Implementation	Recommended Action	Compliance Status
		• If yes, are there any mitigative steps taken to decrease the disturbance/s? • Has the road network been developed after the Project being proposed and during the construction phase? • Are there separate water and sanitation facilities for the construction workers in the Project area?			
7	Green House Gas Controlling Measures	• Use of efficient generator in the construction activities • Regular maintenance of vehicles, generator and machinery in accordance with manufacturer's specifications • Use of approved pollution control devices fitted in the equipment's and machineries • Switching off and throttling down the machines/equipment's/generators which are not in use			

Table B: Checklist of Monitoring ESMP Implementation (During Pre-Construction and Land Development)

(Labor and Working Condition)
Basic Data

Sl No	Description	Values
1	Direct Workers	
2	Contracted Workers	
3	Supply Chain Workers	
	Child labor	
	0 - 12	
	13 - 14	
	14 - 18	

Checklist for Labor and Working Condition

Sl no	Potential Impacts	Proposed EMP	Actual Implementation	Recommended Action	Compliance Status
1	Working Conditions and Management of Worker Relationship	• Preparation of Human Resources Policies and Procedures for Direct workers • Defined Working condition and Terms of Employment for direct worker • Sustainably equivalent terms and condition for migrant workers • Compliance to national law of forming workers' organization • No discrimination and equal opportunity for all • Measures for diminishing past discrimination • Grievance Mechanism			
	Protecting Workforce	• The client will not employ children in any manner that is economically exploitative, or is likely to be hazardous or to interfere with the child education, or to be harmful to the child's health or physical, mental, spiritual, moral, or social development. • No Force Labor			
	Safety at site	• Installation/Construction of Safety Fence around the Project area • Use of Personnel Protective Equipment (i.e. safety suit, safety goggles, ear plug, safety shoes, gloves, dust mask, etc.) • Safety trainings for workers (i.e. fire control, working at height, working in heat, first aid etc.) • Practice of Tool box meeting, safety talks, • Safe Storage of Hazardous Chemicals (e.g. fuel, flammable chemical, toxic chemicals, etc.) • Maintaining Material Safety Data Sheet (MSDS) • Provision of Health care facilities such as doctor, hospital etc available at/nearby the plant construction site			

Sl no	Potential Impacts	Proposed EMP	Actual Implementation	Recommended Action	Compliance Status
		• Availability of First Aid at work place • Preparation and Follow of Emergency Response Plan • Adequate fire precautions in place (for example, fire extinguishers, escape routes etc.) • Documentation and reporting of occupational accidents, diseases, and incidents • Policies and procedures for managing and monitoring the performance of third party employers in relation to OHS			
	Occupational Health and Safety Procedure	• Provision of complete EHS division in the Human Resources Planning/Organogram • Preparation of Safety Policy to be adopted during plant operation			
	Worker's Well Being	• Establishment Grievance Mechanisms • Ensuring fair treatment, non-discrimination and equal opportunity • Compliance of Project's labor policy with the national labor law • No Child Labor • No incident of forced labor • Provision of Welfare facilities for Worker/Labor			

Table C: Checklist of Monitoring ESMP Implementation (During Pre-Construction and Land Development)

(Community Health, Safety and Security)

Sl no	Potential Impacts	Proposed EMP	Actual Implementation	Recommended Action	Compliance Status
1	Disturbance to nearby community due to dust from newly developed land and Noise from construction activities	• Construction of boundary wall around the Project are • Installation of water spraying system to control dusts • Conducting dust monitoring and visual inspection around the site boundary • Adoption of Noise management plan			
2	Grievance of local people	• Availability and operation of Grievance Redress Mechanism • Maintaining open communication channel with the local community			
3	Risk of breaching Community Safety	• Construction of boundary wall/safety fence around the Project area • Practicing Risk Assessment and Evaluation Process • Practicing safe management for hazardous materials which may pose threat to the community • Availability and operation of Emergency Response Plan • Maintaining open communication channel with the local community • Training and instruction to the security personnel about their behaviour and communication with the local people • Aware the security personnel about the right of the community people			
	Community Health Risk	• Provision of providing health service facilities to community if the Project possess any health risk like sexually transmitted disease, communicable disease, vector-borne diseases			***(Continued)***

Sl no	Potential Impacts	Proposed EMP	Actual Implementation	Recommended Action	Compliance Status
		• Implement all pollution mitigation measures to ensure safeguarding to community			
	Youth Employment	• Providing training/awareness program for the local youth to let them aware about the required qualification to get involved in the Project related activities			
	Public Communication, Consultation and Awareness	• Arranging public communication/consultation meeting • Sharing of Project information with local people • Organizing environmental and social awareness programs/meetings			

Table D: Checklist of Monitoring ESMP Implementation (During Pre-Construction and Land Development)

(Biodiversity and Sustainable Management of Living Natural Resources)

Sl no	Potential Impacts	Proposed EMP	Actual Implementation	Recommended Action	Compliance Status
1	Runoff (contain mostly sediment load) from newly developed land falls into nearby river and channel.	• Installation of proper run on/runoff drains • Use of sediment fences, traps and basins for trapping the sediment, if required			
2	Disturbance to nearby ecosystem due to different construction activities	• No cutting/ felling of trees along the river bank • Implementation of on-site waste and air quality management plan • Limiting soil extraction activities limited within the defined area • Limiting the vegetation clearance and base stripping process within the Project boundary • Safety fence around the construction site • Limiting the use of night light • Using shade (directed downwards) around the outdoor lights • Provision of cut-off time to switch off unnecessary lights at night • Initiate Green plantation • No plantation of non-native species			

Sl no	Potential Impacts	Proposed EMP	Actual Implementation	Recommended Action	Compliance Status
		• Retaining top soil for future habitat restoration • No degradation of critical habitat?			
3	Occupation of river, inter-tidal areas and wetlands	• No encroachment of inter-tidal flood plain area • No disturbance to Dolphin community • Monitoring of Ecosystem Health and Monitoring of Sundarbans Forest Health • If required, embankment should be constructed considering a setback distance from river/canal bank • Slope protection work along the Maidara River should be completed on an urgent basis before rainy season come and • BIFPCL may take initiatives of excavating of silted reach of Maidara river near proposed township area to facilitate proper functioning of River for maintaining tidal dynamics			

Appendix II: Photo Album

Environmental Monitoring of Khulna 2×660 MW Power Plant for 4th Quarter of 3rd Year *(January, 2017)*

The Monitoring Team

Experts are sharing informations

Estimation of tree height

Collection of soil samples

Collection of DBH data

Collection of sapling diameter data

Conducting air quality monitoring

Fisheries catch assessment at sibsha river in Akram point

Consultants are inspecting toilets of local labor shed

Inside of the local labor shade

Cistern at the project site

Developing internal road network

Safety sign inside the project area

Warning sign inside the project area

Covered construction materials

Site office premise

Appendix III: Terms of References (ToR)

As per ECA 1995 and ECR 1997, the proposed Project "1320MW coal based thermal Power Plant at Rampal, Khulna" falls under red category; needs proper monitoring and documenting of environmental and socio-economic parameters.

Accordingly, the EIA study of the proposed plant has already been conducted. The EIA of the proposed Power Plant briefly describes the monitoring plan. The ToR has been prepared for engaging Engineering, environmental and social Contractor for monitoring the environmental and socio-economic parameters during pre-construction and construction phases along with the engineering consideration of the site development and construction of the Project so that the monitoring plan suggested in the EIA is properly followed and satisfies the requirement of ECR 1997 and ECR 2005.

The monitoring works has been divided in to two major components:

Work A: Monitoring of Engineering activities of site development and others.

Work B: Monitoring of Social and Environmental parameters for updating the baseline and Implementation of the Project.

Work A: The main objective of this component is to monitoring the engineering activities of site development and others during pre-construction and construction phase for installation of the Power Plant.

The specific objectives of the monitoring program are:

- To establish baseline environmental conditions;
- To detect adverse environmental impacts for river dredging and land filling activities for site development;
- To demonstrate whether the environmental control measures are operating as per designed;
- To provide data for emission inventories;
- To provide data at regular intervals for dissemination to the stakeholders
- To provide data for improvement and updating of the monitoring program;
- To assist in investigating the event of a trigger level or emission limit value being crossed.

Landfill monitoring is an interactive process of incorporating the findings of the site investigation, the environmental impact assessment, environmental monitoring results, risk assessment and the conclusions reached in the investigations.

Work B: The main objective of this component is to monitor the environmental parameters and implementation of environmental management plan during pre-construction and construction phase for installation of the Power Plant. The specific objectives of the monitoring program are:

- Update baseline data as per monitoring schedule and location.
- Monitor and provide the environmental parameters during pre construction activities.
- Provide technical assistance to the client for implementation of the EMP at different sector of construction activities.
- Monitor the environmental aspects during construction of the Project.

- Review the EIA document to evaluate the EMP measures incorporated in the contract to mitigate different social and environmental hazards and risks during construction of the Project
- Submit progress reports to the client.
- Render any other related services as and when requested.

The scope of the services can be specified as bellows:

Monitoring Parameter	Indicators
Socio-economy	Livelihood and Occupation
	Income and expenditure
	Displacement and Migration
	Cultural and heritage
	Health and sanitation
	Risks and accidental assessment
	Transportation and communication
	Public and private Infrastructure development
Ecology and Biodiversity	Bio-indicator Assessment
	Movement of indigenous/ native species
	Envision of exotic species and regime dominance
	Species composition (Flora and Fauna)
	Assessment the services of dependent ecosystem
Agriculture	Land use and canopy coverage
	Soil quality (Salinity, pH, OM,)
	Cropping pattern and crop intensities
	Irrigation and crop production
	Farmers survey result
Fisheries	Fish diversity and specification
	Fish production and availability
	Fisher survey result
Noise level	Sound level at the sensitive zone
Water resources	DO, BOD, COD, Salinity , TDS, TS, pH, Hg, Pb
	Total Hardness, Hg, NO_3 and PO_4
	River Morphology,
	Tidal inundation
	Drainage Network
	Erosion and Accretion
	Ground water quality
Air quality	SOx
	NOx
	SPM (PM_{10} and $PM_{2.5}$)
	CO

Reporting Requirements

As it is proposed to carry out the monitoring program for three (3) years, the schedule of deliverables has to be re-scheduled. The proposed deliverables are scheduled below

- An Inception Report shall be submitted within 30 (thirty) days from the commencement of the assignment
- Submission of 1st quarterly monitoring report at the end of three (3) months from the date of signing contract;
- Submission of 2nd quarterly monitoring report at the end of six (6) months from the date of signing contract;
- Submission of 3rd quarterly monitoring report at the end of nine (9) months from the date of signing contract;

- Submission of Annual (1st) monitoring report at the end of one (1) year from the date of signing contract;
- Submission of 5th quarterly monitoring report at the end of fifteen (15) months from the date of signing contract;
- Submission of 6th quarterly monitoring report at the end of eighteen (18) months from the date of signing contract;
- Submission of 7th quarterly monitoring report at the end of twenty one (21) months from the date of signing contract;
- Submission of Annual (2nd) monitoring report at the end of twenty four (24) months from the date of signing contract;
- Submission of 9th quarterly monitoring report at the end of twenty seven (27) months from the date of signing contract;
- *Submission of 10th quarterly monitoring report at the end of thirty (30) months from the date of signing contract;*
- Submission of 11th quarterly monitoring report at the end of thirty three (33) months from the date of signing contract;
- Submission of Annual (3rd) monitoring report at the end of thirty three months from the date of signing contract;
- All report shall be submitted to BIFPCL in (five) hard copies and soft copy on CD.

Appendix IV: Monitoring Data

(A) Air Quality Data

Table A.1: Ambient Air Quality Monitoring Results

Locations of Monitoring	Pollutants	1st QM, Apr 2014	2nd QM, Jul 2014	3rdQM, Oct 2014	4th QM, Jan 2015	5th QM, Apr 2015	6th QM, Jul2015	7th QM, Oct 2015	8 QM, Jan 2016	9th QM, Apr 2016	10th QM, Jul 2016	11th QM, Oct 2016	12th QM, Jan 2017	Bangladesh (DoE) Standard (ECR 2005)	IFC/WB Standard
Weather		Sunny	Rainy/ Cloudy	Sunny	Sunny	Sunny	Rainy/ Cloudy	Sunny to Rainy	Sunny	Sunny	Rainy/ Cloudy	Rainy/ Cloudy	Sunny		
Wind Direction		SE	SE	SE	NW	SE to NW	SW to NE	SW to NE	NW to SE	SSE to NNW	SW to NE	SE	NW to SE		
		Concentrations are in µg/m³													
SW Corner of the PP area	$PM_{2.5}$	33	37	25	33	47	25	22	34	19	5	9	24.8	*65^{24hr}*	*75^{24hr} (IT-1)*
	PM_{10}	78	77	53	79	83	35	52	135	117	32	22	79	*150^{24hr}*	*150^{24hr}(IT-1)*
	SPM	207	239	190	200	177	42	91	175	332	51	53	115.7	*200^{8hr}*	*NF*
	SO_2	21	24	19	23	15	52	35	14	18	9	8	9.5	*365^{24hr}*	*125^{24hr} (IT-1)*
	NOx	26	29	27	31	29	35	29	18	18	12	10	11.3	*100^{Annual}*	*200^{1hr}, 40^{Annual}*
	CO	120	188	140	190	144	146	88	74	57	35	119	59	*(10000) ^{8hr}*	*NF*
	O_3	27	26	19	22	26	12	5	4	1	1	1	5	*157^{8hr}*	*100^{8hr}*
Proposed Township	$PM_{2.5}$	39	48	48	39	34	18	17	35	25	3	8	25	*65^{24hr}*	*75^{24hr} (IT-1)*

Locations of Monitoring	Pollutants	1st QM, Apr 2014	2nd QM, Jul 2014	3rdQM, Oct 2014	4th QM, Jan 2015	5th QM, Apr 2015	6th QM, Jul2015	7th QM, Oct 2015	8 QM, Jan 2016	9th QM, Apr 2016	10th QM, Jul 2016	11th QM, Oct 2016	12th QM, Jan 2017	Bangladesh (DoE) Standard (ECR 2005)	IFC/WB Standard
Weather		Sunny	Rainy/ Cloudy	Sunny	Sunny	Sunny	Rainy/ Cloudy	Sunny to Rainy	Sunny	Sunny	Rainy/ Cloudy	Rainy/ Cloudy	Sunny		
Wind Direction		SE	SE	SE	NW	SE to NW	SW to NE	SW to NE	NW to SE	SSE to NNW	SW to NE	SE	NW to SE		
	PM_{10}	89	90	74	102	97	31	48	116	44	11	11	99.5	*150^{24hr}*	*150^{24hr}(IT-1)*
	SPM	217	263	217	274	266	47	79	192	187	27	23	154.2	*200^{8hr}*	*NF*
	SO_2	19	28	22	21	22	58	27	13	11	4	6	12.9	*365^{24hr}*	*125^{24hr} (IT-1)*
	NOx	29	39	27	26	24	46	25	16	22	6	8	15.7	*100^{Annual}*	*200^{1hr}, 40^{Annual}*
	CO	165	210	230	164	136	127	102	77	22	31	108	66	*(10000) ^{8hr}*	*NF*
	O_3	33	26	26	23	21	16	1	1	1	0	0	1	*157^{8hr}*	*100^{8hr}*
NW Corner of the PP area	$PM_{2.5}$	37	44	19	42	59	28	19	24	11	3	10	29	*65^{24hr}*	*75^{24hr} (IT-1)*
	PM_{10}	67	78	56	98	91	96	29	125	29	24	14	108.7	*150^{24hr}*	*150^{24hr}(IT-1)*
	SPM	234	217	157	310	244	321	66	187	115	31	35	168	*200^{8hr}*	*NF*
	SO_2	19	22	18	27	21	56	32	13	17	4	8	12.2	*365^{24hr}*	*125^{24hr} (IT-1)*
	NOx	23	28	22	32	39	43	21	18	16	5	11	14.7	*100^{Annual}*	*200^{1hr}, 40^{Annual}*
	CO	110	178	110	210	140	133	87	77	38	47	127	31	*(10000) ^{8hr}*	*NF*
	O_3	25	19	17	36	44	11	8	2	0	1	1	3	*157^{8hr}*	*100^{8hr}*
Barni, Gaurambha	$PM_{2.5}$	39	47	57	39	41	34	11	29	23	9	10	21.7	*65^{24hr}*	*75^{24hr} (IT-1)*

Locations of Monitoring	Pollutants	1st QM, Apr 2014	2nd QM, Jul 2014	3rdQM, Oct 2014	4th QM, Jan 2015	5th QM, Apr 2015	6th QM, Jul2015	7th QM, Oct 2015	8 QM, Jan 2016	9th QM, Apr 2016	10th QM, Jul 2016	11th QM, Oct 2016	12th QM, Jan 2017	Bangladesh (DoE) Standard (ECR 2005)	IFC/WB Standard
Weather		Sunny	Rainy/ Cloudy	Sunny	Sunny	Sunny	Rainy/ Cloudy	Sunny to Rainy	Sunny	Sunny	Rainy/ Cloudy	Rainy/ Cloudy	Sunny		
Wind Direction		SE	SE	SE	NW	SE to NW	SW to NE	SW to NE	NW to SE	SSE to NNW	SW to NE	SE	NW to SE		
	PM_{10}	103	122	67	97	82	65	26	97	82	45	13	105.4	*150^{24hr}*	*150^{24hr}(IT-1)*
	SPM	233	244	183	277	236	79	112	176	268	69	30	167.8	*200^{8hr}*	*NF*
	SO_2	21	23	17	22	25	41	31	16	20	10	7	12.2	*365^{24hr}*	*125^{24hr} (IT-1)*
	NOx	25	28	22	26	27	44	32	21	16	12	9	19.3	*100^{Annual}*	*200^{1hr}, 40^{Annual}*
	CO	175	210	190	150	196	96	96	81	73	41	98	63	*$(10000)^{8hr}$*	*NF*
	O_3	26	29	22	19	15	9	6	4	0	0	3	5	*157^{8hr}*	*100^{8hr}*
Chunkuri-2, Bajua Dacope	$PM_{2.5}$	35	39	46	37	33	35	28	31	25	7	5	25.2	*65^{24hr}*	*75^{24hr} (IT-1)*

Locations of Monitoring	Pollutants	1st QM, Apr 2014	2nd QM, Jul 2014	3rdQM, Oct 2014	4th QM, Jan 2015	5th QM, Apr 2015	6th QM, Jul2015	7th QM, Oct 2015	8 QM, Jan 2016	9th QM, Apr 2016	10th QM, Jul 2016	11th QM, Oct 2016	12th QM, Jan 2017	Bangladesh (DoE) Standard (ECR 2005)	IFC/WB Standard
Weather		Sunny	Rainy/ Cloudy	Sunny	Sunny	Sunny	Rainy/ Cloudy	Sunny to Rainy	Sunny	Sunny	Rainy/ Cloudy	Rainy/ Cloudy	Sunny		
Wind Direction		SE	SE	SE	NW	SE to NW	SW to NE	SW to NE	NW to SE	SSE to NNW	SW to NE	SE	NW to SE		
	PM_{10}	77	86	69	68	61	109	49	98	60	23	20	74.4	*150^{24hr}*	*150^{24hr}(IT-1)*
	SPM	117	113	162	183	188	175	94	167	167	31	48	162	*200^{8hr}*	*NF*
	SO_2	19	24	21	18	11	55	33	21	13	7	9	18.9	*365^{24hr}*	*125^{24hr} (IT-1)*
	NOx	23	26	27	24	18	49	23	16	25	10	8	18	*100^{Annual}*	*200^{1hr}, 40^{Annual}*
	CO	190	205	170	170	33	133	75	70	33	38	79	36	*(10000) ^{8hr}*	*NF*
	O_3	27	24	18	22	41	21	2	1	1	0	2	2	*157^{8hr}*	*100 ^{8hr}*
Pankhali, Dacope	$PM_{2.5}$	47	49	57	41	39	34	25	47	15	8	10	38.7	*65^{24hr}*	*75^{24hr} (IT-1)*

Locations of Monitoring	Pollutants	1st QM, Apr 2014	2nd QM, Jul 2014	3rdQM, Oct 2014	4th QM, Jan 2015	5th QM, Apr 2015	6th QM, Jul2015	7th QM, Oct 2015	8 QM, Jan 2016	9th QM, Apr 2016	10th QM, Jul 2016	11th QM, Oct 2016	12th QM, Jan 2017	Bangladesh (DoE) Standard (ECR 2005)	IFC/WB Standard
Weather		Sunny	Rainy/ Cloudy	Sunny	Sunny	Sunny	Rainy/ Cloudy	Sunny to Rainy	Sunny	Sunny	Rainy/ Cloudy	Rainy/ Cloudy	Sunny		
Wind Direction		SE	SE	SE	NW	SE to NW	SW to NE	SW to NE	NW to SE	SSE to NNW	SW to NE	SE	NW to SE		
	PM_{10}	119	127	139	101	105	144	62	128	46	42	18	141.6	*150^{24hr}*	*150^{24hr}(IT-1)*
	SPM	297	266	254	208	299	339	183	198	114	78	34	194.6	*200^{8hr}*	*NF*
	SO_2	28	31	31	24	30	58	36	18	9	8	8	16.1	*365^{24hr}*	*125^{24hr} (IT-1)*
	NOx	41	39	36	26	27	47	23	15	19	9	9	19	*100^{Annual}*	*200^{1hr}, 40^{Annual}*
	CO	230	217	250	188	177	125	105	101	55	29	112	48	*(10000) ^{8hr}*	*NF*
	O_3	49	38	36	27	11	13	5	2	2	0	0	3	*157^{8hr}*	*100^{8hr}*
Mongla Port area	$PM_{2.5}$	47	55	39	41	26	33	19	34	21	9	11	25.7	*65^{24hr}*	*75^{24hr} (IT-1)*

Locations of Monitoring	Pollutants	1st QM, Apr 2014	2nd QM, Jul 2014	3rdQM, Oct 2014	4th QM, Jan 2015	5th QM, Apr 2015	6th QM, Jul2015	7th QM, Oct 2015	8 QM, Jan 2016	9th QM, Apr 2016	10th QM, Jul 2016	11th QM, Oct 2016	12th QM, Jan 2017	Bangladesh (DoE) Standard (ECR 2005)	IFC/WB Standard
Weather		Sunny	Rainy/ Cloudy	Sunny	Sunny	Sunny	Rainy/ Cloudy	Sunny to Rainy	Sunny	Sunny	Rainy/ Cloudy	Rainy/ Cloudy	Sunny		
Wind Direction		SE	SE	SE	NW	SE to NW	SW to NE	SW to NE	NW to SE	SSE to NNW	SW to NE	SE	NW to SE		
	PM_{10}	139	174	77	82	35	52	33	132	45	29	15	119.3	*150^{24hr}*	*150^{24hr}(IT-1)*
	SPM	288	303	197	217	214	118	65	189	144	50	6	172.3	*200^{8hr}*	*NF*
	SO_2	27	28	26	24	14	45	36	16	10	8	7	16.8	*365^{24hr}*	*125^{24hr} (IT-1)*
	NOx	44	39	33	27	17	40	20	13	14 .	10	8	15.3	*100^{Annual}*	*200^{1hr}, 40^{Annual}*
	CO	230	320	220	211	24	110	84	71	29	31	97	44	*(10000) ^{8hr}*	*NF*
	O_3	57	52	37	26	09	15	8	3	1	2	1	4	*157^{8hr}*	*100^{8hr}*
Harbaria, Sundarbans	$PM_{2.5}$	19	22	33	27	24	27	24	26	13	6	10	19.2	*65^{24hr}*	*75^{24hr} (IT-1)*

Locations of Monitoring	Pollutants	1st QM, Apr 2014	2nd QM, Jul 2014	3rdQM, Oct 2014	4th QM, Jan 2015	5th QM, Apr 2015	6th QM, Jul2015	7th QM, Oct 2015	8 QM, Jan 2016	9th QM, Apr 2016	10th QM, Jul 2016	11th QM, Oct 2016	12th QM, Jan 2017	Bangladesh (DoE) Standard (ECR 2005)	IFC/WB Standard
Weather		Sunny	Rainy/ Cloudy	Sunny	Sunny	Sunny	Rainy/ Cloudy	Sunny to Rainy	Sunny	Sunny	Rainy/ Cloudy	Rainy/ Cloudy	Sunny		
Wind Direction		SE	SE	SE	NW	SE to NW	SW to NE	SW to NE	NW to SE	SSE to NNW	SW to NE	SE	NW to SE		
	PM_{10}	41	39	59	56	49	42	50	82	42	20	14	85.2	*150^{24hr}*	*150^{24hr}(IT-1)*
	SPM	111	117	129	139	109	70	73	159	91	43	44	93.5	*200^{8hr}*	*NF*
	SO_2	9	10	14	12	16	51	34	15	11	6	7	11.9	*365^{24hr}*	*125^{24hr} (IT-1)*
	NOx	19	22	27	18	22	34	22	14	16	8	10	13	*100^{Annual}*	*200^{1hr}, 40^{Annual}*
	CO	65	58	70	64	56	112	81	62	47	32	110	67	*(10000) ^{8hr}*	*NF*
	O_3	13	12	13	11	14	12	4	2	2	0	1	4	*157^{8hr}*	*100^{8hr}*
Akram Point, Sundarbans	$PM_{2.5}$	17	19	23	18	49	*NO*	25	18	9	4	4	14.3	*65^{24hr}*	*75^{24hr} (IT-1)*

Locations of Monitoring	Pollutants	1st QM, Apr 2014	2nd QM, Jul 2014	3rdQM, Oct 2014	4th QM, Jan 2015	5th QM, Apr 2015	6th QM, Jul2015	7th QM, Oct 2015	8 QM, Jan 2016	9th QM, Apr 2016	10th QM, Jul 2016	11th QM, Oct 2016	12th QM, Jan 2017	Bangladesh (DoE) Standard (ECR 2005)	IFC/WB Standard
Weather		Sunny	Rainy/ Cloudy	Sunny	Sunny	Sunny	Rainy/ Cloudy	Sunny to Rainy	Sunny	Sunny	Rainy/ Cloudy	Rainy/ Cloudy	Sunny		
Wind Direction		SE	SE	SE	NW	SE to NW	SW to NE	SW to NE	NW to SE	SSE to NNW	SW to NE	SE	NW to SE		
	PM_{10}	39	44	32	39	77	*NO*	32	77	31	15	14	85.5	*150^{24hr}*	*150^{24hr}(IT-1)*
	SPM	114	133	97	88	102	*NO*	51	128	46	23	27	90.9	*200^{8hr}*	*NF*
	SO_2	7	9	12	13	21	*NO*	27	14	9	4	6	8.4	*365^{24hr}*	*125^{24hr} (IT-1)*
	NOx	17	19	22	17	27	*NO*	19	15	10	5	6	12.7	*100^{Annual}*	*200^{1hr}, 40^{Annual}*
	CO	49	60	50	46	163	*NO*	92	64	21	37	101	58	*(10000) ^{8hr}*	*NF*
	O_3	11	14	9	10	27	*NO*	8	1	0	0	2	3	*157^{8hr}*	*100^{8hr}*
Hiron Point, Sundarbans	$PM_{2.5}$	15	23	19	17	28	*NO*	27	*NO*	17	*NO*	9	21.7	*65^{24hr}*	*75^{24hr} (IT-1)*
	PM_{10}	44	38	34	41	60	*NO*	45	*NO*	40	*NO*	14	104.5	*150^{24hr}*	*150^{24hr}(IT-1)*
	SPM	101	119	107	97	110	*NO*	88	*NO*	132	*NO*	26	111.4	*200^{8hr}*	*NF*
	SO_2	8	7	13	14	15	*NO*	28	*NO*	15	*NO*	9	13.5	*365^{24hr}*	*125^{24hr} (IT-1)*
	NOx	18	18	19	22	20	*NO*	23	*NO*	19	*NO*	9	15.9	*100^{Annual}*	*200^{1hr}, 40^{Annual}*
	CO	52	62	65	60	60	*NO*	93	*NO*	40	*NO*	121	43	*(10000) ^{8hr}*	*NF*
	O_3	14	13	11	9	23	*NO*	2	*NO*	0	*NO*	0	4	*157^{8hr}*	*100^{8hr}*
Khulna City, near Khan Jahan Ali Bridge	$PM_{2.5}$	54	39	52	42	55	46	19	35	11	16	9	34.6	*65^{24hr}*	*75^{24hr} (IT-1)*

Locations of Monitoring	Pollutants	1st QM, Apr 2014	2nd QM, Jul 2014	3rdQM, Oct 2014	4th QM, Jan 2015	5th QM, Apr 2015	6th QM, Jul2015	7th QM, Oct 2015	8 QM, Jan 2016	9th QM, Apr 2016	10th QM, Jul 2016	11th QM, Oct 2016	12th QM, Jan 2017	Bangladesh (DoE) Standard (ECR 2005)	IFC/WB Standard
Weather		Sunny	Rainy/ Cloudy	Sunny	Sunny	Sunny	Rainy/ Cloudy	Sunny to Rainy	Sunny	Sunny	Rainy/ Cloudy	Rainy/ Cloudy	Sunny		
Wind Direction		SE	SE	SE	NW	SE to NW	SW to NE	SW to NE	NW to SE	SSE to NNW	SW to NE	SE	NW to SE		
	PM_{10}	139	117	91	84	75	89	49	112	69	68	24	145.9	*150^{24hr}*	*150^{24hr}(IT-1)*
	SPM	301	287	239	219	222	181	101	181	112	107	64	189.7	*200^{8hr}*	*NF*
	SO_2	33	29	33	28	31	59	28	16	11	10	10	17.1	*365^{24hr}*	*125^{24hr} (IT-1)*
	NOx	49	41	39	36	33	38	26	16	15	15	14	18.6	*100^{Annual}*	*200^{1hr}, 40^{Annual}*
	CO	330	370	330	296	101	89	94	98	68	36	104	66	*(10000) ^{8hr}*	*NF*
	O_3	59	67	57	39	21	7	4	2	1	0	2	3	*157^{8hr}*	*100^{8hr}*

Note(s):

- *Concentrations are in µg/m^3 ;*
- *DoE- Department of Environment, NF- Not found; NO-Not observed*
- *Fine Particulate Matter ($PM_{2.5}$), Respirable Dust Content (PM_{10}), Suspended Particulate Matter (SPM), Oxides of Nitrogen (NO_X). Sulfur dioxide (SO_2), Carbone Monoxide (CO) & Ozone (O_3);*
- *Standards for 1hr, 24hr or Annual are indicated using superscript;*
- *This monitoring was carried out by - Respirable Dust Sampler (Model-Envirotech India APM-460BL) and Fine Particulate Sampler (Model-Envirotech India APM-550).*
- *All data presented here are 8 hrs. Monitoring data.*

Table A.2: Baseline conditions of emission of different infrastructures and sources

		Cement Industry	Condensate Fractionating Plant	LPG Bottling Plant	Brick Field	Road Traffic	Small vessels, engine boat	Inland Water Cargo vessel	Sea going Mother Vessel (MV)	Fly ash Carrier	Clinkers Carrier	Clinker, Fly Ash Handling	Coal Carrier (MV)	Coal Ash Carrier (MV)	Coal Carrier (Lighter Vessel)	Coal Ash Carrier (Lighter Vessel)	Coal Loading and Unloading	Coal Handling (Stock Yard, Conveyor belt, etc)	BIF Power Plant (PP)	Other Coal Based PP	Other Fuel Based PP	Dredging and Land Filling	Earth excavation	Other Construction Activities	Residential sources
SW Corner of the PP area	PM	✓	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✗	✓	✓
	SOx	✗	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓
	NOx	✗	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓
	GHGs	✗	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓
Proposed Township area of the PP	PM	✓	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✗	✗	✓
	SOx	✗	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓
	NOx	✗	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓
	GHGs	✗	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓
NW Corner of the PP area	PM	✗	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✗	✗	✓
	SOx	✗	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓
	NOx	✗	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓
	GHGs	✗	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓
Barni, Gaurambha	PM	✗	✗	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✓
	SOx	✗	✗	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓
	NOx	✗	✗	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓
	GHGs	✗	✗	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓
Chunkuri-2,	PM	✓	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓

Legend ✗ *Absence of source or no emission,* ✓ *Presence of source, emission of pollutant*

		Cement Industry	Condensate Fractionating Plant	LPG Bottling Plant	Brick Field	Road Traffic	Small vessels, engine boat	Inland Water Cargo vessel	Sea going Mother Vessel (MV)	Fly ash Carrier	Clinkers Carrier	Clinker, Fly Ash Handling	Coal Carrier (MV)	Coal Ash Carrier (MV)	Coal Carrier (Lighter Vessel)	Coal Ash Carrier (Lighter Vessel)	Coal Loading and Unloading	Coal Handling (Stock Yard, Conveyor belt, etc)	BIF Power Plant (PP)	Other Coal Based PP	Other Fuel Based PP	Dredging and Land Filling	Earth excavation	Other Construction Activities	Residential sources
	SOx	✗	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓
	NOx	✗	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓
	GHGs	✗	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓
Pankhali, Dacope	PM	✓	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✓
	SOx	✗	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓
	NOx	✗	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓
	GHGs	✗	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓
Mongla Port area	PM	✓	✓	✓	✗	✓	✓	✓	✓	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✓	✗	✗	✗	✓
	SOx	✗	✓	✗	✗	✓	✓	✓	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✗	✗	✓	✓
	NOx	✗	✓	✗	✗	✓	✓	✓	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✗	✗	✗	✓
	GHGs	✗	✓	✗	✗	✓	✓	✓	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✗	✗	✗	✓
Harbaria, Sundarbans	PM	✗	✗	✗	✗	✗	✓	✓	✓	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
	SOx	✗	✗	✗	✗	✗	✓	✓	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
	NOx	✗	✗	✗	✗	✗	✓	✓	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
	GHGs	✗	✗	✗	✗	✗	✓	✓	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Akram	PM	✗	✗	✗	✗	✗	✓	✓	✗	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗

Legend ✗ *Absence of source or no emission,* ✓ *Presence of source, emission of pollutant*

		Cement Industry	Condensate Fractionating Plant	LPG Bottling Plant	Brick Field	Road Traffic	Small vessels, engine boat	Inland Water Cargo vessel	Sea going Mother Vessel (MV)	Fly ash Carrier	Clinkers Carrier	Clinker, Fly Ash Handling	Coal Carrier (MV)	Coal Ash Carrier (MV)	Coal Carrier (Lighter Vessel)	Coal Ash Carrier (Lighter Vessel)	Coal Loading and Unloading	Coal Handling (Stock Yard, Conveyor belt, etc)	BIF Power Plant (PP)	Other Coal Based PP	Other Fuel Based PP	Dredging and Land Filling	Earth excavation	Other Construction Activities	Residential sourceS
	SOx	✗	✗	✗	✗	✗	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
	NOx	✗	✗	✗	✗	✗	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
	GHGs	✗	✗	✗	✗	✗	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Hiron Point Sundarbans	PM	✗	✗	✗	✗	✗	✓	✓	✗	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
	SOx	✗	✗	✗	✗	✗	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
	NOx	✗	✗	✗	✗	✗	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
	GHGs	✗	✗	✗	✗	✗	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Khulna City, near Khan Jahan Ali Bridge	PM	✓	✗	✗	✓	✓	✓	✓	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✓
	SOx	✗	✗	✗	✓	✓	✓	✓	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓
	NOx	✗	✗	✗	✓	✓	✓	✓	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓
	GHGs	✗	✗	✗	✓	✓	✓	✓	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓

Legend ✗ *Absence of source or no emission,* ✓ *Presence of source, emission of pollutant*

(B) Water Quality Data

➢ Surface Water Quality Monitoring Data

Table B.1: pH Values of Passur River Water

Sl	Sampling Locations	pH Values												
		1st year				2nd Year				3rd year				BD Standard
		Apr	July	Oct	Jan	Apr	July	Oct	Jan	Apr	July	Oct	Jan	
		1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	
1	Left Bank of Passur River at 100m u/s of North West corner from the Project boundary	7.2	7.0	8.1	7.9	7.6	7.8	7.6	7.1	7.5	7.27	6.9	7.6	6.5– 8.5
2	Middle Passur River at 100m u/s of North West corner from the Project boundary	7.2	7.0	8.2	8.0	7.7	7.9	7.58	7.3	7.8	7.3	7	7.5	
3	Right Bank of Passur River at 100m u/s of North West corner from the Project boundary	7.2	6.9	8.0	8.1	7.8	7.8	7.64	7.3	7.2	7.93	7.2	7.8	
4	Left Bank of Passur River at Project site-Jetty	7.9	7.1	8.1	7.9	7.5	7.9	7.6	7.1	7.4	7.56	7.3	8.2	
5	Middle Passur River at Project site-Jetty	7.1	6.9	8.1	7.9	7.6	8	7.58	7.5	7.8	7.6	7	8.5	
6	Right Bank of Passur River at Project site-Jetty	7.1	6.9	8.2	7.9	7.7	8	7.62	7.6	7.4	7.9	6.9	8.7	
7	Left Bank of Passur River at South West corner from the Project boundary	7.4	7.0	8.1	7.6	7.5	8.1	7.78	8.1	7.6	7.94	7.2	8.1	
8	Middle of Passur River at South West corner from the Project boundary	7.4	6.9	8.0	7.5	7.2	8	7.6	8	7.1	8.04	7.5	8.6	
9	Right Bank of Passur River at South West corner from the Project boundary	7.3	6.8	8.0	7.8	7.3	8.1	7.64	7.9	7.2	8.2	7.3	8.9	
10	Maidara river of the South East corner of the Project at Ichamoti-Maidara confluence	7.4	6.9	8.1	7.7	7.5	8.1	7.3	7.3	7.1	8.1	6.8	8.1	
11	Maidara river near proposed township area	7.4	6.8	8.1	7.3	7.6	6.9	7.56	7.1	7.4	7.8	7.1	7.6	
12	Passur river at Passur-Ghasiakhali confluence	7.3	6.8	7.4	8.2	7.5	7.9	7.1	7.4	7.3	7.3	6.9	7.2	
13	Passur river at Harbaria of Sundarbans	7.9	6.9	8.0	8.1	7.7	7.9	7.8	8.2	7.3	7.63	7.4	7.8	
14	Passur river at Akram point of Sundarbans	7.2	6.9	7.9	8.1	7.7	NS	7.63	8	7.9	7.67	7.1	8.2	
15	Passur river at Hiron po.000int of Sundarbans	7.2	7.0	7.0	8.1	7.7	NS	7.39	NS	7.8		7.6	8.5	

Source: CEGIS Field Survey- April, July and October 2014 and January, April, July and October 2015, January and April 2016

Note: 1QM= First Quarterly Monitoring, 2QM = Second Quarterly Monitoring, 3QM = Third Quarterly Monitoring, 4QM = Fourth Quarterly Monitoring, NS – Not Surveyed

Table B.2: Surface Water Temperature in Passur River

Sl	Sampling Locations	Temperature (°C)												
		1st Year				2nd Year				3rd year				BD Standard
		Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	
		1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	
1	Left Bank of Passur River at 100m u/s of North West corner from the Project boundary	31	33	31	19	30	31.8	31.2	22.0	31.2	29.6	30.1	22.8	20°C – 30°C
2	Middle Passur River at 100m u/s of North West corner from the Project boundary	31	33	31	20	30	30.5	31.8	21.0	31.1	29.1	30.8	22.5	
3	Right Bank of Passur River at 100m u/s of North West corner from the Project boundary	31	33	30	20	30	30.5	30.9	21.0	30.8	29.4	30.4	22.1	
4	Left Bank of Passur River at Project site-Jetty	31	33	31	19	31	30.8	31.3	22.0	31.4	30.1	30.1	22.8	
5	Middle Passur River at Project site-Jetty	30	32	31	19	30	30.6	31.6	22.0	30.9	30.5	31.0	21.8	
6	Right Left Bank of Passur River at Project site-Jetty	30	32	31	19	30	30.4	31.1	21.0	31.0	30.5	31.1	21.9	
7	Left Bank of Passur River at South West corner from the Project boundary	31	32	30	20	31	30.5	30.3	23.0	30.7	30.7	30.4	22.1	
8	Middle of Passur River at South West corner from the Project boundary	31	31	29	19	30	30.8	30.5	22.0	30.4	29.8	30.2	22.0	
9	Right Bank of Passur River at South West corner from the Project boundary	31	31	29	19	31	30.6	30.8	21.0	30.1	29.8	31.1	22.1	
10	Maidara river of the South East corner of the Project at Ichamoti-Maidara confluence	30	31	28	19	30	30.8	31.8	22.0	31.2	30.4	31.1	21.9	
11	Maidara river near proposed township area	30	32	27	20	30	31.6	31.2	23.0	30.6	30.7	31.2	21.8	
12	Passur river at Passur-Ghasiakhali confluence	29	30	32	19	30	29.8	30.7	21	31.3	30.7	30.38	22.1	
13	Passur river at Harbaria of Sundarbans	30	30	27	22	30	29.0	30.8	22.0	31.5	30.9	29.9	23.1	
14	Passur river at Akram point of Sundarbans	29	29	30	21	30	NS	30.2	21.0	30.8	30.4	30.4	22.5	
15	Passur river at Hiron point of Sundarbans	29	30	29	21	30	NS	30.4	NS	31.4		31.3	21.4	

Source: CEGIS Field Survey- April, July and October 2014 and January, April, July and October 2015, January and April 2016

Note: 1QM= First Quarterly Monitoring, 2QM = Second Quarterly Monitoring, 3QM = Third Quarterly Monitoring, 4QM = Fourth Quarterly Monitoring, NS – Not Surveyed

Table B.3: Salinity (ppt) in Passur River

Sl	Sampling Locations	Salinity (ppt)											
		1st Year				2nd Year				3rd year			
		Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan
		1st QM	2nd QM	3QM	4th QM	1st QM	2nd QM	3QM	4th QM	1st QM	2nd QM	3QM	4th QM
1	Left Bank of Passur River at 100m u/s of North West corner from the Project boundary	11.5	2.5	0.0	4.5	13	0	0	4.1	8	0	0	3.7
2	Middle of Passur River at 100m u/s of North West corner from the Project boundary	11.5	0.3	0.0	4.1	15	0	0	4.3	7.4	0	0	3.8
3	Right Bank of Passur River at 100m u/s of North West corner from the Project boundary	11.5	0.2	0.0	4.5	16	0	0	4.3	7	0	0	3.6
4	Left Bank of Passur River at Project site-Jetty	12.0	2.2	0.0	4.7	9	0	0	4.4	6	0	0	4
5	Middle of Passur River at Project site-Jetty	12.0	0.3	0.0	5.1	13	0	0	5.1	6.2	0	0	3.9
6	Right Bank of Passur River at Project site-Jetty	12.0	0.5	0.0	5.0	14	0	0	5	9	0	0	4.2
7	Left Bank of Passur River at South West corner from the Project boundary	9.5	4.0	0.0	5.2	14	0	0	5.2	8	0	0	4.2
8	Middle of Passur River at South West corner from the Project boundary	9.0	0.0	0.0	5.2	13	0	0	4.9	7	0	0	4.1
9	Right Bank of Passur River at South West corner from the Project boundary	10.0	2.5	0.0	5.1	12	0	0	5.5	6.8	0	0	4.1
10	Maidara river of the South East corner of the Project at Ichamoti-Maidara confluence	10.0	0.5	0.0	5.2	10	0	0	3.8	7.1	0	0	3.9
11	Maidara river near proposed township area	9.0	4.5	0.0	4.5	9	0	0	2.5	6.3	0	0	3.8
12	Passur river at Passur-Ghasiakhali confluence	10.0	9.5	0.0	5.0	14	0	0	4.8	6	0	0	6.7
13	Passur river at Harbaria of Sundarbans	12.0	10.0	0.0	6.0	15	0	0	5.3	8.9	0	0	8.9
14	Passur river at Akram point of Sundarbans	19.0	15.0	1.0	16.0	20	NS	5	11.3	9.4	4	3	16.3
15	Passur river at Hiron point of Sundarbans	23.0	19.5	2.0	23.0	25	NS	6.2	NS	14	NS	5.8	21.4

Source: CEGIS Field Survey- April, July and October 2014 and January, April, July and October 2015, January and April 2016

Note: 1QM= First Quarterly Monitoring, 2QM = Second Quarterly Monitoring, 3QM = Third Quarterly Monitoring, 4QM = Fourth Quarterly Monitoring, NS – Not Surveyed

Table B.4: Dissolve Oxygen in Passur River

SL	Sampling Locations	Dissolve Oxygen (mg/L)												BD Standard
		1st Year				2nd Year				3rd year				
		Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	
		1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	
1	Left Bank of Passur River at 100m u/s of North West corner from the Project boundary	5.9	6.1	5.6	5.5	6.2	5.3	6.8	5.1	7.1	6.2	6	6.1	5 or more (standard for sustaining fisheries)
2	Middle of Passur River at 100m u/s of North West corner from the Project boundary	4.9	6.8	7.7	6.6	6.4	5	6.4	5.1	6.4	5.7	6.1	5.9	
3	Right Bank of Passur River at 100m u/s of North West corner from the Project boundary	5.2	6.7	7.7	6.7	6.2	5	7.1	6.2	6.9	5.6	6	6.1	
4	Left Bank of Passur River at Project site-Jetty	5.7	6.8	7.6	5.8	6.2	6.7	6.8	5.9	5.8	6.1	6.3	6.2	
5	Middle of Passur River at Project site-Jetty	5.9	6.9	7.2	5.9	6.6	6.6	7.2	5.3	6.1	6.3	5.9	5.9	
6	Right Bank of Passur River at Project site-Jetty	5.8	6.6	8.0	6.8	6.4	6	7.6	5.4	6.6	5.8	6.1	5.9	
7	Left Bank of Passur River at South West corner from the Project boundary	6.6	7.3	5.6	6.1	6.3	7.5	6.4	6	6.9	6.3	5.9	6.3	
8	Middle of Passur River at South West corner from the Project boundary	6.5	7.1	5.6	6.9	6.5	7.4	6.1	6.1	7.1	6.4	6	6.4	
9	Right Bank of Passur River at South West corner from the Project boundary	6.5	7.2	5.8	6.6	6.4	7.3	6.3	5.8	6.8	5.6	6	6.4	
10	Maidara river of the South East corner of the Project at Ichamoti-Maidara confluence	6.0	6.5	8.0	6.0	6.2	6	7.1	4.1	6.4	5.2	6.1	6.7	
11	Maidara river near proposed township area	6.7	6.8	8.0	6.2	6.5	6.4	7.1	5.2	5.9	5.4	6.4	6.7	
12	Passur river at Passur-Ghasiakhali confluence	5.3	6.2	7.0	6.5	6.3	7	6.6	5.4	5.8	5.4	5.6	5.9	
13	Passur river at Harbaria of Sundarbans	5.4	5.9	7.0	6.6	5.8	7.5	7.1	5.2	6.4	**5.4**	5.8	6.1	
14	Passur river at Akram point of Sundarbans	7.9	6.4	7.7	6.7	6	NS	7.3	6.2	6.1	6.2	6.7	6.5	
15	Passur river at Hiron point of Sundarbans	7.5	6.5	7.8	6.5	5.8	NS	7	NS	7.1	6.8	6.9	6.8	

Source: CEGIS Field Survey- April, July and October 2014 and January, April, July and October 2015, January and April 2016

Note: 1QM= First Quarterly Monitoring (April, 2014), 2QM = Second Quarterly Monitoring (July, 2014), 3QM = Third Quarterly Monitoring (October, 2014), 4QM = Fourth Quarterly Monitoring (January 2015)

Table B.5: BOD5 of Passur River Water

SL	Sampling Location	Biochemical Oxygen Demand (mg/L)												BD Standard
		1st Year				2nd Year				3rd year				
		Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	
		1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	
1	Left Bank of Passur River at 100m u/s of North West corner from the Project boundary	3.4	2.2	1.9	1.6	3.1	3	2.1	2.1	2.8	2.4	2.8	1.8	6 or less (for sustaining fisheries)
2	Middle of Passur River at 100m u/s of North West corner from the Project boundary	4.9	3.3	4.1	2.3	3.2	2.4	1.9	2.2	3.2	2.8	2.7	1.9	
3	Right Bank of Passur River at 100m u/s of North West corner from the Project boundary	2.2	2.8	3.4	2.7	3.1	2.9	3.4	1.9	3	2.5	2.8	1.9	
4	Left Bank of Passur River at Project site-Jetty	3.2	3.1	4.0	0.8	3	4.4	3.2	1.1	3.6	2.1	3.1	2.1	
5	Middle Passur River at Project site-Jetty	3.0	2.5	3.5	1.4	3.5	4.3	3.7	2.4	3.3	2.2	2.5	2.2	
6	Right Left Bank of Passur River at Project site-Jetty	5.8	3.5	3.6	2.0	3.4	3.7	2.9	1.7	3.1	3.1	2.9	2.1	
7	Left Bank of Passur River at South West corner from the Project boundary	3.9	2.8	2.6	1.0	3.1	5.3	2.2	1.2	3.1	2.9	2.4	2.1	
8	Middle of Passur River at South West corner from the Project boundary	3.8	3.3	2.8	2.6	3.2	5.2	2.3	2.3	2.6	2.7	2.7	1.9	
9	Right Bank of Passur River at South West corner from the Project boundary	6.5	3.8	2.9	2.1	3.4	5	3.1	2.4	3	3.1	3.1	2.1	
10	Maidara river of the South East corner of the Project at Ichamoti-Maidara confluence	3.2	3.3	5.5	1.5	3.2	3.9	4.2	2.7	3.3	3.4	2.8	1.8	
11	Maidara river near proposed township area	4.1	3.7	4.0	2.0	3.4	4.2	1.6	1.8	3.5	3.2	2.9	2.1	
12	Passur river at Passur-Ghasiakhali confluence	2.3	2.2	1.7	2.0	3.3	4.9	2.1	2.2	3.4	2.8	2.3	2	
13	Passur river at Harbaria of Sundarbans	2.2	2.5	2.6	1.9	2.4	3.9	2.7	2.1	3.2	2.8	2.7	2.1	
14	Passur river at Akram point of Sundarbans	5.0	2.9	3.7	2.2	3	NS	2.2	2.4	3.3	2.5	3.4	2.1	
15	Passur river at Hiron point of Sundarbans	4.3	2.7	3.9	2.3	2.7	NS	2.5	NS	2.4	2.1	3.1	2.2	

Source: CEGIS Field Survey- April, July and October 2014 and January, April, July and October 2015, January and April 2016

Note: 1QM= First Quarterly Monitoring, 2QM = Second Quarterly Monitoring, 3QM = Third Quarterly Monitoring, 4QM = Fourth Quarterly Monitoring, NS – Not Surveyed

Table B.6: COD of Passur River System

Sl	Sampling Locations	COD (mg/L)										
		1st Year				2nd year				3rd year		
		Apr	Jul	Oct	Jan	Apr	July	Oct	Jan	Apr	July	Oct
		1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM
1	Left Bank of Passur River at 100m u/s of North West corner from the Project boundary	288	24	6	128	87	42	32	124	220	8	12
2	Middle Passur River at 100m u/s of North West corner from the Project boundary	284	20	30	68	58	43	36	100	240	8	8
3	Right Bank of Passur River at 100m u/s of North West corner from the Project boundary	328	56	14	92	132	18	28	96	280	8	8
4	Left Bank of Passur River at Project site-Jetty	376	28	18	84	102	26	36	100	280	8	12
5	Middle Passur River at Project site-Jetty	400	60	14	116	110	21	36	108	240	12	16
6	Right Bank of Passur River at Project site-Jetty	364	496	18	108	88	24	40	80	260	8	12
7	Left Bank of Passur River at South West corner from the Project boundary	364	108	10	104	96	32	42	100	240	12	8
8	Middle of Passur River at South West corner from the Project boundary	400	40	22	16	18	25	28	100	180	8	8
9	Right Bank of Passur River at South West corner from the Project boundary	408	120	10	100	106	25	48	124	200	12	12
10	Maidara river of the South East corner of the project at Ichamoti-Maidara confluence	276	32	10	116	88	51	40	100	160	8	8
11	Maidara river near proposed township area	284	96	26	84	94	36	42	108	210	30	8
12	Passur river at Passur - Ghasiakhali confluence	408	172	14	96	92	30	46	88	220	12	16
13	Passur river at Harbaria of Sundarbans	372	216	14	96	102	26	36	100	140	16	12
14	Passur river at Akram point of Sundarbans	536	520	54	316	302	NS	84	96	156	4	68
15	Passur river at Hiron point of Sundarbans	540	416	122	472	470	NS	96	NS	160	NS	56

Source: CEGIS Field Survey- April, July and October 2014 and January, April, July and October 2015, January2016

Note: 1QM= First Quarterly Monitoring, 2QM = Second Quarterly Monitoring, 3QM = Third Quarterly Monitoring, 4QM = Fourth Quarterly Monitoring: NS – Not Surveyed.

Table B.7: Oil and grease concentration of Passur River System

Sl	Sampling Locations	Oil and Grease (mg/L)											ECR, 1997 (mg/L)*	IFC, 2007 (mg/L)
		1st Year				2nd year				3rd year				
		Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	Apr	Jul	Oct		
		1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM		
1	Left Bank of Passur River at South West corner from the Project boundary	<5	<5	<5	>15	16.9	9	<5	39	61	5	<5	10	10
2	Passur-Ghasiakhali Confluence	<5	<5	<5	>15	13	7.63	9.87	21	30.3	13.5	<5		
3	Passur river at Harbaria of Sundarbans	<5	6.3	<5	>20	39.1	10.1	<5	14	26	5.73	<5		
4	Passur river at Hiron point of Sundarbans	<5	<5	<5	>20	<5	NS	10.8	ND	31	NS	10.14		
5	Akram Point of Sundarbans	<5	<5	<5	>20	<5	NS	9.73	36	82	5.87	<5		

Source: CEGIS Field Survey- April, July and October 2014 and January, April, July and October 2015, January2016

Note: 1QM= First Quarterly Monitoring, 2QM = Second Quarterly Monitoring, 3QM = Third Quarterly Monitoring, 4QM = Fourth Quarterly Monitoring: NS – Not Surveyed.

Table B.8: TDS of Passur River System

SL	Sampling Locations	TDS (mg/L)										
		1st Year				2nd year				3rd year		
		Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	Apr	Jul	Oct
		1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM
1	Left Bank of Passur River at 100m u/s of North West corner from the Project boundary	13060	251	176	4360	14400	937	158	5570	13400	179	138
2	Middle of Passur River at 100m u/s of North West corner from the Project boundary	12630	246	162	3950	14700	941	169	5910	13280	112	106
3	Right Bank of Passur River at 100m u/s of North West corner from the Project boundary	12900	383	153	4330	14900	127	152	5490	13560	125	108
4	Left Bank of Passur River at Project site-Jetty	13190	445	169	4750	14600	175	172	5720	12830	162	147
5	Middle Passur River at Project site-Jetty	13330	353	156	4920	14500	132	162	5850	13100	185	110
6	Right Bank of Passur River at Project site-Jetty	13380	402	152	4870	14200	156	160	5480	13460	143	112
7	Left Bank of Passur River at South West corner from the Project boundary	13180	655	162	5040	14500	336	192	5650	12820	205	113
8	Middle of Passur River at South West corner from the Project boundary	13390	587	153	5050	14600	158	164	5740	12960	195	108
9	Right Bank of Passur River at South West corner from the Project boundary	13240	916	154	5130	14250	160	164	5650	13590	140	146
10	Maidara river of the South East corner of the project at Ichamoti-Maidara confluence	12400	455	214	5050	14000	2320	183	5450	13340	165	196
11	Maidara river near proposed Township area	10970	2510	257	4390	13900	355	176	4420	11700	5170	238
12	Passur river at Passur - Mongla confluence	12800	6410	209	5130	14050	298	227	4540	11330	893	162
13	Passur river at Harbaria of Sundarbans	12280	9360	285	4780	13900	683	205	4940	13580	1321	301
14	Passur river at Akram point of Sundarbans	21500	15960	3400	12350	13600	NS	4220	13330	20720	7330	2550
15	Passur river at Hiron point of Sundarbans	21500	14050	5720	17900	25300	NS	5830	NS	25500	NS	4120

Source: CEGIS Field Survey- April, July and October 2014 and January, April, July and October 2015, January 2016

Note: 1QM= First Quarterly Monitoring, 2QM = Second Quarterly Monitoring, 3QM = Third Quarterly Monitoring, 4QM = Fourth Quarterly Monitoring: NS – Not Surveyed.

Table B.9: TH Passur River System

SL	Sampling Locations	TH (mg/L)										
		1st Year				2nd year				3rd year		
		Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	Apr	Jul	Oct
		1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM
1	Left Bank of Passur River at 100m u/s of North West corner from the Project boundary	2900	250	216	930	3000	245	250	1270	3130	240	255
2	Middle of Passur River at 100m u/s of North West corner from the Project boundary	2500	180	218	870	3050	110	330	1380	3090	205	250
3	Right Bank of Passur River at 100m u/s of North West corner from the Project boundary	2650	170	335	870	3250	105	360	1240	3140	205	190
4	Left Bank of Passur River at Project site-Jetty	2550	175	390	940	3450	118	365	1220	3010	220	265
5	Middle Passur River at Project site-Jetty	2600	275	340	990	3250	103	355	1300	3070	232	237
6	Right Bank of Passur River at Project site-Jetty	2625	350	355	970	3200	105	350	1260	3100	218	242
7	Left Bank of Passur River at South West corner from the Project boundary	2550	325	330	1045	3600	153	345	1370	3060	235	205
8	Middle of Passur River at South West corner from the Project boundary	2800	350	345	1125	3670	105	390	1340	3130	242	217
9	Right Bank of Passur River at South West corner from the Project boundary	2500	475	325	975	3540	165	445	1270	3110	224	238
10	Maidara river of the South East corner of the project at Ichamoti-Maidara confluence	2500	450	350	980	3260	470	183	950	3180	220	250
11	Maidara river near proposed township area	2400	725	330	970	3190	130	340	1075	3080	875	240
12	Passur river at Passur - Mongla confluence	3150	1400	377	1000	3210	135	410	1090	3060	405	245
13	Passur river at Harbaria of Sundarbans	2625	2150	345	970	3080	200	430	1100	3050	415	282
14	Passur river at Akram point of Sundarbans	4500	3625	980	2380	3420	NS	1090	2850	4520	1750	670
15	Passur river at Hiron point of Sundarbans	4850	3050	1440	2690	3640	NS	1460	NS	5050	NS	810

Source: CEGIS Field Survey- April, July and October 2014 and January, April, July and October 2015, January 2016

Note: 1QM= First Quarterly Monitoring, 2QM = Second Quarterly Monitoring, 3QM = Third Quarterly Monitoring, 4QM = Fourth Quarterly Monitoring: NS – Not Surveyed.

Table B.10: TSS Passur River System

SL	Sampling Locations	TSS (mg/L)										
		1st Year				2nd year				3rd year		
		Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	Apr	Jul	Oct
		1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM
1	Left Bank of Passur River at 100m u/s of North West corner from the Project boundary	598	126	234	180	160	26	76	14	8	61	20
2	Middle of Passur River at 100m u/s of North West corner from the Project boundary	45	92	193	210	167	25	80	12	7	48	18
3	Right Bank of Passur River at 100m u/s of North West corner from the Project boundary	53	112	174	230	170	127	65	14	10	56	16
4	Left Bank of Passur River at Project site-Jetty	54	99	227	450	160	30	92	17	10	62	20
5	Middle Passur River at Project site-Jetty	60	100	232	250	165	27	85	18	8	45	24
6	Right Bank of Passur River at Project site-Jetty	55	105	186	200	155	40	97	22	7	49	19
7	Left Bank of Passur River at South West corner from the Project boundary	24	116	185	300	150	32	104	20	12	51	20
8	Middle of Passur River at South West corner from the Project boundary	27	112	536	530	147	40	90	7	10	43	18
9	Right Bank of Passur River at South West corner from the Project boundary	67	37	459	450	155	44	82	18	11	39	16
10	Maidara river of the South East corner of the project at Ichamoti-Maidara confluence	7	65	798	280	148	36	96	11	7	42	24
11	Maidara river near proposed township area	9	24	389	206	160	28	92	10	6	11	30
12	Passur river at Passur - Mongla confluence	50	310	203	280	165	24	60	15	13	47	27
13	Passur river at Harbaria of Sundarbans	65	90	869	400	160	42	74	22	18	31	18
14	Passur river at Akram point of Sundarbans	115	99	28	103	150	NS	110	16	23	16	41
15	Passur river at Hiron point of Sundarbans	91	72	267	200	180	NS	144	NS	15	NS	33

Source: CEGIS Field Survey- April, July and October 2014 and January, April, July and October 2015, January 2016

Note: 1QM= First Quarterly Monitoring, 2QM = Second Quarterly Monitoring, 3QM = Third Quarterly Monitoring, 4QM = Fourth Quarterly Monitoring: NS – Not Surveyed.

Table B.11: NO32-concentration of Passur River System

Sl	Sampling Locations	NO_3^{2-} (mg/L)										
		1st Year				2nd year				3rd year		
		Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	Apr	Jul	Oct
		1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM
1	Left Bank of Passur River at 100m u/s of North West corner from the Project boundary	0.9	2.89	0.32	3	33	9.1	4	6.3	3	3.9	0.25
2	Middle of Passur River at 100m u/s of North West corner from the Project boundary	0.7	2.4	1.57	1.5	13	7.5	7.1	4.3	2.9	6.2	0.39
3	Right Bank of Passur River at 100m u/s of North West corner from the Project boundary	0.1	3.2	1.84	4.3	39	6.2	5	3.9	2.5	4.3	0.42
4	Left Bank of Passur River at Project site-Jetty	1.3	0.76	1.64	3.1	48	6.6	5.7	3.1	2	5.1	0.76
5	Middle Passur River at Project site-Jetty	1.4	2.69	1.42	2.2	69	6.1	3.3	5.2	3.1	2.7	0.52
6	Right Bank of Passur River at Project site-Jetty	1.1	2.98	1.33	8.5	8	6.6	4.7	4.1	3.6	3.9	0.31
7	Left Bank of Passur River at South West corner from the Project boundary	0.75	2.13	1.85	2.7	87	14.9	4.4	4.9	2.6	3.6	0.2
8	Middle of Passur River at South West corner from the Project boundary	1.1	2.43	2.09	1.8	48	4	6.2	3.7	2.9	5.1	0.41
9	Right Bank of Passur River at South West corner from the Project boundary	1.2	2.05	2.21	1.9	128	4.9	4.4	4.4	2.6	4.9	0.63
10	Maidara river of the South East corner of the project at Ichamoti-Maidara confluence	0.3	2.18	2.26	6	62	7	4.9	5.6	2.7	5.2	0.4
11	Maidara river near proposed township area	0.5	0.88	1.98	4	48	3.1	2.9	3.9	3.1	5.3	0.32
12	Passur river at Passur - Mongla confluence	0.6	1.52	1.64	4.5	29	7.8	3.1	3.7	3	5.2	0.27
13	Passur river at Harbaria of Sundarbans	1.4	1.75	1.67	2.7	18	4.4	4.4	5.1	3.4	5.1	0.39
14	Passur river at Akram point of Sundarbans	2.7	3.32	0.59	1.5	25	NS	3.2	4.9	2.9	5.4	0.25
15	Passur river at Hiron point of Sundarbans	0.8	2.84	0.4	2	28	NS	11.5	NS	3.5	NS	0.38

Source: CEGIS Field Survey- April, July and October 2014 and January, April, July and October 2015, January 2016

Note: 1QM= First Quarterly Monitoring, 2QM = Second Quarterly Monitoring, 3QM = Third Quarterly Monitoring, 4QM = Fourth Quarterly Monitoring: NS – Not Surveyed.

Table B.12: SO_4^{2-} concentration of Passur River System

Sl	Sampling Locations	SO_4^{2-} (mg/L)										
		1st Year				2nd year				3rd year		
		Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	Apr	Jul	Oct
		1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM
1	Left Bank of Passur River at 100m u/s of North West corner from the Project boundary	1840	20	26	580	1360	67	7	570	1080	18	5
2	Middle of Passur River at 100m u/s of North West corner from the Project boundary	1320	23	28	450	1260	11	8	590	1040	10	3
3	Right Bank of Passur River at 100m u/s of North West corner from the Project boundary	1280	36	34	480	1240	9	11	560	1020	13	4
4	Left Bank of Passur River at Project site-Jetty	1360	45	33	550	1240	26	10	550	1060	15	4
5	Middle Passur River at Project site-Jetty	1040	32	30	520	1120	6	8	580	980	17	6
6	Right Bank of Passur River at Project site-Jetty	1320	20	27	540	820	8	9	565	1100	14	5
7	Left Bank of Passur River at South West corner from the Project boundary	1640	60	40	630	880	9	12	640	1060	15	6
8	Middle of Passur River at South West corner from the Project boundary	1520	40	35	560	1180	19	8	560	1020	18	5
9	Right Bank of Passur River at South West corner from the Project boundary	1280	80	64	620	900	12	6	550	1080	12	8
10	Maidara river of the South East corner of the project at Ichamoti-Maidara confluence	1120	20	63	570	1220	72	11	96	1040	11	14
11	Maidara river near proposed township area	1320	210	63	460	840	27	9	480	1020	480	14
12	Passur river at Passur - Mongla confluence	1360	620	44	630	980	39	13	482	1100	42	14
13	Passur river at Harbaria of Sundarbans	1560	860	69	590	900	51	7	500	1080	60	19
14	Passur river at Akram point of Sundarbans	2600	1400	1390	850	1540		84	760	1650	620	190
15	Passur river at Hiron point of Sundarbans	2080	1160	2360	1500	1920		97		2100		320

Source: CEGIS Field Survey- April, July and October 2014 and January, April, July and October 2015, January 2016

Note: 1QM= First Quarterly Monitoring, 2QM = Second Quarterly Monitoring, 3QM = Third Quarterly Monitoring, 4QM = Fourth Quarterly Monitoring: NS – Not Surveyed.

Table B.13: PO42- concentration of Passur River System

Sl	Sampling Locations	PO_4^{2-} (mg/L)										
		1st Year				2nd year				3rd year		
		Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	Apr	Jul	Oct
		1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM
1	Left Bank of Passur River at 100m u/s of North West corner from the Project boundary	0.52	2.23	0.67	0.32	0.86	10	1.27	0.269	0.22	1.14	3.39
2	Middle Passur River at 100m u/s of North West corner from the Project boundary	0.5	1.99	1.12	0.61	0.53	0.23	1.97	0.269	0.36	1.76	4.11
3	Right Bank of Passur River at 100m u/s of North West corner from the Project boundary	1.1	2.55	0.95	0.7	0.72	0.67	1.94	0.179	0.27	1.77	4.58
4	Left Bank of Passur River at Project site-Jetty	2.1	0.45	0.92	0.43	0.49	0.27	2.53	0.357	0.31	2.31	2.76
5	Middle Passur River at Project site-Jetty	2.2	2.13	1.11	0.41	0.68	0.59	1.3	0.536	0.3	0.98	3.2
6	Right Bank of Passur River at Project site-Jetty	2	2.42	0.99	0.55	0.61	0.13	1.32	0.269	0.43	1.01	2.48
7	Left Bank of Passur River at South West corner from the Project boundary	0.57	1.25	1.18	0.76	0.65	0.1	0.99	0.536	0.63	0.87	4.16
8	Middle of Passur River at South West corner from the Project boundary	1.2	1.51	1.25	0.85	0.53	0.18	1.02	0.625	0.21	0.96	2.76
9	Right Bank of Passur River at South West corner from the Project boundary	1.5	1.1	1	0.53	0.6	0.1	1.39	0.536	0.33	1.123	2.71
10	Maidara river of the South East corner of the project at Ichamoti-Maidara confluence	0.55	2.1	1.27	0.59	0.7	0.5	1.27	0.351	0.19	1.06	2.836
11	Maidara river near proposed township area	1.1	0.53	1.04	0.64	0.55	0.29	1.28	0.269	0.13	1	5.23
12	Passur river at Passur - Mongla confluence	1.3	0.35	0.86	0.42	0.71	0.59	0.95	0.179	0.31	0.78	4.01
13	Passur river at Harbaria of Sundarbans	1.1	0.56	1.22	0.61	0.59	0.89	0.35	0.269	0.42	0.53	1.16
14	Passur river at Akram point of Sundarbans	1.3	0.29	0.8	0.42	0.61	NS	0.43	0.357	0.26	0.47	9.08
15	Passur river at Hiron point of Sundarbans	7.51	0.29	1.09	0.44	0.47	NS	0.45	NS	0.36	NS	5.9

Source: CEGIS Field Survey- April, July and October 2014 and January, April, July and October 2015, January 2016

Note: 1QM= First Quarterly Monitoring, 2QM = Second Quarterly Monitoring, 3QM = Third Quarterly Monitoring, 4QM = Fourth Quarterly Monitoring: NS – Not Surveyed.

Table B.14: As concentration of Passur River System

Sl	Sampling Locations	As (mg/L)										
		1st Year				2nd year				3rd year		
		Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	Apr	Jul	Oct
		1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM
1	Left Bank of Passur River at 100m u/s of North West corner from the Project boundary	0.002	0.003	0.004	0.003	0.002	0.002	0.001	0.001	0.001	0.002	0.002
2	Middle Passur River at 100m u/s of North West corner from the Project boundary	0.002	0.003	0.004	0.003	0.002	0.002	0.001	0.001	0.003	0.003	0.003
3	Right Bank of Passur River at 100m u/s of North West corner from the Project boundary	0.001	0.003	0.004	0.003	0.003	0.002	0.001	0.001	0.003	0.005	0.002
4	Left Bank of Passur River at Project site-Jetty	0.002	0.004	0.004	0.004	0.002	0.002	0.001	0.002	0.002	0.004	0.002
5	Middle Passur River at Project site-Jetty	0.002	0.004	0.004	0.003	0.002	0.001	0.001	0.002	0.002	0.002	0.002
6	Right Bank of Passur River at Project site-Jetty	0.002	0.003	0.003	0.003	0.002	0.002	0.001	0.001	0.002	0.002	0.002
7	Left Bank of Passur River at South West corner from the Project boundary	<0.001	0.003	0.006	0.003	0.002	0.002	0.001	0.002	0.001	0.003	0.002
8	Middle of Passur River at South West corner from the Project boundary	<0.002	0.004	0.004	0.003	0.002	0.002	0.001	0.001	0.002	0.003	0.003
9	Right Bank of Passur River at South West corner from the Project boundary	0.002	0.003	0.006	0.003	0.002	0.003	0.001	0.001	0.002	0.004	0.002
10	Maidara river of the South East corner of the project at Ichamoti-Maidara confluence	<0.001	0.003	0.006	0.004	0.003	0.002	0.001	0.002	0.002	0.005	0.002
11	Maidara river near proposed township area	0.002	0.002	0.003	0.003	0.003	0.002	0.001	0.001	0.002	0.002	0.002
12	Passur river at Passur - Mongla confluence	0.002	0.004	0.003	0.003	0.004	0.002	0.001	0.002	0.003	0.004	0.003
13	Passur river at Harbaria of Sundarbans	0.004	0.003	0.004	0.004	0.004	0.002	0.001	0.002	0.005	0.002	0.003
14	Passur river at Akram point of Sundarbans	0.004	0.002	0.002	0.003	0.002	NS	0.001	0.002	0.006	0.001	0.003
15	Passur river at Hiron point of Sundarbans	0.003	0.002	0.003	0.002	0.002	NS	0.001	NS	0.004	NS	0.002

Source: CEGIS Field Survey- April, July and October 2014 and January, April, July and October 2015, January 2016

Note: 1QM= First Quarterly Monitoring, 2QM = Second Quarterly Monitoring, 3QM = Third Quarterly Monitoring, 4QM = Fourth Quarterly Monitoring: NS – Not Surveyed

Table B.15: Pb concentration of Passur River System

Sl	Sampling Locations	Pb (mg/L)										
		1st Year				2nd year				3rd year		
		Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	Apr	Jul	Oct
		1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM
1	Left Bank of Passur River at 100m u/s of North West corner from the Project boundary	0.053	0.004	0.002	0.104	0.098	0.0059	0.007	0.168	0.203	0.01	0.009
2	Middle Passur River at 100m u/s of North West corner from the Project boundary	0.055	0.002	0.003	0.104	0.102	0.0038	0.006	0.092	0.302	0.009	0.007
3	Right Bank of Passur River at 100m u/s of North West corner from the Project boundary	0.055	0.005	0.002	0.111	0.138	0.0058	0.008	0.176	0.347	0.017	0.01
4	Left Bank of Passur River at Project site-Jetty	0.057	0.002	0.003	0.154	0.142	0.011	0.01	0.115	0.336	0.014	0.007
5	Middle Passur River at Project site-Jetty	0.06	0.002	0.002	0.139	0.135	0.002	0.009	0.148	0.317	0.006	0.006
6	Right Bank of Passur River at Project site-Jetty	0.058	0.002	0.002	0.138	0.156	0.0021	0.007	0.112	0.298	0.01	0.005
7	Left Bank of Passur River at South West corner from the Project boundary	0.053	0.002	0.003	0.16	0.142	0.0076	0.01	0.134	0.396	0.007	0.006
8	Middle of Passur River at South West corner from the Project boundary	0.054	0.003	0.004	0.153	0.148	0.002	0.011	0.099	0.323	0.006	0.007
9	Right Bank of Passur River at South West corner from the Project boundary	0.056	0.005	0.004	0.139	0.163	0.002	0.009	0.093	0.331	0.012	0.007
10	Maidara river of the South East corner of the project at Ichamoti-Maidara confluence	0.053	0.004	0.004	0.143	0.135	0.002	0.07	0.023	0.35	0.008	0.008
11	Maidara river near proposed township area	0.048	0.004	<0.002	0.133	0.14	0.002	0.008	0.067	0.275	0.015	0.007
12	Passur river at Passur - Mongla confluence	0.05	0.032	<0.002	0.141	0.14	0.002	0.009	0.078	0.258	0.098	0.011
13	Passur river at Harbaria of Sundarbans	0.043	0.044	0.004	0.137	0.13	0.002	0.012	0.135	0.228	0.02	0.01
14	Passur river at Akram point of Sundarbans	0.194	0.071	0.032	0.309	0.297		0.084	0.302	0.359	0.142	0.126
15	Passur river at Hiron point of Sundarbans	0.224	0.05	0.07	0.309	0.291		0.073		0.607		0.151

Source: CEGIS Field Survey- April, July and October 2014 and January, April, July and October 2015, January 2016

Note: 1QM= First Quarterly Monitoring, 2QM = Second Quarterly Monitoring, 3QM = Third Quarterly Monitoring, 4QM = Fourth Quarterly Monitoring: NS – Not Surveyed.

Table B.16: Hg concentration of Passur River System

Sl	Sampling Locations	Hg (mg/L)										
		1st Year				2nd year				3rd year		
		Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	Apr	Jul	Oct
		1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM
1	Left Bank of Passur River at 100m u/s of North West corner from the Project boundary	< 0.00015	< 0.00015	< 0.00015	< 0.00015	< 0.00015	< 0.00015	< 0.00015	< 0.00015	< 0.00015	< 0.00015	< 0.00015
2	Middle Passur River at 100m u/s of North West corner from the Project boundary	< 0.00015	< 0.00015	< 0.00015	< 0.00015	< 0.00015	< 0.00015	< 0.00015	< 0.00016	< 0.00015	< 0.00015	< 0.00015
3	Right Bank of Passur River at 100m u/s of North West corner from the Project boundary	< 0.00015	< 0.00015	< 0.00015	< 0.00015	< 0.00015	< 0.00015	< 0.00015	< 0.00017	< 0.00015	< 0.00015	< 0.00015
4	Left Bank of Passur River at Project site-Jetty	< 0.00015	< 0.00015	< 0.00015	< 0.00015	< 0.00015	< 0.00015	< 0.00015	< 0.00018	< 0.00015	< 0.00015	< 0.00015
5	Middle Passur River at Project site-Jetty	< 0.00015	< 0.00015	< 0.00015	< 0.00015	< 0.00015	< 0.00015	< 0.00015	< 0.00019	< 0.00015	< 0.00015	< 0.00015
6	Right Bank of Passur River at Project site-Jetty	< 0.00015	< 0.00015	< 0.00015	< 0.00015	< 0.00015	< 0.00015	< 0.00015	< 0.00020	< 0.00015	< 0.00015	< 0.00015
7	Left Bank of Passur River at South West corner from the Project boundary	< 0.00015	< 0.00015	< 0.00015	< 0.00015	< 0.00015	< 0.00015	< 0.00015	< 0.00021	< 0.00015	< 0.00015	< 0.00015
8	Middle of Passur River at South West corner from the Project boundary	< 0.00015	< 0.00015	< 0.00015	< 0.00015	< 0.00015	< 0.00015	< 0.00015	< 0.00022	< 0.00015	< 0.00015	< 0.00015
9	Right Bank of Passur River at South West corner from the Project boundary	< 0.00015	< 0.00015	< 0.00015	< 0.00015	< 0.00015	< 0.00015	< 0.00015	< 0.00023	< 0.00015	< 0.00015	< 0.00015
10	Maidara river of the South East corner of the project at Ichamoti-Maidara confluence	< 0.00015	< 0.00015	< 0.00015	< 0.00015	< 0.00015	< 0.00015	< 0.00015	< 0.00024	< 0.00015	< 0.00015	< 0.00015
11	Maidara river near proposed township area	< 0.00015	< 0.00015	< 0.00015	< 0.00015	< 0.00015	< 0.00015	< 0.00015	< 0.00025	< 0.00015	< 0.00015	< 0.00015
12	Passur river at Passur - Mongla confluence	< 0.00015	< 0.00015	< 0.00015	< 0.00015	< 0.00015	< 0.00015	< 0.00015	< 0.00027	< 0.00015	< 0.00015	< 0.00015
13	Passur river at Harbaria of Sundarbans	< 0.00015	< 0.00015	< 0.00015	< 0.00015	< 0.00015	< 0.00015	< 0.00015	< 0.00029	< 0.00015	< 0.00015	< 0.00015
14	Passur river at Akram point of Sundarbans	< 0.00015	< 0.00015	< 0.00015	< 0.00015	< 0.00015	< 0.00015	< 0.00015	< 0.00030	< 0.00015	< 0.00015	< 0.00015
15	Passur river at Hiron point of Sundarbans	< 0.00015	NS	< 0.00015	< 0.00015	< 0.00015	< 0.00015	NS	NS	< 0.00015	NS	< 0.00015

Source: CEGIS Field Survey- April, July and October 2014 and January, April, July and October 2015, January 2016

Note: 1QM= First Quarterly Monitoring, 2QM = Second Quarterly Monitoring, 3QM = Third Quarterly Monitoring, 4QM = Fourth Quarterly Monitoring: NS – Not Surveyed.

➢ Parameters for ground water quality monitoring

Table B.17: pH and Temperature of Ground Water

Sl	Locations	Tube Well Type	pH value											
			1st Year				2nd year				3rd year			
			Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan
			1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM
1	Near Proposed Township	Deep (>600 ft)	7.6	7.7	7.9	8	TC	8.1	7.49	7.6	7.8	7.8	8.4	8.1
2	Rajnagar	Deep (>600 ft)	7.6	7.8	8	8.2	7.8	8.3	7.93	8.1	8.3	8.1	7.9	7.5
3	Kapasdanga	Deep (>600 ft)	7.6	7.7	8	8.1	7.9	8.3	7.7	7.9	8.2	7.9	7.9	7.6
4	Kalekharber	Shallow (<250 ft)	6.3	6.5	NF	NF	NF	NF	NF	NF	ND			

Locations	Tube Well Type	Temperature (ºC)											
		1st Year				2nd year				3rd year			
		Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan
		1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM
Near Proposed Township	Deep (>600 ft)	**27.3**	**28.5**	**26**	**24.5**	**TC**	**31**	30	24	29.8	28.6	29.1	25.1
Rajnagar	Deep (>600 ft)	**29.6**	**29.9**	**28**	**22.5**	**28.6**	**28**	27.8	23	29.6	29.1	30.4	24.3
Kapasdanga	Deep (>600 ft)	**29.2**	**28.9**	**28**	**25.1**	**28.8**	**30**	28.7	25	30.1	29.4	29.8	24
Kalekharber	Shallow (<250 ft)	**27.5**	**28.7**	**NF**	**NF**	**NF**	**NF**	**NF**	**NF**	**ND**	**NF**	**NF**	

Source: CEGIS Field Survey- April, July and October 2014 and January, April, July and October 2015, January and April 2016

*Note: 1QM= First Quarterly Monitoring, 2QM = Second Quarterly Monitoring, 3QM = Third Quarterly Monitoring, 4QM = Fourth Quarterly Monitoring: NS=Not Surveyed: NF=Non functional *Drinking water quality standards, The Environment Conservation Rules, 1997*

Table B.18: Salinity and DO in Groundwater

Sl	Locations	Tube Well Type	Salinity (ppt)											
			1st Year				2nd year				3rd year			
			Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan
			1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM
1	Near Proposed Township	Deep (>600 ft)	0	0	0	1	TC	0	0	0	0	0	0	0
2	Rajnagar	Deep (>600 ft)	0	0	0	0	0	0	0	0	0	0	0	0
3	Kalekharber	Shallow (<250 ft)	0	0	NF**	NF**	NF**	NF**	NF**	NF**		0	0	0
4	Kapasdanga	Deep (>600 ft)	0	0	0	0	0	0	0	0	0	0	0	

Sl	Locations	Tube Well Type	DO (mg/L)											
			1st Year				2nd year				3rd year			
			Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan
			1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM
1	Near Proposed Township	Deep (>600 ft)	4.4	5.2	6.5	6.7	TC	6	5.4	4.9	6.1	5.8	6.3	4.5
2	Rajnagar	Deep (>600 ft)	6	6.2	7.7	6.3	6	5.9	6.1	5.2	5.8	6.1	5.8	4.8
3	Kapasdanga	Deep (>600 ft)	6.4	6.5	6.1	6.5	6.6	6	5.6	4.8	5.6	5.7	6.1	4.6
4	Kalekharber	Shallow (<250 ft)	4.4	6	NF**	NF**	NF	NF**	NF**	NF**	NF**	NF**	NF**	

Source: CEGIS Field Survey- April, July and October 2014 and January, April, July and October 2015, January and April 2016

*Note: 1QM= First Quarterly Monitoring, 2QM = Second Quarterly Monitoring, 3QM = Third Quarterly Monitoring, 4QM = Fourth Quarterly Monitoring: NS=Not Surveyed: NF=Non functional *Drinking water quality standards, The Environment Conservation Rules, 1997*

Table B.19: TDS and TSS concentrations in Groundwater

SL	Locations	Type of tube wells	TDS (mg/L)										
			1st Year				2nd year				3rd year		
			Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	Apr	Jul	Oct
			1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM
1	Township near project site	Deep (>600 ft)	1113	999	-	1021	NO	881	377	447	1025	1000	617
2	Rajnagar	Deep (>600 ft)	4090	371	-	378	390	574	1007	491	384	408	382
3	Kapasdanga	Deep (>600 ft)	643	635	-	600	600	328	611	284	645	607	636
4	Kalekharber	Shallow (<250 ft)	1055	970	-	NF	D	D	NF	NF	NF		

SL	Locations	Type of tube wells	TSS (mg/L)										
			1st Year				2nd year				3rd year		
			Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	Apr	Jul	Oct
			1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM
1	Township near project site	Deep (>600 ft)	-	6	19	40	NF**	23	4	31	3	5	7
2	Rajnagar	Deep (>600 ft)	-	6	2	28	4	16	5	46	4	4	4
3	Kapasdanga	Deep (>600 ft)	-	8	6	32	6	14	4	41	3	4	5
4	Kalekharber	Shallow (<250 ft)	-	48	NF**	NF**	NF**	NF**	NF**	NF**	NF**		

Source: CEGIS Field Survey- April, July and October 2014 and January, April, July and October 2015, January 2016

Note: 1QM= First Quarterly Monitoring, 2QM = Second Quarterly Monitoring, 3QM = Third Quarterly Monitoring, 4QM = Fourth Quarterly Monitoring: NS=Not Surveyed; NF=Non functional;

Table B.20: TH concentrations in Groundwater

Sl No	Locations	Type of tubewell	TH (mg/L)*											
			1st Year				2nd year				3rd year			BD standard*
			Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	Apr	Jul	Oct	
			1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM	
1	Township near project site	Deep (>600 ft)	425	250	300	235	NO	225	325	295	305	320	175	200-500 mg/L
2	Rajnagar	Deep (>600 ft)	220	175	180	110	138	125	450	195	263	248	295	
3	Kalekarber	Shallow (<250 ft)	780	450	NF	NF	NF	NF	NF	NF		28	183	
4	Kapasdanga	Deep (>600 ft)	190	140	180	125	216	115	480	225	163			

Source: CEGIS Field Survey- April, July and October 2014 and January, April, July and October 2015, January 2016

Note: 1QM= First Quarterly Monitoring, 2QM = Second Quarterly Monitoring, 3QM = Third Quarterly Monitoring, 4QM = Fourth Quarterly Monitoring: NS=Not Surveyed; NF=Non functional;

**Drinking water quality standards, The Environment Conservation Rules, 1997*

Table B.21: COD concentrations of monitored ground water locations

Sl	Locations	Tubewell Type	COD (mg/L)											
			1st Year				2nd year				3rd year			BD standard*
			Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	Apr	Jul	Oct	
			1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM	
1	Township near project site	Deep (>600 ft)	32	32	34	20	NO	12	4	4	4	4	4	4.0 mg/L
2	Rajnagar	Deep (>600 ft)	28	28	18	16	14	10	8	4	4	4	4	
3	Kalekarber	Shallow (<250 ft)	32	36	NF	NF	NF	NF	NF	NF	NF			
4	Kapasdanga	Deep (>600 ft)	48	32	34	20	18	14	4	4	4	2	4	

Source: CEGIS Field Survey- April, July and October 2014 and January, April, July and October 2015, January 2016

*Note: 1QM= First Quarterly Monitoring, 2QM = Second Quarterly Monitoring, 3QM = Third Quarterly Monitoring, 4QM = Fourth Quarterly Monitoring: NS=Not Surveyed; NF=Non functional; N/A=Not Availability; *Drinking water quality standards, The Environment Conservation Rules, 1997*

Table B.22: NO3, SO4 and PO4 Concentrations in Ground Water

SI	Locations	Type of tube well	NO_3^{2-} (mg/L) *BD Standard (10 mg/L)											SO_4^{2-} (mg/L) *BD Standard (400 mg/L)											PO_4^{2-} (mg/L) *BD Standard (6.0 mg/L)										
			1st Year				2nd year				3rd year			1st Year				2nd year				3rd year			1st Year				2nd year				3rd year		
			Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	Apr	Jul	Oct	Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	Apr	Jul	Oct	Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	Apr	Jul	Oct
			1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM
1	Township near project site	Deep (>600 ft)	0.20	0.48	<0.10	28	-	7.6	4.3	2.1	1.7	3.8	6.1	-	3	-	-	-	-	1	5	1	1	1	-	2.2	-	0.74	NO	1.4	0.31	0.267	1.08	0.17	0.167
2	Rajnagar	Deep (>600 ft)	0.60	0.68	0.31	26	-	2.2	4.2	1.9	2.3	3.3	7.51	-	2	-	-	-	-	2	6	2	1	1	-	2.5	-	0.44	1.98	1.6	0.27	0.179	1.53	0.29	0.67
3	Kalekarber	Shallow (<250 ft)	0.40	0.56	NF	NF	-	NF	NF	NF	NF	NF	NF	NF	3	NF	-	-	-	-	NF				-	1.2	NF	NF	NF		NF	NF		0.31	
4	Kapasdanga	Deep (>600 ft)	0.80	0.40	0.80	13	-	4.7	3.8	2.8	1.9	3.7	10.16	-	10	-	-	-	-	2	2	8	1	1	-	6.2	-	0.48	4.54	4.1	0.48	0.179	3.26		0.6

Source: CEGIS Field Survey- April, July and October 2014 and January, April, July and October 2015, January 2016

Note: 1QM= First Quarterly Monitoring, 2QM = Second Quarterly Monitoring, 3QM = Third Quarterly Monitoring, 4QM = Fourth Quarterly Monitoring: NS=Not Surveyed; NF=Non functional;

**Drinking water quality standards, The Environment Conservation Rules, 1997*

Table B.23: As, Pb and Hg concentrations (mg/L) of monitored ground water locations

Sl	Locations	As (mg/L) *BD Standard (0.05 mg/L)											Pb (mg/L) *BD Standard (0.05 mg/L)											Hg (mg/L) *BD Standard (0.001 mg/L)										
		1st Year				2nd year				3rd year			1st Year				2nd year				3rd year			1st Year				2nd year				3rd year		
		Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	Apr	Jul	Oct	Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	Apr	Jul	Oct	Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	Apr	Jul	Oct
		1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM
1	Township near project site	0.013	0.020	0.012	0.014	NO	0.015	0.002	0.008	0.018	0.012	0.033	0.002	<0.002	0.004	0.023	NO	0.002	0.006	0.026	0.019	0.002	0.001	<0.00015	<0.00015	<0.0005	<0.0005	NO	0.00015	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015
2	Rajnagar	0.006	0.009	0.006	0.008	0.01	0.014	0.012	0.002	0.007	0.018	0.011	<0.002	<0.002	<0.002	0.016	0.013	0.0027	0.021	0.011	0.007	0.002	0.001	<0.00015	<0.00015	<0.0005	<0.0005	<0.00015	0.00015	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015
3	Kalekarber	0.376	0.407	NF	NF	D	D	NF	NF	NF	NF	NF	0.002	0.008	NF	NF	D	D	NF	NF	NF	NF	NF	<0.00015	<0.00015	NF	NF	NF	NF	NF	NF	NF	NF	NF
4	Kapasdanga	0.036	0.033	0.020	0.017	0.034	0.024	0.011	0.002	0.047	0.005	0.016	<0.002	0.004	<0.002	0.013	0.017	0.002	0.005	0.012	0.008	0.002	0.001	<0.00015	<0.00015	<0.0005	<0.0005	<0.00015	0.00015	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015

Source: CEGIS Field Survey- April, July and October 2014 and January, April, July and October 2015, January 2016

Note: 1QM= First Quarterly Monitoring, 2QM = Second Quarterly Monitoring, 3QM = Third Quarterly Monitoring, 4QM = Fourth Quarterly Monitoring: NS=Not Surveyed; NF=Non functional; N/A=Not Availability; TC=temporarily closed, D=Damaged

**Drinking water quality standards, The Environment Conservation Rules, 1997*

(C) Noise Level monitoring data

Table C.1: Summary of the ambient noise monitoring in First Year (2014-15)

Sl No	Location	QM1 (Noise Level in dB (A)) Mar-14				QM2 (Noise Level in dB (A)) Jul-14				QM3 (Noise Level in dB (A)) Oct-14				QM4 (Noise Level in dB (A)) Jan-15				Std*
		Morning (9:00)	A.noon (13:00)	Evening (18:00)	Day time AVG	Morning (9:00)	A.noon (13:00)	Evening (18:00)	Day time AVG	Morning (9:00)	A.noon (13:00)	Evening (18:00)	Day time AVG	Morning (9:00)	A.noon (13:00)	Evening (18:00)	Day time AVG	Day time AVG
1	Chalna, Dacope	80.32	60.86	63.22	68.13	52.71	55.62	50.27	52.87	53.37	53.52	57	54.63	51.92	53.7	54.21	53.28	70
2	NW Corner of the Project area	55.23	53	47.43	51.89	NM	NM	NM	NM	42.67	41.73	41.37	41.92	33.87	36.42	35.46	35.25	50
3	Chunkuri-2, Bajua	62.69	57.19	53.39	57.76	54.61	51.14	51.9	52.55	52.26	51.14	50.76	51.39	55.08	46.29	46.49	49.29	50
4	SW corner of the Project area	49.2	NM	NM	49.2	44.55	48.94	49.33	47.6	45.56	45.1	47.18	45.95	36.57	34.24	37.27	36.03	50
5	Proposed Township area, Project site	47.8	49.7	NM	48.75	46.15	47.21	NM	46.68	42.67	41.73	41.37	41.92	41.49	39.55	43.37	41.47	50
6	Barni, Gaurambha	64.95	50.93	60.65	58.84	48.73	50.37	50.75	49.95	50.18	50.89	48.27	49.78	43.36	38.56	48.86	43.6	50
7	Khan Jahan Ali Bridge, Khulna	76.12	66.72	72.25	71.7	55.97	64.68	61.75	60.8	72.24	58.3	68.3	66.28	61.34	63.4	60.41	61.72	70
8	Mongla Port area	69.38	54.55	59.79	61.24	54.75	54.2	52.58	53.84	66.8	55.2	59.5	60.5	40.26	35.04	40.76	38.69	75
9	Harbaria, Sundarbans	39.24	NM	42.51	40.88	59.25	60.52	48.62	56.13	54.08	56.51	NM	55.3	36.36	32.4	NM	34.38	45
10	Akram Point, Sundarbans	40.95	41.98	39.9	40.94	48.95	46.86	NM	47.9	45.27	42.69	NM	43.98	37.9	30.75	NM	34.32	45
11	Hiron Point, Sundarbans	35.99	40.75	39.16	38.63	51.29	NM	NM	51.29	47.98	39.42	NM	47.98	42.82	31.93	NM	37.37	45

*Note(s): NM – Not Monitored, *Std- Standard as defined in National Noise Control Rules 2006*

Table C.2: Summary of the ambient noise monitoring in Second Year (2015-16)

Sl No	Location	QM1 (Noise Level in dB (A)) Apr-15				QM2 (Noise Level in dB (A)) Jul-15				QM3 (Noise Level in dB (A)) Oct-15				QM4 (Noise Level in dB (A)) Jan-16				Std*
		Morning (9:00)	A.noon (13:00)	Evening (18:00)	Day time AVG	Morning (9:00)	A.noon (13:00)	Evening (18:00)	Day time AVG	Morning (9:00)	A.noon (13:00)	Evening (18:00)	Day time AVG	Morning (9:00)	A.noon (13:00)	Evening (18:00)	Day time AVG	Day time AVG
1	Chalna, Dacope	57.27	54.31	59.65	57.08	43.52	54.23	51.56	49.77	68.32	66.09	60.96	65.12	67.84	61.25	66.31	66.07	70
2	NW Corner of the Project area	45.05	42.15	46.8	44.67	37.58	40.91	46.18	41.56	41.51	39.58	44.74	41.94	53.91	49.02	49.95	50.96	50
3	Chunkuri-2, Bajua	45.9	48.19	NM	47.05	40.57	42.23	39.17	40.66	47.53	45.48	49.28	47.43	56.84	48.12	55.90	53.62	50
4	SW corner of the Project area	40.6	43.25	46.89	43.58	44.57	44.30	42.36	43.75	36.15	48.26	43.68	42.70	60.32	55.30	63.70	60.44	50
5	Proposed Township area, Project site	41.49	39.55	43.37	41.47	43.41	50.86	45.99	46.75	46.89	49.47	55.20	50.52	54.79	52.22	54.29	53.77	50
6	Barni, Gaurambha	58.23	50.11	NM	54.17	46.76	44.83	46.95	46.18	56.40	54.19	54.88	55.16	60.62	60.00	56.86	59.16	50
7	Khan Jahan Ali Bridge, Khulna	75.2	72.75	72.42	73.45	52.95	52.18	53.34	52.82	64.43	61.65	66.65	64.25	69.96	64.81	70.56	68.45	70
8	Mongla Port area	46.02	49.29	49.15	48.15	36.72	38.56	43.54	39.61	45.39	NM	48.63	47.01	54.15	51.82	52.14	52.70	75
9	Harbaria, Sundarbans	67.06	64.05	64.99	65.37	39.33	30.74	NM	35.03	54.97	46.54	NM	50.75	45.72	44.69	*NM*	45.20	45
10	Akram Point, Sundarbans	53.35	56.37	NM	54.86	NM	NM	NM	-	45.28	53.92	NM	49.60	45.60	40.29	*NM*	42.95	45
11	Hiron Point, Sundarbans	47.48	48.2	NM	47.84	NM	NM	NM	-	54.44	37.69	NM	46.06	-	-	-	-	45

*Note(s): NM – Not Monitored, *Std- Standard as defined in National Noise Control Rules 2006*

Table C.3: Summary of the ambient noise monitoring in Third Year (2016-17)

Sl No	Location	QM1 (Noise Level in dB (A)) Apr-16				QM2 (Noise Level in dB (A)) Jul-16				QM3 (Noise Level in dB (A)) Oct-16				QM4 (Noise Level in dB (A)) Jan-17				Std*
		Morning (9:00)	A.noon (13:00)	Evening (18:00)	Day time AVG	Morning (9:00)	A.noon (13:00)	Evening (18:00)	Day time AVG	Morning (9:00)	A.noon (13:00)	Evening (18:00)	Day time AVG	Morning (9:00)	A.noon (13:00)	Evening (18:00)	Day time AVG	Day time AVG
1	Chalna, Dacope	67.71	61.23	66.31	65.08	50.92	50.04	52.3	51.42	60.1	68.6	67.8	65.5	54.4	61	61.46	58.95	70
2	NW Corner of the Project area	53.81	48.66	49.90	50.79	54.40	53.19	50.36	52.65	54.7	54.8	57.0	55.5	44.52	44.52	-	44.52	50
3	Chunkuri-2, Bajua	43.30	43.35	46.84	44.49	56.29	49.4	54.51	53.4	50.4	47.7	56.6	51.6	55.73	56.2	53.99	55.31	50
4	SW corner of the Project area	56.81	54.73	51.97	54.50	67.38	74.12	54.61	65.37	47.8	49.0	50.8	49.2	44.41	45.96	-	45.19	50
5	Proposed Township area, Project site	55.02	52.41	52.69	53.37	62.71	52.98	51.67	55.79	45.8	41.6	48.7	45.4	-	43.4	41.85	42.63	50
6	Barni, Gaurambha	50.63	54.19	57.09	53.97	51.2	59.54	59.53	56.75	52.4	57.3	55.0	54.9	49.75	48.35	-	49.05	50
7	Khan Jahan Ali Bridge, Khulna	66.40	64.82	66.34	65.85	63.52	62.15	65.73	63.80	61.9	59.6	61.3	60.9	51.69	60.05	54.97	55.57	70
8	Mongla Port area	49.89	48.67	51.07	49.88	53.87	52.04	52.7	52.87	49.5	50.0	50.2	49.9	47.82	48.67	50.33	48.94	75
9	Harbaria, Sundarbans	44.40	44.69	*NM*	44.55	53.87	53.04	52.79	52.9	57.2	53.5	49.3	53.3	41.13	38.4	37.98	39.17	45
10	Akram Point, Sundarbans	45.60	40.29	*NM*	42.95	47.16	46.48	50.24	47.96	40.5	43.0	42.5	42.0	38.74	38.45	37.06	38.08	45
11	Hiron Point, Sundarbans	48.53	37.69	*NM*	43.11	-	-	-	-	46.1	42,08	41.9	44.0	43.62	40.96	42.29	42.29	45

*Note(s): NM – Not Monitored, *Std- Standard as defined in National Noise Control Rules 2006*

(D) Fisheries resources monitoring data

Table D.1: Data for Basic life Requirements for a Good Fish Community

Life Requirements	Variable Sl.	Habitat Variables
Food (C_F)	V1	Phytoplankton (%)
	V2	Zooplankton (%)
Water Quality (C_{WQ})	V3	Turbidity
	V4	TDS
	V5	Surface water temperature
	V6	Dissolved Oxygen (DO)
	V7	pH
	V8	Salinity
Reproduction (C_R)	V1	Phytoplankton (%)
	V2	Zooplankton (%)
	V3	Turbidity
	V4	TDS
	V5	Surface water temperature
	V6	Dissolved Oxygen (DO)
	V7	pH
	V8	Salinity
Food (C_F)	V1	Phytoplankton (%)
	V2	Zooplankton (%)
Water Quality (C_{WQ})	V3	Turbidity
	V4	TDS
	V5	Surface water temperature
	V6	Dissolved Oxygen (DO)
	V7	pH
	V8	Salinity
Reproduction (C_R)	V1	Phytoplankton (%)

Life Requirements	Variable Sl.	Habitat Variables
	V2	Zooplankton (%)
	V3	Turbidity
	V4	TDS
	V5	Surface water temperature
	V6	Dissolved Oxygen (DO)
	V7	pH
	V8	Salinity
Food (C_F)	V1	Phytoplankton (%)
	V2	Zooplankton (%)
Water Quality (C_{WQ})	V3	Turbidity
	V4	TDS
	V5	Surface water temperature
	V6	Dissolved Oxygen (DO)
	V7	pH
	V8	Salinity
Reproduction (C_R)	V1	Phytoplankton (%)
	V2	Zooplankton (%)
	V3	Turbidity
	V4	TDS
	V5	Surface water temperature
	V6	Dissolved Oxygen (DO)
	V7	pH
	V8	Salinity

Table D.2: Occurrence of Species

Local Name	Scientific Name	Local Status*	1st QM	2nd QM	3rd QM	4th QM	5th QM	6th QM	7th QM	8th QM	9th QM	10th QM	11th QM	12th QM
			'-' = No; '+' = Occurrence											
Amadi Chela	*Chela sp.*	DD	-	-	+	+	+	-	+	+	-	+	-	+
Hilsa	*Tenualosa ilisha*	NO	-	-	+	-	-	+	+	-	-	-	+	-
Sagor Baim	*Anguilla bengalensis*	NT	+	-	-	-	-	+	-	-	-	-	-	-
Bacha	*Eutropiichthys vacha*	CR	+	-	-	-	-	-	-	-	-	+	-	-
Bagda Chingri	*Penaeus monodon*	DD	+	+	+	+	+	+	+	+	+	+	-	+
Banspata	*Brachypleura novae-zeelandiae*	NO	+	+	+	+	-	+	+	+	+	-	+	+
Kukurjib	*Cynoglossus lingua*	NO	+	-	-	-	-	-	-	+	+	+	-	+
Bele	*Glossogobius giuris*	NO	+	+	+	+	+	+	+	+	+	-	+	+
Aswine Bele	*Butis butis*	NO	-	-	-	-	-	-	+	+	+	+	+	+
Bairagi	*Coilia dussumieri*	NO	+	+	+	+	+	+	-	+	-	-	-	+
Boishakhi Chingri	*Macrobrachium* sp.	NO	-	+	-	-	+	+	+	+	+	-	-	-
Chammu Chingri	*Metapenaeus brevicornis*	DD	+	+	+	-	+	+	+	+	+	+	+	-
Chaka Chingri	*Penaeus indicus*	DD	+	+	-	+	+	+	+	+	+	-	+	-
Ghora Chela	*Securicula gora*	-	+	-	-	-	-	-	-	-	-	-	-	-
Chanda Chela	*Securicula* sp.	-	-	+	+	-	-	-	-	-	+	+	-	-
Sada Chewa	*Trepauchen vagina*	NO	+	-	+	-	-	+	-	-	-	+	-	-
Lal Chewa	*Odontamblyopus rubicundus*	NO	+	+	+	+	+	+	+	+	+	-	-	-
Chhuri	*Trichiurus muticus*	NO	+	-	+	-	-	-	-	-	-	-	-	-
Sagor Chela	*Megalops cyprinoids*	NO	+	-	-	-	-	-	-	-	-	-	-	-
Purabi Chela	*Thryssa purava*	NO	+	-	-	-	-	-	-	-	-	-	-	-
Kabashi Tengra	*Mystus cavasius*	DD	+	-	-	-	-	-	-	-	-	-	-	-
Gagra Tengra	*Nemapteryx nenga*	DD	-	+	+	-	+	-	+	-	+	+	+	+
Gulsha Tengra	*Mystus bleekery*	DD	+	+	-	+	-	+	+	+	+	+	+	+
Harina Chingri	*Metapenaeus ensis*	DD	+	+	+	+	+	+	+	+	+	-	+	-
Ekthuto	*Hyporhampus limbatus*	NO	+	-	+	+	-	-	-	+	+	-	+	-
Kakila	*Xenentodon cancila*	NO	+	-	-	-	-	-	-	-	-	-	+	-
Chapila	*Gudusia chapra*	NO	+	+	-	-	-	-	-	-	-	+	-	-

Kuchia	*Monopterus cuchia*	DD	+	+	-	+	+	+	+	+	+	+	+	+
Loitta	*Harpodon nehereus*	NO	+	+	+	-	+	-	-	-	+	+	-	-
Motka Chingri	*Macrobrachium villosimanusless*	DD	+	+	+	+	+	+	+	+	+	+	+	-
Mud Crab	*Scylla serrata*	NO	+	-	+	+	+	+	+	+	+	-	+	+
Tular Dandi	*Sillaginopsis panijus*	NO	+	-	+	-	+	-	+	-	-	-	+	-
Paira Chanda	*Scatophagus argus*	DD	+	-	-	-	-	-	-	-	-	+	-	-
Paissa	*Liza parsia*	NO	+	+	+	+	+	+	+	+	+	+	+	+
Pangas	*Pangasius pangasius*	CR	+	-	+	-	-	-	-	+	-	-	-	+
Tak Chanda	*Leiognathus equulus*	NO	+	-	-	-	-	-	+	-	-	+	-	-
Phessa	*Setipinna phasa*	NO	+	+	+	+	+	+	+	+	+	-	+	-
Teli Phessa	*Setipinna phasa*	DD	-	-	+	-	-	-	-	-	-	+	-	-
Poma	*Poma poma*	NO	+	+	+	+	+	+	+	+	+	+	+	+
Potka	*Chelonodon patoca*	NO	+	+	-	+	+	+	-	+	+	-	+	+
Shilong	*Silonia silondia*	EN	+	-	+	-	-	-	-	-	-	-	+	-
Tailla	*Eleutheronema tetradactylum*	DD	+	-	-	-	-	-	-	-	-	+	-	-
Tapse	*Polynemus paradiseus*	DD	+	+	+	-	-	+	+	+	-	-	+	+
Daitna	*Acanthopagrus latus*	DD	-	-	-	+	-	-	-	+	+	-	+	+
Shole	*Channa striatus*	DD	-	-	-	+	-	-	-	+	-	-	-	-
Magur	*Clarias batrachus*	DD	-	-	-	+	-	-	-	+	-	-	-	+
Koi	*Anabas testudineus*	DD	-	-	-	+	-	-	-	+	-	+	-	-
Vetki	*Lates calcarifer*	DD	-	-	-	+	+	+	+	+	+	-	+	+

**Local Status Source: IUCN Red List*

Table D.3: Length-wise species distribution (%) in sampling sites

Fish Species	Site	L (< 2cm)	L (2 to 3cm)	L (3 to 5cm)	L (5 to 10cm)	L (10 to 20cm)	L (> 25cm)	Brood Fish
Aswene Bele	Chandpai	0	0	76.47	23.53	0	0	0
	Harbaria	0	0	0	0	100	0	0
Bagda	Chalna Point	0	100	0	0	0	0	0
	Maidara	0	100	0	0	0	0	0
	Mongla Point	0	100	0	0	0	0	0
Bairagi	Chalna Point	0	60	40	0	0	0	0
	Maidara	0	86.21	13.79	0	0	0	0
	Mongla Point	0	40	60	0	0	0	0
Banspata	Chandpai	0	0	0	0	0	100	0
Bele	Chandpai	0	0	0	0	100	0	0
	Maidara	100	0	0	0	0	0	0
Chali Chingri	Chalna Point	0	100	0	0	0	0	0
	Maidara	100	0	0	0	0	0	0
	Mongla Point	100	0	0	0	0	0	0
Chata Bele	Chandpai	0	0	0	0	80	20	0
Chela	Chandpai	0	0	100	0	0	0	0
Cheng	Chandpai	0	0	0	100	0	0	0
	Maidara	0	100	0	0	0	0	0
Chitra	Harbaria	0	0	0	100	0	0	0
Daitna	Harbaria	0	0	0	0	100	0	0
Darkina	Maidara	0	0	100	0	0	0	0
Gagra Tengra	Akram Point	0	0	0	0	100	0	0
	Harbaria	0	0	0	0	100	0	0
Golda	Chandpai	0	0	34.84	52.26	5.23	7.67	0
	Harbaria	0	0	0	0	66.67	33.33	0

Fish Species	Site	L (< 2cm)	L (2 to 3cm)	L (3 to 5cm)	L (5 to 10cm)	L (10 to 20cm)	L (> 25cm)	Brood Fish
Gulsha Tengra	Chandpai	0	0	40.82	30.61	28.57	0	0
Kain Magur	Chandpai	0	0	0	0	0	100	0
Khoira Chela	Harbaria	0	0	0	100	0	0	0
	Maidara	0	0	100	0	0	0	0
Koidda Vola	Harbaria	0	0	0	0	100	0	0
Kuchia	Chandpai	0	0	0	0	0	100	0
Magur	Chandpai	0	0	0	100	0	0	0
Mud Crab	Chandpai	0	0	0	100	0	0	0
Mutkura	Chandpai	0	100	0	0	0	0	0
Paissa	Akram Point	0	0	0	84.62	0	0	15.38
	Chandpai	0	0	0	100	0	0	0
Pangas	Harbaria	0	0	0	0	20	80	0
Poma	Chandpai	0	0	0	0	100	0	0
	Harbaria	0	0	0	0	100	0	0
	Mongla Point	100	0	0	0	0	0	0
Potka	Chandpai	0	0	32.43	67.57	0	0	0
Shole	Chandpai	0	0	0	0	0	100	0
Tapse	Harbaria	0	0	0	0	100	0	0
Telcupa	Chandpai	0	0	0	0	0	100	0
Tigar Chingri	Maidara	0	0	100	0	0	0	0

Source: CEGIS field survey, 2015

Table D.4: Purpose, timing and extent of migration for different year-class of migratory fish species

Migratory Fish Species	Sampling Sites	Year Class*	Migration Purpose											
			1st QM	2nd QM	3rd QM	4th QM	5th QM	6th QM	7th QM	8th QM	9th QM	10th QM	11th QM	12th QM
Tapsi	Haldikhali	Juvenile and Age-1 adult	Feeding and Growing	-	Feeding and Growing	-	-	-		-	-		-	-
	Akram Point	Juvenile and Age-1 adult	Feeding and Growing	-	-	-	-	-	Feeding	-	-		-	-
		Adult	-	-	-	-	-	-	-	Feeding	-		-	-
	Chalna Point	Age-1 adult and Brood fish	Feeding and Growing	Spawning	-	-	-	Feeding	Feeding and Spawning	-	-		Feeding and Growing	-
		Adult	-	-	Feeding and Growing	-	-	Feeding	Feeding	-	-			-
	Harbaria	Juvenile and Age-1 adult	Feeding and Growing	Feeding and Growing		-	-	-	-	-	-		-	Feeding
		Adult and Brood Fish	-	-	Breeding and Spawning	-	-	-	-	-	-		-	-
	Chandpai	Juvenile	-	-	Feeding and Growing	-	-	-	Feeding	-	-		Feeding	-
	Mongla Point	Adult	-	-	-	-	-	-	-	-	-			-
	South-west of the Project	Age-1 adult	Feeding and Growing	Feeding and Growing	Feeding and Growing	-	-	Feeding	-	-	-		-	-
		Brood Fish	-	-	-	-	-	Breeding and Spawning	-	-	-		-	-
Bairagi	Haldikhali	Juvenile and Age-1 adult	Feeding and Growing	-	Feeding and Growing	-	-	-	-	-	-		-	-
	Akram Point	Juvenile and Age-1 adult	Feeding and Growing	-	-	-	Feeding and Growing	-	-	-	-		-	-
		Juvenile and Adult	-	-	-	-	-	-	-	Growing and Feeding	-		-	-
	Chandpai	Fry	Breeding and Spawning	Breeding and Spawning	Feeding and Growing	Feeding	-	Feeding	-	-	-		-	-
		Juvenile	-	-	-	-	-	-	-	-	-		-	-
	Chalna Point	Juvenile and Age-1 adult	Feeding and Growing	-	-	-	Feeding and Growing	-	-	-	-		-	-
		Fry	-	-	-	-	-	-	-	-	-		-	Nursing
	Harbaria	Juvenile	Feeding and Growing	-	-	-	-	Feeding	-	-	-		-	-
	Mongla Point	Fry	-	Nursing	-	Feeding	-	-	-	-	-		-	Nursing
		Juvenile	-	-	-	-	-	-	-	Feeding	-		-	-
	South-west of the Project	Juvenile	-	Feeding and Growing	-	-	-	-	-	-	-		-	-
		Fry	-	-	-	-	-	-	-	-	-		-	Nursing
Chapila	Haldikhali	Juvenile	Feeding and Growing	-	-	-	-	-	-	-	-		-	-
	Akram Point	Juvenile	Feeding and Growing	-	-	-	-	-	-	-	-		-	-
	Mongla Point	Fry	-	Nursing	-	-	-	-	-	-	-		-	-
	South-west of the Project	Age-1 adult	-	Feeding and Growing	-	-	-	-	-	-	-		-	-
Loitta	Haldikhali	Juvenile and Age-1 adult	Feeding and Growing	-	Feeding and Growing	-	-	-	-	-	-		-	-
	Akram Point	Juvenile	Feeding and Growing	-	-	-	Feeding and Growing	-	-	-	-		-	-
	Akram Point	Age-1 adult	-	-	Feeding and Growing	-	Feeding and Growing	-	-	-	-		-	-
	Chandpai	Juvenile	Feeding and Growing	-	-	-	-	-	-	-	-		-	-
	Harbaria	Fry, Juvenile and Age-1	-	Nursing, Feeding and	-	-	-	-	-	-	-		-	-

Migratory Fish Species	Sampling Sites	Year Class*	Migration Purpose											
			1st QM	2nd QM	3rd QM	4th QM	5th QM	6th QM	7th QM	8th QM	9th QM	10th QM	11th QM	12th QM
		adult		Growing										
	Chalna Point	Age-1 adult	-	Feeding and Growing	-	-	Feeding and Growing	-	-	-	-		-	-
		Fry	-	-	-	-	-	-	-	-	Nursing		-	-
Poma	Haldikhali	Juvenile	Feeding and Growing	-	-	Feeding	-	-	-		-		-	-
	Akram Point	Juvenile	Feeding and Growing	-	-	-	-	-	-	Growing and Feeding	-		-	-
		Age-1 adult	-	-	Feeding and Growing	-	-	-	Feeding	Feeding	-		-	-
		Adult	-	-	-	-	-	-			-		-	-
	Chandpai	Fry and Juvenile	Breeding and Spawning	Nursing	-	-	-	Feeding	-	-	-		-	-
		Juvenile	-	-	Feeding and Growing	Feeding	Feeding and Growing	-	Feeding and Growing		-		Feeding and Growing	
		Adult	-	-	-	-	-	-	Feeding		-			
		Brood Fish	-	-	-	-	-	-	-		-		Spawning	-
	Haldikhali	Fry and Juvenile	-	-	Nursing	-	-	-	-	-	-		-	-
	Harbaria	Adult and Brood Fish	-	-	Breeding and Spawning	-	-	-	-	-	-		Feeding and Spawning	-
		Adult	-	-	-	-	-	-	Feeding		-		-	Feeding
		Fry and Juvenile						Spawning and Nursery	-	-	Feeding and Growing		-	-
	Mongla Point	Fry, Juvenile and Age-1 adult	-	-	Spawning, Feeding and Growing	-	-	-	-	Nursing	-		-	Nursing
		Juvenile	-	-	-	-	-	-	Feeding and Growing		-		-	-
		Age-1 Adult	-	-	-	-	-	-	Feeding	Feeding	-		-	-
		Adult	-	-		Feeding	-	Feeding	-	-	-		Feeding	-
		Brood Fish	-	-	-	-	-	-	-	-	-		Spawning	-
	South-west of the Project	Adult	-	-	Feeding	Feeding	-	Feeding	-	-	-		-	-
	Chalna Point	Juvenile, Adult and Brood Fish	Breeding and Spawning	-	-	-	-	-	-	-	-		Feeding, Growing and Spawning	-
		Juvenile and Adult	-	-	Feeding and Growing	Feeding	Feeding and Growing	-	Feeding and Growing	-	-		-	-
		Fry	-	-	-	-	-	-	-	-	Nursery		-	Nursing
Chhuri	Haldikhali	Adult	Feeding	-	Feeding	-	-	-	-	-	-		-	-
	Akram Point		Feeding	-	Feeding	-	-	-	-	-	-		-	-
Chela	Haldikhali	Adult	Feeding	-	Feeding	-	-	-	-	-	-		-	-
	Akram Point	Juvenile and Adult	Feeding and Growing	-	-	-	-	-	-	-	-		-	-
	Harbaria	Fry and Juvenile	-	Feeding and Growing	-	-	-	Nursery	-	-	-		-	-
	Chandpai		-	-	-	-	-	-	-	Growing and Feeding	Nursery		-	-
Gang Tengra	Haldikhali	Adult	Feeding	-	Feeding	Feeding	-	-	-	-	-		-	-
	Akram Point	Adult	Feeding and Breeding	-	-	Feeding	-	-	-	-	-		-	-
	Harbaria	Adult	-	-	Feeding	-	-	-	-	-	-		-	-

Migratory Fish Species	Sampling Sites	Year Class*	Migration Purpose											
			1st QM	2nd QM	3rd QM	4th QM	5th QM	6th QM	7th QM	8th QM	9th QM	10th QM	11th QM	12th QM
	Chandpai	Adult	-	-	Feeding	Feeding	-	-	-	-	-		-	-
Gagra Tengra	Chandpai	Juvenile and Age-1 adult	-	Feeding and Growing	-	-	Feeding and Growing	-	-	-	-		-	-
	Chalna Point	Age-1 adult	-	-	-	-	Feeding and Growing	-	-	-	-		-	-
	Mongla Point	Age-1 adult	-	Feeding and Growing	-	-	-	-	-	-	-		-	-
	Akram Point	Juvenile and Adult	-	-	Feeding and Growing	-	-	-	-	-	-		-	Feeding
		Adult	-	-	-	-	-	-	Feeding	-	-		-	-
	Haldikhali	Juvenile	-	-	-	-	-	-	Feeding and Growing	-	-		-	-
	Harbaria	Adult	-	-	Feeding	-	Feeding and Growing	-	-	-	Feeding		Feeding	
Gulsha Tengra	Haldikhali	Adult	Feeding and Breeding	-	-	-	-	-	-	-	-		-	-
	Akram Point	Adult		-	-	-	-	-	-	-	-		-	-
	Chandpai	Age-1 adult	-	-	-	Feeding	-	Feeding	Feeding and Growing	-	-		-	Feeding
		Juvenile	-	-	-	-	-	-	Feeding and Growing		-		Feeding and Growing	-
	Mongla Point	Age-1 adult	-	Feeding and Growing	-	Feeding and Growing	-	Feeding and Growing		-	Feeding and Growing		-	-
		Juvenile	-	-	-	-	-	-	Feeding and Growing		-		Feeding and Growing	-
	Harbaria	Juvenile	-	-	-	-	-	-	Feeding and Growing		-			-
		Age-1 adult	-	-	-	-	-	-	-	-	Feeding and Growing		-	-
	Maidara	Juvenile and Age-1 Adult	-	-	-	-	-	-	Feeding and Growing	-			-	-
	Chalna Point	Juvenile	-	-	-	-	-	-	-	-	-		Feeding and Growing	-
Potka	Haldikhali	Adult	Feeding and Breeding	-	-	-	-	-	-	-	-		-	-
	Chandpai	Fry	Spawning	Spawning and Nursing	-	-	-	-	-	-	-		-	-
		Juvenile	-	-	-	-	-	-	-	Feeding and Growing	-		-	Feeding
		Adult	-	-	-	Feeding	-	-	-	-	-		Feeding	-
	Mongla Point	Fry	Spawning	-	-	-	-	-	-	-	-		-	-
		Juvenile	-	-	-	-	-	-	-	-	Feeding and Growing		-	-
	Harbaria	Fry	-	-	-	-	-	Nursery	-	-	-		-	-
		Juvenile	-	-	-	-	-	-	-	Feeding and Growing	-		-	-
Paira Chanda	Akram Point	Adult	Feeding	-	-	-	-	-	-	-	-		-	-
	Chandpai	Fry	Breeding and Spawning	-	-	-	-	-	-	-	-		-	-
Chewa	Akram Point	Juvenile and Adult	Feeding	-	Feeding and Growing	-	-	-	-	-			-	-
	Chandpai	Fry and Juvenile	Spawning	-	Feeding and Growing	-	Nursing and Grazing	Nursery	Feeding and Growing	-	Nursing		-	-
		Adult	-	-	-	Feeding	-	Feeding	-	Feeding	-		-	-
	Haldikhali	Juvenile and Adult	-	-	Feeding and Growing	-	-	-	-	-	-		-	-

Migratory Fish Species	Sampling Sites	Year Class*	Migration Purpose											
			1st QM	2nd QM	3rd QM	4th QM	5th QM	6th QM	7th QM	8th QM	9th QM	10th QM	11th QM	12th QM
	Harbaria	Juvenile and Adult	-	-	Feeding and Growing	-	-	Feeding and Nursery	-	Feeding	-		-	-
	Mongla Point	Juvenile	-	Feeding and Growing	-	-	-	-	-	-	-		-	-
	South-west of the Project	Juvenile	-	Feeding and Growing	-	-	-	-	-	-	-		-	-
	Chalna Point	Adult	-	-	-	-	Feeding	-	-	-	-		-	-
		Age-1 Juvenile	-	-	-	-	-	-	-	-	Feeding and Growing		-	-
Bele	Akram Point	Adult	Feeding	-	Feeding	Feeding	-	-	-	-	-		-	-
		Juvenile	-	-	-	-	-	-	-	Feeding and Growing	-		-	-
	Haldikhali	Juvenile-1, Juvenile and Adult	-	-	Nursing and Growing	Feeding	-	-	-	-	-		-	-
	Harbaria	Juvenile and Adult	-	-	Feeding and Growing	-	Feeding and Growing	Nursery and Feediing	Feeding and Growing	-	-		-	-
	Chandpai	Fry	Breeding and Spawning	Nursing	-	-	Nursing	Nursery	-	-	Nursery		-	-
	Chandpai	Juvenile and Adult	-	-	Feeding and Growing	Feeding	-	Feeding	-	Feeding	-		Feeding and Growing	
	Harbaria	Juvenile and Age-1 Adult	-	-	-	-	-	-	Feeding and Growing				-	-
	Mongla Point	Fry	Breeding and Spawning	-	-	-	-	Nursery	-	-	-		-	-
	Mongla Point	Fry, Juvenile-1 and Juvenile			Nursing and Growing	-	-	-	-	-	-		-	-
	Mongla Point	Juvenile and Adult	-	-	-	Feeding	Feeding and Growing	Feeding	Feeding and Growing	-	-		-	-
	Chalna Point	Fry	Breeding and Spawning	Nursing	-	-	Nursing	-	-	Nursing	-		-	-
	Chalna Point	Adult	-	-	-	Feeding	-	-	-	-	-		-	-
	Maidara	Juvenile and Age-1 adult	-	Feeding and Growing	Feeding and Growing	Feeding	Feeding and Growing	-	-	-	Feeding and Growing		-	-
		Fry	-	-	-	-	-	-	-	Nursing	-		-	Nursing
Tular Dandi (Nona bele)	Akram Point	Adult	Feeding	-	-	-	-	-	-	-	-		-	-
	South-west of the Project	Adult	-	-	Feeding	-	-	-	-	-	-		Feeding	-
	Chalna Point	Adult	Feeding	-	Feeding	-	Feeding	-	Feeding	-	-		-	-
Tairel	Akram Point	Adult	Feeding	-	-	-	-	-	-	Feeding	-		-	-
	Harbaria	Age-1 Adult	-	-	-	-	-	-	-	-	Feeding and Growing		-	-
	Mongla Point	Juvenile	Feeding	-	-	-	-	-	-	-	-		-	-
Pheksa	Akram Point	Adult	Feeding	-	-	-	-	-	-	Feeding	-		-	-
		Juvenile	-	-	Feeding and Growing	-	-	-	-	-	-		-	-
	Haldikhali	Juvenile	-	-	Feeding and Growing	-	-	-	-	-	-		-	-
	Haldikhali	Adult	-	-	-	Feeding	-	-	-	-	-		-	-
	Harbaria	Juvenile	-	-	-	-	-	-	-	-	Feeding and Growing		-	-
	Chalna Point	Juvenile and Adult	Feeding	Feeding and Growing	-	-	-	-	Feeding and Growing	-			-	-

Migratory Fish Species	Sampling Sites	Year Class*	Migration Purpose											
			1st QM	2nd QM	3rd QM	4th QM	5th QM	6th QM	7th QM	8th QM	9th QM	10th QM	11th QM	12th QM
		Adult	-	-	Feeding	Feeding	Feeding	-	Feeding	-	-		-	-
	Mongla Point	Adult	-	-	Feeding	Feeding	-	-	Feeding and Growing	-	-		Feeding	-
	Chandpai	Juvenile and Adult	Feeding	Feeding and Growing	-	-	Feeding and Growing	-		-	-		-	-
	Maidara	Juvenile and Adult	Feeding	Feeding and Growing	-	-	-	-	-	-	-		-	-
		Juvenile	-	-	-	-	-	-	Feeding and Growing	-	-		-	-
		Adult	-	-	Feeding	Feeding	-	Feeding	-	-	-		-	-
Paissa	Akram Point	Juvenile and Adult	Feeding	-	Feeding and Growing	Feeding	-	-	-	Feeding and Growing	-		-	Feeding
		Brood	-	-	-	-	-	-	-	-	-		-	Spawning
		Juvenile	-	-	-	-	-	-	Feeding and Growing			-	-	-
	Haldikhali	Juvenile and Adult	Feeding	-	Feeding and Growing	Feeding	-	-	-	-	-		-	-
		Juvenile	-	-	-	-	-	-	Feeding and Growing	-	-		-	-
	Harbaria	Juvenile-1 and Juvenile	-	-	Feeding	-	Feeding and Growing	-	Feeding and Growing	-	-		-	-
		Adult	-	-	-	-	-	-	-	Feeding	-		-	-
	Chandpai	Fry	Breeding and Spawning	-	-	-	Nursing	-	-	-	Nursery		-	-
	Chandpai	Juvenile and Adult	-	-	Feeding and Growing	-	-	Nursery and Feeding	-	-	-		Feeding and Growing	Feeding
	Harbaria	Juvenile	-	-	-	-	-	-	Feeding and Growing	-	-			-
	Mongla Point	Fry	Breeding and Spawning	-	-	-	-	Nursery	-	-	Nursery		-	-
		Age-1 Juvenile	-	-	-	-	-	-	-Nursing, Feeding and Growing	-	Feeding and Growing		-	-
		Age-1 Adult	-	-	-	-	Feeding and Growing	Feeding	-	-			-	-
	Maidara	Fry, Juvenile and Age-1 adult	Breeding and Spawning	Feeding and Growing	-	-	Feeding and Growing	-	-	-			-	-
		Age-1 Juvenile, Juvenile and Age-1 Adult	-	-	-	-	-	-	Nursing, Feeding and Growing	-	-		Feeding and Growing	-
		Adult	-	-	-	-	-	Feeding	-	-	-		-	
Banshpata	Chandpai	Juvenile	Feeding	-	-	-	-	-	-	-	-		-	
		Adult	-	-	-	Feeding	-	Feeding	-	-	-		-	
	Akram Point	Juvenile	-	-	-	-	-	-	Feeding and Growing	-	-		-	
		Adult	-	-	-	-	-	-	-	Feeding	-		-	
	Haldikhali	Juvnile and adult	-	-	Feeding and Growing	Feeding	-	-	Feeding and Growing	-	-		-	
	Harbaria	Adult	-	-	-	-	-	-	-	Feeding	Feeding		Feeding	
	Mongla Point	Fry and Adult	Feeding	Nursing	-	-	-	-	-	-	-		-	
		Adult	-	-	-	Feeding	-	-	-	-	Feeding		-	
	Maidara	Adult	-	-	Feeding	Feeding	-	Breeding and Spawning	-	-	-		-	
	Chalna Point	Adult	-	-	Feeding	Feeding	-	-	-	-	-		-	

Migratory Fish Species	Sampling Sites	Year Class*	Migration Purpose											
			1st QM	2nd QM	3rd QM	4th QM	5th QM	6th QM	7th QM	8th QM	9th QM	10th QM	11th QM	12th QM
Hilsa	Akram Point	Brood Fish	-	-	-	-	-	-	-	-	-		Breeding and Spawning	
	Haldikhali	Brood Fish	-	-	-	-	-	-	-	-	-			
		Juvenile	-	-	Feeding and Growing	-	-	-	-	-	-		-	
	Harbaria	Brood Fish	-	-	-	-	-	-	-	-	-		Breeding and Spawning	
	Chandpai	Adult and Brood Fish	-	-	-	-	-	-	Feeding and Breeding	-	-		-	
	Mongla Point	Adult	-	-	Feeding	-	-	-	-	-	-		-	
		Brood Fish	-	-	-	-	-	-	-	-	-		Breeding and Spawning	
	Maidara	Age-1 Adult	-	-	-	-	-	-	-	-	-		Feeding	
	Chalna Point	Brood fish	-	-	-	-	-	Breeding and Spawning	-	-	-		-	
Pangas	Haldikhali	Juvenile	-	-	Feeding and Growing	-	-	-	-	-	-		-	
	Harbaria	Adult	-	-	-	-	-	-	-	Feeding	-		-	
	Mongla Point	Juvenile and Adult	-	-	Feeding	-	-	-	-	-	-		-	

Source: CEGIS Field Survey- April, July and October 2014 and January, April, July and October 2015, January and April 2016

**Only Age-1 to Brood fish has been allowed to interpret the migration purpose; F = Feeding; Sp = Spawning*

Table D.5: The Present Catch in Three Sampling Ghers

Sampling Site	Total Catch (kg): 2014-2015							
	1st QM (April, 2014)		2nd QM (July, 2014)		3rd QM		4th QM	
	Species	ton	Species	ton	Species	ton	Species	ton
1	Bagda	5	Bagda	6.42	Bagda	4.8	-	-
	Vetki	1.57	Bele	0	Gusha Chingri	-	-	-
	Bele	0.98	Cheng	0	Harina Chingri	-	-	-
	Harina Chingri	0.78	Bhangan	0	Rui (kg)	-	-	-
	Chali Chingri	0.11	Chali Chingri	0	Catla (kg)	-	-	-
	Chaka Chingri	0.08	-	-	-	-	-	-
Sub-total =		**8.52**		**6.42**		**4.8**	**-**	**-**
2	Bagda	4	Bagda	1	Bagda	7	-	-
	Harina Chingri	2	Harina Chingri	0.33	Vetki	1	-	-
	Chali Chingri	0.18	Chali Chingri	0.08	Paissa	10	-	-
	-	-	Golda Chingri	0.01	Phessa	2.4	-	-
	-	-	Bele	0.08	Bhangan	1.7	-	-
	-	-	Tengra&Paissa	0.04	Golda Chingri	0.9	-	-
	-	-	-		Gulsha Tengra	0.2	-	-
Sub-total =		**6.00**		**2.00**		**23**		**-**
3	Bagda	1.38	Bagda	2.4	Bagda	1.5	-	-
	Harina Chingri	0.34	Harina Chingri	0.34	Paissa	10	-	-
	Chali Chingri	0.17	Chali Chingri	0.17	Tengra	10	-	-
	-	-	-	-	Bele	20	-	-
	-	-	-	-	Tilapia	22	-	-
	-	-	-	-	Rui	28	-	-
	-	-	-	-	Vetki	-	-	-
	-	-	-	-	Harina Chingri	-	-	-
	-	-	-	-	Chami Chingri	-	-	-
	-	-	-	-	Catla	56	-	-
	-	-	-	-	Mrigel	50	-	-
Sub-total =		**1.89**		**2.91**		**197.5**	**-**	**-**
Grand-total =		**17.00**		**11.33**		**226.5**	**-**	**-**

Source: CEGIS Field Survey- April, July and October 2014 and January, April, July and October 2015, January and April 2016

(E) Land Resource Monitoring Data

Table E.1: Detailed Information of the Selected Monitoring Plot

Plot No.	Location	GPS	Distance from the plant location(km)	Plot size (ha)	Plot owner
1	Mouza: Baran Para Union:Gongarampur Upazila-Batiaghata District:Khulna	E-89° 30′59.1″ N-22° 37′57.0″	About 3.5	About 0.4	Name: Anil Krishna Roy Father: Keshab Lal Roy
2	Mouza:Chunkuri-2 Union:Bajua Upazila:Dacope District:Khulna	E-89° 32′20.0″ N-22° 34′51.0″	About 1.0	About 0.93	Name: Md. Abul Sheikh Father: Md. Jamir Sheikh
3	Mouza:Kapalirmet Buridmial Union: Burirdanaga Upazila:Mongla District:Bagerhat	E-89° 36′8.8″ N-22° 32′18.9″	About 5.5	About 0.14	Name: Panesh Biswas Father: Nishikanto Biswas
4	Mouza: Chakgona Union:Rajnagar Upazila:Rampal District:Bagerhat	E-89° 34′25.3″ N-22° 34′18.3″	About 1.0	About 0.28	Name: Manoj Das Father: Mahendra Nath Das
5	Mouza: Basherhula Union:Rajnagar Upazila:Rampal District: Bagerhat	E-89° 34′25.0″ N-22° 36′14.0″	About 1.0	About 0.47	Name: Amjad Hajra Father: Chirman Ali Hajra Share cropper: Md. Oliur Rahman Hajra

Source: Field survey; 2014

Table E.2: Chemical Properties of Soil on Monitoring Land

Sl. No.	Location	Parameter	2013-2014				2014-2015				2015-2016			
			Dry season (April)	Remarks	Wet season (Oct)	Remarks	Dry season (April)	Remarks	Wet season (Oct)	Remarks	Dry season (Mar)	Remarks	Wet season (Oct)	Remarks
1.	Baran para	**Top soil(0-15cm)**												
		EC(ds/m)	9.1	Moderately saline	1.8	Non saline	10.01	Moderately saline	2.54	Very slightly saline	2.46	Very slightly saline	3.25	Very slightly saline
		pH	4.2	Very strongly acid	6.7	Neutral	7.6	Slightly alkaline	6.9	Neutral	7.0	Neutral	7.4	Slightly alkaline
		OM (%)	3.1	Medium	2.5	Medium	0.93	Very low	1.27	Low	1.35	Low	1.28	Low
		N (%)	0.16	Low	0.12	Low	0.05	Very low	0.06	Very low	0.08	Very low	0.06	Very low
		K (meq/100g)	1.00	Very high	0.59	Very high	1.61	Very high	0.57	Very high	0.69	Very high	0.61	Very high
		Ca (meq/100g)	11.3	Very high	14.3	Very high	31.50	Very high	14.75	Very high	15.12	Very high	14.68	Very high
		Mg (meq/100g)	10.7	Very high	8.6	Very high	6.00	Very high	2.06	Very high	2.58	Very high	1.92	Very high
		Na(meq/100g)	5.50	*	2.7	*	10.01	*	4.76	*	4.43	*	5.07	*
		P(µg/gm)	2.7	Very low	14.3	Medium	8.19	Low	4.60	Very low	5.33	Low	4.82	Very low
		S(µg/gm)	523.2	Very high	41.4	Very high	354.40	Very high	210.0	Very high	212.18	Very high	226.43	Very high
		B(µg/gm)	0.45	Medium	0.55	Very high	2.37	Very high	2.11	Very high	2.05	Very high	1.98	Very high
		Fe(µg/gm)	150.3	Very high	258.6	Very high	49.72	Very high	78.25	Very high	42.96	Very high	79.39	Very high
		Mn(µg/gm)	7.2	Very high	11.3	Very high	24.72	Very high	6.89	Very high	11.90	Very high	6.87	Very high
		Zn(µg/gm)	1.4	Medium	1.2	Medium	1.88	High	2.47	Very high	1.82	High	2.33	Very high
		Lead(Pb) (µg/gm)	31.8	Not polluted	33.7	Not polluted	32.21	Not polluted	25.95	Not polluted	24.23	Not polluted	23.75	Not polluted
		Cadmium	0	0	0	Not	2.39	Not	00	Not	00	Not	00	Not

Sl. No.	Location	Parameter	2013-2014				2014-2015				2015-2016			
			Dry season (April)	Remarks	Wet season (Oct)	Remarks	Dry season (April)	Remarks	Wet season (Oct)	Remarks	Dry season (Mar)	Remarks	Wet season (Oct)	Remarks
		(Cd)(µg/gm)				polluted		polluted		polluted		polluted		polluted
		Chloride (Cl-) (µg/gm)	762.2	*	0	0	0	0	00		00	0	0	0
		Subsurface soil(15-30cm)												
		EC(ds/m)	8.4	Moderately saline	2.0	Non saline	7.90	Slightly saline	4.65	Slightly saline	2.23	Very slightly saline	4.88	Slightly saline
		pH	4.3	Very strongly acid	6.9	Neutral	7.8	Slightly alkaline	7.4	Slightly alkaline	7.1	Neutral	7.6	Slightly saline
		OM (%)	2.9	Medium	2.2	Medium	1.46	Low	1.53	Low	1.67	Low	1.49	Low
		N (%)	0.15	Low	0.2	Medium	0.08	Very low	0.08	Very low	0.09	Very low	0.08	Very low
		K (meq/100g)	1.0	Very high	0.61	Very high	1.46	Very high	0.59	Very high	0.58	Very high	0.60	Very high
		Ca (meq/100g)	10.48	Very high	14.3	Very high	26.84	Very high	12.31	Very high	12.67	Very high	11.96	Very high
		Mg (meq/100g)	8.8	Very high	8.2	Very high	5.30	Very high	2.15	Very high	2.10	Very high	2.17	Very high
		Na(meq/100g)	5.00	*	2.7	*	8.95	*	6.32	*	4.22	*	6.48	*
		P(µg/gm)	2.9	Very low	22.8	High	9,23	Low	4.65	Very low	4.74	Very low	5.03	Very low
		S(µg/gm)	513.7	Very high	31.4	High	307.65	Very high	221.0	Very high	210.06	Very high	222.75	Very high
		B(µg/gm)	0.36	Medium	0.49	Optimum	1.86	Very high	0.90	Very high	1.02	Very high	1.02	Very high
		Fe(µg/gm)	39.1	Very high	60.9	Very high	26.60	Very high	29.27	Very high	22.53	Very high	28.65	Very high
		Mn(µg/gm)	3.3	High	10.9	Very high	41.87	Very high	5.75	Very high	7.11	Very high	6.04	Very high
		Zn(µg/gm)	1.5	Optimum	0.87	Low	1.56	Optimum	1.69	Optimum	1.31	Medium	1.62	Medium

Sl. No.	Location	Parameter	2013-2014				2014-2015				2015-2016			
			Dry season (April)	Remarks	Wet season (Oct)	Remarks	Dry season (April)	Remarks	Wet season (Oct)	Remarks	Dry season (Mar)	Remarks	Wet season (Oct)	Remarks
		Lead(Pb) (µg/gm)	31.8	Not polluted	32.1	Not polluted	31.54	Not polluted	22.56	Not polluted	22.35	Not polluted	21.32	Not polluted
		Cadmium (Cd)(µg/gm)	0	Not polluted	0	Not polluted	2.42	Not polluted	00	Not polluted	00	Not polluted	00	Not polluted
		Chloride (Cl-) (µg/gm)	398.4	*	0	0	0	0	0	0	0	0	00	0
		Substratum(30-45cm)												
		EC(ds/m)	9.6	Moderately saline	5.8	Slightly saline	9.26	Moderately saline	5.56	Slightly saline	4.32	Slightly saline	6.48	Slightly saline
		pH	5.7	Slightly acid	6.9	Neutral	7.7	Slightly alkaline	7.0	Neutral	7.0	Neutral	7.5	Slightly alkaline
		OM (%)	1.6	Low	1.1	Low	1.62	Low	1.48	Low	1.69	Low	1.46	Low
		N (%)	0.08	Very low	0.06	Very low	0.09	Very low	0.07	Very low	0.09	Very low	0.07	Very low
		K (meq/100g)	1.0	Very high	0.6	Very high	2.00	Very high	0.60	Very high	0.51	Very high	0.58	Very high
		Ca (meq/100g)	12.6	Very high	16.3	Very high	28.69	Very high	14.06	Very high	13.78	Very high	13.87	Very high
		Mg (meq/100g)	15.9	Very high	8.8	Very high	5.57	Very high	2.71	Very high	3.03	Very high	2.66	Very high
		Na(meq/100g)	6.00	*	3.7	*	9.91	*	6.83	*	5.51	*	6.71	*
		P(µg/gm)	2.00	Very low	13.3	Medium	8.24	Low	2.99	Very low	3.13	Very low	3.24	Very low
		S(µg/gm)	490.9	Very high	31.9	High	307.29	Very high	262.0	Very high	279.37	Very high	259.66	Very high
		B(µg/gm)	0.73	High	0.77	Very high	1.67	Very high	1.16	Very high	1.34	Very high	1.22	Very high
		Fe(µg/gm)	51.3	Very high	113.9	Very high	33.91	Very high	73.87	Very high	52.21	Very high	73.56	Very high
		Mn(µg/gm)	3.9	Very high	5.2	Very high	88.75	Very high	6.21	Very high	6.34	Very high	5.90	Very high

Sl. No.	Location	Parameter	2013-2014				2014-2015				2015-2016			
			Dry season (April)	Remarks	Wet season (Oct)	Remarks	Dry season (April)	Remarks	Wet season (Oct)	Remarks	Dry season (Mar)	Remarks	Wet season (Oct)	Remarks
		Zn(µg/gm)	1.6	Optimum	0.49	Low	1.74	Optimum	3.19	Very high	2.94	Very high	3.25	High
		Lead(Pb) (µg/gm)	37.8	Not polluted	31.5	Not polluted	32.29	Not polluted	18.89	Not polluted	19.18	Not polluted	19.68	Not polluted
		Cadmium (Cd)(µg/gm)	0	Not polluted	0	0	2.17	Not polluted	00	Not polluted	00	Not polluted	00	Not polluted
		Chloride (Cl-) (µg/gm)	692.9	*	0	0	0	0	0	0	0	0	00	0
2.	Chunkuri-2	**Top soil (0-15cm)**												
		EC(ds/m)	11.2	Moderately saline	5.6	Slightly saline	13.05	Strongly saline	8.20	Moderately saline	6.92	Slightly saline	6.15	Slightly saline
		pH	6.1	Slightly acid	6.4	Slightly acid	5.9	Slightly acid	6.0	Slightly acid	6.3	Slightly acid	5.6	Slightly acid
		OM (%)	2.1	Medium	1.2	Low	3.22	Medium	1.75	Low	1.98	Medium	1.70	Low
		N (%)	0.11	Low	0.06	Very low	0.18	Low	0.09	Very low	0.11	Low	0.09	Very low
		K (meq/100g)	1.5	Very high	1.14	Very high	2.97	Very high	0.79	Very high	0.86	Very high	0.77	Very high
		Ca (meq/100g)	12.3	Very high	12.9	Very high	27.15	Very high	11.88	Very high	11.89	Very high	12.15	Very high
		Mg (meq/100g)	9.8	Very high	8.9	Very high	6.33	Very high	2.50	Very high	2.47	Very high	2.52	Very high
		Na(meq/100g)	8.5	*	9.4	*	12.51	*	8.16	*	7.11	*	7.19	*
		P(µg/gm)	2.7	Very low	12.8	Medium	8.34	Low	6.89	Low	8.05	Low	6.90	Low
		S(µg/gm)	401.9	Very high	16.9	Medium	673.58	Very high	500.0	Very high	574.26	Very high	476.51	Very high
		B(µg/gm)	0.57	Optimum	0.74	High	0.75	High	1.52	Very high	1.88	Very high	1.50	Very high
		Fe(µg/gm)	60.2	Very high	223.6	Very high	52.46	Very high	89.23	Very high	48.75	Very high	88.47	Very high
		Mn(µg/gm)	5.3	Very high	12.8	Very high	74.59	Very high	7.05	Very high	7.44	Very high	7.00	Very high
		Zn(µg/gm)	1.7	Medium	2.5	Very high	2.66	Very	5.32	Very high	4.36	Very	4.91	Very high

Sl. No.	Location	Parameter	2013-2014				2014-2015				2015-2016			
			Dry season (April)	Remarks	Wet season (Oct)	Remarks	Dry season (April)	Remarks	Wet season (Oct)	Remarks	Dry season (Mar)	Remarks	Wet season (Oct)	Remarks
								high				high		
		Lead(Pb) (µg/gm)	0.00	Not polluted	29.2	Not polluted	31.34	Not polluted	14.09	Not polluted	15.12	Not polluted	15.91	Not polluted
		Cadmium (Cd)(µg/gm)	0	Not polluted	0	Not polluted	2.31	Not polluted	00	Not polluted	00	Not polluted	00	Not polluted
		Chloride (Cl-) (µg/gm)	1957.6	*	0	0	0	0	0		0	0	00	0
		Subsurface soil(15-30cm)												
		EC(ds/m)	9.1	Moderately saline	5.6	Slightly saline	10.48	Moderately saline	6.97	Slightly saline	5.74	Slightly saline	5.44	Slightly saline
		pH	6.7	Neutral	6.4	Slightly acid	6.4	Slightly acid	6.7	Neutral	7.00	Neutral	6.3	Slightly acid
		OM (%)	1.8	Low	0.95	Very low	3.08	High	1.64	Low	1.66	Low	1.68	Low
		N (%)	0.09	Very low	0.06	Very low	0.17	Low	0.08	Very low	0.10	Low	0.08	Very low
		K (meq/100g)	1.6	Very high	1.1	Very high	2.68	Very high	0.75	Very high	0.77	Very high	0.77	Very high
		Ca (meq/100g)	12.6	Very high	13.8	Very high	26.29	Very high	15.65	Very high	16.44	Very high	16.07	Very high
		Mg (meq/100g)	9.5	Very high	8.9	Very high	6.29	Very high	3.13	Medium	3.16	Very high	2.95	Very high
		Na(meq/100g)	8.5	*	9.9	Very high	10.61	*	7.89	*	6.88	*	6.03	*
		P(µg/gm)	2.7	Very low	18.4	Optimum	7.32	Low	6.67	Low	5.77	Low	6.59	Low
		S(µg/gm)	280.5	Very high	23.8	Optimum	487.29	Very high	298.0	Very high	311.15	Very high	312.20	Very high
		B(µg/gm)	1.1	Very high	1.7	Very high	0.92	Very high	1.44	Very high	1.37	Very high	1.39	Very high
		Fe(µg/gm)	133.9	Very high	193.3	Very high	52.20	Very high	75.51	Very high	35.34	Very high	76.44	Very high
		Mn(µg/gm)	2.8	Optimum	11.6	Very high	17.75	Very high	8.29	Very high	11.21	Very high	7.98	Very high
		Zn(µg/gm)	0.99	Medium	1.4	Optimum	2.00	High	1.71	Optimum	1.28	Medium	1.73	Optimum
		Lead(Pb)	0.00	Not	29.9	Not	31.52	Not	16.63	Not	17.07	Not	15.34	Not

Sl. No.	Location	Parameter	2013-2014				2014-2015				2015-2016			
			Dry season (April)	Remarks	Wet season (Oct)	Remarks	Dry season (April)	Remarks	Wet season (Oct)	Remarks	Dry season (Mar)	Remarks	Wet season (Oct)	Remarks
		(µg/gm)		polluted		polluted		polluted		polluted		polluted		polluted
		Cadmium (Cd)(µg/gm)	0	Not polluted	0	Not polluted	2.35	Not polluted	00	Not polluted	00	Not polluted	00	Not polluted
		Chloride (Cl-) (µg/gm)	1,472.5	*	0	0	0	0	0		0	0	00	00
		Substratum(30-45cm)												
		EC(ds/m)	10.1	Moderately saline	5.3	Slightly saline	10.00	Moderately saline	6.91	Slightly saline	6.59	Slightly saline	5.64	Slightly saline
		pH	6.6	Neutral	6.2	Slightly acid	6.6	Neutral	6.4	Slightly acid	6.2	Slightly acid	6.4	Slightly acid
		OM (%)	1.9	Medium	1.4	Low	3.36	High	1.53	Low	1.68	Low	1.55	Low
		N (%)	0.09	Low	0.08	Low	0.19	Medium	0.08	Low	0.10	Low	0.08	Very low
		K (meq/100g)	1.5	Very high	1.2	Very high	2.60	Very high	0.72	Very high	0.67	Very high	0.69	Very high
		Ca (meq/100g)	13.7	Very high	34.4	Very high	18.87	Very high	13.16	Very high	11.99	Very high	13.11	Very high
		Mg (meq/100g)	11.8	Very high	6.4	Very high	6.34	Very high	3.08	Very high	3.12	Very high	3.11	Very high
		Na(meq/100g)	8.5	*	9.3	*	10.92	*	7.69	*	6.98	*	6.25	*
		P(µg/gm)	1.3	Very low	19.5	Optimum	6.11	Low	5.71	Low	7.70	Low	5.70	Low
		S(µg/gm)	320.4	Very high	32.8	High	428.10	Very high	262.0	Very high	265.61	Very high	273.38	Very high
		B(µg/gm)	1.14	Very high	1.5	Very high	1.12	Very high	1.36	Very high	1.28	Very high	1.42	Very high
		Fe(µg/gm)	125.3	Very high	175.5	Very high	117.70	Very high	91.20	Very high	71.63	Very high	89.71	Very high
		Mn(µg/gm)	2.7	Optimum	12.2	High	46.08	Very high	6.09	Very high	8.79	Very high	6.55	Very high
		Zn(µg/gm)	1.8	Optimum	0.5	Low	2.15	High	2.83	Very high	2.09	High	2.80	Very high
		Lead(Pb) (µg/gm)	31.3	Not polluted	29.7	Not polluted	32.46	Not polluted	14.10	Not polluted	13.58	Not polluted	13.59	Not polluted
		Cadmium	0	Not	0	Not	2.12	Not	00	Not	00	Not	00	Not

Sl. No.	Location	Parameter	2013-2014				2014-2015				2015-2016			
			Dry season (April)	Remarks	Wet season (Oct)	Remarks	Dry season (April)	Remarks	Wet season (Oct)	Remarks	Dry season (Mar)	Remarks	Wet season (Oct)	Remarks
		(Cd)(µg/gm)		polluted		polluted		polluted		polluted		polluted		polluted
		Chloride (Cl-) (µg/gm)	1715.0	*	0	0	0	0	0	0	0	0	0	0
3.	Kapalirmet	**Top soil(0-15cm)**												
		EC(ds/m)	4.8	Slightly saline	8.5	Moderatel y saline	3.89	Very slightly saline	8.29	Moderatel y saline	8.22	Moderat ely saline	7.53	Slightly saline
		pH	7.0	Neutral	7.6	Slightly alkaline	6.2	Slightly acid	8.0	Slightly alkaline	8.1	Slightly alkaline	7.8	Slightly alkaline
		OM (%)	3.0	Medium	1.5	Low	2.01	Medium	1.75	Low	2.03	Medium	1.77	Low
		N (%)	0.2	Low	0.07	Very low	0.11	Low	0.09	Very low	0.11	Low	0.09	Very low
		K (meq/100g)	1.5	Very high	1.7	Very high	1.32	Very high	0.92	Very high	0.89	Very high	0.87	Very high
		Ca (meq/100g)	18.2	Very high	19.9	Very high	27.04	Very high	10.77	Very high	11.09	Very high	12.47	Very high
		Mg (meq/100g)	15.3	Very high	10.0	Very high	6.21	Very high	2.67	Very high	3.48	Very high	2.49	Very high
		Na(meq/100g)	12.0	*	11.9	*	5.22	*	7.77	*	7.87	*	7.28	*
		P(µg/gm)	3.2	Very low	7.3	Low	6.76	Very high	5.01	Very low	6.26	Low	4.98	Very low
		S(µg/gm)	545.2	Very high	20.8	Medium	216.69	Very high	700.0	Very high	710.4	Very high	741.10	Very high
		B(µg/gm)	1.2	Very high	1.3	Very high	0.95	Very high	1.69	Very high	2.03	Very high	1.70	Very high
		Fe(µg/gm)	37.3	Very high	230. 2	Very high	34.56	Very high	94.22	Very high	45.52	Very high	94.20	Very high
		Mn(µg/gm)	3.8	Very high	6.6	Very high	10.26	Very high	7.28	Very high	6.05	Very high	7.47	Very high
		Zn(µg/gm)	2.0	High	1.0	Low	1.64	Optimum	3.58	Very high	2.68	Very high	3.66	Very high
		Lead(Pb) (µg/gm)	12.5	Not polluted	28.9	Not polluted	47.12	Not polluted	8.17	Not polluted	6.89	Not polluted	7.53	Not polluted
		Cadmium (Cd)(µg/gm)	0	Not polluted	0	Not polluted	2.86	Not polluted	00	Not polluted	00	Not polluted	00	Not polluted
		Chloride (Cl-) (µg/gm)	3741.9	*	0	0	0	0	0		0	0	00	00
		Subsurface soil(15-30cm)												
		EC(ds/m)	11.1	Moderatel	6.3	Slightly	4.26	Slightly	7.43	Slightly	8.60	Moderat	7.55	Slightly

Sl. No.	Location	Parameter	2013-2014				2014-2015				2015-2016			
			Dry season (April)	Remarks	Wet season (Oct)	Remarks	Dry season (April)	Remarks	Wet season (Oct)	Remarks	Dry season (Mar)	Remarks	Wet season (Oct)	Remarks
				y saline		saline		saline		saline		ely saline		saline
		pH	7.2	Neutral	7.9	Slightly alkaline	6.3	Slightly acid	8.0	Slightly alkaline	8.1	Slightly alkaline	8.2	Slightly alkaline
		OM (%)	2.6	Medium	1.3	Low	3.36	High	1.69	Low	1.95	Medium	1.72	Low
		N (%)	0.2	Low	0.06	Very low	0.19	Medium	0.08	Very low	0.10	Low	0.09	Very low
		K (meq/100g)	1.5	Very high	1.6	Very high	1.13	Very high	0.98	Low	0.98	Very high	0.96	Very high
		Ca (meq/100g)	11.7	Very high	14.4	Very high	25.16	Very high	16.89	Very high	16.12	Very high	16.00	Very high
		Mg (meq/100g)	7.1	Very high	9.9	Very high	6.22	Very high	3.94	Very high	3.88	Very high	4.03	Very high
		Na(meq/100g)	8.5	*	9.8	*	5.45	*	7.86	*	7.89	*	7.66	*
		P(µg/gm)	3.8	Very low	5.6	Low	5.29	Low	5.52	Low	6.21	Low	5.55	Low
		S(µg/gm)	341.4	Very high	52.1	Very high	236.58	Very high	655.0	Very high	666.23	Very high	707.00	Very high
		B(µg/gm)	0.86	Very high	1.6	Very high	0.21	Low	1.93	Very high	2.11	Very high	1.95	Very high
		Fe(µg/gm)	140.2	Very high	249.0	Very high	30.03	Very high	93.15	Very high	73.04	Very high	93.69	Very high
		Mn(µg/gm)	3.7	High	5.9	Very high	11.23	Very high	6.95	Very high	8.16	Very high	7.30	Very high
		Zn(µg/gm)	0.94	Medium	0.5	Low	1.04	Medium	2.39	Very high	1.96	High	2.34	Very high
		Lead(Pb) (µg/gm)	0.00	Not polluted	29.3	Not polluted	33.66	Not polluted	9.58	Not polluted	10.03	Not polluted	10.14	Not polluted
		Cadmium (Cd)(µg/gm)	0	Not polluted	0	Not polluted	2.18	Not polluted	00	Not polluted	00	Not polluted	00	Not polluted
		Chloride (Cl-) (µg/gm)	2217.4	*	0	0	0	0	0		0	0	0	0
		Substratum(30-45cm)												
		EC(ds/m)	10.8	Moderately saline	7.5	Slightly saline	3.99	Very slightly saline	7.06	Slightly saline	6.77	Slightly saline	8.44	Moderately saline
		pH	7.3	Neutral	7.8	Slightly alkaline	6.3	Slightly acid	7.9	Slightly alkaline	7.9	Slightly alkaline	8.1	Slightly alkaline
		OM (%)	2.8	Medium	1.3	Low	4.03	High	2.38	Medium	2.42	Medium	2.21	Medium
		N (%)	0.15	Low	0.06	Very low	0.23	Medium	0.12	Low	0.13	Low	0.11	Low

Sl. No.	Location	Parameter	2013-2014				2014-2015				2015-2016			
			Dry season (April)	Remarks	Wet season (Oct)	Remarks	Dry season (April)	Remarks	Wet season (Oct)	Remarks	Dry season (Mar)	Remarks	Wet season (Oct)	Remarks
		K (meq/100g)	1.5	Very high	1.6	Very high	1.16	Very high	0.87	Very high	0.88	Very high	0.88	Very high
		Ca (meq/100g)	12.9	Very high	15.4	Very high	27.13	Very high	17.20	Very high	16.88	Very high	16.78	Very high
		Mg (meq/100g)	10.4	Very high	9.7	Very high	6.25	Very high	3.90	Very high	4.12	Very high	4.00	Very high
		Na(meq/100g)	8.5	*	9.6	*	5.76	*	7.27	*	7.03	*	8.05	*
		P(µg/gm)	3.4	Very low	5.8	Low	9.24	Optimum	3.65	Very low	3.81	Very low	4.12	Very low
		S(µg/gm)	345.1	Very high	5.6	Very low	231.67	Very high	732.0	Very high	764.07	Very high	664.37	Very high
		B(µg/gm)	1.4	Very high	1.1	Very high	1.55	Very high	1.83	Very high	1.56	Very high	1.85	Very high
		Fe(µg/gm)	120.3	Very high	247.8	Very high	33.82	Very high	87.26	Very high	38.64	Very high	88.40	Very high
		Mn(µg/gm)	2.9	Optimum	7.2	Very high	53.90	Very high	7.31	Very high	9.43	Very high	7.50	Very high
		Zn(µg/gm)	0.88	Low	0.79	Low	1.00	Medium	2.09	High	2.35	High	2.21	High
		Lead(Pb) (µg/gm)	0.00	Not polluted	27.6	Not polluted	34.37	Not polluted	7.88	Not polluted	7.57	Not polluted	8.05	Not polluted
		Cadmium (Cd)(µg/gm)	0	Not polluted	0	Not polluted	2.20	Not polluted	00	Not polluted	00	Not polluted	00	Not polluted
		Chloride (Cl-) (µg/gm)	1801.6	*	0	0	0	0	0	0	0	0	00	0
4	Chalkghona	**Top soil(0-15cm)**												
		EC(ds/m)	11.5	Moderately saline	7.2	Slightly saline	7.36	Slightly saline	7.31	Slightly saline	7.67	Slightly saline	8.56	Moderately saline
		pH	7.7	Slightly alkaline	8.0	Slightly alkaline	5.7	Slightly acid	8.5	Strongly alkaline	8.6	Strongly alkaline	8.3	Slightly alkaline
		OM (%)	1.5	Low	1.5	Low	2.13	Medium	2.17	Medium	2.15	Medium	2.20	Medium
		N (%)	0.08	Low	0.08	Low	0.12	Low	0.11	Low	0.11	Low	0.11	Low
		K (meq/100g)	1.5	Very high	1.4	Very high	1.72	Very high	0.86	Very high	0.88	Very high	0.88	Very high
		Ca (meq/100g)	22.2	Very high	14.3	Very high	18.79	Very high	14.58	Very high	15.31	Very high	14.44	Very high
		Mg (meq/100g)	11.7	Very high	9.4	Very high	6.29	Very high	3.87	Very high	3.89	Very high	3.85	Very high

Sl. No.	Location	Parameter	2013-2014				2014-2015				2015-2016			
			Dry season (April)	Remarks	Wet season (Oct)	Remarks	Dry season (April)	Remarks	Wet season (Oct)	Remarks	Dry season (Mar)	Remarks	Wet season (Oct)	Remarks
		Na(meq/100g)	8.5	*	8.4	*	9.81	*	6.56	*	6.33	*	6.52	*
		P(µg/gm)	5.6	Very low	9.2	Low	4.11	Very low	10.88	Medium	11.26	Medium	11.13	Medium
		S(µg/gm)	444.2	Very high	4.1	Very low	440.19	Very high	975.0	Very high	982.55	Very high	978.43	Very high
		B(µg/gm)	0.98	Very high	1.2	Very high	0.85	Very high	1.65	Very low	1.88	Very high	1.69	Very high
		Fe(µg/gm)	55.3	Very high	189.0	Very high	41.14	Very high	68.05	Very high	43.62	Very high	70.23	Very high
		Mn(µg/gm)	4.3	High	16.4	Very high	32.04	Very high	7.23	Very high	8.34	Very high	7.42	Very high
		Zn(µg/gm)	0.76	Low	4.8	Very high	4.33	Very high	3.28	Very high	2.14	High	3.33	Very high
		Lead(Pb) (µg/gm)	0.00	Not polluted	27.2	Not polluted	30.99	Not polluted	14.94	Not polluted	14.88	Not polluted	15.26	Not polluted
		Cadmium (Cd)(µg/gm)	0	Not polluted	0	Not polluted	2.38	Not polluted	00	Not polluted	00	Not polluted	00	Not polluted
		Chloride (Cl-) (µg/gm)	1576.4	*	0	0	0	0	0		0	0	00	0
		Subsurface soil(15-30cm)												
		EC(ds/m)	11.3	Moderately saline	6.2	Slightly saline	7.81	Slightly saline	7.38	Slightly saline	7.02	Slightly saline	7.99	Slightly saline
		pH	7.7	Slightly alkaline	8.2	Slightly alkaline	5.9	Slightly acid	8.6	Strongly alkaline	8.5	Strongly alkaline	8.4	Slightly alkaline
		OM (%)	2.6	Medium	1.3	Low	1.88	Medium	1.90	Medium	1.88	Medium	1.84	Medium
		N (%)	0.13	Low	0.07	Very low	0.10	Low	0.10	Low	0.10	Low	0.09	Very low
		K (meq/100g)	1.5	Very high	1.1	Very high	1.54	Very high	0.81	Very high	0.84	Very high	0.79	Very high
		Ca (meq/100g)	22.6	Very high	17.8	Very high	18.96	Very high	16.05	Very high	16.00	Very high	17.10	Very high
		Mg (meq/100g)	16.3	Very high	8.3	Very high	6.30	Very high	4.25	Very high	4.33	Very high	4.33	Very high
		Na(meq/100g)	8.5	*	8.6	*	9.23	*	6.93	*	6.56	*	7.10	*
		P(µg/gm)	13.6	Medium	9.4	Low	3.23	Very low	9.23	Low	8.27	Low	8.79	Low
		S(µg/gm)	415.6	Very high	47.7	Very high	393.37	Very high	886.0	Very high	990.48	Very high	903.11	Very high
		B(µg/gm)	0.66	High	0.97	Very high	0.79	Very high	1.46	Very high	1.17	Very high	1.45	Very high

Sl. No.	Location	Parameter	2013-2014				2014-2015				2015-2016			
			Dry season (April)	Remarks	Wet season (Oct)	Remarks	Dry season (April)	Remarks	Wet season (Oct)	Remarks	Dry season (Mar)	Remarks	Wet season (Oct)	Remarks
		Fe(µg/gm)	124.1	Very high	172.7	Very high	25.52	Very high	77.47	Very high	55.06	Very high	76.67	Very high
		Mn(µg/gm)	6.1	Very high	13.8	Very high	26.59	Very high	6.78	Very high	7.05	Very high	7.53	Very high
		Zn(µg/gm)	1.1	Medium	3.2	Very high	1.09	Medium	3.37	Very high	2.73	Very high	3.12	Very high
		Lead(Pb) (µg/gm)	6.3	Not polluted	28.4	*Not polluted*	30.81	Not polluted	11.83	Not polluted	12.43	Not polluted	11.72	*
		Cadmium (Cd)(µg/gm)	0	Not polluted	0	Not polluted	2.35	Not polluted	00	Not polluted	00	Not polluted	00	*
		Chloride (Cl-) (µg/gm)	2113.5	*	0	0	0	0	0	*	0	0	00	0
		Substratum(30-45cm)												
		EC(ds/m)	10.9	Moderately saline	5.1	Slightly saline	7.14	Slightly saline	7.12	Slightly saline	7.45	Slightly saline	7.87	Slightly saline
		pH	7.5	Slightly alkaline	8.2	Slightly alkaline	6.0	Slightly acid	8.9	Strongly alkaline	8.7	Strongly alkaline	8.4	Slightly alkaline
		OM (%)	1.7	Low	1.0	Very low	2.94	Medium	1.53	Low	1.57	Low	1.55	Low
		N (%)	0.09	Very low	0.06	Very low	0.17	Low	0.08	Very low	0.09	Very low	0.08	Very low
		K (meq/100g)	1.5	Very high	0.95	Very high	1.57	Very high	0.89	Very high	0.90	Very high	0.95	Very high
		Ca (meq/100g)	13.9	Very high	14.4	Very high	19.10	Very high	15.95	Very high	16.25	Very high	16.72	Very high
		Mg (meq/100g)	11.1	Very high	7.2	Very high	6.26	Very high	4.15	Very high	4.06	Very high	3.97	Very high
		Na(meq/100g)	8.5	*	6.7	*	9.33	*	7.20	Very high	7.39	*	6.77	*
		P(µg/gm)	4.1	Very low	9.5	Low	5.67	Low	11.26	Medium	12.33	Medium	10.46	Low
		S(µg/gm)	334.6	Very high	8.3	Low	343.00	Very high	465.0	Very high	543.04	Very high	562.60	Very high
		B(µg/gm)	0.67	High	0.63	High	1.05	Very high	1.14	Very high	1.11	Very high	1.22	Very high
		Fe(µg/gm)	75.3	Very high	160.0	Very high	29.70	Very high	90.55	Very high	67.84	Very high	90.64	Very high
		Mn(µg/gm)	3.6	Very high	14.1	Very high	25.22	Very high	6.03	Very high	7.03	Very high	6.61	Very high
		Zn(µg/gm)	1.7	Optimum	2.9	Very high	1.78		2.94	Very high	2.00	High	3.05	Very high

Sl. No.	Location	Parameter	2013-2014				2014-2015				2015-2016			
			Dry season (April)	Remarks	Wet season (Oct)	Remarks	Dry season (April)	Remarks	Wet season (Oct)	Remarks	Dry season (Mar)	Remarks	Wet season (Oct)	Remarks
		Lead(Pb) (µg/gm)	6.3	Not polluted	26.5	Not polluted	32.23	Not polluted	15.50	Not polluted	14.71	Not polluted	14.64	Not polluted
		Cadmium (Cd)(µg/gm)	0	Not polluted	0	Not polluted	2.55	Not polluted	00	Not polluted	00	Not polluted	00	Not polluted
		Chloride (Cl-) (µg/gm)	1715.0	*	0	0	0	0			0	0	00	0
5.	Basherhula	**Top soil(0-15cm)**												
		EC(ds/m)	11.7	Moderatel y saline	6.0	Slightly saline	7.14	Slightly saline	5.58	Slightly saline	9.10	Moderael y saline	6.41	Slightly saline
		pH	7.7	Slightly alkaline	8.3	Slightly alkaline	7.3	Neutral	8.7	Strongly alkaline	8.8	Strongly alkaline	8.3	Slightly alkaline
		OM (%)	1.7	Low	1.2	Low	1.74	Low	1.59	Low	1.79	Medium	1.48	Low
		N (%)	0.09	Low	0.06	Very low	0.10	Low	0.08	Very low	0.09	Very low	0.07	Very low
		K (meq/100g)	1.5	Very high	1.2	Very high	1.67	Very high	0.75	Very high	0.81	Very high	0.77	Very high
		Ca (meq/100g)	23.6	Very high	31.4	Very high	25.26	Very high	15.11	Very high	16.53	Very high	15.08	Very high
		Mg (meq/100g)	11.9	Very high	7.9	Very high	5.50	Very high	4.05	Very high	4.42	Very high	3.90	Very high
		Na(meq/100g)	8.5	*	8.1	*	7.06	*	6.32	*	8.24	*	6.61	*
		P(µg/gm)	4.5	Very low	7.4	Low	7.12	Low	5.92	Low	5.47	Low	5.87	Low
		S(µg/gm)	272.3	Very high	21.8	Medium	454.19	Very high	607.0	Very high	623.73	Very high	579.39	Very high
		B(µg/gm)	0.94	Very high	1.1	Very high	1.00	Very high	1.19	Very high	1.32	Very high	1.15	Very high
		Fe(µg/gm)	50.3	Very high	205. 6	Very high	53.37	Very high	85.08	Very high	48.00	Very high	87.22	Very high
		Mn(µg/gm)	3.4	High	5.9	Very high	49.22	Very high	6.50	Very high	5.22	Very high	6.55	Very high
		Zn(µg/gm)	1.4	Medium	1.1	Medium	2.27	Very high	1.86	High	1.04	Medium	1.89	High
		Lead(Pb) (µg/gm)	18.8	Not polluted	25.1	Not polluted	30.55	Not polluted	6.19	Not polluted	5.77	Not polluted	5.77	Not polluted
		Cadmium (Cd)(µg/gm)	0	Not polluted	0	Not polluted	2.21	Not polluted	00	Not polluted	00	Not polluted	00	Not polluted

Sl. No.	Location	Parameter	2013-2014				2014-2015				2015-2016			
			Dry season (April)	Remarks	Wet season (Oct)	Remarks	Dry season (April)	Remarks	Wet season (Oct)	Remarks	Dry season (Mar)	Remarks	Wet season (Oct)	Remarks
		Chloride (Cl-) (µg/gm)	2442.6	*	0	0	0	0	0	0	0	0	00	0
		Subsurface soil (15-30cm)												
		EC(ds/m)	10.7	Moderatel y saline	7.0	Slightly saline	7.44	Slightly saline	7.16	Slightly saline	6.29	Slightly saline	7.30	Slightly saline
		pH	7.7	Slightly alkaline	8.2	Slightly alkaline	7.7	Slightly alkaline	8.7	Strongly alkaline	8.6	Strongly alkaline	8.4	Slightly alkaline
		OM (%)	1.5	Low	0.9	Low	2.01	Medium	1.43	Low	1.31	Low	1.42	Low
		N (%)	0.08	Very low	0.05	Very low	0.11	Low	0.07	Very low	0.07	Very low	0.07	Very low
		K (meq/100g)	1.0	Very high	1.2	Very high	2.20	Very high	0.76	Very high	0.77	Very high	0.71	Very high
		Ca (meq/100g)	24.0	Very high	32.6	Very high	33.28	Very high	14.75	Very high	13.87	Very high	13.77	Very high
		Mg (meq/100g)	11.7	Very high	8.4	Very high	6.10	Very high	3.76	Very high	3.69	Very high	3.52	Very high
		Na(meq/100g)	7.0	*	10.1	*	8.66	*	7.06	*	6.93	*	6.74	*
		P(µg/gm)	3.9	Very low	5.3	Low	8.19	Low	6.82	Low	7.03	Low	7.14	Low
		S(µg/gm)	317.2	Very high	2.8	Very low	379.38	Very high	627.0	Very high	652.28	Very high	568.50	Very high
		B(µg/gm)	0.71	High	1.0	Very high	1.38	Very high	1.31	Very high	1.08	Very high	1.38	Very high
		Fe(µg/gm)	121.4	Very high	307.0	Very high	53.18	Very high	83.13	Very high	50.12	Very high	84.36	Very high
		Mn(µg/gm)	3.9	Very high	15.5	Very high	45.34	Very high	5.98	Very high	5.62	Very high	6.26	Very high
		Zn(µg/gm)	1.8	Optimum	0.8	Low	1.99	High	2.27	Optimum	2.34	Very high	2.23	Very high
		Lead(Pb) (µg/gm)	18.8	Not polluted	23.7	Not polluted	31.49	Not polluted	16.35	Not polluted	17.15	Not polluted	15.69	Not polluted
		Cadmium (Cd)(µg/gm)	0	Not polluted	0	Not polluted	2.32	Not polluted	00	Not polluted	00	Not polluted	00	Not polluted
		Chloride (Cl-) (µg/gm)	1611.1	*	0	0	0	0	0		0	0	00	0
		Substratum (30-45cm)												
		EC(ds/m)	10.9	Moderatel y saline	6.3	Slightly saline	6.68	Slightly saline	6.96	Slightly	6.38	Slightly saline	7.39	Slightly saline

Sl. No.	Location	Parameter	2013-2014				2014-2015				2015-2016			
			Dry season (April)	Remarks	Wet season (Oct)	Remarks	Dry season (April)	Remarks	Wet season (Oct)	Remarks	Dry season (Mar)	Remarks	Wet season (Oct)	Remarks
										saline				
		pH	7.7	Slightly alkaline	8.2	Slightly alkaline	7.8	Slightly alkaline	8.8	Strongly alkaline	8.7	Strongly alkaline	8.7	Strongly alkaline
		OM (%)	1.5	Low	1.0	Low	2.81	Medium	2.17	Medium	2.18	Medium	2.09	Medium
		N (%)	0.08	Very low	0.06	Very low	0.16	Low	0.11	Low	0.11	Low	0.11	Low
		K (meq/100g)	1.5	Very high	1.2	Very high	2.20	Very high	0.86	Very high	0.85	Very high	0.90	Very high
		Ca (meq/100g)	24.4	Very high	32.1	Very high	30.68	Very high	13.95	Very high	12.92	Very high	14.05	Very high
		Mg (meq/100g)	12.9	Very high	8.3	Very high	6.11	Very high	3.80	Very high	4.01	Very high	3.78	Very high
		Na(meq/100g)	7.5	*	9.8	*	8.76	*	7.68	*	7.01	*	7.48	*
		P(µg/gm)	6.1	Low	5.9	Low	11.14	Medium	9.12	Low	8.77	Low	8.90	Low
		S(µg/gm)	321.1	Very high	3.1	Very low	305.69	Very high	182.0	Very high	230.62	Very high	264.81	Very high
		B(µg/gm)	0.63	High	0.85	Very high	2.95	Very high	1.40	Very high	1.54	Very high	1.44	Very high
		Fe(µg/gm)	77.3	Very high	162.4	Very high	42.36	Very high	66.29	Very high	39.40	Very high	68.25	Very high
		Mn(µg/gm)	3.2	High	16.9	Very high	31.74	Very high	5.69	Very high	7.16	Very high	5.74	Very high
		Zn(µg/gm)	2.1	High	2.7	Very high	1.62	Optimum	2.04	High	1.46	Optimum	1.97	High
		Lead(Pb) (µg/gm)	25.00	Not polluted	22.2	Not polluted	31.54	Not polluted	14.96	Not polluted	16.02	Not polluted	15.20	Not polluted
		Cadmium (Cd)(µg/gm)	0	Not polluted	0	Not polluted	2.44	Not polluted	00	Not polluted	00	Not polluted	00	Not polluted
		Chloride (Cl-) (µg/gm)	1489.8	*	0	0	0	0	0		0	0	00	0

*Source: SRDI Laboratory analysis, 2014, 2015 and July 2016 * Not specified*

Table E.3: Different Concentrations of metals in the agricultural soil of the study area over three seasons in 2013-14, 2014-15 and 2015-16(dry season)

Parameter	Safe limit of India (mg/kg/ µg/gm/ ppm)	Range in uncontaminated soil in India	Maximum Acceptable Concentration of Agricultural soil in Austria (mg/kg/µg/gm/ ppm)	2013-2014							2014-2015								2015-2016								
				Dry season (April)			Wet season (October)				Dry season (April)				Wet season (October)				Dry season (March)				Wet season (October)				
				Mean (mg/kg/ µg/gm/ ppm)	SD	Min (mg/kg /µg/gm/ ppm)	Max (mg/kg /µg/gm /ppm)	Mean (mg/kg/ µg/gm/ ppm)	SD	Min (mg/kg /µg/gm/ ppm)	Max (mg/kg /µg/gm/ ppm)	Mean (mg/kg/ µg/gm/ ppm)	SD	Min (mg/kg /µg/gm/ ppm)	Max (mg/kg /µg/gm /ppm)	Mean (mg/kg/ µg/gm/ ppm)	SD	Min (mg/kg /µg/gm/ ppm)	Max (mg/kg /µg/gm/ ppm)	Mean (mg/kg/ µg/gm/ ppm)	SD	Min (mg/kg /µg/gm/ ppm)	Max (mg/kg /µg/gm / ppm)	Mean (mg/kg/ µg/gm/ ppm)	SD	Min (mg/kg /µg/gm/ ppm)	Max (mg/kg /µg/gm /ppm)
Fe	75-150	*	*	80.8	40.8	37.3	150.3	196.6	61.1	60.9	307	44	23.1	26.6	117.7	74.3	16.3	29.27	90.55	45.8	13.8	22.35	73.04	79.33	16.3	28.65	94.2
Mn	*	100-4000	*	4.0	1.3	2.7	7.2	11.1	4.02	5.3	16.9	25.4	17.6	10.26	88.75	6.7	0.72	5.75	7.31	7.8	1.91	5.22	11.9	6.85	0.68	5.74	7.98
Zn	300-600	10-300	300	1.4	0.42	0.76	2.1	1.7	1.28	0.49	4.8	1.9	0.81	1.09	4.33	2.7	0.95	1.69	5.32	2.2	0.83	1.04	4.36	2.70	0.88	1.62	4.91
Pb	250-500	2-200	100	14.7	14	6.3	37.8	28.3	3.1	22.2	33.7	30.8	4.1	29.9	34.37	14.5	5.4	7.88	25.95	14.5	5.4	5.77	24.23	14.24	5.1	5.77	23.75
Cd	3.0-6.0	0.01-0.7	5.0	0	0	6.3	37.8	00	0	22.2	33.7	2.4	0.18	29.9	34.37	0	0	7.88	25.95	0	0	5.77	24.23	0	0	0	0

*Source: SRDI laboratory analysis (2016), Awashthi (2000) and Kabata-Pendias, A. and H.Pendias, (1992) *Not specified*

Table E-4: Upazila Wise Cropping Pattern of the Monitoring Area for the Period of 2014-15

Name of Upazila	2014-15				
	Kharif-I (March-June)	**Kharif-II (July-October)**	**Rabi (Nov-February)**	**Area(ha)**	**% of NCA**
Batiaghata	Fish	Local Aman	HYV Boro	250	1.3
	Fallow	Local Aman	HYV Boro	2,950	15.4
	Fish	Fish	HYV Boro	200	1.0
	HYV Aus	Local Aman	HYV Boro	200	1.0
	Sesame	Local Aman	Fallow	8,500	44.4
	Pulses	HYV Aman	Fallow	1,200	6.3
	Vegetables	Local Aman	Fallow	100	0.5
	Fallow	HYV Aman	Fallow	5,147	26.9
	Fallow	HYV Aman	Pulses	75	0.4
	Vegetables	Vegetables	Vegetables	450	2.4
	Vegetables	Vegetables	Potato	55	0.3
			Sub-total	**19,127**	**100**
Dacope	Fallow	HYV Aman	Fallow	16,166	81.5
	Fallow	Local Aman	Fallow	25	0.1
	Fallow	Local Aman	Water melon	2,025	10.2
	HYV Aus	Local Aman	Water melon	600	3.0
	HYV Aus	Local Aman	Fallow	100	0.5
	Fallow	Fallow	HYV Boro	30	0.2
	Fallow	Local Aman	Sesame	16	0.1
	Fallow	Local Aman	Mung bean	18	0.1
	Vegetables	Fallow	Potato	100	0.5
	Vegetables	Vegetables	Potato	30	0.2
	Vegetables	Vegetables	Spices	50	0.3
	Vegetables	Fallow	Vegetables	175	0.9
	Vegetables	Vegetables	Vegetables	75	0.4
	Fallow	Local Aman	Vegetables	350	1.8
	HYV Aus	Local Aman	Vegetables	70	0.4
			Sub-total	**19,830**	**100**
Rampal	Fallow	Local Aman	Fallow	7,225	73.7

Name of Upazila	2014-15				
	Kharif-I (March-June)	**Kharif-II (July-October)**	**Rabi (Nov-February)**	**Area(ha)**	**% of NCA**
	Fallow	HYV Aman	HYV Boro	300	3.1
	Fallow	Fallow	Local Boro	1,500	15.3
	Vegetables	Vegetables	Vegetables	325	3.3
	Vegetables	Fallow	Vegetables	450	4.6
			Sub-total	**9,800**	**100**
Mongla	Fallow	HYV Aman	Vegetables	410	3.7
	Vegetables	HYV Aman	Vegetables	50	0.5
	Fallow	Local Aman	Fallow	10,450	95.3
	Vegetables	HYV Aman	Pulses	50	0.5
			Sub-total	**10,960**	**100**
			Total	**59,717**	**0**

Table E.5: Upazila wise Cropped Area, Yield and Production of the Monitoring Area for the Period of 2014-15

Name of upazila	2014-15				
	Crop name	**Area (ha)**	**Yield (Ton/ha)**	**Production (Tons)**	**% of production contribution**
Batighata	HYV Aus	200	2.45	490	1
	HYV Aman	6,422	2.82	18,110	20
	Local Aman	12,000	1.8	21,600	24
	HYV Boro	3,600	3.7	13,320	15
	Pulses	1,275	1.1	1,403	2
	Potato	55	16.5	908	1
	Summer vegetables	1,110	16.4	18,204	20
	Winter vegetables	450	19.8	8,910	10
	Sesame	8,500	0.95	8,075	9
	Sub-total	**33,612**	**-**	**91,019**	**100**
Dacope	Local Aman	3,204	2.1	2,871	2
	HYV Aman	16,166	3.3	52,857	41
	HYVBoro	30	3.5	28,336	22
	Potato	130	15.0	1,950	2

Name of upazila	2014-15				
	Crop name	**Area (ha)**	**Yield (Ton/ha)**	**Production (Tons)**	**% of production contribution**
	Sesame	16	0.9	14	0
	Spices	50	7.0	350	0
	Mung bean	18	0.8	14	0
	Water melon	2,625	42.0	27,132	21
	Summer vegetables	485	11.9	6,067	5
	Winter vegetables	670	14.3	9,574	7
	Sub-total	**23,394**	**-**	**129,165**	**100**
Rampal	Local Aman	7,225	1.86	13,439	32
	HYV Aman	300	3.0	900	2
	HYVBoro	300	3.86	1,158	3
	Local Boro	1,500	2.5	3,750	9
	Summer vegetables	1,100	11	12,100	29
	Winter vegetables	775	14	10,850	26
	Sub-total	**11,200**	**-**	**42,197**	**100**
Mongla	Local Aman	10,450	1.7	17,765	68
	HYV Aman	460	3.1	1,426	5
	Summer vegetables	50	12	600	2
	Winter Vegetables	460	14	6,440	24
	Pulses	50	1.1	55	0
	Sub-total	**11,470**	**-**	**26,286**	**100**
	Total	**79,676**	**-**	**288,667**	0

Source: Local DAE Offices, April; 2016* indicates cleaned rice

Table E.6: Existing Cropping Pattern of Monitoring Agriculture Plot

Monitoring agriculture plot	2013-14			2014-15			2015-16		
	Kharif-I (March-June)	Kharif-II (July-October)	Rabi (Nov-February)	Kharif-I (March-June)	Kharif-II (July-October)	Rabi (Nov-February)	Kharif-I (March-June)	Kharif-II (July-October)	Rabi (Nov-February)
Monitoring agriculture plot-1(Baranpara)	Fallow	Local Aman	Fallow	Fallow	HYV Aman	Fallow	Fallow	HYV Aman	Fallow
Monitoring agriculture plot-2(Chunkuri-2)	Fallow	HYV Aman	Fallow	Fallow	Local Aman	Fallow	Fallow	Local Aman	Fallow
Monitoring agriculture plot-3(Kapalirmet)	Fallow	Local Aman	Fallow	Fallow*	Fallow*	Fallow*	Fallow*	Fallow*	Fallow*
Monitoring agriculture plot-4(Chakgona)	Fallow	Local Aman	Fallow	Fallow*	Fallow*	Fallow*	Fallow*	Fallow*	Fallow*
Monitoring agriculture plot-5(Basherhula)	Fallow	Local Aman	Fallow	Fallow	Local Aman	Fallow	Fallow	Local Aman	Fallow

*Source: Based on field information and farmers interviewed, April and October; 2014 and April and October; 2015, April and October, 2016 *Fallow-Shrimp/Fish culture*

Table E.7: Results of Crop production in Monitoring Plots

Monitoring Plots	Crop Production(tons)								
	2013-14			2014-15			2015-2016		
	Kharif I (March – June)	Kharif II (July to Oct.)	Rabi (Nov. to Feb.)	Kharif I (March – June)	Kharif II (July to Oct.)	Rabi (Nov. to Feb.)	Kharif I (March – June)	Kharif II (July to Oct.)	Rabi (Nov. to Feb.)
Agriculture plot -1(Baranpara)									
Production (Ton/Plot)	-	0.8*	-	-	1.4*	-	-	1.5*	-
Yield (ton/Ha)	-	1.9*	-	-	3.5*	-	-	3.8*	-
Agriculture plot- 2(Chunkuri-2)									
Production (Ton/Plot)	-	2.4*	-	-	1.1	-	-	1.9*	-
Yield (ton/Ha)	-	2.6*	-	-	1.7*	-	-	2.0*	-
Agriculture plot- 3(Kapalirmet)									
Production (Ton/Plot)	-	0.2*	-	-	-	-	-	-	-
Yield (ton/Ha)	-	1.6*	-	-	-	-	-	-	-
Agriculture plot- 4(Chakgona)									
Production (Ton/Plot)	-	0.6*	-	-	-	-	-	-	-
Yield (ton/Ha)	-	1.9*	-	-	-	-	-	-	-

Monitoring Plots	Crop Production(tons)								
	2013-14			2014-15			2015-2016		
	Kharif I (March – June)	Kharif II (July to Oct.)	Rabi (Nov. to Feb.)	Kharif I (March – June)	Kharif II (July to Oct.)	Rabi (Nov. to Feb.)	Kharif I (March – June)	Kharif II (July to Oct.)	Rabi (Nov. to Feb.)
Agriculture plot-5(Basherhula)									
Production (Ton/Plot)	-	0.8*	-	-	0.57*	-	-	0.99*	-
Yield (ton/Ha)	-	1.8*	-	-	1.9*	-	-	2.1*	-

*Source: Based on field information and farmers interviewed, April 2014, April 2015 and April 2016 * indicates cleaned rice*

Table E.8: Results of Crop Damage in Monitoring Plots

Monitoring plot	Crop damage(tons)								
	2013-14			2014-15			2015-16		
	Area (ha)	Prod. (tons)	Causes	Area (ha)	Prod (tons)	Causes	Area (ha)	Prod (tons)	Causes
Agriculture plot-1(Baranpara)	-	*Not found	-	-	-	-	-	*Not found	-
Agriculture plot-2(Chunkuri-2)	-	*Not found	-	0.33*	0.4*	E	-	*Not found	-
Agriculture plot-3(Kapalirmet)	-	*Not found	-	-	-	-	-	*Not found	-
Agriculture plot-4(Chakgona)	-	*Not found	-	-	-	-	-	*Not found	-
Agriculture plot-5(Basherhula)	-	*Not found	-	0.17*	0.12*	E	-	*Not found	-
Total	-	-	**-**	**0.50***	**0.52***	**-**	**-**	**-**	**-**

*Source: Based on field information and farmers interviewed, April 2014, April 2015 and April 2016 * indicates cleaned rice*

Appendix V: Monitoring Data observed During EIA Study

Table F.1: Air quality monitoring results of different location

Date	Sample location	SPM (µg/m^3)	SO_x (µg/m^3)	NO_x (µg/m^3)
01/05/2012	Shibbari More, Khulna	410.0	<25	46.0
	College More, Khulna	320.0	<25	36.0
	Natunrasta More, Khulna	350.0	<25	33.0
	Sonadanga Bus stand	335.0	<25	41.0
Bangladesh Standard (ECR 1997) for residential and rural area		200	80	80
02/05/2012	Bus stand more, Sharankhola Sadar	155.0	10.0	21.0
	In front of Upazila Palli Unnoyon Board Office, Sharankhola Sadar	140.0	11.0	20.
	Thana More, Sharankhola Sadar	150.0	09.0	18.0
	In front of Upazila Health Complex Office, Sharankhola Sadar	148.0	08.0	16.0
Bangladesh Standard (ECR 1997) for sensitive area as the location is within the ECA of Sundarbans		100	30	30
ECR Amendment, 2005		150 (24-hr)	365 (24-hr)	100 (Annual)

Source: CEGIS investigation, 2012

Note: Experts from DoE, Khulna collected samples and all the parameters were tested in the labs of DoE, Khulna. During sample collection, the day was sunny and gentle wind was flowing northwestwards.

Table F.2: Water quality monitoring results

location	Date	Temp.	pH	EC	Cl^-	T.Alkalinity	Turbidity	T S	TDS	SS	DO	BOD	COD	Salinity
		°C		µS/cm	mg/l	mg/l	NTU	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
1	7-Jan	27.4	7.74	3010	879	36	68.7	1565	1510	55	5.1	0.8	55	1.6
2	7-Jan	27.1	7.72	3020	878.8	36	68.5	1570	1510	60	5.1	0.8	55	1.6
3	7-Jan	27.8	7.71	3030	879	36	68.8	1565	1510	55	5.1	0.8	55	1.6
1	11-Feb	29.8	7.66	4380	1262	36	182	2390	2180	210	4.7	1	76	2.3
2	11-Feb	29.2	7.63	4380	1268	36	178	2390	2190	200	4.7	1	76	2.3
3	11-Feb	29.1	7.65	4380	1263	36	179	2380	2180	200	4.7	1	76	2.3
1	9-Mar	32.6	7.56	11780	2944.4	38	176	6080	5890	190	4.7	1.2	76	6.7
2	9-Mar	32.6	7.57	11780	2945.2	38	178	6080	5890	190	4.7	1.2	76	6.7
3	9-Mar	32.1	7.55	11780	2946.4	38	177	6090	5890	200	4.7	1.2	76	6.7
1	17-Apr	32.6	7.59	25300	8273	36	185.6	12950	12700	250	4.6	0.7	136	15.5
2	17-Apr	32.6	7.59	25300	8273	36	186.2	12950	12700	250	4.6	0.7	138	15.5
3	17-Apr	32.6	7.59	25300	8273	36	184.8	12950	12700	250	4.6	0.7	136	15.5
1	5-May	32.6	7.59	29200	9480	36	198.6	14900	14600	300	4.5	1.2	177	17.6
2	5-May	32.9	7.54	29200	9470	36	198.6	14900	14600	300	4.4	1.2	177	17.6
3	5-May	33.2	7.57	29200	9470	36	199.6	14900	14600	300	4.5	1.2	177	17.6
1	13-Jun	31.6	7.69	18000	5820	36	112.6	9200	9000	200	4.7	1.1	97	10.8
2	13-Jun	31.6	7.69	18000	5800	36	113.2	9200	9000	200	4.7	1.1	97	10.8
3	13-Jun	31.6	7.69	18000	5810	36	112.4	9200	9000	200	4.7	1.1	97	10.8
1	1-Jul	31.6	7.69	440	32.6	36	76.6	285	220	65	5.2	0.8	26	-
2	1-Jul	31.6	7.69	440	32.6	36	76.6	285	220	65	5.2	0.8	26	-
3	1-Jul	31.6	7.69	440	32.6	36	76.6	285	220	65	5.2	0.8	26	-
1	5-Aug	31.6	7.69	275	16.6	36	68.6	192	137	55	5.3	0.7	22	-
2	5-Aug	31.6	7.69	275	16.6	36	68.6	192	137	55	5.3	0.7	22	-
3	5-Aug	31.6	7.69	275	16.6	36	68.6	192	137	55	5.3	0.7	22	-
1	8-Sep	31.6	7.74	270	15.6	36	65.6	180	135	45	5.5	0.7	22	-
2	8-Sep	31.6	7.76	270	15.6	36	65.6	180	135	45	5.5	0.7	22	-
3	8-Sep	31.6	7.74	270	15.6	36	65.6	180	135	45	5.5	0.7	22	-
1	12-Oct	30.6	7.79	290	26.6	36	62.6	192	145	47	5.6	0.7	22	-
2	12-Oct	30.6	7.78	290	26.6	36	62.6	192	145	47	5.6	0.7	22	-
3	12-Oct	30.6	7.78	290	25.6	36	62.6	192	145	47	5.6	0.7	22	-
1	5-Nov	24.6	7.79	340	38.6	36	56.6	210	170	40	5.6	0.7	22	-
2	5-Nov	26.6	7.79	340	38.6	36	56.6	210	170	40	5.6	0.7	22	-
3	5-Nov	25.6	7.79	340	38.6	36	56.6	210	170	40	5.6	0.7	22	-
1	12-Dec	21.5	772	520	62.6	36	72.6	320	260	60	5.1	0.9	25	0.4
2	12-Dec	20.9	7.71	520	62.6	36	73.6	320	260	60	5.1	0.9	25	0.4
3	12-Dec	21.1	7.72	520	62.6	36	71.6	320	260	60	5.1	0.9	25	0.4

Source: DOE, 2010

Note: All samples collected from Mongla port (location 1 - Port side river sample, location 2 – middle of the river and location 3 - Opposite of Mongla port) during high tide period in 200