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 1320 MW Coal based Thermal Power Plant




First Quarter Monitoring Report of Third Year (2016)

Monitoring Period: February 2016 – April 2016

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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
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
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 Datum
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
U.S.EPA	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 = 0.621371192 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 = 274.15K=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

The study covers quarterly monitoring of different environmental and social parameters and environmental compliance monitoring of pre-construction activities. CEGIS has carried out the **1st** quarter of the **3rd** year monitoring activities in April, 2016 comprising of the monitoring of implementation of Environmental Management Plan (EMP) and Environmental Compliance, ambient air quality, noise level, water quality and hydro-morphological condition, agricultural resources, fisheries resources covering fish habitats, migration and production and Sundarbans forest health.

EMP Monitoring during pre-construction activities deduced that the land development for the BIFPCL's site (Block A) has been completed. Construction of the embankments and slope protection work are about to complete. Site office construction has been continued. At present, the construction of main access road from Babur Bari to the Plant site is in progress and near to completion. In general, in this quarter, the environmental due diligence covered the Environmental Management System and Action Plan, Occupational Health and safety, workers' well being, 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, which are stipulated in the pre-construction (Land development) stage, and has taken the preparation to meet the compliance requirements to the next stages. 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 road signs; temporary drainage for rain fall runoff should be constructed 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 labor shed, and working area; the HR policies which are under preparation should include: Working Conditions and Management of Worker Relationship, Child labor policy, Occupational Health and Safety Policies, and worker's well beings following OHSAS 18001, ISO 14001; the grievance redress mechanism should be established; proper documentation of any accident or any health hazard risk needs to be maintained; preventive measures for near miss accidental events and any unforeseeable injury, illness, or damage should be adopted; an officer responsible for enforcing and monitoring safety procedure should be assigned; site specific ESMP should be prepared by the EPC contractors; safety training program for the Project personnel and labor force should be arranged.

Air quality monitoring inferred that the wind headed from South-Southeast to North-Northwest. The weather condition is found mostly sunny except there were possibilities for storms with gust of wind. This time all the monitoring parameters (SO_2, NO_2, $PM_{2.5}$, PM_{10}, CO and O_3) of the ambient air are found within the standard limit except SPM which has been exceedingly higher at places (i.e., in the South-West corner of the Project boundary and at Barni, Gaurambha), might be because of the dry season and this will likely be continued till the monsoon begins. Newly developed land for industrial activities along the Passur River, loading-unloading activities and cement industries are the known sources of SPM in this area. Other pollutants are generated from the commonly known sources like the rural vehicles (human hauler/ Nosimon) while working beside the roads; whereas in case of the monitoring spot in or around the waterways, the sources are engines of trawler, barges, ship etc.

Noise level has been found comparatively higher around the Project site, at township area due to the accelerated construction work, and at Gaurambha, because of the overcrowded

bazar. In the Sundarbans, noise level has been found within the threshold for a silent class (50dB)at all the sampling points (Harbaria, Hiron Point, and Akram Point) during this monitoring period Wind action on trees, splashing waves, bird's chirping, ship and fishing boats etc. are the sources of noise observed in Sundarbans. Mostly the noise generation sources are natural in the Sundarbans and anthropogenic i.e. traffic and local vehicles in the other locations.

In continuation of the monitoring study, this time in April, 2016 water samples were collected from all the earlier locations (15 locations for surface water and 3 locations for ground water analysis). The samples have been submitted to DPHE and BCSIR for laboratory analysis. This monitoring report contains laboratory reports of the last monitoring study and in-situ monitoring results of this quarter. The analyzed results of all parameters are found within the standard limit set by ECR' 1997. However, similar to the earlier year, spatial and seasonal variation is still present. For example, the values of TDS are found very high comparing to the last monitoring period. This may be due to the lack of fresh water flow from upstream and the erosion accretion process of the said river system.

Hydromorphological monitoring included monitoring of drainage network, erosion, accretion and river bed material quality. A detail drainage network has been prepared from the analysis of satellite image. Location of present eroding and accreting areas were identified on the basis of satellite image analysis and field observation. River bed sediments collected during previous quarter (4th Quarter of 2nd Year) monitoring were tested in the SRDI laboratory. The result of laboratory test has been provided in this quarterly monitoring report.

The soil samples have been collected for dry season of 2015-16 to determine the soil quality of the selected plots of five mauzas (Baranpara, Chunkuri-2, Kapalirmet, Chakgona and Basherhula). The collected soil samples have been handed over to the Soil Resource Development Institute (SRDI), Dhaka for laboratory analysis. Results will be presented in the next (2nd quarter of 3rd year) monitoring report after the analysis.

Fisheries resources have been monitored and the findings show that yearly changes in habitat uses (when compared among first quarter of 1st, 2nd and 3rd year of monitoring) are mainly due to having tidal effect, seasonal variability and fisheries resource management. Moreover, through analyzing the type of habitat usage by different ages of various fish species (based on the length-based community structure model) two types of habitats have been found: i) Spawning and Nursery ground and ii) Feeding and Growing ground. Moreover, highest habitat suitability index has been observed in case of Sheola Khal at Chandpai. Shannon-Weiner index has also been observed to vary among 1st quarter of 2014, 2015 and 2016. The highest index has been found at Maidara-Passur Confluence (0.75). On the contrary, the lowest evenness has been found at Harbaria (0.57), although species evenness was more or less same for all the sampling sites. Maximum FSR is recorded at Sheola Khal at Chandpai and Mongla Point (n=4), while very low FSR at Chalna Point (n=2). Furthermore, a management initiative of banning the fishing activities especially in the downstream of the Passur River (inside the Sundarbans) is expected to be a major cause of the spatial and annual variation for both the evenness and richness of fish species. Fry and juveniles for fin fish were more widely distributed among the middle and lower stretches of the Passur River. Among these Bagda, Bele, Daitna and Paissa fishes were widely distributed among the sampling sites. Moreover, fry fish of Daitna and Paissa were found at Mongla Port, Loitta and Poma at Chalna Point; Bagda, Bata, Bele, Golda, Maya Chela and Paissa at Sheola Khal of Chandpai. Morover, brood female fish of Punti in Mongla and of Gulsha Tengra and Paissa in Harbaria have highly observed in this quarter. Fish species like Bele attains the maximum abundance among the migratory fish species. Two species, Poma and Pheksa showed long range of distribution. The highest productivity has

been found in Mongla-Passur River Confluence and the lowest in the Chalna Point, because of the abundance of fries which are not considered as the production. Moreover, more or less similar productivity has been observed in this 1st quarter of 2016 as compared to the 1st quarter monitoring of the year 2015 but less than that of 2014. The most frequently used gears are Ber Jal and Suti Jal in upper reach and Charpata Jal in lower reach of the Passur River. Furthermore, the total catch is lower in this monitoring year than that found in the second and even first monitoring year. The highest fish production has been found in the Gher of Kapasdanga and lowest in Gher of Chunkuri-2. However, no fish production has been found in case of Rajnagar because of soil dumping and creating impediment at the mouth of khal resulting from river restoration project of BWDB.

Agricultural resources monitoring data on crop area, crop production and crop damage have been collected from the selected five mauzas for the year of 2015-16. In addition, agricultural data also have been collected from the local DAE offices to know the existing situation of agricultural practices and crop production in the study area. Among five sample plots, HYV Aman (BR-23) is cultivated in Baranpara site while in other plots, local Aman (Baran) is being cultivated. In Kapalirmet and Chakgona sites, no agricultural activities have been observed during 2015-16 due to the adverse impacts of salinity. The highest production (1.9 tons) has been observed in monitoring plot-2(Chunkuri-2) and the lowest production (0.99 tons) has been observed in monitoring plot-5(Basherhula) during this period. According to the farmer of Baranpara plot, HYV Aman (BR23) has suffered this year due to water logging, resulting less yield. . It has also been observed that the crop production has slightly decreased from 2013-14 and has increased over 2014-15 in all the monitoring plots, except in Kapalirmet and Chakgona. No crop damage has been noticed in the monitoring plots in the year of 2015-2016. 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.

Sundarbans Forest Health Monitoring observed seven indicators (seedling density, Pneumatophore density, crab hole density, canopy cover, net canopy photosynthesis, basal area and soil properties) in third year first quarter and compared with previous findings. Forest health monitoring indicators are interlinked with each other and combinedly determine the health of a forest. After comparing the monitoring results, it can be predicted that the changing trend for almost majority of the indicators of forest health in SRF is related to seasonal variation. For example, seedlings density, Pneumatophore and canopy cover are found the highest and the lowest after and before monsoon period, respectively. However, basal area per hectare is being increased with time interval except some anthropogenic interventions. The indicators even show variation among the monitoring sites (PSPs) that could be due to different physical environment for respective locations. Hence, with a view to establish a baseline on Sundarbans forest health monitoring attributes, this survey should be continued.

Socio-economic Monitoring provided opportunities to study compensation, rehabilitation and resettlement, project related employment generation, labor and working condition, community health, safety and security, corporate social responsibility. First phase of compensation to the affected landowners has almost finished by the DC office, Bagerhat. Few landowners have not yet got compensation due to the inadequacy of land ownership documents that may be considered in the second phase. Eighteen households were found resettled in the Foyla Cluster village among which four households were left due to the lack of accommodation facilities and earning options. The inhabitants of the existing resettled households still feel insecure as they have not got the legal documents for their allotted houses and surrounding buffer area. It has been revealed that the number of local labors working in the Project are significantly less than the migrated labors. With the progress of

construction work, demand of skilled labors is increased. In this situation, the local people requested to give priority to them in employment opportunities during the recruiting processes. At present the Plant is in preliminary site preparation (pre-construction) phase and for the last few months, practically no works have taken place. Main activities at site for Power Plant construction will commence when EPC contractor will set in. Numbers of toilets including pucca, porta cabin type and RCC ring type have been seen at Project site for creating good sanitation facilities for labors and workers. Water treatment plant has been installed in the Project site. In terms of safety issues, labors are provided with safety equipments as per the requirement. In terms of skilled labor recruitment, contractors feel comfortable recruiting migrated labors (with whom they are working for years) rather than local labors. There should be provisions for prioritizing the employment of the local people in non-technical activities.

The labor and working condition(s) have been seen gradually improving as it was in the beginning of the monitoring program in early 2014. It should, however, be improved further to ensure the best possible working environment with allied facilities, as soon as the EPC contractor sets in. Emphasis should be on the labor hiring method for recruiting local labor, living condition including sanitation, proper ventilation, and occupational health safety issues. Almost similar types of diseases were observed in the study mouzas as the other unions of Rampal and Dacope upazila. For example, suffering from fatigue, headache, pain in lower abdomen, coughing, acidity etc. in females, and dysentery, coughing, fever etc. in males are found common in the community within the vicinity of the Project area. About 2,711 people received health facilities from the health camping of the Project authority during the last five months (Nov'15 - Mar'16), and this number has decreased a little compared to the previous six months (May, 2015 - Oct, 2016). The health camp offers free health consultation and provides medicine as per its availability.

1 Introduction

1.1 Background

1. This study report intends to accomplish the monitoring of the recommended different environmental and social parameters, and environmental compliance monitoring of pre-construction activities for this quarter (**1st quarter of 3rd year)** for the proposed 1320 MW Coal based Thermal Power Plant being constructed at Rampal, Bagerhat.

2. 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 Ltd. (BIFPCL).

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

4. 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 Sundarbans Mangrove Forest 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 preconstruction, construction and operation phase in order to minimize the negative impacts.

5. 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 under the Department of environmental health and safety. 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.

6. 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 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 will continue till early 2017 over a span of three (3) years.

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 23km south from the Khulna City and 14 km in the north-west direction from the Sundarbans. Location of the study area and their relative distance from various heritage sites are presented in Map1.1. The study area includes: i) area covering 10 km radius from the Plant location, ii) 10km strip from both bank of Passur and Sibsa rivers starting from the Plant site to Hiron point (**Map 1.2**).

8. The results of all the monitorings are reported quarterly to BIFPCL through monitoring reports. Eventually, BIFPCL submits these reports to DoE and Forest

Department. Accordingly, CEGIS has so far submitted eight (8) monitoring reports on quarterly basis. The current document constitutes **9th monitoring** report (i.e. monitoring activities of the **1st quarter of 3rd year**); the field study has been carried out in April 2016 covering Project monitoring locations, and the generated report upgrades the environmental monitoring database up to date.

1.2 Objectives

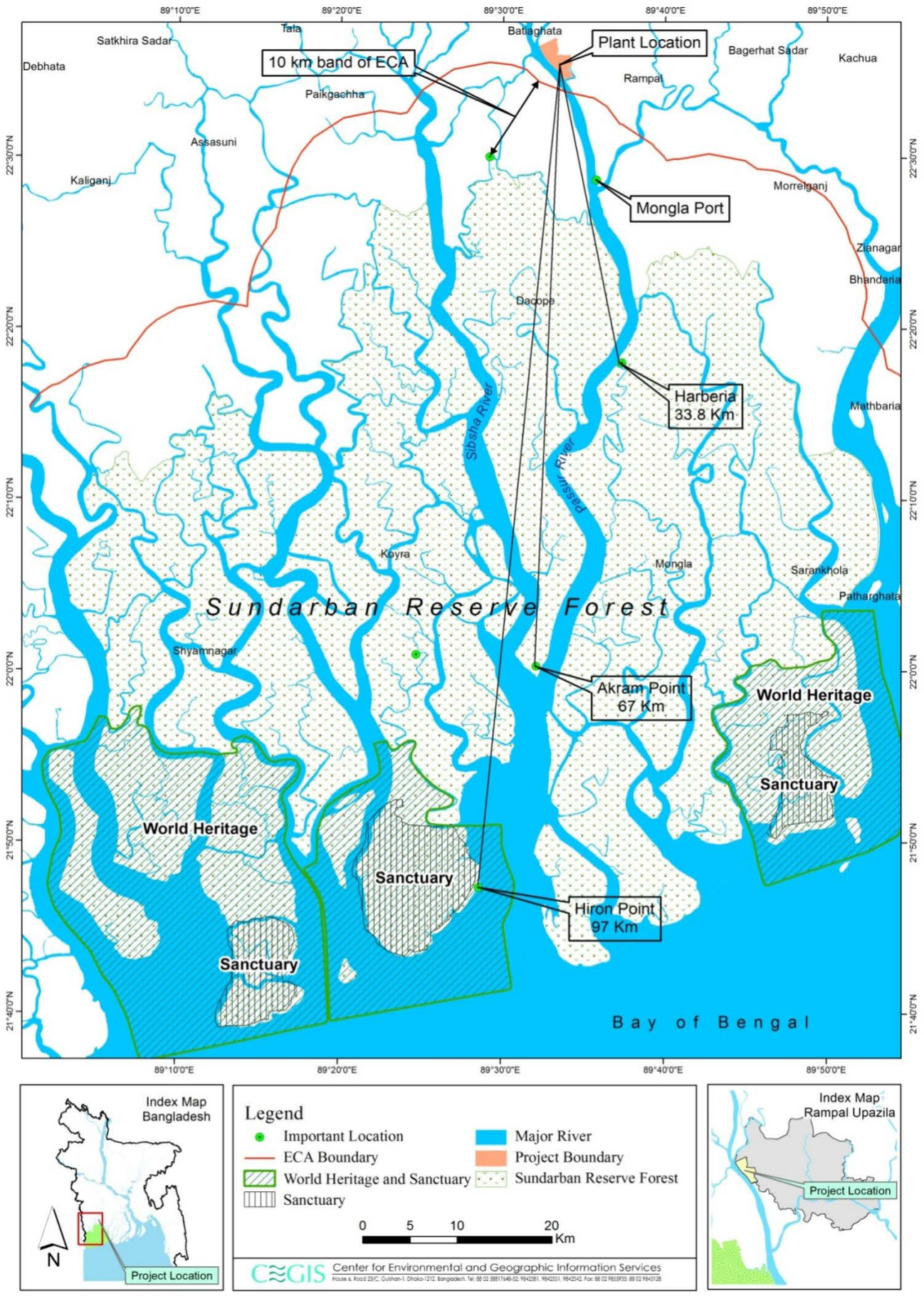
9. The overall objective is to monitor the environmental parameters and implementation of Environmental Management Plan (EMP) during pre-construction and construction phases of the installation of the Power Plant.

10. The aim of the quarter 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

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 are 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 are selected by considering the water sources likely to be impacted/polluted by the project activities.
- 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.
- Sundarbans forest health Monitoring locations (PSPs) have been selected in view of the potential access routes for Power Plant which may have impacts on Sundarbans Reserve Forest (SRF).



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

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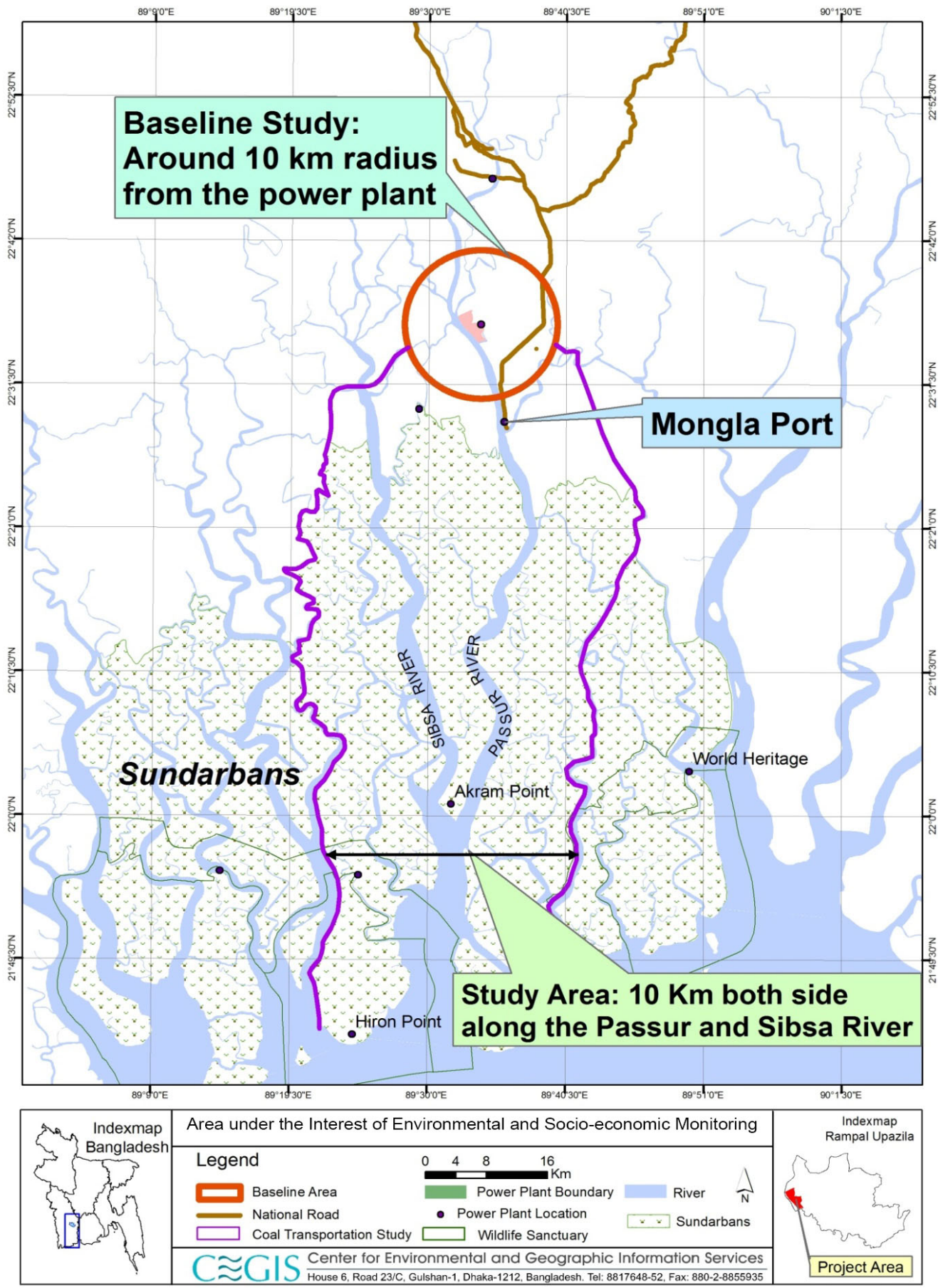


Map 1.2: Area under the Interest of Environmental and Socio-economic Monitoring

1.4 Main stakeholders

Forest Department

11. The monitoring of the study area includes some locations in Sundarbans that needs to comply to 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.

12. 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 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 condition.

13. The monitoring team has been formed as per the requirements of the Forest Department. BIFPCL also forwarded a copy of an 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 will also be forwarded to the Forest Department.

Department of Environment (DoE)

14. 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 is held with experts of DoE to finalize the monitoring plan at CEGIS office.

15. The BIFPCL forwarded the monitoring reports and data to the DoE regularly. In addition, the BIFPCL officials along with the study team members of the monitoring study visited DoE office to inform them the progress of the study. The monitoring report will also be presented to the Environmental Clearance Committee of the DoE during the renewal of the EIA approval.

Bangladesh India Friendship power company (Pvt.) Limited (BIFPCL)

16. 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)

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

Local Community

18. 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

In this study, the Physical, Biological and Social aspects would be 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, land resources and hydro morphology;
- Biological environment include fisheries resources, ecological resources, Sundarbans Reserve Forest (SRF) health conditions and agricultural resources; and
- Social aspect would be socio-economic condition and social safeguard.

2 Physical Environment

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

2.1 Air Quality

19. The ambient air quality has been monitored in this **1st quarter of 3rd year** at 11 (eleven) specific locations.

2.1.1 Methodology

20. Five (5) major air quality pollutants i.e., Particulate Matter ($PM_{2.5}$, PM_{10}, SPM), SO_X, NO_X, CO and O_3 expected to occur from the proposed Power Plant in the ambient air has been considered for monitoring in this study. The locations for monitoring have been selected during the EIA study. In this context, eleven (11) sites have been selected based on a number of criteria e.g., the sensitivity of the receptors, project activities like coal-carrying vessel movement, transhipment 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 SCREEN 3.0. has been used to select the location of potential pollutants which may be dispersed from the Power Plant.

Method of Sampling and Laboratory Testing

21. Respirable Dust Sampler (Model-Envirotech India APM-460BL) and Fine Particulate Sampler (Model-Envirotech India APM-550) have been used to collect the air sample. The $PM_{2.5}$, PM_{10}, and SPM have been tested by gravimetric method. The concentration of SO_2 has been tested by West-Gaeke method. Likewise the NO_2 has been tested by Jacob and Hochheiser method.

Monitoring locations

22. Ambient air quality 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 2.1.1**. The details of the monitoring plan have been provided in the **Table 2.1.1**.

Pollution Sources

Pollution sources at Project area

23. The major pollution sources currently contributing to the ambient air pollution along the Passur River in between the Project site and Mongla Port 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

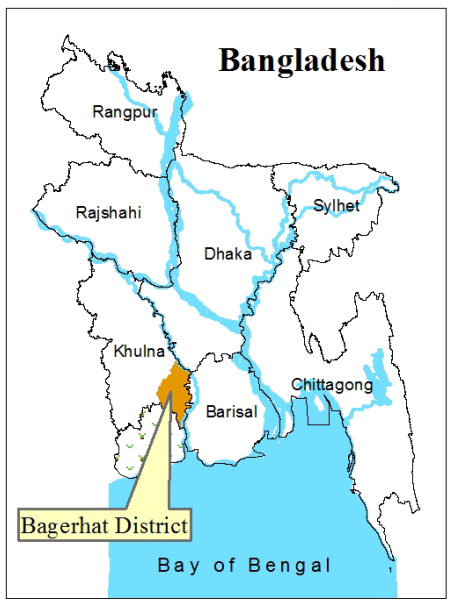
24. Mostly river traffic of Mongla Port travelling across the Sundarbans are the sources of Suspended Particulate Matter (SPM), Oxides of Sulphur (SOx), Oxides of Nitrogen (NOx) and Green House Gas (GHG).

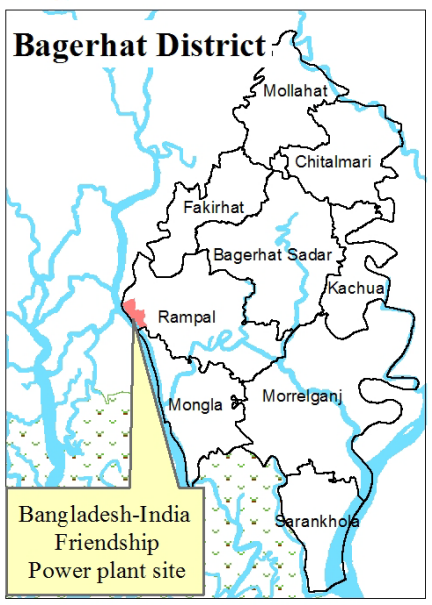
25. An inventory of the existing emission types and sources in the study area have been provided in **Table A.2** of **Appendix IV**.

Table 2.1.1: 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		

Index Map





Legend

- International boundary
- District boundary
- Upazila boundary
- National highway
- Regional highway
- Zilla road
- Upazila road
- Major river
- Plant site
- Sundarbans Reserved Forest
- ECA boundary
- District HQ
- Upazila HQ
- Range Office
- Location of air quality monitoring

Data sources:
National Water Resources Database (NWRD)
CEGIS archive
Monitoring of Khulna 1320 MW
CBTPP, BIFPCL

0 5 10 20 km

Map projection: Bangladesh Transverse Mercator (BTM)

Map prepared by:
CEGIS Center for Environmental and Geographic Information Services
June 2016

Map 2.1.1: Air Quality Monitoring Locations

2.1.2 Status of air quality

26. Air quality is expressed in terms of standards set forth for public health and welfare protection (against decreased visibility and damage to animals, crops, vegetation etc.). The current standards are listed below. Units of measurement for the standards are parts per million (ppm) by volume, parts per billion (ppb) by volume, and micrograms per cubic meter of air (µg/m^3).

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
		-	-	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	50 µg/m^3	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)

The values of $PM_{2.5}$ and PM_{10} have been found within the standard limit at each location. Among those locations, the maximum concentration of $PM_{2.5}$ (25 µg/m^3) is found in the Township area (Sapmari, Katakhali Mauza) and in Bajua Union area. Surprisingly, during this time of monitoring, PM_{10} and SPM have been recorded unusually high (117 µg/m^3 and 332 µg/m^3 respectively) in the South-West corner of the Project boundary (Passur-Maidara confluence) which might have been due to the stormy weather prevailing at the sampling site. The SPM is also noted higher (268 µg/m^3) at Barni, Gaurambha than the standard. Large number of two-strokes human hauler, small engine boats and the anthropogenic activities are the possible sources of SPM. Cement industries, road traffic and ongoing dredging operation of Mongla Port Authority in Passur River might be the sources of SPM. All the monitoring data are given in **Table A.1** in **Appendix IV.**

Sulphur Dioxide (SO_2)

27. Concentration of Sulphur dioxide in the ambient air is found within the Bangladesh standard limit of *455 µg/m^3 for 8 hours (calculated)*. The SO_2 values in and around the Project ranged between 9 and 20 µg/m^3. SO_2 concentration is measured in the Sundarbans reserve forest; the result indicates a moderate condition ranging from 9 to 15 µg/m^3.

Nitrogen Dioxide (NO_2)

28. NO_2 concentration in the ambient air of Sundarbans ranged between 14 and 25 µg/m^3. In Project site and its adjoining areas, the values are found higher but still within the

Bangladesh standard limit of *405 µg/m^3 for 8 hours(calculated)*. The monitoring results are shown in **Table A.1** in **Appendix IV**.

Carbon Monoxide (CO)

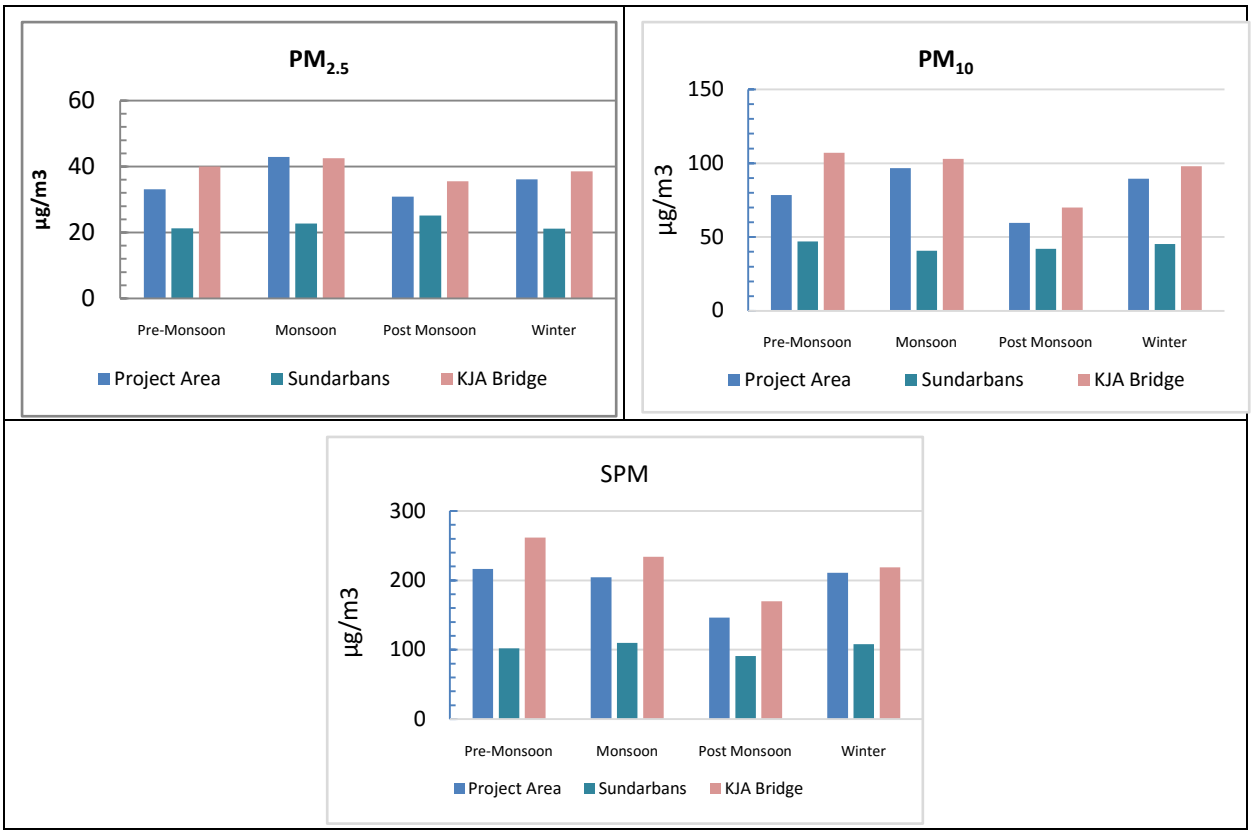
29. CO concentration is 22 - 73 µg/m^3 in and around Project area. The possible causes for the CO concentration could be the big ship's anchorage beside the sampling point and for the loading-unloading activity , the concentration in the Sundarbans ranges between 21 and 47 µg/m^3. The values are found very insignificant in the context of national standard (*10,000 µg/m^3 for 8 hours*).

Ozone (O_3)

30. Similarly, results of O_3 both in the Sundarbans and Project area are lower (0 - 2 µg/m^3) than the Bangladesh standards of *200 µg/m^3 for 8 hours*. 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

31. All the air pollutant data satisfactorily comply with the national standards except the values of SPM especially for dry season (i.e. winter and pre-monsoon) (**Figure 2.1.1**). This issue, however, is not a major concern for the ecosystem of Sundarbans.



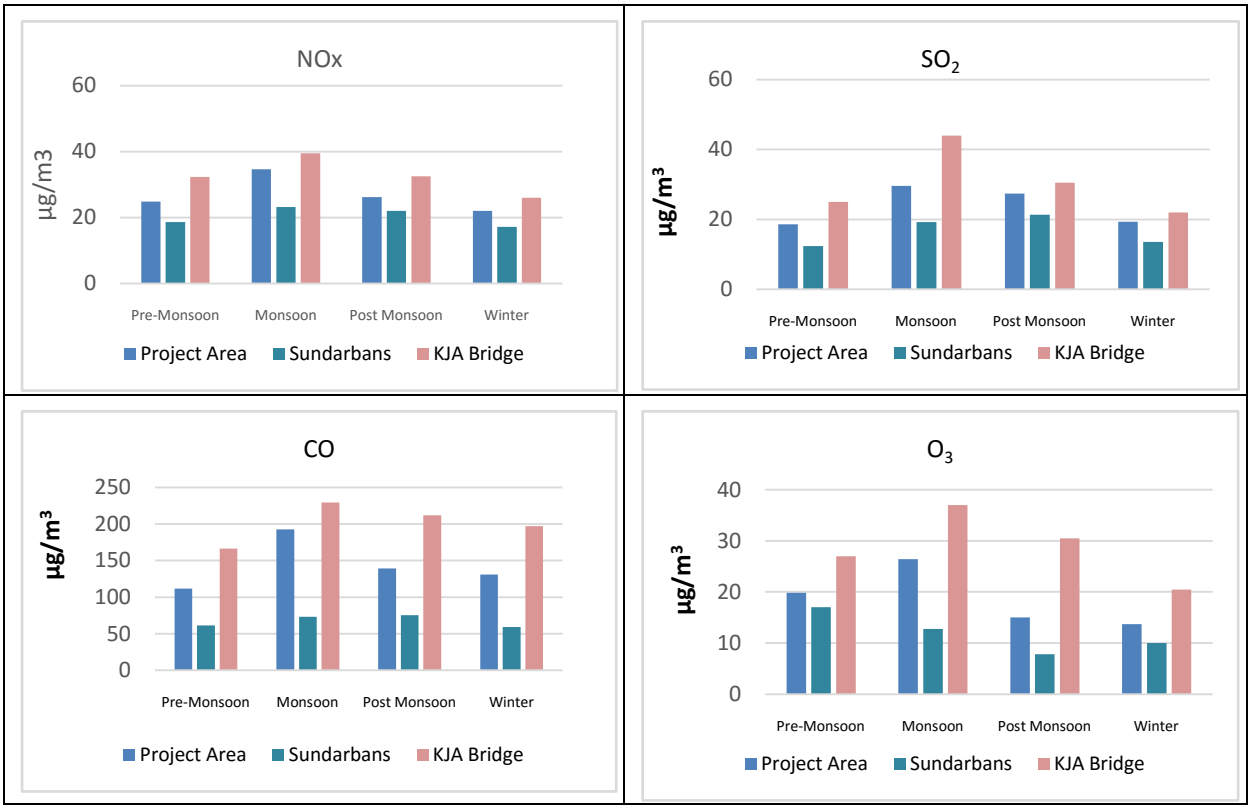


Figure 2.1.1: Seasonal variation of the Air Quality Parameters

2.2 Noise

32. 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.

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

34. In this **1st quarter** monitoring **of 3rd year**, the noise level has been recorded in pre-monsoon period.

35. 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.

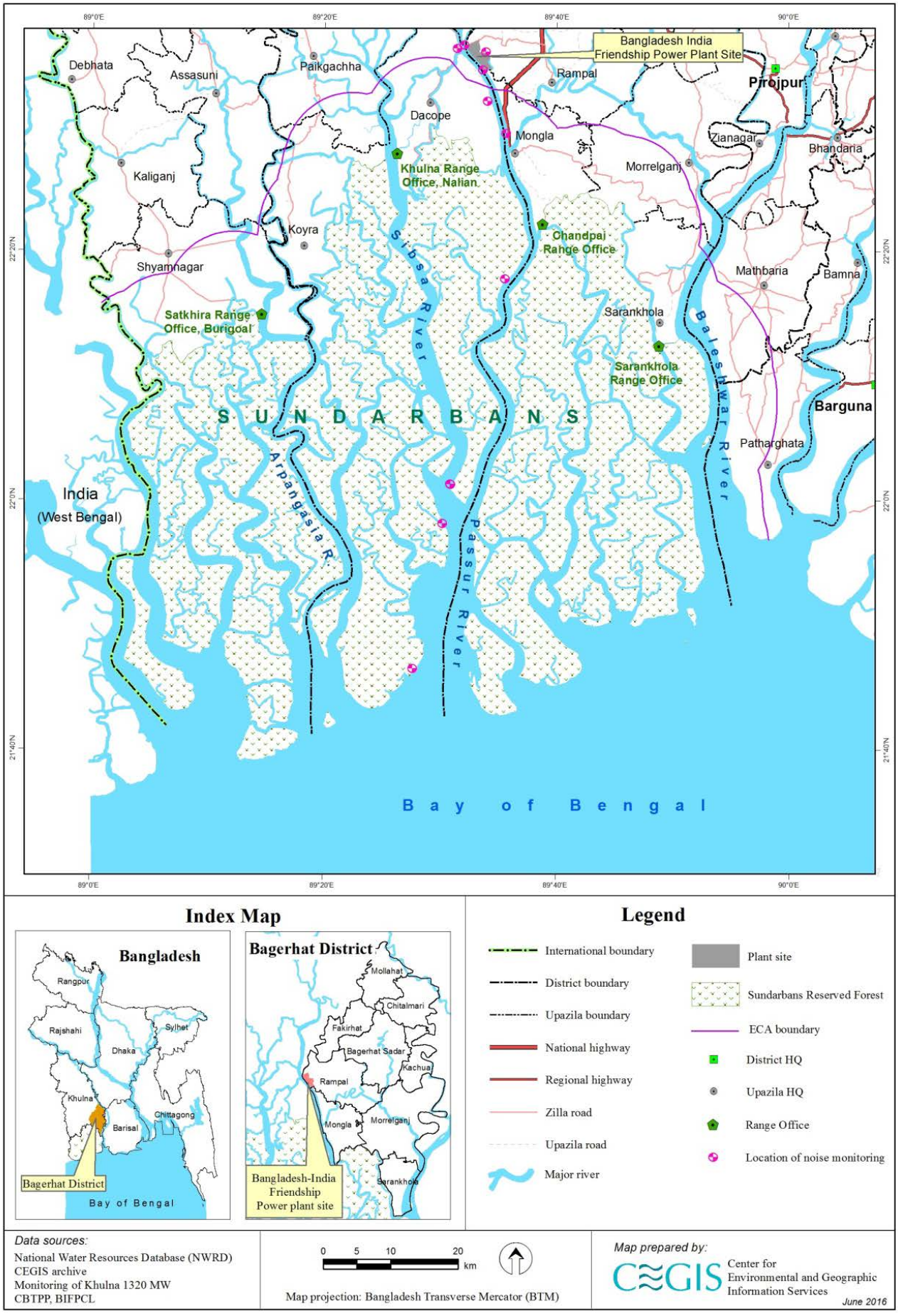
2.2.1 Methodology

36. 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

37. There are eleven (11) locations for the noise level monitoring. 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 2.2.1**).

Photo 2.2.1: Professional conducting an ambient noise acquisition survey



Map 2.2.1: Noise Level Monitoring Locations

2.2.2 Status of Noise

38. The brief summary of Noise level data is appended in the **Table 2.2.1**; 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

39. 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 66.07 dB which is below the Bangladesh standard (**Table 2.2.2**).

40. 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 Corner of the Project Area

41. 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 nearby 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 50.79 dB, which is nearly similar to the day time standard value.

Chunkuri-2, Bajua

42. 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). Noise levels in two consecutive years are found abrupt and fluctuating around the day time. During this time (April, 2016), it is found to be 44.49 dB which is below the standard. 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

43. The South West corner of the Project area [89.5601°E, 22.5761°N] is in Sapmari, Katakhali mauza of Rajnagar union. This area is residential and the standard is 55dB (A) at day time (ECR, 1997). The noise level is found slightly lower (54.50 dB) than the standard. Frequent movement of water vessel is the main reason for the exceedance of the standard.

Proposed township area of the Project

44. The proposed township area [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). Compared to the previous quarterly monitoring data collected in the 1st monitoring year, the noise level of the last couple of quarters is found slightly higher (above 53 dB) due to accelerated construction works in the area but within the day time standard.

Barni, Gaurambha

45. 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 levels are found lower (53.97 dB) than the standard limit. There are lots of commercial activities increasing continuously, the ambience is becoming noisier due to these commercial activities (bazaar, local traffic, crowd etc.). The traffic load is higher than most of the past which has also accelerated the increase of the noise level.

Khan Jahan Ali Bridge, Khulna

46. 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 is found 65.85 dB which is below the standard of day time. The highway traffic is the main source of noise. The highest noise level has been recorded both in the morning and evening due to higher traffic load.

Mongla Port area

47. 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 is found lower (49.88 dB) than the standard.

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

Harbaria, Sundarbans

49. 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 are used to anchor at this site for lighterage 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 is 44.55 dB measured 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 is found to be almost equal to the day time standard value.

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

Akram point, Sundarbans

51. Akram Point of the Sundarbans is another biodiversity hot spot in the Sundarbans. This area has been 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 is recorded at about 100m inside the forest from the river bank to avoid noise from wave breaking. The average day time ambient noise level during this monitoring period is found to be 42.95 dB which is within the standard . Birds' chirping, stormy wind, wave and tree leaves are the main sources of noise here.

Hiron Point, Sundarbans

52. This noise sampling location [89.4614° E, 21.7755° N] falls under the demarcated area of World Heritage Site. Noise level is 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 has been recorded around 43 dBA at this area throughout the year except in the winter while it goes below 40 dBA. Sound of sea shore, wind blow, creeping of birds and small mechanized sea going boat might be responsible for the present noise level.

Table 2.2.1: Summary of the ambient noise recorded in consecutive 9 Quarter monitoring sessions in 2014, 2015 & 2016

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	Std*
1	**Chalna, Dacope**	68.13	52.87	54.63	53.28	57.08	49.77	65.12	66.07	65.08	*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	*55*
3	**Chunkuri-2, Bajua**	57.76	52.55	51.39	49.29	47.05	40.66	47.43	53.62	44.49	*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	*55*
5	**Proposed Township area, project site**	48.75	46.68	41.92	41.47	41.47	46.75	50.52	53.77	53.37	*55*
6	**Barni, Gaurambha**	58.84	49.95	49.78	43.6	54.17	46.18	55.16	59.16	53.97	*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	*70*
8	**Mongla Port area**	61.24	53.84	60.5	38.69	48.15	39.61	47.01	52.7	49.88	*75*
9	**Harbaria, Sundarbans**	40.88	56.13	55.3	34.38	65.37	35.03	50.75	45.2	44.55	*50*
10	**Akram Point, Sundarbans**	40.94	47.9	43.98	34.32	54.86	*NM*	49.6	42.95	42.95	*50*
11	**Hiron Point, Sundarbans**	38.63	51.29	47.98	37.37	47.84	*NM*	46.06	*NM*	43.11	*50*

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

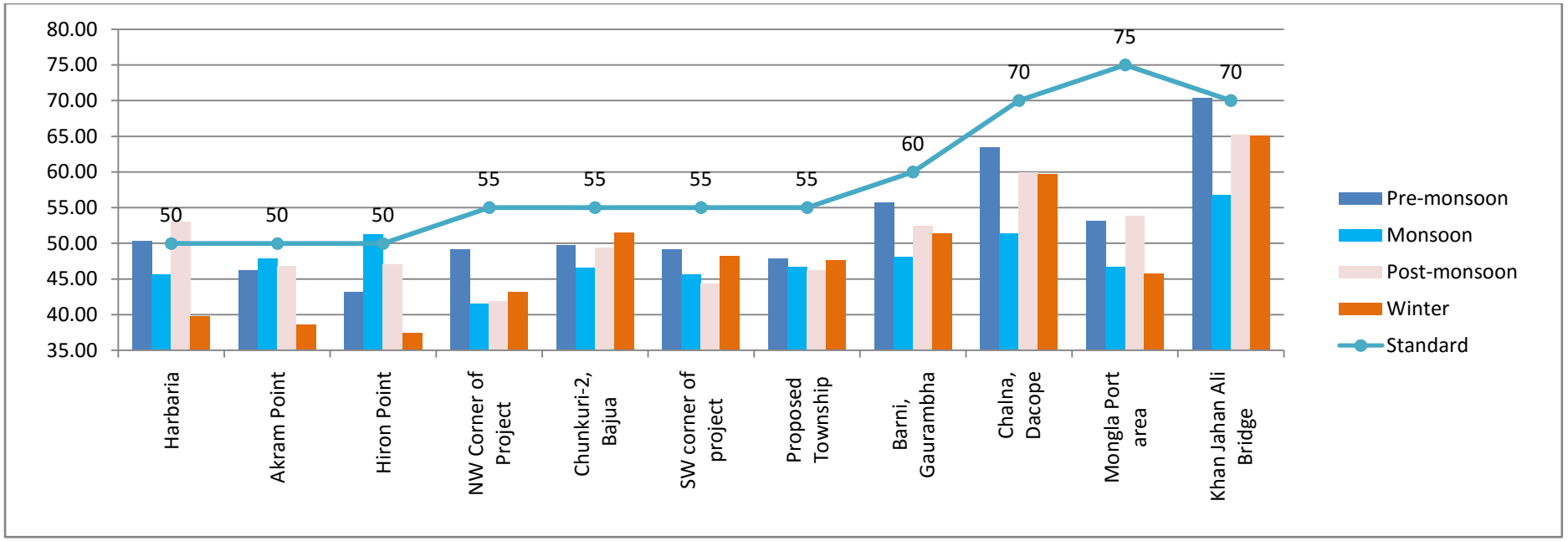


Figure 2.2.1: Seasonal variation of Noise level at different

2.2.3 Findings

53. The overall observation is that mostly the noise generation sources are natural in the Sundarbans and anthropogenic i.e. traffic and local vehicles in the other locations. Nevertheless, all the average day time noise level data are relatively closer or within the standard limits (**Figure 2.2.1**). In the Sundarbans, noise level has been found within the threshold at all the sampling points during this monitoring period (April, 2016).

2.3 Water Quality

54. 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 analysing methodologies has been adopted followingboth the national and international guidelines. A systematic sampling design has also been adopted in order toemphasize the multiple lines of evidence of the water quality.This report includes thein-situ water quality data collected duringthe **1st quarter of 3rdyear** (9th program) and the available laboratory data obtained up to January 2016.

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

56. The samples collected for the 8thmonitoring program (in January, 2016) have been analysed for the specific parameters which is included in this report and the data of the recently collected samples (April, 2016) will be reflected in the next 10th Monitoring report due to timing of laboratory analysis.

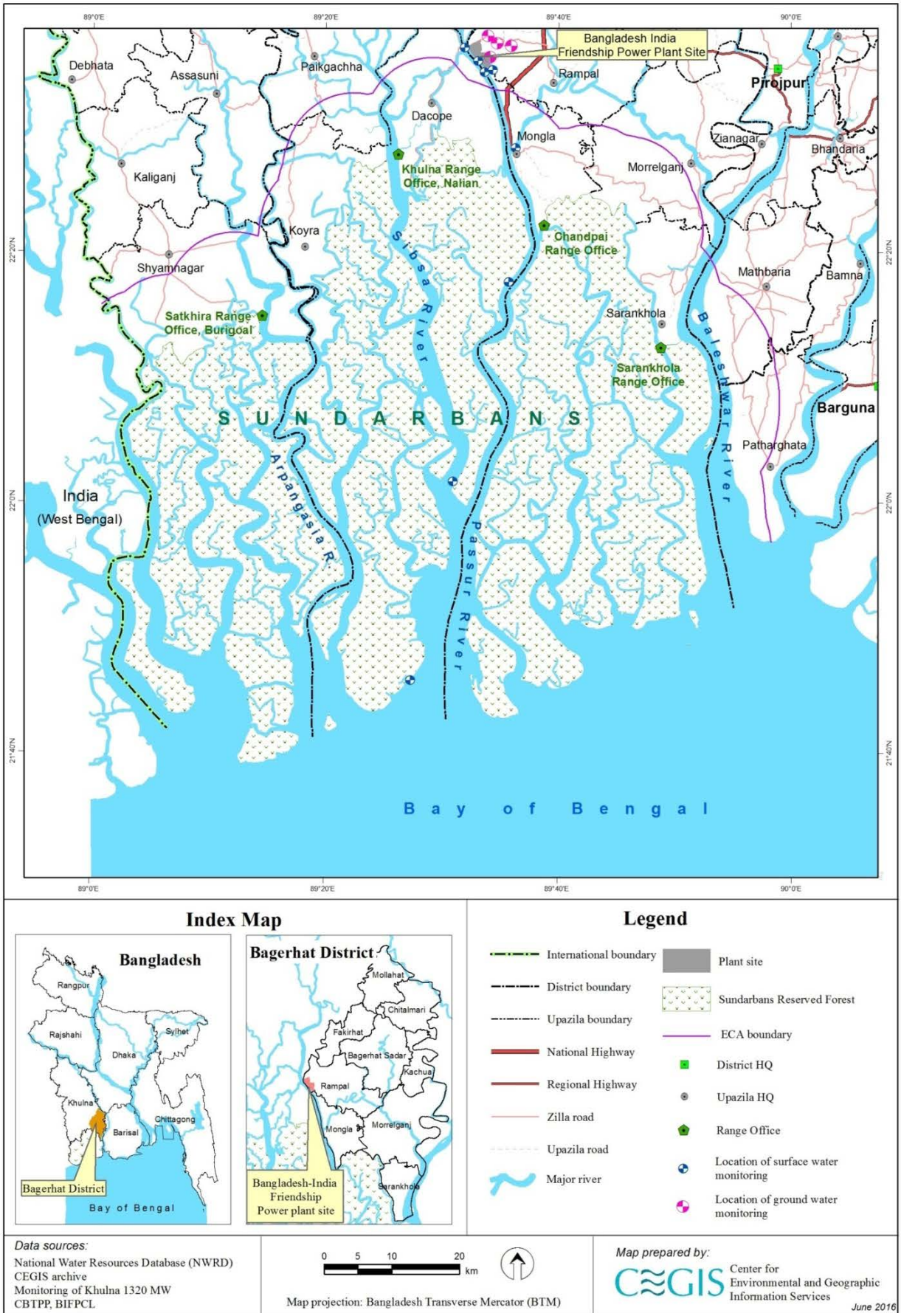
2.3.1 Methodology

57. 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 analyse 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).

58. The samples have been collected from the 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 9th monitoring program as shown in the **Map 2.3.1**. One tube well, once used for collecting groundwater sample, has been found damaged near Kalekarber from the 3rd monitoring program; hence the site has not been monitored since then. These sampling locations are 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 2.3.1** and for groundwater in **Table 2.3.2**.

Table 2.3.1: 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 2.3.1: Surface water and Ground water Quality Monitoring Locations

Table 2.3.2: 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

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

Photo 2.3.1 Professional assessing Dissolve Oxygen

Surface Water Sampling Procedure

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

Groundwater Sampling Procedure

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

Photo 2.3.2: Assessing Water pH

Parameters tested for water quality

62. 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

63. 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

64. The parameters for ground water quality includes Dissolved Oxygen (DO), Chemical Oxygen Demand (COD), Heavy Metals (As, Pb, Hg), pH, Salinity, Hardness, Nitrate (NO_3), Total Dissolve Solids (TDS), Total Hardness (TH) and Temperature.

Water quality analysis procedure

65. The collected samples of selected water quality parameters are analyzed as per the procedure of American Public Health Association (APHA) standard**.** The analysis procedures along with the standards have been appended in **Table 2.3.3.**

Table 2.3.3: Testing Methodology of Water Quality Parameter

Parameters	Methods/Measuring Tools	Unit	BD Standard (ECR 1997)
Temperature	Thermometer	^{0}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^{0}C	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
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	ppm or mg/l	0.05

Parameters	Methods/Measuring Tools	Unit	BD Standard (ECR 1997)
	Vapor Generating (AAS-HVG)		
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

66. During this period of monitoring pH values ranged between 7.1 - 7.9 among all the sites. The highest value is found in Passur River at Akram point of Sundarbans while the lowest value is observed in the Middle of Passur River at South West corner from the Project boundary and Maidara River of the South East corner of the Project at Ichamoti-Maidara confluence. The results show close conformity among all the locations and to the monitoring results of the same period of previous years.

67. Seasonal variation is observed in pH values of the Passur-Sibsa RS (River system). According to the eight consecutive quarterly monitoring results, pH values of pre-monsoon and monsoon seasons are 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 from u/s flow 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).

68. No significant pH differences are observed except spatial variation in the river water. Seasonal variations in pH among the selected monitoring locations during first and second year quarterly monitoring of Passur-Sibsa RS are presented in **Figure-2.3.1** and all the observed dataset are attached in **Table B.1** of **Appendix- IV.**

(b) Temperature

69. Recent monitoring results of temperature show close conformity with the previously monitored values in the same season of 1st year. The latest values vary from 30.1 ^{0}C to 31.5 ^{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. But all the observed values are found to be within the BD standard (20^{o}C-30^{o}C).

70. 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-2.3.2** and all the observed dataset are attached in **Table B.2** of **Appendix- IV**

(c) Salinity

71. The observed salinity values vary from 6 ppt to 14 ppt during this monitoring period and the maximum value is observed at Hiron point while the minimum value has been

recorded in Left Bank of Passur River at Project site-Jetty and in Passur Mongla confluence.. Noteworthy that the salinity of Passur River at Akram point and Hiron point has always been found higher than the other locations in any season as these are nearer to the sea.

72. During this monitoring period fresh water flow from upstream was found negligible and thus the tidal inflow acts as a dominant factor in increasing the salinity level. Similar results were found for the same seasons in the previous years.;salinity was found to be zero in Passur River from project site to Harbaria during post monsoon of 2014 and monsoon and post-monsoon of 2015. This might be due to excessive rainfall and fresh water flow from upstream. The highest average values are found in pre-monsoon season of the both years.

73. Water salinity data at the selected sampling stations of Passur-Sibsa RS of nine consecutive periods are presented in **Figure: 2.3.3** and all the observed dataset are attached in **Table B.3** of **Appendix- IV.**

(d) Dissolved Oxygen

74. DO concentrations were found to be slightly lower (5.8 and 5.9 mg/L) than the standard limit (6 or more) in project site jetty, township area and in Mongla-Passur confluence respectively. Higher temperature results in increasing molecular activity of aquatic organisms which in turn decrease the amount of DO in water. In addition, the concentration may decrease due to the discharge of untreated sewage, partially treated sewage, organic discharges, and anoxic discharges. On the contrary the highest amount (7.1 mg/L) was recorded in Passur River at Hiron point of Sundarbans which is also evident in the last monitoring periods.

75. It may be mentioned that the Maximum concentrations are observed during monsoon and post monsoon than the other two seasons. These higher values of DO in the upstream stations could be due to DO enriched inland freshwater input through the river.

76. Seasonal variations of DO at the monitoring sites of Passur-Sibsa RS are shown in **Figure: 2.3.4;** all the observed dataset are attached in **Table B.4** of **Appendix- IV**.

(e) Biochemical Oxygen Demand (BOD_5)

77. The BOD_5 values ranged from 2.4-3.6 mg/L. Maximum value of BOD_5 is found at the Left Bank of Passur River at Project site-Jetty.while. the lowest (2.4 mg/L) value is observed at Passur river at Hiron point of Sundarbans

78. When BOD_5 levels are high, dissolved oxygen (DO) levels decrease because the oxygen that is available in the water is being consumed by the bacteria (Sawyer et al., 2003) in the water. All the recorded values have showed this general trend and are found within BD standards at all the stations except at Right Bank of Passur River at South West corner from the Project boundary which is observed to be 6.5 in first year during pre-monsoon season. 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.

79. 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.

80. The measured BOD_5 values at different monitoring locations during the monitoring of Passur-Sibsa RS are presented in **Figure: 2.3.5** and all the observed dataset are attached in **Table B.5** of **Appendix- IV.**

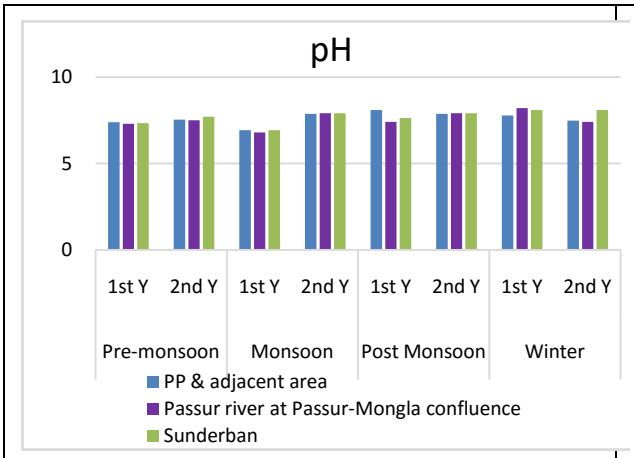


Figure 2.3.1: Variations in average pH values in sampling spots for the consecutive seasons

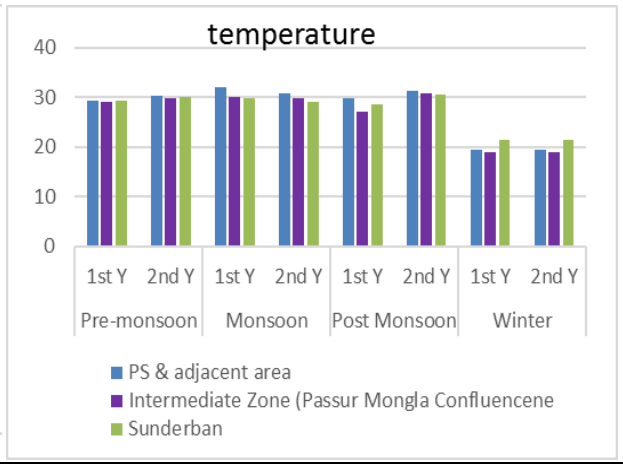


Figure 2.3.2: Variations in average temperature values in sampling spots for the consecutive seasons

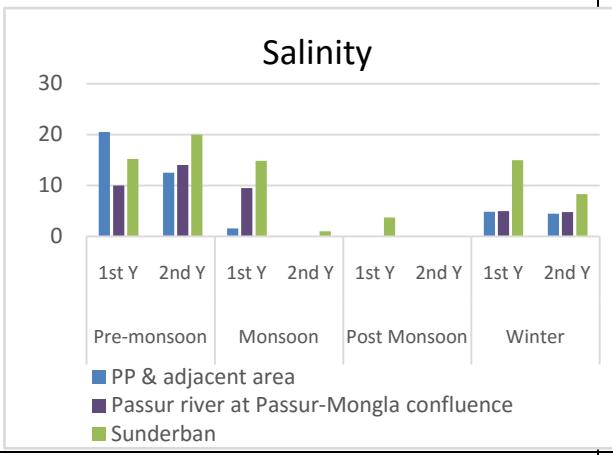


Figure 2.3.3: Variations in average salinity values in sampling spots for the consecutive seasons

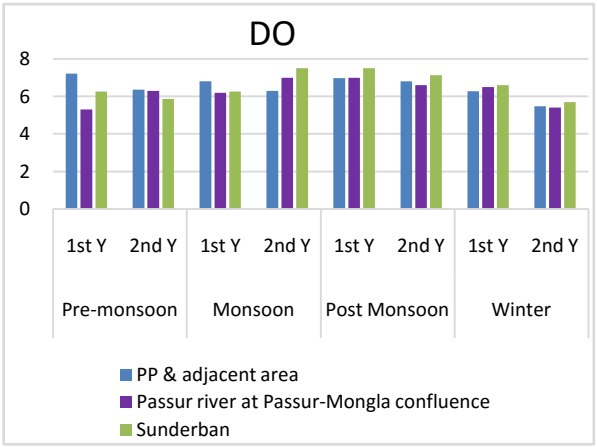


Figure 2.3.4: Variations in average DO values in sampling spots for the consecutive seasons

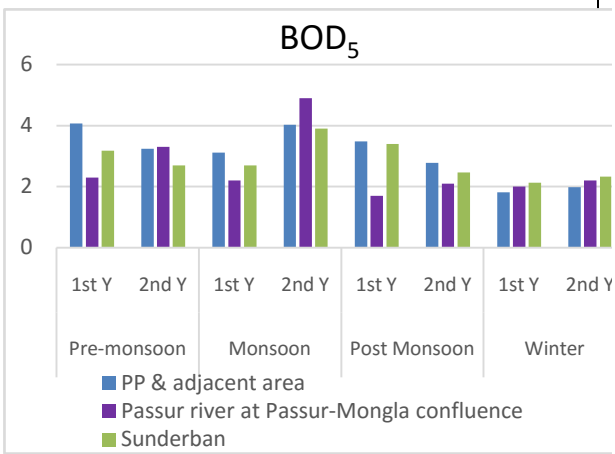


Figure 2.3.5: Variations in average BOD_5 values in sampling spots for the consecutive seasons

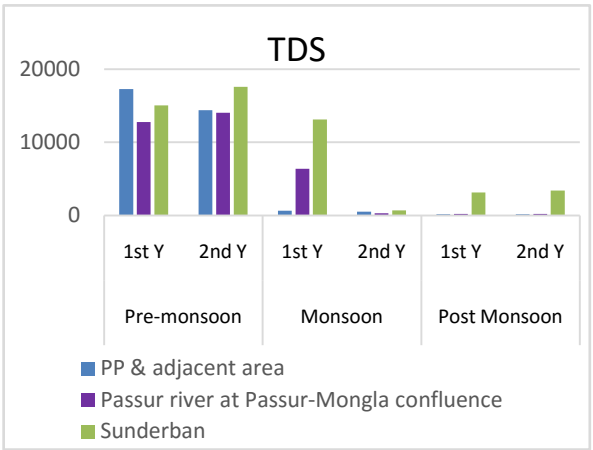


Figure: 2.3.6 Variations in average TDS values in sampling spots for the consecutive seasons

Laboratory tested parameters

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

81. The observed values of TDS vary from 4420 mg/L to 13330 mg/L which shows a little proximity to that of the previously obtained data of the same season of 2014. However, the highest concentration is found in Passur river at Akram point while the lowest value is recorded in Maidara river near township area.

82. The results revealed a moderate level of TDS concentration in the samples as per Bangladesh and WHO (1000 mg/L) standards (ECR, 1997 and WHO, 1993 and 2007). 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).

83. The values of Total hardness are found slightly higher than the previous results found in winter, 2014. In this season, tidal inflow is dominant comparing to the upstream flow. Therefore, the water becomes harder in this season. However, the highest and lowest concentration are found to be 950 mg/L and 2850 mg/L and observed in Ichamoti-Moidara confluence and in Passur River at Akram point respectively. During the rainy season, the hardness in all monitoring stations in Passur River are found to be lower whereas it is found remarkably higher in pre-monsoon season. Because, 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). However, the fresh water sometimes lowers down the amount of hardness in post-monsoon and monsoon period. It is also observed that in Akram point and Hiron point of the Sundarbans the TH values always found higher than those of other monitored locations. This is because the locations are nearer to the Bay of Bengal than all the monitored sites.

84. 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. During the last monitoring period The TSS concentrations vary from 7mg/L to 22 mg/L among the monitoring locations. The highest value is found in Passur river at Harbaria while the lowest value is found in Middle of Passur River at South West corner from the Project boundary.However, TSS values in every spots are found to be within the standard limit (150 mg/L) suggested for Bangladesh (ECR, 1997) inland fresh water.. The values are 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. In Mongla-Passur confluence the concentration is very high which could be due to the heavy load of marine vehicles, and Mongla Port Authority's development work, and most importantly the domestic and industrial runoff from the adjacent areas.

85. 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: 2.3.6, 2.3.7** and **2.3.8** respectively and all the observed dataset are attached in **Table B.8** of **Appendix-IV**.

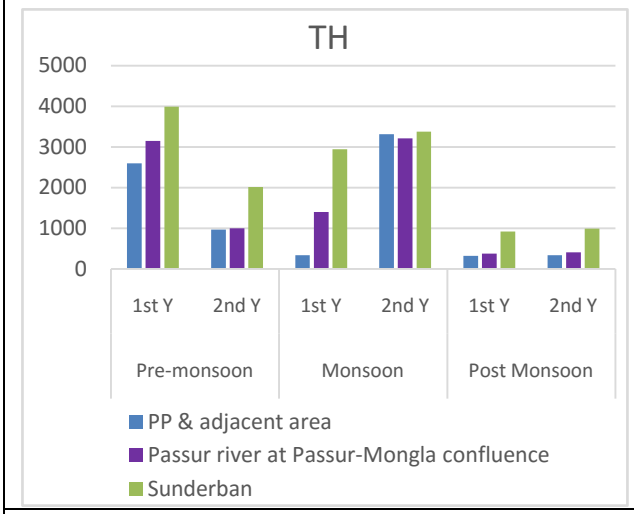


Figure 2.3.7: Variations in average TH values in sampling spots for the consecutive seasons

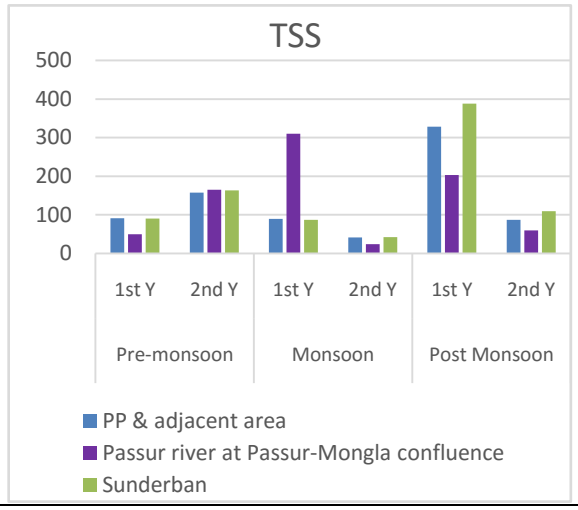


Figure: 2.3.8 Variations in average TSS values in sampling spots for the consecutive seasons

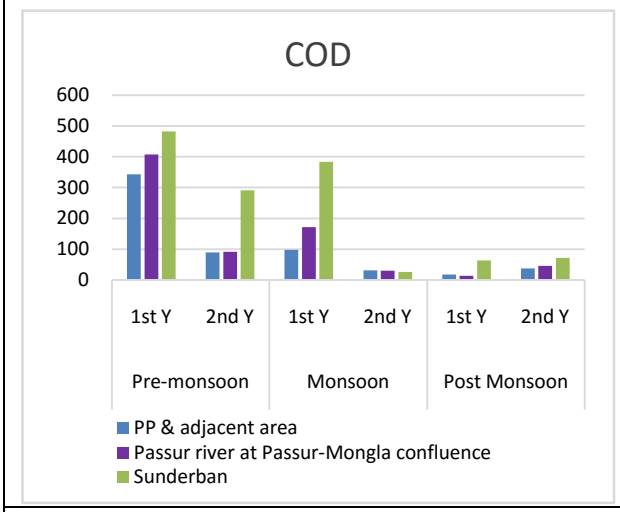


Figure 2.3.9: Variations in average COD values in sampling spots for the consecutive seasons

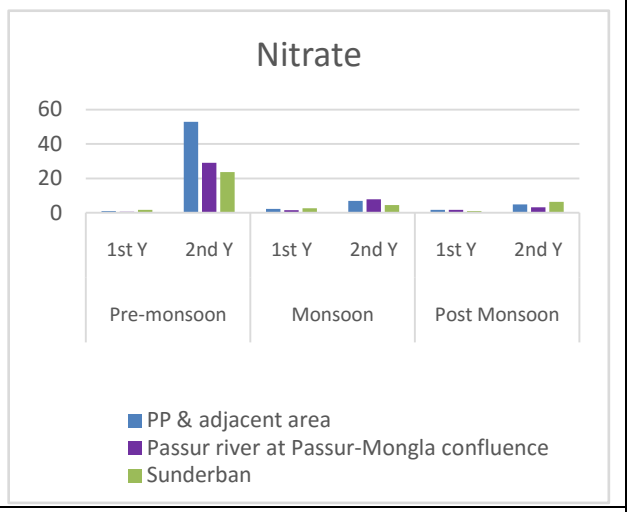


Figure 2.3.10: Variations in average Nitrate values in sampling spots for the consecutive seasons

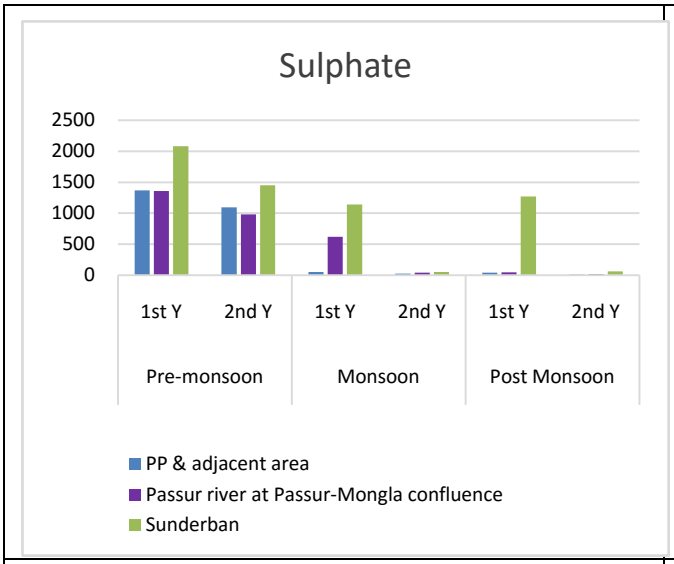


Figure 2.3.11: Variations in average Sulphate values in sampling spots for the consecutive seasons

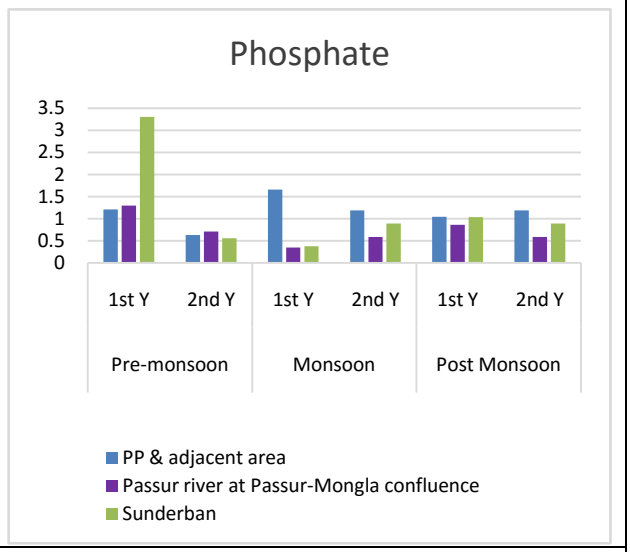


Figure 2.3.12: Variations in average Phosphate values in sampling spots for the consecutive seasons

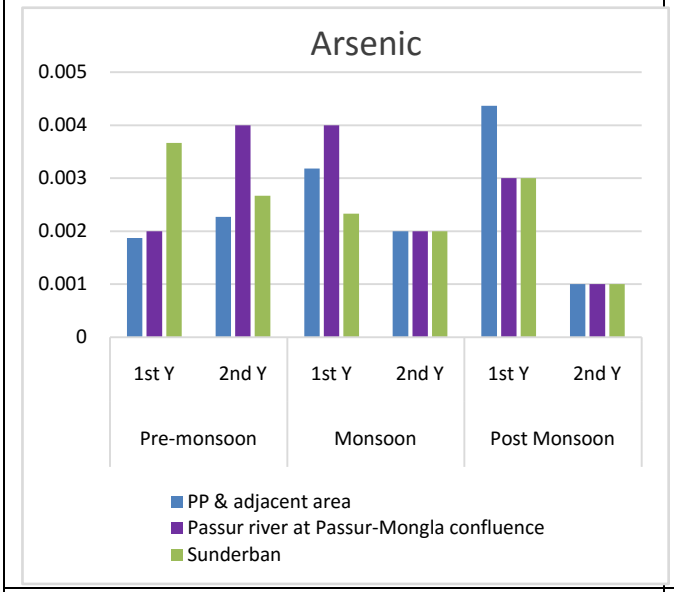


Figure 2.3.13: Variations in average Arsenic values in sampling spots for the consecutive seasons

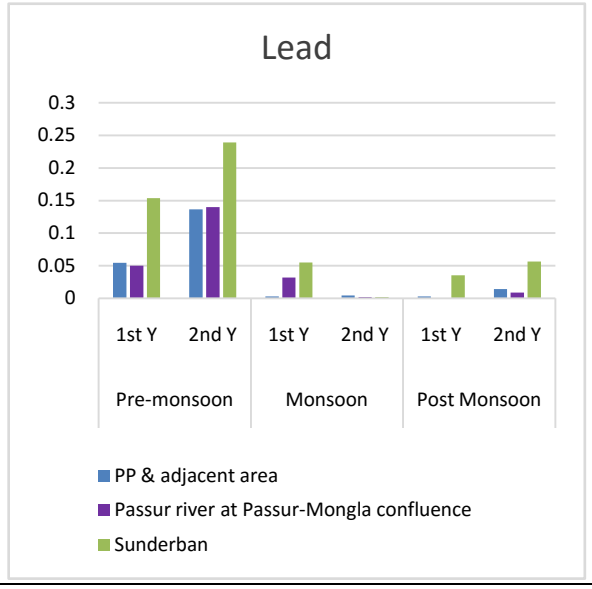


Figure 2.3.14: Variations in average Pb values in sampling spots for the consecutive seasons

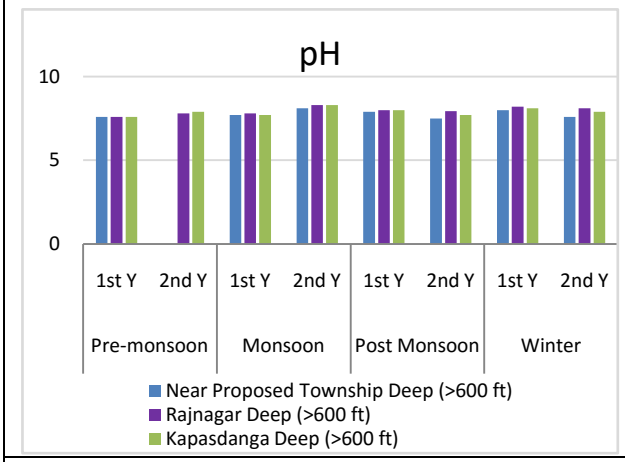


Figure 2.3.15: Variations in average Ground water pH values in sampling spots for the consecutive seasons

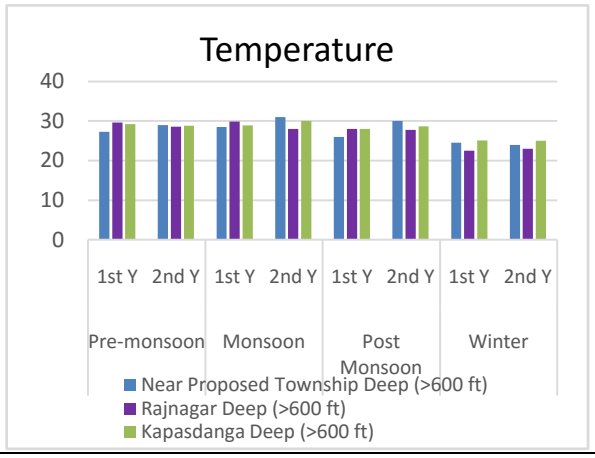


Figure 2.3.16: Variations in average Ground water Temperature values in sampling spots for the consecutive seasons

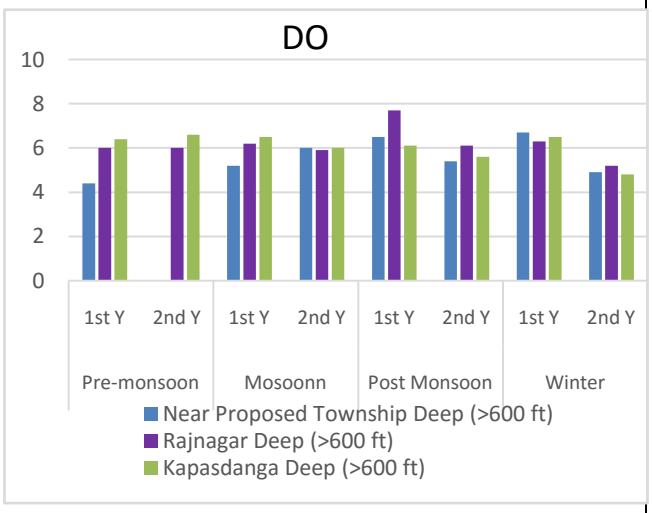


Figure 2.3.17: Variations in average Ground water DO values in sampling spots for the consecutive seasons

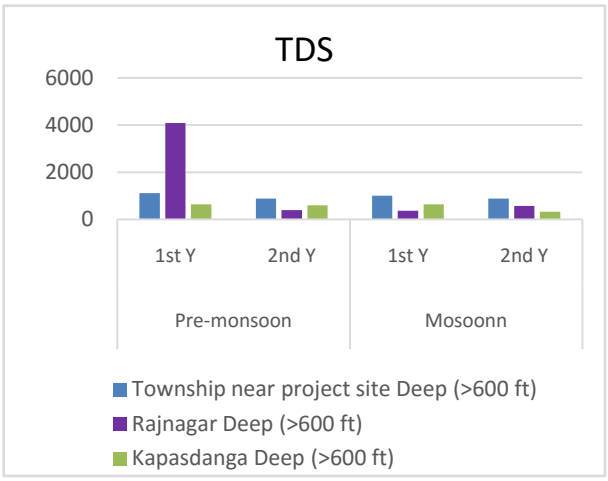
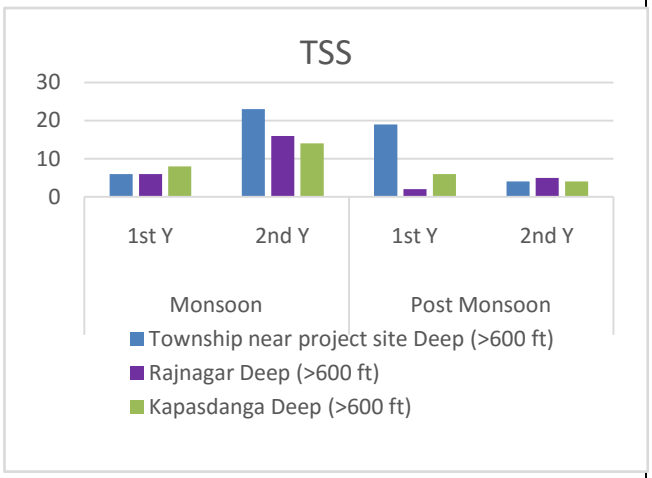


Figure 2.3.18: Variations in average Ground water TDS values in sampling spots for the consecutive seasons



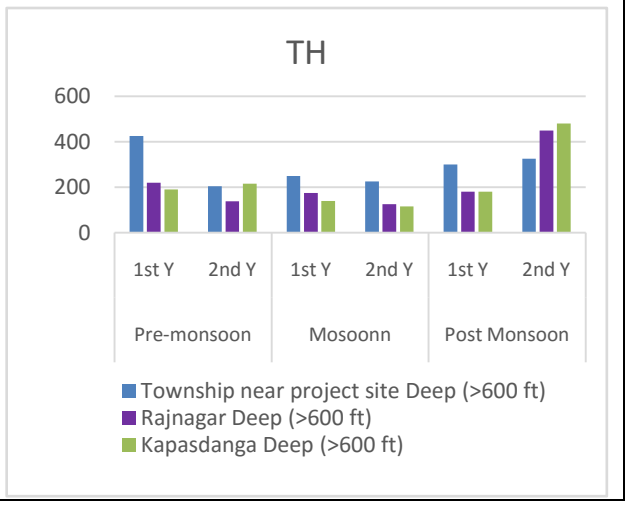


Figure 2.3.19: Variations in average Ground water TSS values in sampling spots for the consecutive seasons

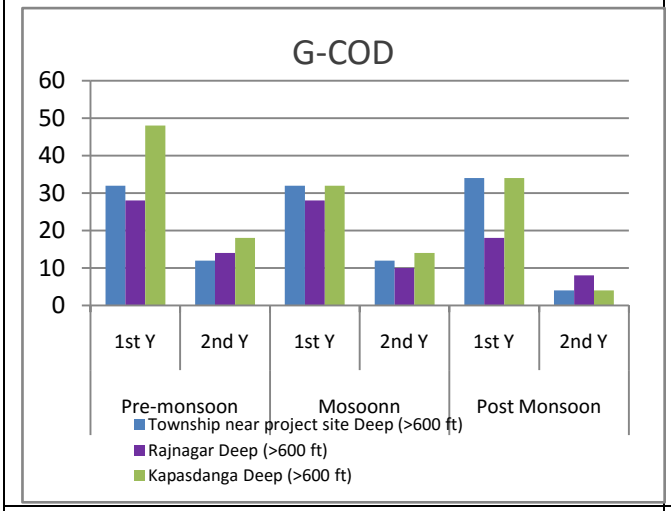


Figure 2.3.20: Variations in average Ground water TH values in sampling spots for the consecutive seasons

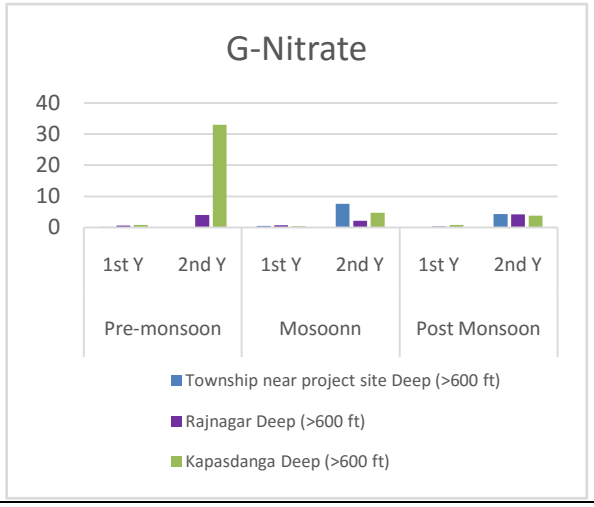
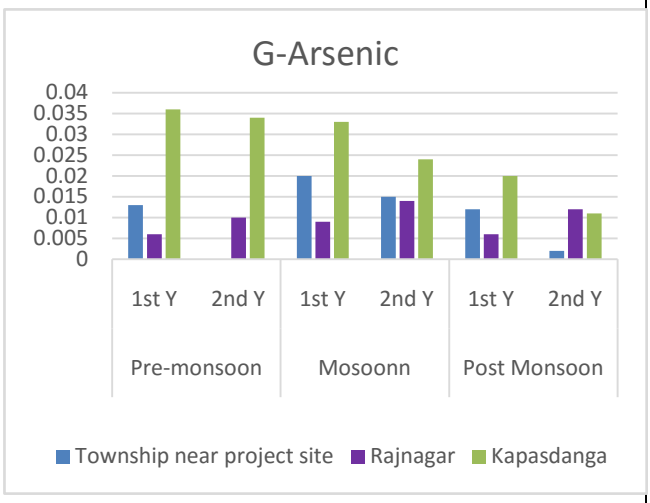


Figure 2.3.21: Variations in average Ground water COD values in sampling spots for the consecutive seasons

Figure 2.3.22: Variations in average Ground water Nitrate values in sampling spots for the consecutive seasons



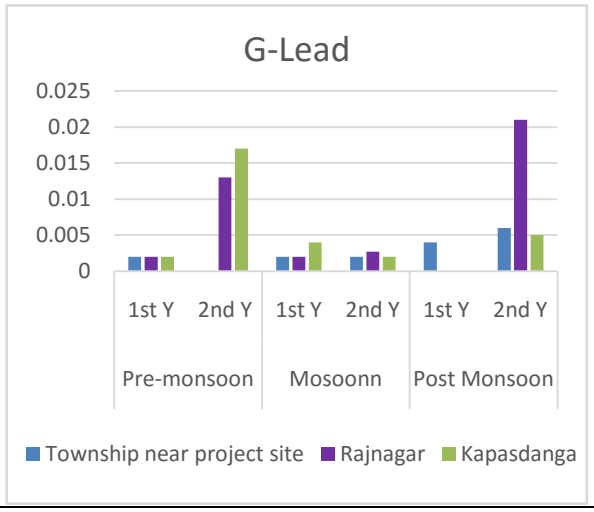


Figure 2.3.23: Variations in average G-Nitrate values in sampling spots for the consecutive seasons

Figure 2.3.24: Variations in average G-Nitrate values in sampling spots for the consecutive seasons

(b) Chemical Oxygen Demand

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, COD found to be 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. The observed values vary from 80 mg/L to 124 mg/L in the last monitoring period among all the spots. The highest amount was found in Left Bank of Passur River at 100m u/s of North West corner from the Project boundary and in Right Bank of Passur River at Project site-Jetty respectively.

86. 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.

87. The COD concentrations of pre-monsoon and winter seasons (dry) are found to be 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: 2.3.9** and all the observed dataset are attached in **table B.6** of **Appendix- IV.**

(c) Nitrate, Sulphate and Phosphate

88. Among the 15 monitoring locations the nitrate values vary from 3.1 mg/L to 6.3 mg/L. The maximum value of nitrate (6.3 mg/L) is recorded in Left Bank of Passur River at 100m u/s of North West corner from the Project boundary. This may be due to the excessive agricultural runoff from the nearby areas..While on the other hand the lowest value (3.1 mg/L) is recorded at left bank of Passur River at project site jetty.. The results obtained from all the monitoring locations from 8thmonitoring period are found within the standard limit set by the Environmental Conservation Rules 1997, Bangladesh but higher than the previously analysed data of the same season. However, the highest values are found in pre-monsoon season 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).

89. Naturally, SO_4^{2-} concentration is higher in sea water as well as in river in coastal region due to the tidal behaviour 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. Accordingly, the highest value (760 mg/L) is recorded in Passur river at Akram point and the lowest value is found in Maidara river of the South East corner of the project at Ichamoti-Maidara confluence. A higher concentration (640 mg/L) is found in Left Bank of Passur River at South West corner from the Project boundary which may be due to the surface runoff and dry deposition generated from the nearby industrial area. However, all the observed dataset of Sulphate found to be 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.

90. In the 8th monitoring phase, the values of PO_4^{2-} (0.179-0.625 mg/L) are found to be relatively similar to that of the results of winter period (0.32-0.85 mg/L) in the previous year. The highest value observed in pre-monsoon period of 2014 and could be due to the discharge of bilge water from numerous ships and fishing boats, agricultural and industrial runoff. During the last monitoring period the highest amount of phosphate is found at Middle of Passur River at South West corner from the Project boundary while the lowest is recorded in Right Bank of Passur River at 100m u/s of North West corner from the Project boundary. No significant variations are found at the observed locations in all four consecutive seasons of 2nd year. 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 alkyl phosphates used in households as detergents can be other sources of inorganic phosphates during the season (Tiwari and Nair, 1993).

91. 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: 2.3.10, 2.3.11** and in **2.3.12** and all the observed dataset are attached in **table B.9** of **Appendix- IV.**

(d) Heavy Metals

92. The observed dataset of Arsenic (As) concentrations demonstrated conformity among all the spots which vary from 0.001 mg/L to 0.002 mg/L. during the last monitoring period the arsenic concentration are found to be slightly lower than the previously monitored data found in 2014 winter season. In pre-monsoon season subsurface flow from groundwater to river might increase the concentration of As 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.

93. The average values of Pb are observed to be higher in pre-monsoon than in monsoon and post-monsoon in both the years. Huge amount of fresh water flow from upstream during monsoon results in lower concentration of Pb in the river water. On the other hand, the concentration is seen higher in the post monsoon and in winter season. 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- $Pb_5(PO_4)_3(X)$) (Zhu et. al., 2004) which may results in higher amount of Pb concentration in river water in winter season. During the last winter, the highest concentration of Pb (0.302 mg/L) was found in Passur River at Akram point and the lowest value (0.023 mg/L) was found in Maidara river of the South East corner of the project at Ichamoti-Maidara confluence.

94. The values of Hg (Mercury) revealed a continuous consistency among all the spots in all the seasons. The values never exceeded 0.0020 mg/L. All observed data found to be within the Bangladesh standard limit set by the environmental Conservation rule, 1997, Bangladesh.

95. The observed As, Pb concentrations at different monitoring locations of the consecutive monitoring periods are presented in **Figure: 2.3.13** and in **2.3.14** and all the observed dataset are attached in **table B.10** and **B.11** of **Appendix- IV.**

(e) Oil and Grease

96. In order to measure the concentration of oil and grease in Passur River, samples have been taken from five 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.**

97. During pre-monsoon, monsoon and post monsoon periods, the concentration of oil and grease has been found negligible and all of the monitoring results are fully in conformity with the Standard of ECR 1997. Passur and Sibsa rivers have contained high concentration of oil and grease in winter period 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 km^2 area (Welle, 2014).

98. During the last monitoring period, the concentrations of oil and grease varied from 14 mg/L to 39 mg/L and are found to be exceeded the standard limits for inland surface water, 10 mg/L (ECR, 1997) in all the spots. Maximum concentration was found in project site jytty. This higher concentration may be due to oil spillage and other organic residues discharges from marine vessels; oil discharge from the fishing boats and other anthropogenic activities might contribute to this higher amount of oil and grease concentration.

2.3.3 Status of the Groundwater quality

In-situ tested parameters

a) pH and Temperature

99. 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 9thmonitoring program are found to be varied from 7.8 to 8.3 while temperature is found to be between 29.6°C and 30.1°C (Table 5.15). The recorded pH values are 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. In addition, larger seasonal variations, related to warming of or cooling at the surface are common, and ranges in the order of 5 to 10 degrees.

100. Both the results of pH and Temperature are found to be more or less consistent with all the previously obtained data. The seven consecutive monitoring results of pH and temperatures of selected locations are presented in **Figure: 2.3.15** and **2.3.16** and all the observed dataset are attached in **Table B.12** of **Appendix- IV**

b) Salinity and Dissolved Oxygen

101. 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 allthe consecutive monitoring seasons.

102. The observed values of dissolved oxygen are ranged in between 5.6mg/L and 6.1 mg/L and found in Karpashdanga and in near proposed township area respectively all the observed data are found to be are within the BD standard (6.0 mg/L) set by ECR, 1997. Higher DO values makes water more tasty but cause corrosion to the supply pipe.

103. Eight (8) consecutive monitoring results of salinity and DO of selected locations are presented in **Figure: 2.3.17** and all the observed dataset are attached in **Table B.13** of **Appendix- IV.**

Laboratory tested parameters

(a) TDS, TSS and TH

104. During the 8th monitoring period TDS values are found within the standard limit (1000 mg/L). Highest value (491 mg/L) is recorded in Rajnagar area while the lowest value (284 mg/L) is recorded in kapashdanga. The TDS concentration is found to be much lower than the BD standard (ECR, 1997) found in the last monitoring period.

105. Total Suspended Solids (TSS), also known as non-filterable residue, are those solids (minerals and organic material) that remain trapped on a 1.2µm filter (U.S.EPA, 1998). Among all the monitoring season the values are found to be much higher in monsoon season which could be due to the runoff from industrial, urban or agricultural areas. In all the monitoring locations the concentration found to be 4 mg/L which presents an ideal condition and fully in conformity with the BD drinking water standards (ECR, 1997).

106. TH concentrations of the three monitored spots vary from 195 mg/l to 295 mg/l. The maximum value is found in Township area near project site. The monitored values are 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 TH.

107. Groundwater TDS, TSS and TH value of seven (7) consecutive monitoring periods in all the monitoring period are presented in **Figure: 2.3.18, 2.3.19** and **2.3.20** and all the observed dataset are attached in **table B.14** and **B.15** of **Appendix- IV.**

(b) Chemical Oxygen Demand

108. 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 within the standard limit. COD concentrations found higher than those of second year. Such high COD value is likely from anthropogenic sources such as percolation from landfill leachates and/ or industrial effluents.

109. The analyzed results are found to be lower than those of the previously monitored results. The COD concentrations of all the monitoring locations are presented in **Figure: 2.3.21**.and all the observed dataset are attached in **Table B.16** of **Appendix- IV.**

(c) Nitrate, Sulphate and Phosphate

110. Nitrate values are found to be varied from 1.9 mg/L to 2.8 mg/L and remained 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 Kapasdanga which might be due to the excessive fertilizer use in the nearby agricultural field.

111. 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 are found to be zero in all the points in every monitoring season except in monsoon of first year and winter of second year. During 8th monitoring the values have varied from 2 to 6 mg/L. On the other hand, the values of PO_4^{2-} are within the standard limit (6 mg/L) and ranged between 0.179 mg/L to 0.267 mg/L. Among all the monitoring period the recorded data are found maximum in the post-monsoon period. The values have never been higher than the Bangladesh drinking water quality standard. The observed ground water NO_3^-, SO_4^{2-} and PO_4^{2-} concentrations are presented in **Figure 2.3.22** and all the observed dataset are attached in **Table B.17** of **Appendix- IV**.

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

112. 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 0.002 and 0.008 mg/L which is completely within the BD permissible standard limit (ECR, 1997). However, the As values in Kapasdanga are found to have a decreasing trend in all the consecutive seasons and may be considered as suitable for the drinking purpose.

113. The Pb and Hg concentrations are detected and the values remained much lower than the acceptable limit specified in ECR 1997. The concentration of Pb is found higher in pre-monsoon and post-monsoon in Rajnagar and Kapasdanga respectively. In the 8th monitoring period the values of Pb concentration have ranged between 0.011 mg/L and 0.026 mg/L, while Hg concentration for that period is very much negligible (<0.00015 mg/L). Therefore, it reveals that the monitored tube well is found suitable for drinking purposes.

114. The observed values of As, Pb and Hg in all the monitored locations are presented in **Figure: 2.3.23** and **2.3.24** and all the observed dataset are attached in **Table B.18** of **Appendix-IV.**

2.4 Land Resources

2.4.1 Methodology

Monitoring Indicators

115. 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

116. For dry season, soil samples have been collected in April, 2016 and for wet season, soil samples will be collected in October 2016.

Location

117. 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 the **Map 2.4.1.**

Process of soil samples collection

Plot selection

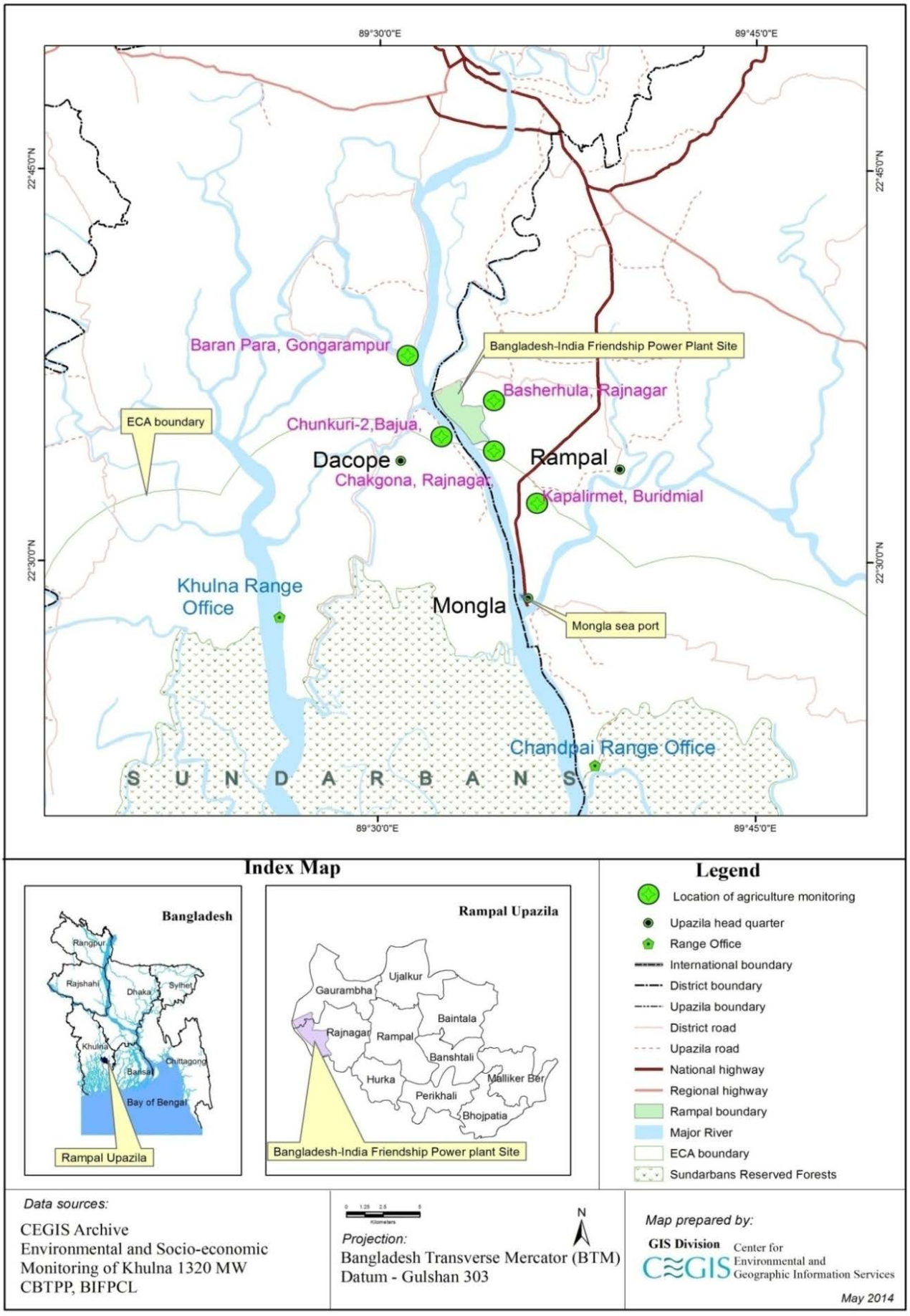
118. Monitoring plots have been selected before initiation of the monitoring through group discussion, especially with the plot owners and specific experts such as Upazila Agriculture Officers of Batiaghata, Dacope, Rampal and Mongla of Khulna and Bagerhat districts and Senior Scientific Officer of Soil 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

119. 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, 2016. 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

120. Collected soil samples have been handed over to the SRDI, Dhaka for laboratory analysis. Results will be presented in the next monitoring report (2nd quarterly monitoring report of 3rd year) after obtaining it from SRDI.



Map 2.4.1: Soil Quality Monitoring Locations

2.5 Hydro-morphology

121. A comprehensive study has been conducted for morphological dynamics of river systems, drainage network and tidal properties of the study area. The monitoring information has been documented maintaining the temporal and spatial distribution. This study will articulate the result considering a number of analyses and will be preserved for future comparisons.

2.5.1 Methodology

122. Four indicators namely tidal characteristics, drainage network, river bed sediment (quality and texture), and erosion-accretion process have been considered for monitoring hydro-morphological condition of the study area mainly Passur River .

Tidal behaviour

123. The Rampal Power Plant project is situated within the tidal river systems of South West hydrological region. Passur, Maidara, Ichamoti, Chunkuri rivers are highly influenced by tides. Two automated tide gauges of Mongla Port Authority (at Mongla port and Hiron point) have been selected to monitor the tidal characteristics of the Passur river.

Drainage network

124. Connectivity among the internal creeks, between the creeks and rivers in the study area has been verified. The drainage network would be monitored by analyzing high resolution satellite image.

River bed sediment

a) Particle size distribution

125. The particle size distribution of the river bed material reveals nature of sediment transportation as well as the nature of erosion and accretion of the river. Three (3) locations (**Map 2.5.1**) of the study area have been fixed for bed material monitoring. The selected locations are at Project jetty site, Harbaria and Akram point in the Passur River.

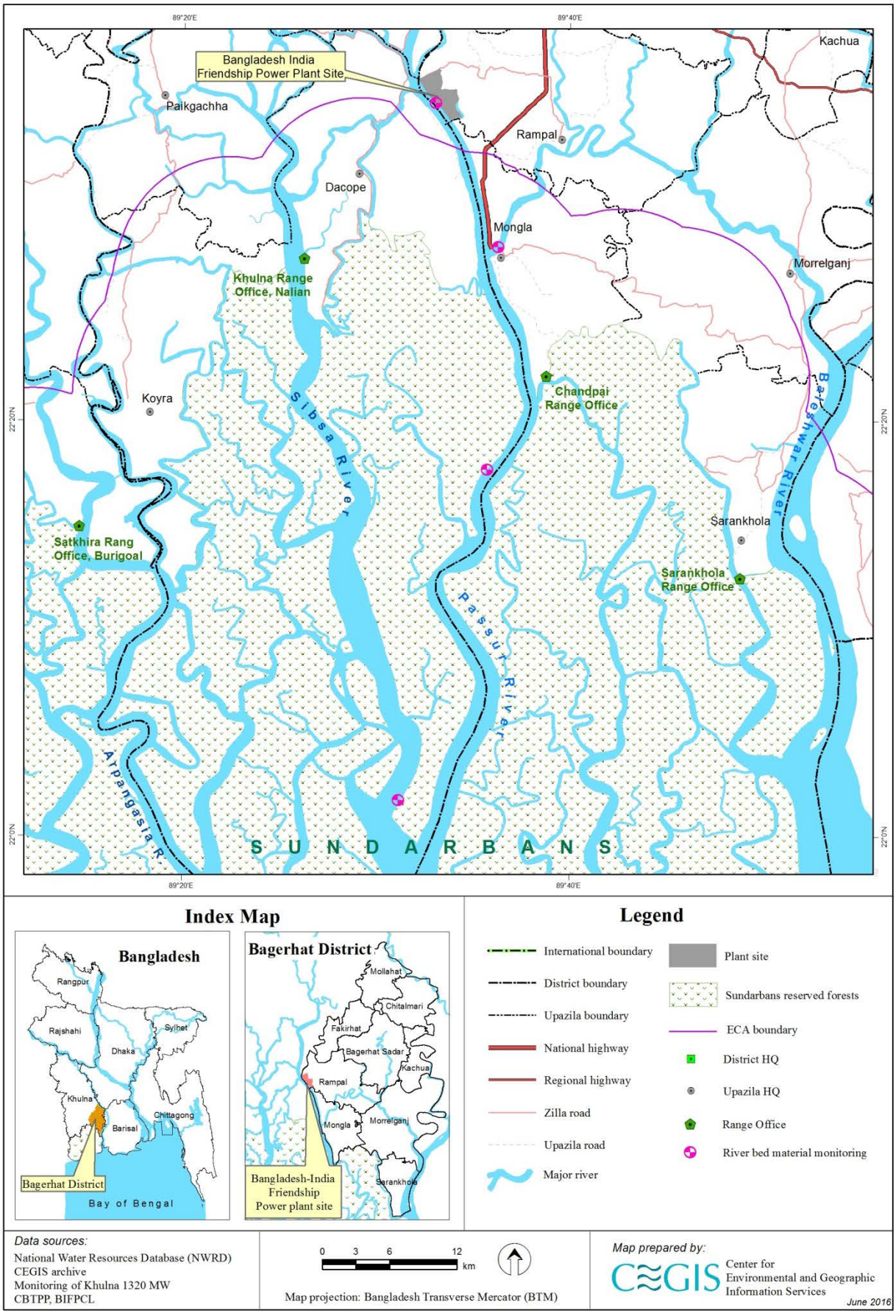
126. Collections of river bed sediment have been conducted by grab sampling procedure. River bed samples are collected at the time when the river current is relatively sluggish or calm; otherwise, the grab would not perform well at the bottom of the river effectively. The samples are then preserved following the procedure of the Soil Resource Development Institution (SRDI) where the samples are tested.

b) River bed sediment quality

127. In addition to the particle size distribution, the sediment quality has also been considered for monitoring. The collected samples have been analysed by SRDI laboratory for sediment quality analysis that would cover soil Organic Matter, Heavy Metals, pH, etc.

Erosion and accretion

128. Initially erosion and accretion process of the study area have been planned to monitor through satellite image analysis. Erosion and accretion have been monitored at project site, Mongla port site and Akram point areas. Mostly, erosion of river bank, formation of new char or bank line shifting has been considered as the key indicators for this monitoring study.



Map 2.5.1: Location of River bed material monitoring

2.5.2 Status of monitoring

129. During this session of monitoring period, data of tidal variation from MPA have been acquired.

130. The Passur River is mainly a tidal river, which is receiving fresh water mainly during the monsoon through the Gorai-Madhumati system.

131. The minimum width of the river is about 690 m which is near the project location and maximum is about 8.0 km which is near Akram point. Maximum discharge through the river system runs during July – September and minimum during February – April. There are no intervention in the river but Mongla Port and proposed Maitree Coal base Power plant is at the left bank of the river. Chalna – Mongla portion of the river is a class 1(4 m draft) inland water way of Bangladesh Inland Water Transport Authority (BIWTA) and the remaining part is maritime route maintained by Mongla Port Authority.

Tidal behaviour

a) Tidal Fluctuations

132. Two water level (Mongla and Hiron Point) data has been analyzed considering the coal transportation requirement from fairway Buoy to project Jetty. In this regard five years water level data (2008-2012) of BIWTA at Hiron Point has been collected and analyzed to find out the tidal fluctuation at that location. A hydrograph of the Passur River based on water level data is given in Figure 2.5.1,shows the variation of daily maximum and minimum water level. The water level of the Passur River rises from April to August and then recedes up to January. The highest water level was observed at Hiron Point,is 4.58 m in the year 2009 (Figure 2.5.2) and the lowest is -0.12 m in 2010. The tidal variation of Hiron point is about 2 m. Daily minimum water level increases by 0.5 m during the monsoon.

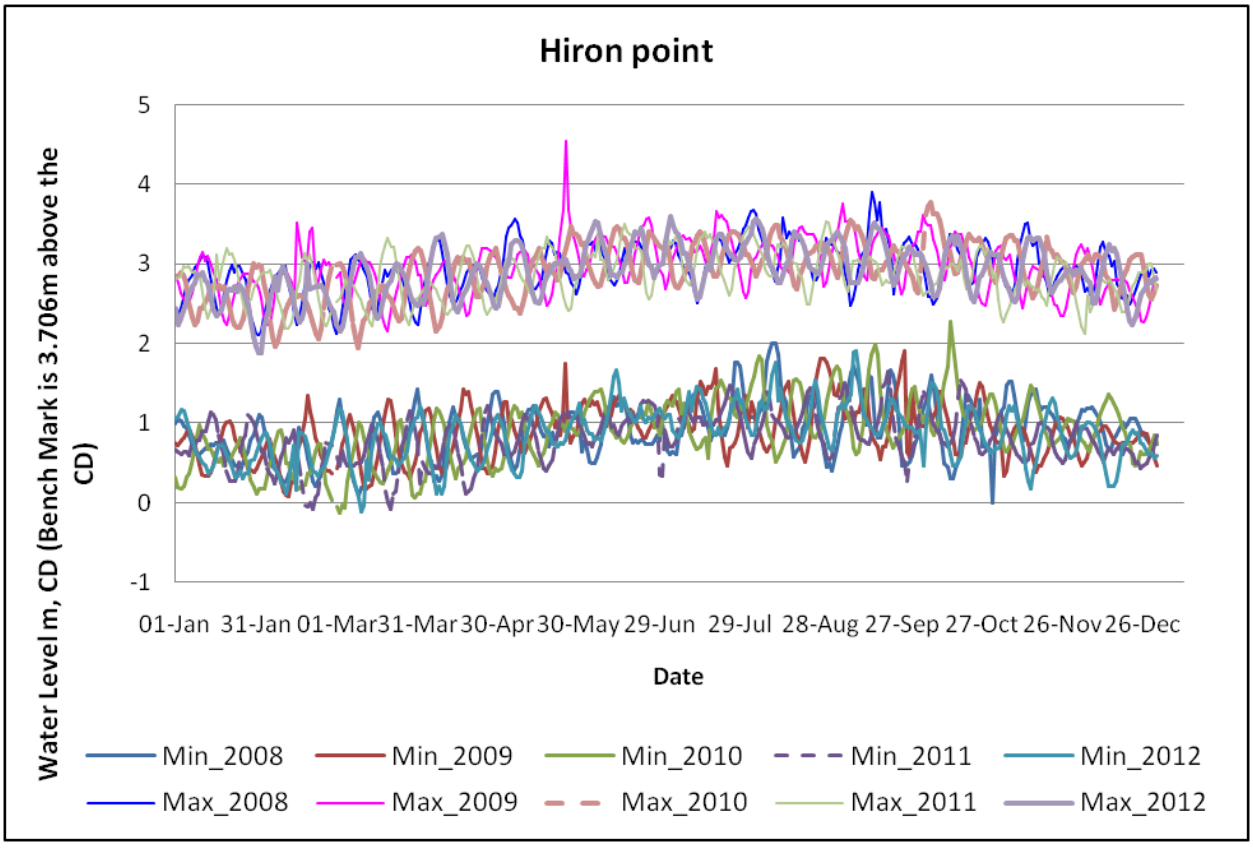


Figure 2.5.1: Tidal water level fluctuation at Hiron point over time

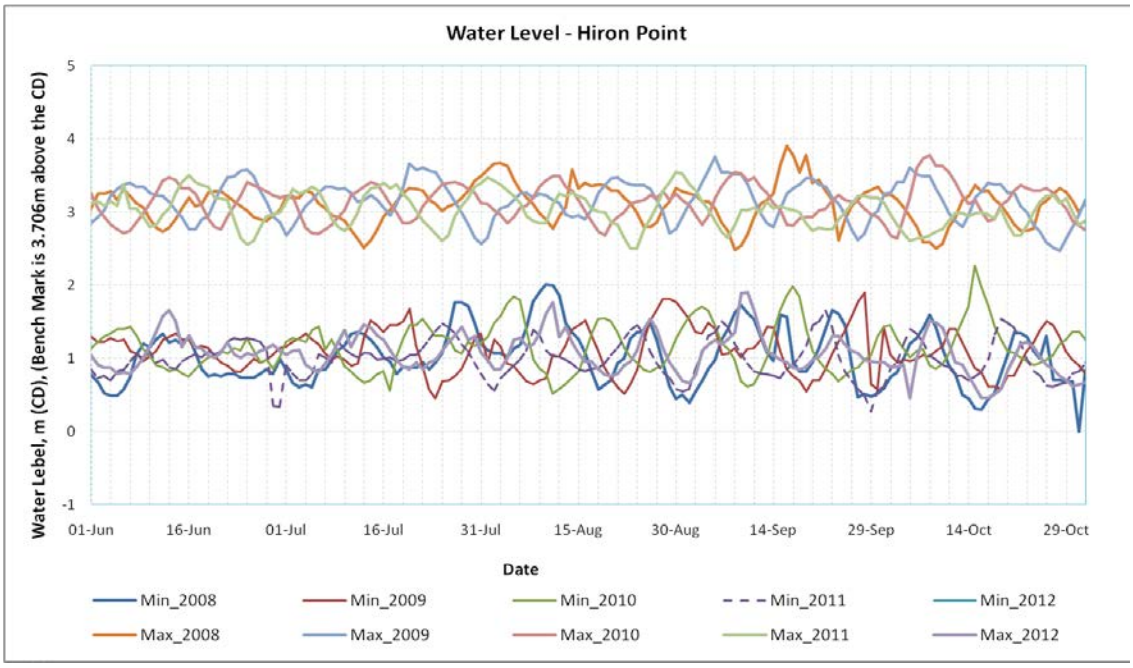


Figure 2.5.2: Tidal water level fluctuation during monsoon period

133. To analyze tidal fluctuation at Mongla, water level data of six years (2005-2010) from BIWTA at Mongla Port station has been collected and analyzed. Figure 2.5.3 shows the daily variation of water level of Passur River at Mongla Port is about 2.5 m. It also indicates that both the maximum and minimum water level rises from the month of April to July and the recession period from August to October. From December to February, the maximum and minimum water level is fairly uniform.

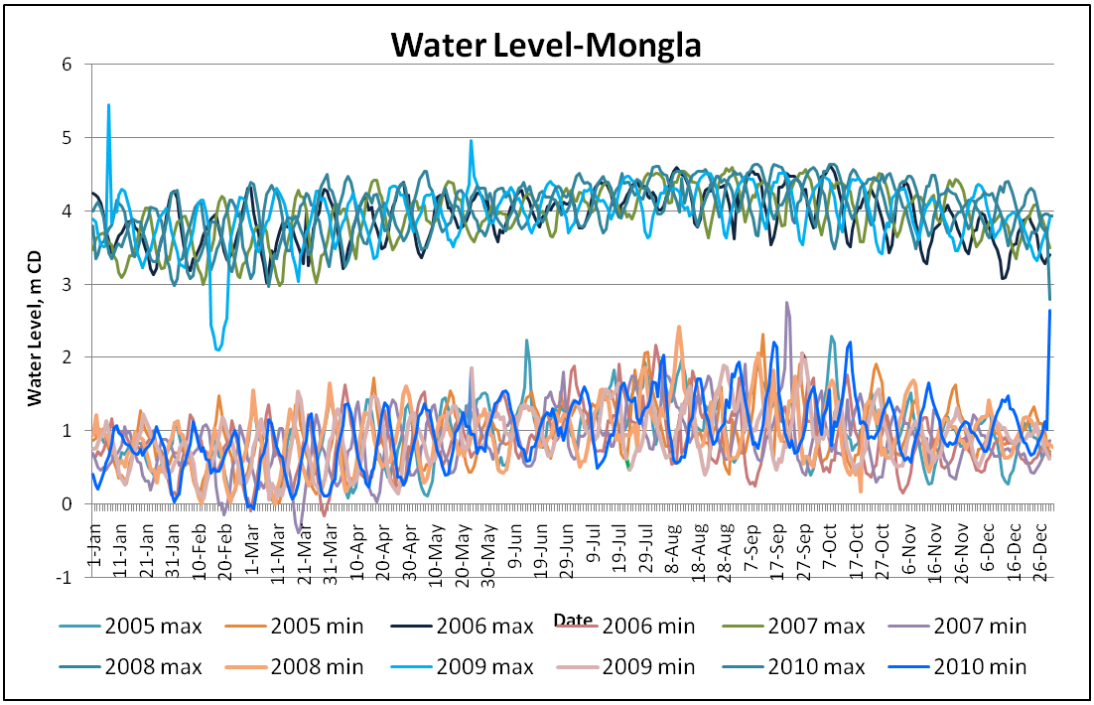


Figure 2.5.3: Water Level variation at Mongla

134. Water level fluctuation from April to October in the period of 2005-2010 at Mongla Port is shown in **Figure 2.5.4**. The observed highest water level in the range of 2005-2010 was 4.96 in 2009 and minimum water level was 0.03 in 2007.

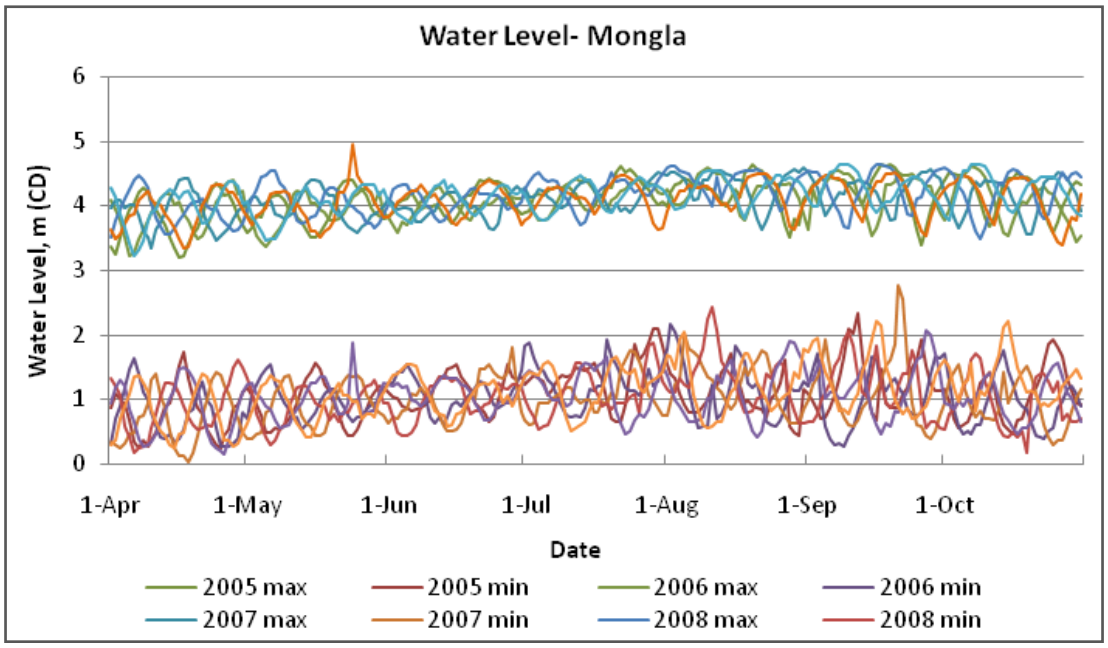


Figure 2.5.4: Water level variation at Mongla (April- October)

b) River Draft

135. Maitree Coal based power plant to mother vessel anchorage point the navigation route is divided in two categories - i) Inland Waterway (Chalna - Mongla) and ii) Maritime (Mongla Port – Anchorage Point) route. Hydrographic charts were analyzed according to the project requirement for the transportation of coal from the anchorage point of mother vessel to project site.

136. For the inland waterways portion time series Hydrographic charts were analyzed (**Figure 2.5.5**). It has been observed that there is no drastic change in the Draft but it is significant that the draft is very low in different reachfrom Mongla to Project site. The analysis indicates that from Mongla Port – project site 0-4 km and 8.7 – 12.3 km stretch have less draft compared to project requirement.

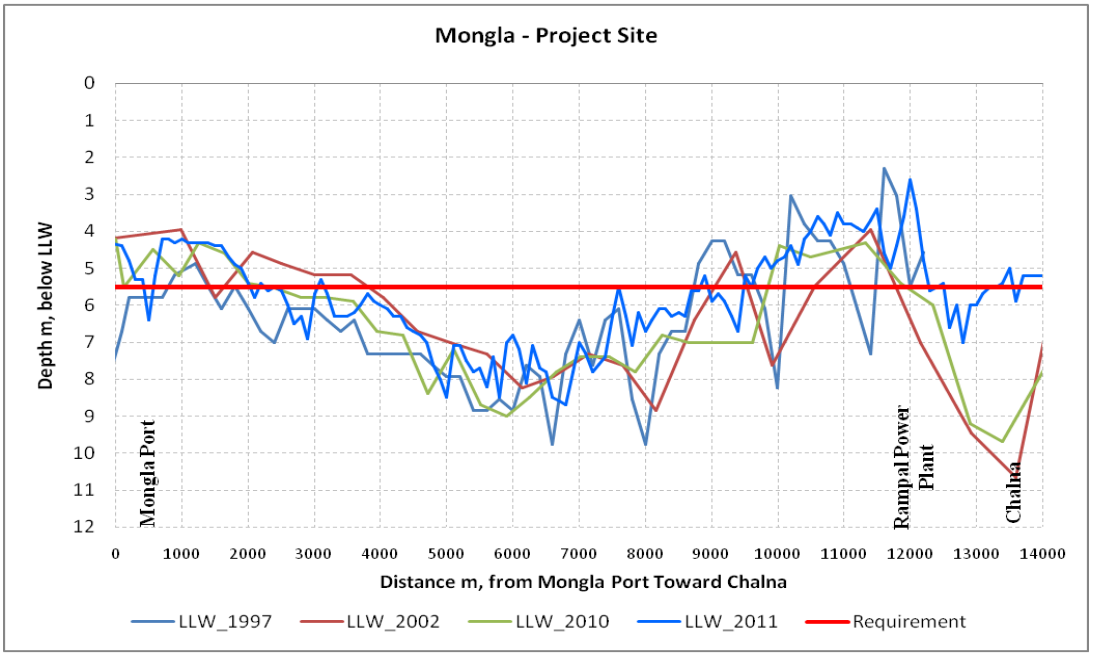


Figure 2.5.5: Time Series Long profile of Passur River from Mongla Port to Chalna

137. For the maritime portion (Mongla Port to Fairway Buoy) Hydrographic Chart and cross sections are prepared (**Map 2.5.2**) based on latest hydrographic charts, which are collected from Bangladesh Navy, BIWTA and Mongla Port Authority. A surface is generated with the help of GIS tool to observe the bed profile and to find out the suitable paths for navigation of coal carrying vessel as well as project sites. Hydrographic chart of two rivers Passur and Sibsa are collected from BIWTA and Mongla Port Authority to analyze two alternative routes for project site of proposed Maitree coal base power plant.

138. In Passur River, survey was conducted from 2007 to 2009 by Mongla Port Authority. BIWTA conducted Hydrographic survey up to 1 km downstream of Nalian Hat (village market) in Sibsa River in 2010. For better understanding of the bathymetry of two rivers cross-section of different location are given in map (**Map 2.5.2**) as section 1-1, 2-2, 3-3, 4-4, 5-5 and 6-6,

139. In existing condition, Akram point shows depth of 15 m to 20 m but there are some shoals in outer bar that limit approaching of vessel having Draft over 8m. The same vessel can proceed up to near Harbaria (12 nautical miles downstream of Mongla Port Jetty). Presently, vessel of maximum 5 m – 6 m Draft can proceed up to port jetty with taking tidal advantage. Up to south end to the project area Draft varies 4m to 7m. But in some places, shoals restrictDraft. Further upstream of the south end of the project the Draft decreases due to some shoals and submergible sandbars.

140. To facilitate the transportationof coalfor the Maitree coal base power plant jetty it is required to dredge the river in different reach from the anchorage point to project jetty. The experience of Mongla – Port Authority suggested that it is possible to maintain the route through the capital dredging. But it is also suggested that 55 – 60% maintenance dredging may require in each year.

141. To find out the favorable travel time one (1) tidal cycle of spring tide and one (1) of neap tide cycle data of Hiron point has been analyzed and compared with the Mongla data for the same cycle. Hiron Point analysis indicates that the tidal fluctuation is sharper for the spring than that of neap tide (**Figure 2.5.6**). The tidal difference between spring and neap is around 0.75m during flooding and ebbing is 1.0m.At Hiron point flooding and time is nearly same for spring and neap tide.

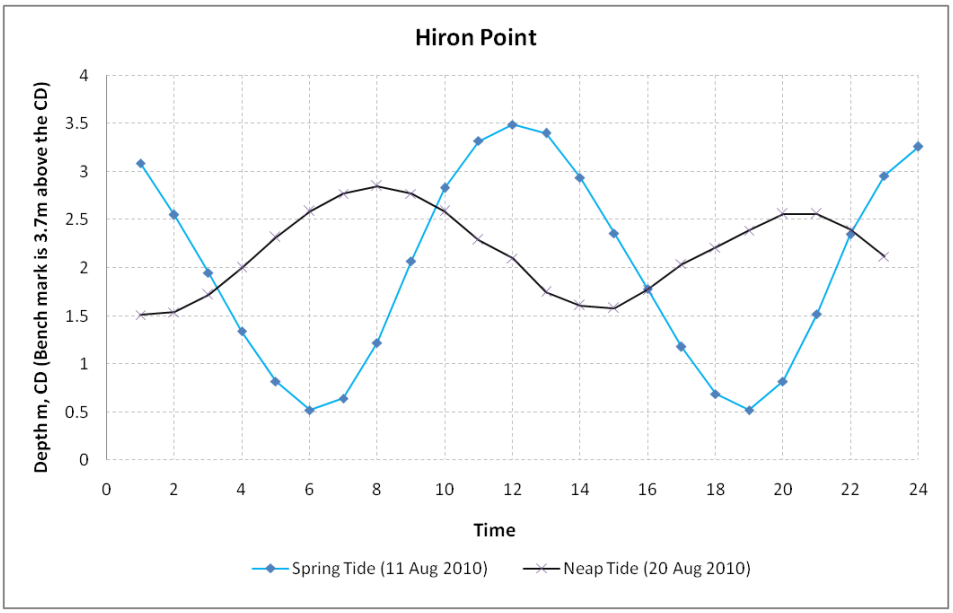


Figure 2.5.6: Tidal cycle at Hiron Point

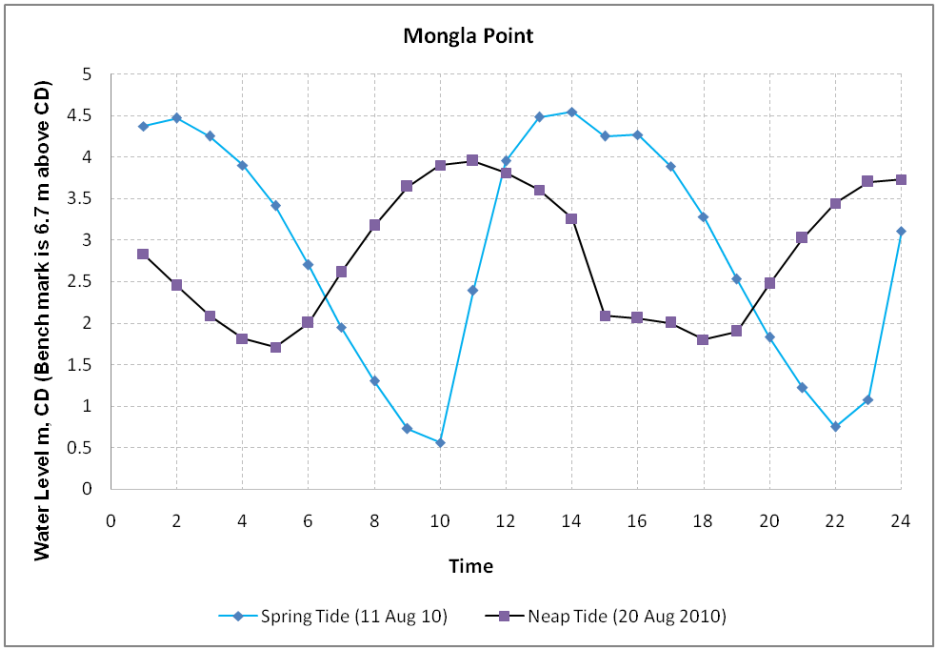
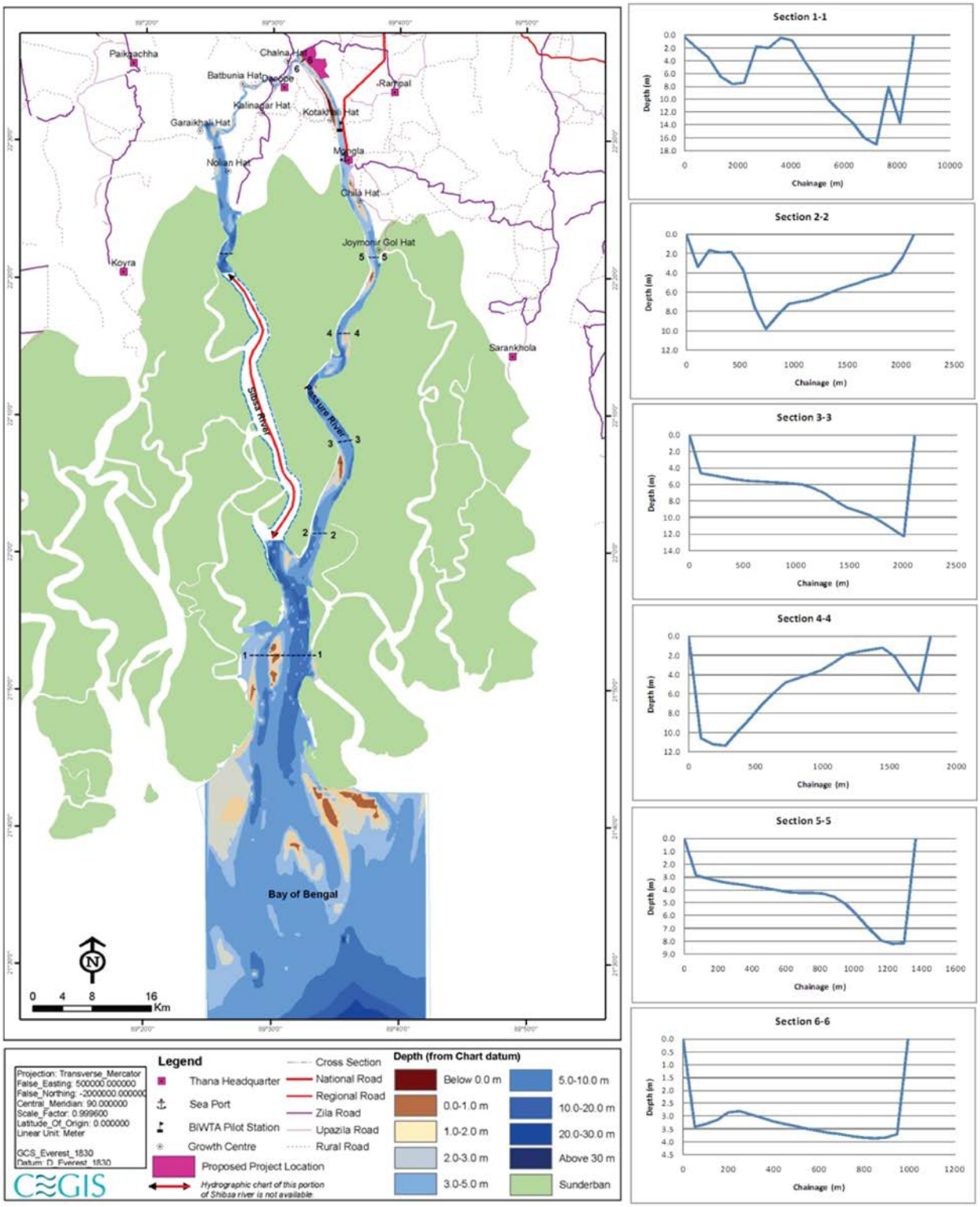


Figure 2.5.7: Tidal Cycle at Mongla

142. Mongla data analysis (**Figure 2.5.7**) indicates that the flooding time during spring tide is 5 hours and during neap tide is 6 hours, Ebbing time for the both nearly 7.5 hours. Due to tidal asymmetry Mongla is very much sedimentation prone area than that of hiron point vicinity. Flooding difference between for the neap and spring is around 0.5m and during ebbing it is around 1.0m. Flooding starts after 2 hours later from the Hiron Point for both cases. So the vessel movement can take the advantage of this situation.



Map 2.5.2: Hydrographic map of Passur River System

Drainage network and Connectivity

143. The RapidEye Satellite Image of 5 m resolution acquired from GEOPeakk Singapore has been used for drainage network analysis. The monitoring study area is surrounded by a number of rivers and canals. Passur – Sibsha river system the governing river system here. The river system is hydrologically connected with numerous canals, tidal creeks and inter-tidal areas (**Map 2.5.3**). The river receives fresh water from Ganges through Gorai,

Mathabhanga, Nabaganga, Bhairab and Rupsha river, and ultimately drains to the Bay of Bengal. The tide enters from the Bay of Bengal and reaches to its tidal flood plains through numerous tidal canals, and creeks.

144. Passur River is the downstream river of the Rupsha River. Flowing alongside the Khulna city , the Bhairab-Rupsha flows further South and is renamed as Passur near Chalna and falls into the Bay of Bengal flowing to the right of Trikona and Dubla islands while from down of the Mongla port, the river flows through the Sundarbans. The maximum flow of the Gorai-Madhumati flows into this river through the Nabanganga. The Mongla canal joins the river at about 32 km south from Chalna. Flowing further south, the river meets the Sibsha at about 75 km downstream of Chalna and finally the combined river falls into the sea with its original name Passur.

145. The flow of the Passur River is dominated by the Atai and Bhairab rivers. The wet season brings additional volume of water from the Ganges through Gorai-Nabaganga-Atai into the system.

River bed sediment

a) Particle size distribution

146. The geometry and morphology of Passur river have direct consequence of the sediment transport process, discharge properties, catchment properties and tidal influences. Transported materials are used in eroding a riverbed (degradation) or deposited (aggradations) either temporarily or permanently along the course of a river. Throughout geological history, Passur river has altered its channels through erosion and deposition or human intervention. The SRDI laboratory analysis shows that bed sediments near Project site are mostly silty loam whereas in Sundarbans region, bed materials are mostly loam.

Table 2.5.1: Particle size distribution (PSD) at three points in Passur River

Name of the Place	GPS Location	Sand (%)	Silt (%)	Clay (%)	Remark
Project site at Jetty location	N:22°35´21.6" E: 89°32´53.6"	31.06	55.92	13.02	Silt Loam
Harbaria point	N: 22°17´42.9" E: 89°35´35.3"	37.27	35.56	27.18	Loam
Akram point	N: 22°35´35.3" E: 89°32´53.6"	38.91	36.09	25.00	Loam

Source: Sample collected in Jan 2016 and Laboratory analysis in SRDI Laboratory

b) River bed sediment quality

147. In addition to the particle size distribution, the sediment quality has also been considered for monitoring. The collected samples have been tested in SRDI laboratory for sediment quality analysis of organic matter and heavy metals content, pH, etc. (**Table 2.5.2**).

Table 2.5.2: Quality of river bed sediments at three points in Passur River

Name of the Place	GPS Location	pH	OM (%)	S (µg/g)	Pb (µg/g)
Project site at Jetty location	N:22°35´21.6" E: 89°32´53.6"	8.8	1.0	126.30	14.02
Harbaria point	N: 22°17´42.9" E: 89°35´35.3"	8.0	1.69	354.70	0.00
Akram point	N: 22°35´35.3" E: 89°32´53.6"	8.8	1.28	172.10	7.01

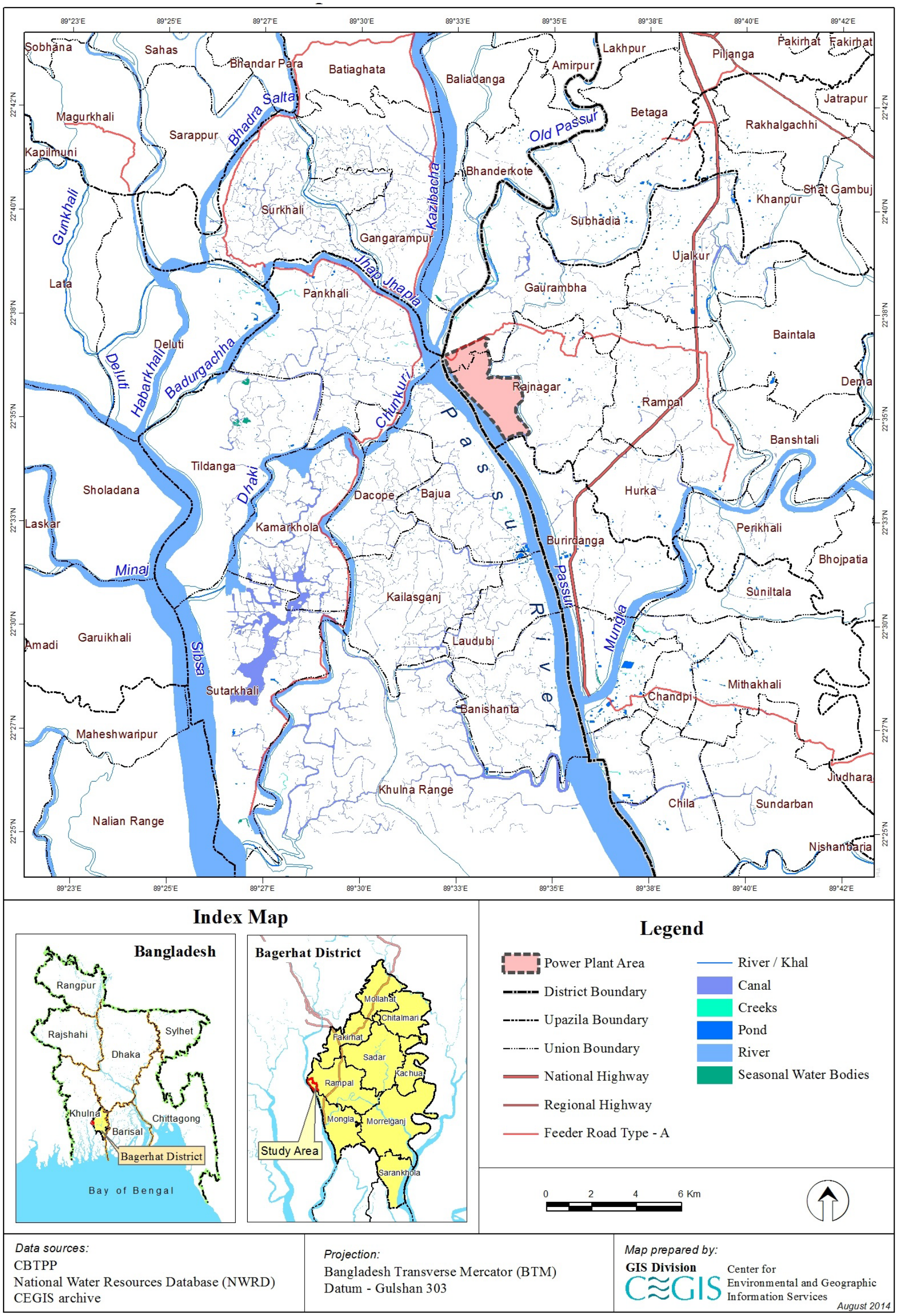
Source: Sample collected in Jan 2016 and Laboratory analysis in SRDI Laboratory

- Riverbed sediments were found to be alkaline in all the locations.
- Organic matter content was found low in all locations.
- Sulpher content was found high in the Sundarbans. This might be from the marine sources from the organic matter deposited from Sundarbans.
- Pb varies from 7-14 µg/g

Erosion and accretion

148. The erosion and accretion is a big concern for river morphology. The erosion and accretion of the river has been analyzed with the help of Arc-GIS tool using banklines of 1973, 1984, 1997 and 2010 (**Map 2.5.4**). The upper portion from Mongla experienced erosion at left bank whereas accretion at right bank at the time of 1973 to 1984. From 1984 to 2010 erosion observed at right bank and accretion at left bank.

149. The lower portion of Passur River from Mongla port experienced significant erosion and accretion. From 1973 to 1984 both the bank of the river inside the Sundarbans eroded and accreted at higher rate. The erosion rate of any bank of Passur River is approximately equal to the rate of accretion on the other bank. The downstream portion of the river from Hiron point became narrower in 2010 than 1984 and 1997 due to accretion. The extent of right bankline reduces approximately 700 m to 1.4 km compared to the banklines of 1984 while the change is about 800 m to 1.5 km at the left bank.



Index Map

Legend

- Power Plant Area
- District Boundary
- Upazila Boundary
- Union Boundary
- National Highway
- Regional Highway
- Feeder Road Type - A
- River / Khal
- Canal
- Creeks
- Pond
- River
- Seasonal Water Bodies

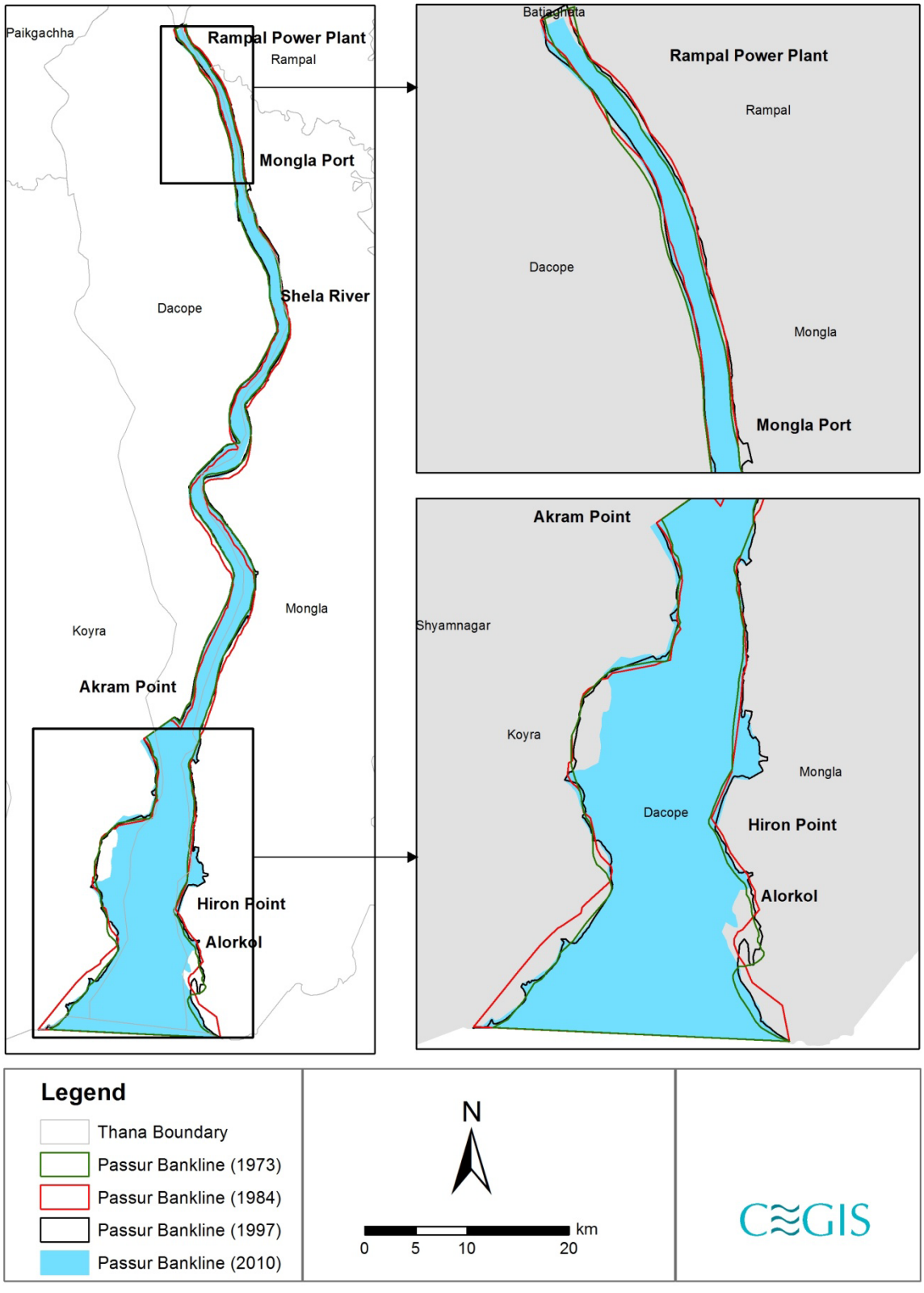
0 2 4 6 Km

Data sources:
CBTPP
National Water Resources Database (NWRD)
CEGIS archive

Projection:
Bangladesh Transverse Mercator (BTM)
Datum - Gulshan 303

Map prepared by:
GIS Division
Center for Environmental and Geographic Information Services
August 2014

Map 2.5.3: Map of the River Network



Map 2.5.4: Erosion and Accretion map of Passur River

3 Biological Environment

150. 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 three major groups and monitored quarterly 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 and Sundarbans Reserve Forest (SRF).

3.1 Fisheries Resources

151. Fisheries resources are being monitored quarterly in a year. Monitoring of 1st (2014) and 2nd (2015) year have been completed and reported earlier. This chapter contains the outcome of this 1st quarter monitoring of the 3rd year along with the comparisons with the earlier eight quarters.

Location of Monitoring Sites

152. The monitoring activities are being carried out at ten pre-selected locations of which seven (7) are capture fish habitat and three (3) are shrimp/fish farm. The capture sampling sites have been selected based on the fishing availability of upstream, middle stream and downstream of Passur River system. Shrimp/fish farms have been selected based on the direct impacted area of Plant site. The sampling sites are detailed in **Table 3.1.1**.

Table 3.1.1: The Sampling Locations for monitoring of Fisheries Resources

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

Selection of Parameters

153. Five major parameters have been selected according to TOR, such as, fish habitat status, fish migration, fish diversity, shrimp/fish farm practices and fish production. Fish habitat status has been monitored through investigating *Habitat Suitability Index* that covers 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 has been monitored through assessing migratory fish species diversity, migration pattern, migration purpose, period and extent of migration etc. Species evenness, species richness and community structure have been investigated for monitoring fish diversity. Shrimp/fish farm practice has been monitored by viewing stocking pattern, growth rate and mortality rate. Fish production monitoring has been divided into capture and shrimp/fish farm production.

3.1.1 Methodology

Fish Habitat Status

154. Fish habitat status has been monitored through determination of Habitat Suitability Index (HSI) 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 has been analyzed by calculating Ecludean Distance among sampling sties. Moreover, the similarities in species composition among the sites are 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 D.1 of Appendix IV.

Fish Migration

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

Fish Diversity

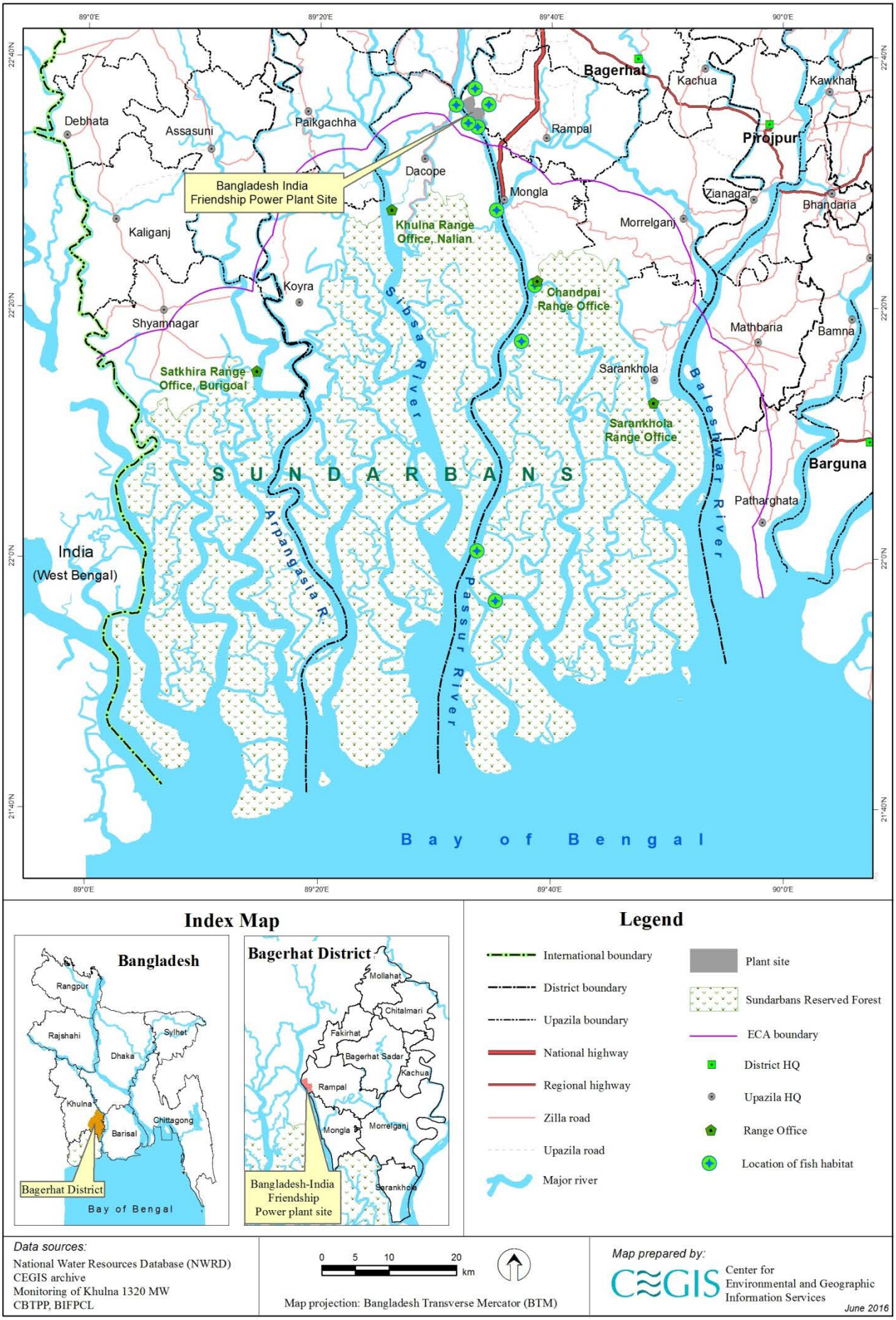
156. Fish diversity has been surveyed by Catch Per Unit Effort (CPUE) method. The fish individuals are counted according to the length of each species from the samples. Diversity has been estimated by analyzing Shannon-Weiner Index ranges from 0 to 1. Fish species richness (FSR) has been analyzed using the Sympson'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 means 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

157. For monitoring shrimp/fish farm, three farms within the direct impact zone of the proposed Power Plant have been 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 have been surveyed intensively.

Fish Production

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



Map 3.1.1: Fisheries Resources Monitoring Locations

3.1.2 Status of monitoring

159. Followed by the fourth quarter monitoring of the second year, first quarter monitoring of third year has been conducted during the period of 02 to 10 April, 2016.

Fish Habitat Status

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

(a) Habitat Classification

161. Habitat classification is 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 is then calculated with the similarity in distribution. The entire stretch of the Passur River System consists of three major behavioural habitats. The sampling sites have been classified (shown in the **Figure 3.1.1**) on the basis of abundance of different life stages of fish species in those habitats.

162. 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 have been identified. However, during third quarter monitoring in the month of October 2014 the similarity of size group distribution of fish species among the habitats has been found to beshifted 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 have been identified. During the 1st quarter (April, 2015) of the second year three habitats – i) grazing ground, ii) nursery ground; and iii) spawning and nursery have been identified. During the 2nd quarter monitoring of 2nd year (October, 2015) two habitats have been 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 have been 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 have been identified.

163. During the 1st quarter monitoring of 3rd year (April, 2016) two major habitats – i) spawning and nursery ground and ii) feeding and growing ground have been identified as shown in the **Figure-3.1.1**.

164. ***Spawning and Nursery Ground:*** Among the sampling sites, Sheola Khal at Chandpai (D) and Chalna Point (G) of Passur River were identified as the spawning and nursery ground for abundance of fry to age-1 juvenile fishes.

165. ***Feeding and Growing Ground:*** Among the sampling sites, the Harbaria Khal at Harbaria (C) and Maidara-Passur confluence (F) were similar in the distribution of life stages from first aged juvenile to adult fish. These habitats were classified as the feeding and growing ground.

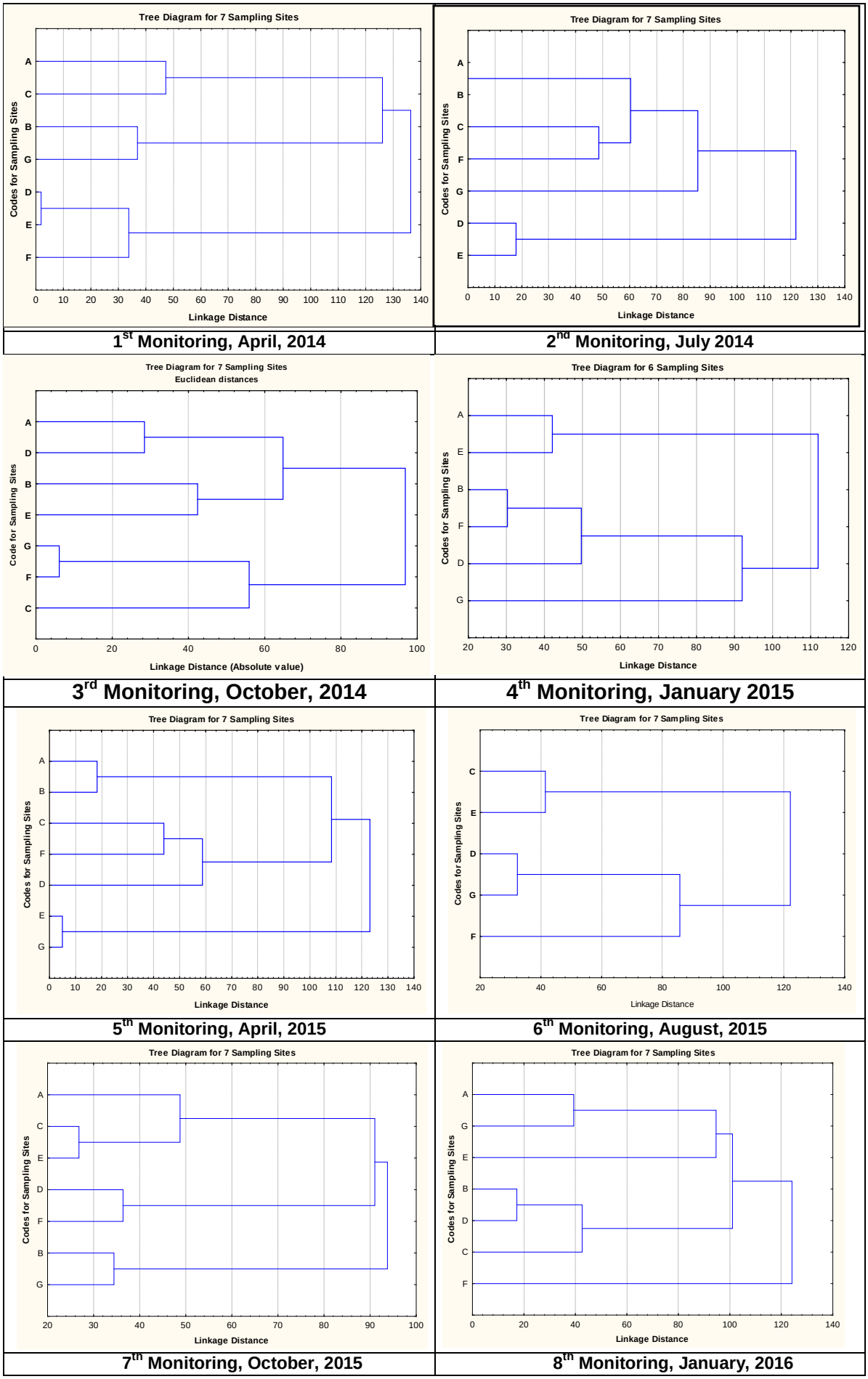
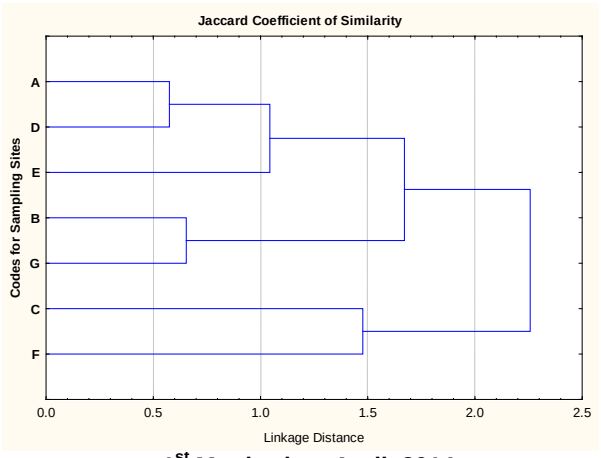
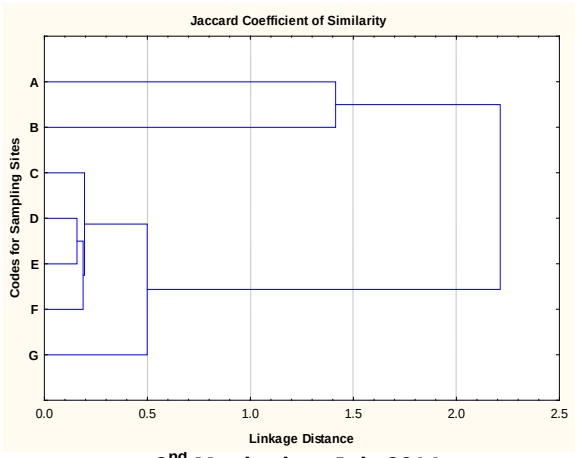


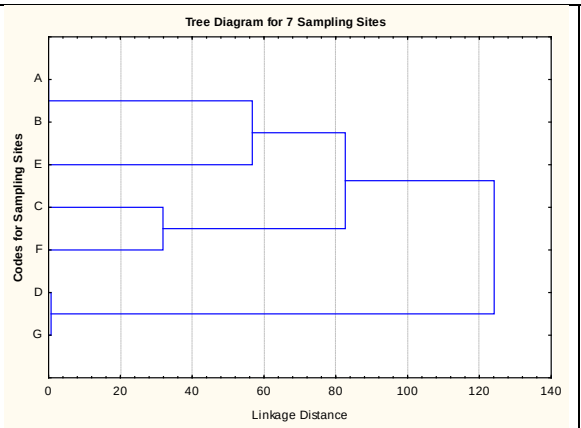
Figure 3.1.1: Habitat Classification on the basis of Different Life Stages of Fish Species ***(continued)***



1st Monitoring, April, 2014



2nd Monitoring, July 2014

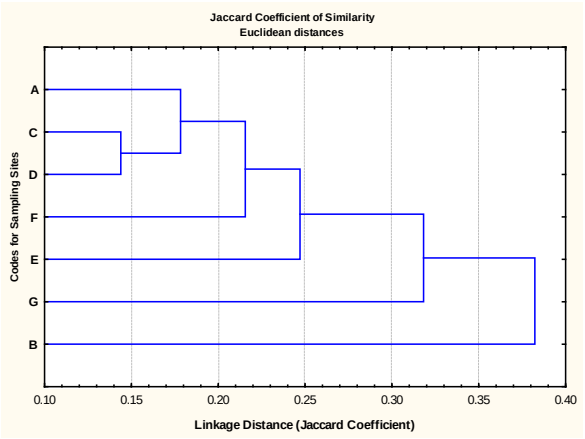


9th Monitoring, April, 2016

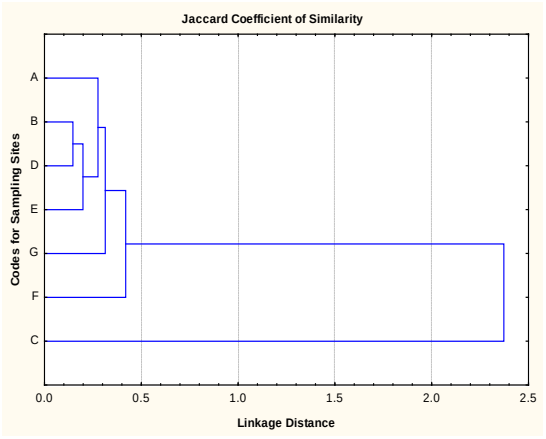
Figure 3.1.1: Habitat Classification on the basis of Different Life Stages of Fish Species

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

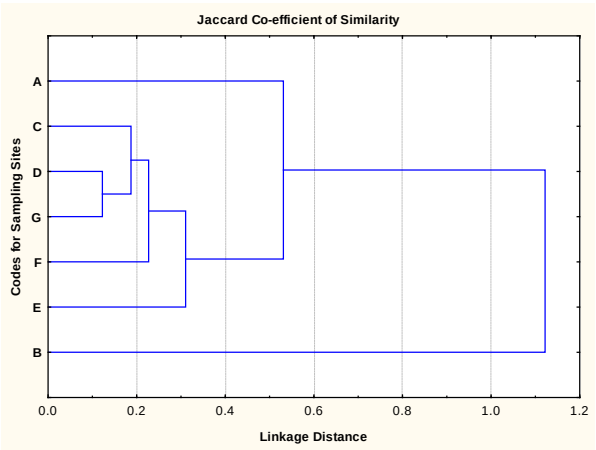
166. The dendogram analyses the distances among the JI (Jaccard Coefficient Index) indices which are opposite to the JI values. It has been found that the length-wise distribution relationship varies not only with four quarted but also with year to year. In the first quarter of the third monitoring year,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



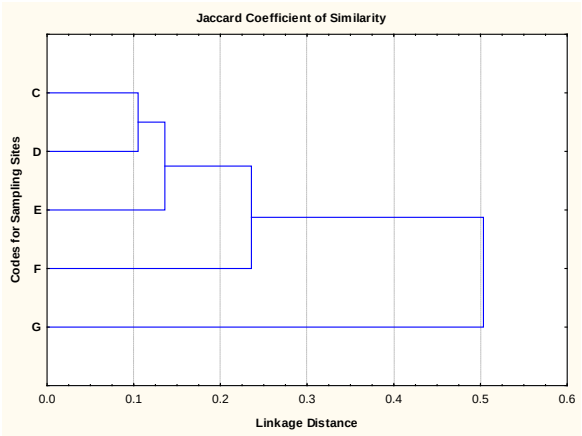
3rd Monitoring, October, 2014



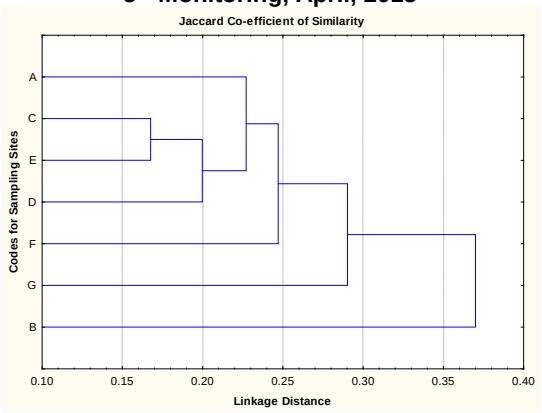
4th Monitoring, January 2015



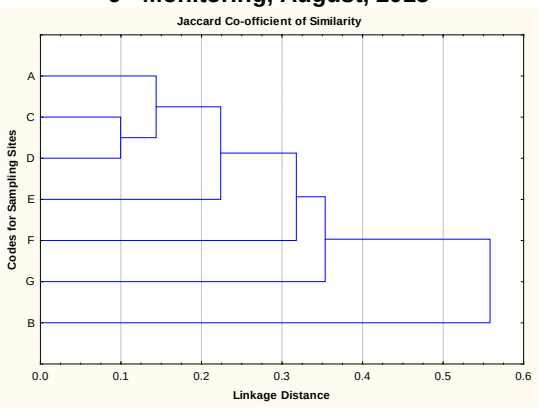
5th Monitoring, April, 2015



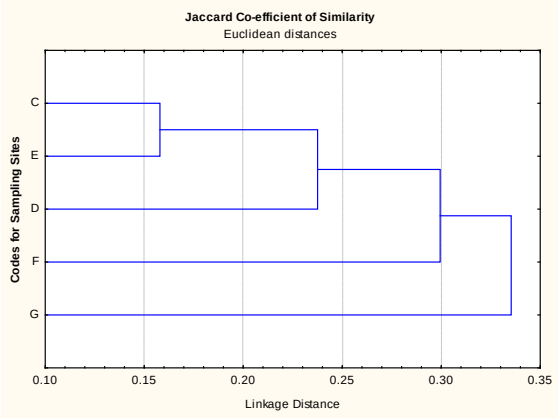
6th Monitoring, August, 2015



7th Monitoring, October, 2015



8th Monitoring, January, 2016



9th Monitoring, April, 2016

Figure 3.1.2: Dendogram Showing Similarity in Binary Species Composition in seven sampling sites

(b) Habitat Suitability Index (HSI)

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

168. In the first year of monitoring, Sheola khal at Chandpai has been found as the most suitable habitat for fish species among Passur River System. Sheola khal has also been identified as the most suitable which is followed by Harbaria, Akram Point, Haldikhali, Mongla Point, Maidara and Chalna Point (**Table 3.1.2**).

Table 3.1.2: 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

a) Shannon-Weiner Index

169. In the fourth quarter monitoring of second year (2015-16), species evenness are more or less similar among the sampling sites. However, highest Shannon-Weiner index has been found at Maidara (0.75) indicating most evenly distributed fish species. On the contrary, lowest evenness was found at Harbaria (0.57) (shown in the **Table 3.1.3**).

Table 3.1.3: Site Wise Species Diversity using Shannon–Weiner Index

Site	Species No												Shannon-Weiner Index*											
	1st QM (April, 2014)	2nd QM (July, 2014)	3rd QM (Oct 2014)	4th QM(Jan 2015)	5th QM (Apr 2015)	6th QM (Aug 2015)	7th QM (Oct 2015)	8th QM (Jan 2016)	9th QM	10th QM	11th QM	12th QM	1st QM	2nd QM	3rd QM	4th QM	5th QM	6th QM	7th QM	8th QM	9th QM	10th QM	11th QM	12th QM
A	33	0	13	7	3	-	10	15	0				0.49	0	0.73	0.57	0.96	-	0.55	0.44				
B	12	0	24	14	0	-	11	3	0				0.85	0	0.57	0.39	0.00	-	0.56	0.58				
C	2	12	9	0	11	26	18	24	17				0.29	0.77	0.40	0.00	0.78	0.59	0.54	0.67	0.57			
D	12	22	15	26	27	24	20	25	8				0.31	0.78	0.73	0.51	0.65	0.72	0.51	0.71	0.61			
E	7	13	10	11	6	16	9	9	15				0.38	0.60	0.76	0.77	0.15	0.73	0.85	0.41	0.66			

Site	Species No												Shannon-Weiner Index*											
	1st QM (April, 2014)	2nd QM (July, 2014)	3rd QM (Oct 2014)	4th QM(Jan 2015)	5th QM (Apr 2015)	6th QM (Aug 2015)	7th QM (Oct 2015)	8th QM (Jan 2016)	9th QM	10th QM	11th QM	12th QM	1st QM	2nd QM	3rd QM	4th QM	5th QM	6th QM	7th QM	8th QM	9th QM	10th QM	11th QM	12th QM
F	3	13	6	4	10	8	14	6	7				0.82	0.77	0.54	0.60	0.67	0.39	0.77	0.65	0.75			
G	6	3	5	7	18	3	8	6	6				0.68	0.82	0.72	0.66	0.18	0.95	0.72	0.81	0.58			

*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)

b) Fish Species Richness (FSR)

170. Fish species richness has been identified through Simpson's Index[1]. Considerable difference is noticed in the fish species richness (FSR) in different habitat classes (**Table 3.1.4** and **Figure-3.1.3**).

171. In this monitoring phase, the sampling sites have more or less same species richness. However, maximum FSR is obtained in Harbaria, Sheola Khal at Chandpai and Mongla Point (n=4), while very low FSR is recorded at Chalna Point (n=2). The richness in this quarter is more or less the same in both the monitoring years. Among habitats in upstream portions of the Passur river, Mongla Port has been home to a rich assemblage of Chaka; Maidara River at Baro Durgapurwas of Daitna, Paissa and Punti; and Chalna Point has been of Motka Chingri and Tigar Chingri. Among the habitats in down stream portions, Chandpai has been rich in Boisakhai Chingri, Chami Chingri, Horina Chingri and Motka Chingri; Harbaria has been in Bele, Boisakhai Chingri, Chaka Chingri and Chami Chingri.

Table 3.1.4: Site wise Rich Species Number

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

[1]Simpson'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.

	
Rupchanda in 1st Quarter 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

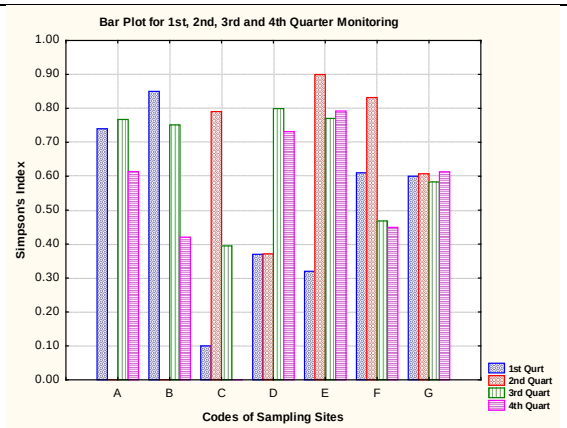
Female Gulsha Tengra

Fry Fishes

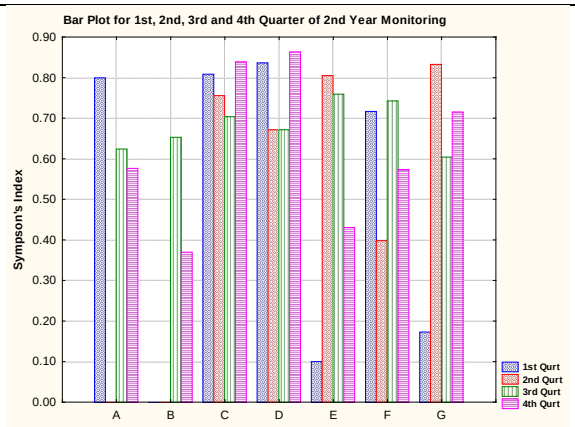
Chata Bele

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

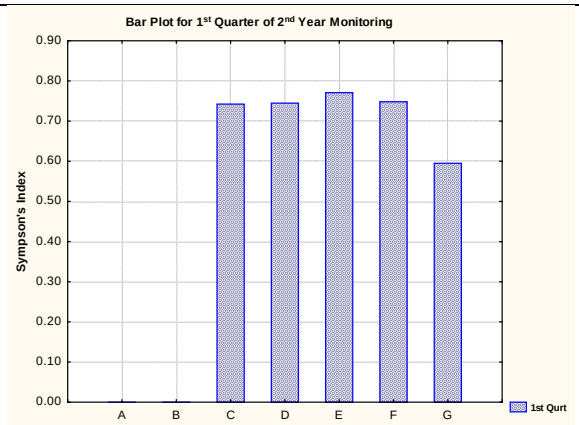
Photo 3.1.2: Length-wise distribution of fish species



2014-2015



2015-2016

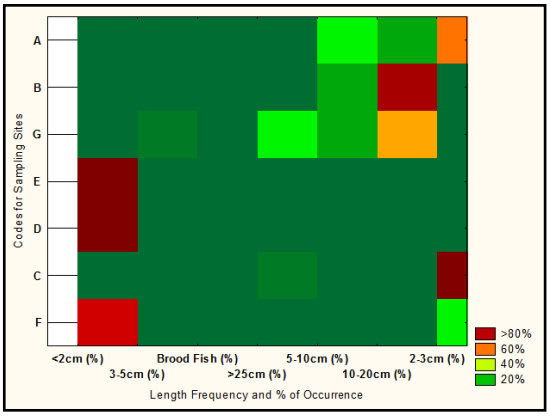


2016-2017

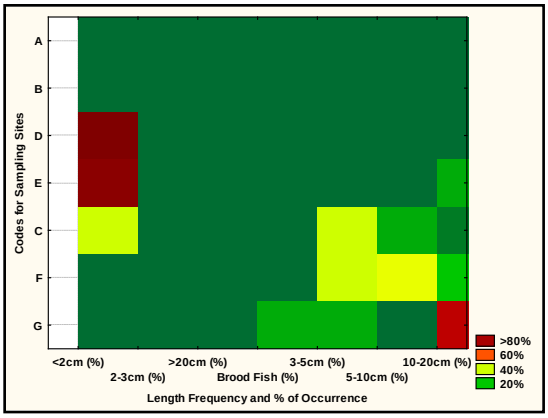
Figure 3.1.3: Site-wise fish species richness (FSR) in the Passur River System.
(FSR is identified though Simpson's Index)

c) Fish Community Structure

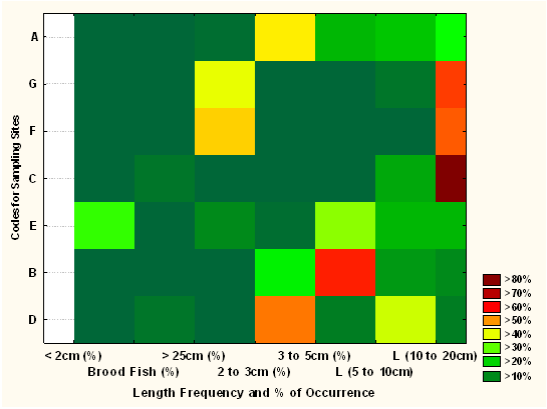
172. Fish community structure has been analyzed through counting the length-wise fish individuals (**Photo 3.1.2**). The following Table **D.2** and **D.3** of **Appendix IV** and **Figure 3.1.4** for first quarter of third monitoring year shows that fry and juveniles for fin fish were more widely distributed among the middle and lower stretches of the Passur River. Among these Bagda, Bele, Daitna and Paissa fishes were widely distributed among the sampling sites. Moreover, fry fish of Daitna and Paissa were found at Mongla Port, Loitta and Poma at Chalna Point; Bagda, Bata, Bele, Golda, Maya Chela and Paissa at Sheola Khal of Chandpai. Morover, brood female fish of Punti in Mongla and of Gulsha Tengra and Paissa in Harbaria have highly observed in this quarter.



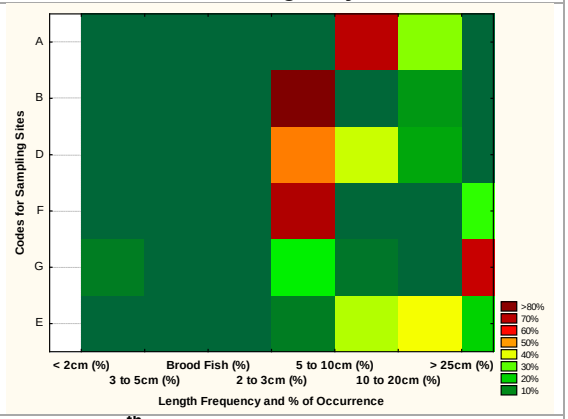
1st Monitoring, April, 2014



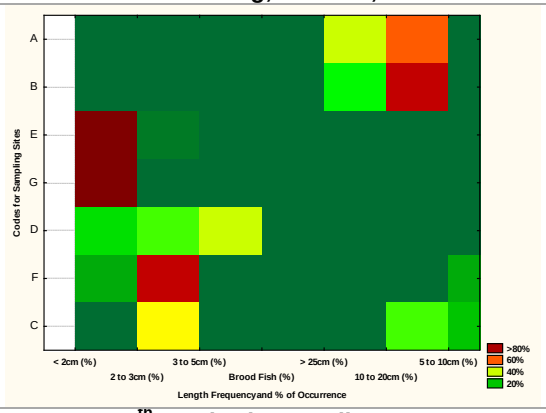
2nd Monitoring, July 2014



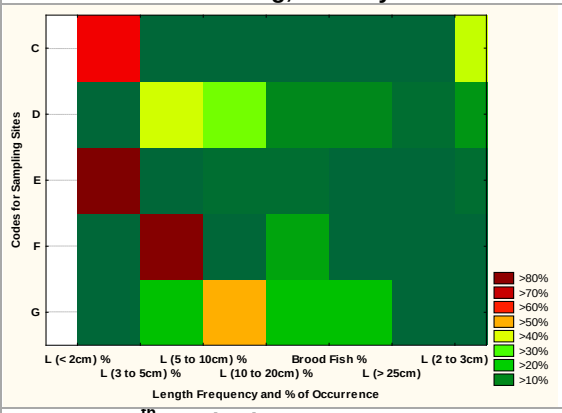
3rd Monitoring, October, 2014



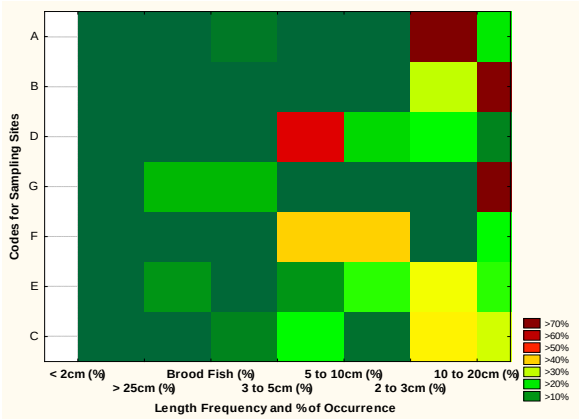
4th Monitoring, January 2015



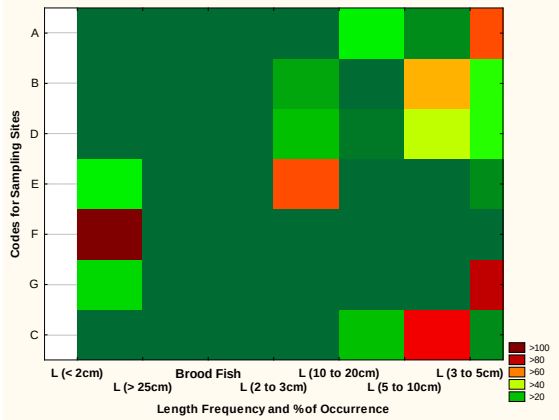
5th Monitoring, April, 2015



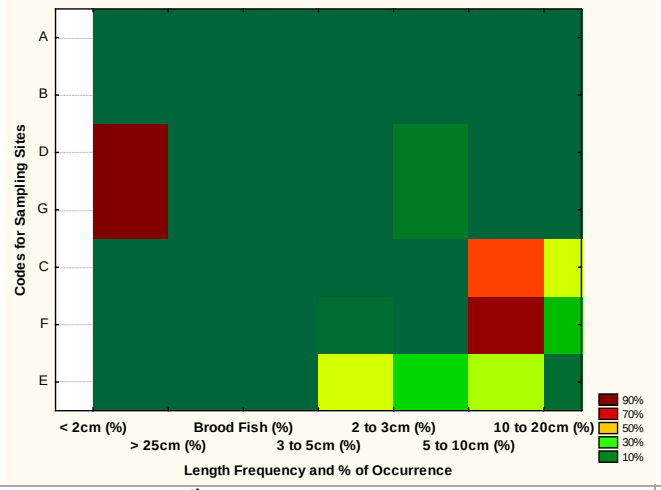
6th Monitoring, August, 2015



7th Monitoring, October, 2015



8th Monitoring, January, 2016



9th Monitoring, April, 2016

Figure 3.1.4: Habitat Distribution of Different Life Stages of Fish Species

Note: N.B.: Color 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

(a) Migratory Species Diversity

173. Migratory species have been identified by analyzing the common species available in the regular catch from the sampling sites. Fish species like Bele attains the maximum abundance among the migratory fish species observed in first quarter of third monitoring year. The relative abundance of the migratory species is give below in the **Figure 3.1.5**.

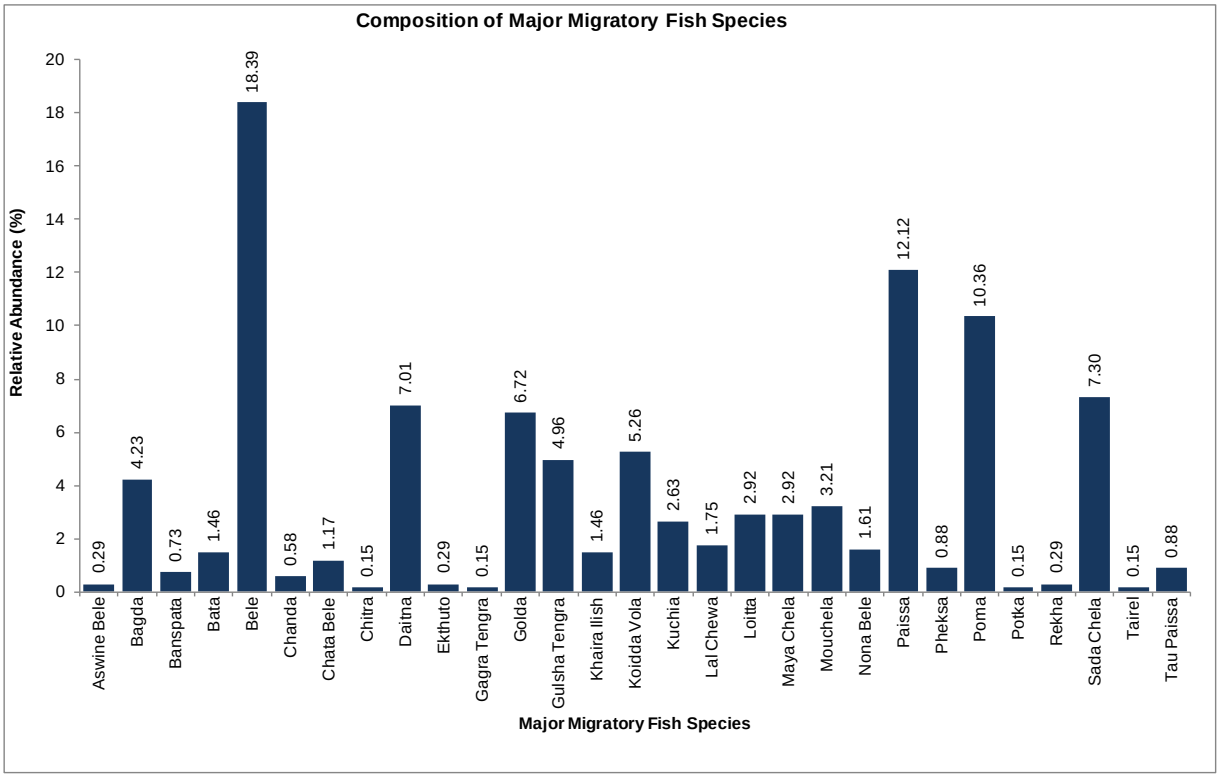


Figure 3.1.5: Relative abundance of major migratory fish species in sampling sites

(b) Migration Extent, Time and Purpose

174. Major fish species showed interesting pattern in distribution for exploiting different purposes mentioned in the following table all along the sampling sites. Six (6) fish species were found common in most of the sites. Only two species, Poma and Pheksa, have been observed indicating long range of distribution (**Table D.4 of Appendix IV**).

175. It is interpreted from the findings that in the month of April fish species migrate to the middle reaches of the Passur River mainly for breeding purpose and lower reaches for nursing.

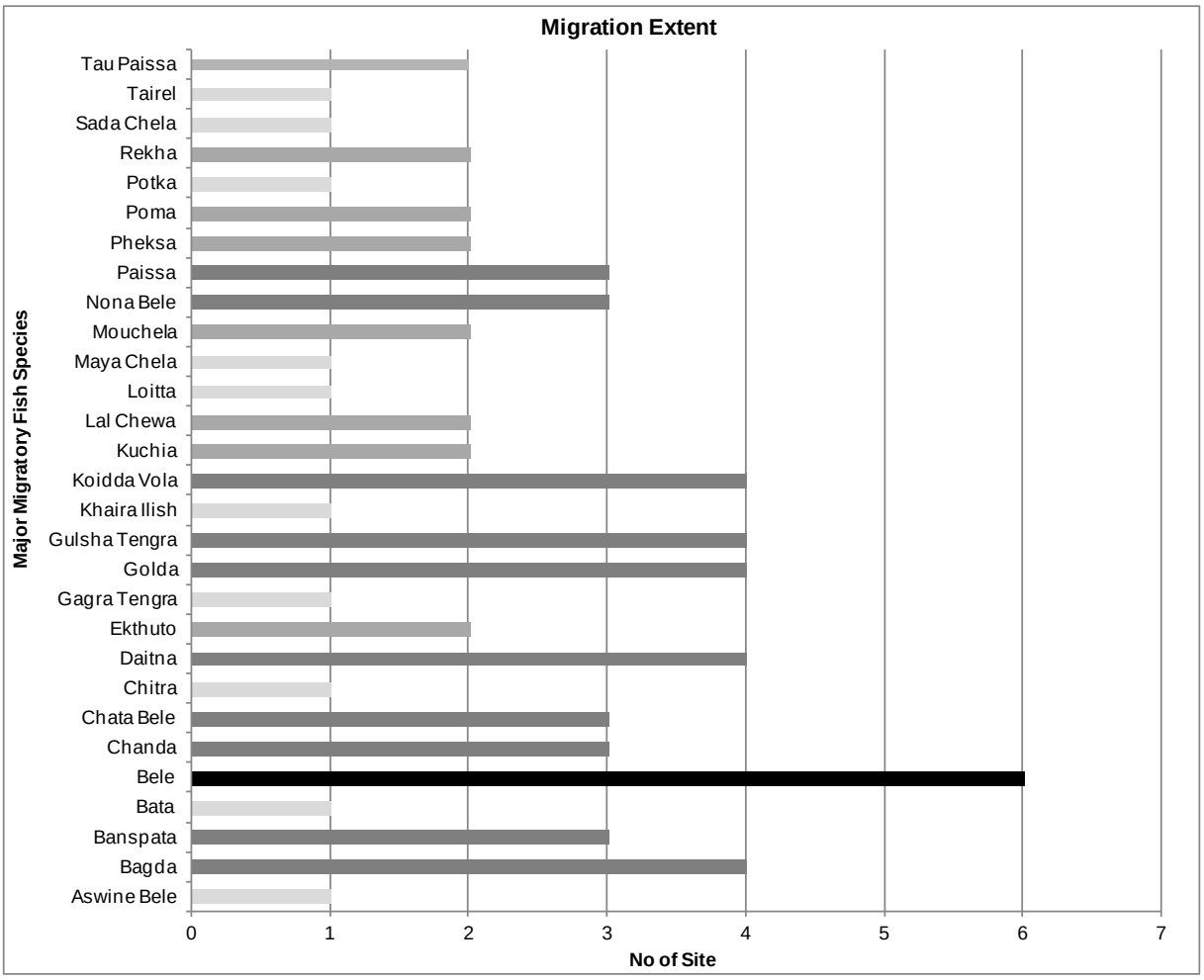


Figure 3.1.6: Migration extent of major migratory fish species in sampling sites

Shrimp/Fish Farm

176. Three farms situated in the direct impact zone of Power Plant have been 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 have been surveyed intensively.

(a) Stocking Pattern

177. It was reported by the farmers of the shrimp farms that availability of wild seed (PL) has been declining over the years. For this reason, one of the farm collect Bagda fry from both the wild (Passur) and hatchery (Namira and Sonar Gaor at Chalna) and another farm of Chunkuri-2 collected Bagda seed directly from Passur river. However, farm at Rajnagar could not stocking in this month because of soil dumping and creating bundh at the mouth of khal resulting from river restoration project of BWDB.

(b) Shrimp/Fish Growth Rate and Mortality

178. During the first quarter of third monitoring year, highest growth rate has been observed at farm in Kapashdanga and higest mortality rate (30%) at farms in Chunkuri-2.

Table 3.1.5: Growth Rate and Mortality of Fish/Shrimp

Gher No.	1st QM (Apr 2014)		2nd QM (Jul 2014)		3rd QM (Oct 2014)		4th QM (Jan 2015)		5th QM (Apr 2015)		6th QM (Aug2015)		7th QM (Oct 2015)		8th QM (Jan 2016)		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	-	-	-	-						
2	0.3	30-35	0.3	94	0.25	10	-	-	-	-	0.14	20	0.15	100	-	-	0.21	15						
3	0.2	25-30	0.2	25	0.20	65	-	-	-	10	0.15	50	0.25	20	-	-	0.17	30						

Source: CEGIS Field Survey, 2014 & 2015

Fish Production

(a) Capture Fish Production

179. In first quarter monitoring of the third year, the highest productivity has been found in Mongla-Passur River Confluence **(Table 3.1.6**). The lowest productivity has been found in the Chalna Point. However, in case of Chandpai and Harbaria lower productivity has been observed mainly because all the fry fishes (not considered as catch) have been found in these sites.

180. The present study observed that Charpata, Ber and Net Jal are frequently used to catch fish. The highest catch susceptibility has been found in case of Ber Jal (5 kg/haul) (**Table 3.1.6**). The following table also expresses that Ber Jal and Suti Jal are very commonly used in upper reach and Charpata Jal in lower reach of the Passur River. Moreover, the highest total catch is observed in Mongla Point and lowest in the Chalna Point in this monitoring phase (**Table-3.1.7**).

Table 3.1.6: Total Catch in Different Gears in the Sampling Sites

Sl. No	Site	Habitat	Gear Name/Type	Haul Duration (hr)	No of Haul	Total Catch (kg)	kg/haul
A	Akram Point	Kukilmoni Khal	0	0	0	0	0
B	Haldikhali	Haldikhali Khal	0	0	0	0	0
C	Harbaria	Harbaria Khal	Charpata Jal	14	1	2.75	2.75
D	Chandpai	Sheola Khal	Net Jal	2.5	1	0.75	0.00
E	Mongla Point	Passur River	Ber Jal	6	1	5	5.00
F	Maidara	Maidara River	Ber Jal	2	1	1.5	1.50
G	Chalna Point	Passur River	Suti Jal	2.42	1	1	1.00

Source: Catch assessment survey, CEGIS (2015)

Table 3.1.7: Total Catch in the Sampling Sites

Sampling Site	Total Catch (kg)											
	1st QM (April, 2014)	2nd QM (July, 2014)	3rd QM(Oct 2014)	4th QM(Jan 2015)	5th QM(Apr 2015)	6th QM(Aug 2015)	7th QM(Oct 2015)	8th QM(Jan 2016)	9th QM	10th QM	11th QM	12th QM
A	28*	0	3	28.7	6	-	20	276.2	0			
B	65	0	1	3.3	0	-	10	12.8	0			
C	1,559	0.5	8	8.7	1.05	0.33	19.5	173.6	2.75			
D	**	12	3	30.0	10.5	5.08	10.75	189	0.00			
E	**	0.6	5	0	0.5	0.40	0.6	7.8	5.00			
F	**	1.2	13	3.7	1.5	0.70	0.8	0	1.50			
G	**	1.6	4	0.7	2.9	0.83	0.825	70	1.00			

*Average Weight 0.15kg/mud crab and average weight 0.6 kg/mud eel
** Weight of Fry is not considered for catch assessment

(b) Culture Fish Production

181. The present study on shrimp/fish farm in the first quarter monitoring of 3rd year phase showed that the highest fish production has been found in the Gher of Kapasdanga and lowest in Chunkuri-2. However, no fish production has been found in case of Gher in Rajnagar **(Table D.5 in Appendix IV)**.

3.2 Agriculture Resources

182. Monitoring of agriculture resources has been scheduled twice a year as per the contract. Accordingly, a survey has been conducted in April 2016. 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 2014-15has 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.

3.2.1 Methodology

Monitoring Indicators

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

Sampling Method

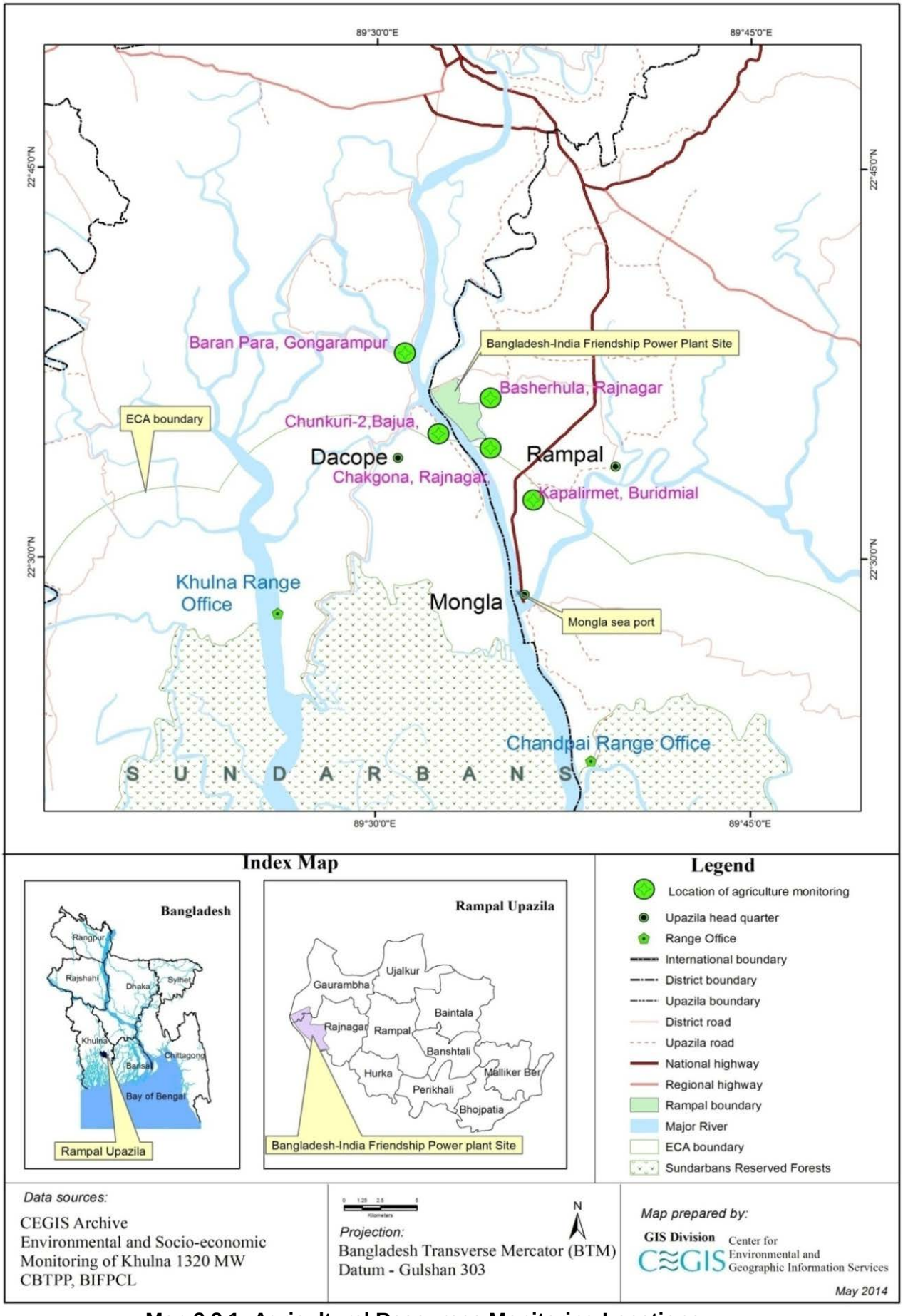
During field visit, extensive consultations/group discussions have been held with local people to know the use of inputs, present cropping patterns by land type, crop damage due to drainage congestion/water logging, salinity or other natural calamities induced impacts as well as management practices and crop production in the selected locations of the monitoring area.

Sampling Frequency

184. Land use, major crops area, major crop production and damages are monitored quarterly in a year. Data related to the cropping season of 2015-16 were collected in October, 2015 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, 2016 for the 1st quarterly monitoring of the 3rd year.

Location

185. 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 the **Map 3.2.1**.



Map 3.2.1: Agricultural Resources Monitoring Locations

3.2.2 Description of the selected agriculture land for monitoring

186. Detailed information of the selected plot for agriculture monitoring is presented in **Appendix IV.**

Upazila wise cropping pattern of the monitoring area for the period of 2014-15

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 **Appendix IV**.

Upazila wise cropped area, yield and crop production for the period of 2014-15

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 **Appendix IV**.

3.2.3 Present cropping patterns of monitoring plots

187. 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 **Appendix IV**. The cropping patterns for different years are presented in the following paragraphs.

Agriculture plot-1(Baranpara)

188. 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, 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.

189. In the Kharif-II season of 2015-16, 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 @ 500gmplot. 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 the **Appendix IV.**

Agriculture plot-2(Chunkuri-2)

190. 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, 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.

191. Farmer of the plot has been practicing Baran in Kharif-II season of 2015-16due 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: 3.5kg/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 the **Appendix IV**.

Agriculture plot-3 (Kapalirmet)

192. 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, 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 2014-15Due 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.

193. 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 **Appendix IV**.

Agriculture plot-4 (Chakgona)

194. 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.

195. Unfortunately, salinity contamination continued thereafter. So, he could not cultivate crops in his plot in Kharif-II season of 2015-16. 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 **Appendix IV**.

Agriculture plot-5 (Basherhula)

196. 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, 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.

Farmer of the plot cultivated Local Aman (Baran) in Karif-II season of 2015-16. 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 **Appendix IV.**

3.2.4 Status of Agricultural Resources

Crop Production

197. 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. The highest production (2.6 tons) has been observed in the monitoring agriculture plot-2 (Chunkuri-2) because only HYV Aman is cultivated in this plot 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 the **Figure 3.2.1 and Appendix IV**.

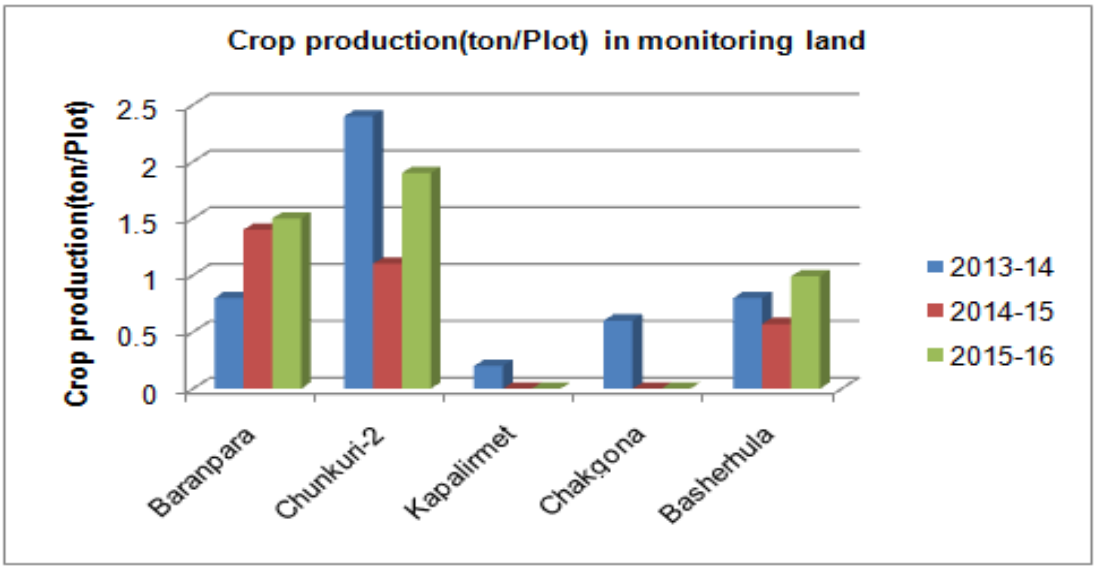


Figure 3.2.1: Crop production in the monitoring agriculture lands for the three consecutive years

Crop damage in monitoring plots

198. 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. Crop damage was observed in plot-2 (About 0.33ha) and plot-5 (About 0.17ha) in the year of 2014-15. 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 (plot-2 and 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 **Appendix IV.**

3.3 Sundarbans Forest Health

199. CEGIS team is monitoring Sundarbans forest health periodically to oversee the probable impact of Rampal Thermal Coal Power Plant Project under implementation. This monitoring program will also support to determine the status, trend and changes in indicators of the forest condition. The Sundarbans forest health is being monitored quarterly as per monitoring schedule and so far nine (9) surveys has been conducted at five locations, namely Sutarkhali, Karamjal, Harbaria, Akram point and Hiron point. The overall monitoring indicators observed in nine monitoring schedule broadly includes 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 First Quarter

200. Monitoring frequency for different indicators has been determined considering efficiency in time, cost and applicability. In this quarter, the following indicators have been observed:

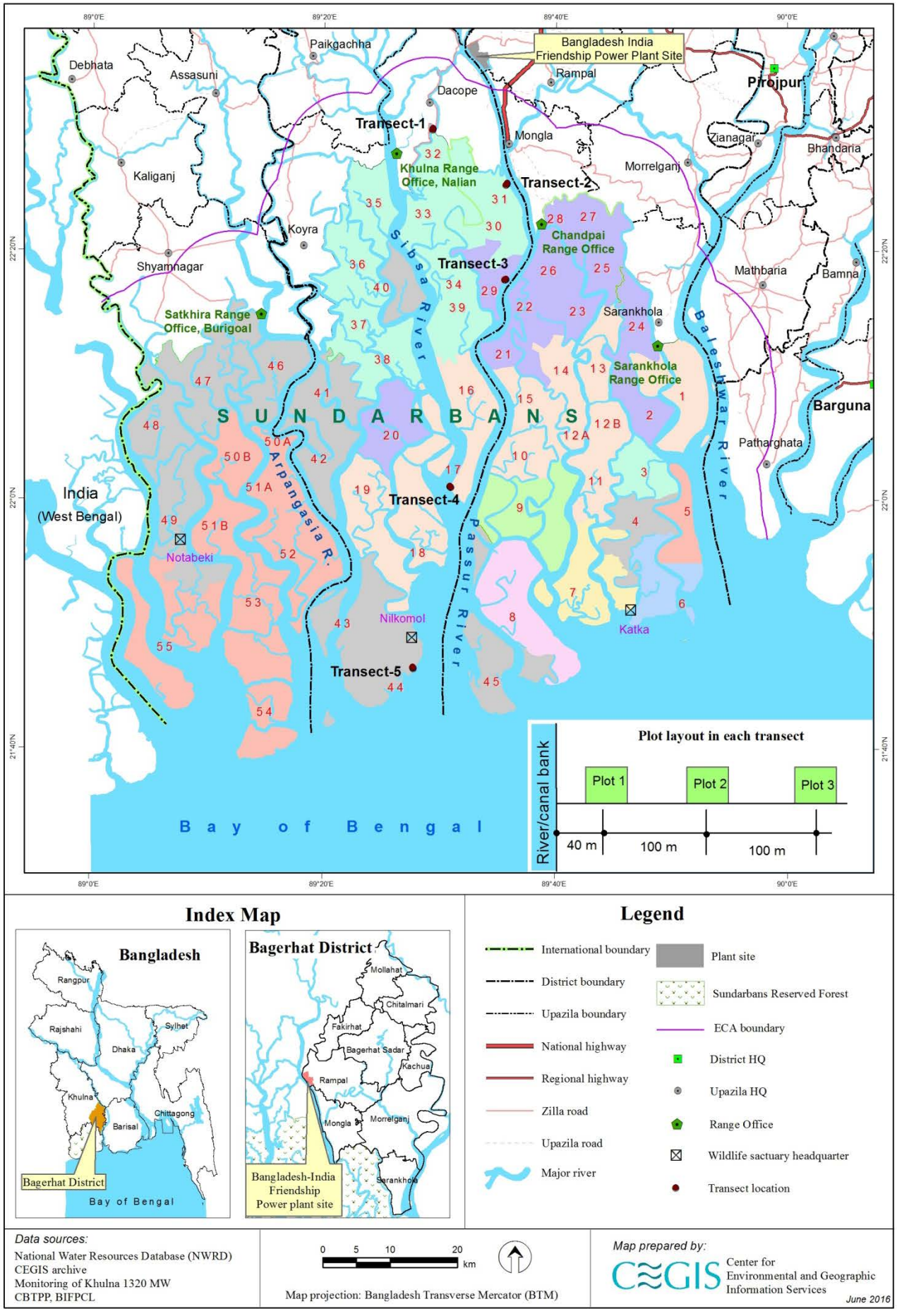
- Seedling Regeneration
- Pneumatophores
- Crab hole density
- Canopy cover
- Net canopy photosynthesis
- Basal Area
- Soil Properties

Forest Health Monitoring Location

201. Five sites have been selected to set up permanent sample plot on the basis of the survey conducted from April 3 to 6, 2014 (**Map 3.3.1**). 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. The sites have been selected considering 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)

202. 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 has been laid out at 100 m intervals in order to capture maximum tree species (**Figure 3.3.1**). Because of the variation in species composition in SRF observation plots have been laid out from 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 are again subdivided into four quadrates for the ease of data detection and recording (**Figure 3.3.2**).



Map 3.3.1: Location Map of Sundarbans Forest Health Monitoring Plots (PSPs)

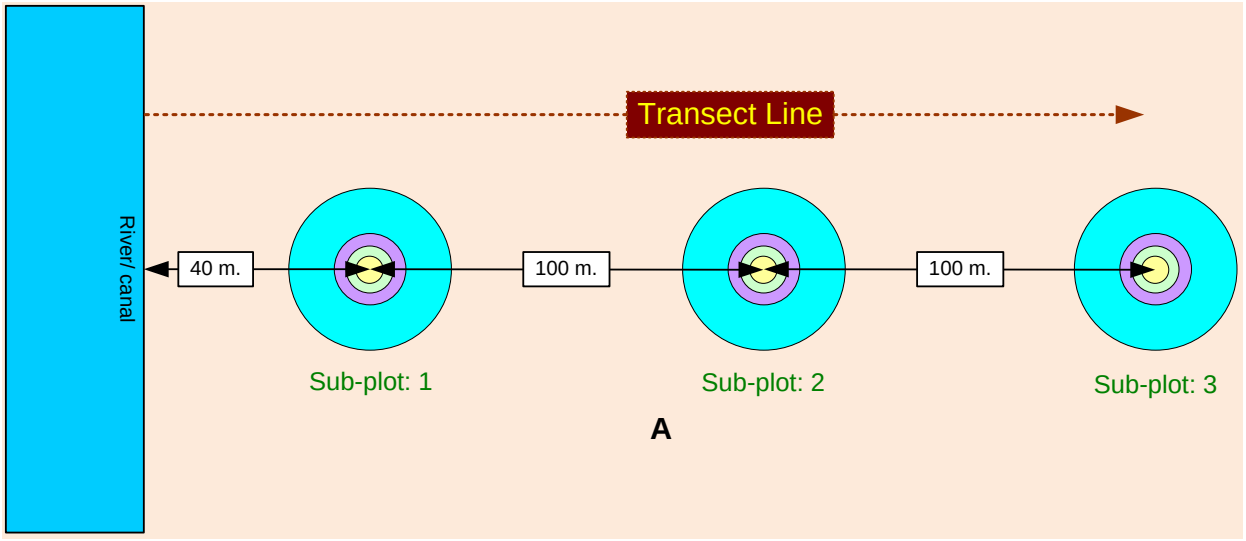


Figure 3.3.1: Layout of the subplots and transect line perpendicular from ecotone (river or canal bank)

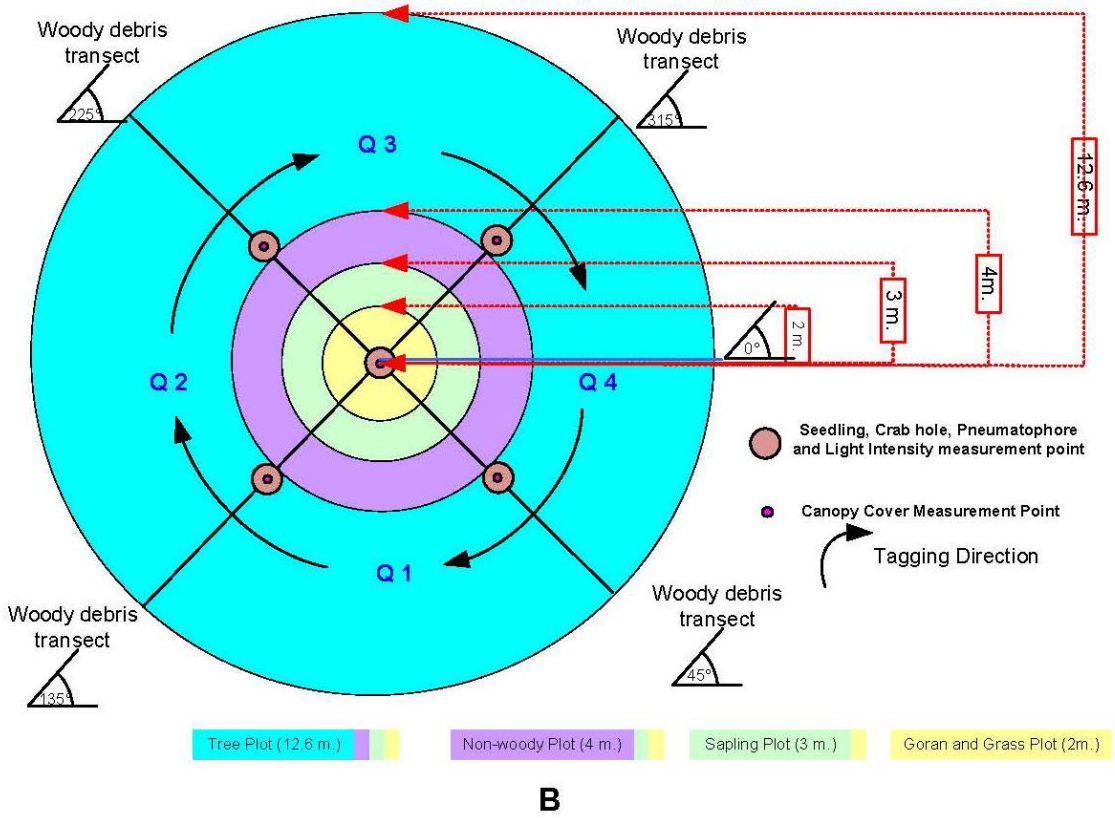


Figure 3.3.2: Layout of the survey activities in each subplot

Forest Health Survey

(a) Trees

203. The tag number of trees (DBH ≥ 5cm and lean angle greater than 450) is monitored and rewritten if any shade is found within 12.62 m radius circle of Permanent Sample Plot (PSP). In the same monitoring period a map showing the location of all trees (tag number) is developed for the ease of data collection next time (**Photo 3.3.1 & Photo 3.3.2**).

(b) Sapling and seedling

204. 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 there living status also recorded (**Photo 3.3.3**). For saplings species name and DBH have been recorded along with living status (**Photo 3.3.4**).

Photo 3.3.1: Team members checking tree tag number and painting marks on trees

Photo 3.3.2: Team Member recording and cross checking data in the field sheet

Photo 3.3.3: Team member counting the seedlings in the subplot

Photo 3.3.4: Surveyor measuring the DBH of saplings in the subplot

(c) Pneumatophores

205. The total number of pneumatophores with its living status has been recorded within a circular area of one meter radius around five points of each of the subplots. The first point

has been laid out in the center 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 3.3.5**).

(d) Crab hole

206. 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 center and in the midpoint of four woody debris transects in this study (**Photo 3.3.6**).

Photo 3.3.5: Team member counting pnuematophore on forest floor

Photo 3.3.6: Team members counting crab hole on forest floor

(e) Canopy Cover

207. Percentage (%) of canopy cover has been estimated by a spherical densiometer which is 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 in front of the body and at an elbow height, so that head is not visible in the mirror (**Photo 3.3.7**). After levelling the instrument using the level bubble, the dots, which are not occupied by canopy, are systematically counted. In each subplot, the readings have been taken at five points facing at north, south, east, and west direction including subplot center point. First one has been taken standing at subplot center and the other four are taken at the middle point of the four transects between center and periphery. The canopy cover has been calculated by taking the average of these five readings.

c) Net Photosynthesis

208. Light absorption by the forest canopy can be used to estimate leaf area index (**Photo 3.3.8**). By using this leaf area index, the net photosynthesis can be measured. Leaf area index and net canopy photosynthesis are calculated as follows:

- Leaf area index = loge (I/Io) / -k m_2 leaf area /m_2 area of ground (where k value is 0.5)
- Leaf area index correction = Leaf area index x Cos (O x 3.141593/180)

  (where 0 is zenith Angle of the sun for a given latitude, longitude, date and time of day from internet).
- Net canopy photosynthesis = Leaf area x rate of photosynthesis (0. g C /m_2) x day length

Photo 3.3.7: Team member taking canopy cover using Densiometer

Photo 3.3.8: Team member taking light intensity using Lux Meter

(f) Tree Basal Area

209. Tree basal area indicates the growth health of a forest which depends on tree diameter. Diameter (at breast height) and height of all the trees within the subplot has been recorded in this period (**Photo 3.3.9 & Photo 3.3.10**). Tree basal area has been estimated by the following equation:

$$BA\ (m^2) = 3.1416x\ (dbh/2)^2$$

Where, dbh = Diameter at Breast Height

Photo 3.3.9: Team member measuring the DBH of tree using Diameter tape

Photo 3.3.10: Team member measuring the height of tree using Range finder

(g) Soil sampling

210. 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 3.3.11**).

211. 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 3.3.11: CEGIS Professionals scaling out the soil sample

212. ***Bulk Density:*** 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.

213. ***Soil Salinity (EC):*** 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)

214. ***Soil pH:*** 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).

215. ***Total Organic Carbon:*** 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

$$LOI\% = (Wt105\ °C - Wt450\ °C)/Wt105\ °C$$

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

217. 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)

218. ***Soil Total Kjeldahl Nitrogen:*** 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.

219. ***Soil Total Phosphorus:*** 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

220. The seedlings density (number of seedlings per ha) has been monitored in all PSPs in the third year first monitoring period. The last eight monitoring period graph predicts that the seedlings survival rate is increasing almost all monitoring locations. The graph has also predicted that higher number of seedlings is being found during monsoon to post-monsoon period whereas the number has decreased during winter to pre-monsoon period. Among all monitoring locations, the seedlings status is comparatively lower Akram point (**Figure 3.3.3**). Seedlings usually die at the 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 and Hiron point also face natural stresses due to their location at very much close to the sea. In the Sundarbans, most of the mangroves' seeds disperse in the rainy seasons and go up to forest floor. In this relation, seedlings are usually found more after the rainy season than that of other seasons.

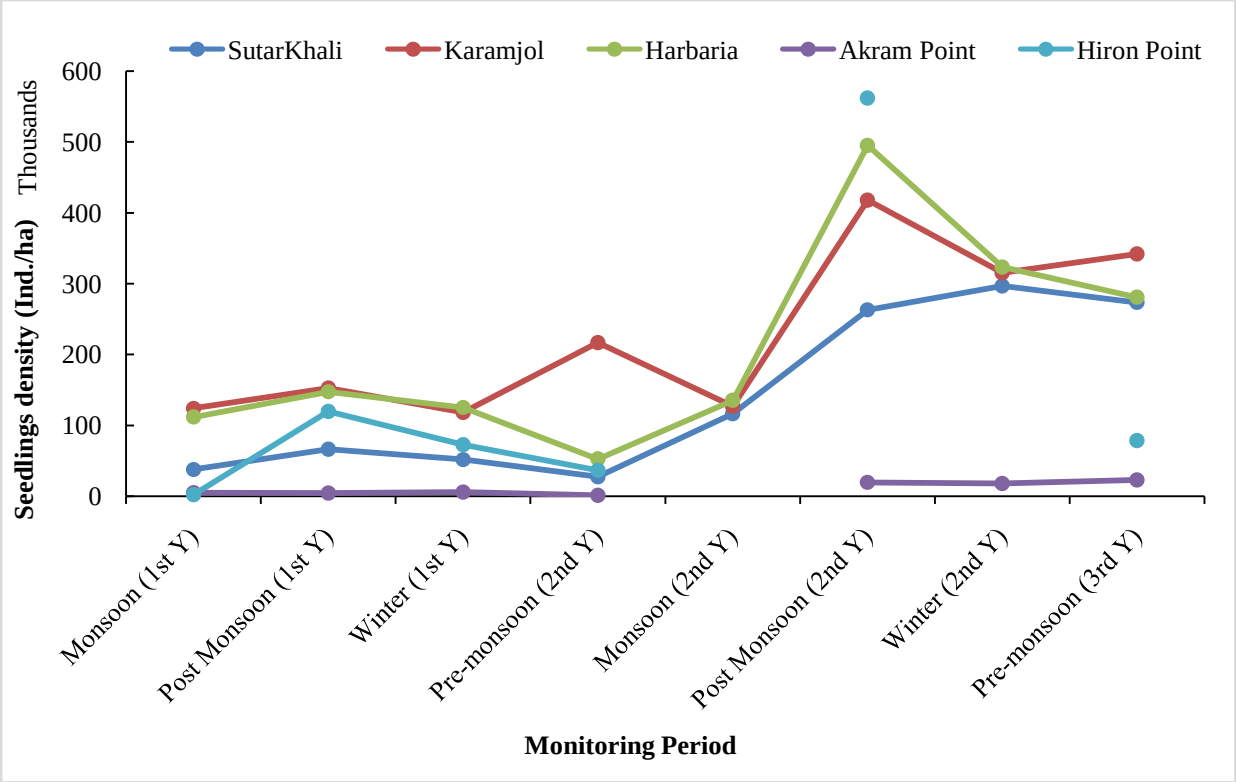


Figure 3.3.3: Mean (±95%CI) seedlings density among the quarterly surveys in five PSPs

(Seedlings density was not monitored at Akram Point during Monsoon 2nd Y as well as at Hiron point during Monsoon 2nd and Winter 2nd)

Pneumatophores

221. Like seedlings, pneumatophores density also changes due to seasonal variability (**Figure 3.3.4**). Pneumatophores usually dry up and die during dry season. Hence, the number of pneumatophores per hectare is found comparatively higher in monsoon period. However, among five monitoring sites, the mean pneumatophores density is found lower in Akram point and Hiron point due to floristic composition. From the species composition inventory, it is found that these two monitoring sites are 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 elevation of the forest floor from mean sea level (MSL). During survey, the monitoring plot at Hiron point has been observed much higher than others from MSL. As pneumatophores major function is to exchange gas from and/or into the atmosphere during tidal inundation, here due to less effect of inundation the number of pneumatophores may be less.

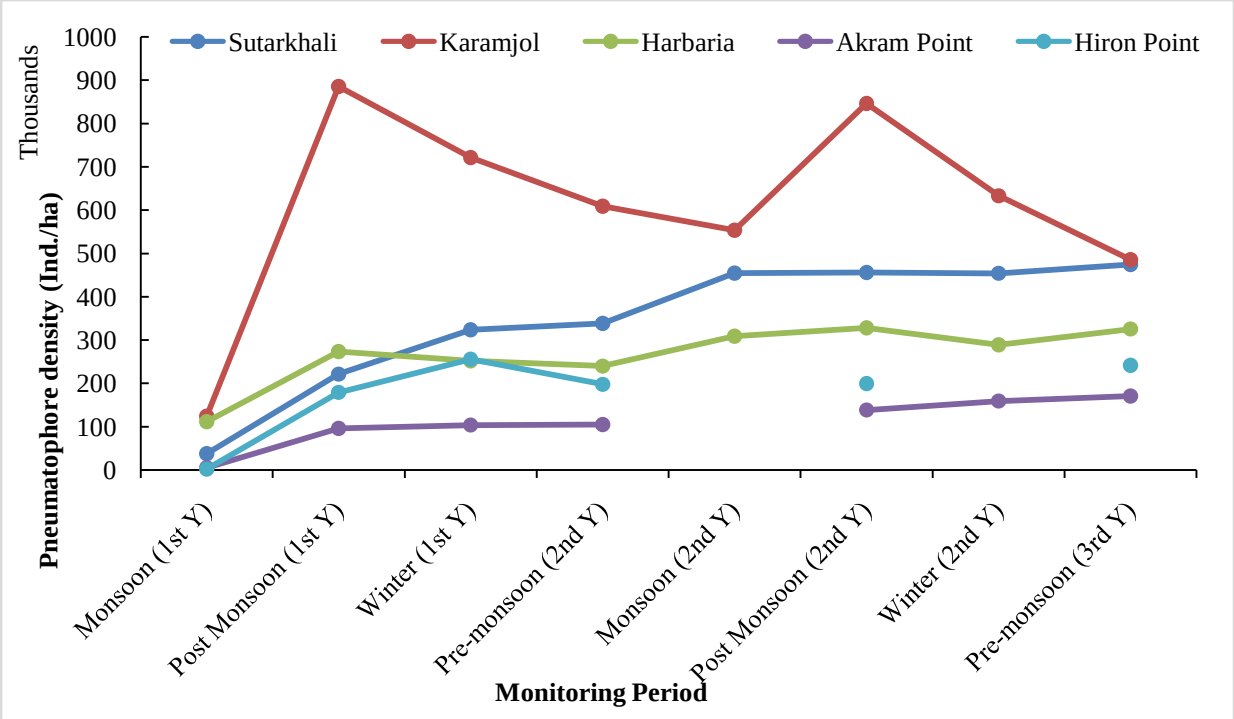


Figure 3.3.4: Mean (±95%CI) Pneumatophores Density among the quarterly surveys in five PSPs

(Pneumatophores density was not monitored at Akram Point during Monsoon 2nd Y as well as at Hiron point during Monsoon 2nd and Winter 2nd)

Crab hole

222. The crab hole density, the indicator of availability of crab in a site, has been found highest at Akram point and lowest at Hiron point among the monitoring sites (**Figure 3.3.5**). Like pneumatophores, crab hole may be less at Hiron point due to high elevation of the forest floor from MSL and the area does not inundated even during high tide.

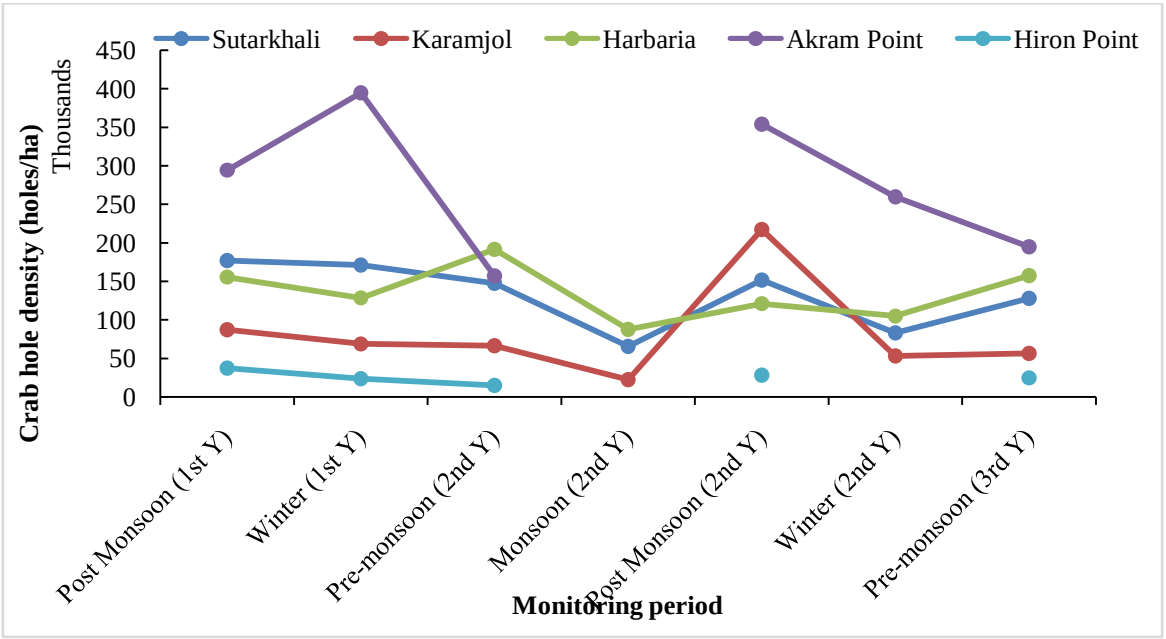


Figure 3.3.5: Mean crab hole density among the quarterly surveys in five PSPs

(Crab hole density was not monitored at Akram Point during Monsoon 2nd Y as well as at Hiron point during Monsoon 2nd and Winter 2nd)

Canopy cover

223. In the monitoring plots, the canopy cover percentages have not varied significantly. It is found that the canopy cover percentages are similar among the monitoring sites (**Figure 3.3.6**). Since greater than 60% of canopy coverage in a site is treated as healthy, all the locations of the monitoring sites are in good shape. However, this attribute has also shown similar characteristics in terms of change i.e. highest canopy cover percentage are observed during monsoon to post monsoon which started decreasing at winter and found lowest at pre-monsoon period except this monitoring tier. A comparative study between second year and third year pre-monsoon period has shown positive difference of canopy cover (%).

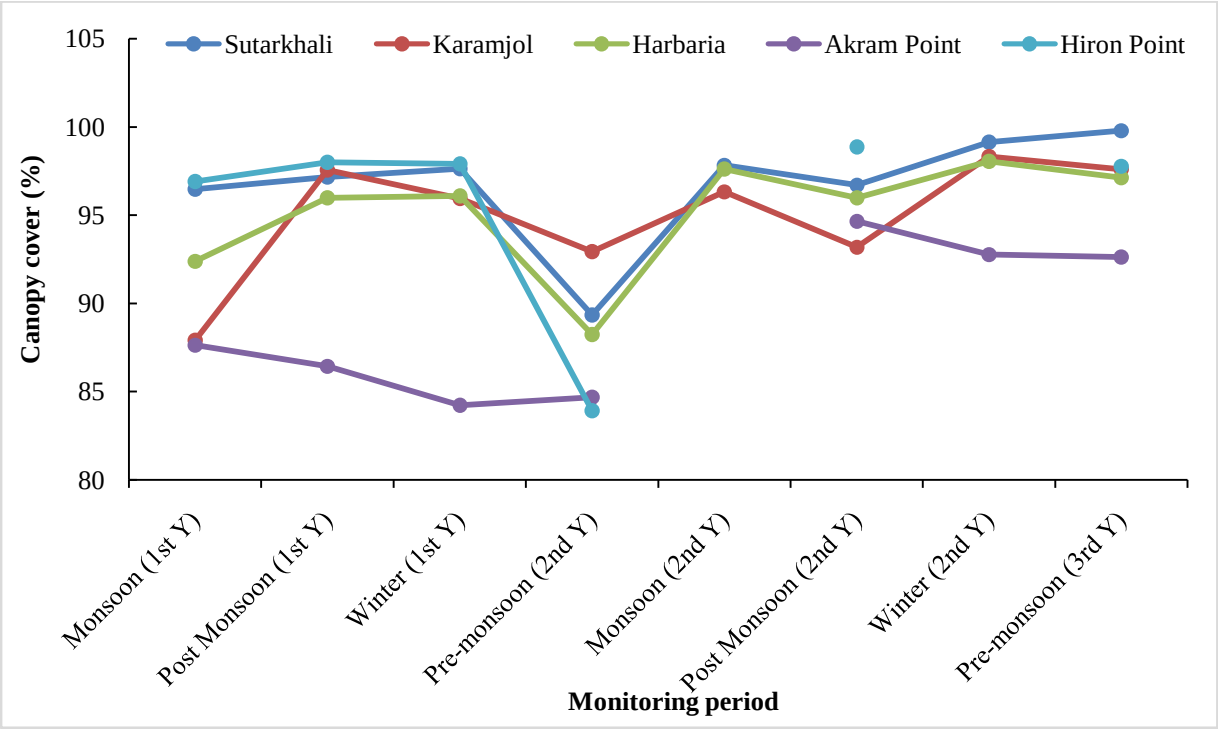
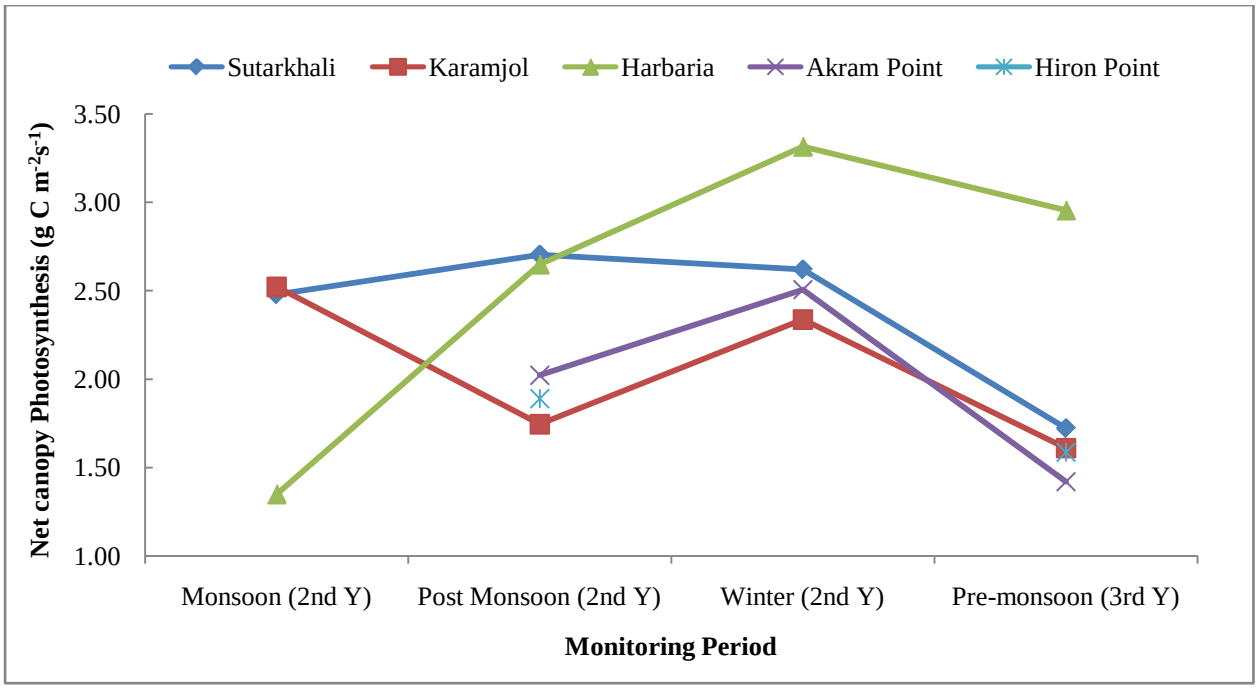


Figure 3.3.6: Mean canopy cover (%) among the quarterly surveys in five PSPs

(Canopy cover was not monitored at Akram Point during Monsoon 2nd Y as well as at Hiron point during Monsoon 2nd and Winter 2nd)

Net canopy photosynthesis

224. Net photosynthesis of the five monitoring sites has been given in the (**Figure 3.3.7**). The daily rate of net canopy photosynthesis depends on irradiance (the fact of shining brightly), atmospheric CO_2 and leaf area index. However, it is difficult to predict the effect of seasonal variability on net canopy photosynthesis from the graph. This may be due to cumulative impact of all dependant attributes.



225.

Figure 3.3.7: Net canopy Photosynthesis (g C $m^{-2}s^{-1}$) among the quarterly surveys in five PSPs

3.3.3 Tree Biomass

Tree height and diameter data is collected every alternate monitoring period preferably pre-monsoon and post-monsoon period**. Figure 3.3.8** shows comparative picture of basal area per hectare between second year post-monsoon and third year pre-monsoon period among five monitoring sites. The figure predicts that basal area (indicator of forest growth) per hectare is increasing with time interval almost all locations except Hiron point. The result is reverse at Hiron point because of massive illegal felling of trees that has been observed during field survey **Photo 3.3.12**).

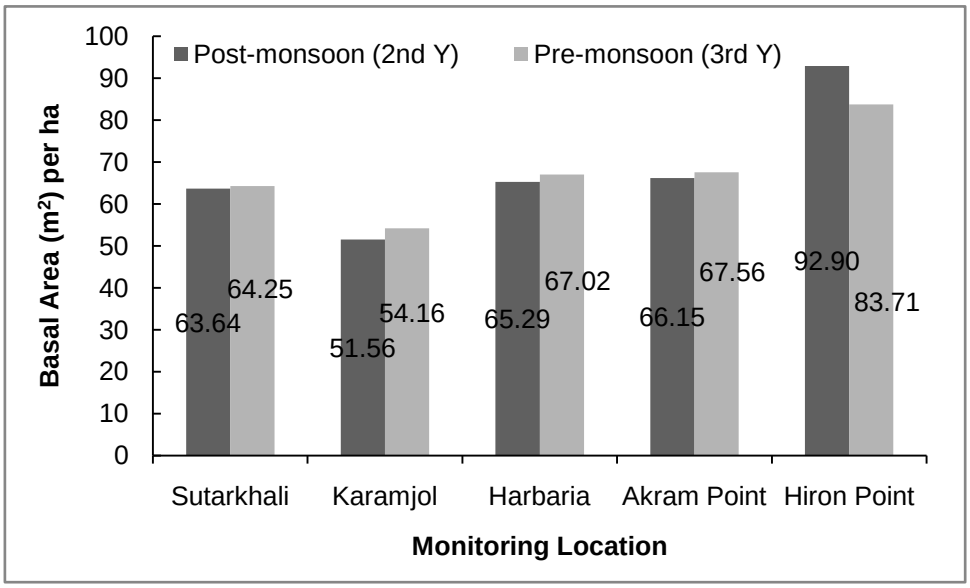


Figure 3.3.7: Basal Area (m^2) per ha among the quarterly surveys in five PSPs


Photo 3.3.12: Status of illegal felling of trees at Hiron point

3.3.4 Soil properties

226. The soil properties were analysed using samples collected in second year final quarter (winter period) from four monitoring sites (excluding Hiron point). The mean bulk density, Soil pH, soil salinity (EC), OC%, N and P contain across the four monitoring sites were given in table 3.3.1. The bulk density, pH and P contain of soil across the depth intervals in the four monitoring showed a similar figure. The mean bulk density of the monitoring sites was slightly higher than that of the range of bulk density of SRF (1.18- 1.27 g cm-3). 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 (8.35 ms cm-1), while this figure was lowest in Harbaria (3.05 ms cm^{-1}, Table 3.3.1). The OC% has been observed similar figure in all monitoring locations (four). However, in Sutar Khali OC has been found 8.63 % at 30 – 50 cm soil depth, which is much higher than the average range. This finding may be due to the presence of organic debris at the sample collection point. The N concentration was found similar in Karamjol, Harbaria and Akram Point (Table 10.3). Lowest N concentration has been observed at Sutar Khali site (Table 10.3).

Table 3.3.1: 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	1.51	7.83	4.85	2.95	0.51	0.44
15-30	1.52	8.03	5.14	2.72	0.59	0.45
30-50	1.33	8.22	4.75	8.63	0.65	0.40
50-100	1.38	7.97	7.21	3.19	0.33	0.42
0-100	1.51	7.83	4.85	2.95	0.51	0.44
Karamjol						
0-15	1.35	7.65	8.35	3.67	0.68	0.42

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})
15-30	1.58	7.71	6.96	3.28	0.56	0.38
30-50	1.57	7.77	7.89	2.63	0.58	0.41
50-100	1.60	7.96	7.49	2.63	0.98	0.44
0-100	1.35	7.65	8.35	3.67	0.68	0.42
Harbaria						
0-15	1.29	7.83	3.19	3.15	0.70	0.45
15-30	1.53	7.82	4.61	3.37	0.60	0.43
30-50	1.50	7.94	3.05	2.91	0.44	0.43
50-100	1.46	7.23	5.92	3.00	0.61	0.42
0-100	1.29	7.83	3.19	3.15	0.70	0.45
Akram Point						
0-15	1.49	7.87	5.83	2.66	0.64	0.42
15-30	1.37	7.78	5.07	2.97	0.85	0.43
30-50	1.52	7.76	5.94	2.66	0.80	0.44
50-100	1.60	7.77	5.38	2.70	0.36	0.38
0-100	1.49	7.87	5.83	2.66	0.64	0.42

3.3.5 Findings

227. After analyzing the nine monitoring survey indicators, it can be predicted that the changing trend for majority of the indicators of forest health in SRF is related to seasonal variation. For example, seedlings' density, pneumatophores, crab hole and canopy cover are found highest and lowest after and before monsoon period, respectively. It can also be predicted that the indicators vary with locations due to different environmental and biophysical parameters. However, this monitoring tier has found major impact of anthropogenic interventions forest growth (biomass per hectare) at six month intervals. Hence, It is strongly recommended that the monitoring should be continued to observe the seasonal variation of concerned indicators for sustenance of Sundarbans forest health.

4 Social Environment

4.1 Socio-economic Condition and Social Safeguard

228. This section of the report intends to investigate the change (either improvement or deterioration) of the identified socio-economic indicators/parameters with reference to the previous monitoring results and constitutes 9th Monitoring report (i.e. 1st Quarter 3rd year-submitted Quarterly and initiated from 4th to 10th April, 2016) covering fourth phase of socio economic monitoring (six months interval) study and also updates environmental and social monitoring data to April, 2016.

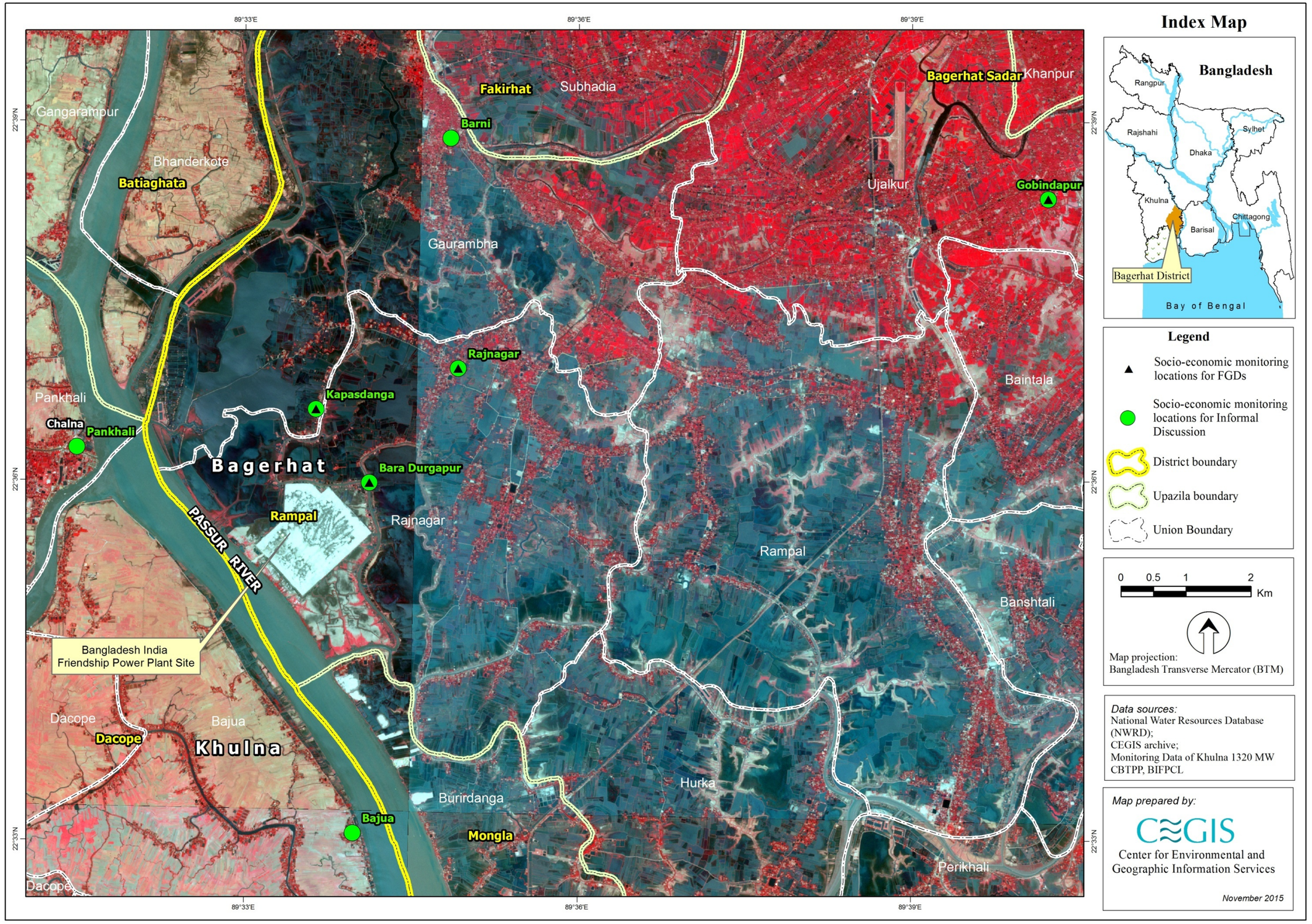
229. The socio-economic status changes gradually with time and as such the frequency this assessment is planned tri-annually and subsequently resumed during this current monitoring period.

4.1.1 Methodology

230. All socio-economic parameters will not necessarily be changed due to Project activities. So for that, changes on important parameters/indicators were examined in this phase with reference to its earlier condition. The monitoring methodologies adopted in this study was similar to the previous study (conducted in October, 2015) such as Focus Group Discussion (FGD) and informal discussions.

231. Total 4 FGDs and 5 informal discussions were conducted both in Project site and adjacent areas. One FGD in Foyla bazaar comprising of resettled populations and the rest three were conducted in Rajnagar, Baradurgapur and Kapasdanga mouzas comprising of local inhabitants. Out of four (5) informal discussions, two were with Project Management and the rest three (3) in Barni, Pankhali and Bajua mouzas with local people (**Map 4.1**).

232. For both FGDs and informal discussion a checklist with the compliance of "Performance Standards on Environmental and Social Sustainability" formulated by International Finance Corporation (IFC) was followed.



Map 4.1: Socio-economic Monitoring Locations

4.1.2 Exploration of Monitoring Parameters

Compensation

233. In the previous monitoring reports, it was mentioned that the compensation process for most of the affected people had been completed and the remaining would be compensated within the next six months period subject to provide the legal documents of the acquired land. At present, during the study, it is noticed that a small number of land leases are being compensated. Due to inadequate legal documents, a considerable number of affected people did not get compensation. It is mentionable that the lessees are not getting the administrative support for facilitation of the compensation money in every case. Local people are expecting the involvement of Government/Project authority to resolve the issues as soon as possible.

234. During the field visit of present quarter monitoring, an issue regarding compensation of the acquired land of the Project came up.

235. Before acquiring, the lands of the proposed Power Plant were sparsely populated and generally used for fish culture by the local people or remained vacant. After acquisition, the stakeholders were prohibited to do any activities within the acquired land.

236. Due to inadequate legal documents, a considerable number of affected people could not claim compensation against the acquired land and remained out of the compensation process. This situation created frustration among the affected people regarding the land acquisition and compensation procedure being followed. In this regard the Project authority informed that land acquired and compensation for the acquired lands of the said Project have been given to the affected people having legal document following the provisions of The Acquisition and Requisition of Immovable Property Ordinance, 1982.

Resettlement/Rehabilitation

237. Total 18 households have been resettled in Foyla Cluster Village without sufficient livelihood options. However, 4 allotters have left the cluster village due to lack of accommodation and income generating options. The resettled people are not able to cope with the existing facilities.

238. These affected people, who were engaged in shrimp culture related activities on the Plant acquired land, are mainly landless. The affected people are being bound to change their profession due to acquisition of land. These people are now coped with non-agricultural labor, rickshaw or van puller, day labourer and other sub-urban working patterns, etc. Their working experience is not matching with the livelihood options in Foyla Bazar, a sub-urban area. In addition, the social bondage and relation with the neighbours and the host communities are not yet built up. The host of these affected people are not treating them nicely, which impacted the scope of their employment and building up their relationship.

239. Lands (6 decimal) have been allocated to each resettled household, but the re-settlers haven't got permission to pay land tax. Unethical demands of land office, which is beyond their capacity, may be the cause of delay for the preparation of resettles land document, where they are currently residing. As a result, the resttlers still remained landless and fear of eviction anytime from the present residence is always there.

240. It is noticed that until last survey, few re-settlers, involved in Project site activities for harnessing livelihood, are not involved in the Project related activities in present days. Reasons for neglecting Project related works are - uncertainty of work period and high travel cost from the residences to the Project site. It was opinioned that if the Project authority can arrange transport allowance and the opportunity of secured jobs for a reasonable period, these affected people may work willingly at the Project site.

241. After opening the Mongla-Ghaisakhali navigation route, internal silted-up *khals* were re-excavated, which has interrupted the communication facilities of the re-settlers. A wooden bridge over the Mora *khal* would be helpful to the resettles for easy access to the urban side.

242. The resettled population urged to be involved in Project related activities suitable for them. As the resettled site is far from Project site, accommodation facilities in the labor shed at the Project site or transport allowance would be helpful for their movement from the shelter home home.

Project Related Employment Generation

243. At this stage, the current activities of the Project including- constructing base office at Block a brick crushing, tree plantation and land preparation at Block B etc. At this stage, number of skilled migrated labours has been engaged in those activities. Therefore, involvements of local labourers are negligible.

244. The sub-contractors, called *Sarder,* are responsible for hiring labors from locality and beyond (other districts). There are some variations on payment of wages among the labors according to the types of activities. For earth work and light weight lifting activities, labors are paid Tk. 290 per day excluding the commission of *sarder* which is 10 Tk per head. For rod bending and binding, the payment is Tk. 500 per head including commission of *Sarder;* and masons are paid Tk. 600 to Tk. 650 per head including commission. During recruiting, contractors mainly consider the availability of labors, suitability of work and payment rate per day. Four *Sarders* are locally selected from two adjacent unions with duly noticing the respective union Chairman. The contractors contact with labors for meeting up their requirements on need basis.

245. With the progress of construction work, demand of skilled labours is increased. Therefore, scope for unskilled local labours is reduced. However, the local people have the anticipation that they will be prioritized in employment opportunities for the Project.

246. The Project proponent is also expecting to employ huge manpower assuring engagement of all the locals very soon as the EPC contractor is about to set in for a full-fledged construction activity of the Power Plant.

Labor and Working conditions

247. At present the Plant is in preliminary site preparation (pre-construction) phase. Main activities at site will commence as soon as the EPC contractor sets in. In recruiting, no formal written agreement is made with labors. Therefore, verbal agreement is practiced for both recruitment and dismissal process. In terms of skilled labour recruitment, contractors feel comfortable recruiting migrated labour (with whom they are working for years) rather than local labors. There should be provisions for prioritizing the employment of the local people in non- technical activities.

248. A considerable number of labors (about 300) used to stay in the temporary labor sheds that are made of locally available thatching materials e.g., Golpata and Bamboo. Presently, a few labors are using those temporary labor sheds as because for the last few months no works have been taken place at Project site due to completion of preconstruction work, they will do until starting construction work. The condition of these labor sheds urgently needs repair. The respective authority assured that the conditions of these temporary sheds would be improved by the EPC contractor when activities of the Power Plant will commence.

249. Numbers of toilets including pucca, porta cabin type and RCC ring type have been seen at the Project site constructed for creation of better sanitation facilities for labors and workers. Water treatment plant has been installed in the Project site for drinking, cooking and bathing water supply which is planned to start operating in the 2nd week of October, 2015. Before that drinking water for the labors and officers staying in the Project site was supplied from the deep tubewell installed within the premises.

250. In the case of occupation health and safety, labors are found to use safety shoes and helmets which are provided by the authority. Regarding welding activities, hand gloves and glasses are also provided for safety. It was observed that most of the skilled workers are used to those safety equipments but the unskilled labors showed a little unwillingness to use those equipments. For regular use of those equipments the labors need more counseling and convincing activities by the Project authority. In several cases, the labors when experienced minor injury they were immediately provided first aid, necessary medical support and free medicines by the Project authority.

251. Land of the Project site is developed by sand, so blowing of sand in heavy wind is creating harmful situations for the labors as well as the inhabitants of the peripheral. This may create health (occupational) hazard as dust may cause respiratory and skin diseases. Sprinkle water system is not yet installed in the Project site for dust control. Water is sprayed around the premises of site office to control dust. A boundary wall around the proposed Plant has been constructed to control dust, a portion of which was damaged during the last monsoon. Initiative has been taken by the Project authority to repair the damaged portion of boundary wall. Laborers are encouraged to use musk during the works. However, the Project management has informed that control measures are being taken to reduce the impact of dust generated in the Project area.

252. It was informed that there is no bonus in festivals (Eid, Puja etc), the labours get leave as “leave without pay” basis in festivals. It was also informed that there is lack of grievance redress mechanism. In response to this, the Project management informed that grievance redress cell would be formed soon to take care of the labor related problematic issues.

253. It has been observed that the labor and their working conditions have been gradually improving since early 2014. Thought the condition of labour is improving gradually, mentioned conditions should be further improved based on the required standard.

Toilets for Labors

Treatment Plant for Drinking water

Photo 4.1: Facilities provided relating to labor and working condition

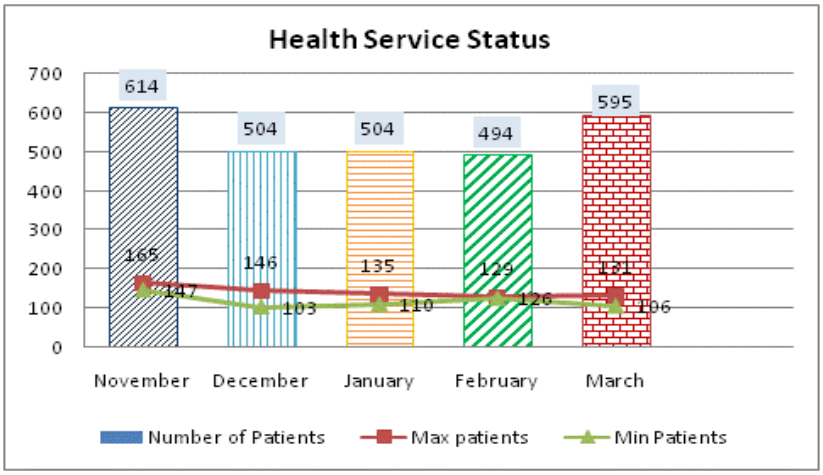
Community Health Safety and Security

254. People residing in the adjacent area particularly Kapasdanga, Geronkhali and Bara Durgapur are facing trouble as dust generated from the Project area is spoiling their food and causing itching. The Project authority informed that the boundary wall would decrease the spread of dust. But after building the boundary wall, still dust is spreading Abundantly. So, to reduce the spread of dust there should be watered in the project site and planting grass.

255. Grievance Redress Mechanism should be established immediately; a system to receive the grievance and to take appropriate measures has to be developed too.

Activities under Corporate Social Responsibilities

256. Free medical service is being continued and getting familiar o local people. The coverage area of this service is growing day by day. This free service is provided in the Project site on every Wednesday from 10:00 am up to the last service recipient. Unlike previously, it has now taken an institutional form: a separate room for providing service, separate shelf for keeping medicines and other particulars, a bed for check-up and 3 supporting staffs etc. A record is maintained including receivers' address and contracted diseases.



Source: CEGIS's Field visit to Project office, April 2016

Figure 4.1: Record of health service recipients under CSR program

257. From the record it was found that 2,711 people had received health services in the last five months. The highest recipients are in November-2015 (as it has 4 weeks) and the lowest is in February-2016 (**Figure: 4.1**). The above figure also shows the maximum and minimum recipients on monthly basis. Usually the service is provided once in a week (Wednesday); however, patients can get medicine or other minor medical facilities from the paramedics throughout the week except the weekends. It appears in **Figure 4.1** that number of minimum recipients fluctuated more compared to the number of maximum recipients over last five months.

258. In analyzing gender of the patients, it was found that females are the predominant group. However, number of male patients is also increasing. Females received medical facilities for fatigue, headache, and pain in lower abdomen, coughing, acidity etc. On the other hand, the dominant male recipients mainly received facilities for dysentery, coughing, fever and some minor injuries occurring during laboring works.

259. The local people and the service recipients are satisfied for having such opportunity. However, it was observed that the recipients had to walk a long way for receiving health services due to poor communication system, which is troublesome, particularly for women. Therefore, if the Project authority insists the LGIs for developing road communication system from surrounding localities to the Project site, the patients would be relieved of that hardship.

Bara Durgapur

Kapasdanga

Foyla Shelter Home

Photo 4.2: Photographs of stakeholder consultations

5 Environmental Compliance

5.1 Introduction

260. The Project is now at the site development stage and various development activities are in progress. The land development activities of the Project area for the first phase are nearly completed. The Project site for the first phase is encircled by boundary wall. Pre-fabricated office building, slope protection works, tree plantation activities etc. have been moving ahead. Construction and development of connecting (approach) road between the Project site and Khulna-Mongla road is progressing fast. However, there are some environmental compliance measures in environmental management plan that should be at place during this pre-construction stage.

261. The environmental compliance monitoring that includes monitoring of EMP implementation is based on physical observation and assessment. A comprehensive diligence checklist has been developed to monitor the environmental compliance to 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.

262. The aim of the checklists is to check the diligence of measures 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 labor 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	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. • Sprinkling of water at some places • Preparing for construction of paved road	• Construct brick road within the Project site for traffic movement firstly(if possible) • Otherwise, demarcate traffic way and enforce that all the vehicles are using the demarcated way only. • Spray water along the road and road side to suppress dust generation	Being Complied
3	Water Quality	• Fencing the construction site • 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	• Construction of boundary wall for the main Plant • Rainfall runoff discharge to nearby river through unmanaged/unplanned drainage network at some places • Onsite sanitation facilities	• Temporary drainage for rain fall runoff should be constructed; • Stockpile of construction material should be placed at a safe distance from drainage network; • Sediment trapping pool	Being Complied

*Table 5.1: Monitoring of Environmental and Social Management System Action Plan Implementation **(continued)***

Sl no	Potential Impacts	EMP measures as proposed in the EIA	Actual condition/ Measures already Implemented	Recommended Action	Compliance Status
		• No disposal of waste and waste water to river or canal.	has been developed at the labor sheds as well as the working places	may be created before final discharge of the rainfall runoff from the Project site.	
4	Waste Management System	• Provision of onsite waste management system	• Conventional way of waste collection and disposal system at Plant office and kitchen	• Sufficient waste disposal bin/s with labelling should be installed at labor shed, and working area before the main construction works	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 • 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,	• 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 • BPDB is communicating to the GoB for taking some further initiatives for resettlement of the people who do not own the land but have been dependent on it	• 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

*Table 5.1: Monitoring of Environmental and Social Management System Action Plan Implementation **(continued)***

Sl no	Potential Impacts	EMP measures as proposed in the EIA	Actual condition/ Measures already Implemented	Recommended Action	Compliance Status
		indigenous people etc.) • Provision of monitoring the compensation and resettlement process	for their livelihoods		
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 laborers 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 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?	• Recruited a social officer responsible for maintaining social liaison; • Engagement of Human Resources consultant for preparing HR policies, Labor recruitment Policies, Manpower set up etc.; • Construction of toilets for labor near labor shed; • Provision of first aid; • Setting up medical unit capable of dealing emergency situation like injury, accident, etc.	• 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	Being Complied
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 and machineries; • Switching off and throttling down the machines/equipment/generators which are not in use.	• Informing the bidders for EPC 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.	• Prepare checklist on 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.	To be 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; • Preparing to recruit Environment, Occupation and Health Safety Expert; • No discrimination has been recorded.	• The proposed EMP measures should be addressed in the HR policies; • Local unskilled workers would be given priority during recruitment for non-technical jobs. • Grievance Redress Mechanism should be established.	Compliance action initiated
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 education, or to be harmful to the child health or physical, mental, spiritual, moral, or social development. • No Forced Labor	• Ensured no child labor employment • Ensured no forced labor • Using of appropriate PPE	• The HR policy should cover child labor policy and Labor Law 2006 and all other amendments; • Proper documentation of contract with the worker is required, which includes working hour, wage, and benefit.	Compliance action initiated

*Table 5.2: Monitoring of Labor and Working Condition **(continued)***

Sl no	Potential Impacts	EMP measures as proposed in the EIA	Actual measures already Implemented	Recommended Action	Compliance Status
3	Safety at site	• Installation/Construction of Safety Fence around the Project area; • Use of Personnel Protective Equipments (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; • 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 occupational accidents, diseases, and incidents; • Policies and procedures for managing and monitoring the performance of third party employers in relation to OHS.	• Construction of boundary wall; • Encouraged labor 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.	• The EPC contractor should prepare Health and Safety Plan and safety procedure which covers all the measures of the EMP; • They should create suitable environment for the workers, safety equipments and facilities, develop an emergency response system; • Improve present situation of first aid medical facilities before commencing the main plant construction, as such many patients can be treated simultaneously	Being Complied

*Table 5.2: Monitoring of Labor and Working Condition **(continued)***

Sl no	Potential Impacts	EMP measures as proposed in the EIA	Actual measures already Implemented	Recommended Action	Compliance Status
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.	• Develop a complete EHS division in the HR Management; • Regular training, awareness, motivational and mock drill should be arranged at this pre-construction phase; • The EPC contractor should prepare a safety policy for Plant operation; • OHS should also be followed by all workers including the labor from sub-contractors.	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 are facilitated by the proponents.	• 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.	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; • Water spray for dust suppression being carried out around the Plant office.	• Water spray along the road way/walk way, major working area, labor sheds needs to be carried out.	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.	• Establish a Grievance Redress Mechanism; • Establish a system to receive the grievance, and to take appropriate measures to redress it; • Regular local level consultation is necessary in presence of the officers from BIFPCL.	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;	• 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	• Assign responsibility of enforcing and monitoring safety procedure to an officer • Aware labors and all employees about the safety procedure; • The EPC contractors should prepare site specific ESMPs;	BIFPCL agrees to comply all the measures during construction stage

*Table 5.3: Monitoring of Community Health, Safety and Security **(continued)***

Sl no	Potential Impacts	Proposed EMP	Actual measures already Implemented	Recommended Action	Compliance Status
		• Maintaining open communication channel with the local community; • Training and instruction to the security personnel about their behavior and communication with the local people; • Aware the security personnel about the right of the community people.	selection of construction contractors; • Maintaining a good communication with local community; • Negotiation with local DC office and Bangladesh Ansar and VDP (who are responsible for security).	• Arrange a safety training program for Project personnel and labors; • Training and instruction to the security personnel about their behavior 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 2,711 people from November, 2015 to March, 2016.	• The proponent should train the migrated labour regarding the local culture and customs • The proponent may arrange consultation meeting with the local communities	Being Complied
5	Youth Employment	• Providing training/awareness program for the local youth to let them aware about the required qualification to get involved in the	• Informal sitting with the community	• Initiate awareness program for the local youth to let them aware about the required qualification to get	Will be complied during construction stage

*Table 5.3: Monitoring of Community Health, Safety and Security **(continued)***

Sl no	Potential Impacts	Proposed EMP	Actual measures already Implemented	Recommended Action	Compliance Status
		Project related activities		involved in the Project related activities; • Appropriate hands on and hands-off training sessions, building them up for employment; • Assign job responsibilities 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; • Recruitment of a Public Relation Officer at head office; • Preparing a video documentation on Project related information; • Publishing Project related discussion/article in different print media.	• Arrange 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; • Preparing to develop the drainage network inside the Project boundary.	• Sediment trap should be developed to prevent sediment wash load to Maidara and Passur river to minimize the impact on the aquatic ecosystem prevailing there; • The proponent has to ensure a good drainage system in before commencing the construction works by the EPC contractor.	Will be complied during the construction stage
2	Disturbance to nearby ecosystem due to different construction activities	• No cutting/ felling of trees along the river bank; • 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	• No cutting/ felling of trees occurred along the river bank; • 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	• Using of light shade (directed downwards) around the outdoor lights; • Regular monitoring of the trees planted around the Project site.	Being Complied

*Table 5.4: Monitoring of Biodiversity and Sustainable Management of Living Natural Resources **(continued)***

Sl no	Potential Impacts	EMP measures as proposed in the EIA	Actual condition/ Measures already Implemented	Recommended Action	Compliance Status
		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?	switch off unnecessary lights at night; • Selection of local plant species for green plantation; • No degradation of critical habitat.		
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 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	• 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 keeping necessary setback distance from Maidara River. • The stream flow of Maidara River near access road has been blocked by a temporary cross dam of LGED and BWDB requested to keep it for the time being for widening and channel improvement of Maidara River.	• The proponent should develop sediment trap before final discharge of rainfall runoff into the 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 dynamics. • For removal of blockade, BIFPCL has taken up this matter with BWDB through LGED to keep the natural stream flow of Maidara River as it is and ensure the water connectivity like before.	Being Complied

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***
3	Project Proponent may undertake activities for land development and infrastructural development of the Project.	BIFPCL has started land and infrastructure development activities.	***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.	***To be Complied***
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.	At present the Plant is in preliminary stage. 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	BIFPCL is also monitoring the	***Complied at***

Compliance to Conditions of DoE ***(continued)***

Sl no	Condition of DoE	Compliance	Remarks
	measures shall be ensured throughout preparation, construction and operation period of the proposed Khulna 1320 MW Coal based Thermal Power Plant Project activities.	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.EMP prepared & monitoring is being done for pre-construction period.	***present and will be complied at Construction and Operation phase***
7	Any heritage sight, ecologically critical area, and other environmentally, religious and archaeologically sensitive places shall be kept protected during Project construction phase.	There is no religious, archaeological place in and around the site. The pre-construction activities has been carried out ensuring safeguarding to Sundarbans and ECA	***Complied at present and 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	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	***Being Complied***

Compliance to Conditions of DoE ***(continued)***

Sl no	Condition of DoE	Compliance	Remarks
	avoided.	Clause no 14.11 of SCC and in Health & Safety Manual.	
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 check up of the workers. Villagers of surrounding areas also availing the health facilities. Emergency response plan shall be strictly implemented and kept operative/ functioning on a continuous basis.	***Being Complied***
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	Run off/ storm water drainage system	***Being***

Compliance to Conditions of DoE ***(continued)***

Sl no	Condition of DoE	Compliance	Remarks
	ensured for silt trap to avoid clogging of drain/canal/water bodies	shall have silt trap.	***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 are being 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.	***Compliance action initiated***
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	Coal 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 Specification.	***Compliance action initiated***
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	***Compliance action initiated***

Compliance to Conditions of DoE ***(continued)***

Sl no	Condition of DoE	Compliance	Remarks
		Specification of main plant EPC contract package (Section V, Chapter B4).	
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, 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, construction and post-construction stage) should be implemented	BIFPCL has adopted all of the EMP applicable at this stage. CEGIS, as an environmental consultant of BIFPCL is	***Being Complied***

Compliance to Conditions of DoE ***(continued)***

Sl no	Condition of DoE	Compliance	Remarks
	according to EMP clearly listed in the EIA report.	monitoring implementation of EMP. BIFPCL is taking all possible actions based on EMP monitoring report.	
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	***Being Complied***

Compliance to Conditions of DoE ***(continued)***

Sl no	Condition of DoE	Compliance	Remarks
		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, Government of Bangladesh.	
36	Online air and water quality monitoring system should be made functional throughout the life of the Plant.	The online monitoring system will be installed when the Plant will be in operation phase and will continue 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).	***Compliance action initiated***
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.	***Ready to comply***
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***

Compliance to Conditions of DoE ***(continued)***

Sl no	Condition of DoE	Compliance	Remarks
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 the EIA report and conveyed to DoE and other concern authorities.	In February 2014, CEGIS has been engaged for preparing Detail Environmental Baseline. CEGIS has submitted annual monitoring report along with reports of quarterly monitoring containing latest baseline datato BIFPCL for further dissemination to DoE and other concerned authorities.	***Being Complied***
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	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.	***Agreed to Comply***

Compliance to Conditions of DoE ***(continued)***

Sl no	Condition of DoE	Compliance	Remarks
	the Project.		
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 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.)	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 such incident as suggested, when main plant construction activities start.	***Compliance action initiatedand Will be complied as and when required***
48	The Project authority or its employees must notify the department of Environment of incidents causing or threatening	So far no such incident has occurred.BIFPCL would establish a proper mechanism for recording such incident as suggestedand notify the	***Will be complied as and when required***

Compliance to Conditions of DoE ***(continued)***

Sl no	Condition of DoE	Compliance	Remarks
	material harm to the environment as soon as practicable after the person becomes aware of the incident.	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 preparedand CEGIS is monitoring EMP.	
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 favor 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 7500 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 dredging to develop sound environmental management plan towards conservation of ecosystem and biodiversity.	Mongla Port Authority (MPA) is the Implementing Agency for dredging. Coal transportation will be done 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.	***Being Complied***

Compliance to Conditions of DoE ***(continued)***

Sl no	Condition of DoE	Compliance	Remarks
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 Honorable 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.	-

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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/equipments/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			

(continued)

Sl no	Potential Impacts	Proposed EMP	Actual Implementation	Recommended Action	Compliance Status
		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.			
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.)			

(continued)

Sl no	Potential Impacts	Proposed EMP	Actual Implementation	Recommended Action	Compliance Status
		• 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 laborers 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 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 equipments and machineries • Switching off and throttling down the machines/equipments/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			

Sl no	Potential Impacts	Proposed EMP	Actual Implementation	Recommended Action	Compliance Status
		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 Equipments (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 • 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			

Sl no	Potential Impacts	Proposed EMP	Actual Implementation	Recommended Action	Compliance Status
	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			

(continued)

Sl no	Potential Impacts	Proposed EMP	Actual Implementation	Recommended Action	Compliance Status
		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 posses any health risk like sexually transmitted disease, communicable disease, vector-borne diseases • 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 • 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			

Sl no	Potential Impacts	Proposed EMP	Actual Implementation	Recommended Action	Compliance Status
		• 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 Rampal 1320 MW Power Plant for 1st Quarter of 3rd Year *(April 2016)*

The Monitoring Team

Estimating Light Intensity by Lux Meter at Karamjal

Observe Tree Canopy cover with Densiometer

	
Taking Tree DBH at Akram Point	Counting woody debris at Akram Point
	
Temporary cross-dam over Maidara River restricting natural flow	Environmental Experts visiting the Plant site for EMP status monitoring
	
Length frequency survey for Fish of Passur R.	Fish community structure evaluation at Harbaria

	
Choto Charer gher at Rajnagar	Capture fish habitat at Chalna point
	
Capture fish habitat at Maidara River	Capture fish habitat at Harbaria

	
Consultation with DAE Officials of Batiaghata, Khulna about Rampal Power plant	Consultation with local people at Chakgona, Rampal, Bagerhat

	
View of agricultural monitoring plot at Chakgona, Rampal, Bagerhat	Soil sample collection at Chunkuri-2 plot, Dacope, Khulna
	
Soil sample collection at Basherhula plot, Rampal, Bagerhat	View of agricultural monitoring plot at Kapalirmet, Mongla, Bagerhat

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					
Wind Direction		SE	SE	SE	NW	SE to NW	SW to NE	SW to NE	NW to SE	SSE to NNW					
		Concentrations are in µg/m^3													
SW Corner of the PP area	$PM_{2.5}$	22	23	16	21	30	16	14	21	12				65^{24hr} $(100)^{8\ hr}$	25^{24hr} $(39)^{8\ hr}$
	PM_{10}	50	49	34	51	54	23	34	87	76				150^{24hr} $(233)^{8\ hr}$	50^{24hr} $(78)^{8\ hr}$
	SPM	134	155	123	129	115	28	59	113	214				$(200)^{8\ hr}$	*NF*
	SO_2	21	24	12	15	10	34	23	9	12				365^{24hr} $(455)^{8\ hr}$	125^{24hr} $(80)^{8\ hr}$
	NOx	17	19	17	20	19	23	19	12	12				100^{Annual} $(405)^{8\ hr}$	200^{1hr} $(162)^{8\ hr}$
	CO	77	121	90	122	93	94	57	48	37				$(10000)^{8\ hr}$	*NF*
	O_3	17	17	12	14	17	8	3	3	1				*(157)*	*(100)*
Proposed Township area of the PP	$PM_{2.5}$	26	31	31	25	22	12	11	23	16				65^{24hr} $(100)^{8\ hr}$	25^{24hr} $(39)^{8\ hr}$

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
	PM_{10}	57	58	48	66	63	20	31	75	28				150^{24hr} $(233)^{8\ hr}$	50^{24hr} $(78)^{8\ hr}$
	SPM	140	169	140	177	171	30	51	124	121				$(200)^{8\ hr}$	NF
	SO_2	12	18	14	14	14	37	17	8	7				365^{24hr} $(455)^{8\ hr}$	125^{24hr} $(80)^{8\ hr}$
	NOx	19	25	17	17	15	30	16	10	14				100^{Annual} $(405)^{8\ hr}$	200^{1hr} $(162)^{8\ hr}$
	CO	106	135	148	106	88	82	66	50	14				$(10000)^{8\ hr}$	NF
	O_3	21	17	17	15	14	10	1	1	1				(157)	(100)
NW Corner of the PP area	$PM_{2.5}$	24	28	12	27	38	18	12	15	7				65^{24hr} $(100)^{8\ hr}$	25^{24hr} $(39)^{8\ hr}$
	PM_{10}	43	50	36	63	59	62	19	81	19				150^{24hr} $(233)^{8\ hr}$	50^{24hr} $(78)^{8\ hr}$
	SPM	151	140	101	200	157	207	43	121	74				$(200)^{8\ hr}$	NF
	SO_2	12	14	12	17	14	36	21	8	11				365^{24hr} $(455)^{8\ hr}$	125^{24hr} $(80)^{8\ hr}$
	NOx	15	18	14	21	25	28	14	12	10				100^{Annual} $(405)^{8\ hr}$	200^{1hr} $(162)^{8\ hr}$
	CO	71	115	71	135	90	86	56	50	24				(10000)	NF
	O_3	16	12	11	23	28	7	5	1	0				$(157)^{8\ hr}$	(100)
Barni, Gaurambha	$PM_{2.5}$	25	30	37	25	26	22	7	19	15				65^{24hr} $(100)^{8\ hr}$	25^{24hr} $(39)^{8\ hr}$

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
	PM_{10}	66	79	43	63	53	42	17	63	53				150^{24hr} $(233)^{8\ hr}$	50^{24hr} $(78)^{8\ hr}$
	SPM	150	157	118	178	152	51	72	113	173				$(200)^{8\ hr}$	NF
	SO_2	14	15	11	14	16	26	20	10	13				365^{24hr} $(455)^{8\ hr}$	125^{24hr} $(80)^{8\ hr}$
	NOx	16	18	14	17	17	28	21	14	10				100^{Annual} $(405)^{8\ hr}$	200^{1hr} $(162)^{8\ hr}$
	CO	113	135	122	97	126	62	62	52	47				(10000)	NF
	O_3	17	19	14	12	10	6	4	3	0				$(157)^{8\ hr}$	$(100)^{8\ hr}$
Chunkuri-2, Dacope	$PM_{2.5}$	23	25	30	24	21	23	18	20	16				65^{24hr} $(100)^{8\ hr}$	25^{24hr} $(39)^{8\ hr}$
	PM_{10}	50	55	44	44	39	70	32	63	39				150^{24hr} $(233)^{8\ hr}$	50^{24hr} $(78)^{8\ hr}$
	SPM	75	73	104	118	121	113	61	108	108				(200)	NF
	SO_2	12	15	14	12	7	35	21	14	8				365^{24hr} $(455)^{8\ hr}$	125^{24hr} $(80)^{8\ hr}$
	NOx	15	17	17	15	12	32	15	10	16				100^{Annual} $(405)^{8\ hr}$	200^{1hr} $(162)^{8\ hr}$
	CO	122	132	110	110	21	86	48	45	21				(10000)	NF
	O_3	17	15	12	14	26	14	1	1	1				(157)	(100)
Pankhali, Dacope	$PM_{2.5}$	30	32	37	26	25	-	16	30	10				65^{24hr} $(100)^{8\ hr}$	25^{24hr} $(39)^{8\ hr}$

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
	PM_{10}	77	82	90	65	68	93	40	82	30				150^{24hr} (233) $^{8\ hr}$	50^{24hr} (78) $^{8\ hr}$
	SPM	191	171	164	134	193	218	118	128	73				(200)	NF
	SO_2	18	20	20	15	19	37	23	12	6				365^{24hr} (455) $^{8\ hr}$	125^{24hr} (80) $^{8\ hr}$
	NOx	26	25	23	17	17	30	15	10	12				100^{Annual} (405) $^{8\ hr}$	200^{1hr} (162) $^{8\ hr}$
	CO	148	140	161	121	114	81	68	65	35				(10000)	NF
	O_3	32	24	23	17	7	8	3	1	1				(157)	(100)
Mongla Port area	$PM_{2.5}$	30	35	25	26	17	21	12	22	21				65^{24hr} (100) $^{8\ hr}$	25^{24hr} (39) $^{8\ hr}$
	PM_{10}	90	112	50	53	23	34	21	85	45				150^{24hr} (233) $^{8\ hr}$	50^{24hr} (78) $^{8\ hr}$
	SPM	186	195	127	140	138	76	42	122	144				(200)	NF
	SO_2	17	18	17	15	9	29	23	10	10				365^{24hr} (455) $^{8\ hr}$	125^{24hr} (80) $^{8\ hr}$
	NOx	28	25	21	17	11	26	13	8	14				100^{Annual} (405) $^{8\ hr}$	200^{1hr} (162) $^{8\ hr}$
	CO	148	206	142	136	15	71	54	46	29				(10000)	NF
	O_3	37	34	24	17	6	10	5	2	1				(157)	(100)
Harbaria, Sundarbans	$PM_{2.5}$	12	14	21	17	15	17	15	17	8				65^{24hr} (100) $^{8\ hr}$	25^{24hr} (39) $^{8\ hr}$

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
	PM_{10}	26	25	38	36	32	27	32	53	27				*150^{24hr} (233)$^{8\ hr}$*	*50^{24hr} (78)$^{8\ hr}$*
	SPM	72	75	83	90	70	45	47	102	59				*(200)*	*NF*
	SO_2	6	6	9	8	10	33	22	10	7				*365^{24hr} (455)$^{8\ hr}$*	*125^{24hr} (80)$^{8\ hr}$*
	NOx	12	14	17	12	14	22	14	9	10				*100^{Annual} (405)$^{8\ hr}$*	*200^{1hr} (162)$^{8\ hr}$*
	CO	42	37	45	41	36	72	52	40	30				*(10000)*	*NF*
	O_3	8	8	8	7	9	8	3	1	1				*(157)*	*(100)*
Akram Point, Sundarbans	$PM_{2.5}$	11	12	15	12	32	-	16	12	6				*65^{24hr} (100)$^{8\ hr}$*	*25^{24hr} (39)$^{8\ hr}$*
	PM_{10}	25	28	21	25	50	-	21	50	20				*150^{24hr} (233)$^{8\ hr}$*	*50^{24hr} (78)$^{8\ hr}$*
	SPM	73	86	63	57	66	-	33	82	30				*(200)*	*NF*
	SO_2	5	6	8	8	14	-	17	9	6				*365^{24hr} (455)*	*125^{24hr} (80)*
	NOx	11	12	14	11	17	-	12	10	6				*100^{Annual} (405)*	*200^{1hr} (162)*
	CO	32	39	32	30	105	-	59	41	14				*(10000)*	*NF*
	O_3	7	9	6	6	17	-	5	1	0				*(157)*	*(100)*
Hiron Point,	$PM_{2.5}$	10	15	12	11	18	-	17	-	11				*65^{24hr} (100)$^{8\ hr}$*	*25^{24hr} (39)$^{8\ hr}$*

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
	PM_{10}	28	24	22	26	39	-	29	-	26				150^{24hr} $(233)^{8\ hr}$	50^{24hr} $(78)^{8\ hr}$
	SPM	65	77	69	63	71	-	57	-	85				*(200)*	*NF*
	SO_2	5	5	8	9	10	-	18	-	10				365^{24hr} $(455)^{8\ hr}$	125^{24hr} $(80)^{8\ hr}$
	NOx	12	12	12	14	13	-	15	-	12				100^{Annual} $(405)^{8\ hr}$	200^{1hr} $(162)^{8\ hr}$
	CO	34	40	42	39	39	-	60	-	26				*(10000)*	*NF*
	O_3	9	8	7	6	15	-	1	-	0				*(157)*	*(100)*
Khulna City, near Khan Jahan Ali Bridge	$PM_{2.5}$	35	25	34	27	35	30	12	23	7				65^{24hr} $(100)^{8\ hr}$	25^{24hr} $(39)^{8\ hr}$
	PM_{10}	90	75	59	54	48	57	32	72	44				150^{24hr} $(233)^{8\ hr}$	50^{24hr} $(78)^{8\ hr}$
	SPM	194	185	154	141	143	117	65	117	72				*(200)*	*NF*
	SO_2	21	19	21	18	20	38	18	10	7				365^{24hr} $(455)^{8\ hr}$	125^{24hr} $(80)^{8\ hr}$
	NOx	32	26	25	23	21	24	17	10	10				100^{Annual} $(405)^{8\ hr}$	200^{1hr} $(162)^{8\ hr}$
	CO	213	238	213	191	65	57	61	63	44				*(10000)*	*NF*
	O_3	38	43	37	25	14	5	3	1	1				*(157)*	*(100)*

Note(s):

- *Concentrations are in µg/m^3 and values are calculated for 24 hours ;*
- *DoE- Department of Environment, NF – Not found;*
- *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);*
- *All Standards within parentheses "()" are calculated for 8hr or collected directly from standard guidelines for 8hr;*
- *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).*

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	✗	✗	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✓

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

*Table A.2: Baseline conditions of emission of different infrastructures and sources **(continued)***

		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	✗	✗	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓
Chunkuri-2, Dacope	PM	✓	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓
	SOx	✗	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓
	NOx	✗	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓
	GHGs	✗	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓
Pankhali, Dacope	PM	✓	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✓
	SOx	✗	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓
	NOx	✗	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓
	GHGs	✗	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓
Mongla Port area	PM	✓	✓	✓	✗	✓	✓	✓	✓	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✓	✗	✗	✗	✓
	SOx	✗	✓	✗	✗	✓	✓	✓	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✗	✗	✓	✓
	NOx	✗	✓	✗	✗	✓	✓	✓	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✗	✗	✗	✓
	GHGs	✗	✓	✗	✗	✓	✓	✓	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✗	✗	✗	✓
Harbaria, Sundarbans	PM	✗	✗	✗	✗	✗	✓	✓	✓	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗

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

*Table A.2: Baseline conditions of emission of different infrastructures and sources **(continued)***

		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	✗	✗	✗	✗	✗	✓	✓	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Akram Point Sundarbans	PM	✗	✗	✗	✗	✗	✓	✓	✗	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
	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	
		1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	1QM	
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	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	
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	
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	
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	
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	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	
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	
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	
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	
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	
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	
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	
14	Passur river at Akram point of Sundarbans	7.2	6.9	7.9	8.1	7.7	NS	7.63	8	7.9	
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	

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	Apr	Jan	Apr	Jul	Oct	Jan	Apr	
		1QM	2QM	1QM	4QM	1QM	2QM	3QM	4QM	1QM	
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	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	
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	
4	Left Bank of Passur River at Project site-Jetty	31	33	31	19	31	30.8	31.3	22.0	31.4	
5	Middle Passur River at Project site-Jetty	30	32	31	19	30	30.6	31.6	22.0	30.9	
6	Right Left Bank of Passur River at Project site-Jetty	30	32	31	19	30	30.4	31.1	21.0	31.0	
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	
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	
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	
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	
11	Maidara river near proposed township area	30	32	27	20	30	31.6	31.2	23.0	30.6	
12	Passur river at Passur-Ghasiakhali confluence	29	30	32	19	30	29.8	30.7	21	31.3	
13	Passur river at Harbaria of Sundarbans	30	30	27	22	30	29.0	30.8	22.0	31.5	
14	Passur river at Akram point of Sundarbans	29	29	30	21	30	NS	30.2	21.0	30.8	
15	Passur river at Hiron point of Sundarbans	29	30	29	21	30	NS	30.4	NS	31.4	

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	Apr	Jan	Apr	Jul	Oct	Jan	Apr
		1st QM	2nd QM	1QM	4th QM	1st QM	2nd QM	3rd QM	4th QM	1QM
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
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
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
4	Left Bank of Passur River at Project site-Jetty	12.0	2.2	0.0	4.7	9	0	0	4.4	6
5	Middle of Passur River at Project site-Jetty	12.0	0.3	0.0	5.1	13	0	0	5.1	6.2
6	Right Bank of Passur River at Project site-Jetty	12.0	0.5	0.0	5.0	14	0	0	5	9
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
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
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
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
11	Maidara river near proposed township area	9.0	4.5	0.0	4.5	9	0	0	2.5	6.3
12	Passur river at Passur-Ghasiakhali confluence	10.0	9.5	0.0	5.0	14	0	0	4.8	6
13	Passur river at Harbaria of Sundarbans	12.0	10.0	0.0	6.0	15	0	0	5.3	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
15	Passur river at Hiron point of Sundarbans	23.0	19.5	2.0	23.0	25	NS	6.2	NS	14

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)									
		1st Year				2nd Year				3rd year	BD Standard
		Apr	Jun	Apr	Jan	Apr	July	Oct	Jan	Apr	
		1QM	2QM	1QM	4QM	1QM	2QM	3QM	4QM	1QM	
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	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	
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	
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	
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	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	
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	
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	
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	
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	
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	
12	Passur river at Passur-Ghasiakhali confluence	5.3	6.2	7.0	6.5	6.3	7	6.6	5.4	5.8	
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	
14	Passur river at Akram point of Sundarbans	7.9	6.4	7.7	6.7	6	NS	7.3	6.2	6.1	
15	Passur river at Hiron point of Sundarbans	7.5	6.5	7.8	6.5	5.8	NS	7	NS	7.1	

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: BOD_5 of Passur River Water

SL	Sampling Locations	Biochemical Oxygen Demand (mg/L)									
		1st Year				2nd Year				3rd year	BD Standard
		Apr	Jul	Apr	Jan	Apr	July	Oct	Jan	Apr	
		1QM	2QM	1QM	4QM	1QM	2QM	3QM	4QM	1QM	
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	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	
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	
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	
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	
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	
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	
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	
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	
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	
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	
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	
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	
14	Passur river at Akram point of Sundarbans	5.0	2.9	3.7	2.2	3	NS	2.2	2.4	3.3	
15	Passur river at Hiron point of Sundarbans	4.3	2.7	3.9	2.3	2.7	NS	2.5	NS	2.4	

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.6: COD of Passur River System

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

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					
		Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan'16		
		1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM		
1	Left Bank of Passur River at South West corner from the Project boundary	<5	<5	<5	>15	16.9	9	<5	39	10	10
2	Passur-Ghasiakhali Confluence	<5	<5	<5	>15	13	7.63	9.87	21		
3	Passur river at Harbaria of Sundarbans	<5	6.3	<5	>20	39.1	10.1	<5	14		
4	Passur river at Hiron point of Sundarbans	<5	<5	<5	>20	<5	NS	10.8	ND		
5	Akram Point of Sundarbans	<5	<5	<5	>20	<5	NS	9.73	36		

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, TH and TSS of Passur River System

SL	Sampling Locations	TDS (mg/L)								TH (mg/L)								TSS (mg/L)							
		1St Year				2nd year				1St Year				2nd year				1St Year				2nd year			
		Apr	Jul	Oct	Jan	April	July	Oct	Jan	April	Jul	Oct	Jan	April	July	Oct	Jan	Apr	Jul	Oct	Jan	April	July	Oct	Jan
		1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	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	13060	251	176	4360	14400	937	158	5570	2900	250	216	930	3000	245	250	1270	59	126	234	180	160	26	76	14
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	2500	180	218	870	3050	110	330	1380	45	92	193	210	167	25	80	12
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	2650	170	335	870	3250	105	360	1240	53	112	174	230	170	127	65	14
4	Left Bank of Passur River at Project site-Jetty	13190	445	169	4750	14600	175	172	5720	2550	175	390	940	3450	118	365	1220	54	99	227	450	160	30	92	17
5	Middle Passur River at Project site-Jetty	13330	353	156	4920	14500	132	162	5850	2600	275	340	990	3250	103	355	1300	60	100	232	250	165	27	85	18
6	Right Bank of Passur River at Project site-Jetty	13380	402	152	4870	14200	156	160	5480	2625	350	355	970	3200	105	350	1260	55	105	186	200	155	40	97	22
7	Left Bank of Passur River at South West corner from the Project boundary	13180	655	162	5040	14500	336	192	5650	2550	325	330	1045	3600	153	345	1370	24	116	185	300	150	32	104	20
8	Middle of Passur River at South West corner from the Project boundary	13390	587	153	5050	14600	158	164	5740	2800	350	345	1125	3670	105	390	1340	27	112	536	530	147	40	90	7
9	Right Bank of Passur River at South West corner from the Project boundary	13240	916	154	5130	14250	160	164	5650	2500	475	325	975	3540	165	445	1270	67	37	459	450	155	44	82	18

SL	Sampling Locations	TDS (mg/L)								TH (mg/L)								TSS (mg/L)							
		1St Year				2nd year				1St Year				2nd year				1St Year				2nd year			
		Apr	Jul	Oct	Jan	April	July	Oct	Jan	April	Jul	Oct	Jan	April	July	Oct	Jan	Apr	Jul	Oct	Jan	April	July	Oct	Jan
		1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM
10	Maidara river of the South East corner of the project at Ichamoti-Maidara confluence	12400	455	214	5050	14000	2320	183	5450	2500	450	350	980	3260	470	183	950	7	65	798	280	148	36	96	11
11	Maidara river near proposed township area	10970	2510	257	4390	13900	355	176	4420	2400	725	330	970	3190	130	340	1075	9	24	389	206	160	28	92	10
12	Passur river at Passur - Ghasiakhali confluence	12800	6410	209	5130	14050	298	227	4540	3150	1400	377	1000	3210	135	410	1090	50	310	203	280	165	24	60	15
13	Passur river at Harbaria of Sundarbans	12280	9360	285	4780	13900	683	205	4940	2625	2150	345	970	3080	200	430	1100	65	90	869	400	160	42	74	22
14	Passur river at Akram point of Sundarbans	21500	15960	3400	12350	13600	NS	4220	13330	4500	3625	980	2380	3420	NS	1090	2850	115	99	280	103	150	NS	110	16
15	Passur river at Hiron point of Sundarbans	21500	14050	5720	17900	25300	NS	5830	-	4850	3050	1440	2690	3640	NS	1460	-	91	72	267	200	180	NS	144	-

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: NO_3^{2-}, SO_4^{2-} and PO_4^{2-} concentration of Passur River System

SL	Sampling Locations	NO_3^{2-}(mg/L)								SO_4^{2-} (mg/L)								PO_4^{2-} (mg/L)							
		1St Year				2nd year				1St Year				2nd year				1St Year				2nd year			
		Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan
		1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	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	0.90	2.89	0.32	3	-	9.1	4	6.3	1840	20	26	580	1360	67	7	570	0.52	2.23	0.67	0.32	0.86	.10	1.27	0.269
2	Middle of Passur River at 100m u/s of North West corner from the Project boundary	0.70	2.40	1.57	1.5	-	7.5	7.1	4.3	1320	23	28	450	1260	11	8	590	0.50	1.99	1.12	0.61	0.53	0.23	1.97	0.269
3	Right Bank of Passur River at 100m u/s of North West corner from the Project boundary	0.10	3.20	1.84	4.3	-	6.2	5	3.9	1280	36	34	480	1240	9	11	560	1.10	2.55	0.95	0.7	0.72	0.67	1.94	0.179
4	Left Bank of Passur River at Project site-Jetty	1.30	0.76	1.64	3.1	-	6.6	5.7	3.1	1360	45	33	550	1240	26	10	550	2.10	0.45	0.92	0.43	0.49	0.27	2.53	0.357
5	Middle Passur River at Project site-Jetty	1.40	2.69	1.42	2.2	-	6.1	3.3	5.2	1040	32	30	520	1120	6	8	580	2.20	2.13	1.11	0.41	0.68	0.59	1.3	0.536
6	Right Bank of Passur River at Project site-Jetty	1.10	2.98	1.33	8.5	-	6.6	4.7	4.1	1320	20	27	540	820	8	9	565	2.00	2.42	0.99	0.55	0.61	0.13	1.32	0.269
7	Left Bank of Passur River at South West corner from the Project boundary	0.75	2.13	1.85	2.7	-	14.9	4.4	4.9	1640	60	40	630	880	9	12	640	0.57	1.25	1.18	0.76	0.65	0.1	0.99	0.536
8	Middle of Passur River at South West corner from the Project boundary	1.10	2.43	2.09	1.8	-	4	6.2	3.7	1520	40	35	560	1180	19	8	560	1.20	1.51	1.25	0.85	0.53	0.18	1.02	0.625

SL	Sampling Locations	NO_3^{2-}(mg/L)								SO_4^{2-} (mg/L)								PO_4^{2-} (mg/L)							
		1St Year				2nd year				1St Year				2nd year				1St Year				2nd year			
		Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan
		1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM
9	Right Bank of Passur River at South West corner from the Project boundary	1.20	2.05	2.21	1.9	-	4.9	4.4	4.4	1280	80	64	620	900	12	6	550	1.50	1.10	1	0.53	0.6	0.1	1.39	0.536
10	Maidara river of the South East corner of the project at Ichamoti-Maidara confluence	0.3	2.18	2.26	6	-	7	4.9	5.6	1120	20	63	570	1220	72	11	96	0.55	2.1	1.27	0.59	0.7	0.5	1.27	0.351
11	Maidara river near proposed township area	0.5	0.88	1.98	4	-	3.1	2.9	3.9	1320	210	63	460	840	27	9	480	1.1	0.53	1.04	0.64	0.55	0.29	1.28	0.269
12	Passur river at Passur - Ghasiakhali confluence	0.6	1.52	1.64	4.5	-	7.8	3.1	3.7	1360	620	44	630	980	39	13	482	1.3	0.35	0.86	0.42	0.71	0.59	0.95	0.179
13	Passur river at Harbaria of Sundarbans	1.4	1.75	1.67	2.7	-	4.4	4.4	5.1	1560	860	69	590	900	51	7	500	1.1	0.56	1.22	0.61	0.59	0.89	0.35	0.269
14	Passur river at Akram point of Sundarbans	2.7	3.32	0.59	1.5	-	NS	3.2	4.9	2600	1400	1390	850	1540	NS	84	760	1.3	0.29	0.8	0.42	0.61	NS	0.43	0.357
15	Passur river at Hiron point of Sundarbans	0.8	2.84	0.4	2	-	NS	11.5	-	2080	1160	2360	1500	1920	NS	97	-	7.51	0.29	1.09	0.44	0.47	NS	0.45	-

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: As, Pb concentration of Passur River System

Sl	Sampling Locations	As (mg/L)								Pb (mg/L)							
		1st Year				2nd year				1st Year				2nd year			
		Apr	Jul	Oct	Jan	Apr	July	Oct	Jan	Apr	Jul	Oct	Jan	Apr	July	Oct	Jan
		1QM	2QM	3QM	4QM	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	0.002	0.003	0.004	0.003	0.002	0.002	0.001	0.001	0.053	0.004	0.002	0.104	0.098	0.0059	0.007	0.168
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	0.055	0.002	0.003	0.104	0.102	0.0038	0.006	0.092
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	0.055	0.005	0.002	0.111	0.138	0.0058	0.008	0.176
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	0.057	0.002	0.003	0.154	0.142	0.011	0.01	0.115
5	Middle Passur River at Project site-Jetty	0.002	0.004	0.004	0.003	0.002	0.001	0.001	0.002	0.060	0.002	0.002	0.139	0.135	0.002	0.009	0.148
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	0.058	0.002	0.002	0.138	0.156	0.0021	0.007	0.112
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	0.053	0.002	0.003	0.16	0.142	0.0076	0.01	0.134
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	0.054	0.003	0.004	0.153	0.148	0.002	0.011	0.099
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	0.056	0.005	0.004	0.139	0.163	0.002	0.009	0.093
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	0.053	0.004	0.004	0.143	0.135	0.002	0.07	0.023
11	Maidara river near proposed township area	0.002	0.002	0.003	0.003	0.003	0.002	0.001	0.001	0.048	0.004	<0.002	0.133	0.14	0.002	0.008	0.067
12	Passur river at Passur - Ghasiakhali confluence	0.002	0.004	0.003	0.003	0.004	0.002	0.001	0.002	0.050	0.032	<0.002	0.141	0.14	0.002	0.009	0.078
13	Passur river at Harbaria of Sundarbans	0.004	0.003	0.004	0.004	0.004	0.002	0.001	0.002	0.043	0.044	0.004	0.137	0.13	0.002	0.012	0.135
14	Passur river at Akram point of Sundarbans	0.004	0.002	0.002	0.003	0.002	NS	0.001	0.002	0.194	0.071	0.032	0.309	0.297	NS	0.084	0.302
15	Passur river at Hiron point of Sundarbans	0.003	0.002	0.003	0.002	0.002	NS	0.001		0.224	0.050	0.07	0.309	0.291	NS	0.073	

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: Hg concentration of Passur River System

Sl	Sampling Locations	Hg (mg/L)							
		1st Year				2nd year			
		Apr	Jul	Oct	Jan	Apr	July	Oct	Jan
		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	<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	0,00015
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	0,00015
4	Left Bank of Passur River at Project site-Jetty	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015	0.00015	0,00015	0,00015
5	Middle Passur River at Project site-Jetty	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015	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	0,00015
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	0,00015
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	0,00015
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	0,00015
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	0,00015
11	Maidara river near proposed township area	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015	0.00015	0,00015	0,00015
12	Passur river at Passur - Ghasiakhali confluence	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015	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	0,00015
14	Passur river at Akram point of Sundarbans	0.0020	<0.00015	<0.00015	<0.00015	<0.00015	NS	0,00015	0,00015
15	Passur river at Hiron point of Sundarbans	0.0023	<0.00015	<0.00015	<0.00015	<0.00015	NS	0,00015	**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

➢ Parameters for ground water quality monitoring

Table B.12: pH and Temperature of Ground Water

Sl	Locations	Tube Well Type	pH value*										Temperature (°C)*									
			1st Year				2nd Year				3rd year	BD Standard*	1st year				2nd Year				3rd year	BD Standard*
			Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	Apr		Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	Apr	
			1st QM	2nd QM	3rd QM	4th QM	1st QM	2nd QM	3rd QM	4th QM	1st QM		1st QM	2nd QM	3rd QM	4th QM	1st QM	2nd QM	3rd QM	4th QM	1st QM	
1	Near Proposed Township	Deep (>600 ft)	7.6	7.7	7.9	8.0	TC	8.1	7.49	7.6	7.8	6.5 -8.5	27.3	28.5	26	24.5	TC	31	30	24	29.8	20 – 30 °C
2	Rajnagar	Deep (>600 ft)	7.6	7.8	8.0	8.2	7.8	8.3	7.93	8.1	8.3		29.6	29.9	28	22.5	28.6	28	27.8	23	29.6	
3	Kalekarber	Shallow (<250 ft)	6.3	6.5	NF	NF	NF	NF	NF	NF	NF		27.5	28.7	NF	NF	NF	NF	NF	NF	NF	
4	Kapasdanga	Deep (>600 ft)	7.6	7.7	8.0	8.1	7.9	8.3	7.7	7.9	8.2		29.2	28.9	28	25.1	28.8	30	28.7	25	30.1	

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.13: Salinity and DO in Groundwater

Sl	Locations	Tube Well Type	Salinity (ppt)										DO (mg/L)*									
			1st Year				2nd Year				3rd year	BD Standard*	1st Year				2nd Year				3rd year	BD Standard*
			Apr	Jul	Oct	Jan	Apr	Jul	Apr	Jan	Apr		Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	Apr	
			1st QM	2nd QM	3rd QM	4th QM	1st QM	2nd QM	1st QM	4th QM	1st QM		1st QM	2nd QM	3rd QM	4th QM	1st QM	2nd QM	3rd QM	4th QM	1st QM	
1	Near Proposed Township	Deep (>600 ft)	0	0	0	1	TC	0	0	0	0	N/A	4.4	5.2	6.5	6.7	TC	6	5.4	4.9	6.1	6 mg/L
2	Rajnagar	Deep (>600 ft)	0	0	0	0	0	0	0	0	0		6.0	6.2	7.7	6.3	6.0	5.9	6.1	5.2	5.8	
3	Kalekarber	Shallow (<250 ft)	0	0	NF	NF	NF	NF	NF	NF	NF		4.4	6.0	NF	NF	NF	NF	NF	NF	NF	
4	Kapasdanga	Deep (>600 ft)	0	0	0	0	0	0	0	0	0		6.4	6.5	6.1	6.5	6.6	6	5.6	4.8	5.6	

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; N/A=Not Availability;

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

Table B.14: TDS and TSS concentrations in Groundwater

Sl	Locations	Type of tube wells	TDS (mg/L)*									TSS (mg/L)*								
			1st Year				2nd year				BD Standard*	1st Year				2nd year				BD Standard*
			Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan		Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	
			1 QM	2 QM	3 QM	4 QM	1 QM	2 QM	3 QM	4 QM		1 QM	2 QM	3 QM	4 QM	1 QM	2 QM	3 QM	4 QM	
1	Township near project site	Deep (>600 ft)	1113	999	-	1021	NF	881	377	447	1000 mg/L	-	6	19	40	NO	23	4	5	10 mg/L
2	Rajnagar	Deep (>600 ft)	4090	371	-	378	390	574	1007	491		-	6	2	28	4	16	5	4	
3	Kalekarber	Shallow (<250 ft)	1055	970	-	NF	NF	NF	NF	NF		-	48	NF	NF	NF	NF	NF	NF	
4	Kapasdanga	Deep (>600 ft)	643	635	-	600	600	328	611	284		-	8	6	32	6	14	4	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;

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

Table B.15: TH concentrations in Groundwater

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

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.16: COD concentrations of monitored ground water locations

Sl	Locations	Tubewell Type	COD (mg/L)								
			1st Year				2nd year				BD standard*
			Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	
			1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	
1	Township near project site	Deep (>600 ft)	32	32	34	20	NO	12	4	4	4.0 mg/L
2	Rajnagar	Deep (>600 ft)	28	28	18	16	14	10	8	4	
3	Kalekarber	Shallow (<250 ft)	32	36	NF	NF	NF	NF	NF	NF	
4	Kapasdanga	Deep (>600 ft)	48	32	34	20	18	14	4	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.17: NO_3, SO_4 and PO_4 Concentrations in Ground Water

Sl	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				1st Year				2nd year				1st Year				2nd year			
			Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan
			1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM
1	Township near project site	Deep (>600 ft)	0.20	0.48	<0.10	28	-	7.6	4.3	2.1	-	3	-	-	-	-	1	5	-	2.2	-	0.74	NO	1.4	0.31	0.267
2	Rajnagar	Deep (>600 ft)	0.60	0.68	0.31	26	-	2.2	4.2	1.9	-	2	-	-	-	-	2	6	-	2.5	-	0.44	1.98	1.6	0.27	0.179
3	Kalekarber	Shallow (<250 ft)	0.40	0.56	NF	NF	-		NF	NF	-	3	NF	-	-	-	-	NF	-	1.2	NF	NF	NF		NF	NF
4	Kapasdanga	Deep (>600 ft)	0.80	0.40	0.80	13	-	4.7	3.8	2.8	-	10	-	-	-	-	2	2	-	6.2	-	0.48	4.54	4.1	0.48	0.179

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.18: 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				1st Year				2nd year				1st Year				2nd year			
		Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	APR	Jul	Oct	Jan
		1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM
1	Township near project site	0.013	0.020	0.012	0.014	NO	0.015	0.002	0.008	0.002	<0.002	0.004	0.023	NO	0.002	0.006	0.026	<0.00015	<0.00015	<0.0005	<0.0005	NO	0.00015	<0.00015	<0.00015
2	Rajnagar	0.006	0.009	0.006	0.008	0.01	0.014	0.012	0.002	<0.002	<0.002	<0.002	0.016	0.013	0.0027	0.021	0.011	<0.00015	<0.00015	<0.0005	<0.0005	<0.00015	0.00015	<0.00015	<0.00015
3	Kalekarber	0.376	0.407	NF	NF	D	D	NF	NF	0.002	0.008	NF	NF	D	D	NF	NF	<0.00015	<0.00015	NF	NF	NF	NF	NF	NF
4	Kapasdanga	0.036	0.033	0.020	0.017	0.034	0.024	0.011	0.002	<0.002	0.004	<0.002	0.013	0.017	0.002	0.005	0.012	<0.00015	<0.00015	<0.0005	<0.0005	<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	-	-	-	-	-	-	-	-	-	-	-	-	70
2	NW Corner of the Project area	53.81	48.66	49.90	50.79	-	-	-	-	-	-	-	-	-	-	-	-	50
3	Chunkuri-2, Bajua	43.30	43.35	46.84	44.49	-	-	-	-	-	-	-	-	-	-	-	-	50
4	SW corner of the Project area	56.81	54.73	51.97	54.50	-	-	-	-	-	-	-	-	-	-	-	-	50
5	Proposed Township area, Project site	55.02	52.41	52.69	53.37	-	-	-	-	-	-	-	-	-	-	-	-	50
6	Barni, Gaurambha	50.63	54.19	57.09	53.97	-	-	-	-	-	-	-	-	-	-	-	-	50
7	Khan Jahan Ali Bridge, Khulna	66.40	64.82	66.34	65.85	-	-	-	-	-	-	-	-	-	-	-	-	70
8	Mongla Port area	49.89	48.67	51.07	49.88	-	-	-	-	-	-	-	-	-	-	-	-	75
9	Harbaria, Sundarbans	44.40	44.69	*43.52*	44.55	-	-	-	-	-	-	-	-	-	-	-	-	45
10	Akram Point, Sundarbans	45.60	40.29	*41.87*	42.95	-	-	-	-	-	-	-	-	-	-	-	-	45
11	Hiron Point, Sundarbans	48.53	37.69	*42.37*	43.11	-	-	-	-	-	-	-	-	-	-	-	-	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	A	B	C	D	E	F	G
2014-2015									
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							
2015-2016									
Food (C_F)	V1	Phytoplankton (%)							
	V2	Zooplankton (%)							
Water Quality (C_{WQ})	V3	Turbidity							

Life Requirements	Variable Sl.	Habitat Variables	A	B	C	D	E	F	G
	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							
2016-2017									
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	A	B	C	D	E	F	G
	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 (April, 2014)	2nd QM (July, 2014)	3rd QM (Oct, 2014)	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*		+	-	-	-	-	-	-	-	-			
Baim	*Pisodonophis cancrivorus*	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		NO	-	-	-	-	-	-	+	+	+			

Boiragi	*Coilia dussumieri*	NO	+	+	+	+	+	+	-	+	-			
Boishakhi Chingri		NO	-	+	-	-	+	+	+	+	+			
Chammu Chingri	*Metapenaeus brevicornis*	DD	+	+	+	-	+	+	+	+	+			
Chaka Chingri	*Penaeus indicus*	DD	+	+	-	+	+	+	+	+	+			
Ghora Chela	*Securicula gora*	-	+	-	-	-	-	-	-	-	-			
Chanda Chela			-	+	+	-	-	-	-	-	+			
Chitra			+	-	-	+	+	+	-	+	+			
Khayra Chela			-	+	-	-	-	-	+	-	+			
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		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	+	+	-	+	+	+	+	+	+			
Kain Magur		EN	-	+	+	+	+	+	+	+	+			
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	-	-	-	-	+	-	-	-	-	-	-			
Poma	*Poma poma*	NO	+	+	+	+	+	+	+	+	+			
Potka	*Chelonodon patoca*	NO	+	+	-	+	+	+	-	+	+			
Shilong	*Silonia silondia*	EN	+	-	+	-	-	-	-	-	-			
Tailla	*Eleutheronema tetradactylum*	-	+	-	-	-	-	-	-	-	-			
Tapse	*Polynemus paradiseus*	-	+	+	+	-	-	+	+	+	-			
Datina			-	-	-	+	-	-	-	+	+			
Jaba			-	-	-	+	-	-	+	+	-			
Shole	*Channa striatus*		-	-	-	+	-	-	-	+	-			
Magur	*Clarias batrachus*		-	-	-	+	-	-	-	+	-			
Koi	*Anabas testudineus*		-	-	-	+	-	-	-	+	-			
Vetki			-	-	-	+	+	+	+	+	+			
Gangania			-	-	-	+	+	-	+	-	-			

**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
Aswine Bele	Harbaria	0	0	0	0	50	50	0
Bagda	Chandpai	100	0	0	0	0	0	0
	Harbaria	0	0	0	50	50	0	0
	Mongla Point	0	0	0	100	0	0	0
Banspata	Harbaria	0	0	0	50	50	0	0
	Mongla Point	0	0	0	100	0	0	0
Bata	Chandpai	100	0	0	0	0	0	0
Bele	Chandpai	100	0	0	0	0	0	0
	Harbaria	0	0	0	75	25	0	0
	Maidara	0	0	0	57	43	0	0
	Mongla Point	0	0	44	56	0	0	0
Boisakhai	Chandpai	0	100	0	0	0	0	0
	Harbaria	0	0	0	0	100	0	0
Chaka Chingri	Chandpai	100	0	0	0	0	0	0
	Harbaria	0	0	0	0	100	0	0
	Mongla Point	0	0	0	100	0	0	0
Chami Chingri	Chandpai	100	0	0	0	0	0	0
	Harbaria	0	0	0	100	0	0	0
	Mongla Point	0	0	100	0	0	0	0
Chanda	Maidara	0	0	0	100	0	0	0
	Mongla Point	0	33	33	33	0	0	0
Chata Bele	Harbaria	0	0	0	0	100	0	0
	Mongla Point	0	0	0	50	50	0	0
Chitra	Mongla Point	0	0	100	0	0	0	0
Daitna	Harbaria	0	0	45	55	0	0	0
	Maidara	0	0	4	96	0	0	0
	Mongla Point	17	0	0	83	0	0	0
Ekthuto	Harbaria	0	0	0	0	100	0	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
	Mongla Point	0	0	0	0	100	0	0
Gagra Tengra	Harbaria	0	0	0	100	0	0	0
Golda	Chandpai	100	0	0	0	0	0	0
	Harbaria	0	0	0	0	40	60	0
Gulsha Tengra	Harbaria	0	0	0	0	84	0	16
	Maidara	0	0	0	89	11	0	0
	Mongla Point	0	0	0	100	0	0	0
Horina Chingri	Chandpai	100	0	0	0	0	0	0
	Harbaria	0	0	0	100	0	0	0
	Mongla Point	0	0	0	100	0	0	0
Katali Chingri	Harbaria	0	0	0	100	0	0	0
Khaira Ilish	Chalna Point	0	100	0	0	0	0	0
Koidda Vola	Harbaria	0	0	0	16	81	3	0
	Maidara	0	0	0	0	100	0	0
	Mongla Point	0	0	0	0	100	0	0
Korhina	Mongla Point	0	0	100	0	0	0	0
Kuchia	Chandpai	0	0	0	0	100	0	0
Lal Chewa	Chalna Point	0	0	0	0	100	0	0
	Chandpai	0	0	100	0	0	0	0
Loitta	Chalna Point	100	0	0	0	0	0	0
Maya Chela	Chandpai	100	0	0	0	0	0	0
Motka Chingri	Chalna Point	100	0	0	0	0	0	0
	Chandpai	100	0	0	0	0	0	0
	Harbaria	0	0	0	100	0	0	0
	Mongla Point	0	33	67	0	0	0	0
Mouchela	Harbaria	0	0	0	100	0	0	0
	Mongla Point	0	86	14	0	0	0	0
Moukatali	Mongla Point	0	0	0	100	0	0	0
Mud Crab	Harbaria	0	0	100	0	0	0	0
Murukke Chela	Mongla Point	0	0	0	0	100	0	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
Mutkura	Chandpai	100	0	0	0	0	0	0
	Mongla Point	0	0	100	0	0	0	0
Nona Bele	Harbaria	0	0	0	44	56	0	0
	Mongla Point	0	0	100	0	0	0	0
Paissa	Chandpai	100	0	0	0	0	0	0
	Maidara	0	0	3	68	30	0	0
	Mongla Point	4	0	0	85	12	0	0
Pheksa	Chalna Point	0	0	0	0	100	0	0
	Harbaria	0	0	0	100	0	0	0
Poikka	Harbaria	0	0	71	29	0	0	0
Poma	Chalna Point	100	0	0	0	0	0	0
	Harbaria	0	0	0	0	100	0	0
Potka	Mongla Point	0	0	100	0	0	0	0
Punti	Maidara	0	0	0	100	0	0	0
Rekha	Maidara	0	0	0	100	0	0	0
	Mongla Point	0	0	100	0	0	0	0
Sada Chela	Chalna Point	0	100	0	0	0	0	0
Tairel	Harbaria	0	0	0	0	100	0	0
Tau Paissa	Harbaria	0	0	0	50	50	0	0
Tigar Chingri	Chalna Point	100	0	0	0	0	0	0
	Chandpai	98	0	2	0	0	0	0
	Maidara	0	0	0	100	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 Monitoring (April, 2014)	2nd Monitoring (July, 2014)	3rd Monitoring (Oct, 2014)	4th Monitoring (Dec, 2014)	5th Monitoring (April, 2015)	6th Monitoring (July, 2015)	7th Monitoring (Oct, 2015)	8th Monitoring (Dec, 2015)	9th Monitoring (April, 2016)	10th Monitoring (July, 2016)	11th Monitoring (Oct, 2016)	12th Monitoring (Dec, 2016)
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	-	-			
		Adult	-	-	Feeding and Growing	-	-	Feeding	Feeding	-	-			
	Harbaria	Juvenile and Age-1 adult	Feeding and Growing	Feeding and Growing	7	-	-	-	-	-	-			
		Adult and Brood Fish	-	-	Breeding and Spawning	-	-	-	-	-	-			
	Chandpai	Juvenile	-	-	Feeding and Growing	-	-	-	Feeding	-	-			
	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	-	-	-	-			
	Harbaria	Juvenile	Feeding and Growing	-	-	-	-	Feeding	-	-	-			
	Mongla Point	Fry	-	Nursing	-	Feeding	-	-	-	-	-			
		Juvenile	-	-	-	-	-	-	-	Feeding	-			
	South-west of the Project	Juvenile	-	Feeding and Growing	-	-	-	-	-	-	-			
Chapila	Haldikhali	Juvenile	Feeding and Growing	-	-	-	-	-	-	-	-			

Migratory Fish Species	Sampling Sites	Year Class*	Migration Purpose											
			1st Monitoring (April, 2014)	2nd Monitoring (July, 2014)	3rd Monitoring (Oct, 2014)	4th Monitoring (Dec, 2014)	5th Monitoring (April, 2015)	6th Monitoring (July, 2015)	7th Monitoring (Oct, 2015)	8th Monitoring (Dec, 2015)	9th Monitoring (April, 2016)	10th Monitoring (July, 2016)	11th Monitoring (Oct, 2016)	12th Monitoring (Dec, 2016)
	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 adult	-	Nursing, Feeding and Growing	-	-	-	-	-	-	-			
	Chalna Point	Age-1 adult	-	Feeding and Growing	-	-	Feeding and Growing	-	-	-	-			
		Fry	-	-	-	-	-	-	-	-	Nursing			
Poma	Haldikhali	Juvenile	Feeding and Growing	-	-	Feeding	-	-	-		-			

Migratory Fish Species	Sampling Sites	Year Class*	Migration Purpose											
			1st Monitoring (April, 2014)	2nd Monitoring (July, 2014)	3rd Monitoring (Oct, 2014)	4th Monitoring (Dec, 2014)	5th Monitoring (April, 2015)	6th Monitoring (July, 2015)	7th Monitoring (Oct, 2015)	8th Monitoring (Dec, 2015)	9th Monitoring (April, 2016)	10th Monitoring (July, 2016)	11th Monitoring (Oct, 2016)	12th Monitoring (Dec, 2016)
	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		-			
		Adult	-	-	-	-	-	-	Feeding		-			
	Haldikhali	Fry and Juvenile	-	-	Nursing	-	-	-	-	-	-			
	Harbaria	Adult and Brood Fish	-	-	Breeding and Spawning	-	-	-	-	-	-			
		Adult	-	-	-	-	-	-	Feeding		-			
		Fry and Juvenile						Spawning and Nursery	-	-	Feeding and Growing			
	Mongla Point	Fry, Juvenile and Age-1 adult	-	-	Spawning, Feeding and Growing	-	-	-	-	Nursing	-			
		Juvenile	-	-	-	-	-	-	Feeding and Growing		-			
		Age-1 Adult	-	-	-	-	-	-	Feeding	Feeding	-			
		Adult	-	-		Feeding	-	Feeding	-	-	-			
	South-west of the Project	Adult	-	-	Feeding	Feeding	-	Feeding	-	-	-			
	Chalna Point	Juvenile, Adult and Brood Fish	Breeding and Spawning	-	-	-	-	-	-	-	-			
		Juvenile and Adult	-	-	Feeding and Growing	Feeding	Feeding and Growing	-	Feeding and Growing	-	-			
		Fry	-	-	-	-	-	-	-	-	Nursery			
Chhuri	Haldikhali	Adult	Feeding	-	Feeding	-	-	-	-	-	-			
	Akram Point		Feeding	-	Feeding	-	-	-	-	-	-			
Chela	Haldikhali	Adult	Feeding	-	Feeding	-	-	-	-	-	-			

Migratory Fish Species	Sampling Sites	Year Class*	Migration Purpose											
			1st Monitoring (April, 2014)	2nd Monitoring (July, 2014)	3rd Monitoring (Oct, 2014)	4th Monitoring (Dec, 2014)	5th Monitoring (April, 2015)	6th Monitoring (July, 2015)	7th Monitoring (Oct, 2015)	8th Monitoring (Dec, 2015)	9th Monitoring (April, 2016)	10th Monitoring (July, 2016)	11th Monitoring (Oct, 2016)	12th Monitoring (Dec, 2016)
	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	-	-	-	-	-	-			
	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	-	-	-	-	-	-			
		Adult	-	-	-	-	-	-	Feeding	-	-			
	Haldikhali	Juvenile	-	-	-	-	-	-	Feeding and Growing	-	-			
	Harbaria	Adult	-	-	Feeding	-	Feeding and Growing	-	-	-	Feeding			
Gulsha Tengra	Haldikhali	Adult	Feeding and Breeding	-	-	-	-	-	-	-	-			
	Akram Point	Adult		-	-	-	-	-	-	-	-			
	Chandpai	Age-1 adult	-	-	-	Feeding	-	Feeding	Feeding and Growing	-	-			
		Juvenile	-	-	-	-	-	-	Feeding and Growing		-			
	Mongla Point	Age-1 adult	-	Feeding and Growing	-	Feeding and Growing	-	Feeding and Growing		-	Feeding and Growing			
		Juvenile	-	-	-	-	-	-	Feeding and Growing		-			
	Harbaria	Juvenile	-	-	-	-	-	-	Feeding and Growing		-			
		Age-1 adult	-	-	-	-	-	-	-	-	Feeding and Growing			
	Maidara	Juvenile and Age-1 Adult	-	-	-	-	-	-	Feeding and Growing	-				
Potka	Haldikhali	Adult	Feeding and Breeding	-	-	-	-	-	-	-	-			

Migratory Fish Species	Sampling Sites	Year Class*	Migration Purpose											
			1st Monitoring (April, 2014)	2nd Monitoring (July, 2014)	3rd Monitoring (Oct, 2014)	4th Monitoring (Dec, 2014)	5th Monitoring (April, 2015)	6th Monitoring (July, 2015)	7th Monitoring (Oct, 2015)	8th Monitoring (Dec, 2015)	9th Monitoring (April, 2016)	10th Monitoring (July, 2016)	11th Monitoring (Oct, 2016)	12th Monitoring (Dec, 2016)
	Chandpai	Fry	Spawning	Spawning and Nursing	-	-	-	-	-	-	-			
		Juvenile	-	-	-	-	-	-	-	Feeding and Growing	-			
		Adult	-	-	-	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	-	-	-	-	-	-			
	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	-	-	-	-	-			

Migratory Fish Species	Sampling Sites	Year Class*	Migration Purpose											
			1st Monitoring (April, 2014)	2nd Monitoring (July, 2014)	3rd Monitoring (Oct, 2014)	4th Monitoring (Dec, 2014)	5th Monitoring (April, 2015)	6th Monitoring (July, 2015)	7th Monitoring (Oct, 2015)	8th Monitoring (Dec, 2015)	9th Monitoring (April, 2016)	10th Monitoring (July, 2016)	11th Monitoring (Oct, 2016)	12th Monitoring (Dec, 2016)
		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	-			
	Harbaria	Juvenile and Age-1 Adult	-	-	-	-	-	-	Feeding and Growing					
	Mongla Point	Fry	Breeding and Spawning	-	-	-	-	Nursery	-	-	-			
	Mongla Point	Fry, Juvenile-1 and Juvenile	8	9	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	-			
Tular Dandi (Nona bele)	Akram Point	Adult	Feeding	-	-	-	-	-	-	-	-			
	South-west of the Project	Adult	-	-	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	-	-	-	-	-	-	-	-			
Phekssa	Akram Point	Adult	Feeding	-	-	-	-	-	-	Feeding	-			

Migratory Fish Species	Sampling Sites	Year Class*	Migration Purpose											
			1st Monitoring (April, 2014)	2nd Monitoring (July, 2014)	3rd Monitoring (Oct, 2014)	4th Monitoring (Dec, 2014)	5th Monitoring (April, 2015)	6th Monitoring (July, 2015)	7th Monitoring (Oct, 2015)	8th Monitoring (Dec, 2015)	9th Monitoring (April, 2016)	10th Monitoring (July, 2016)	11th Monitoring (Oct, 2016)	12th Monitoring (Dec, 2016)
		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	-				
	Chalna Point	Adult	-	-	Feeding	Feeding	Feeding	-	Feeding	-	-			
	Mongla Point	Adult	-	-	Feeding	Feeding	-	-	Feeding and Growing	-	-			
	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	-			

Migratory Fish Species	Sampling Sites	Year Class*	Migration Purpose											
			1st Monitoring (April, 2014)	2nd Monitoring (July, 2014)	3rd Monitoring (Oct, 2014)	4th Monitoring (Dec, 2014)	5th Monitoring (April, 2015)	6th Monitoring (July, 2015)	7th Monitoring (Oct, 2015)	8th Monitoring (Dec, 2015)	9th Monitoring (April, 2016)	10th Monitoring (July, 2016)	11th Monitoring (Oct, 2016)	12th Monitoring (Dec, 2016)
		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	-	-	-			
	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	-	-			
		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			
	Mongla Point	Fry and Adult	Feeding	Nursing	-	-	-	-	-	-	-			
	Mongla Point	Adult	-	-	-	Feeding	-	-	-	-	Feeding			
	Maidara	Adult	-	-	Feeding	Feeding	-	Breeding and Spawning	-	-	-			
	Chalna Point	Adult	-	-	Feeding	Feeding	-	-	-	-	-			
Hilsa	Haldikhali	Juvenile	-	-	Feeding and Growing	-	-	-	-	-	-			

Migratory Fish Species	Sampling Sites	Year Class*	Migration Purpose											
			1st Monitoring (April, 2014)	2nd Monitoring (July, 2014)	3rd Monitoring (Oct, 2014)	4th Monitoring (Dec, 2014)	5th Monitoring (April, 2015)	6th Monitoring (July, 2015)	7th Monitoring (Oct, 2015)	8th Monitoring (Dec, 2015)	9th Monitoring (April, 2016)	10th Monitoring (July, 2016)	11th Monitoring (Oct, 2016)	12th Monitoring (Dec, 2016)
	Chandpai	-	-	-	-	-	-	-	Feeding and Breeding	-	-			
	Mongla Point	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)																					
	1st QM (April, 2014)		2nd QM (July, 2014)		3rd QM		4th QM		5th QM		6th QM		7th QM		8th QM		9th QM		10th QM		11th QM		12th QM	
	Species	ton	Species	ton	Species	ton	Species	ton	Species	ton	Species	ton	Species	ton	Species	ton	Species	ton	Species	ton	Species	ton	Species	ton
1	Bagda	5	Bagda	6.42	Bagda	4.8	-	-	Bagda	-	Bagda	1.6	Bagda	2	Catla	2	-	0						
	Vetki	1.57	Bele	0	Gusha Chingri	-	-	-	Horina Chingri	1	Horina Chingri	1	Horina Chingri	3.2	Glass Carp	0.1	-	0						
	Bele	0.98	Cheng	0	Harina Chingri	-	-	-	Tengra	-	Chali Chingri	0.5	Gusha Chingri	0.8	Horina Chingri	0.8	-	0						
	Harina Chingri	0.78	Bhangan	0	Rui (kg)	-	-	-	Paissa	-	Paissa	0.25	Paissa	24	Minar Carp	0.1	-	0						
	Chali Chingri	0.11	Chali Chingri	0	Catla (kg)	-	-	-	Chela	-	Bele	0.25	Vetki	0.2	Nilotica	1.6	-	0						
	Chaka Chingri	0.08	-	-	-	-	-	-	Vetki	-	-	-	Kailla	0.4	Paissa	0.6	-	0						
	-	-	-	-	-	-	-	-	-	-	-	-	Bele	0	Rui	3	-	0						
	-	-	-	-	-	-	-	-	-	-	-	-	Tilapia	0	Vetki	0.8	-	0						
	-	-	-	-	-	-	-	-	-	-	-	-	Catla	0	-	0	-	0						
	-	-	-	-	-	-	-	-	-	-	-	-	Minar Carp	0	-	0	-	0						
	-	-	-	-	-	-	-	-	-	-	-	-	Glass Carp	0	-	0	-	0						
	-	-	-	-	-	-	-	-	-	-	-	-	Kakra	0.4	-	0	-	0						
Sub-total =		**8.52**		**6.42**		**4.8**	**-**	-		**1**		**3.06**	**-**	**31**	**-**	**9**	**-**	**0**						
2	Bagda	4	Bagda	1	Bagda	7	-	-	Bagda	-	Bagda	1.67	Bagda	0	-	0	Bagda	1						
	Harina Chingri	2	Harina Chingri	0.33	Vetki	1	-	-	-	-	Chali Chingri	0.30	Horina Chingri	0	-	0	Horina	0.14						
	Chali Chingri	0.18	Chali Chingri	0.08	Paissa	10	-	-	-	-	Horina Chingri	0.50	Chali Chingri	0	-	0	-	0						
	-	-	Golda Chingri	0.01	Phessa	2.4	-	-	-	-	Bele	0.30	Tilapia	0	-	0	-	0						
	-	-	Bele	0.08	Bhangan	1.7	-	-	-	-	Paissa	0.25	Vetki	0	-	0	-	0						
	-	-	Tengra& Paissa	0.04	Golda Chingri	0.9	-	-	-	-	-	-	Tengra	0	-	0	-	0						
	-	-	-		Gulsha Tengra	0.2	-	-	-	-	-	-	Paissa	0	-	0	-	0						

CEGIS

Sampling Site	Total Catch (kg)																							
	1st QM (April, 2014)		2nd QM (July, 2014)		3rd QM		4th QM		5th QM		6th QM		7th QM		8th QM		9th QM		10th QM		11th QM		12th QM	
Sub-total =		**6.00**		**2.00**		**23**		-	-	**-**		**3.02**	**-**	**0**	**-**	**0**		1.14						
3	Bagda	1.38	Bagda	2.4	Bagda	1.5	-	-	Bagda	-	Bagda	3.5	Bagda	0.4	-	0	Bagda	2						
	Harina Chingri	0.34	Harina Chingri	0.34	Paissa	10	-	-	-	-	-	-	Paissa	3.2	**-**	0	**-**	0						
	Chali Chingri	0.17	Chali Chingri	0.17	Tengra	10	-	-	-	-	-	-	Vetki	0.4	-	0	-	0						
	-	-	-	-	Bele	20	-	-	-	-	-	-	Tilapia	0.06	-	0	-	0						
	-	-	-	-	Tilapia	22	-	-	-	-	-	-	Horina Chingri	0.35	-	0	-	0						
	-	-	-	-	Rui	28	-	-	-	-	-	-	Chali Chingri	0.6	-	0	-	0						
	-	-	-	-	Vetki	-	-	-	-	-	-	-	Chaka Chingri	0.1	**-**	0	**-**	0						
	-	-	-	-	Harina Chingri	-	-	-	-	-	-	-	Tengra	0	-	**0**	-	**0**						
	-	-	-	-	Chami Chingri	-	-	-	-	-	-	-	Bele	0	-	0	-	0						
	-	-	-	-	Catla	56	-	-	-	-	-	-	Tairel	0.06	-	0	-	0						
	-	-	-	-	Mrigel	50	-	-	-	-	-	-	Bhangan	0	-	0	-	0						
Sub-total =		**1.89**		**2.91**		**197.5**	-	-	-	-	-	-	-	**5.17**	-	0		**2**						
Grand-total =		**17.00**		**11.33**		**226.5**	-	-		**1**		**3.5**		**36.17**	-	**0**		**3.14**						

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

(E) Agricultural resources monitoring data

Table E.1: Detailed information of the selected plots

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: Upazila wise cropping pattern of the monitoring area for the period 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

Name of Upazila	2014-15				
	Kharif-I (March-June)	**Kharif-II (July-October)**	**Rabi (Nov-February)**	**Area(ha)**	**% of NCA**
	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
	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**

Source: Local DAE Offices, April; 2016

Table E.3: Upazila wise cropped area, yield and production of the monitoring area for the period of 2014-15

Name of upazila	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
	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

Name of upazila	Crop name	Area (ha)	Yield (Ton/ha)	Production (Tons)	% of production contribution
	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

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

Table E.4: 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

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

Table E.5: Results of crop production in monitoring plots

Monitoring Plots	Crop Production								
	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*	-	-	-	-	-	-	-
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 and April 2015, April 2016 * indicates cleaned rice*

Table E.6: Results of crop damage in monitoring plots

Monitoring plot	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(Chak-gona)	-	*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, April 2014 and April 2015, April 2016 A: water logging due to heavy rainfall, B: water logging due to internal river water, C: water logging, D: Salinity, E: Other (Pest infestation)

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 2010