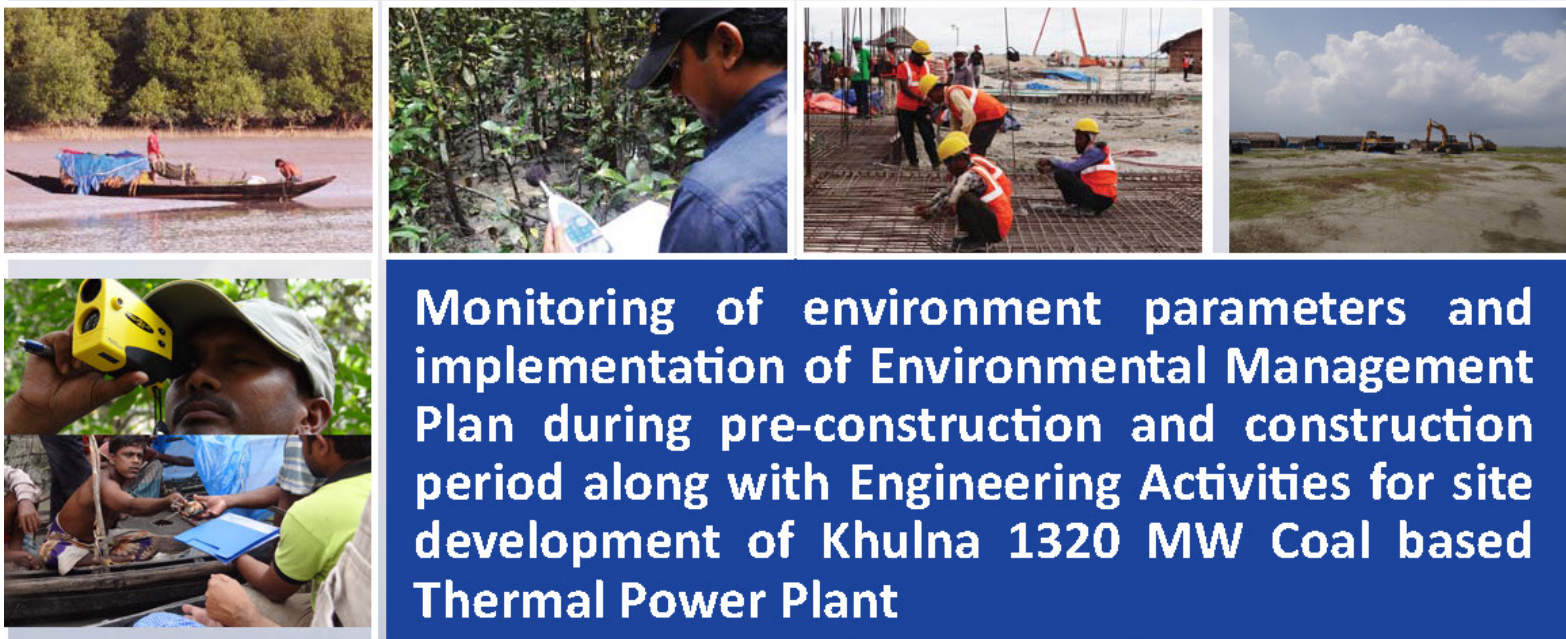




Bangladesh – India Friendship Power Company (Pvt.) Limited
(A joint Venture of NTPC Ltd and BPDB)



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



Third Quarter Monitoring Report of Second Year (2015)

Monitoring Period:

August 2015 – October 2015

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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	Electric Conductivity
ECR	Environment Conservation Rules
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
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
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

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
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 km²
1 hectare = 10⁻² km² = 2.471 acres
1 pascal = 1 N/m² = 0.01 millibar
1 liter = 0.001 cubic meter
1°C = 274.15K = 33.8°F
1 mg/m³ = 1 µg /L
1 mg/L ≈ 1 g/m³ ≈ 1 ppm (w/w)

Energy Unit

1 KWh = 3412 Btu
1MW=1000KW=10⁶ W
1 KWh = 3.6 x 10⁶ J
1 kWh = 859.85 kcal
1 horsepower = 746 W
1 GWyr = 8.76 x 10⁹ kWh

Glossary

<i>Aman:</i>	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.
<i>Aus:</i>	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.
<i>B:</i>	When preceding a crop means broadcast (B. Aus)
<i>Bazar:</i>	Market
<i>Beel:</i>	A saucer-shaped natural depression, which generally retains water throughout the year and in some cases seasonally connected to the river system.
<i>Boro:</i>	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.
<i>Haat:</i>	Market place where market exchanges are carried out either once, twice or thrice a week, however not every day.
<i>Gear/Jaal:</i>	Different types of fishing net to catch fish from the water bodies.
<i>Kutcha:</i>	A house made of locally available materials with earthen floor, commonly used in the rural areas.
<i>Khal:</i>	A drainage channel usually small, sometimes man-made. The channel through which the water flows. These may or may not be perennial.
<i>Kharif:</i>	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).
<i>Perennial Khal:</i>	Water available in the khal all the year round.
<i>Pacca:</i>	Well constructed building using modern masonry materials.
<i>Rabi:</i>	Dry agricultural crop growing season; mainly used for the cool winter season between November and February.
<i>Seasonal Khal:</i>	Water not available in the khal all the year round.
<i>T. Aman:</i>	When preceding a crop means transplanted (T. Aman).
<i>Upazila:</i>	Upazila is an administrative subdivision of a District.

Executive Summary

The Bangladesh-India Friendship Power Company Pvt. Ltd. (BIFPCL) has initiated a study on monitoring environmental and social parameters and implementation of environmental management plans during pre-construction and construction phases of the proposed Power Plant at Rampal, Bagerhat to ensure safeguard of the Sundarbans Mangrove Forest environment and the surrounding communities. Center for Environmental and Geographic Information Services (CEGIS) has been entrusted for carrying out the study. The study covers quarterly monitoring of different environmental and social parameters, and environmental compliance monitoring of pre-construction activities. The results of the monitoring are reported quarterly to BIFPCL through Monitoring Report of each quarter. Eventually, the BIFPCL submits these reports to DoE and Forest Department.

CEGIS has initiated the monitoring activities since February 2014. So far six (6) quarterly monitoring reports have been submitted. In the process of 3rd quarter of the 2nd year (2015), monitoring activities were carried out in October, 2015. The monitoring activities involved:

- Monitoring of implementation of EMP and Environmental Compliance
- Monitoring of ambient air quality
- Monitoring of ambient noise condition
- Monitoring of ambient water quality
- Monitoring of fisheries resources covering fish habitats, biodiversity, migration and production
- Monitoring of ecosystem and biodiversity
- Monitoring of Sundarbans forest health

A brief summary of the aforementioned activities are provided in the following paragraphs.

Monitoring of EMP during Pre-construction Activities

Land development for the BIFPCL's site (Block A) has been completed. Construction of embankments and slope protection work are about to complete. Site office construction has already been started. At present, the construction of main access road from Babur Bari to the Plant site is ongoing. However, as per the EMP approved by DoE, there are some measures that should be adopted during this stage.

In general, in this quarter, the environmental due diligence covered the following components:

- 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

The monitoring study found that BIFPCL has mostly complied with the EMP as suggested in the EIA report, which were stipulated in the pre-construction (Land development) stage, and has taken the preparation to meet the compliance requirements to the next stages. 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, which are:

- Demarcation of traffic way and ensure that the vehicles are using the demarcated way only, 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 as it has been done earlier;
- More waste disposal bins need to be installed 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;
- Establish the grievance redress mechanism; proper documentation of any accident or any health hazard risk; adopt near miss for any unforeseeable injury, illness, or damage
- Assign responsibility of enforcing and monitoring safety procedure to an officer;
- The EPC contractors should prepare site specific ESMP;
- Arrange safety training program for the Project personnel and labor force.

Air Quality Monitoring

Ambient air quality has been monitored at eleven (11) locations in the present second year's (2015) 3rd quarterly monitoring. Wind direction was also identified; and it headed to North-East from the South-West. The weather condition was sunny to rainy. This time all the monitoring parameters (SO₂, NO₂, PM_{2.5}, PM₁₀, SPM, CO and O₃) of the ambient air were found well within the standard. This is because it was already the end of rainy season and all the air pollutants were showered down and settled..

Newly developed land for industrial activities along the Passur River, rain droplets 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 Monitoring

This time, ambient noise was monitored at the pre-selected eleven (11) points. Around the Project site, at township area, the nearby accelerated construction work, at Gaurambha the overcrowded bazar contributed to the elevated noise level. Noise data at all points (Harbaria, Akram Point & Hiron Point) inside the Sundarbans exceeded the threshold for a silent class (45dB) ranging from ~46dB to as high as ~51dB, probably due to the forest had become so livelier during this time. Wind action on trees, splashing waves, bird's chirping, ship and fishing boats etc. are the sources of noise observed in Sundarbans.

Water Quality Monitoring

In this season, the team has monitored the water samples from each predestined sites of the Passur-Sibsa river system. The physico-chemical parameters of the water samples were compared with the water quality standards, specified in ECR' 1997 and the values were found to be within the Bangladesh Standard and WHO guidelines. In addition, Spatial and seasonal variations have also been examined and no significant variation was found among the monitored values. Furthermore, the results of heavy metal content both in surface water and ground water were found to be within the permissible level. Therefore, it can be stated that the observed values of all the consecutive seasons represent a moderate water quality condition for the community use, aquatic life, and most importantly for the Sundarbans forest ecosystem.

Agriculture Resources Monitoring

It was observed during field visit that among the five (5) monitoring agriculture lands, farmers of the three (3) monitoring lands, monitoring land-1, monitoring land-2 and monitoring land-5, cultivated Aman crops this year (2015-16). The farmer of the monitoring land-1 was cultivating HYV Aman (BR23) rice and the farmers of the monitoring land-2 and monitoring land-5 were cultivating Benapole rice. The rest two, monitoring land-3 and monitoring land-4, remained fallow this year due to submergence by the river and rain water. The salinity issue has been a major factor for the above said monitoring lands to succumb the cropping production.

Fisheries Monitoring

Fisheries resources have been monitored at the same locations and samples were taken for seven capture and three culture fisheries. The followings are the key findings of the monitoring in 3rd quarter of 2nd year (2015):

- Changes in habitat usage have been observed when compared between the year of 2014-2015 and 2015-2016, which is supposed to be caused by tidal effect, seasonal variability and fisheries resource management. Moreover, habitat usage analysis by different ages of different fish species (based on the length-based community structure model), three types of habitat were found: i) Grazing ground, ii) Nursery ground and iii) Grow out and Feeding ground.
- Shannon-Weiner index has also been observed to vary between 3rd quarter of 2014 and that of 2015. The highest index has been found at Mongla Point (0.85). On the contrary, the lowest evenness has been found at Sheola Khal in Chandpai (0.51). Moreover, maximum Fisheries Species Richness (FSR) was recorded at Mongla Point and Maidara Point (n=4), while very low FSR was recorded in the other sampling sites (n=3). 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 yearly variation for both the evenness and richness of fish species.
- Juveniles of fin fish species were more widely distributed among the upper, middle and lower reaches of the Passur River.
- Fish species like Bairagi attains the maximum abundance among the migratory fish species. Moreover, three species like Poma, Gulsha Tengra and Phekssa showed long range of distribution.
- Bagda stock of the entire selected shrimp/fish farm are collected from the hatchery among which some are from Chalna and some are from Foyla Bazaar. The highest stocking rate has been observed in the selected Gher at Chunkuri-2. The highest mortality rate due to viral infection has been observed in the selected Gher at Kapasdanga.
- The highest productivity has been found in Sheola Khal at Chandpai, and the lowest in the Harbaria Khal because of the abundance of fries which are not considered as the production. Moreover, higher productivity was observed in this third quarter of 2015 as compared to the third quarter monitoring of the year 2014. It is reported by the commercial fishermen that the declaration of fishing ban is presumed to be the main reason of that higher productivity. The most frequently used gear is Charpata Jal in lower reaches of the Passur River and Jhaki Jal in upper reaches of the Passur River. However, the total catch is higher in this monitoring year than that found in the first monitoring year.

- Fish production from Shrimp/fish farm (Gher) has reached as much as 31 tons, which is the highest amount recorded for the selected Gher in Rajnagar in terms of catch within the months of September and October. This total weighing amount of fish includes the weight of Bagda, Horina Chingri, Gusha Chingri, Paissa, Vetki, Kailla, Bele, Tilapia, Catla, Mirror Carp, Glass Carp and Kakra.

Ecosystem and Biodiversity Monitoring

Plant health, vegetation canopy status, lichen cover on tree barks, bird habitat, butterfly occurrence and dolphin occurrence have been monitored for this monitoring season. Overall plant health has remained unchanged in all the monitoring locations than in previous monitoring season, except for Date Palm in Rajnagar and Coconut in Chalkghona. The health of Date palm plant species has showed a deterioration trend due to excess sogginess from flooding of the homestead yard. Coconut plant followed a good health trend in Chalkghona as a result of the reduced soil salinity.

Tree Canopy status of the studied homesteads has remained unchanged in Rajnagar, Kalekarber and Chalkghona sites. In case of Barni, canopy coverage has improved due to the growth and expansion of planted saplings' branches and shoots in this rainy season.

Alive lichen covers have been observed higher than previous monitoring in April 2015 due to having required moisture on tree barks. No bird nest has been observed in any of the monitoring sites. Population of butterflies is found higher than previous monitoring season as huge grasses and herbs have grown in all the homestead platforms.

Occurrences of dolphin have recorded in Maidara River near Project site, Passur River near Dhangmari Forest Station, Harbaria Khal and also in Sibsa downstream at Akram Point.

Sundarbans Forest Health Monitoring

In this seventh forest health monitoring, the team investigated seedling regeneration, pneumatophore, crab hole, lichen coverage, canopy cover, net canopy photosynthesis rate and tree tag numbers. Sundarbans forest health was monitored in all the five sites namely Sutarkhali, Karamjal, Harbaria, Akram Point and Hiron Point. In this present study, CEGIS survey team talked to Forest Department field level officials of Dangmari forest station, Karamjal patrol post, Harbaria patrol post, Kokilmoni patrol post and Sutarkhali forest station and informed them about survey objectives and permanent sample plots establishment for the Sundarbans forest health monitoring. There was no significant difference of seedlings density, pneumatophores density, crab hole density, lichen coverage, canopy cover percentage and net canopy photosynthesis rate among the seven monitoring quarters in the five monitoring sites. In the monitoring sites, all the forest health parameters were found good which indicated that the ongoing civil construction activities of the proposed coal based power plant at Rampal had no adverse effect on SRF forest health.

Socio-economic Monitoring

Compensation

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. Some discrepancy was found for getting compensation of the leasees.

Rehabilitation and Resettlement

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.

Project Related Employment Generation

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.

Labor and Working Condition

At present the Plant is in preliminary site preparation (pre-construction) phase and for the last few months, practically no works have taken place at site due to monsoon. 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. Main activities at site for Power Plant construction will commence when EPC contractor will set in. Water treatment plant has been installed in the Project site and it is expected that it will start operation in 2nd week of October, 2015. 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. Temporary labor sheds have been found that are made out of locally available thatching materials e.g., Golpata and bamboo.

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.

Community Health, Safety and Security

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.

People living in the vicinity of the Project area complained about dust generated from the newly filled land in the Project area. Construction of boundary wall around the Project is completed which will help to reduce the dust problem. An *Ansar* Camp has also been established in the Project site for ensuring security.

Corporate Social Responsibility

About 2,902 people received health facilities from the health camping of the Project authority during the last six months (May-Oct, 2015), and this number has increased compared to the previous six months' (Nov, 2014-Apr, 2015). The health camp offers free health consultation and provides medicine as per its availability.

1 Introduction

1.1 Background

1. The Project proponent (BIFPCL) has entrusted CEGIS with the responsibility for conducting the environmental and social monitoring relevant to the pre-construction and construction activities of Khulna 1320 MW Coal Based Thermal Power Plant under the caption “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”.

2. Accordingly, CEGIS has been carrying out the monitoring activities since February 2014. So far six (6) monitoring reports have been submitted on quarterly basis. The current document constitutes **7th monitoring** report (i.e. monitoring activities of the **3rd quarter of 2nd year, 2015**) has been carried out in October 2015 covering Project monitoring locations and updates environmental monitoring data to November, 2015.

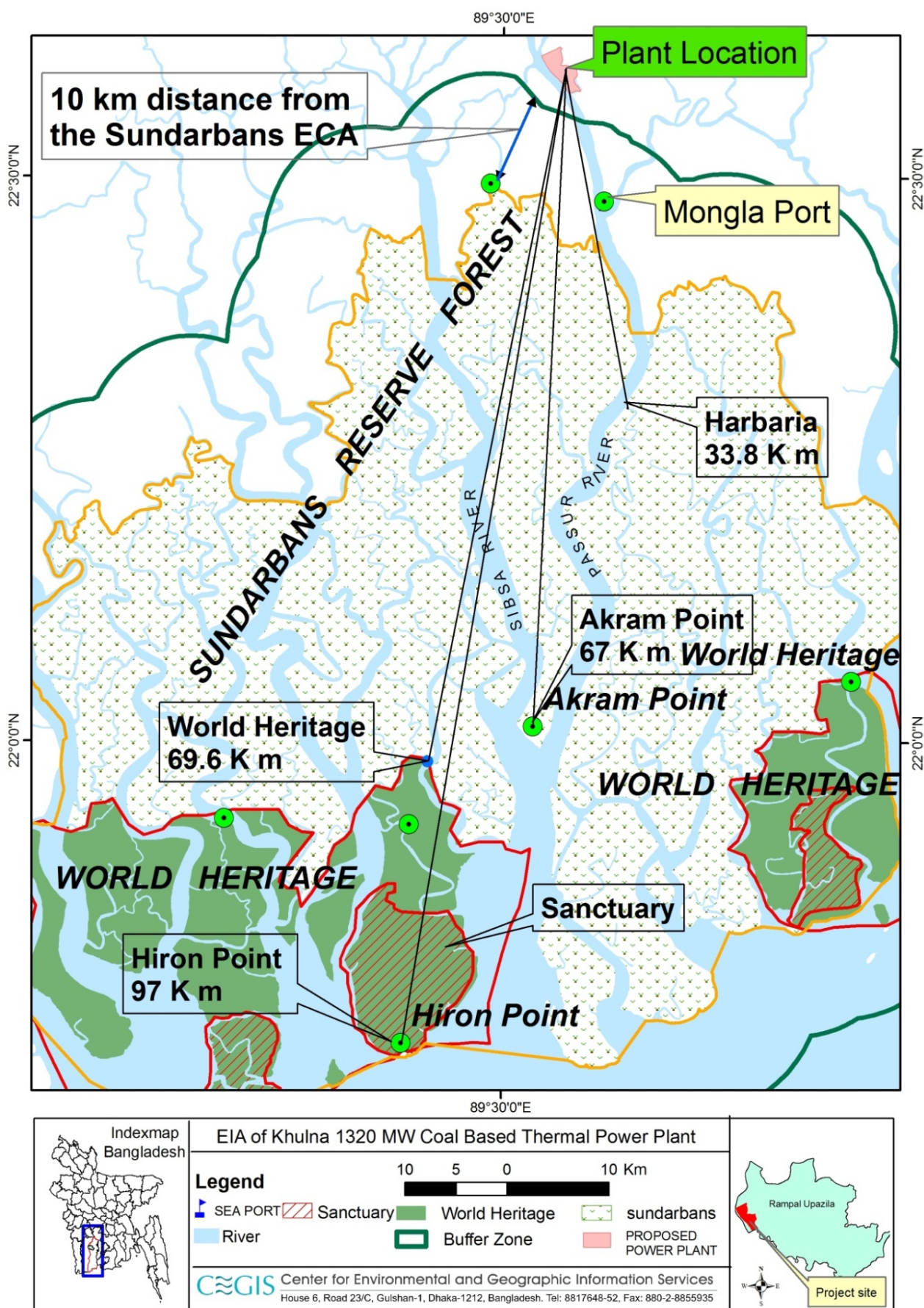
1.2 Objectives of Monitoring

3. 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.

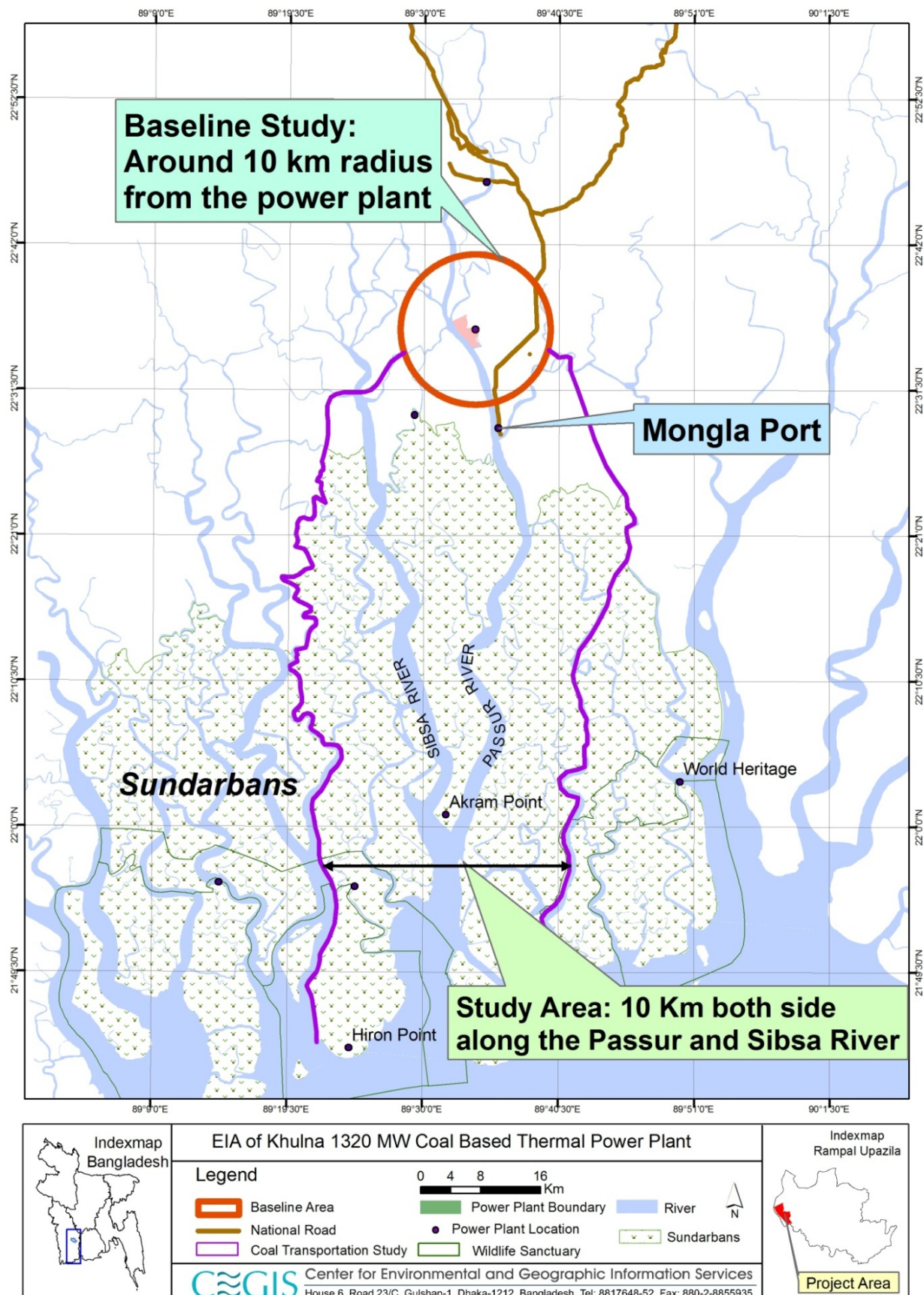
4. The aim of the quarter monitoring is to monitor the ambient state of environment that will be considered as the baseline and these will be compared with the environmental condition in future when the Power Plant will be in operation phase. The monitoring activities also include monitoring of environmental compliance of power plant pre-construction activities.

1.3 Project Location and Study Area

5. The Power Plant is located in between latitude 22°37'0"N to 22°34'30"N and longitude 89°32'0"E to 89°34'5"E, about 23km south from the Khulna City and 14 km north-westward from the Sundarbans. Location of the study area and their relative distance from various heritage site is presented in **Map1.1**. The study area includes: i) area of 10 km radius from the Plant location, ii) 10km strip from the both bank of Passur and Sibsa rivers starting from Plant site to Hiron point (**Map 1.2**).



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



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

1.4 Collaboration with Forest Department

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

7. 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,
- Above ground and below ground carbon measurement, and
- Impacts on Canopy Cover, Leaves Phenology, Flowers Behaviour, Pneumatophore Condition

8. The monitoring team was 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.

1.5 Collaboration with Department of Environment

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

10. The BIFPCL forwarded the submitted monitoring report 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 EC committee of the DoE during the renewal of the EIA approval.

2 Environmental Compliance Monitoring

2.1 Background

11. 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 brick 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 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.

2.2 Monitoring of Environmental Compliance

12. The environmental compliance monitoring that includes monitoring of EMP implementation was based on physical observation and assessment. A comprehensive diligence checklist was 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

13. The aim of the checklists is to check the diligence of measures and effectiveness of the measures. The checklists produce a Compliance Data Sheet that would contain both quantitative and qualitative data. The details of the compliance checklist are attached in Annex I. The **Table 2.1, 2.2, 2.3 and 2.4** presents summary of the findings of the environmental compliance monitoring:

Table 2.1: Monitoring of Environmental and Social Management System Action Plan Implementation

SI 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	<ul style="list-style-type: none"> 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 	<ul style="list-style-type: none"> 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 	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> 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 	<ul style="list-style-type: none"> CEGIS is quarterly monitoring dust generated. Construction of boundary wall for the main Plant is completed. Sprinkling of water at some places 	<ul style="list-style-type: none"> Construct brick road within the Project site for traffic movement (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 	BIFPCL agrees to take such recommended measures
3	Water Quality	<ul style="list-style-type: none"> 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 	<ul style="list-style-type: none"> Construction of boundary wall for the main Plant Rainfall runoff discharge to nearby river through unmanaged/unplanned drainage network at some places 	<ul style="list-style-type: none"> Temporary drainage for rain fall runoff should be constructed; Stockpile of construction material should be placed at a safe distance from drainage network; 	Being Complied

Table 2.1: Monitoring of Environmental and Social Management System Action Plan Implementation (**continued**)

SI no	Potential Impacts	EMP measures as proposed in the EIA	Actual condition/ Measures already Implemented	Recommended Action	Compliance Status
		stored on river bank/slope • No disposal of waste and waste water to river or canal.	• Onsite sanitation facilities has been developed at the labor sheds as well as the working places	• Sediment trapping pool 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 labeling should be installed at labor shed, and working area	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.	• 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 has to be undertaken.	In the process of Compliance

Table 2.1: Monitoring of Environmental and Social Management System Action Plan Implementation (continued)

SI no	Potential Impacts	EMP measures as proposed in the EIA	Actual condition/ Measures already Implemented	Recommended Action	Compliance Status
		women, children, ethnic minorities, indigenous people etc.) • Provision of monitoring the compensation and resettlement process	for their livelihoods		
6	Livelihood and living condition	<ul style="list-style-type: none"> 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? 	<ul style="list-style-type: none"> 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. 	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> 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. 	<ul style="list-style-type: none"> 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. 	<ul style="list-style-type: none"> Prepare a checklist on equipment and condition of the equipment that should be owned by the contractors; GHG inventory checklist might be mandatory for the EPC contractors. 	To be complied during construction and operation stage

Table 2.2: Monitoring of Labor and Working Condition

SI 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	<ul style="list-style-type: none"> 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. 	<ul style="list-style-type: none"> Engaged HR consultant to prepare relevant policies; Preparing to recruit Environment, Occupation and Health Safety Expert; No discrimination has been recorded. 	<ul style="list-style-type: none"> 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. 	BIFPCL agrees to comply all the measures
2	Protecting Workforce	<ul style="list-style-type: none"> 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 	<ul style="list-style-type: none"> Ensured no child labor employment Ensured no forced labor Using of appropriate PPE 	<ul style="list-style-type: none"> 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, benefit. 	Agrees to comply

Table 2.2: Monitoring of Labor and Working Condition (continued)

SI no	Potential Impacts	EMP measures as proposed in the EIA	Actual measures already Implemented	Recommended Action	Compliance Status
3	Safety at site	<ul style="list-style-type: none"> • 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. 	<ul style="list-style-type: none"> • 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. 	<ul style="list-style-type: none"> • 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. 	Being Complied

Table 2.2: Monitoring of Labor and Working Condition (**continued**)

SI no	Potential Impacts	EMP measures as proposed in the EIA	Actual measures already Implemented	Recommended Action	Compliance Status
4	Occupational Health and Safety Procedure	<ul style="list-style-type: none"> Provision of complete EHS division in the Human Resources Planning/Organogram Preparation of Safety Policy to be adopted during Plant operation 	<ul style="list-style-type: none"> 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. 	<ul style="list-style-type: none"> Provision of 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. 	BIFPCL agrees to comply all the measures. EHS & OHS policy in line with World Bank standard are included in the scope of services of EPC contractor.
5	Workers Well Being	<ul style="list-style-type: none"> 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. 	<ul style="list-style-type: none"> Engagement of HR consultant to develop HR policy and Organogram; Health care & information, canteen, restrooms, accommodation are facilitated by the proponents. 	<ul style="list-style-type: none"> 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 2.3: 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	<ul style="list-style-type: none"> 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. 	<ul style="list-style-type: none"> Construction of boundary wall around the Project area already completed; Water spray for dust suppression being carried out around the Plant office. 	<ul style="list-style-type: none"> Water spray along the road way/walk way, major working area, labor sheds needs to be carried out. 	BIFPCL agrees to take more such measures
2	Grievance of local people	<ul style="list-style-type: none"> Availability and operation of Grievance Redress Mechanism; Maintaining open communication channel with the local community. 	<ul style="list-style-type: none"> 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 . 	<ul style="list-style-type: none"> 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. 	BIFPCL agrees to establish a grievance redress mechanism
3	Risk of breaching Community Safety	<ul style="list-style-type: none"> 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; 	<ul style="list-style-type: none"> 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 	<ul style="list-style-type: none"> 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 	BIFPCL agrees to comply all the measures during construction stage

Table 2.3: Monitoring of Community Health, Safety and Security (continued)

SI no	Potential Impacts	Proposed EMP	Actual measures already Implemented	Recommended Action	Compliance Status
		<ul style="list-style-type: none"> • 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. 	<ul style="list-style-type: none"> to be followed during 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). 	<ul style="list-style-type: none"> specific ESMPs; • 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	<ul style="list-style-type: none"> • 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. 	<ul style="list-style-type: none"> • 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 2902 people during May'15 to October'15. 		Being Complied
5	Youth Employment	<ul style="list-style-type: none"> • Providing training/awareness program for the local youth to let them aware about the required qualification to get involved in the 	<ul style="list-style-type: none"> • Informal sitting with the community 	<ul style="list-style-type: none"> • Initiate awareness program for the local youth to let them aware about the required qualification to get 	Will be complied during construction stage

Table 2.3: Monitoring of Community Health, Safety and Security (*continued*)

SI no	Potential Impacts	Proposed EMP	Actual measures already Implemented	Recommended Action	Compliance Status
		Project related activities		involved in the Project related activities; <ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • Arranging public communication/consultation meeting; • Sharing of Project information with local people; • Organizing environmental and social awareness programs/meetings. 	<ul style="list-style-type: none"> • 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. 	<ul style="list-style-type: none"> • 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 2.4: Monitoring of Biodiversity and Sustainable Management of Living Natural Resources

SI 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.	<ul style="list-style-type: none"> • Installation of proper runoff drains; • Use of sediment fences, traps and basins for trapping the sediment, if required. 	<ul style="list-style-type: none"> • 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. • At certain locations of the Project area, temporary drainage system along with a portion of the boundary wall was damaged during the last monsoon due to heavy rainfall runoff accumulation. 	<ul style="list-style-type: none"> • 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 develop the required drainage system before the next monsoon to avoid any further damage of the newly developed land. • The surface slope of the developed land must be maintained as per the design for easy drainage of the runoff to the nearby Maidara and Passur river through the drainage system. 	Will be complied during the construction stage
2	Disturbance to nearby ecosystem due to different construction activities	<ul style="list-style-type: none"> • 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; 	<ul style="list-style-type: none"> • 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; 	<ul style="list-style-type: none"> • Using of light shade (directed downwards) around the outdoor lights; • Regular monitoring of the trees planted around the Project site. 	Being Complied

Table 2.4: Monitoring of Biodiversity and Sustainable Management of Living Natural Resources (*continued*)

SI no	Potential Impacts	EMP measures as proposed in the EIA	Actual condition/ Measures already Implemented	Recommended Action	Compliance Status
		<ul style="list-style-type: none"> • 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? 	<ul style="list-style-type: none"> • Installation of few numbers of night light; • Provision of cut-off time to switch off unnecessary lights at night; • Selection of local plant species for green plantation; • No degradation of critical habitat. 		
3	Disturbance to river, inter-tidal areas and wet lands	<ul style="list-style-type: none"> • 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 	<ul style="list-style-type: none"> • 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. 	<ul style="list-style-type: none"> • 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. 	Being Complied

2.3 Compliance to Conditions for Environmental Clearance 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	<i>BPDB will comply with the condition prior to initiation of any extension/ expansion.</i>
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.	<i>BIFPCL will comply with the condition</i>
3	Project Proponent may undertake activities for land development and infrastructural development of the Project.	BIFPCL has started land and infrastructure development activities-under pre-construction stage.	<i>Complied</i>
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.	<i>To be Complied</i>
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 impact has been reported yet.	<i>Complied at present</i>
6	Proper and adequate mitigation measures shall be ensured throughout preparation, construction and operation period of the proposed Khulna 1320 MW Coal based Thermal Power Plant Project activities.	Mitigation measures appropriate at this stage (pre-construction) have been taken. BIFPCL is monitoring adoption of mitigation measures through CEGIS, as an environmental monitoring consultant.	<i>Complied at present</i>

Compliance to Conditions for Environmental Clearance of DoE (*continued*)

Sl no	Condition of DoE	Compliance	Remarks
7	Any heritage sight, ecologically critical area, and other environmentally, religious and archaeologically sensitive places shall be kept protected during Project construction phase.	Sundarbans, 14 km away from the Project site is the only critical area of concern here. 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
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 local communities are notably far from 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.	The Project is in pre-construction phase. Adequate and hygienic sanitation facilities are being ensured before starting of major construction works	Being Complied
11	In order to control noise pollution, vehicles & equipment shall undergo regular maintenance; working during sensitive hours and locating machinery close to sensitive receptor shall be avoided.	All vehicle & equipment used at site are under regular maintenance.	Being Complied
12	No solid waste can be burnt in the Project area. An environment friendly solid waste management should be in place during the whole period of the Project in the field.	At present (pre-construction phase), insignificant amount of solid waste (mostly papers, construction waste, kitchen waste etc) is generated at site. No waste is burnt at site. However, a proper system of waste collection and disposal system will be maintained at site when the major construction work will be started.	Being Complied
13	Proper and adequate on-site precautionary measures and safety measures shall be ensured	Pre-construction activities are being taken up with adequate on-site precautionary measures and safety	Being Complied

Compliance to Conditions for Environmental Clearance of DoE (*continued*)

Sl no	Condition of DoE	Compliance	Remarks
	so that no habitat of any flora and fauna would be endangered or destructed.	measures to safeguard flora and fauna.	
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.	BIFPCL has appointed a doctor for regular health check up of the workers and villagers. Surrounding areas are 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 dust. However, the Project management has informed that measures are being taken to reduce the impact of dust generated in the Project area.	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 in some selected storage areas to avoid disturbance of the natural drainage.	Being Complied
17	Adequate considerations should be given to facilitate drainage system for runoff water from rain/tidal surge.	At certain locations of the Project area temporary drainage system along with a portion of the boundary wall was damaged during the last monsoon due to heavy rainfall runoff accumulation. The Project authority has undertaken necessary actions to repair the damaged portion of the boundary wall as well as proper drainage system to facilitate drainage of the runoff water as required at this stage. Adequate drainage shall be ensured during construction and operation phase.	Being Complied
18	Adequate facilities should be ensured for silt trap to avoid clogging of drain/canal/water bodies	Run off/ storm water drainage system shall have silt trap. BIFPCL has taken action to address the issues.	Being Complied
19	The entire coal handling system should be designed as an enclosed (and not only covered)	Entire coal handling system are being designed as an enclosed conveyor system as per DoE requirement.	Being Complied

Compliance to Conditions for Environmental Clearance of DoE (**continued**)

Sl no	Condition of DoE	Compliance	Remarks
	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.	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.	
20	Coal plant should have high-efficiency bag filter for arresting dust emissions.	All these stipulations have been included in the technical specification of EPC contract package and will be implemented accordingly.	Will be Complied
21	Coal should be stored in a covered storage yard.	same as above	Will be Complied
22	The entire coal stockyard should be covered with water sprinkler provided with automated moisture sensor to control self-combustion.	same as above	Will be Complied
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 is being planned and shall be implemented throughout the operation of the plant.	Will be Complied
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.	Will be Complied
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 EPC contract package.	Will be Complied
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.	Will be Complied
27	Resettlement and rehabilitation of the displaced population (including those who do not own land) should be done properly.	Resettlement and rehabilitation action has been taken as per the law of GoB. BPDB has approached to GoB for suitable resettlement and rehabilitation as per requirements of the DoE.	Being Complied

Compliance to Conditions for Environmental Clearance of DoE (*continued*)

Sl no	Condition of DoE	Compliance	Remarks
28	Resettlement plan should be properly implemented and people should be adequately compensated.	Mentioned above	Being Complied
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.	Being Complied
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 reports have been submitted regularly, based on study conducted for that period, to be shared with DoE, which are available at BIFPCL web page.	Being Complied
31	All activities (pre-construction, construction and post-construction stage) should be implemented according to EMP clearly listed in the EIA report.	BIFPCL has adopted all of the EMP applicable at this stage. CEGIS, as an environmental consultant of BIFPCL is monitoring implementation of EMP. BIFPCL is taking all possible actions based on EMP monitoring report.	Being Complied
32	A third party/independent monitoring bodies excluding JVC/BPDB should be engaged immediately for monitoring of all activities during pre-construction, construction and operation phases as per monitoring plan of EIA report and monitoring report must be submitted to Bagerhat District Office, Khulna Divisional Office and Headquarters of the Department of Environment simultaneously.	CEGIS, as an independent monitoring body has been engaged by BIFPCL as environmental consultant since February 2014. From then on, CEGIS has been conducting the monitoring programs quarterly and producing monitoring reports on regular basis which are submitted to BIFPCL for onward submission to the relevant offices 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.	Being Complied
34	Air, water, soil, biological and	The network monitoring system will be	Will be Complied

Compliance to Conditions for Environmental Clearance of DoE (*continued*)

Sl no	Condition of DoE	Compliance	Remarks
	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.	installed when the Plant will be in operation.	
35	There should be regularly disclosure of the report through workshops and websites and responses should be taken care accordingly.	All the reports are available on website of BIFPCL (www.bifpcl.com). CEGIS is regularly carrying out public consultation. The progress of the monitoring is regularly discussed in monthly Project implementation monitoring meeting in presence of PGCB, LGED, Bangladesh Army, BPDB, CEGIS, etc. The same is being reviewed by the Project Steering Committee, Chaired by the Secretary, Power Division, Ministry of PE&MR, Government of Bangladesh.	Being Complied
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.	Will be Complied
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	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.	Will be Complied

Compliance to Conditions for Environmental Clearance of DoE (*continued*)

Sl no	Condition of DoE	Compliance	Remarks
	accessing every individual to show the real time monitored records.		
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 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
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.	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 data.	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.	BIFPCL shall submit detail work plan before the start of Main Plant Works.	Agreed to Comply.
44	Environmental Monitoring Reports according to specific format specified in the EIA Report shall	EMP Reports as per specific format provided in the EIA Report shall be made available by BIFPCL to DOE on a	Agreed to Comply.

Compliance to Conditions for Environmental Clearance of DoE (*continued*)

Sl no	Condition of DoE	Compliance	Remarks
	be made available simultaneously to DoE Bagerhat District Office, Khulna Divisional Office and Headquarters on a monthly basis during the construction period of the Project.	monthly basis during the construction period of the Project.	
45	<p>The following records must be kept in respect if any samples required to be collected for the purpose of environmental monitoring activities:</p> <ul style="list-style-type: none"> (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	<p>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</p> <ul style="list-style-type: none"> 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 	So far no such emergency has occurred.. BIFPCL would establish a proper mechanism for recording such incident as suggested.	Will be complied as and when required

Compliance to Conditions for Environmental Clearance of DoE (*continued*)

Sl no	Condition of DoE	Compliance	Remarks
	fighting, etc.)		
48	The Project authority or its employees must notify the department of Environment of incidents causing or threatening material harm to the environment as soon as practicable after the person becomes aware of the incident.	BIFPCL would establish a proper mechanism for recording such incident as suggested.	Agreed to Comply
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	To be Complied
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	To be Complied
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 9000 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 under process of implementation.	Being Complied

Compliance to Conditions for Environmental Clearance 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.	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.	To be Complied
59	This EIA Approval has been issued with the approval of the appropriate authority.	BPDB and BIFPCL are thankful to DoE.	-

3 Air Quality Monitoring

14. The ambient air quality has been monitored in this **3rd Quarter** of the **2nd year (2015)** at 11 (eleven) specific locations within the study area of monitoring interest. The details of the monitoring plan have been provided in the **Table 3.1**.

3.1 Methodology

15. The air quality monitoring program team considered six major air quality parameters such PM_{2.5}, PM₁₀, SO_x, and NO_x concentration in the ambient air in regard to particulate matter and gracious emission based on the expected pollutants of the proposd power plant. In this context, eleven sensitive receptor locations surrounding the Project site were nominated considering proposed Project related activities and the model generated emission scenario (CEGIS, 2015).

3.1.1 Method of Sampling and Laboratory Testing

16. 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}, PM₁₀, and SPM have been tested by gravimetric method. The concentration of SO₂ has been tested by West-Gaeke method. Likewise the NO₂ has been tested by Jacob and Hochheiser method.

3.1.2 Locations of air quality monitoring

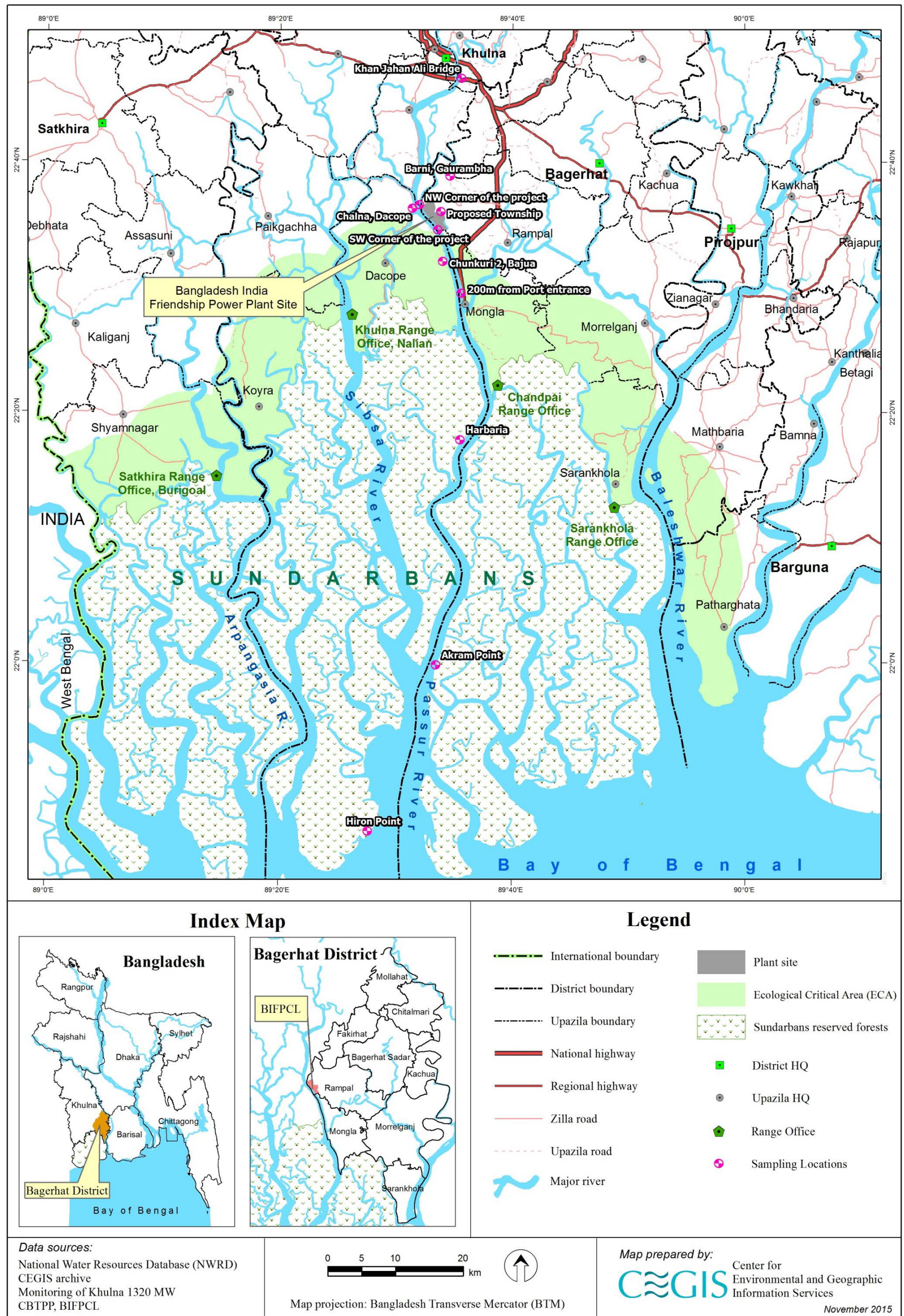
17. Ambient air quality has been monitored during this quarterly (**3rd Quarter** of the **2nd year**) monitoring phase in the same locations as monitored in most of the earlier quarters. The locations of the air quality monitoring points have been shown in **Map 3.1**.



Photo 3.1: Air quality parameters sampling in the Sundarbans

Table 3.1 Air Quality Monitoring Plan

Sl no	Monitoring Indicators	Locations	GPS Points	Frequency	Methods/Tools/Techniques
1	SO _x , NO _x , PM ₁₀ , PM _{2.5}	South West corner of the Project boundary	89°33'34.5"E, 22°34'33.8"N	Quarterly	<p>In situ field measurement provided with the facilities of outsourced laboratory.</p> <p>Method of testing SO_x: USEPA (2000) Method 6 or 6A or 6B or ISO (1998) Method 11632 (as appropriate)</p> <p>Method of testing NO_x: USEPA (2000) Method 7 or 7A or 7B or 7C or 7D or ISO (1993)</p> <p>Method 10396 (as appropriate).</p> <p>Method of testing PM_{2.5}: Gravimetric Method of testing PM₁₀: USEPA (1997) Method 201 or 201A (as appropriate)</p>
2		Proposed township area near Chimney location, Mouza: Sapmari Katakali	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°1'23.50"N		
10		Hiron Point, Sundarbans	89°27'53.2"E, 21°46'27.60"N		
11		Khulna city near Khan Jahan Ali Bridge	89°35'35.5"E, 22°46'36.8"N		



Map 3.1: Air Quality Monitoring Locations

3.2 Results of air quality monitoring

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

18. The values of $PM_{2.5}$ and PM_{10} were found within the standard limit at each location. Among those locations, the maximum concentration of $PM_{2.5}$ ($28 \mu\text{g}/\text{m}^3$) was found in Bajua (Chunkuri-2, Dacope) and that of PM_{10} ($62 \mu\text{g}/\text{m}^3$) was near Pankhali, Dacope, the SPM was also noted the highest ($182 \mu\text{g}/\text{m}^3$) at Pankhali, Dacope. The results revealed that the SPM concentration at Pankhali, Dacope was recorded highest compared to all other monitoring locations. Large number of two strokes human hauler, small engine boats and a number of anthropogenic activities might be the source of SPM there. Industries especially Cement Industries, road traffic and ongoing dredging operation of Mongla Port Authority in Passur River might be the sources of SPM there. All the monitoring data are given in **Table 3.2**.

3.2.2 Sulfur Dioxide (SO_2)

19. Concentration of Sulfur dioxide in the ambient air was found within the standard. The values of SO_2 ranged in between $27 \mu\text{g}/\text{m}^3$ and $36 \mu\text{g}/\text{m}^3$. SO_2 concentration was also measured in the Sundarbans reserve forest; the result indicated a moderate condition in there. All the monitoring data of ambient air quality are given in **Table 3.2**. Excess presence of SO_2 irritates the nose, throat, and airways to cause coughing, wheezing, shortness of breath, or a tight feeling around the chest.

3.2.3 Nitrogen Dioxide (NO_2)

20. NO_2 concentration in the ambient air of Sundarbans adjacent areas ranged between $21 \mu\text{g}/\text{m}^3$ and $32 \mu\text{g}/\text{m}^3$. NO_2 concentrations were also checked In Project site and its adjoining areas and were found a little bit higher than that of Sundarbans but still within the standard limit. The monitoring results are shown in **Table 3.2**. Excess Nitrogen dioxide in air can irritate the lungs and lower resistance to respiratory infections such as influenza.

3.2.4 Carbon Monoxide (CO)

21. CO concentration ranged from $75 \mu\text{g}/\text{m}^3$ to $105 \mu\text{g}/\text{m}^3$ in Project area and its adjoining areas. The possible causes for the CO concentration might be such activity as the big ship's anchorage beside the sampling point and for the loading-unloading activity; while in Sundarbans the concentration ranges from $81 \mu\text{g}/\text{m}^3$ to $93 \mu\text{g}/\text{m}^3$. Carbon monoxide enters the bloodstream and reduces oxygen delivery to the body's organs and tissues. The health threat from exposure to CO is most serious for those who suffer from cardiovascular disease.

3.2.5 Ozone (O_3)

22. Similarly, results of O_3 were laid between $1 \mu\text{g}/\text{m}^3$ to $8 \mu\text{g}/\text{m}^3$ which were found to be much lower than the BD standards. Ground-level or "bad" ozone is not emitted directly into the air, but is created by chemical reactions between oxides of nitrogen (NO_x) and volatile organic compounds (VOC) in the presence of sunlight.

3.2.6 Discussions

23. All the air pollutant data shows relatively similar to the data collected during October, 2014 (1st year 3rd Quarter Monitoring). High monsoon rainfall is responsible for washing out the pollutants in ambient environment. Therefore, the pollution concentration in the ambient satisfactorily comply to the national or international standards. However, there is no scope of impact on the present ecosystem health as well as the living bodies in the study area.

3.3 Pollution Sources

3.3.1 Pollution sources at Project area

24. A number of cement industries and petroleum industries are currently operating along the Passur River at different locations in between the Project site and Mongla Port area.

3.3.2 Pollution sources in the Sundarbans

25. Mostly river traffics of Mongla Port area travelling across the Sundarbans are the sources of Suspended Particulate Matter (SPM), Oxides of Sulphur (SO_x), Oxides of Nitrogen (NO_x) and Green House Gas (GHG) in the Sundarbans.

26. An inventory of the current emission sources in the study area with the types of emissions have been provided in **Table 3.3**.

Table 3.2: Ambient Air Quality Monitoring Results

Locations of Monitoring	Pollutants	1st QM, April 2014	2nd QM, July 2014	3rd QM, October 2014	4th QM, January 2015	5th QM, April 2015	6th QM, July 2015	7th QM, October 2015	8 QM, January 2016	9th QM, April 2016	10th QM, July 2016	11th QM, October 2016	12th QM, January 2017	Bangladesh (DoE) Standard for ambient Air (ECR 2005)	IFC/WB Standard
Weather		Sunny	Rainy/ Cloudy	Sunny	Sunny	Sunny	Rainy/ Cloudy	Sunny to Rainy							
Wind Direction		SE	SE	SE	NW	SE to NW	SW to NE	SW to NE							
		Concentrations are in $\mu\text{g}/\text{m}^3$													
SW Corner of the PP area	PM _{2.5}	33	37	25	33	47	25	22						65	75
	PM ₁₀	78	77	53	79	83	35	52						150	150
	SPM	207	239	190	200	177	42	91						200	NF
	SO ₂	21	24	19	23	15	52	35						365	125
	NO _x	26	29	27	31	29	35	29						100	200
	CO	120	188	140	190	144	146	88						40000*	NF
	O ₃	27	26	19	22	26	12	5						160*	160
Proposed Township area of the PP	PM _{2.5}	39	48	48	39	34	18	17						65	75
	PM ₁₀	89	90	74	102	97	31	48						150	150
	SPM	217	263	217	274	266	47	79						200	NF

Note(s):

- Concentrations are in $\mu\text{g}/\text{m}^3$;
- DoE- Department of Environment, NF – Not found;
- Fine Particulate Matter (PM_{2.5}), Respirable Dust Content (PM₁₀), Suspended Particulate Matter (SPM), Oxides of Nitrogen (NO_x). Sulfur dioxide (SO₂), Carbone Monoxide (CO) & Ozone (O₃);
- All standards are for 24hr average except CO and O₃, standards for CO and O₃ are for 1 hr average;
- This monitoring was carried out by - Respirable Dust Sampler (Model-Envirotech India APM-460BL) and Fine Particulate Sampler (Model-Envirotech India APM-550).

Table 3.2: Ambient Air Quality Monitoring Results (continued)

Locations of Monitoring	Pollutants	1st QM, April 2014	2nd QM, July 2014	3rd QM, October 2014	4th QM, January 2015	5th QM, April 2015	6th QM, July 2015	7th QM, October 2015	8 QM, January 2016	9th QM, April 2016	10th QM, July 2016	11th QM, October 2016	12th QM, January 2017	Bangladesh (DoE) Standard for ambient Air (ECR 2005)	IFC/WB Standard
Weather		Sunny	Rainy/Cloudy	Sunny	Sunny	Sunny	Rainy/Cloudy	Sunny to Rainy							
Wind Direction		SE	SE	SE	NW	SE to NW	SW to NE	SW to NE							
		Concentrations are in $\mu\text{g}/\text{m}^3$													
	SO ₂	19	28	22	21	22	58	27						365	125
	NO _x	29	39	27	26	24	46	25						100	200
	CO	165	210	230	164	136	127	102						40000*	NF
	O ₃	33	26	26	23	21	16	1						160*	160
NW Corner of the PP area	PM _{2.5}	37	44	19	42	59	28	19						65	75
	PM ₁₀	67	78	56	98	91	96	29						150	150
	SPM	234	217	157	310	244	321	66						200	NF
	SO ₂	19	22	18	27	21	56	32						365	125
	NO _x	23	28	22	32	39	43	21						100	200
	CO	110	178	110	210	140	133	87						40000*	NF
	O ₃	25	19	17	36	44	11	8						160*	160
Barni,	PM _{2.5}	39	47	57	39	41	34	11						65	75

Note(s):

- Concentrations are in $\mu\text{g}/\text{m}^3$;
- DoE- Department of Environment, NF – Not found;
- Fine Particulate Matter (PM_{2.5}), Respirable Dust Content (PM₁₀), Suspended Particulate Matter (SPM), Oxides of Nitrogen (NO_x). Sulfur dioxide (SO₂), Carbone Monoxide (CO) & Ozone (O₃);
- All standards are for 24hr average except CO and O₃, standards for CO and O₃ are for 1 hr average;
- This monitoring was carried out by - Respirable Dust Sampler (Model-Envirotech India APM-460BL) and Fine Particulate Sampler (Model-Envirotech India APM-550).

Table 3.2: Ambient Air Quality Monitoring Results (continued)

Locations of Monitoring	Pollutants	1st QM, April 2014	2nd QM, July 2014	3rd QM, October 2014	4th QM, January 2015	5th QM, April 2015	6th QM, July 2015	7th QM, October 2015	8 QM, January 2016	9th QM, April 2016	10th QM, July 2016	11th QM, October 2016	12th QM, January 2017	Bangladesh (DoE) Standard for ambient Air (ECR 2005)	IFC/WB Standard
Weather		Sunny	Rainy/ Cloudy	Sunny	Sunny	Sunny	Rainy/ Cloudy	Sunny to Rainy							
Wind Direction		SE	SE	SE	NW	SE to NW	SW to NE	SW to NE							
		Concentrations are in $\mu\text{g}/\text{m}^3$													
Gaurambha	PM ₁₀	103	122	67	97	82	65	26						150	150
	SPM	233	244	183	277	236	79	112						200	NF
	SO ₂	21	23	17	22	25	41	31						365	125
	NO _x	25	28	22	26	27	44	32						100	200
	CO	175	210	190	150	196	96	96						40000*	NF
	O ₃	26	29	22	19	15	9	6						160*	160
Chunkuri-2, Dacope	PM _{2.5}	35	39	46	37	33	35	28						65	75
	PM ₁₀	77	86	69	68	61	109	49						150	150
	SPM	117	113	162	183	188	175	94						200	NF
	SO ₂	19	24	21	18	11	55	33						365	125
	NO _x	23	26	27	24	18	49	23						100	200
	CO	190	205	170	170	33	133	75						40000*	NF

Note(s):

- Concentrations are in $\mu\text{g}/\text{m}^3$;
- DoE- Department of Environment, NF – Not found;
- Fine Particulate Matter (PM_{2.5}), Respirable Dust Content (PM₁₀), Suspended Particulate Matter (SPM), Oxides of Nitrogen (NO_x). Sulfur dioxide (SO₂), Carbone Monoxide (CO) & Ozone (O₃);
- All standards are for 24hr average except CO and O₃, standards for CO and O₃ are for 1 hr average;
- This monitoring was carried out by - Respirable Dust Sampler (Model-Envirotech India APM-460BL) and Fine Particulate Sampler (Model-Envirotech India APM-550).

Table 3.2: Ambient Air Quality Monitoring Results (continued)

Locations of Monitoring	Pollutants	1st QM, April 2014	2nd QM, July 2014	3rd QM, October 2014	4th QM, January 2015	5th QM, April 2015	6th QM, July 2015	7th QM, October 2015	8 QM, January 2016	9th QM, April 2016	10th QM, July 2016	11th QM, October 2016	12th QM, January 2017	Bangladesh (DoE) Standard for ambient Air (ECR 2005)	IFC/WB Standard
Weather		Sunny	Rainy/ Cloudy	Sunny	Sunny	Sunny	Rainy/ Cloudy	Sunny to Rainy							
Wind Direction		SE	SE	SE	NW	SE to NW	SW to NE	SW to NE							
		Concentrations are in $\mu\text{g}/\text{m}^3$													
	O ₃	27	24	18	22	41	21	2						160*	160
Pankhali, Dacope	PM _{2.5}	47	49	57	41	39	-	25						65	75
	PM ₁₀	119	127	139	101	105	144	62						150	150
	SPM	297	266	254	208	299	339	183						200	NF
	SO ₂	28	31	31	24	30	58	36						365	125
	NO _x	41	39	36	26	27	47	23						100	200
	CO	230	217	250	188	177	125	105						40000*	NF
	O ₃	49	38	36	27	11	13	5						160*	160
Mongla Port area	PM _{2.5}	47	55	39	41	26	33	19						65	75
	PM ₁₀	139	174	77	82	35	52	33						150	150
	SPM	288	303	197	217	214	118	65						200	NF
	SO ₂	27	28	26	24	14	45	36						365	125

Note(s):

- Concentrations are in $\mu\text{g}/\text{m}^3$;
- DoE- Department of Environment, NF – Not found;
- Fine Particulate Matter (PM_{2.5}), Respirable Dust Content (PM₁₀), Suspended Particulate Matter (SPM), Oxides of Nitrogen (NO_x). Sulfur dioxide (SO₂), Carbone Monoxide (CO) & Ozone (O₃);
- All standards are for 24hr average except CO and O₃, standards for CO and O₃ are for 1 hr average;
- This monitoring was carried out by - Respirable Dust Sampler (Model-Envirotech India APM-460BL) and Fine Particulate Sampler (Model-Envirotech India APM-550).

Table 3.2: Ambient Air Quality Monitoring Results (continued)

Locations of Monitoring	Pollutants	1st QM, April 2014	2nd QM, July 2014	3rd QM, October 2014	4th QM, January 2015	5th QM, April 2015	6th QM, July 2015	7th QM, October 2015	8 QM, January 2016	9th QM, April 2016	10th QM, July 2016	11th QM, October 2016	12th QM, January 2017	Bangladesh (DoE) Standard for ambient Air (ECR 2005)	IFC/WB Standard
Weather		Sunny	Rainy/ Cloudy	Sunny	Sunny	Sunny	Rainy/ Cloudy	Sunny to Rainy							
Wind Direction		SE	SE	SE	NW	SE to NW	SW to NE	SW to NE							
		Concentrations are in $\mu\text{g}/\text{m}^3$													
	NO _x	44	39	33	27	17	40	20						100	200
	CO	230	320	220	211	24	110	84						40000*	NF
	O ₃	57	52	37	26	09	15	8						160*	160
Harbaria, Sundarbans	PM _{2.5}	19	22	33	27	24	27	24						65	75
	PM ₁₀	41	39	59	56	49	42	50						150	150
	SPM	111	117	129	139	109	70	73						200	NF
	SO ₂	9	10	14	12	16	51	34						365	125
	NO _x	19	22	27	18	22	34	22						100	200
	CO	65	58	70	64	56	112	81						40000*	NF
	O ₃	13	12	13	11	14	12	4						160*	160
Akram Point Sundarbans	PM _{2.5}	17	19	23	18	49	-	25						65	75
	PM ₁₀	39	44	32	39	77	-	32						150	150

Note(s):

- Concentrations are in $\mu\text{g}/\text{m}^3$;
- DoE- Department of Environment, NF – Not found;
- Fine Particulate Matter (PM_{2.5}), Respirable Dust Content (PM₁₀), Suspended Particulate Matter (SPM), Oxides of Nitrogen (NO_x), Sulfur dioxide (SO₂), Carbone Monoxide (CO) & Ozone (O₃);
- All standards are for 24hr average except CO and O₃, standards for CO and O₃ are for 1 hr average;
- This monitoring was carried out by - Respirable Dust Sampler (Model-Envirotech India APM-460BL) and Fine Particulate Sampler (Model-Envirotech India APM-550).

Table 3.2: Ambient Air Quality Monitoring Results (continued)

Locations of Monitoring	Pollutants	1st QM, April 2014	2nd QM, July 2014	3rd QM, October 2014	4th QM, January 2015	5th QM, April 2015	6th QM, July 2015	7th QM, October 2015	8 QM, January 2016	9th QM, April 2016	10th QM, July 2016	11th QM, October 2016	12th QM, January 2017	Bangladesh (DoE) Standard for ambient Air (ECR 2005)	IFC/WB Standard
Weather		Sunny	Rainy/ Cloudy	Sunny	Sunny	Sunny	Rainy/ Cloudy	Sunny to Rainy							
Wind Direction		SE	SE	SE	NW	SE to NW	SW to NE	SW to NE							
		Concentrations are in $\mu\text{g}/\text{m}^3$													
	SPM	114	133	97	88	102	-	51						200	NF
	SO ₂	7	9	12	13	21	-	27						365	125
	NO _x	17	19	22	17	27	-	19						100	200
	CO	49	60	50	46	163	-	92						40000*	NF
	O ₃	11	14	9	10	27	-	8						160*	160
Hiron Point Sundarbans	PM _{2.5}	15	23	19	17	28	-	27						65	75
	PM ₁₀	44	38	34	41	60	-	45						150	150
	SPM	101	119	107	97	110	-	88						200	NF
	SO ₂	8	7	13	14	15	-	28						365	125
	NO _x	18	18	19	22	20	-	23						100	200
	CO	52	62	65	60	60	-	93						40000*	NF
	O ₃	14	13	11	9	23	-	2						160*	160

Note(s):

- Concentrations are in $\mu\text{g}/\text{m}^3$;
- DoE- Department of Environment, NF – Not found;
- Fine Particulate Matter (PM_{2.5}), Respirable Dust Content (PM₁₀), Suspended Particulate Matter (SPM), Oxides of Nitrogen (NO_x). Sulfur dioxide (SO₂), Carbone Monoxide (CO) & Ozone (O₃);
- All standards are for 24hr average except CO and O₃, standards for CO and O₃ are for 1 hr average;
- This monitoring was carried out by - Respirable Dust Sampler (Model-Envirotech India APM-460BL) and Fine Particulate Sampler (Model-Envirotech India APM-550).

Table 3.2: Ambient Air Quality Monitoring Results (continued)

Locations of Monitoring	Pollutants	1st QM, April 2014	2nd QM, July 2014	3rd QM, October 2014	4th QM, January 2015	5th QM, April 2015	6th QM, July 2015	7th QM, October 2015	8 QM, January 2016	9th QM, April 2016	10th QM, July 2016	11th QM, October 2016	12th QM, January 2017	Bangladesh (DoE) Standard for ambient Air (ECR 2005)	IFC/WB Standard
Weather		Sunny	Rainy/ Cloudy	Sunny	Sunny	Sunny	Rainy/ Cloudy	Sunny to Rainy							
Wind Direction		SE	SE	SE	NW	SE to NW	SW to NE	SW to NE							
		Concentrations are in $\mu\text{g}/\text{m}^3$													
Khulna City, near Khan Jahan Ali Bridge	PM _{2.5}	54	39	52	42	55	46	19						65	75
	PM ₁₀	139	117	91	84	75	89	49						150	150
	SPM	301	287	239	219	222	181	101						200	NF
	SO ₂	33	29	33	28	31	59	28						365	125
	NO _x	49	41	39	36	33	38	26						100	200
	CO	330	370	330	296	101	89	94						40000*	NF
	O ₃	59	67	57	39	21	7	4						160*	160

Note(s):

- Concentrations are in $\mu\text{g}/\text{m}^3$;
- DoE- Department of Environment, NF – Not found;
- Fine Particulate Matter (PM_{2.5}), Respirable Dust Content (PM₁₀), Suspended Particulate Matter (SPM), Oxides of Nitrogen (NO_x). Sulfur dioxide (SO₂), Carbone Monoxide (CO) & Ozone (O₃);
- All standards are for 24hr average except CO and O₃, standards for CO and O₃ are for 1 hr average;
- This monitoring was carried out by - Respirable Dust Sampler (Model-Envirotech India APM-460BL) and Fine Particulate Sampler (Model-Envirotech India APM-550).

Table 3.3: Baseline conditions of emission of different infrastructures and sources

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

Legend

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

Table 3.3: 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
Chunkuri-2, Dacope	PM	✓	×	×	×	✓	✓	✓	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	✓
	SOx	×	×	×	×	✓	✓	✓	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	✓
	NOx	×	×	×	×	✓	✓	✓	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	✓
	GHGs	×	×	×	×	✓	✓	✓	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	✓
Pankhali, Dacope	PM	✓	×	×	×	✓	✓	✓	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	✓	✓
	SOx	×	×	×	×	✓	✓	✓	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	✓
	NOx	×	×	×	×	✓	✓	✓	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	✓
	GHGs	×	×	×	×	✓	✓	✓	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	✓
Mongla Port area	PM	✓	✓	✓	×	✓	✓	✓	✓	✓	✓	✓	×	×	×	×	×	×	×	×	✓	×	×	×	✓
	SOx	×	✓	×	×	✓	✓	✓	✓	✓	✓	×	×	×	×	×	×	×	×	×	✓	×	×	✓	✓
	NOx	×	✓	×	×	✓	✓	✓	✓	✓	✓	×	×	×	×	×	×	×	×	×	✓	×	×	×	✓
	GHGs	×	✓	×	×	✓	✓	✓	✓	✓	✓	×	×	×	×	×	×	×	×	×	✓	×	×	×	✓
Harbaria, Sundarbans	PM	×	×	×	×	×	✓	✓	✓	✓	✓	✓	×	×	×	×	×	×	×	×	×	×	×	×	×
	SOx	×	×	×	×	×	✓	✓	✓	✓	✓	×	×	×	×	×	×	×	×	×	×	×	×	×	×
	NOx	×	×	×	×	×	✓	✓	✓	✓	✓	×	×	×	×	×	×	×	×	×	×	×	×	×	×
	GHGs	×	×	×	×	×	✓	✓	✓	✓	✓	×	×	×	×	×	×	×	×	×	×	×	×	×	×

Legend × Absence of source or no emission, ✓ Presence of source, emission of pollutant

Table 3.3: 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
Akram Point Sundarbans	PM	X	X	X	X	X	✓	✓	X	X	X	✓	X	X	X	X	X	X	X	X	X	X	X	X	X
	SOx	X	X	X	X	X	✓	✓	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	NOx	X	X	X	X	X	✓	✓	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	GHGs	X	X	X	X	X	✓	✓	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Hiron Point Sundarbans	PM	X	X	X	X	X	✓	✓	X	X	X	✓	X	X	X	X	X	X	X	X	X	X	X	X	X
	SOx	X	X	X	X	X	✓	✓	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	NOx	X	X	X	X	X	✓	✓	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	GHGs	X	X	X	X	X	✓	✓	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Khulna City, near Khan Jahan Ali Bridge	PM	✓	X	X	✓	✓	✓	✓	X	✓	✓	✓	X	X	X	X	X	X	X	X	X	X	X	✓	✓
	SOx	X	X	X	✓	✓	✓	✓	X	✓	✓	✓	X	X	X	X	X	X	X	X	X	X	X	X	✓
	NOx	X	X	X	✓	✓	✓	✓	X	✓	✓	✓	X	X	X	X	X	X	X	X	X	X	X	X	✓
	GHGs	X	X	X	✓	✓	✓	✓	X	✓	✓	✓	X	X	X	X	X	X	X	X	X	X	X	X	✓

Legend X Absence of source or no emission, ✓ Presence of source, emission of pollutant

4 Noise Monitoring

27. Ambient noise levels were monitored quarterly every year. During this session, ambient noise levels were monitored at eleven (11) locations. Monitoring activities were carried out in March-14, July-14, October-14, January-15, April-15, July/August-15 and October-15. The detail of the monitoring plan is described in **Table 4.1**.

28. In this **3rd Quarter** monitoring of the **2nd year**, the noise level recorded was nothing out of the ordinary as it prevailed in normal period.

29. It has been found that the Noise was generated from the commonly known sources like the rural vehicles (human hauer/ Nosimon, auto-rickshaw) while working beside the roads; whereas in case of the monitoring spot in or around the waterways, the sources of noise were trawler, ship, random waves breaking against the shore, etc. Barges, trawlers and ships have been seen plying over the waterway as usual at this time.

4.1 Methodology

30. Noise levels were measured thrice in a day (morning, afternoon and evening) in each of the eleven (11) locations selected for noise monitoring. Each time noise level was recorded for a five minutes time span with a 30 second interval by using portable noise level meter. Each time the noise meter was set up and calibrated depending on the site condition and acoustic environment, following the manufacturer's instruction manual.



Photo 4.1: Specialists calibrating and setting up noise meter at site before use



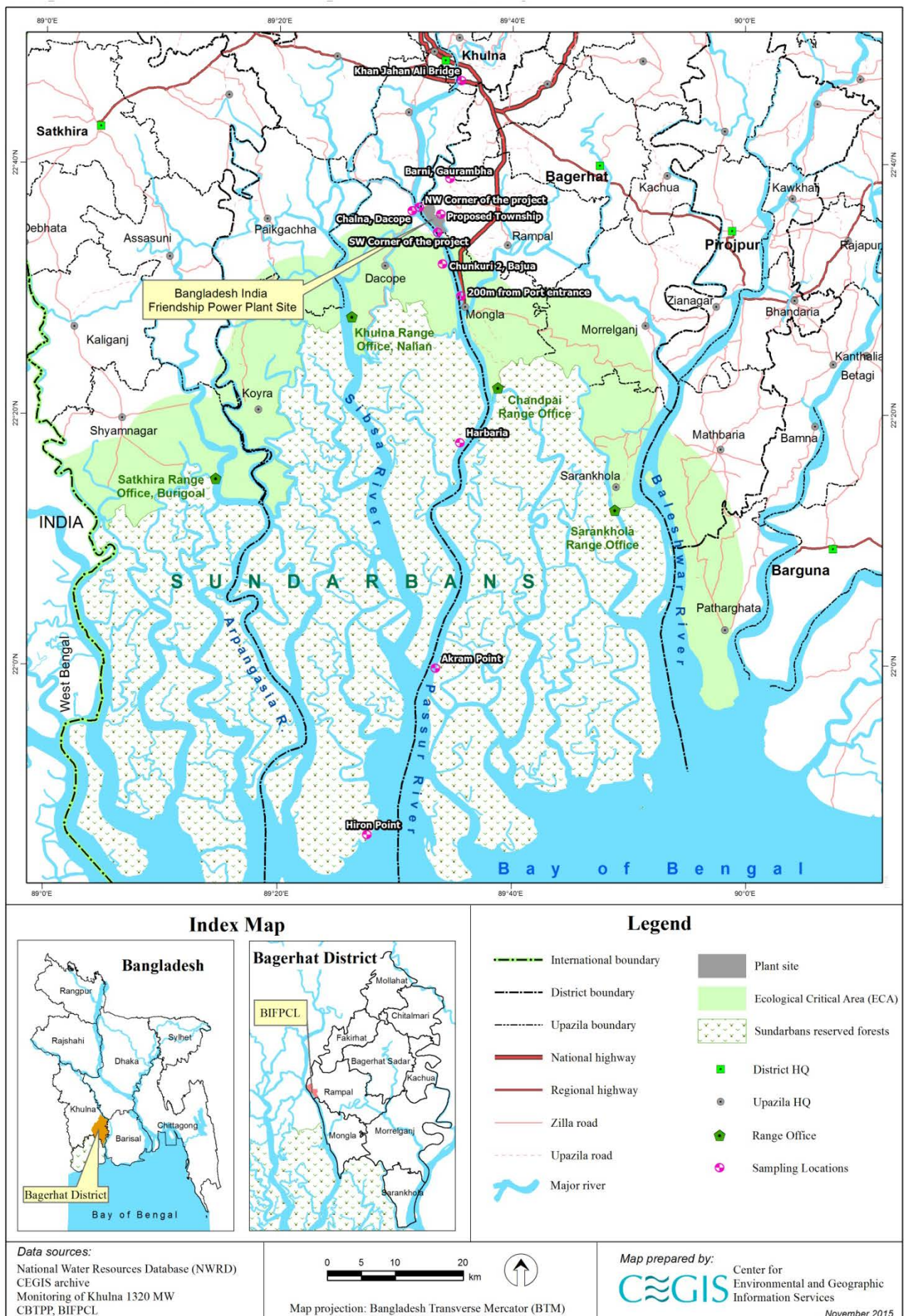
Photo 4.2: Professional conducting an ambient noise acquisition survey

4.2 Locations of Noise Monitoring

31. There are eleven locations for 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 and one is at Mongla Port (**Map 4.1**).

Table 4.1: Noise Level Monitoring Plan

SI no	Monitoring Indicators	Locations	GPS Points (Decimal Degree)	Frequency	Methods/Tools/Techniques
1	Ambient Sound Pressure Level	South West corner of the Project boundary	89.5601° E, 22.5761° N	Quarterly	In situ field measurement by CEGIS Team using portable Noise Level (Sound Pressure Level) Meter
2		Proposed township area	89.5644° E, 22.6005° N		
3		North West corner of the Project boundary (Kaigardas Kati)	89.5334° E, 22.6093° N		
4		Barni, Gaurambha union (4km North East from the chimney location)	89.5772° E, 22.6477° N		
5		Chunkuri-2, Bazua Union (4km South West from the chimney location)	89.5669° E, 22.5342° N		
6		Pankhali, Dacope (4km North West from the Chimney location)	89.5234° E, 22.6046° N		
7		Mongla Port Area	89.5936° E, 22.4916° N		
8		Harbaria, Sundarbans	89.5926° E, 22.2968° N		
9		Akram point, Sundarbans	89.5152° E, 22.0219° N		
10		Hiron Point, Sundarbans	89.4614° E, 21.7755° N		
11		Khulna city near Khan Jahan Ali Bridge	89.5935° E, 22.7779° N		



Map 4.1: Noise Monitoring Locations

4.3 Results of Noise Monitoring

32. For the purpose of noise monitoring, ambient noise data were recorded in some of the preselected representative places as stated below, alongwith the possible sources of noise generation and comparison of data with the previous monitoring sessions wherever necessary:

4.3.1 Dacope Upazila Parishad

33. The monitoring location was at Chalna Bazar which falls under commercial area. According to Environmental Conservation Rules (ECR) 1997, noise level standard for commercial area is 70dB (A). The data shows that noise level of 3rd quarter monitoring of the 2nd year has been recorded below the standard (**Table 4.2b**).

34. There, the significant noise sources were road traffic and people's crowd. The road traffics were mostly from locally made engine van (locally called Nosimon), motor bike, easy bike (battery operated tri-cycle), etc. Traffic load seemed higher than most of the previous monitoring periods that eventually resulted in increased noise level.

4.3.2 North West Corner of the Project Area

35. The North West (NW) corner of the Project area falls in Kaigar Daskati mouza of Gaurambha union. The monitoring location was nearby Gucchha gram (a cluster village built by the Government for the landless and homeless people). This area can be categorized as residential area where standard maximum ambient noise level is 50dB (A) at day time (ECR, 1997). This time the noise level has also been recorded at 41.94dB which is well within the standard just as it has been depicted in the near past.

4.3.3 Chunkuri-2, Bajua

36. This area is classified as residential area [50dB (A) at day time] (ECR, 1997). Noise levels during the first, second and third quarter monitoring of 1st year were found exceeding the standard limit (**Table 4.2b**) but similar to last three quarters' monitoring, at this time of monitoring, it was found at 47.43 dB which is below the standard. The significant noise sources are rural road traffic and people's crowd. The road traffics were mostly locally made engine van (called as Nosimon), motorcycle, bicycle, van, etc. that are very frequent here.

4.3.4 South West corner of the Project area

37. The South West corner of the Project area falls in Sapmari, Katakhal mouza of Rajnagar union. The area also falls under residential class [50dB (A) at day time] (ECR, 1997). Similar to the earlier monitoring, noise levels in this quarter monitoring were within standard limit (**Table 4.2b**).

4.3.5 Proposed township area of the Project

38. The proposed township area of the Power Plant is located at the middle of the eastern portion of the Project area. The area falls under residential or rural class area [50dB (A) at day time] (ECR, 1997). Contrary to the previous quarterly monitoring(s), noise levels recorded in this period were slightly higher (50.52 dB) than the standard limit (**Table 4.2b**). This time accelerated construction works have increased the ambient noise as a whole.

4.3.6 Barni, Gaurambha

39. This area also falls under residential class area [50dB (A) at day time] (ECR, 1997). The noise levels were found higher (55.16 dB) than the acceptable standard limit. It's noteworthy that though this area falls under rural classification, the commercial activities like

bazaar, local traffic, crowd etc. are increasing day by day, thus the ambience is getting noisier.

4.3.7 Khan Jahan Ali Bridge, Khulna

40. The monitoring location is beside the toll booth of the Khan Jahan Ali Bridge, Khulna. This area falls under commercial class where the standard maximum ambient noise level is 70 dB (A) at day time. During this quarterly monitoring, noise levels were found well within the standard limit. Here the highway traffic is the main source of noise. In the day of monitoring, Noise level was recorded the highest during evening when traffic load was also higher. It is expected that this road will be busier in coming days due to the increased port activities.

4.3.8 Mongla Port area

41. The monitoring location was at Khulna-Mongla highway, 200m northward from the main entrance of the Mongla Port area. The area is completely industrial. The ECR 1997 defines ambient maximum noise level for this class as 75dB (A). During the monitoring, noise levels were found much lower (47.01 dB) than the standard.

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

4.3.9 Harbaria, Sundarbans

43. Harbaria area of the Sundarbans is very critical in terms of biodiversity consideration. The area is also important for sea going vessels of Mongla Port Area. Most of the sea going vessel of the Port anchor here for lighterage operation. The area falls under silent class of noise standard and the ambient day time noise standard is 45dB (A) (ECR, 1997). Here, noise was recorded at about 100m inside the forest from right bank of the Passur River to avoid noise from wave breaking against the shore and it has been found higher (50.75 dB) than the acceptable limit as has happened before for several times.

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

4.3.10 Akram point, Sundarbans

45. Akram Point of the Sundarbans is another biodiversity hot spot in Sundarbans. This area has been selected for anchorage area of coal carrying mother vessel for the Power Plant. This area also falls under the silent zone where the ambient day time noise standard is 45dB (A). The monitoring location is at the left bank of the Sibsa River. Noise was recorded at about 100m inside the forest from the river bank to avoid noise from wave breaking. The ambient noise level was found above (49.60 dB) the standard limit in this of monitoring period. Birds' chirping, stormy wind, wave and tree leaves are the main sources of noise here.

4.3.11 Hiron Point, Sundarbans

46. Hiron point is the wildlife sanctuary of the Sundarbans. As per the Noise Control Rules, 2006, the appropriate standard for this zone would be 45dB (A). Noise level was recorded during morning and midday; but in the afternoon it was not possible to stay as because the ship had to retreat with the high tides. The ambient noise level has been found 46.06 dB which is above the standard limit. Birds, stormy wind, wave breaking on the sandy shore and rattling sound of tree leaves are the main sources of noise here.

Table 4.2a: Summary of the ambient noise monitoring in First Year (2014)

SI No	Location	QM1 (Noise Level in dB (A))				QM2 (Noise Level in dB (A))				QM3 (Noise Level in dB (A))				QM4 (Noise Level in dB (A))				Std*
		Mornin g (9:00)	A.noon (13:00)	Evenin g (18:00)	Day time AVG	Morni ng (9:00)	A.noon (13:00)	Evenin g (18:00)	Day time AVG	Mornin g (9:00)	A.noon (13:00)	Evening (18:00)	Day time AVG	Mornin g (9:00)	A.noon (13:00)	Evening (18:00)	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 4.2b: Summary of the ambient noise monitoring in Second Year (2015)

SI No	Location	QM1 (Noise Level in dB (A))				QM2 (Noise Level in dB (A))				QM3 (Noise Level in dB (A))				QM4 (Noise Level in dB (A))				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	
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					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					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					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					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					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					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					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					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
10	Akram Point, Sundarbans	53.35	56.37	NM	54.86	NM	NM	NM	-	45.28	53.92	NM	49.60					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

5 Water Quality Monitoring

47. This section describes the current water quality status that exists in the monitoring locations of the Project study area which covers Passur-Sibsa river system. A systematic sampling design emphasizing the multiple lines of evidence of the water quality covering Passur-Sibsa river system has been adopted. The information obtained from this section will constitute part of the 7th monitoring report (3rd Quarter of 2nd year) and updates environmental monitoring data to November 2015.

48. The water quality monitoring activities include: surface water and ground water of the respective locations. A number of identical parameters were chosen in order to understand the quality of the water whether it is ideal for the community use, aquatic life, and most importantly for the Sundarbans forest ecosystem.

49. The samples collected for the 6th monitoring program (in August, 2015) have been analyzed for the specific parameters; and accordingly the analysis report has been included in this 7th Monitoring report; the delay is due to long turn around period of DPHE laboratory located at Dhaka.

50. The details of the surface water monitoring plan are shown in **Table 5.1**

5.1 Methodology

51. Monitoring of water quality directly depends on selection of water quality parameters, sampling locations, sampling frequency, evaluation criteria etc. Standard practices have been followed for monitoring of water quality. This study is intended for assessment of both surface and ground water quality parameters to examine the present water quality status in the surroundings of Rampal Power Plant and the Sundarbans. As a part of entire monitoring activities, sample collection for 7th monitoring program (3rd quarterly monitoring of 2nd year, 2015) was scheduled from 1st October to 14th October 2015.. In order to establish a strong baseline, monitoring results have not only been presented but also been compared with the national (ECR, 1997 and all amendments) and Sampling Locations.

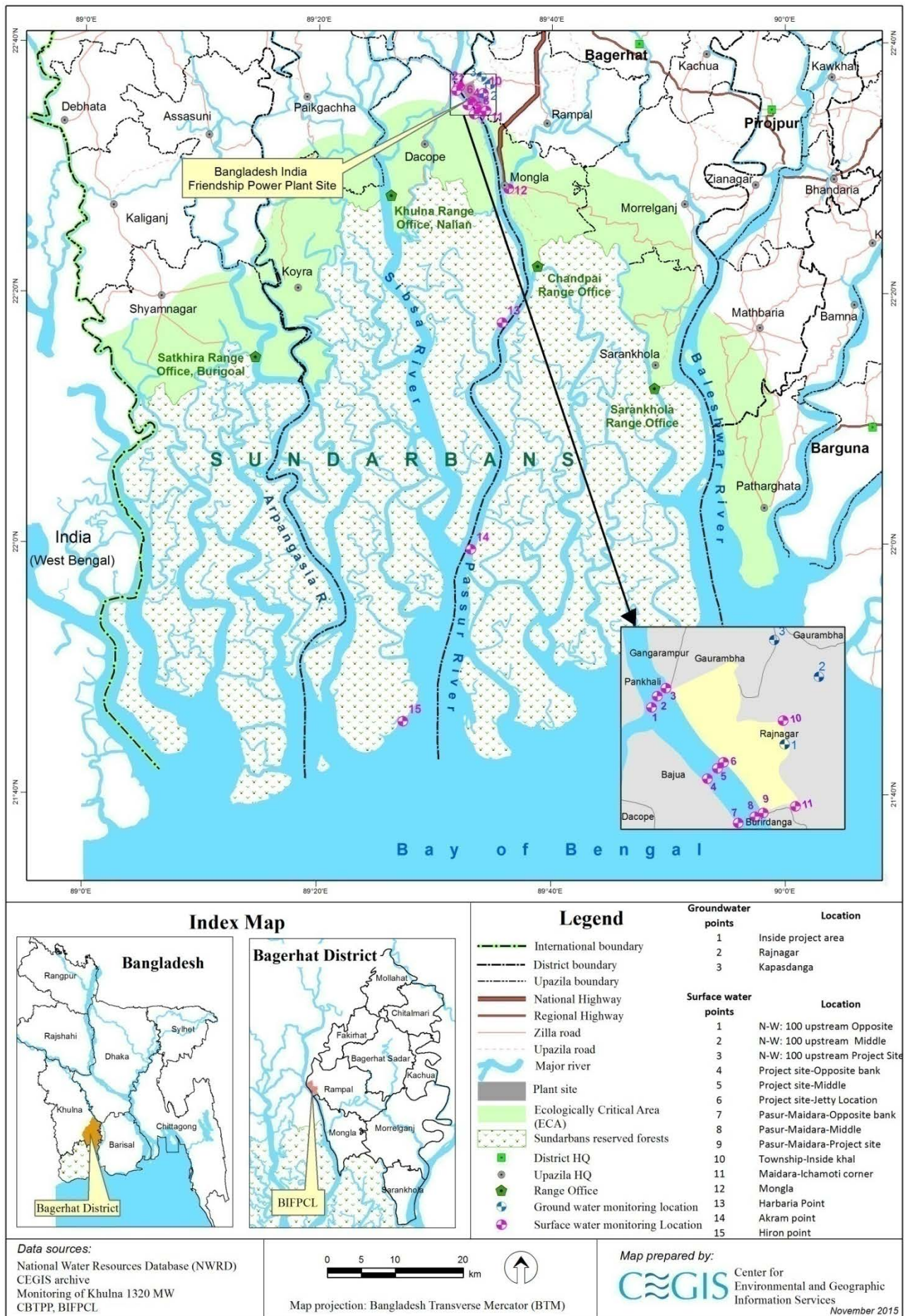
52. The water sample monitoring team has collected samples from the predestined sites (15 locations for surface water in Passur River, Sibsa River, Maidara River, near the plant site and, three locations for ground water surrounding study area) for 7th monitoring program as shown in the **Map 5.1**. as one tube well was found damaged near kalekharber from the 3rd monitoring programme hence the site has not been monitored since that period. These sampling locations were preliminary selected at inception stage and finalized during first quarter monitoring of this study and the future sampling will be continued from the same locations.

5.2 Laboratory Analysis Frequency

53. The collected water samples for 7th monitoring program have been handed over to the Department of Public Health Engineering (DPHE), Dhaka for laboratory analysis. Results will be presented in the next monitoring report (i.e. 8th monitoring report i.e. 4th quarter of 2nd year) after obtaining the water analysis reports from DPHE.

Table 5.1: 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	89.527222	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	89.528889		
3		Right Bank of Passur River at 100m u/s of North West corner from the Project boundary	22.609361	89.531417		
4		Left Bank of Passur River at Project site-Jetty	22.584833	89.543583		
5		Middle of Passur River at Project site-Jetty	22.587667	89.546472		
6		Right Bank of Passur River at Project site-Jetty	22.589333	89.548222		
7		Left Bank of Passur River at South West corner from the Project boundary	22.572889	89.552583		
8		Middle of Passur River at South West corner from the Project boundary	22.574611	89.557500		
9		Right Bank of Passur River at South West corner from the Project boundary	22.575667	89.559861		
10		Maidara river at the South East corner of the Project at Ichamoti-Maidara confluence	22.600639	89.565611		
11		Maidara river near proposed Township area	22.577472	89.569250		
12		Passur river at Passur – Ghasiakhali confluence	22.473861	89.602361		
13		Passur river at Harbaria of Sundarbans	22.295250	89.593139		
14		Passur river at Akram Point of Sundarbans				
15		Passur river at Hiron point of Sundarbans				



Map 5.1: Surface water and Groundwater Quality Monitoring Locations

5.3 Sampling Procedure

54. Sampling of surface and groundwater has been conducted following the standard methodologies and practices. The study area is highly influenced by tidal variation. Hence, temporal and spatial variations of tides have been considered significantly in sampling procedure. The standard sampling procedure maintained in pragmatic manner which would



Photo 5.1: On-spot Water Quality parameters test at Harbaria

in turn reduce the probability of error as well as increase the level of confidence of the study.

sample water. Acidified sampling bottles were used for heavy metals (As, Pb, Hg) sampling and wrinkle bottles were used for BOD5 sampling. After that samples were preserved as per standard practices.

57. A number of water quality parameters have been tested on the spot as in-situ measurement. Temperature, pH, DO and Salinity have been tested on the spot while the rest of the samples have been collected, preserved and analyzed in the laboratory.

55. Each sample was tagged at the time of sampling. Maximum surface water samples were collected during the low tides or relatively slag period after the low tide. Samples were taken 50m away from the riverbank. Samples were collected from a depth of 6 cm below the river surface and only for oil and grease, samples were collected from the river surface.

56. Ground water samples were collected from hand pump tube wells after 5-7 minute water extraction. Samples were collected in four kinds of different bottles. Every sampling bottle was rinsed before sampling with



Photo 5.2: Assess salinity at Hiron Point sampling Site

5.3.1 Parameters tested for Surface water quality

58. The selected parameters for water quality monitoring includes Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Heavy Metals (As, Pb, Hg), pH, Salinity, Hardness, Nitrate (NO₃), Total Dissolve Solids (TDS), Total Hardness (TH), Turbidity, Temperature and Oil and Grease. Selected water quality parameters and their collected locations and frequency of sampling at each of the locations have been presented in **Table 5.1**.

5.3.2 Parameters tested for Groundwater quality

59. Four locations have been selected for monitoring the ground water quality of the study area. Among them, one well is located in the Project area (near the proposed townships area) and other three tube wells are located in Rajnagar, Kapasdanga and Kalekharber but the well at Kalekharber is currently out of monitoring program as it was

damaged. . Collected samples have been tested in the laboratories of Department of Public Health Engineering (DPHE). The selected parameters are presented in **Table 5.2**.

Table 5.2: Ground Water Quality Monitoring Parameters, Locations and Plan

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

5.3.3 Water quality analysis procedure

60. 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. The collected samples have been analyzed as per the procedure of APHA standard. A number of parameters have been scheduled to be analyzed in each quarter of a year. Only five parameters namely pH, temperature, salinity, DO and BOD₅ were analyzed on the spots and the rest of the preselected parameters were analyzed at DPHE. But for the oil and grease analysis the samples were sent to the BCSIR (Bangladesh council for the scientific and industrial research) laboratory.

Table 5.3: Testing Methodology of Water Quality Parameter

Parameters	Unit	Methods/Measuring Tools
Temperature	⁰ C	TDS meter
pH		Microprocessor pH meter
TDS	Ppm	TDS meter
TSS	Ppm	Drying and Filtration
Salinity	Ppt	Salinity Refractometer (Master- S/MillM Cal. No. 2493, ATAGO)
DO	Ppm	Dissolved Oxygen meter DO-5509
BOD	Ppm	5-Day BOD Test at 20 ⁰ C
COD	Ppm	Closed Reflux Method
Total Hardness	Ppm	Titrimetric
Ortho-Phosphate (PO ₄ ³⁻)	Ppm	UV-VIS Spectrophotometers
Nitrate (NO ₃ ⁻)	Ppm	UV-VIS Spectrophotometers
SO ₄ ²⁻	Ppm	UV-VIS Spectrophotometers
Oil and Grease	Ppm	Liquid-liquid extraction with hexane, treatment with silica gel and gravimetric determination
As	Ppm	Atomic Absorption Spectrophotometers–Hydride Vapor Generating (AAS-HVG)
Pb	Ppm	Atomic Absorption Spectrophotometers–Graphite Furnace (AAS-GF)

Parameters	Unit	Methods/Measuring Tools
Hg	Ppm	Mercury Analyzer

61. In case of surface water quality monitoring, the main parameters which have been monitored are grouped into four categories:

- Physical and aggregate properties i.e. pH, Temperature, Salinity, Hardness, TDS, TS, Turbidity, Oil & Grease
- Inorganic non-metallic constituents' i.e. DO, NO³⁻, PO₄³⁻ and SO₄²⁻
- Aggregate organic constituents i.e. BOD, COD
- Heavy metals i.e. As, Pb and Hg

5.4 Results of surface water quality monitoring

5.4.1 In-situ tested parameters

(a) pH

62. pH values in this period ranged from 7.1 to 7.8 found to be within the BD standard limit (ECR'97 for inland surface waters). Highest value (7.8) was observed in Passur River at Harbaria of Sundarbans. Nearly similar result (7.78) was found in the left Bank of Passur River at South West corner from the Project boundary. The results showed conformity among the spots but the results were little bit lower compared to the monitoring results of the same period of the previous year of the said river system. However, the lowest value (7.1) was recorded in Passur-Ghasiakhali confluence.

63. The monitoring results show that there lies a seasonal variation in pH results of the Passur-Sibsa River system (RS). According to the seven consecutive quarterly monitoring results, pH values of pre-monsoon and monsoon seasons were found to be comparatively lower than post-monsoon and winter seasons. During post monsoon and winter seasons, river water level normally goes down because of less rainfall and less upstream flow of Passur-Sibsa RS and increase pH values little bit higher than pre-monsoon and monsoon seasons as reported by others (Rahman et al., 2013). No significant seasonal pH differences were observed except spatial variation in the river water. The measured pH values of selected monitoring locations during first and second year quarterly monitoring of Passur-Sibsa RS are presented in **Table 5.4**

Table 5.4: pH Values of Passur River Water

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

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

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

(b) Temperature

64. In this period of monitoring, temperature values varied from 30.20C - 31.80C which are almost alike compared to the previously monitored data. The figures also showed a close conformity with the first year 2nd quarterly monitoring data.

65. The standard temperature for sustaining aquatic life is 20oC-30oC as per the Environment Conservation Rules, 1997 of Bangladesh. In this post monsoon season the observed temperature values were found to be within the standard. The surface water temperature largely depends on daily weather condition (Bartram J et al., 1996). Of them, winter was the cooler season than the pre-monsoon, monsoon and post-monsoon seasons and hence January is cooler period than April, July and October of the year (according to the seasonal weather pattern exists in Bangladesh). The measured temperature values of selected monitoring locations during first and second year quarterly monitoring of Passur-Sibsa RS are presented in **Table 5.5**.

Table 5.5: Surface Water Temperature in Passur River

SI	Sampling Locations	Temperature (°C)							
		1 st Year				2 nd Year			BD Standard
		Apr	Jul	Oct	Jan	Apr	Jul	Oct	
		1QM	2QM	3QM	4QM	1QM	2QM	3QM	
1	Left Bank of Passur River at 100m u/s of North West corner from the Project boundary	31	33	31	19	30	31.8	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	
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	
4	Left Bank of Passur River at Project site-Jetty	31	33	31	19	31	30.8	31.3	
5	Middle Passur River at Project site-Jetty	30	32	31	19	30	30.6	31.6	
6	Right Left Bank of Passur River at Project site-Jetty	30	32	31	19	30	30.4	31.1	
7	Left Bank of Passur River at South West corner from the Project boundary	31	32	30	20	31	30.5	30.3	
8	Middle of Passur River at South West corner from the Project boundary	31	31	29	19	30	30.8	30.5	
9	Right Bank of Passur River at South West corner from the Project boundary	31	31	29	19	31	30.6	30.8	
10	Maidara river of the South East corner of the Project at Ichamoti-Maidara confluence	30	31	28	19	30	30.8	31.8	
11	Maidara river near proposed township area	30	32	27	20	30	31.6	31.2	
12	Passur river at Passur-Ghasiakhali confluence	29	30	32	19	30	29.8	30.7	
13	Passur river at Harbaria of Sundarbans	30	30	27	22	30	29.0	30.8	
14	Passur river at Akram point of Sundarbans	29	29	30	21	30	NS	30.2	
15	Passur river at Hiron point of Sundarbans	29	30	29	21	30	NS	30.4	

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

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

(c) Salinity

66. Water salinity at the selected sampling stations of Passur-Sibsa RS of seven consecutive periods is presented in **Table 5.6**. No salinity was found in the Passur river up to Harbaria in this monitoring period (August- October, 2015) while in July, 2014 salinity was measured 0) to 2 ppt at the Project site and the Hiron Point respectively. The rainfall (for more than a month) and fresh water flow from upstream reduce the salinity to zero level. In this monitoring period, maximum salinity was found in Hiron point and in Akram point (5 ppt and 6.2 ppt respectively) which is quite common during this time period.

Table 5.6: Salinity (ppt) in Passur River

SI	Sampling Locations	Salinity (ppt)						
		1 st Year				2 nd Year		
		Apr	Jul	Oct	Jan	Apr	Jul	Oct
		1st QM	2nd QM	3rd QM	4th QM	1st QM	2nd QM	3rd QM
1	Left Bank of Passur River at 100m u/s of North West corner from the Project boundary	11.5	2.5	0.0	4.5	13	0	0
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
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	Left Bank of Passur River at Project site-Jetty	12.0	2.2	0.0	4.7	9	0	0
5	Middle of Passur River at Project site-Jetty	12.0	0.3	0.0	5.1	13	0	0
6	Right Bank of Passur River at Project site-Jetty	12.0	0.5	0.0	5.0	14	0	0
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
8	Middle of Passur River at South West corner from the Project boundary	9.0	0.0	0.0	5.2	13	0	0
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
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
11	Maidara river near proposed township area	9.0	4.5	0.0	4.5	9	0	0
12	Passur river at Passur-Ghasiakhali confluence	10.0	9.5	0.0	5.0	14	0	0
13	Passur river at Harbaria of Sundarbans	12.0	10.0	0.0	6.0	15	0	0
14	Passur river at Akram point of Sundarbans	19.0	15.0	1.0	16.0	20	NS	5
15	Passur river at Hiron point of Sundarbans	23.0	19.5	2.0	23.0	25	NS	6.2

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

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

(d) Dissolved Oxygen

67. In this season, the obtained DO values fluctuated from 6.1 to 7.6 mg/L. It has also been observed that the results were relatively same with the results of the post-monsoon period of 2014. During all the monitoring seasons, dissolved oxygen was found sufficient for sustaining the aquatic fisheries except one point (4.9 mg/L) of middle of Passur river at 100 m upstream of North West corner from the Project boundary in pre-monsoon of 1st monitoring report (i.e first quarter of the 1st year). On the contrary, in second year, it was found within limit of Bangladesh for sustaining the aquatic fisheries.

68. The higher values of DO in the upstream stations may be due to DO enriched inland freshwater input through the river. In addition, the oxygen saturation concentration depends on temperature and salinity (Weiss 1970). High temperature and salinity cause the oxygen to be relatively low (Badran 2001). In addition, It is widely known that the higher the temperature, the lower the solubility of oxygen in seawater. Monitoring results found relatively low DO level through the river directed from upstream to downstream of the Passur-Sibsa RS. Seasonal variations of DO at the monitoring sites of Passur-Sibsa RS are shown in **Table 5.7**.

Table 5.7: Dissolve Oxygen in Passur River

SL	Sampling Locations	Dissolve Oxygen (mg/L)							BD Standard
		1 st Year				2 nd Year			
		Apr	Jun	Oct	Jan	Apr	July	Oct	
		1QM	2QM	3QM	4QM	1QM	2QM	3QM	
1	Left Bank of Passur River at 100m u/s of North West corner from the Project boundary	5.9	6.1	5.6	5.5	6.2	5.3	6.8	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	
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	
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	Middle of Passur River at Project site-Jetty	5.9	6.9	7.2	5.9	6.6	6.6	7.2	
6	Right Bank of Passur River at Project site-Jetty	5.8	6.6	8.0	6.8	6.4	6	7.6	
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	
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	
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	
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	
11	Maidara river near proposed township area	6.7	6.8	8.0	6.2	6.5	6.4	7.1	
12	Passur river at Passur-Ghasiakhali confluence	5.3	6.2	7.0	6.5	6.3	7	6.6	
13	Passur river at Harbaria of Sundarbans	5.4	5.9	7.0	6.6	5.8	7.5	7.1	
14	Passur river at Akram point of Sundarbans	7.9	6.4	7.7	6.7	6	NS	7.3	
15	Passur river at Hiron point of Sundarbans	7.5	6.5	7.8	6.5	5.8	NS	7	

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

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)

(e) Biochemical Oxygen Demand (BOD₅)

69. The BOD₅ values were found to be ranged in between 1.6-4.2 mg/L. Maximum value of BOD₅ (4.2mg/L) was found at the South East corner of the Project at Ichamoti-Maidara confluence in which the result showed quite similar magnitude in the same season in 2014 of the Passur-Sibsa River system. However, the lowest (1.6 mg/L) value was observed at near proposed Township area (Project area). The BOD₅ levels were found within BD standards (ECR, 1997) in all the sampling results reported in the consecutive monitoring reports except at Right Bank of Passur River at South West corner from the Project boundary (6.5) which was observed in first year pre-monsoon season.

70. In general, among the seven consecutive seasons, BOD₅ was found to be very low in winter season while comparatively high BOD₅ was observed in pre-monsoon and monsoon season of first and second year monitoring studies. The water temperature normally goes down lower towards the winter season than those of pre-monsoon, monsoon and post monsoon seasons, which intern decreases the bacterial and microbial activities and contributes a low level of BOD₅. The measured BOD₅ values at different monitoring locations during first and second year monitoring of Passur-Sibsa RS are presented in **Table 5.8**.

Table 5.8: BOD₅ of Passur River Water

S L	Sampling Locations	Biochemical Oxygen Demand (mg/L)							BD Standard
		1 st Year				2 nd Year			
		Apr	Jul	Oct	Jan	Apr	July	Oct	
		1QM	2QM	3QM	4QM	1QM	2QM	3QM	
1	Left Bank of Passur River at 100m u/s of North West corner from the Project boundary	3.4	2.2	1.9	1.6	3.1	3	2.1	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	
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	
4	Left Bank of Passur River at Project site-Jetty	3.2	3.1	4.0	0.8	3	4.4	3.2	
5	Middle Passur River at Project site-Jetty	3.0	2.5	3.5	1.4	3.5	4.3	3.7	
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	
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	
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	
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	
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	
11	Maidara river near proposed township area	4.1	3.7	4.0	2.0	3.4	4.2	1.6	
12	Passur river at Passur-Ghasiakhali confluence	2.3	2.2	1.7	2.0	3.3	4.9	2.1	
13	Passur river at Harbaria of Sundarbans	2.2	2.5	2.6	1.9	2.4	3.9	2.7	
14	Passur river at Akram point of Sundarbans	5.0	2.9	3.7	2.2	3	NS	2.2	
15	Passur river at Hiron point of Sundarbans	4.3	2.7	3.9	2.3	2.7	NS	2.5	

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

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

5.4.2 Laboratory tested parameters

(a) Total Dissolved Solids, Total Hardness and Total Suspended Solids

71. Among the samples, the values of TDS varied from 127 mg/L to 2320 mg/L. The observed results were found to be higher in Left Bank of Passur River at 100m u/s of North West corner from the Project boundary, Middle of Passur River at 100m u/s of North West corner from the Project boundary and in Maidara river of the South East corner of the Project at Ichamoti-Maidara confluence than the previously monitored results in the same season. But the values were also found to be much lower in Maidara river near proposed township area, Passur river at Passur - Mongla confluence and in Passur River at Harbaria of Sundarbans. Before this monitoring period heavy rainfall was observed in Sundarbans. Moreover, in pre-monsoon and monsoon period the river receives huge amount of water from the upstream and from inland sources which intern increase the concentration of TDS.

72. The results confirmed 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). However, Sediment load in Passur River is relatively high as it is located in the south western part of Bangladesh. In most of the observed locations, the TDS concentrations were seem to be lower in monsoon and post monsoon period and higher in pre-monsoon and winter season. A Significant spatial variation was found and this may be because of the seawater and the erosion-accretion nature of the river.

73. The values of TH in the water samples were found to be ranged between 105 mg/L to 470 mg/L. The results showed a close similarity to that of 2014 monsoon period. It was also been observed that the values of TH in monsoon and post-monsoon were much lower than the other seasons. Availability of large volume of fresh water from upstream of the river mainly influenced to reduce the hardness of the water in monsoon and post-monsoon season. Therefore, in this season the results did not exhibit any abnormal abundance of TH.

74. Total Suspended Solid (TSS) includes solid materials of organic and inorganic in origins which are suspended in the water. In Passur and Sibsa Rivers system the suspended matters generally contain sand, clay, silt and loam. During this period, the maximum TSS concentration (127 mg/L) was found in Right Bank of Passur River at 100m u/s of North West corner from the Project boundary while the lowest amount was recorded as 24 mg/L and found at Passur - Mongla confluence. However, TSS values in every spots were found to be within the standard (150 mg/L) suggested for Bangladesh (ECR, 1997) during this season. The values were found to be relatively higher in pre-monsoon season than in monsoon and in winter season. 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.

75. The TDS, TH and TSS of pre-monsoon, monsoon, post-monsoon and winter seasons at different monitoring locations are presented in **Table 5.9**.

Table 5.9: TDS, TH and TSS of Passur River System

SL	Sampling Locations	TDS (mg/L)						TH (mg/L)						TSS (mg/L)					
		1 st Year				2 nd year		1 st Year				2 nd year		1 st Year				2 nd year	
		Apr	Jul	Oct	April	April	July	April	Jul	Oct	Jan	April	July	Apr	Jul	Oct	Jan	April	July
		1QM	2QM	3QM	4QM	1QM	2QM	1QM	2QM	3QM	4QM	1QM	2QM	1QM	2QM	3QM	4QM	1QM	2QM
1	Left Bank of Passur River at 100m u/s of North West corner from the Project boundary	13060	251	176	4360	14400	937	2900	250	216	930	3000	245	59	126	234	180	160	26
2	Middle of Passur River at 100m u/s of North West corner from the Project boundary	12630	246	162	3950	14700	941	2500	180	218	870	3050	110	45	92	193	210	167	25
3	Right Bank of Passur River at 100m u/s of North West corner from the Project boundary	12900	383	153	4330	14900	127	2650	170	335	870	3250	105	53	112	174	230	170	127
4	Left Bank of Passur River at Project site-Jetty	13190	445	169	4750	14600	175	2550	175	390	940	3450	118	54	99	227	450	160	30
5	Middle Passur River at Project site-Jetty	13330	353	156	4920	14500	132	2600	275	340	990	3250	103	60	100	232	250	165	27
6	Right Bank of Passur River at Project site-Jetty	13380	402	152	4870	14200	156	2625	350	355	970	3200	105	55	105	186	200	155	40
7	Left Bank of Passur River at South West corner from the Project boundary	13180	655	162	5040	14500	336	2550	325	330	1045	3600	153	24	116	185	300	150	32
8	Middle of Passur River at South West corner from the Project boundary	13390	587	153	5050	14600	158	2800	350	345	1125	3670	105	27	112	536	530	147	40
9	Right Bank of Passur River at South West corner from the Project boundary	13240	916	154	5130	14250	160	2500	475	325	975	3540	165	67	37	459	450	155	44
10	Maidara river of the South East corner of the Project at Ichamoti-Maidara confluence	12400	455	214	5050	14000	2320	2500	450	350	980	3260	470	7	65	798	280	148	36
11	Maidara river near proposed township area	10970	2510	257	4390	13900	355	2400	725	330	970	3190	130	9	24	389	206	160	28
12	Passur river at Passur - Ghasiakhali confluence	12800	6410	209	5130	14050	298	3150	1400	377	1000	3210	135	50	310	203	280	165	24
13	Passur river at Harbaria of Sundarbans	12280	9360	285	4780	13900	683	2625	2150	345	970	3080	200	65	90	869	400	160	42
14	Passur river at Akram point of Sundarbans	21500	15960	3400	12350	13600	NS	4500	3625	980	2380	3420	NS	115	99	280	103	150	NS
15	Passur river at Hiron point of Sundarbans	21500	14050	5720	17900	25300	NS	4850	3050	1440	2690	3640	NS	91	72	267	200	180	NS

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

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

(b) Chemical Oxygen Demand

76. Generally, COD found to be higher in Passur-Sibsa RS as it contain high amount of organic matter from the Sundarbans forest. The values of Chemical Oxygen Demand varied from 18 mg/L to 51 mg/L in this monitoring period. Maximum value was obtained from the Maidara River of South East corner of the Project at Ichamoti-Maidara confluence where extensive agricultural practices were observed which might be the reason of this higher concentration. However, high values of COD indicate high levels of organic pollution in the river water (Sivasubramaniam, 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.

77. The COD concentrations of pre-monsoon and winter seasons (dry) were found to be higher than monsoon and post-monsoon seasons. In monsoon, higher discharge diluted the COD load in the river which also influenced to reduce COD concentration in post monsoon.

Table 5.10: COD of Passur River System

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

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

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

(c) Nitrate, Sulphate and Phosphate

78. The concentrations of Nitrate were found to be varied from 3.1 mg/L -14.9 mg/L. . The results obtained from 2nd year 2nd quarterly monitoring period were found to be lies within the standard though the observed values were found to be higher than the previously analyzed data of the same season.

79. However the maximum value (14.9 mg/L) was obtained in Left Bank of Passur River at South West corner from the Project boundary while the lowest value (3.1 mg/L) was recorded at Maidara River near proposed township area. This higher amount of nitrate might be due to the 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). Naturally, SO_4^{2-} concentration is higher in sea water as well as in river in coastal region. From the observed dataset, it is seen that SO_4^{2-} concentration is very high in pre-monsoon followed by the winter season. However, the values ranged in between 6 mg/L to 72 mg/L in July 2015. It has also been observed that, SO_4^{2-} concentration were lower in monsoon (ranged from 20mg/L to 1,400 mg/L) and post monsoon (ranged from 27mg/L to 2,360 mg/L) except Akram and Hiron points of Sundarbans. Usually, SO_4^{2-} concentration of Passur-Sibsa RS increases in the direction of upstream to downstream but in this monitoring period but the recent trend showed the otherwise (second highest value 67mg/L was recorded in the Left Bank of Passur River at 100m u/s of North West corner from the Project boundary). Comparatively lower concentration of SO_4^{2-} in monsoon and post monsoon seasons is indicating the dilution effect of upstream fresh water.

80. In most of the spots, the values of PO_4^{2-} were found to be slightly lower in 2015 monsoon period (from 0.1 mg/L to 0.89 mg/L) than in the last monsoon (0.29-2.55 mg/L). The results also indicated similarity with the pre-monsoon period. However, the highest amount of phosphate was found in Passur river at Harbaria of Sundarbans while the lowest was recorded in Right Bank of Passur River at South West corner from the Project boundary, left Bank of Passur River at South West corner from the Project boundary and in Left Bank of Passur River at 100m u/s of North West corner from the Project boundary. In addition, significant variations were not found in all the observed locations.

81. 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 **Table 5.11**.

Table 5.11: NO₃²⁻, SO₄²⁻ and PO₄²⁻ concentration of Passur River System

SI	Sampling Locations	NO ₃ ²⁻ (mg/L)						SO ₄ ²⁻ (mg/L)						PO ₄ ²⁻ (mg/L)					
		1 st Year				2nd year		1 st Year				2nd year		1 st Year				2nd year	
		Apr	Jul	Oct	Jan	Apr	July	Apr	Jul	Oct	Jan	Apr	July	Apr	Jul	Oct	Jan	Apr	July
		1QM	2QM	3QM	4QM	1QM	2QM	1QM	2QM	3QM	4QM	1QM	2QM	1QM	2QM	3QM	4QM	1QM	2QM
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	1840	20	26	580	1360	67	0.52	2.23	0.67	0.32	0.86	.10
2	Middle Passur River at 100m u/s of North West corner from the Project boundary	0.70	2.40	1.57	1.5	-	7.5	1320	23	28	450	1260	11	0.50	1.99	1.12	0.61	0.53	0.23
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	1280	36	34	480	1240	9	1.10	2.55	0.95	0.7	0.72	0.67
4	Left Bank of Passur River at Project site-Jetty	1.30	0.76	1.64	3.1	-	6.6	1360	45	33	550	1240	26	2.10	0.45	0.92	0.43	0.49	0.27
5	Middle Passur River at Project site-Jetty	1.40	2.69	1.42	2.2	-	6.1	1040	32	30	520	1120	6	2.20	2.13	1.11	0.41	0.68	0.59
6	Right Bank of Passur River at Project site-Jetty	1.10	2.98	1.33	8.5	-	6.6	1320	20	27	540	820	8	2.00	2.42	0.99	0.55	0.61	0.13
7	Left Bank of Passur River at South West corner from the Project boundary	0.75	2.13	1.85	2.7	-	14.9	1640	60	40	630	880	9	0.57	1.25	1.18	0.76	0.65	0.1
8	Middle of Passur River at South West corner from the Project boundary	1.10	2.43	2.09	1.8	-	4	1520	40	35	560	1180	19	1.20	1.51	1.25	0.85	0.53	0.18
9	Right Bank of Passur River at South West corner from the Project boundary	1.20	2.05	2.21	1.9	-	4.9	1280	80	64	620	900	12	1.50	1.10	1	0.53	0.6	0.1
10	Maidara river of the South East corner of the Project at Ichamoti-Maidara confluence	0.3	2.18	2.26	6	-	7	1120	20	63	570	1220	72	0.55	2.1	1.27	0.59	0.7	0.5
11	Maidara river near proposed township area	0.5	0.88	1.98	4	-	3.1	1320	210	63	460	840	27	1.1	0.53	1.04	0.64	0.55	0.29
12	Passur river at Passur - Ghasiakhali confluence	0.6	1.52	1.64	4.5	-	7.8	1360	620	44	630	980	39	1.3	0.35	0.86	0.42	0.71	0.59
13	Passur river at Harbaria of Sundarbans	1.4	1.75	1.67	2.7	-	4.4	1560	860	69	590	900	51	1.1	0.56	1.22	0.61	0.59	0.89
14	Passur river at Akram point of Sundarbans	2.7	3.32	0.59	1.5	-	NS	2600	1400	1390	850	1540	NS	1.3	0.29	0.8	0.42	0.61	NS
15	Passur river at Hiron point of Sundarbans	0.8	2.84	0.4	2	-	NS	2080	1160	2360	1500	1920	NS	7.51	0.29	1.09	0.44	0.47	NS

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

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

(d) Heavy Metals

82. The dataset of Arsenic (As) concentrations demonstrated conformity among all the seasons. As concentrations varied from 0.001 mg/L to 0.003 mg/L. maximum value was recorded in Right Bank of Passur River at South West corner from the Project boundary while the lowest value was obtained in Middle portion of Passur River at Project site-Jetty. On the other hand, the concentrations of Pb were found to be higher in January, 2014 and April 2015 compared to the other seasons. Maximum values i.e. 0.011 mg/L was found in the Left Bank of Passur River at South West corner from the Project boundary. The values of Hg revealed a continuous contingency among all the spots in all the seasons. The values never exceeded more than 0.0020 mg/L.

83. As, Pb and Hg concentrations were found to be very low in river water during all four seasons of pre-monsoon, monsoon, post monsoon and winter. As and Pb concentrations of four observation periods of the 1st monitoring year (2014) and two observation periods of the 2nd monitoring year (2015) are presented in **Table 5.12**, whereas Hg concentrations are presented in **Table 5.13**.

Table 5.12: As, Pb concentration of Passur River System

SI	Sampling Locations	As (mg/L)						Pb (mg/L)					
		1 st Year				2nd year		1 st Year				2nd year	
		Apr	Jul	Oct	Jan	Apr	July	Apr	Jul	Oct	Jan	Apr	July
		1QM	2QM	3QM	4QM	1QM	2QM	1QM	2QM	3QM	4QM	1QM	2QM
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	0.053	0.004	0.002	0.104	0.098	0.0059
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	0.055	0.002	0.003	0.104	0.102	0.0038
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	0.055	0.005	0.002	0.111	0.138	0.0058
4	Left Bank of Passur River at Project site-Jetty	0.002	0.004	0.004	0.004	0.002	0.002	0.057	0.002	0.003	0.154	0.142	0.011
5	Middle Passur River at Project site-Jetty	0.002	0.004	0.004	0.003	0.002	0.001	0.060	0.002	0.002	0.139	0.135	0.002
6	Right Bank of Passur River at Project site-Jetty	0.002	0.003	0.003	0.003	0.002	0.002	0.058	0.002	0.002	0.138	0.156	0.0021
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	0.053	0.002	0.003	0.16	0.142	0.0076
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	0.054	0.003	0.004	0.153	0.148	0.002
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	0.056	0.005	0.004	0.139	0.163	0.002
10	Maidara river of the South East corner of the Project at Ichamoti-Maidara confluence	<0.001	0.003	0.006	0.004	0.003	0.002	0.053	0.004	0.004	0.143	0.135	0.002
11	Maidara river near proposed township area	0.002	0.002	0.003	0.003	0.003	0.002	0.048	0.004	<0.002	0.133	0.14	0.002
12	Passur river at Passur - Ghasiakhali confluence	0.002	0.004	0.003	0.003	0.004	0.002	0.050	0.032	<0.002	0.141	0.14	0.002
13	Passur river at Harbaria of Sundarbans	0.004	0.003	0.004	0.004	0.004	0.002	0.043	0.044	0.004	0.137	0.13	0.002
14	Passur river at Akram point of Sundarbans	0.004	0.002	0.002	0.003	0.002	NS	0.194	0.071	0.032	0.309	0.297	NS
15	Passur river at Hiron point of Sundarbans	0.003	0.002	0.003	0.002	0.002	NS	0.224	0.050	0.07	0.309	0.291	NS

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

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

Table 5.13: Hg concentration of Passur River System

Sl	Sampling Locations	Hg (mg/L)					
		1 st Year				2nd year	
		Apr	Jul	Oct	Jan	Apr	July
		1QM	2QM	3QM	4QM	1QM	2QM
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
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
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
4	Left Bank of Passur River at Project site-Jetty	<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
6	Right Bank of Passur River at Project site-Jetty	<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
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
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
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
11	Maidara river near proposed township area	<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
13	Passur river at Harbaria of Sundarbans	<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
15	Passur river at Hiron point of Sundarbans	0.0023	<0.00015	<0.00015	<0.00015	<0.00015	NS

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

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

(e) Oil and Grease

84. In order to measure the concentration of oil and grease in Passur River, samples were taken from three locations during low tide from the surface layer. The analysis has been conducted through standard testing method of APHA. **Table 5.14** shows the concentration of oil and grease presents in Passur River.

85. During pre-monsoon, monsoon and post monsoon periods, the concentration of oil and grease was found negligible and all of the monitoring results fully meet the terms with the ECR' 1997 Standard. However, Passur and Sibsa rivers were containing high concentration of oil and grease in winter period. This high concentration might be due to accidental oil spill occurred on the 9th December, 2014. An amount of 350,000 liters (Philips, 2014) of furnace oil was spilled in the river which spread over a 350 km² area (Welle, 2014).

86. However during the monitoring period, the concentration of oil and grease did not exceed the standard limit (specified in ECR, 1997) in three specific sites. Among those sites the maximum values (10.1 mg/L) of oil and grease concentration was found in Passur River at Harbaria of Sundarbans. Some other causes such as discharge of oil and other organic residues from mother vessels (as all the mother vessel were seen anchoring in Harbaria due to the lack of Navigability), oil discharge from the fishing boats and other anthropogenic activities might contribute to this higher amount of oil and grease concentration.

Table 5.14: Oil and grease concentration of Passur River System

SI	Sampling Locations	Oil and Grease (mg/L)						ECR, 1997 (mg/L)*	IFC, 2007 (mg/L)
		1 st Year				2 nd year			
		Apr	Jul	Oct	Jan	Apr	Jul		
		1QM	2QM	3QM	4QM	1QM	2QM		
1	Left Bank of Passur River at South West corner from the Project boundary	<5	<5	<5	>15	16.9	9	10	10
2	Passur-Ghasiakhali Confluence	<5	<5	<5	>15	13	7.63		
3	Passur river at Harbaria of Sundarbans	<5	6.3	<5	>20	39.1	10.1		
4	Passur river at Hiron point of Sundarbans	<5	<5	<5	>20	<5	NS		
5	Akram Point of Sundarbans	<5	<5	<5	>20	<5	NS		

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

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

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

5.5 Results of Groundwater quality monitoring

5.5.1 In-situ tested parameters

(a) pH and Temperature

87. The values of Groundwater pH and temperature in observed locations were found fully complied with the drinking water quality standards as specified in ECR, 1997. The pH values of 7th monitoring program found to be varied from 7.49 to 7.93 while temperature was found to be in between 27.8°C to 30°C (**Table 5.15**). Both the results of pH and Temperature were found to be lower than the previously obtained dataset. It should be mentioned that ground water samples from Khalekharber was not collected because the tube well was abandoned. The seven consecutive monitoring results of pH and temperatures of selected locations are presented in **Table 5.15**.

Table 5.15: pH and Temperature of Ground Water

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

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

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

(b) Salinity and Dissolved Oxygen

88. Among the monitoring locations, saline free groundwater was found during these seven consecutive monitoring seasons. In case of dissolved oxygen, observed DO levels were found to be in between 5.4mg/L to 6.1 mg/L which is within ECR, 1997.. Sampling point of Kalekharber was found to be completely damaged. The seven consecutive monitoring results of salinity and DO of selected locations are presented in **Table 5.16**.

Table 5.16: Salinity and DO in Groundwater

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

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

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

5.5.2 Laboratory tested parameters**(a) TDS, TSS**

89. During the last monitoring period TDS values were found to be within the standard limit (1000 mg/L). Highest value (881mg/L) was recorded in the township area while the lowest value (328 mg/L) was recorded in Kapasdanga. Among all the monitoring period, TDS concentration was found to be much higher than the BD standard (ECR, 1997) in the pre -monsoon of the first quarterly monitoring period. On the contrary, TSS was measured in all the monitoring study except in first quarterly monitoring. The sample from Khakerbari tube well was not collected as it is abandoned. However, the TSS values of the last monitoring period varied from 14mg/L to 23mg/L which does not represent an ideal condition and further exceeded the BD drinking water standards (ECR, 1997). The maximum TSS value (23 mg/L) was found in the township area and the lowest value (14mg/L) was recorded in Karpasdanga.

90. Ground water TDS and TSS value of six consecutive monitoring periods have been presented in **Table 5.17**

Table 5.17: TDS and TSS concentrations in Groundwater

SI	Locations	Type of tube wells	TDS (mg/L)							TSS (mg/L)						
			1 st Year				2 nd year		BD Standard*	1 st Year				2 nd year		BD Standard*
			Apr	Jul	Oct	Jan	Apr	Jul		Apr	Jul	Oct	Jan	Apr	Jul	
			1 ^Q M	2 ^Q M	3 ^Q M	4 ^Q M	1 ^Q M	2 ^Q M		1 ^Q M	2 ^Q M	3 ^Q M	4 ^Q M	1 ^Q M	2 ^Q M	
1	Township near Project site	Deep (>600 ft)	1113	999	-	1021	NF	881	1000 mg/L	-	6	19	40	NO	23	10 mg/L
2	Rajnagar	Deep (>600 ft)	4090	371	-	378	390	574		-	6	2	28	4	16	
3	Kalekharber	Shallow (<250 ft)	1055	970	-	NF	NF	NF		-	48	NF	NF	NF	NF	
4	Kapasdanga	Deep (>600 ft)	643	635	-	600	600	328		-	8	6	32	6	14	

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

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

(b) Total Hardness

91. In this season, TH concentration varied from 115 mg/l to 225 mg/l among all the spots. The maximum measured value was found in the township area. The monitored values were found to be far lower than the standard limit. However, No incidents of weathering of Ca^{2+} bearing minerals or excessive application of lime was not found during the monitoring period. TH of Khalekharber has not been monitored since the third quarter monitoring because the well was abandoned..

92. Groundwater TH values of six consecutive monitoring periods have been presented in Table 5.18

Table 5.18: TH concentrations in Groundwater

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

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

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

(c) Chemical Oxygen Demand

93. The Bangladesh standard for COD in drinking water is 4.0 mg/L. However, all the monitored data from the tube wells showed higher concentration of COD than the limits imposed by ECR'97. COD concentrations found in between 10 mg/L to 14 mg/L. The analysed results were found to be lower than all the pre monitored results. The COD concentrations of all the monitoring locations are presented in **Table 5.19**.

Table 5.19: COD concentrations of monitored ground water locations

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

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

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

(d) Nitrate, Sulphate and Phosphate

94. Nitrate values were found to be varied from 2.2 mg/L to 7.6 mg/L and remained within the standard limit (10mg/L) as specified in ECR, 1997. Maximum values were observed in winter season in 4th monitoring report (i.e. 1st year 4th quarter). SO_4^{2-} and PO_4^{2-} concentrations monitoring of Passur-Sibsa RS have been included in this study since 2nd monitoring report (i.e. 1st year 2nd quarter).. Sulphate concentrations were found to be zero in all the points in every monitoring season except in 2nd monitoring report (1st year 2nd quarter) On the contrary, the values of PO_4^{2-} were within the standard limit (6 mg/L) and were ranged between 1.4 mg/L to 4.1mg/L.

95. The observed ground water NO_3^- , SO_4^{2-} and PO_4^{2-} concentrations are presented in **Table 5.20**.

Table 5.20: NO_3 , SO_4 and PO_4 Concentrations in Ground Water

SI	Locations	Type of tubewell	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)			
			1 st Year				2 nd year				1 st Year			
			Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan
			1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM
1	Township near Project site	Deep (>600 ft)	0.20	0.48	<0.10	28	-	7.6	-	3	-	-	-	-
2	Rajnagar	Deep (>600 ft)	0.60	0.68	0.31	26	-	2.2	-	2	-	-	-	-
3	Kalekharber	Shallow (<250 ft)	0.40	0.56	NF	NF	-	-	3	NF	-	-	-	-
4	Kapasdanga	Deep (>600 ft)	0.80	0.40	0.80	13	-	4.7	-	10	-	-	-	-

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

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;

(e) Arsenic, Lead and Mercury

Table 5.21: As, Pb and Hg concentrations (mg/L) of monitored ground water locations

SI	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)					
		1 st Year				2 nd year		1 st Year				2 nd year		1 st Year				2 nd year	
		Apr	Jul	Oct	Jan	Apr	Jul	Apr	Jul	Oct	Jan	Apr	Jul	Apr	Jul	Oct	Jan	APR	Jul
		1QM	2QM	3QM	4QM	1QM	2QM	1QM	2QM	3QM	4QM	1QM	2QM	1QM	2QM	3QM	4QM	1QM	2QM
1	Township Project site near	0.013	0.020	0.012	0.014	NO	0.015	0.002	<0.002	0.004	0.023	NO	0.002	<0.00015	<0.00015	<0.0005	<0.0005	NO	0.00015
2	Rajnagar	0.006	0.009	0.006	0.008	0.01	0.014	<0.002	<0.002	<0.002	0.016	0.013	0.0027	<0.00015	<0.00015	<0.0005	<0.0005	<0.00015	0.00015
3	Kalekharber	0.376	0.407	NF	NF	D	D	0.002	0.008	NF	NF	D	D	<0.00015	<0.00015	NF	NF	NF	NF
4	Kapasdanga	0.036	0.033	0.020	0.017	0.034	0.024	<0.002	0.004	<0.002	0.013	0.017	0.002	<0.00015	<0.00015	<0.0005	<0.0005	<0.00015	0.00015

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

6 Land Resources Monitoring

97. This section is focused on the land Resources quality and constitutes a part of the quarterly environmental monitoring report for 7th Program from August, 2015 to October, 2015 (i.e. 3rd Quarter of the 2nd year, 2015) covering BIFPCL Project study area at Batiaghata, Dacope, Rampal and Mongla Upazila of Khulna and Bagerhat Districts. In regard to assessment of land resources performance standards, soil samples were collected from 3/10/2015 to 5/10/2015 to cover wet season of 2015 to determine the levels of pH, OM, EC, N, P, K, S, Ca, Mg, Na, Fe, Mn, Zn, B, Pb and Cd.

98. Monitoring of Land Resources has been scheduled twice a year as per the contract. In this monitoring report, land resources monitoring chapter hasn't been populated with sampling data due to the reason that no data have been assayed yet due to long turn around period of SRDI laboratory. The 8th report (associated with the field visit in January, 2016) will contain a chapter on the results and findings of the Land Resources samples collected during 7th monitoring program. The next monitoring has been scheduled in the month of April, 2016 .

7 Agriculture Resources Monitoring

Monitoring of Agriculture Resources section constitutes a part of the 7th Quarter monitoring report from August-2015 to October-2015 (i.e. 3rd Quarter of the 2nd year) covering BIFPCL Project study area at Batiaghata, Dacope, Rampal and Mongla Upazila of Khulna and Bagerhat District.

7.1 Methodology

7.1.1 Monitoring Indicators

99. The major monitoring indicators for agriculture sector as per monitoring plan are major crop area, crop production and crop damage. It is expected that ash might be deposited in the agriculture land and which might influence to reduce the production of crops.

7.1.2 Method

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

7.1.3 Sampling Frequency

101. Land use, major crop production and damage are conducted twice in a year covering wet season (June to November of one year) and dry season (December to May of the next year), overlapping two calendar years. As such for the cropping season of 2015-16, these data were collected in October, 2015 as presented in **Table 7.1a** and **7.1b**. The farmers under the monitoring survey stated that, they are harvesting their Aman crops during end of November to early December. So, crop production and damage data will be collected during the field visit in April, 2016.

7.1.4 Location

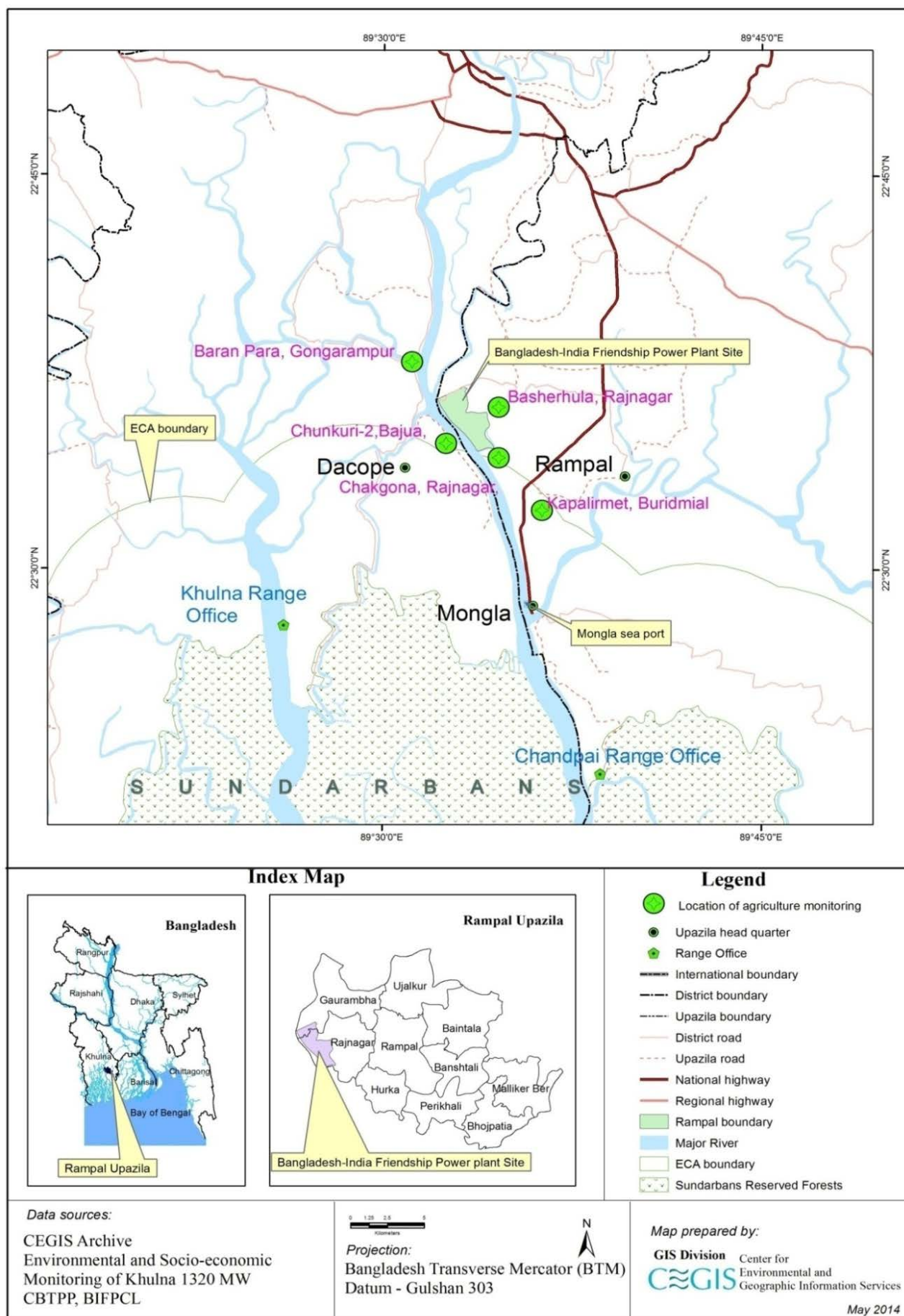
102. The same mouzas have been selected for land resources as well as agricultural resources monitoring. The selected mouzas are Baranpara, Chunkuri-2, Kapalirmet, Chakghona and Basherhula. The agriculture monitoring plan and the Locations of the agriculture lands under monitoring programme are presented in the **Table 7.1a** and **Map 7.1** respectively.



Photo 7.1: Sampling at selected agricultural land in Kapalirmet (Left) & in Basherhula (Right)

Table 7.1a: Agriculture Resources Monitoring Plan

Site No.	Monitoring indicators	Location	GPS(Decimal Degree)		Frequency	Methods/Tools/Techniques
			Easting	Northing		
1	Land use, Soil fertility and Nutrient, Chemical Properties of Soil (pH, Pb and Cd), Crop production, and damage	Mouza: Baran Para, Union: Gongarampur Upazila: Batiaghata, District: Khulna	E-89° 30'59.1"	N-22° 37'57.0"	Twice crop season (May and October)	Consultation with the land owner/share croppers
2		Mouza: Chunkuri-2, Union: Bajua Upazila: Dacope, District: Khulna	E-89° 32'20.0"	N-22° 34'51.0"		
3		Mouza: Kapalirmet/Buridmial Union: Burirdanaga, Upazila: Mongla District: Bagerhat	E-89° 36'8.8"	N-22° 32'18.9"		
4		Mouza: Chakgona, Union: Rajnagar Upazila: Rampal, District: Bagerhat	E-89° 34'25.3"	N-22° 34'18.3"		
5		Mouza: Basherhula, Union: Rajnagar Upazila: Rampal, District: Bagerhat	E-89° 34'25.0"	N-22° 36'14.0"		



Map 7.1: Agriculture Resources Monitoring Locations

7.1.5 Description of the selected agriculture land for monitoring

103. Details of the locations, sizes, land owner related information of the selected lands for agriculture monitoring activities are presented in the **Table 7.1b**.

Table 7.1b: Detailed information of the selected lands

Site No.	Location	GPS	Distance from the plant location(km)	Plot size (ha)	Land 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. Olitor Rahman Hajra

Source: Field survey, 2015

7.1.6 Present cropping patterns

104. Detail data on last three years cropping pattern of the selected lands for monitoring were obtained through an extensive discussions with the respective land owners. Based on the discussion, the following land based cropping patterns were identified to exist in the monitoring area for the year 2013-14. Details of cropping patterns were collected in October 2014 for 2014-15. Cropping pattern data of the land under monitoring programme were collected in October 2015 for the year of 2015-16. Detailed cropping pattern are presented in the **Table 7.2**.

(a) Monitoring of selected representative agricultural land-1

105. This land is located at Baran para and the size of the unit plot is about 0.4 ha. Farmer of the respective plot cultivated Local Aman (Kumragur) in last Kharif-II season (2013-14). Chemical fertilizer and liquid pesticides are being used in the land for crop production. Rice straw and bajua grass are mixed with the land to improve the soil fertility level. In the year 2014-15, he cultivated HYV Aman: BRRIdhan30 in the Kharif-II season. He stated that, yield rate of local variety is lower than HYV Aman. It is mentioned that farmers are growing HYV instead of Local rice. Pest like Stem borer and Leaf roller infestation observed in his land. Chemical fertilizer and pesticides are being used in the land for crop production. Chemical fertilizer used the following rate in his land, Urea: Not applied, MP: 11.2kg/plot and DAP: 37kg/plot. To protect crop from pest infestation granular pesticide Virtako 40WG applied @ 500gm/plot.

106. Farmer of the respective plot cultivated HYV Aman (BR23) in this Kharif-II season (2015-16). Chemical fertilizer and liquid pesticides are being used in the land for crop production. Pest like Stem borer and Leaf roller infestation observed in his land. Chemical fertilizer and pesticides are being used in the land for crop production. Chemical fertilizer used the following rate in his land, Urea: 15.0 kg/plot, TSP: Not applied and MP: 5.0kg/plot. To protect crop from pest infestation liquid pesticide Virtako applied @ 60ml/plot. Detailed cropping pattern is shown in the **Table 7.2**



Photo 7.2: Use of pesticide in monitoring agriculture land at Basherhula

(b) Monitoring of selected representative agricultural land-2

107. This monitoring site is located at Chunkuri-2 and the size of the plot is about 0.93 ha. Farmer of the respective plot was practicing HYV Aman (BR-23) in Kharif-II season in last year (2013-14). Chemical fertilizer and liquid pesticides are being used in the land for crop production. Rice straw and bajua grass are mixed with the land to improve the soil fertility level. In 2014-15, farmer of this land cultivated Local Aman such as Benapole in his land due to the high market price of local variety than HYV aman. Stem borer infestation observed in his land. Chemical fertilizer and pesticides are being used in the land for crop production. Chemical fertilizer used the following rate in his land, Urea: 125 kg/plot, TSP: 42kg/plot and

MP: 20kg/plot. To protect crop from pest infestation liquid pesticide Karate 2.5 EC applied @700ml/plot.

108. Farmer of the respective plot was practicing Benapole in Kharif-II season this year due to the high market price of local variety than HYV aman as well as saline tolerant. Chemical fertilizer and liquid pesticides are being used in the land for crop production. Stem borer infestation observed in his land. Chemical fertilizer and pesticides are being used in the land for crop production. Chemical fertilizer used the following rate in his land, Urea: 42 kg/plot, TSP: 7kg/plot and MP: 3.5kg/plot. To protect crop from pest infestation liquid pesticide Karate 2.5 EC applied @500ml/plot. Detailed cropping pattern is shown in the **Table 7.2**

(c) Monitoring of selected representative agricultural land-3

109. This monitoring site is located at Kapalirmet and the size of the plot is about 0.14 ha. Farmer of the respective plots is practicing Local Aman (Chapsail) in Kharif-II season last year (2013-14). In Kharif-I and Rabi season, shrimp culture in this plot every year. Chemical fertilizer and liquid pesticides are being used in the land for crop production. In 2014-15, this land remains fallow due to salinity. Shrimp gher owners of this area, enters saline water from Ghona river for shrimp culture every year. There was no scope to drain/washed out saline water from this area. On the other hand, inadequate rainfall occurs in this year. Farmers of this locality opined that, many of them cultivated T. Aman crops their land. But most of the crop lands are damaged by saline water. However, he culture shrimp/fish in his land this Kharif-II season (2015-4-15). He opined that, I could not cultivated Aman crops this Kharif-II season by lesson learnt from others. He also stated that, he will cultivate next Kharif-II season.

110. Farmers of this locality opined that, Bangladesh Water Development Board (BWDB) decided re-excavated work would be done on Gona River. They remove all the obstacles to re-excavate the Golbunia khals mouth as well as breakdown the bank of the khals. For this reason, water enters into the settlements areas including their cultivated lands. The whole areas were submergence by saline water this year. Resulting farmers of the locality could not cultivate crops and culture shrimp. Many of the farmers cultivated crops in their land in this adverse situation, but all crops land damages in growing stage by river water and rain water as well. The farmer of the monitoring land opined that, I could not cultivated Aman crops this Kharif-II season by lesson learnt from others. He also stated that, he will cultivate next Kharif-II season if the situation would improve in future. Detailed cropping pattern is presented in the **Table 7.2**

(d) Monitoring of selected representative agricultural land-4

111. This monitoring site is located at Chakgona and the size of the plot is about 0.28 ha. Farmer of the respective plot is practicing Local Aman (Chapsail) in Kharif-II season last year (2013-14). In Kharif-I and Rabi season shrimp culture in this plot every year but this year there is no shrimp culture in this particular piece of land. Chemical fertilizer and liquid pesticides are being used in the land for crop production. Due to adverse situation of salinity, he felt that his land was not suitable for crop cultivation this year Kharif-II season (2014-15). He also stated that, he will cultivate next Kharif-II season.

112. Farmers of the respective plot stated that, his land was suffered by salinity. So, he continued culture shrimp in his land rather than crop cultivation. He seems that his land was not suitable for crop cultivation. So, he could not cultivated crops in his land this year Kharif-II season. He also stated that, he will cultivate if the situation would improve in future. Detailed cropping pattern is presented in the **Table 7.2**



Photo 7.3: Focus Group Discussion (FGD) at Baranpara



Photo 7.4: Focus Group Discussion (FGD) at Chunkuri-2

(e) Monitoring of selected representative agricultural land-5

113. This monitoring site is located in Basherhula and the size of the plot is about 0.47 ha. Farmer of the respective plot is practicing Local Aman (Benapole) in Karif-II season last year (2013-14). Chemical fertilizer and liquid pesticides are being used in the land for crop production. In 2014-15, the farmer of this monitoring land cultivated Local aman variety Chapsail. Pest like Stem borer infestation observed in his land. Chemical fertilizer and pesticides are being used in the land for crop production. Chemical fertilizer used the following rate in his land, 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.

114. Farmer of the respective plot is practicing Local Aman (Benapole) in Karif-II season this year. He stated that, Benapole rice is salt tolerant variety. Chemical fertilizer and liquid pesticides are being used in the land for crop production. Pest like Stem borer infestation observed in his land. Chemical fertilizer and pesticides are being used in the land for crop production. Only Urea applied in his plot. Chemical fertilizer used the following rate in his land, Urea: 30kg/plot, TSP: Not applied and MP: Not applied. Stem borer infestation observed in his land. To protect crop from pest infestation granular pesticide Karate applied @500ml/plot. Detailed cropping pattern is shown in the **Table 7.2**

Table 7.2: Existing cropping pattern of monitoring agriculture land

Monitoring agriculture land	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 land-1	Fallow	Local Aman	Fallow	Fallow	HYV Aman	Fallow	Fallow	HYV Aman	Fallow
Monitoring agriculture land-2	Fallow	HYV Aman	Fallow	Fallow	Local Aman	Fallow	Fallow	HYV Aman	Fallow
Monitoring agriculture land-3	Fallow	Local Aman	Fallow	Fallow*	Fallow*	Fallow*	Fallow*	Fallow*	Fallow*
Monitoring agriculture land-4	Fallow	Local Aman	Fallow	Fallow*	Fallow*	Fallow*	Fallow*	Fallow*	Fallow*
Monitoring agriculture land-5	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 *Fallow-Shrimp/Fish culture

7.1.7 Crop Production

115. Crop production varies from plot to plot and variety to variety due to fertility status and management practices of the land. For this reason, the production level of the plots is not same. The highest production was observed in selected representative agricultural land-2 because HYV aman is cultivated in this plot only while in others plot local Aman was cultivated in 2013-14. Of these monitoring agricultural lands, farmers of Chakgona and Kapalirmet could not cultivate crops in 2014-15. Highest production (1.4 tons) observed in selected representative agricultural land-1 and lowest (0.57 tons) observed in monitoring land-5. The crop production of the monitoring lands shall be monitored in April 2016. Detailed information on crop production in monitoring plots is presented in the **Table 7.3**.

Table 7.3: Results of crop production monitoring

Monitoring Plots	Crop Production								
	2013-14			2014-15			2015-2016		
	Kharif I (Mar-Jun)	Kharif II (Jul-Oct)	Rabi (Nov-Feb)	Kharif I (Mar-Jun)	Kharif II (Jul-Oct)	Rabi (Nov-Feb)	Kharif I (Mar-Jun)	Kharif II (Jul-Oct)	Rabi (Nov-Feb)
Monitoring agriculture land -1									
Production (Ton/Plot)	-	0.8*	-	-	1.4*	-			
Yield (ton/Ha)	-	1.9*	-	-	3.5*	-			
Monitoring agriculture land- 2									
Production (Ton/Plot)	-	2.4*	-	-	1.1	-			
Yield (ton/Ha)	-	2.6*	-	-	1.7*	-			
Monitoring agriculture land- 3									
Production (Ton/Plot)	-	0.2*	-	-	-	-			
Yield (ton/Ha)	-	1.6*	-	-	-	-			
Monitoring agriculture land- 4									
Production (Ton/Plot)	-	0.6*	-	-	-	-			
Yield (ton/Ha)	-	1.9*	-	-	-	-			
Monitoring agriculture land-5									
Production (Ton/Plot)	-	0.8*	-	-	0.57*	-			
Yield (ton/Ha)	-	1.8*	-	-	1.9*	-			

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

7.1.8 Crop damage

116. There was no crop damage noticed in any monitoring land in 2013-14. The owners of the agriculture monitoring land-1(Baranpara), agriculture monitoring land-2(Chunkuri-2) and agriculture monitoring land-5(Basherhula) were cultivated HYV and Local Aman crops in this Kharif-II season (2014-15). The rest land (Kapalirmet and Chakghona) remains fallow due to adverse impact of salinity. Crop damage was observed in land-2(About 0.33ha) and monitoring land-5(About 0.17ha). This is happened due to pest infestation in these two

lands. Leaf roller observed in monitoring land-2 and Stem borer, Rice hispa and Rat observed in monitoring land-5. Total 0.52 tons crop production was loss from 0.50 ha lands.

117. The monitoring land (Kapalirmet and Chakgona) also remains fallow this year (2015-16) due to adverse impact of salinity. The crop damage of the monitoring lands shall be monitored in April 2016. Detailed crop damage information is presented in **Table 7.4**.

Table 7.4: Results of crop damage monitoring

Monitoring site	2013-14			2014-15			2015-16		
	Area (ha)	Prod. (tons)	Causes	Area (ha)	Prod (tons)	Causes	Area (ha)	Prod (tons)	Causes
Monitoring agriculture land-1	-	*Not found	-	-	-	-			
Monitoring agriculture land-2	-	*Not found	-	0.33*	0.4*	E			
Monitoring agriculture land-3	-	*Not found	-	-	-	-			
Monitoring agriculture land-4	-	*Not found	-	-	-	-			
Monitoring agriculture land-5	-	*Not found	-	0.17*	0.12*	E			
Total	-	-	-	0.50*	0.52*				

Source: Based on field information, April 2014 and April 2015, A: water logging due to heavy rainfall, B: water logging due to internal river water, C: water logging, D: Salinity, E: Other (Pest infestation)

8 Fisheries Resources Monitoring

118. Fisheries resources have been monitoring by quarterly for three years. The monitoring study has already covered four quarters of first year (2014-2015), and two quarters of second year (2015-2016). The report is prepared for third quarter of the second year monitoring and the period of the study was 4 to 14 October, 2015. This report contains the result of the third quarter monitoring along with earlier six quarters.

8.1 Monitoring Location

119. The monitoring activities are being carried out at ten locations - (i) Akram Point, at the confluence of the Passur and the Sibsa, (ii) Haldikhali, (iii) Charapuntia, (iv) Bhadra, (v) Harbaria, (vi) Chandpai, (vii) Jongra, (viii) Mongla Point, (ix) Baro Durgapur and (x) Chalna Point, Botiaghata. The sampling sites are detailed out in **Table 8.1**.

Table 8.1: The Sampling Locations for Fisheries Resources Monitoring

Site	Habitat Location	North	East	Habitat (River /Khal)	Area (ha)
Capture Fish Habitat					
A	Akram Point	21° 56' 40.8''	89° 35' 5.6''	Kukilmoni Khal	3
B	Haldikhali	22° 00' 38.9''	89° 33' 29''	Haldikhali Khal	4
C	Harbaria	22° 17' 24.4''	89° 37' 17.2''	Harbaria Khal	2.4
D	Chandpai	22° 21' 53.7''	89° 38' 25.8''	Sheola Khal	3
E	Mongla Point	22° 27' 50.9''	89° 35' 6.9''	Passur River	2.4
F	Maidara	22° 34' 29.1''	89° 33' 28.4''	Mouth of Moidhara River	4
G	Chalna Point, Botiaghata,	22° 36' 15.3''	89° 31' 36.4''	Passur River	0
Sub-total =					19
Shrimp/Fish Farm					
1	Bhekatkhali Khal, Rajnagar	22° 36' 17.0''	89° 34' 24.9''	Shrimp farm	42.09
2	Kapashdanga-Muralia	22° 37' 34.4''	89° 33' 14.5''	Shrimp farm	115.7
3	Chunkuri-2	22° 34' 49.3''	89° 32' 38.2''	Shrimp/fish farm	6.07
Sub-total =					163.86
Grand-total =					182.86

8.2 Methods, Tools and Techniques of Monitoring

8.2.1 Fish Habitat Status Monitoring

120. The following indicators have been monitored to understand the fish habitat status and quality: (i) water quality; (ii) bed material; (iii) hydrological condition; (iv) morphological aspects; (v) vegetation cover etc. These indicators would present the maximum natural capability of habitats to provide healthy habitat for fish and other aquatic organisms, edible quality fish safe for human consumption, or to support growing microorganisms upon which fish depends. These issues are also important for understanding the condition of spawning and nursery grounds. Length-wise distribution of different fish species have been analyzed to identify major behavioral fish habitat by sampling sites. The length of different life stages of fish species was identified and collected from

literature (Bhuiyan A. L. (1964), Rahaman A.K.A (2005) and Talwar P. K and Jhingran (1991). The similarity in species composition among the sites are analyzed using the Jaccard index (JI)¹ for estimating the extent of similarity between pairs of data sets. The linkage distance was estimated with the similarity in species distribution.

121. Moreover, Habitat Suitability Index (HSI) has been determined for the year 2014 and 2015. The same thing will be done for the year 2016. The data for basic life requirements for fish community are shown in **Table 8.2** which are compiled at the end of each monitoring year. The HSI will be calculated from the data of basic life requirements for fish community for a complete year. Once the monitoring of the fourth quarter is completed, the HSI value will be calculated and then analyzed by plotting this data with the survival curve of the fish community structure. The objective of the model is to produce an index between 0 and 1 that has a positive relationship to survival success of sampled individuals of different life stage (fry-brood fish).

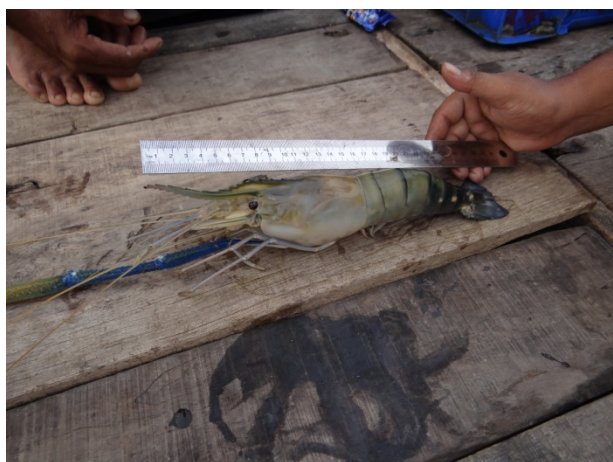
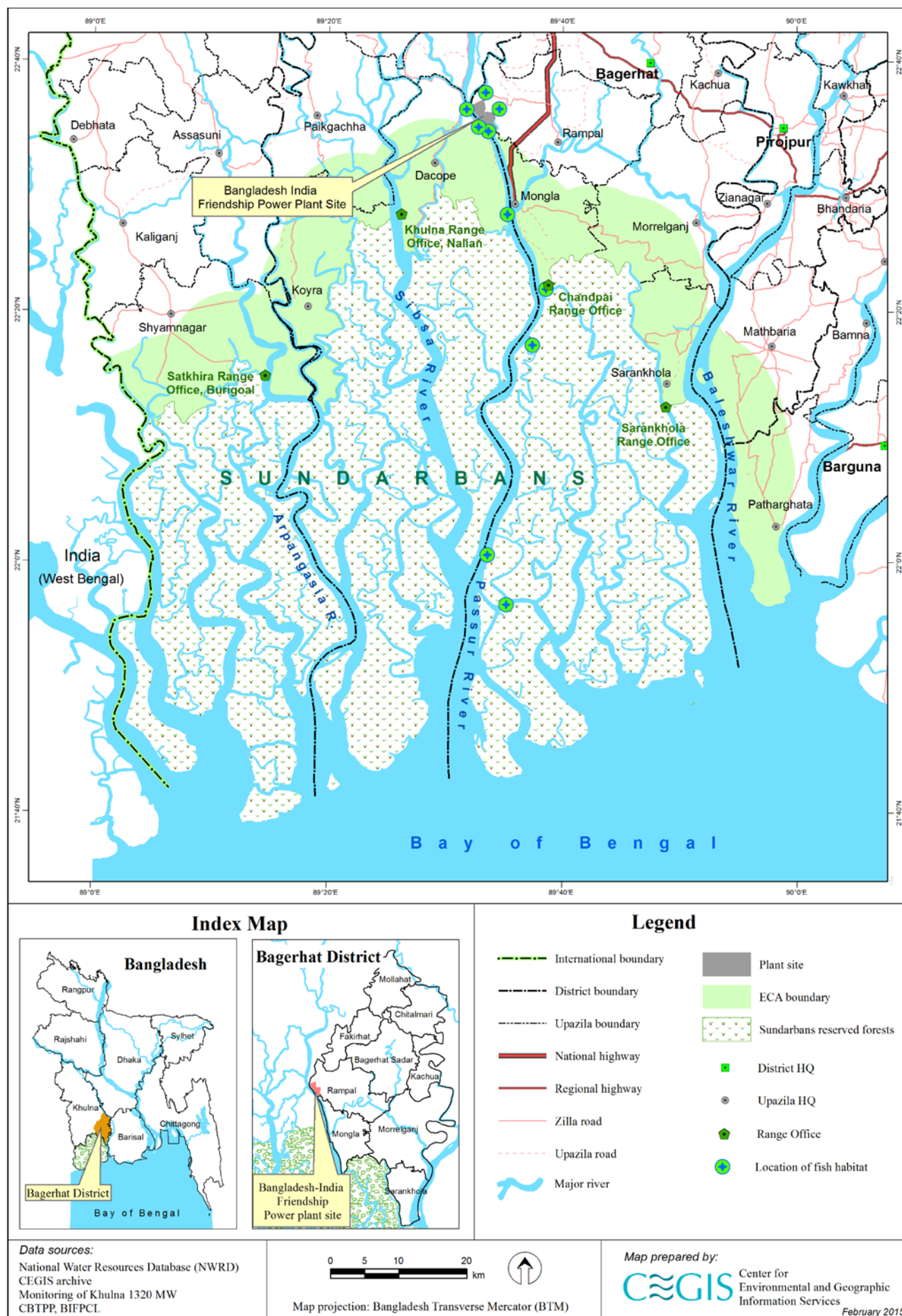


Photo 8.1: Measuring prawn size at Akram Point



Photo 8.2: Interviewing fishermen at Harbaria

¹The Jaccard similarity (Jaccard 1902, Jaccard 1912) is defined as the quotient between the intersection and the union of the pairwise compared variables among two objects. The Jaccard similarity or Jaccard similarity coefficient is often called Jaccard index. In the equation d^{JAD} is the Jaccard distance between the objects i and j .



Map 8.1: Fisheries Resources Monitoring Locations

Table 8.2: 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							
	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							

Table 8.2: Data for Basic life Requirements for a Good Fish Community (*continued*)

Life Requirements	Variable SI.	Habitat Variables	A	B	C	D	E	F	G
	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							

122. The first associated information shown in the above table has already been collected for the month of April, 2015, July 2015 and October, 2015 at the selected sites. However, the HSI value will be estimated for the entire year after getting all information on survival rate of different life stages.

8.2.2 Fish Migration

123. Information on fish migration has been collected from and observed at the selected sites along the water ways generally used by the ships and cargos for carrying all sorts of goods including coal. Issues like migratory fish species diversity, migration pattern, migration purpose, period and extent of migration etc. have been investigated. Migratory species have been identified by analyzing the common species found in the catch assessment survey from the sampling sites. Only Age-1 to Brood fish has been allowed to interpret the migration pattern and purpose. The migration extent has been identified through analyzing the length of fishes among sampling sites.

8.2.3 Fish Biodiversity

124. Fish species diversity and composition has been selected as an indicator for fish monitoring. In the context of fish biodiversity, the vulnerable to critically endangered fish species (enlisted by IUCN), fish densities and catch composition of different strata (Vertical and Horizontal) in the selected habitats have been given emphasis to monitor quarterly. Fish biodiversity has been surveyed by Catch Per Unit Effort (CPUE) method. Gears have been selected on the basis of on-going fishing activities. The fish individuals were then counted according to the length of each species from the samples. Diversity has been estimated by analyzing Shannon-Weiner Index². This index generates values between 0 and 1. Shannon-Weiner Index classifies the diversity as –

- 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)

²The Shannon is the most widely used species diversity indices for examining overall community characteristics. It is derived from a function used in the field of describing the average degree of uncertainty of predicting the species of an individual picked at random from the community. The uncertainty of occurrence increases both as the number of species increases and as the individuals are distributed more and more evenly among the species already present. The value of this index ranges from 0 to 1. According to this 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).

125. Fish species richness (FSR) has been analyzed using the Simpson's Index generating two types of values. The first one includes values between 0 (having only one species in the sample) and one (01) (having more than one species with same proportion) indicating general richness of the observed species distribution. The second one includes values that start from one (01) (having only one species in the sample) to equal to the total number of species found in the sample. Fish community structure has been analyzed through counting the length-wise fish individuals.

8.2.4 Fish-Shrimp Culture Practice

126. 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.

8.2.5 Fish Production

127. 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.

8.3 Outcome of 3rd Quarter Monitoring of the 2nd Year (2015)

128. Followed by the second quarter monitoring of the second year, third quarter monitoring has been conducted during the period of 4 to 14 October, 2015.

8.3.1 Fisheries Resources

129. Fisheries resources for the monitoring study are identified as riverine fisheries, resident fish species and shrimp/fish farming. Based on these resources, the fisheries monitoring survey has been devised and conducted in different sampling sites comprising both capture and culture fisheries. The capture fish habitat includes major fishing grounds in the Passur River System. The estimated total area of capture fish habitat is about 183 ha. The culture fish habitat includes three shrimp/fish farms, which are situated in a range of 0.5-1 km distance from the proposed Power Plant boundary. The farms were selected for monitoring on the basis of the probable dispersion of fly ash from the Plant in its operation stage. The culture fish habitat is about 164 ha in total. The fishing activities in the Passur River System (shown in **Photo 8.1**) generally depend on the lunar phase and tide condition. The survey, therefore, has been conducted in the morning to find low tide condition when large scale fishing is made.

130. Fishes are generally become less abundant during high tide condition in this system. In some locations, survey was conducted during high tide as it was not possible to reach that places timely due to accessibility and safety concerns.

8.3.2 Features to be considered

Following features are considered in conducting the fisheries monitoring:

- The Passur River System, the lone capture fishery, has been aggrading due to siltation, oil spillage and other pollutants from the running and sunken vessels
- Reduction of upstream fresh water flow
- Risk to aquaculture farms from river bank erosion and tidal surge

- Fishing mortality because of indiscriminate activities (e.g. during catching of PL of tiger shrimp many other fries are also damaged)
- Dominancy of fish diversity during lunar phase and tide condition.

8.3.3 Fish Habitat Status

(a) Habitat Classification

131. 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 are identified and collected from literature. Linkage distance was then calculated with the similarity in distribution. The entire reach of the Passur River System consists of three major behavioral habitats. The sampling sites have been classified (shown in the **Figure 8.1**) on the basis of abundance of different life stages of fish species in those habitats.

132. 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 be shifted to some extent. In fourth monitoring phase in the month of January 2015 three habitats – i) Grazing ground, ii) Grazing and Breeding ground; and iii) Spawning, Nursery and Grazing ground 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 (August, 2015) two habitats have been identified as: i) Grazing and breeding ground and ii) Spawning and Nursery ground.

133. During the monitoring three habitats – i) Grazing ground, ii) Nursery ground and iii) Grow out and Feeding ground have been identified as shown in the **Figure-8.1**.

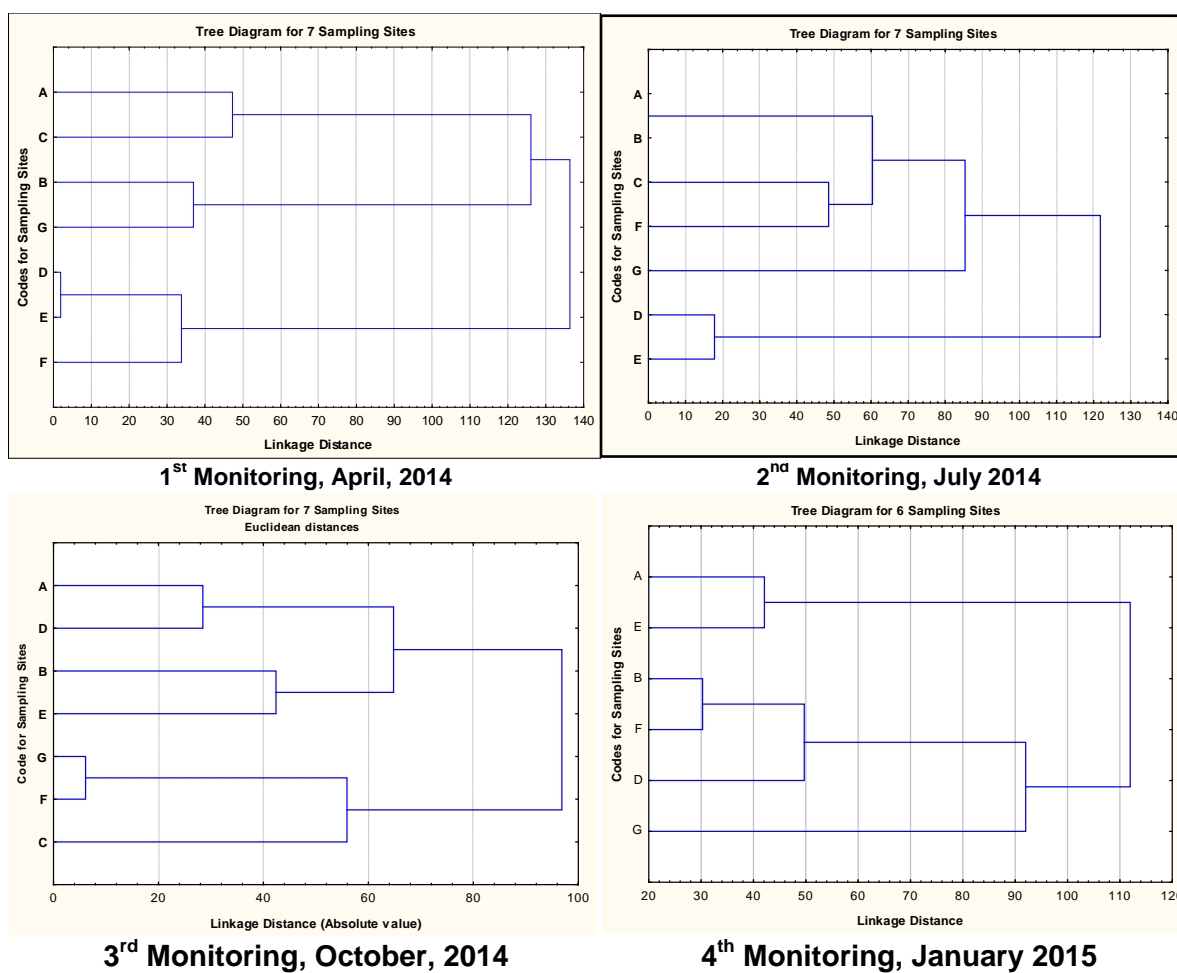
134. **Grazing Ground:** The Haldikhali Khal (B) and Chalna Point (G) of the Passur River respectively have been identified as the grazing ground in the Passur River System during this quarter.

135. **Nursery Ground:** Among the sampling sites, the Kukilmoni Khal at Akram Point (A), Harbaria Khal (C) and even Mongla-Passur confluence (E) are identified as the nursery ground.

136. **Grow out and Feeding Ground:** Among the sampling sites, the Sheola Khal at Chandpai (D) and Maidara-Passur confluence (F) are similar in the distribution of life stages from first aged juvenile to adult fish. These habitats are classified as grow out and feeding ground as first aged juvenile use such habitats for their growth.



Photo 8.3: Fish habitat in the Passur River System

Figure 8.1: Habitat Classification on the basis of Different Life Stages of Fish Species (*continued*)

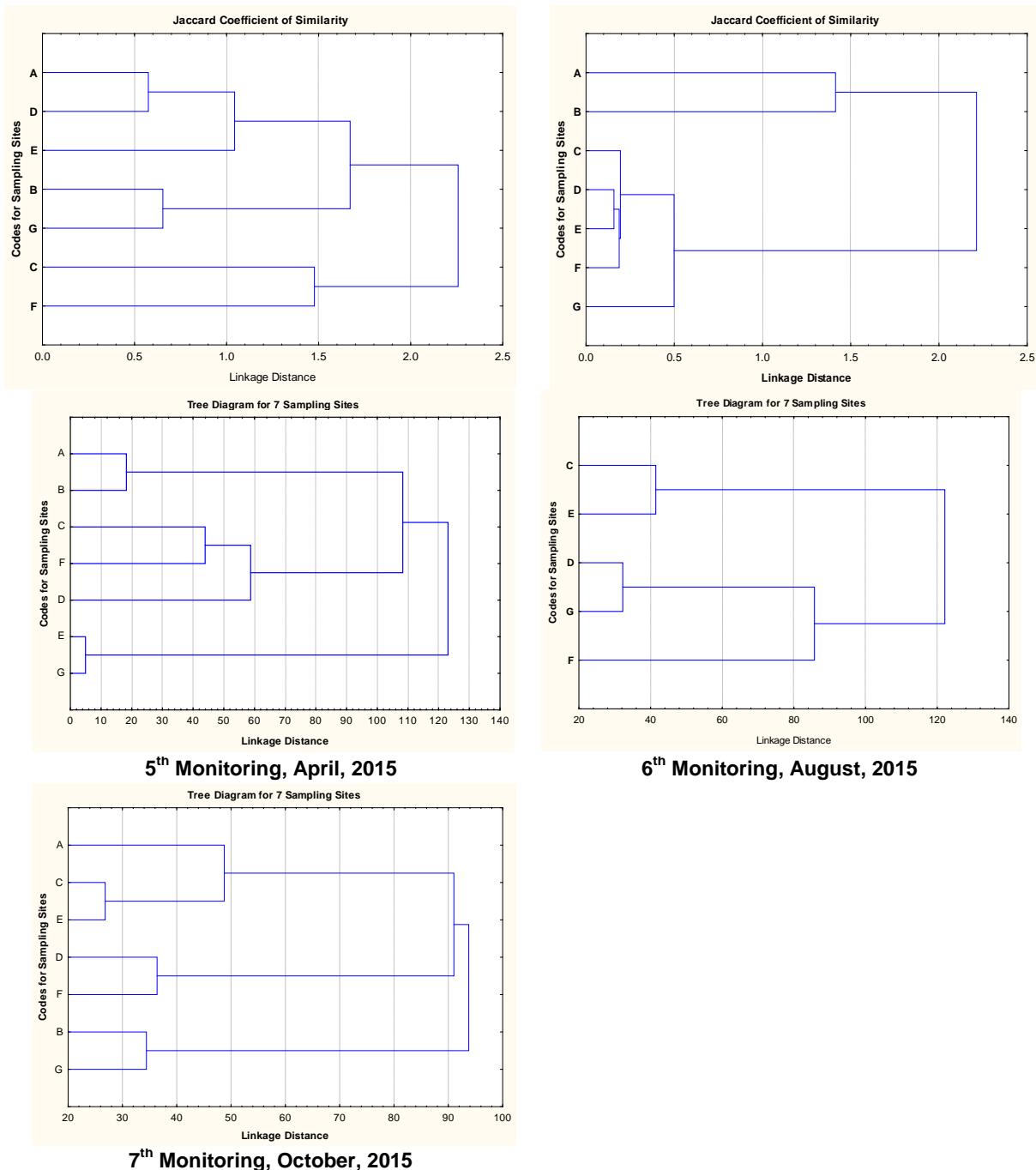


Figure 8.1: Habitat Classification on the basis of Different Life Stages of Fish Species

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

137. This figure analyses the distances among the JI (Jaccard Coefficient Index) indices which are opposite to the JI values. The length-wise distribution relationship among the sampling sites was also found different between first, second and third quarter of the second monitoring year (2015). In the third quarter of the year of 2015, the JI coefficient value between C and E sampling sites was the highest and indicating very closely similar in fish species distribution (**Figure 8.2**).

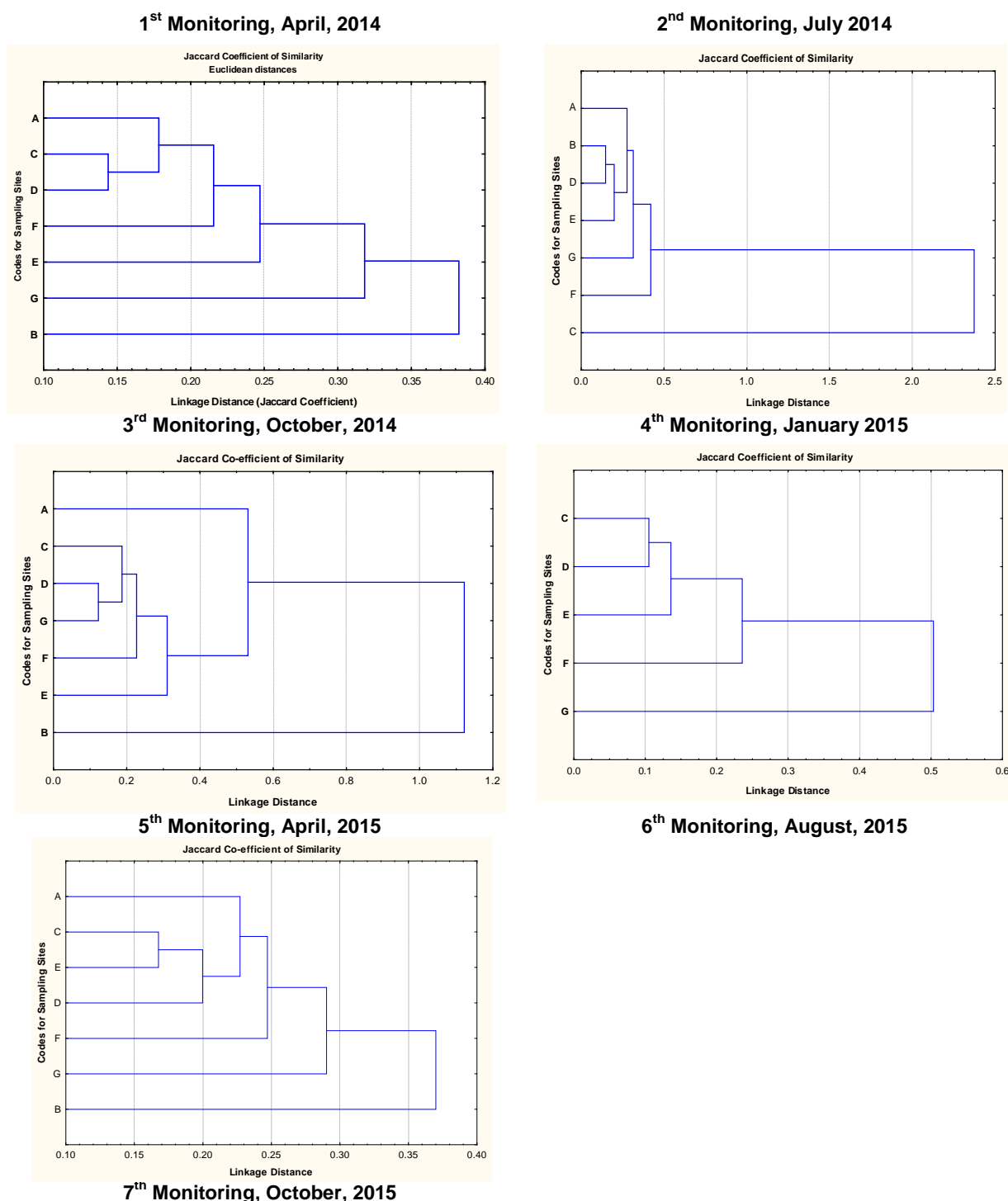


Figure 8.2: Dendrogram Showing Similarity in Binary Species Composition in seven sampling sites

(b) Habitat Suitability Index (HSI)

138. 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 considered under this model has been normalized using UNDP developed normalization equation (UNDP, 2006).

139. Sheola khal at Chandpai has been found as the most suitable habitat for fish species among the selected sampling sites in the Passur River System, followed by Haldikhali, Akram Point, Mongla Point, Harbaria, Maidara and Chalna Point (**Table 8.3**).

Table 8.3: 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		
B	Haldikhali	0.408		
C	Harbaria	0.226		
D	Chandpai	0.520		
E	Mongla Point	0.321		
F	Maidara	0.224		
G	Botiaghata, Chalna Point	0.218		

**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

8.3.4 Fish Bio-diversity

140. Fish biodiversity has been surveyed by CPUE method. Gears have been selected on the basis of ongoing fishing activities. Then the fish individuals were counted based on the length of each species from the samples. Diversity has been estimated by analyzing Shannon-Weiner Index.

a) Shannon-Weiner Index

In the third quarter monitoring of second year (2015), highest Shannon-Weiner index has been found at Mongla Point (0.85) indicating most evenly distributed fish species. On the contrary, lowest evenness has been found at Sheola Khal at Chandpai (shown in the **Table 8.4**). It is noted here that in spite of being the most suitable habitat in the Passur River System for highest number of fish species, Sheola Khal at Chandpai has shown lowest species evenness. This is because of having lowest fish species richness of major number of fish species which results from over dominance of Motka and Katali Chingri. Moreover, it is observed that biological interchange period from fresh water dominant fish species to stenohaline fish group (Saline tolerate limit: 5-25ppt) and most of the freshwater fish species may move towards upstream and the latter group start to move from downstream to upstream through Sheola Khal. And it may can create an opportunity for Motka and Katali Chingri to increase their dominance over the other observed fish species.

Table 8.4: Site Wise Species Diversity using Shannon–Weiner Index

Site	Species No												Shannon-Weiner Index*											
	1 st QM	2 nd QM	3 rd QM	4 th QM	5 th QM	6 th QM	7 th QM	8 th QM	9 th QM	10 th QM	11 th QM	12 th QM	1 st QM	2 nd QM	3 rd QM	4 th QM	5 th QM	6 th QM	7 th QM	8 th QM	9 th QM	10 th QM	11 th QM	12 th QM
A	33	0	13	7	3	-	10						0.49	0	0.73	0.57	0.96	-	0.55					
B	12	0	24	14	0	-	11						0.85	0	0.57	0.39	0.00	-	0.56					
C	2	12	9	0	11	26	18						0.29	0.77	0.40	0.00	0.78	0.59	0.54					
D	12	22	15	26	27	24	20						0.31	0.78	0.73	0.51	0.65	0.72	0.51					
E	7	13	10	11	6	16	9						0.38	0.60	0.76	0.77	0.15	0.73	0.85					
F	3	13	6	4	10	8	14						0.82	0.77	0.54	0.60	0.67	0.39	0.77					
G	6	3	5	7	18	3	8						0.68	0.82	0.72	0.66	0.18	0.95	0.72					

*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)

141. Fish species richness has been identified through Simpson's Index³. Considerable difference was noticed in the fish species richness (FSR) in different habitat classes (**Table 8.5** and **Figure-8.3**).

142. In this monitoring phase, maximum FSR was obtained in Mongla Point and Maidara Point (n=4), while very low FSR was recorded in other sampling sites (n=3). Among habitats in upstream reaches of the Passur river, Mongla Point was home to a rich assemblage of Tit Gulsha Tengra, Horina Chingri, Pheksa and Poma; Maidara River at Baro Durgapur of Gulsha Tengra, Nilotica, Paissa and Tilapia and at Chalna Point of Poma, Tapsi and Tular Dandi. Among habitats in lower stream portions, Chandpai was rich in Bairagi, Katali Chingri and Motka Chingri, Harbaria in Katali Chingri, Motka Chingri and Mud Crab, Haldikhali Khal in Gagra Tengra, Motka Chingri and Paissa and Akram Point in Chaka Chingri, Motka Chingri and Poma.

Table 8.5: Site wise Rich Species Number

Site	Location	No. of Rich Species											
		2013-2014				2014-2015				2015-2016			
		1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th
A	Akram Point	4	0	4	3	3	-	3					
B	Haldikhali	7	0	4	2	0	-	3					
C	Harbaria	1	5	2	0	4	4	3					
D	Chandpai	2	2	5	4	5	8	3					
E	Mongla Point	1	10	4	5	3	6	4					
F	Maidara at Baro Durgapur	3	6	2	2	4	2	4					
G	Batiaghata, Chalna Point	3	3	2	3	1	3	3					

³Simpson'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 to measure the species richness in the sampling sites.









	
Rupchanda in 1 st Quarter, 2014 Monitoring	Chela in 2 nd Quarter, 2014 Monitoring
	
Phesa, Chela, Hilsa, Gagla Tengra	Harina Chingri
Fish Species at 3 rd Quarter, 2014 Monitoring	
	
Amadi Chela	Banspata
Fish Species in Upstream of Passur River at 4 th Quarter, 2014 Monitoring	
	
Adult Poma in Chalna Point	Fry of Bagda at Chalna Point
Fish species found in 1 st quarter of the 2 nd monitoring year (2015)(continued)	

Photo 8.4: Length-wise distribution of fish species (continued)









	
Meth and Gagra Tengra	Gagra Tengra
Fish species found in 1st quarter of the 2nd monitoring year (2015)	
	
Mutmure and Paissa	Khorsula
	
Menu	Vetki
Fish species found in 2nd quarter of the 2nd monitoring year (2015)	
	
Gulsha Tengra, Bele, Aswine Bele and Paissa	Gangania
Fish species found in 3rd quarter of the 2nd monitoring year (2015)(continued)	

Photo 8.4: Length-wise distribution of fish species (continued)

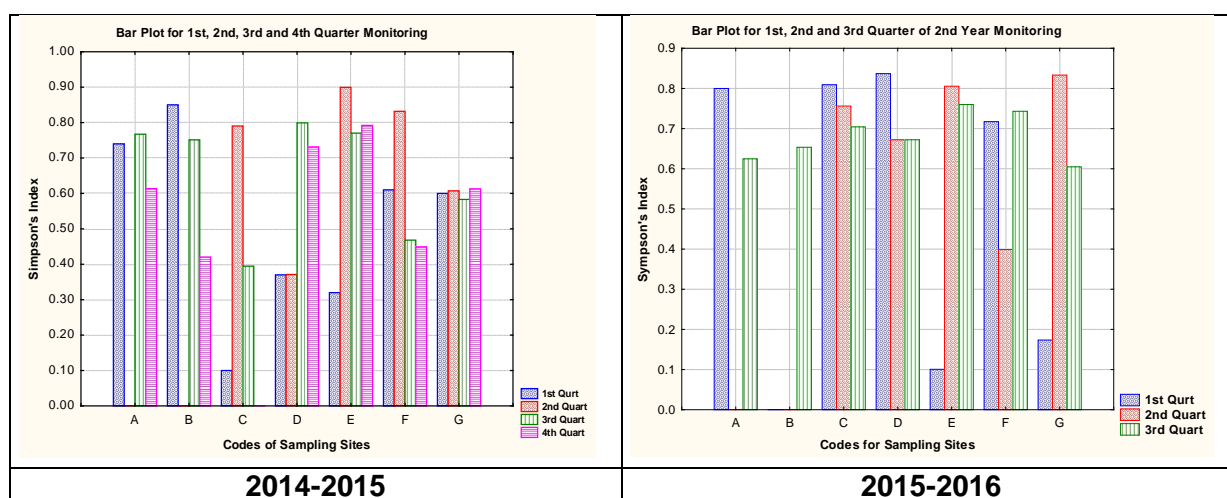


Figure 8.3: Site-wise fish species richness (FSR) in the Passur River System.
(FSR is identified through Simpson's Index)

c) Fish Community Structure

143. Fish community structure has been analyzed through counting the length-wise fish individuals (**Photo 8.2**). The following **Table 8.6&8.7** and **Figure 8.4** shows that juveniles for fin fish were more widely distributed among the upper, middle and lower reaches of the Passur River. Among these Bele and Paissa fishes were widely distributed among the sampling sites. However, brood female of Hilsa has been observed in Sheola Khal at Chandpai, Banspata and Tapsi in Passur at Chalna Point in third quarter monitoring of 2nd year (2015) in the month of October. Moreover, Harbaria has been found as the harbor of brood Katali and Moukatali Chingri. Furthermore, some culture fish species (like Tilapia and Nilotica) have been found in the Passur river system at Maidara Point which has been reported as the result of being over topping of the cultured ponds caused due to tidal surge.

Table 8.6: Occurrence of Species

Local Name	Scientific Name	Local Status*	1 st QM	2 nd QM	3 rd QM	4 th QM	5 th QM	6 th QM	7 th QM	8 th QM	9 th QM	10 th QM	11 th QM	12 th QM
			‘-’ = No; ‘+’ = Occurrence											
Amadi Chela	<i>Chela sp.</i>	DD	-	-	+	+	+	-	+					
Hilsa	<i>Tenuulosa ilisha</i>	NO	-	-	+	-	-	+	+					
Sagor Baim	<i>Anguilla bengalensis</i>		+	-	-	-	-	-	-					
Baim	<i>Pisodonophis cancrivorus</i>	NT	-	-	-	-	-	+	-					
Bacha	<i>Eutropiichthys vacha</i>	CR	+	-	-	-	-	-	-					
Bagda Chingri	<i>Penaeus monodon</i>	DD	+	+	+	+	+	+	+					
Banspata	<i>Brachypleura novae-zeelandiae</i>	NO	+	+	+	+	-	+	+					
Kukurjib	<i>Cynoglossus lingua</i>	NO	+	-	-	-	-	-	-					
Bele	<i>Glossogobius giuris</i>	NO	+	+	+	+	+	+	+					
Aswine Bele		NO	-	-	-	-	-	-	+					
Boiragi	<i>Coilia dussumieri</i>	NO	+	+	+	+	+	+	+					
Boishakhi Chingri		NO	-	+	-	-	+	+	+					
Chammu Chingri	<i>Metapenaeus brevicornis</i>	DD	+	+	+	-	+	+	+					
Chaka Chingri	<i>Penaeus indicus</i>	DD	+	+	-	+	+	+	+					
Ghora Chela	<i>Securicula gora</i>	-	+	-	-	-	-	-	-					
Chanda Chela			-	+	+	-	-	-	-					
Chitra			+	-	-	+	+	+	-					
Khayra Chela			-	+	-	-	-	-	+					
Sada Chewa	<i>Trepauchen vagina</i>	NO	+	-	+	-	-	+	-					
Lal Chewa	<i>Odontamblyopus rubicundus</i>	NO	+	+	+	+	+	+	+					
Chhuri	<i>Trichiurus muticus</i>	NO	+	-	+	-	-	-	-					
Sagor Chela	<i>Megalops cyprinoids</i>	NO	+	-	-	-	-	-	-					
Purabi Chela	<i>Thryssa purava</i>	NO	+	-	-	-	-	-	-					
Kabashi Tengra	<i>Mystus cavasius</i>	DD	+	-	-	-	-	-	-					
Gagra Tengra		DD	-	+	+	-	+	-	+					
Gulsha Tengra	<i>Mystus bleekery</i>	DD	+	+	-	+	-	+	+					
Harina Chingri	<i>Metapenaeus ensis</i>	DD	+	+	+	+	+	+	+					
Ekthuto	<i>Hyporhamphus limbatus</i>	NO	+	-	+	+	-	-	-					
Kakila	<i>Xenentodon cancila</i>	NO	+	-	-	-	-	-	-					
Chapila	<i>Gudusia chapra</i>	NO	+	+	-	-	-	-	-					
Kuchia	<i>Monopterusuchia</i>	DD	+	+	-	+	+	+	+					
Kain Magur		EN	-	+	+	+	+	+	+					
Loitta	<i>Harpodon nehereus</i>	NO	+	+	+	-	+	-	-					
Motka Chingri	<i>Macrobrachium villosimanusless</i>	DD	+	+	+	+	+	+	+					
Mud Crab	<i>Scylla serrata</i>	NO	+	-	+	+	+	+	+					
Tular Dandi	<i>Sillaginopsis panijus</i>	NO	+	-	+	-	+	-	+					
Paيرا Chanda	<i>Scatophagus argus</i>	DD	+	-	-	-	-	-	-					
Paissa	<i>Liza parsia</i>	NO	+	+	+	+	+	+	+					
Pangas	<i>Pangasius pangasius</i>	CR	+	-	+	-	-	-	-					
Tak Chanda	<i>Leiognathus equulus</i>	NO	+	-	-	-	-	-	+					
Phessa	<i>Setipinna phasa</i>	NO	+	+	+	+	+	+	+					
Teli Phessa	-	-	-	-	+	-	-	-	-					
Poma	<i>Poma poma</i>	NO	+	+	+	+	+	+	+					
Potka	<i>Chelonodon patoca</i>	NO	+	+	-	+	+	+	-					
Shilong	<i>Silonia silondia</i>	EN	+	-	+	-	-	-	-					
Tailla	<i>Eleutheronema tetradactylum</i>	-	+	-	-	-	-	-	-					
Tapse	<i>Polynemus paradiseus</i>	-	+	+	+	-	-	+	+					
Datina			-	-	-	+	-	-	-					
Jaba			-	-	-	+	-	-	+					
Shol	<i>Channa striatus</i>		-	-	-	+	-	-	-					
Magur	<i>Clarias batrachus</i>		-	-	-	+	-	-	-					
Koi	<i>Anabas testudineus</i>		-	-	-	+	-	-	-					
Vetki			-	-	-	+	+	+	+					
Gangania			-	-	-	+	+	-	+					

*Local Status Source: IUCN Red List

Table 8.7: 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	100	0	0	0
Bagda	Akram Point	0	0	0	0	100	0	0
Bairagi	Chandpai	0	0	0	76	24	0	0
Banspata	Akram Point	0	0	0	0	100	0	0
	Haldikhali	0	0	0	0	90	10	0
Bele	Chalna Point	0	0	0	0	0	100	0
	Harbaria	0	0	0	50	50	0	0
	Mongla -- Point	0	0	100	0	0	0	0
Chaka Chingri	Akram Point	0	100	0	0	0	0	0
Chami Chingri	Chandpai	0	0	100	0	0	0	0
	Harbaria	0	100	0	0	0	0	0
Gagra Tengra	Akram Point	0	0	0	0	0	100	0
	Haldikhali	0	0	0	0	100	0	0
Gangania	Haldikhali	0	0	0	0	100	0	0
Goda Chingri	Harbaria	0	0	0	100	0	0	0
	Maidara	0	33	0	67	0	0	0
Golda	Chandpai	0	0	0	63	0	38	0
	Haldikhali	0	0	0	0	100	0	0
	Harbaria	0	0	0	57	14	29	0
	Maidara	0	0	100	0	0	0	0
Gulsha Tengra	Chandpai	0	0	0	44	56	0	0
	Harbaria	0	0	0	100	0	0	0
	Maidara	0	0	53	47	0	0	0
	Mongla Point	0	0	0	40	60	0	0
Hilsha	Chandpai	0	0	0	0	0	60	40
Horina Chingri	Harbaria	0	100	0	0	0	0	0
	Maidara	0	0	0	100	0	0	0
	Mongla Point	0	100	0	0	0	0	0
Jaba	Chandpai	0	0	0	0	0	100	0
	Haldikhali	0	0	0	0	0	100	0
Kain Magur	Chandpai	0	0	0	0	60	40	0
	Haldikhali	0	0	0	0	95	5	0
	Harbaria	0	0	0	0	0	100	0
Katali Chingri	Akram Point	0	0	0	0	0	0	100
	Chandpai	0	100	0	0	0	0	0
	Haldikhali	0	100	0	0	0	0	0
	Harbaria	0	8	72	0	0	0	20
Khaira Ilish	Haldikhali	0	0	0	100	0	0	0
Khorsula	Maidara	0	0	0	0	100	0	0
	Mongla Point	0	0	0	0	100	0	0
Koidda	Harbaria	0	0	0	0	100	0	0
Kuchia	Chandpai	0	0	0	0	0	100	0
Lal Chewa	Chandpai	0	0	0	0	100	0	0
Motka	Akram Point	0	100	0	0	0	0	0

Table 8.7: Length-wise species distribution in sampling sites(continued)

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
Chingri	Chandpai	0	0	97	3	0	0	0
	Haldikhali	0	100	0	0	0	0	0
	Harbaria	0	100	0	0	0	0	0
Moukatali	Harbaria	0	22	0	22	0	0	56
Mud Crab	Harbaria	0	0	0	0	100	0	0
Nilotica	Maidara	0	0	67	33	0	0	0
Paissa	Akram Point	0	0	0	0	100	0	0
	Haldikhali	0	0	0	0	100	0	0
	Harbaria	0	0	0	93	7	0	0
	Maidara	0	0	33	33	33	0	0
	Mongla Point	0	0	100	0	0	0	0
Pheksa	Chalna Point	0	0	0	0	100	0	0
	Chandpai	0	0	0	0	100	0	0
	Maidara	0	0	0	40	60	0	0
	Mongla Point	0	0	0	9	27	64	0
Poma	Akram Point	0	0	0	0	100	0	0
	Chalna Point	0	0	0	0	93	7	0
	Chandpai	0	0	0	50	42	8	0
	Harbaria	0	0	0	0	75	25	0
	Mongla Point	0	0	0	88	12	0	0
Tapsi	Akram Point	0	0	0	0	100	0	0
	Chalna Point	0	0	0	0	43	0	57
	Chandpai	0	0	0	0	100	0	0
Telcupa	Harbaria	0	0	0	0	0	100	0
Tilapia	Maidara	0	0	71	21	7	0	0
Tular Dandi	Chalna Point	0	0	0	0	0	100	0
Vetki	Akram Point	0	0	0	0	0	100	0
	Haldikhali	0	0	0	0	0	100	0

Source: CEGIS field survey, 2015

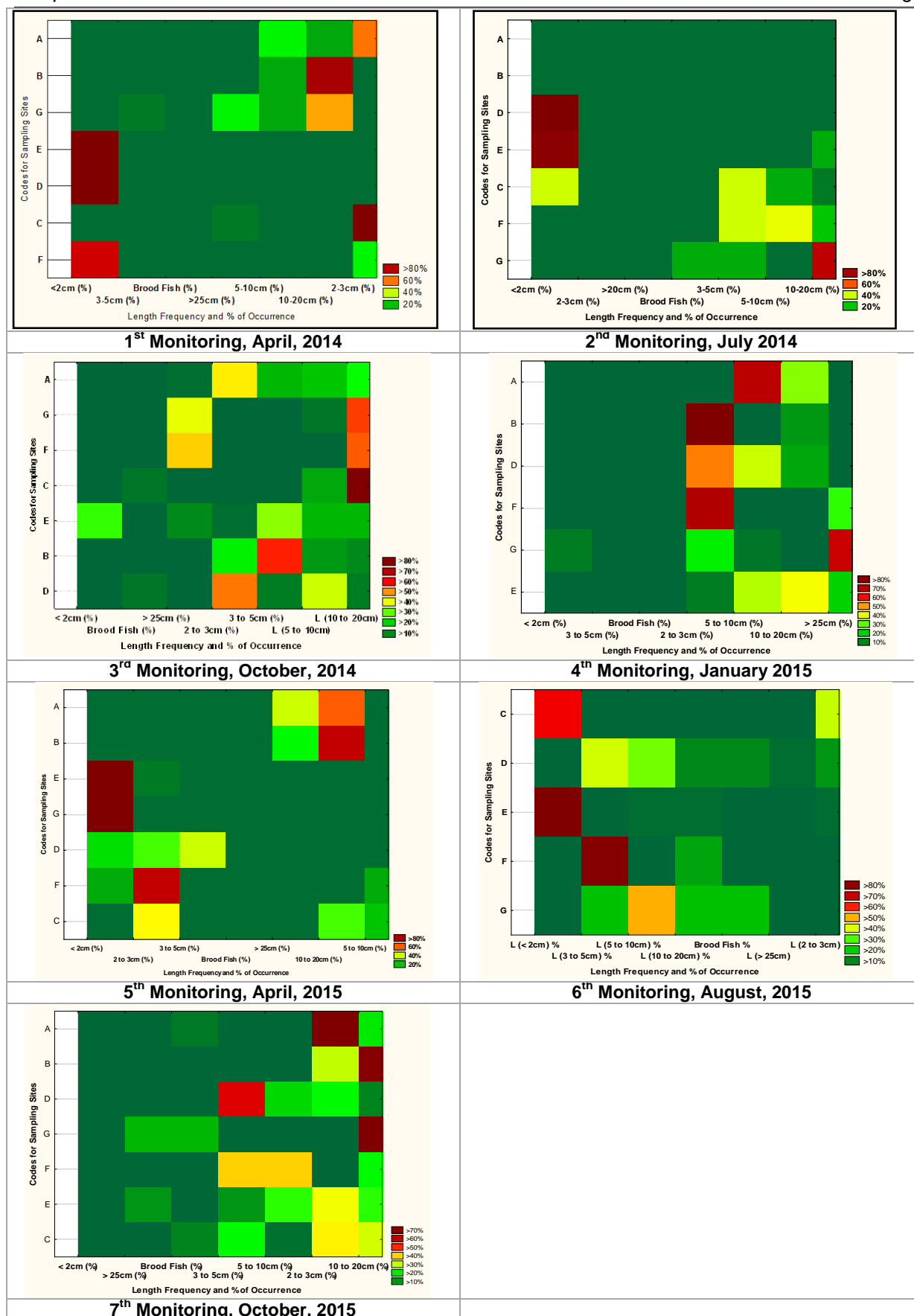


Figure 8.4: Habitat Distribution of Different Life Stages of Fish Species

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

8.3.5 Fish Migration

(a) Migratory Species Diversity

144. Migratory species have been identified by analyzing the common species available in the regular catch from the sampling sites. Fish species like Bairagi attains the maximum abundance among the migratory fish species observed in third quarter of second monitoring year. The relative abundance of the migratory species is give below in the **Figure 8.5**.

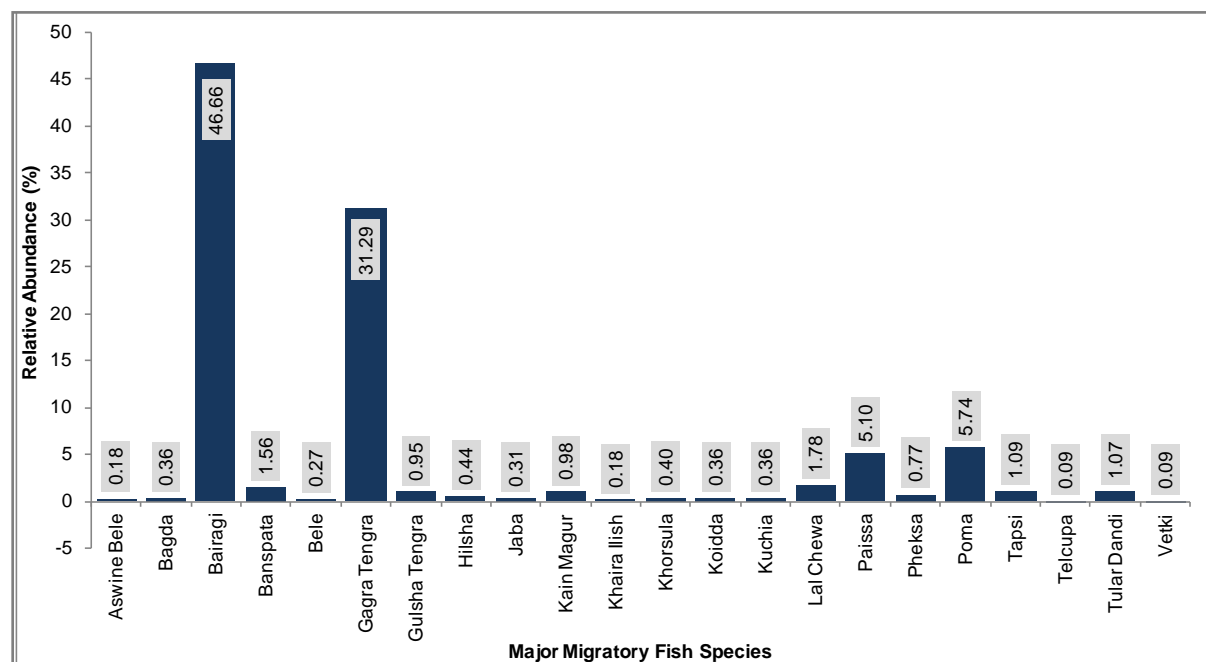


Figure 8.5: Relative abundance of major migratory fish species in sampling sites

(b) Migration Extent, Time and Purpose

145. Major fish species showed interesting pattern in distribution for exploiting different purposes mentioned in the following table all along the sampling sites. This means such fish species are migratory in nature. Four (4) fish species were found common in most of the sites. The longest distance from site to site is the distance from the Akram Point to the Chalna Point in the study reach. Only three species have been observed in this range like Poma, Gulsha Tengra and Phekssa indicating long range of distribution (**Table 8.8**).

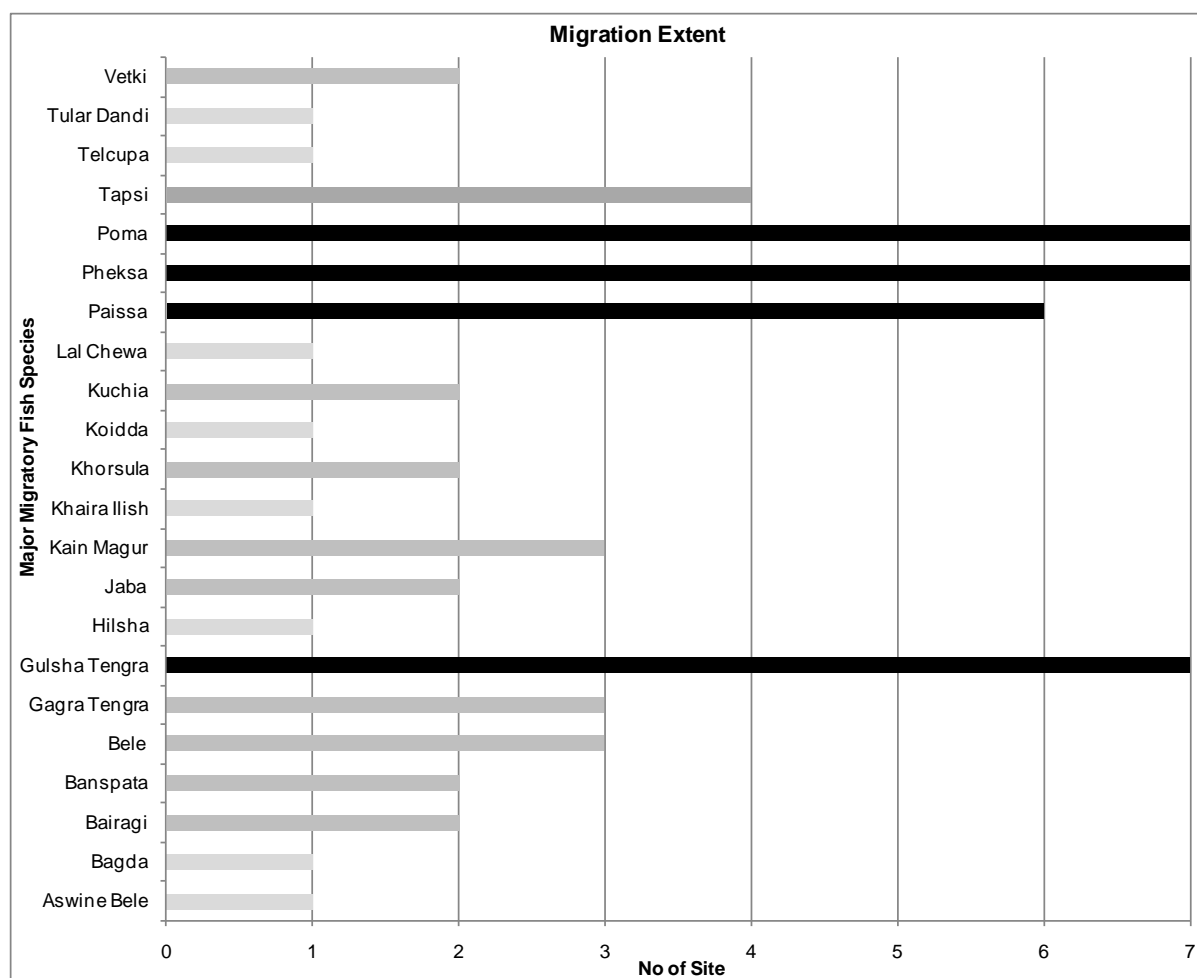


Figure 8.6: Migration extent of major migratory fish species in sampling sites

Table 8.8: 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					
	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		-	-	-	-					
		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	-	-					
	Chandpai	Fry	Breeding and Spawning	Breeding and Spawning	Feeding and Growing	Feeding	-	Feeding	-					
		Juvenile	-	-	-	-	-	-	Feeding					
	Chalna Point	Juvenile and Age-1 adult	Feeding and Growing	-	-	-	Feeding and Growing	-	-					
	Harbaria	Juvenile	Feeding and Growing	-	-	-	-	Feeding	-					
	Mongla Point	Fry	-	Nursing	-	Feeding	-	-	-					
	South-west of the Project	Juvenile	-	Feeding and Growing	-	-	-	-	-					
Chapila	Haldikhali	Juvenile	Feeding and Growing	-	-	-	-	-						

Table 8.8: Purpose, timing and extent of migration for different year-class of migratory fish species(continued)

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	-	-					
Poma	Haldikhali	Juvenile	Feeding and Growing	-	-	Feeding	-	-	-					
	Akram Point	Juvenile	Feeding and Growing	-	-	-	-	-	-					
	Akram Point	Age-1 adult	-	-	Feeding and Growing	-	-	-	Feeding					
	Chandpai	Fry and Juvenile	Breeding and Spawning	Nursing	-	-	-	Feeding	-					
	Chandpai	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	-					
	Mongla Point	Fry, Juvenile and Age-1 adult	-	-	Spawning, Feeding and Growing	-	-	-	-					
		Juvenile	-	-	-	-	-	-	Feeding and Growing					

Table 8.8: Purpose, timing and extent of migration for different year-class of migratory fish species(continued)

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)
		Age-1 Adult	-	-	-	-	-	-	Feeding					
		Adult	-	-		Feeding	-	Feeding	-					
	South-west of the Project	Adult	-	-	Feeding	Feeding	-	Feeding	-					
	Chalna Point	Juvenile, Adult and Brood Fish	Breeding and Spawning	-	-	-	-	-	-					
	Chalna Point	Juvenile and Adult	-	-	Feeding and Growing	Feeding	Feeding and Growing	-	Feeding and Growing					
Chhuri	Haldikhali	Adult	Feeding	-	Feeding	-	-	-	-					
	Akram Point	Adult	Feeding	-	Feeding	-	-	-	-					
Chela	Haldikhali	Adult	Feeding	-	Feeding	-	-	-	-					
	Akram Point	Juvenile and Adult	Feeding and Growing	-	-	-	-	-	-					
	Harbaria	Juvenile	-	Feeding and Growing	-	-	-	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	-	-					
Gulsha Tengra	Haldikhali	Adult	Feeding and Breeding	-	-	-	-	-	-					
	Akram Point	Adult	Feeding and Breeding	-	-	-	-	-	-					

Table 8.8: Purpose, timing and extent of migration for different year-class of migratory fish species(continued)

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	Age-1 adult	-	-	-	Feeding	-	Feeding	Feeding and Growing					
		Juvenile	-	-	-	-	-	-	Feeding and Growing					
	Mongla Point	Age-1 adult	-	Feeding and Growing	-	Feeding	-	Feeding	Feeding					
		Juvenile	-	-	-	-	-	-	Feeding and Growing					
	Harbaria	Juvenile	-	-	-	-	-	-	Feeding and Growing					
	Maidara	Juvenile and Age-1 Adult	-	-	-	-	-	-	Feeding and Growing					
Potka	Haldikhali	Adult	Feeding and Breeding	-	-	-	-	-	-					
	Chandpai	Fry	Spawning	Spawning and Nursing	-	-	-	-	-					
		Adult	-	-	-	Feeding	-	-	-					
	Mongla Point	Fry	Spawning	-	-	-	-	-	-					
	Harbaria	Fry	-	-	-	-	-	Nursery	-					
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					
	Chandpai	Adult	-	-	-	Feeding	-	Feeding	-					
	Haldikhali	Juvenile and Adult	-	-	Feeding and Growing	-	-	-	-					
	Harbaria	Juvenile and Adult	-	-	Feeding and Growing	-	-	Feeding and Nursery	-					
	Mongla Point	Juvenile	-	Feeding and Growing	-	-	-	-	-					
	South-west of the Project	Juvenile	-	Feeding and Growing	-	-	-	-	-					
	Chalna Point	Adult	-	-	-	-	Feeding	-	-					
Bele	Akram Point	Adult	Feeding	-	Feeding	Feeding	-	-	-					
	Haldikhali	Juvenile-1, Juvenile and Adult	-	-	Nursing and Growing	Feeding	-	-	-					
	Harbaria	Juvenile and Adult	-	-	Feeding and Growing	-	Feeding and Growing	Nursery and Feeding	Feeding and Growing					

Table 8.8: Purpose, timing and extent of migration for different year-class of migratory fish species(continued)

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	Breeding and Spawning	Nursing	-	-	Nursing	Nursery	-					
	Chandpai	Juvenile and Adult	-	-	Feeding and Growing	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			Nursing and Growing	-	-	-	-					
	Mongla Point	Juvenile and Adult	-	-	-	Feeding	Feeding and Growing	Feeding	Feeding and Growing					
	Chalna Point	Fry	Breeding and Spawning	Nursing	-	-	Nursing	-	-					
	Chalna Point	Adult	-	-	-	Feeding	-	-	-					
	South-west of the Project	Juvenile and Age-1 adult	-	Feeding and Growing	Feeding and Growing	Feeding	Feeding and Growing	-	-					
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	-	-	-	-	-	-					
	Mongla Point	Juvenile	Feeding	-	-	-	-	-	-					
Phekssa	Akram Point	Adult	Feeding	-	-	-	-	-	-					
		Juvenile	-	-	Feeding and Growing	-	-	-	-					
	Haldikhali	Juvenile	-	-	Feeding and Growing	-	-	-	-					
	Haldikhali	Adult	-	-	-	Feeding	-	-	-					
	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	-	Feeding and Growing					
	South-west of the Project	Juvenile and Adult	Feeding	Feeding and Growing	-	-	-	-	-					
		Juvenile	-	-	-	-	-	-	Feeding and					

Table 8.8: Purpose, timing and extent of migration for different year-class of migratory fish species(continued)

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)
									Growing					
		Adult	-	-	Feeding	Feeding	-	Feeding	-					
Paissa	Akram Point	Juvenile and Adult	Feeding	-	Feeding and Growing	Feeding	-	-	-					
		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					
	Chandpai	Fry	Breeding and Spawning	-	-	-	Nursing	-	-					
	Chandpai	Juvenile and Adult	-	-	Feeding and Growing	-	-	Nursery and Feeding	-					
	Harbaria	Juvenile	-	-	-	-	-	-	Feeding and Growing					
	Mongla Point	Fry	Breeding and Spawning	-	-	-	-	Nursery	-					
		Age-1 Juvenile	-	-	-	-	-	-	- Nursing, Feeding and Growing					
		Age-1 Adult	-	-	-	-	Feeding and Growing	Feeding	-					
	South-west of the Project	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					
	Haldikhali	Juvnile and adult	-	-	Feeding and Growing	Feeding	-	-	Feeding and Growing					
	Mongla Point	Fry and Adult	Feeding	Nursing	-	-	-	-	-					
	Mongla Point	Adult	-	-	-	Feeding	-	-	-					
	South-west of the Project	Adult	-	-	Feeding	Feeding	-	Breeding and Spawning	-					

Table 8.8: Purpose, timing and extent of migration for different year-class of migratory fish species(continued)

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)
	Chalna Point	Adult	-	-	Feeding	Feeding	-	-	-					
Hilsa	Haldikhali	Juvenile	-	-	Feeding and Growing	-	-	-	-					
	Chandpai	-	-	-	-	-	-	-	Feeding and Breeding					
	Mongla Point	Adult	-	-	Feeding	-	-	-	-					
	Chalna Point	Brood fish	-	-	-	-	-	Breeding and Spawning	-					
Pangas	Haldikhali	Juvenile	-	-	Feeding and Growing	-	-	-	-					
	Mongla Point	Juvenile and Adult	-	-	Feeding	-	-	-	-					

Source: Field findings at different monitoring programs

*Only Age-1 to Brood fish has been allowed to interpret the migration purpose;

146. It is interpreted from the findings that in the month of October fish species migrate to the upper reaches of the Passur River mainly for feeding purpose, some for breeding.

8.3.6 Shrimp/Fish Farm

147. For monitoring shrimp/fish farm, three farms situated in the direct impact zone of the proposed Power Plant have been surveyed. 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

148. It is reported by the farmers of the shrimp farms that availability of wild seed (PL) has been declining over the years. For this reason, most of the farmers are compelled to stock hatchery produced seeds along with some wild seeds in their farms. Similar to the previous monitoring phase, most of the stocks are still collected from wild source of the Passur River in the third quarter of second monitoring year phase too.

149. In this monitoring year, all the seeds for Bagda stock of the entire selected shrimp/fish farm are collected from the hatchery among which some are from Chalna and some are from Foyla Bazaar. The stocking density varies with the size of the gher, socio-economic status of the gher owners and seed availability. The highest stocking rate has been observed in case of the Gher situated in Chunkuri-2 (**Table 8.9**).

Table 8.9: Stocking Pattern of Fish/Shrimp farm

Location	Fish Species	Stocking Density (No/ha)	Stocking Date	Food Item	Total Production (ton)
Bhekatkhali Khal, Rajnagar	Bagda	7,128	First Week, Aug	Natural	2
	Horina Chingri	Natural Stocking			3.2
	Gusha Chingri				0.8
	Paissa				24
	Vetki				0.2
	Kailla				0.4
	Bele				0
	Tilapia	2,851	First Week, June		0
	Catla	4,752	Mid-July		0
	Minar Carp	7,128	Mid-July		0
	Glass Carp	3,500	Mid-July		0
	Kakra	Natural Stocking			0.4
Kapasdhanga-Muralia	Bagda	1,729	Last July		0.00
	Horina Chingri	Natural Stocking			0.00
	Chali Chingri				0.00
	Tilapia				0.00
	Vetki				0.00
	Tengra				0.00
	Paissa			0.00	
Chunkuri-2	Bagda	24,959	First-Jan	0.40	
	Paissa	4,283		3.20	

Table 8.9: Stocking Pattern of Fish/Shrimp farm(*continued*)

Location	Fish Species	Stocking Density (No/ha)	Stocking Date	Food Item	Total Production (ton)
	Vetki	49			0.40
	Tilapia	1,483			0.06
	Horina Chingri	7,414			0.35
	Chali Chingri	Natural Stocking			0.60
	Chaka Chingri				0.10
	Tengra				0.00
	Bele				0.00
	Tairel				0.06
	Bhangan				0.00

Source: CEGIS Field Survey, 2014 & 2015

(b) Shrimp/Fish Growth Rate and Mortality

150. During the third quarter of second monitoring year, the highest growth rate has been observed in case of Gher at Chunkuri-2 and lowest at Gher of Kapasdanga. The highest mortality has been reported in case of Gher in Kapasdanga due to viral infection (**Table 8.10**). It has been found that viral infection, predation by voracious predator like Vetki, and even river flooding are the major causes for the natural mortality to the selected sampling Ghers.

Table 8.10: Growth Rate and Mortality of Fish/Shrimp

Gher No.	1 st QM		2 nd QM		3 rd QM		4 th QM		5 th QM		6 th QM		7 th QM		8 th QM		9 th QM		10 th QM		11 th QM		12 th 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										
3	0.2	25-30	0.2	25	0.20	65	-	-	-	10	0.15	50	0.25	20										

Source: CEGIS Field Survey, 2014 & 2015

8.3.7 Fish Production

(a) Capture Fish Production

151. In this quarter, the highest productivity has been found in Sheola Khal at Chandpai (**Table 8.11**), while the lowest in the Harbaria. Because most of the fishes have been found in the age of age-1 juvenile which are considered low level of productivity.

152. The present study observed that Charpata, Jhaki Jal and Ber (Ilish and Vola Jal) are frequently used to catch fish. The highest catch susceptibility has been found in case of Charpata Jal (23 kg/haul) (**Table 8.11**). The following table also expresses that Ber Jal and Jhaki 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 Akram Point and lowest in the Mongla Point in this monitoring phase (**Table-8.12**).

Table 8.11: Total Catch in Different Gears in the Sampling Sites

Sl. No	Site	Habitat	Gear Name/Type	Haul Duration (hr)	No of Haul	kg/haul
A	Akram Point	Passur River	Charpata Jal	12	1	20
B	Haldikhali	Passur River	Charpata Jal	12	1	10
C	Harbaria	Harbaria Khal	Arakole	11	245	0.22
			Charpata Jal	8	1	0.00
			Jhaki Jal	2	20	0.08
D	Chandpai	Sheola Khal	Behundi Jal	5.5	1	8.00
			Charpata Jal	13	1	23.00
			Ilish Jal	1	1	4.00
E	Mongla Point	Passur River	Jhaki Jal	2.56	120	0.01
			Vola Jal	4	10	0.16
F	Maidara	Passur River	Jhaki Jal	6.2	6	0.13
G	Chalna Point	Passur River	Vola Jal	0.575	1	0.83

Source: Catch assessment survey, CEGIS (2015)

Table 8.12: Total Catch in the Sampling Sites

Sampling Site	Total Catch (kg)											
	1 st QM	2 nd QM	3 rd QM	4 th QM	5 th QM	6 th QM	7 th QM	8 th QM	9 th QM	10 th QM	11 th QM	12 th QM
A	28*	0	3	28.7	6	-	20					
B	65	0	1	3.3	0	-	10					
C	1,559	0.5	8	8.7	1.05	0.33	19.5					
D	**	12	3	30.0	10.5	5.08	10.75					
E	**	0.6	5	0	0.5	0.40	0.6					
F	**	1.2	13	3.7	1.5	0.70	0.8					
G	**	1.6	4	0.7	2.9	0.83	0.825					

*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

153. The present study on shrimp/fish farm in this quarter showed that the highest production was in the Gher of Rajnagar and lowest in the Gher of Kapasdanga (**Table 8.13**).

Table 8.13: The Present Catch in Three Sampling Ghers

Sampling Site	Total Catch (kg)																							
	1 st QM		2 nd QM		3 rd QM		4 th QM		5 th QM		6 th QM		7 th QM		8 th QM		9 th QM		10 th QM		11 th QM		12 th 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										
	Vetki	1.57	Bele	0	Gusha Chingri	-	-	-	Horina Chingri	1	Horina Chingri	1	Horina Chingri	3.2										
	Bele	0.98	Cheng	0	Harina Chingri	-	-	-	Tengra	-	Chali Chingri	0.5	Gusha Chingri	0.8										
	Harina Chingri	0.78	Bhangan	0	Rui (kg)	-	-	-	Paissa	-	Paissa	0.25	Paissa	24										
	Chali Chingri	0.11	Chali Chingri	0	Catla (kg)	-	-	-	Chela	-	Bele	0.25	Vetki	0.2										
	Chaka Chingri	0.08	-	-	-	-	-	-	Vetki	-	-	-	Kailla	0.4										
	-	-	-	-	-	-	-	-	-	-	-	-	Bele	0										
	-	-	-	-	-	-	-	-	-	-	-	-	Tilapia	0										
	-	-	-	-	-	-	-	-	-	-	-	-	Catla	0										
	-	-	-	-	-	-	-	-	-	-	-	-	Minar Carp	0										
	-	-	-	-	-	-	-	-	-	-	-	-	Glass Carp	0										
	-	-	-	-	-	-	-	-	-	-	-	-	Kakra	0.4										
Sub-total =		8.52		6.42		4.8	-	-		1		3.06	-	31										
2	Bagda	4	Bagda	1	Bagda	7	-	-	Bagda	-	Bagda	1.67	Bagda	0										
	Harina Chingri	2	Harina Chingri	0.33	Vetki	1	-	-	-	-	Chali Chingri	0.30	Horina Chingri	0										
	Chali Chingri	0.18	Chali Chingri	0.08	Paissa	10	-	-	-	-	Horina Chingri	0.50	Chali Chingri	0										

Table 8.13: The Present Catch in Three Sampling Ghers(continued)

Sampling Site	Total Catch (kg)																							
	1 st QM		2 nd QM		3 rd QM		4 th QM		5 th QM		6 th QM		7 th QM		8 th QM		9 th QM		10 th QM		11 th QM		12 th QM	
	-	-	Golda Chingri	0.01	Phessa	2.4	-	-	-	-	Bele	0.30	Tilapia	0										
	-	-	Bele	0.08	Bhangan	1.7	-	-	-	-	Paissa	0.25	Vetki	0										
	-	-	Tengra & Paissa	0.04	Golda Chingri	0.9	-	-	-	-	-	-	Tengra	0										
	-	-	-		Gulsha Tengra	0.2	-	-	-	-	-	-	Paissa	0										
Sub-total =		6.00		2.00		23		-	-	-		3.02	-	0										
3	Bagda	1.38	Bagda	2.4	Bagda	1.5	-	-	Bagda	-	Bagda	3.5	Bagda	0.4										
	Harina Chingri	0.34	Harina Chingri	0.34	Paissa	10	-	-	-	-	-	-	Paissa	3.2										
	Chali Chingri	0.17	Chali Chingri	0.17	Tengra	10	-	-	-	-	-	-	Vetki	0.4										
	-	-	-	-	Bele	20	-	-	-	-	-	-	Tilapia	0.06										
	-	-	-	-	Tilapia	22	-	-	-	-	-	-	Horina Chingri	0.35										
	-	-	-	-	Rui	28	-	-	-	-	-	-	Chali Chingri	0.6										
	-	-	-	-	Vetki	-	-	-	-	-	-	-	Chaka Chingri	0.1										
	-	-	-	-	Harina Chingri	-	-	-	-	-	-	-	Tengra	0										
	-	-	-	-	Chami Chingri	-	-	-	-	-	-	-	Bele	0										
	-	-	-	-	Catla	56	-	-	-	-	-	-	Tairai	0.06										
Sub-total =		1.89		2.91		197.5	-	-	-	-	-	-	-	5.17										
Grand-total =		17.00		11.33		226.5	-	-		1		3.5		36.17										

Source: CEGIS Field Survey, 2014 & 2015

9 Ecosystem and Biodiversity Monitoring

154. This section defines the current ecological conditions that prevail in the surrounding monitoring sites of the Project study area and include terrestrial and aquatic flora and fauna status in different habitats of the selected monitoring sites. The information obtains from this section will constitute part of the 7th monitoring (3rd Quarter of 2nd year) report and updates environmental monitoring data to November 2015.

9.1 Terrestrial Ecosystem

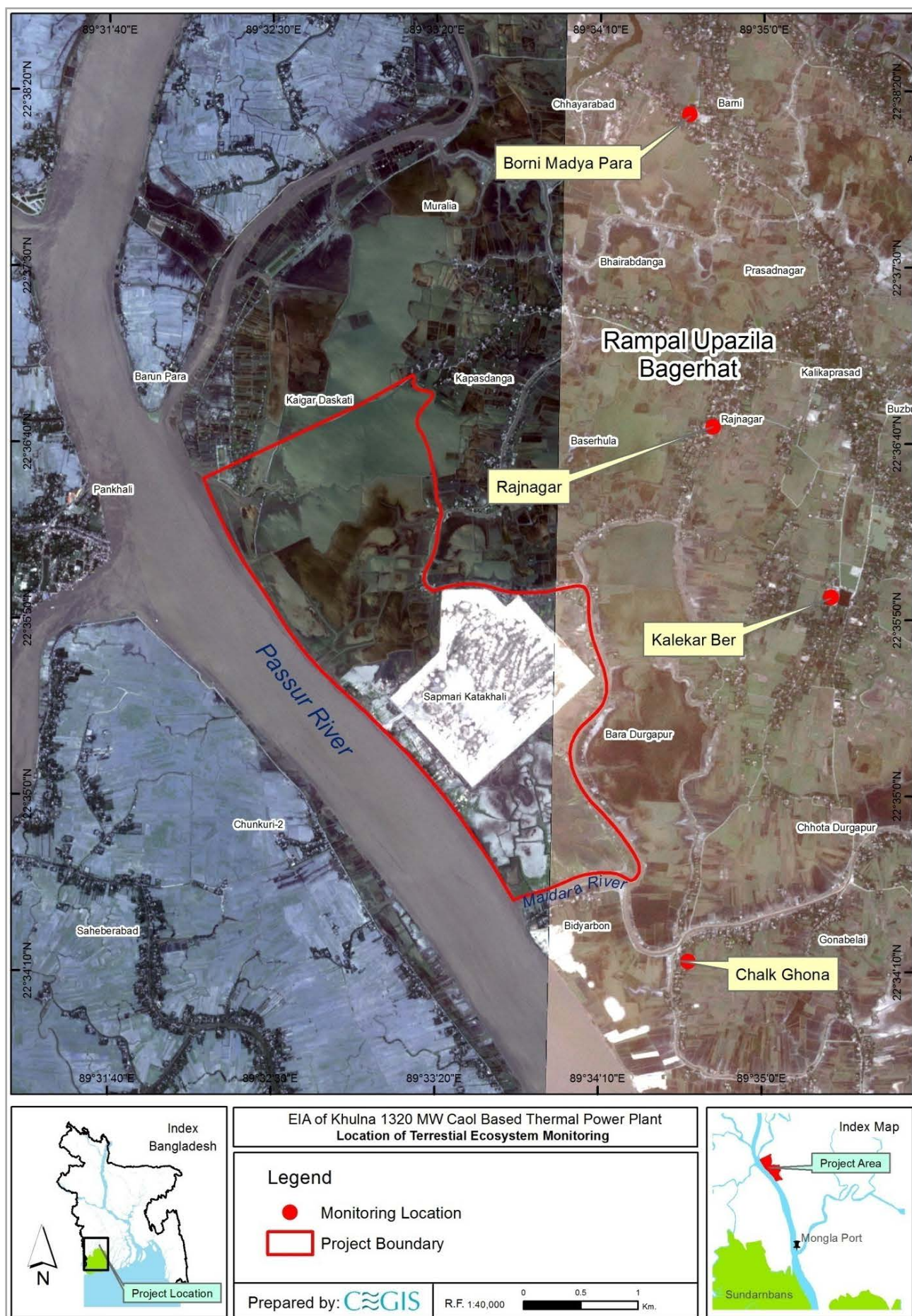
155. Terrestrial ecosystem supports most of the floral and faunal communities which are directly related to the environmental parameters like temperatures, air quality, sunlight, soil nutrients etc. In the study area, homesteads occupy maximum portions of terrestrial ecosystems. As such, observation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

9.1.1 Indicators Selection

156. Indicators for terrestrial and aquatic ecosystems have been selected on the basis of prior anticipation of probable impacts on ecological resources in different phases of the proposed Project. As such the identified indicators of terrestrial floral ecosystem for this study include: species composition and diversity, health of plants, vegetations and canopy status including lichen coverage. Simultaneously, the terrestrial faunal indicators cover: local birds and their habitats including species diversity, butterfly occurrence while aquatic ecosystems include: dolphin occurrences at the monitoring sites covering Project monitoring study area.

9.1.2 Description of the selected sites

157. The homestead in Rajnagar is located at 2.5 km. east from upper North-east boundary of the Project site. This is situated inside the damp area as numerous small swamps exist inside and surround the homesteads. Water retention capacity of surface soil of this homestead is very low and for this reason very little number of grasses and other herbs are present. Land elevation of selected homestead at Kalekar Ber dighi village is comparatively flood free. This is located at about 1.8 km. east from Middle-east boundary of the Project. Chalkghona village is located about 0.5 km south from south-east boundary of the Project. The selected homestead of this village is close to Maidara River to it's north side and saline water shrimp farms to its south periphery. Presence of shallow ditches and peripheral waterbodies support to grow staple coverage of saline tolerant plant species. Barni village is located at about 3.0 km north from north-east boundary. Sampled homestead at Barni is situated at the middle part of the village. This homestead is also dominated by planted tree species and soil condition is similar to Rajnagar site. Vegetation of this homestead have been severely been damaged by past Cyclone Aila. The monitoring locations are shown in **Map 9.1**.



9.1.3 Species Composition of selected homestead vegetation

Homestead at Rajnagar

158. Among the trees, Gewa (*Excoecaria agallocha*) is dominating among all trees. Moist and saline soil favors luxurious succession of this mangrove plant in homestead vegetation. Beside this, Safeda (*Manilkara zapota*) and Boroi (*Zizyphus sp*) are the two species of fruit yielding trees. Monocots including Narikel (*Cocos nucifera*) and Khejur (*Phoenix sylvestris*) occupied the top canopy of the vegetation. In addition three Bola (*Hibiscus tiliaceus*) and one Sundari (*Heritiera fomes*) also found to exist. The homestead has no grasses or undergrowth vegetation.

Homestead at Kalekar Ber dighi

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



Photo 9.1 : A part of homestead vegetation at Kalekarber Village

Homestead at Chalkghona

160. Similar to the above homesteads, in the selected homestead at Chalkghona, Narikel is the dominating tree species as well as occupying the top canopy. As the homestead is near the peripheries of river and shrimp gher, soil salinity supports luxurious growth of mangrove plant Gewa (*Excoecaria agallocha*). This homestead has two shallow ditches

which contain brackish water throughout the year and 2 Gol (*Nipa fruticans*) bushes are existing there. Most of the medium size trees like Safeda (*Manilkara zapota*), Aam (*Mangifera indica*), Peyara (*Psidium guajava*), Papay (*Carica papaya*) etc are fruit bearing trees. Beside this, some ornamental plants also exist. Detail plant species (trees and monocots only) are listed in **Table 9.1**.

Homestead at Barni

161. The homestead at Barni contains 21 tree species. Except Narikel (*Cocos nucifera*), Khejur (*Phoenix sylvestris*) and Taal (*Borassus flabellifer*), most of trees are young in age. The devastating cyclone Aila caused huge damage to the tree species. Then the house owner planted many timber and fruit yielding trees throughout the home yard. Detail plant species composition of this homestead has been mentioned in **Table 9.1**.

Table 9.1: Species Composition of studied homestead vegetation

Species Name	Local Name	Family	IUCN Global Conservation Significance	No. of Plants			
				Barni	Kalekar Ber Dighi	Chalkghona	Rajnagar
<i>Acacia moniliformes</i>	Akashmoni	Leguminosae	NE	6	-	-	3
<i>Aegle marmelos</i>	Bel	Rutaceae	NE	-	-	2	-
<i>Albizia richardiana</i>	Chambol	Leguminosae	NE	2	8	3	-
<i>Albizia saman</i>	Sirish/Rendi Koro	Leguminosae	NE	6	7	3	2
<i>Anona squamosa</i>	Ata	Anonaceae	NE	-	1	-	-
<i>Areca catechu</i>	Supari	Palmae	NE	10	18	-	-
<i>Avecenia alba</i>	Baen	Aviceniaceae	NE	-	-	2	-
<i>Azadirachta indica</i>	Neem	Meliaceae	NE	-	-	3	2
<i>Borassus flabellifer</i>	Taal	Palmae	NE	6	8	2	-
<i>Carica papaya</i>	Pepey	Caricaceae	NE	-	-	5	-
<i>Citrus medica</i>	Kagoji Lebu	Rutaceae	NE	-	-	2	-
<i>Cocos nucifera</i>	Narikel	Palmae	NE	10	56	39	17
<i>Cordia dichotoma</i>	Bohal	Boraginaceae	NE	-	-	1	-
<i>Diospyrus pregrina</i>	Deshi Gab	Ebenaceae	NE	-	-	3	-
<i>Diospyros blancoi</i>	Bilati Gab	Ebnaceae	NE	-	12	-	-
<i>Excoecaria agallocha</i>	Gewa	Euphorbiaceae	NE	8	6	36	100
<i>Feronia lemonia</i>	Kaotbel	Rutaceae	NE	1	-	1	1
<i>Ficus religiosa</i>	Aswath	Moraceae	NE	3	-	-	-
<i>Ficus sp</i>	Zeer Bat	Moraceae	NE	2	-	-	-
<i>Gardenia augusta</i>	Gondhoraj	Rubiaceae	NE	-	-	2	-
<i>Hibiscus rosa sinensis</i>	Jaba	Malvaceae	NE	-	2	3	2
<i>Hibiscus</i>	Bola	Malvaceae	NE	-	-	-	3
<i>Herritiera fomes</i>	Sundari	Sterculiaceae	NE	-	-	-	1

Table 9.1: Species Composition of studied homestead vegetation(continued)

Species Name	Local Name	Family	IUCN Global Conservation Significance	No. of Plants			
				Barni	Kalekar Ber Dighi	Chalkghona	Rajnagar
<i>Ixora coccinea</i>	Rangan	Rubiaceae	NE	1	-	1	-
<i>Mangifera indica</i>	Aam	Anacardiaceae	DD	6	6	7	3
<i>Manilkara zapota</i>	Safeda	Zapotaceae	NE	1	1	1	1
<i>Mimusops elengii</i>	Bakul	Zapotaceae	NE	-	1	-	-
<i>Moringa oleifera</i>	Sazna	Moringaceae	NE	-	-	2	-
<i>Musa sp</i>	Kola	Musaceae	NE	6	-	10	-
<i>Nypa fruticans</i>	Gol	Palmae	LC	-	-	2	-
<i>Phoenix sylvestris</i>	Khejur	Palmae	NE	12	10	24	25
<i>Phyllanthus acidus</i>	Naul/Orboroi	Euphorbiaceae	NE	-	-	2	-
<i>Pongamia sp</i>	Koroj	Leguminosae	NE	-	-	2	3
<i>Psidium guajava</i>	Peyara	Myrtaceae	NE	2	8	17	2
<i>Punica granatum</i>	Dalim	Lythraceae	LC	-	-	4	-
<i>Quisqualis indica</i>	Madhabilata	Combrataceae	NE	-	-	4	-
<i>Sonneratia apetala</i>	Kewra	Lythraceae	LC	-	-	3	-
<i>Spondias pinnata</i>	Amra	Anacardiaceae	NE	1	-	-	-
<i>Swietenia mehogani</i>	Mehogani	Meliaceae	NE	11	17	1	2
<i>Syzygium cumini</i>	Jaam	Myrtaceae	NE	-	2	2	-
<i>Syzygium samarengense</i>	Jamrul	Myrtaceae	NE	1	-	-	-
<i>Tamarindus indica</i>	Tentul	Leguminosae	NE	2	2	1	1
<i>Terminalia catapa</i>	Kathbadam	Combrataceae	NE	5	-	1	-
<i>Zizyphus mauritiana</i>	Kul	Rhamnaceae	NE	-	2	4	2
<i>Elaeis guineensis</i>	Palm Oil	Palmae	NE	-	4	-	-
<i>Nyctanthes arbor-tristis</i>	Shewly	Oleaceae	NE	-	-	4	-

Source: CEGIS Field Monitoring, April 2014 and June 2014

Note: Conservation Significance “NE”=Not Evaluated; “LC”=Least Concern; “DD”=Data Deficient (According to The IUCN Global Red List of Threatened Species, 2015)

9.1.4 Species Diversity of homestead vegetation

162. A total number of 47 plant species belonging to 22 families have been enumerated from the 4 studied plots (except Homestead plot at Rajnagar). These species represent 8 monocots. Among the families, Palmae hold 7 species and *Cocos nucifera* having higher abundance. Species diversity of each studied homestead is described in following **Table 9.2**.

Table 9.2: Composition, Density and Abundance of top 5 species in studied homesteads

Location	Sl. No.	Species Name	Local Name	Family	Total Number of individuals	Density	Abundance
Chalkghona	1	<i>Cocos nucifera</i>	Narikel	Palmae	39	7.8	975
	2	<i>Excoecaria agallocha</i>	Gewa	Euphorbiaceae	36	7.2	720
	3	<i>Phoenix sylvestris</i>	Khejur	Palmae	24	4.8	600
	4	<i>Psidium guajava</i>	Peyara	Myrtaceae	17	3.4	567
	5	<i>Carica papaya</i>	Pepey	Caricaceae	5	1.0	500
Barni	1	<i>Swietenia mehogani</i>	Mehogani	Meliaceae	11	2.2	550
	2	<i>Excoecaria agallocha</i>	Gewa	Euphorbiaceae	8	1.6	400
	3	<i>Areca catechu</i>	Supari	Palmae	10	2	333
	4	<i>Musa sp</i>	Kola	Musaceae	6	1.2	300
	5	<i>Phoenix sylvestris</i>	Khejur	Palmae	12	2.4	240
Kalekar Ber Dighi	1	<i>Cocos nucifera</i>	Narikel	Palmae	56	11.2	1120
	2	<i>Excoecaria agallocha</i>	Gewa	Euphorbiaceae	6	1.2	600
	3	<i>Swietenia mehogani</i>	Mehogani	Meliaceae	17	3.4	567
	4	<i>Areca catechu</i>	Supari	Palmae	18	3.6	450
	5	<i>Dyospyros blancoi</i>	Bilati Gab	Ebnaceae	12	2.4	300
Rajnagar	1	<i>Excoecaria agallocha</i>	Gewa	Euphorbiaceae	25	5	1250
	2	<i>Phoenix sylvestris</i>	Khejur	Palmae	25	5	500
	3	<i>Cocos nucifera</i>	Narikel	Palmae	17	3.4	340
	4	<i>Psidium guajava</i>	Peyara	Myrtaceae	2	0.4	200
	5	<i>Pongamia pinnata</i>	Koroj	Leguminosae	3	0.6	150

Source: CEGIS Field Monitoring, April 2014 and June 2014

9.1.5 Diversity Index of Sampling homesteads vegetation

163. The average Diversity Index of this area is 2.47. Chalkghona possess top diversity rating with presence of 34 plant species. Following table provides the plant diversity index of different studied homesteads.

Table 9.3: Diversity Index of homestead plant species

Location	Total No. of Tree Species	Diversity Index (H)
Barni	20	2.75
Kalekar Ber Dighi	19	2.35
Chalkghona	34	2.80
Rajnagar	15	1.99

Source: CEGIS Vegetation Survey, April 2014 and June 2014

9.1.6 Plant health

164. Plant health of this area is not satisfactory. Vegetation structure of this area is tree dominant. Random saline water shrimp farming is a big threat to plant health of this area. Expansion of shrimp farming in this area triggered increase of soil salinity. For this reason, plant succession, growth and productivity have fallen down.

Plant Diseases and symptoms in homestead vegetation

165. Plant diseases observation of an area is needed to evaluate plant health and productivity. During field survey, some tree species were selected for regular observation of plant disease. In this regards, a number of common tree species have been observed in each homesteads.

166. Leaf spot, leaf blast, nut fall, Mite damage on nut fruit are common diseases of the plants in the study area. A brief discussion was held with home owners about diseases of selected economic plants which exist in their homesteads. Most symptoms for plant diseases are descriptive. Although, all plant diseases symptoms are not visible at a same time of the year, but it was tried to observe the existing disease symptoms. Leaf spot and mite damage on fruits is the common symptoms of *Cocos nucifera*. In addition, bud/trunk rot, lethal yellowing and diameter loss at top portion of this monocot is also common symptom of this plant in all location. Fungal/ bacterial infection is not remarkable in the homesteads. But Leaf Anthracnose on *Mangifera indica* and Bacteriosis on *Psidium guajava* is commonly found most of the trees. *Phoenix sylvestris* also found unhealthy due to leaf yellowing from manganese deficiency.



Photo 9.2 : Unhealthy coconut and date palm plant at studied homesteads in Rajnagar (Left) and Chalkghona (Right)

Number of disease affected trees

167. Trees look livelier in all the monitoring locations than previous season because of rain. Date Palm (*Phoenix sylvestris*) followed remarkable change in health deterioration at 3 monitoring locations and improved in one location. The unhealthy date palm plant which is followed previous monitoring, continue deteriorating due to top narrowing and shrinking crown. Except this, health situation of other plants are remain about unchanged.

168. Following table represents the proportion of healthy and unhealthy plants in studied homesteads.

Table 9.4: Proportion of healthy and unhealthy plants in studied homesteads

Location	Plant Name	Total No. of Plant	No. of Healthy Plant							No. of Unhealthy Plant						
			1 st QM (Apr 2014)	2 nd QM (Jun 2014)	3 rd QM (Oct 2014)	4 th QM (Jan 2015)	5 th QM (Apr 2015)	6 th QM (Aug 2015)	7 th QM (Oct 2015)	1 st QM (Apr 2014)	2 nd QM (Jun 2014)	3 rd QM (Oct 2014)	4 th QM (Jan 2015)	5 th QM (Apr 2015)	6 th QM (Aug 2015)	7 th QM (Oct 2015)
Rajnagar	<i>Cocos nucifera</i>	17	NS	7	11*	1	2	13	11	NS	10	5	5	15	4	5
	<i>Phoenix sylvestris</i>	25	NS	10	21	2	3	16	12	NS	15	4	4	22	9	13
	<i>Manilkara zapota</i>	1	NS	1	1	1	1	1	1	NS	0	0	0	0	0	0
	<i>Albizia saman</i>	2	NS	2	2	2	2	2	2	NS	0	0	0	0	0	0
	<i>Excoecaria agallocha</i>	10	NS	10	98*	9	99	99	100	NS	0	1	1	0	0	0
	<i>Mangifera indica</i>	3	NS	2	3	3	1	3	3	NS	1	0	0	2	0	0
	<i>Psidium guajava</i>	2	NS	0	2	2	0	2	2	NS	2	0	0	2	0	0
Chalkghona	<i>Cocos nucifera</i>	10	3	7	10	1	7	9	8	7	3	0	0	3	1	2

Table 9.4: Proportion of healthy and unhealthy plants in studied homesteads(continued)

Location	Plant Name	Total No. of Plant	No. of Healthy Plant							No. of Unhealthy Plant						
			1 st QM (Apr 2014)	2 nd QM (Jun 2014)	3 rd QM (Oct 2014)	4 th QM (Jan 2015)	5 th QM (Apr 2015)	6 th QM (Aug 2015)	7 th QM (Oct 2015)	1 st QM (Apr 2014)	2 nd QM (Jun 2014)	3 rd QM (Oct 2014)	4 th QM (Jan 2015)	5 th QM (Apr 2015)	6 th QM (Aug 2015)	7 th QM (Oct 2015)
	<i>Phoenix sylvestris</i>	12	12	7	8	8	9	11	8	0	5	4	4	3	1	4
	<i>Borassus flabellifer</i>	6	3	5	6	6	6	6	6	3	1	0	0	0	0	0
	<i>Mangifera indica</i>	6	3	3	5	5	2	6	6	3	3	1	1	4	0	0
	<i>Excoecaria agallocha</i>	18	18	18	18	18	18	18	18	0	0	0	0	0	0	0
	<i>Swietenia mehogani</i>	11	11	11	11	11	10	11	11	0	0	0	0	1	0	0
	<i>Areca catechu</i>	10	10	4	8	8	2	8	8	0	6	2	2	8	2	2
	<i>Manilkara zapota</i>	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0
Kalekarber Dighi	<i>Psidium guajava</i>	2	0	1	2	2	3	2	2	2	1	0	0	0	0	0
	<i>Cocos nucifera</i>	56	21	50	55	55	54	54	53	35	5	1	1	2	2	3
	<i>Phoenix sylvestris</i>	10	10	7	10	10	9	10	9	0	3	0	0	1	0	1
	<i>Mangifera indica</i>	5	3	5	5	5	5	5	5	1	1	0	0	0	0	0
	<i>Manilkara zapota</i>	2	1	1	1	1	2	1	1	0	0	0	0	1	0	0
	<i>Borassus flabellifer</i>	8	8	8	8	8	8	8	8	0	0	0	0	0	0	0
	<i>Zizyphus sp</i>	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0
Chalkghona	<i>Psidium guajava</i>	8	7	8	8	8	8	8	8	0	0	0	0	0	0	0
	<i>Tamarindus indica</i>	2	2	2	2	2	1	2	2	0	0	0	0	1	0	0
	<i>Cocos nucifera</i>	39	35	20	34	34	5	19	39	25	19	5	5	34	20	0
	<i>Phoenix sylvestris</i>	24	24	14	23	23	18	19	23	0	10	1	1	6	5	1
	<i>Albizia saman</i>	3	1	3	3	3	2	3	3	0	0	0	0	1	0	0
	<i>Excoecaria agallocha</i>	36	36	36	35	35	36	36	36	0	0	1	1	0	0	0
	<i>Manilkara zapota</i>	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0
	<i>Psidium guajava</i>	17	16	10	17	17	17	17	17	1	7	0	0	0	0	0
	<i>Mangifera indica</i>	7	5	6	7	7	7	7	7	2	1	0	0	0	0	0
	<i>Borassus flabellifer</i>	2	2	2	2	2	2	2	2	0	0	0	0	0	0	0

Note: NS = Not Surveyed

*=1 Cocos have been cut and 1 Excoecaria have been died

9.1.7 Vegetation canopy status

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

Species representation in different canopy layers of homestead vegetation

170. *Cocos nucifera* occupied top canopy of all the homestead vegetation under monitoring study locations. *Phoenix sylvestris* is prevalent as second top layer followed by *Excoecaria agallocha*. Most of the fruit yielding trees like *Manilkara zapota*, *Mangifera indica* possess upper bole of canopy layer. Lower bole are occupied by small fruit yielding trees like *Psidium guajava*, *Musa sp.*, very few grass species and undergrowth vegetation were noted at the homesteads under monitoring locations.

Estimated Canopy cover in homestead vegetation of sampling sites

171. Tree Canopy status of the homesteads under monitoring study are found unchanged in Rajnagar, Kalekarber and Chalkghona sites. In case of Barni, canopy coverage have been improved due to growth and expansion of planted saplings branches and shoots in this rainy season of this year.

172. Canopy coverage of the homesteads under monitoring study have been presented in following table:

Table 9.5: Vegetation Canopy Cover in different studied homesteads

Location	% of canopy Coverage						
	1st QM (Apr 2014)	2nd QM (Jun 2014)	3rd QM (Oct 2014)	4th QM (Jan 2015)	5th QM (Apr 2015)	6th QM (Aug 2015)	7th QM (Oct 2015)
Rajnagar	NS	19	19	17	20	20	20
Barni	NS	26	18	18	12	14	20
Kalekarber	NS	20	24	25	23	24	24
Chalkghona	NS	13	24	22	17	21	21

Note: NS = Not Surveyed

9.1.8 Lichen coverage on tree bark

173. Alive lichen cover on tree barks have been observed higher than previous monitoring in April, 2015. Sufficient moisture on tree barks triggered propagation of lichen at the study area. *Areca catechu*, and *Phoenix sylvestris* are mostly infected species with lichen all of the monitoring sites. Lichen coverage recorded highest in Barni site. **Table 9.6** refers average percentage of lichen coverage of the monitoring locations under this study.

Table 9.6: Lichen Coverage on different tree barks at studied homestead vegetation

Location	% of Lichen Coverage				
	1st QM (Apr 2014)	2nd QM (Jun 2014)	3rd QM (Oct 2014)	5th QM (Apr 2015)	7th QM (Oct 2015)
Raj Nagar	NS	5.1	2.5	1.4	2.6
Barni	NS	7.8	3.1	2.4	4.8
Kalekarber	NS	4.3	3.2	1.0	2.1
Chalkghona	NS	2.1	2.6	1.6	3.1

Note: NS = Not Surveyed

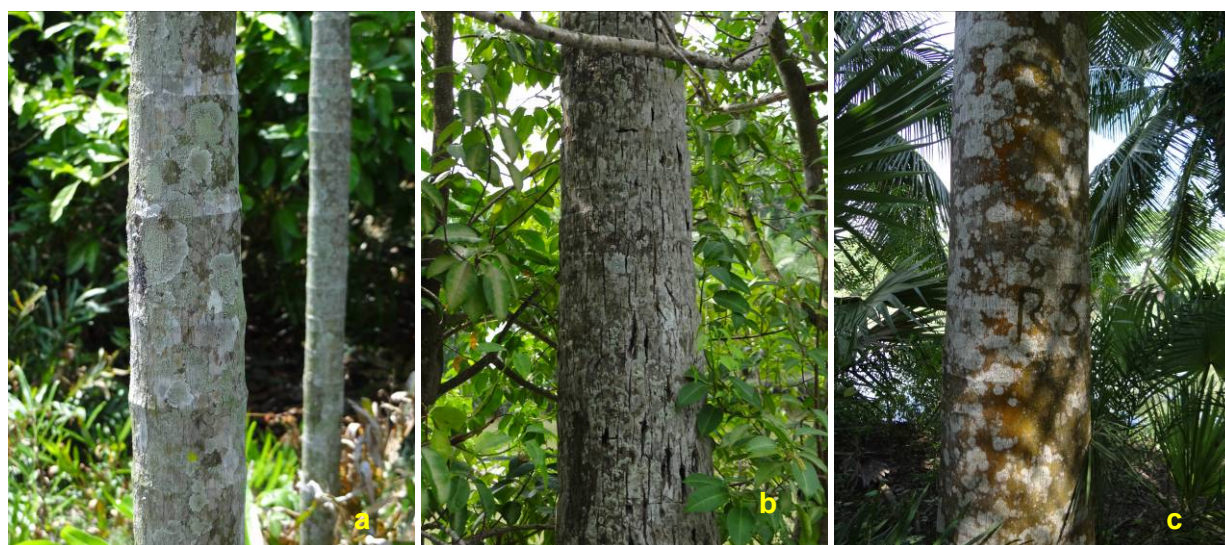


Photo 9.3: Lichen coverage on a) *Areca catechu* (at Barni), b) *Cocos nucifera* (at Chalkghona) and c) *Albizia richardiana* (Kalekarber) at homesteads of different monitoring sites

9.1.9 Bird Habitat

Local birds and their nesting behavior

174. The study area supports numerous local bird species, most of which dwell in homestead vegetation. Existence of vast shrimp farms as well as canals and rivers also favor good number of water dependent bird species in this area. Most of the birds are nesting on tall trees of homesteads. Coconut and Gewa are considered as top priority for nesting. Small bird like Tailor bird, prefer small bushy shrubs. Although, birds do not follow any local boundaries, a clear conception on available bird species have been gathered through discussions with studied homestead owners as well as physical observation. A list of local bird species is presented in **Table 9.7** as initial inventory of this study.

Table 9.7: Local Bird Species of the study area

Scientific Name	Common Name	Local Name	IUCN Conservation Significance	
			Global	Local
<i>Accipiter badius</i>	Shikra	Shikra	LC	NO
<i>Acridotheres fuscus</i>	Jungle Myna	Jhuti Shalik	LC	NO
<i>Acridotheres tristis</i>	Common Myna	Bhat Shalik	LC	NO
<i>Actitis hypoleucos</i>	Common Sandpiper	Chah Pakhi	NE	NO
<i>Aegithina tiphia</i>	Common Iora	Pati Fatikjal	NE	NO
<i>Alcedo atthis</i>	Common Kingfisher	Pati Machranga	LC	NO
<i>Amaurornis phoenicurus</i>	White-breasted Waterhen	Dholabook Dahuk	LC	NO
<i>Ardeola grayii</i>	Indian Pond Heron	Deshi Kanibok	LC	NO
<i>Athene brama</i>	Spotted Owlet	Khuruley Pencha	LC	NO
<i>Bubulcus ibis</i>	Cattle Egret	Go Boga	LC	NO
<i>Butorides striatus</i>	Little Heron	Choto Bok	NE	NO
<i>Casmerodius albus</i>	Great Egret	Jattha Bok	LC	NO
<i>Centropus bengalensis</i>	Lesser Coucal	Kana Kukka	LC	NO
<i>Copsychus saularis</i>	Oriental Magpie-Robin	Udoi Doel	LC	NO
<i>Cypsiurus balasiensis</i>	Asian Palm Swift	Ashio Talbatashi	LC	NO
<i>Dendrocygna bicolor</i>	Fulvous Whistling-Duck	Boro Sarali	LC	NO
<i>Dendrocitta vagabunda</i>	Rufous Treepie	Khoira Harichacha	LC	NO
<i>Dendrocygna javanica</i>	Lesser Whistling Duck	Choto Sarali	LC	NO
<i>Dendrocopos macei</i>	Fulvous breasted woodpecker	Kathkurali	LC	NO
<i>Dicrurus macrocercus</i>	Black Drongo	Kala Fingey	LC	NO
<i>Dinopium benghalense</i>	Black ramped Frameback	-	LC	NO
<i>Egretta garzetta</i>	Little Egret	Choto Boga	LC	NO
<i>Eudynamis scolopacea</i>	Asian Koel	Kokil	LC	NO
<i>Gallinula chloropus</i>	Common Moorhen	Jolmurgi	LC	NO

Table 9.7: Local Bird Species of the study area(continued)

Scientific Name	Common Name	Local Name	IUCN Conservation Significance	
			Global	Local
<i>Halcyon smyrnensis</i>	White-throated Kingfisher	Dholagola Machranga	LC	NO
<i>Haliastur indus</i>	Brahminy Kite	Shonkho Chil	LC	NO
<i>Ixobrychus cinnamomeus</i>	Cinnamon Bittern	Nolkhoka	LC	NO
<i>Ixobrychus sinensis</i>	Yellow Bittern	-	LC	NO
<i>Ketupa zeylonensis</i>	Brown fish owl	Bhutum pecha	LC	NO
<i>Lanus schach</i>	Long-tailed Shrike	Lenja Latora	NE	NO
<i>Macronous gularis</i>	Striped Tit Babbler	-	LC	NO
<i>Megalaima haemacephala</i>	Coppersmith Barbet	Choto Boshonto Bauri	LC	NO
<i>Merops orientalis</i>	Green Bee Eater	Suichora	LC	NO
<i>Motacilla maderaspatensis</i>	White-browed Wagtail	-	NE	NO
<i>Nectarinia asiatica</i>	Purple Sunbird	Durgo Tuntuni	LC	NO
<i>Netapus coromandelianus</i>	Cotton pygmy goose	Bali Hansh	NE	NO
<i>Oriolus xanthornus</i>	Black-hooded Oriole	Kalamatha Benebou	LC	NO
<i>Orthotomus sutorius</i>	Common Tailorbird	Pati Tuntuni	LC	NO
<i>Passer domesticus</i>	House Sparrow	Charui	LC	NO
<i>Phalacrocorax niger</i>	Little Cormorant	Choto Pankouri	LC	NO
<i>Porzana fusca</i>	Ruddy-breasted Crake	Ranga Ulti	LC	NO
<i>Porphyrio porphyrio</i>	Purple Swamphen	Kalim	LC	NO
<i>Pycnonotus cafer</i>	Red Vented Bulbul	Bulbuli	LC	NO
<i>Rhipidura albicollis</i>	White-throated Fantail	Dholagola Chatighurani	LC	NO
<i>Sterna albifrons</i>	Little tern	Choto Gangchil	LC	NO
<i>Streptopelia chinensis</i>	Spotted Dove	Tila Ghughu	NE	NO
<i>Streptopelia tranquebarica</i>	Red Collared Dove	Penchi Ghughu	LC	NO
<i>Sturnus contra</i>	Asian pied starling	Go Shalik	LC	NO
<i>Tachybaptus ruficollis</i>	Little Grebe	Choto Duburi	LC	NO
<i>Todiramphus chloris</i>	Collared Kingfisher	Dholaghar Machranga	LC	NO
<i>Treron bicincta</i>	Orange-breasted Green Pigeon	-	LC	NO
<i>Tyto abba</i>	Barn owl	Laksmi pecha	NE	NO
<i>Upupa epops</i>	Hoopoe	Hudhud	LC	NO
<i>Vanells indicus</i>	Red-wattled Lapwing	Lal Hotiti	NE	NO

Source: CEGIS Field Monitoring, April 2014

Note: Conservation Significance "NE"=Not Evaluated; "LC"=Least Concern (According to the IUCN Global Red List of Threatened Species, 2015), "NO"= Not Threatened (According to the Red Book of Threatened Birds of Bangladesh, IUCN Bangladesh 2000)

Migratory birds and their habitats

175. Migratory birds and their habitats are not investigated in this monitoring period as they are not available in this time.

Bird species and number of Bird nests in sampling sites

176. No bird nest has been observed in any of the four monitoring locations. Hence no description of local birds and their habitats are mentioned here.

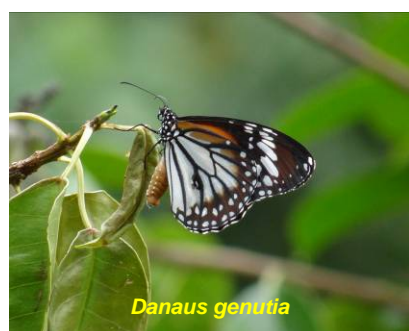
Table 9.8: Bird nest monitoring datasheet

Bird Name	No. of Bird Nest observed																			
	1st QM (Apr 2014)				2nd QM (Jun 2014)				3rd QM (Oct 2014)				4th QM (Jan 2015)				5th QM (Apr 2015)			
	R	B	K	C	R	B	K	C	R	B	K	C	R	B	K	C	R	B	K	C
Little Cormorant	NS	-	NS	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Little Egret	NS	-	NS	1	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Asian Pied Starling	NS	1	NS	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Tailor Bird	NS	-	NS	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
Spotted Dove	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-

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

9.1.10 Butterfly occurrence

A total of 10 butterfly species have been recorded from different monitoring locations. Population of butterflies is found higher than previous monitoring season. Common Albatross, Common Crow, Peacock Pansy are recorded in higher number than other species. Highest population of butterfly have been followed at Barni. Recorded butterfly species and their occurrences are listed in **Table 9.9** below:



Danaus genutia



Matapa aria



Pachliopta aristolochiae



Junonia almana



Elymnias hypermnestra

Photo 9.4: Some of the observed butterflies at different locations of the study area

Table 9.9: Occurrences of Butterflies in the study area

Common Name	Scientific Name	Time and locations for Occurrence of Butterfly species																			
		Apr 2014				Jun 2014				Oct 2014				Jan 2015				Apr 2015			
		R	B	K	C	R	B	K	C	R	B	K	C	R	B	K	C	R	B	K	C
Common Albatross	<i>Appias albina</i>																				
Blue Tiger	<i>Tirumala hamata</i>									*	*	*									
Lime Butterfly	<i>Papilio demoleus</i>							*				*	*	*							*
Chocolate Argus	<i>Junonia hedonia</i>					*		*					*								
Common albatross	<i>Appias albina</i>																*				
Common Cerulean	<i>Jamides celeno</i>										*										
Common Crow	<i>Euploea core</i>					*		*	*	*	*	*	*			*				*	*
Common Emigrant	<i>Catopsilia pomona</i>									*	*	*	*	*	*	*					
Common Gull	<i>Cepora nerissa</i>									*											
Common Leopard	<i>Papilio phalantha</i>									*	*										
Common palmfly	<i>Elymnias hypermnestra</i>									*	*		*	*	*	*				*	*
Common Pierrot	<i>Castalius rosimon</i>									*		*	*	*	*						
Common Rose	<i>Pachliopta aristolochiae</i>										*		*			*		*		*	*
Common Sailor	<i>Neptis hylas</i>														*						
Dainty Grass-blue	<i>Zizula hylax</i>									*	*								*	*	*
Danaid Eggfly	<i>Hypolimnasia misippus</i>	N	S	N	S								*								
Evening Brown	<i>Melanitis leda</i>							*					*	*	*						
Foscu Swallowtail	<i>Papilio fuscus</i>																				
Grey Pansy	<i>Junonia atlites</i>									*							*				
Indian sunbeam	<i>Curetis thetis</i>										*				*						
Lemon Pansy	<i>Junonia lemonius</i>									*			*								
Mangrove Jewel	<i>Hypochrysops epicurus</i>					*		*													
Stripped Tiger	<i>Danaus genutia</i>									*	*	*							*	*	*
Orchard Swallowtail	<i>Papilio aegeus</i>		*	*												*					
Pale Grass Blue	<i>Pseudozizeeria maha</i>														*	*	*				
Three spot Grass Yellow	<i>Eurema blanda</i>					*	*	*	*			*									
Peacock pansy	<i>Junonia almana</i>									*	*	*			*				*	*	*
Rice Swift	<i>Borbo cinnara</i>									*	*	*	*	*							
Small Grass-yellow	<i>Eurema smilax</i>		*	*									*		*	*	*	*	*	*	*

Table 9.9: Occurrences of Butterflies in the study area(continued)

Common Name	Scientific Name	Time and locations for Occurrence of Butterfly species																			
		Apr 2014				Jun 2014				Oct 2014				Jan 2015				Apr 2015			
		R	B	K	C	R	B	K	C	R	B	K	C	R	B	K	C	R	B	K	C
Spotted Pea-blue	<i>Euchrysops cnejus</i>																				
Swamp Tiger	<i>Danaus affinis</i>															*		*			
Common Red Eye	<i>Matapa aria</i>																				*

Note: Occurrence Status; '*'= Occasional, '**'= Common, '-'=Not Found, 'NS' = Not Surveyed

'R'=Rajnarar, 'B'=Barni, 'K'=Kalekarber, 'C'=Chalkghona

9.2 Aquatic Ecosystem

9.2.1 Monitoring Locations

177. Passur is the only external river beside the Project area which maintains connectivity with all flowing water systems of the study area. On the other hand, Maidara River including two branches (Maidara Sailtakhal and Ichamoti) exists as internal river system. Hence, status of benthos, planktons and aquatic mammals (Dolphin) in different locations of the study area has been monitored. In the case of stagnant (lentic) water system, indicator specimen has been collected from two big ponds inside the study area. Village pond is the only type of stagnant water body in the study area as maximum ditches, canals and beels have merged with saline water shrimp farms. All types of these wetlands are directly or indirectly connected with flowing river system.

9.2.2 Dolphin Occurrence

Dolphin migration route in study area

178. Two Two dolphin species (Ganges River Dolphin and Irrawaddi Dolphin) travel throughout the Passur river for whole of the year. The Ganges river dolphin (*Platanista gangetica*) is listed as Endangered (EN) according to IUCN Red List that migrates from estuary regions to upstream connected rivers such as Rupsha and Madhumoti. Though Irrawardi Dolphin (*Orcaella brevirostris*) is mostly habituated in estuary regions of Bangladesh, but this aquatic mammal is also sighted at downstream of the Passur river. This species is also listed in IUCN Red List as Critically Endangered (CR). Ganges Dolphins also roam through Maidara river mainly during high tide. Siltation and narrowing of upstream branches is limiting the travel length of this river day by day.

Dolphin occurrence in Passur and Maidara River

179. Occurrence of dolphin have been monitored during this study by boat transect along about 8.5 km length of Passur River and 1.5 km of Maidara River surrounding the Project area. The transect started from Chalna Bazar, Tulshi Ghat in last ebb tide of the river. The transect ended at upstream of Maidara River near Chalkghona village. A total of 4 Ganges River dolphins have been sighted in Maidara River. No dolphin was recorded in Passur river channel along the Project site due to high tide and wavy condition of the river during ebb.

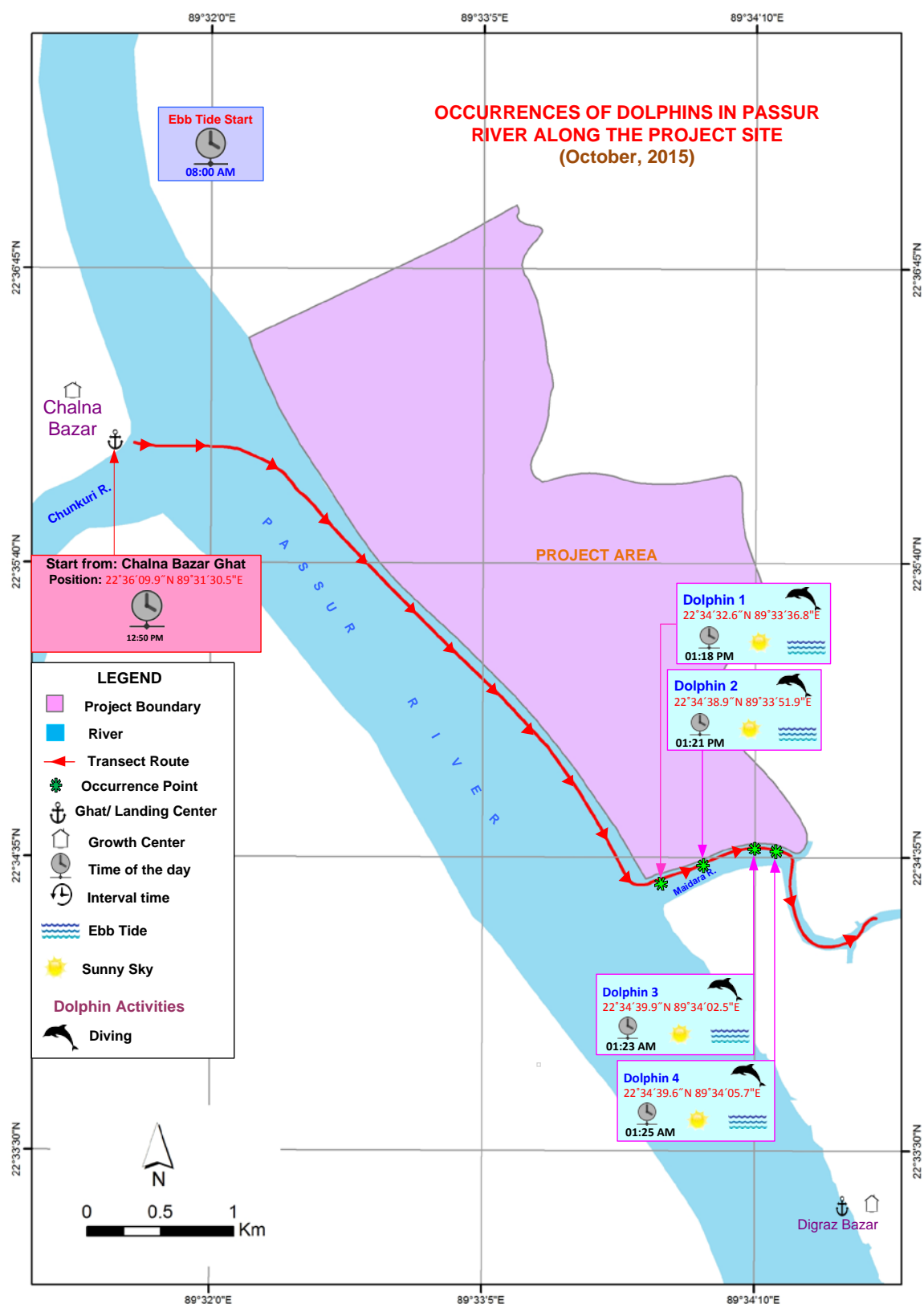
180. **Map 9.2** shows the transect route and occurrence of dolphins at surrounding rivers of the Plant site.

181. At the river confluence in front of Dhangmari Forest Station near Karamjal three dolphin folks containing 4-6 dolphins also observed during neap tide. Beside this, 4 individuals of Ganges Dolphin have also been sighted at confluence point of Passur-Harbaria khal and Akram Point during high tide. However, the survey result is included in **Table: 9.10**.

Table 9.10: Dolphin observation Datasheet

Location of River systems	Occurrence Status													
	1st QM (Apr 2014)		2nd QM (Jun 2014)		3rd QM (Oct 2014)		4th QM (Jan 2015)		5th QM (Apr 2015)		6th QM (Aug 2015)		7th QM (Oct 2015)	
	F T	N T	F T	N T	F T	N T	F T	N T	F T	N T	F T	N T	F T	N T
Passur River Near Project Site	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	NS	Y
Karamjal	NS	NS	NS	N	NS	Y	Y	Y	N	N	NS	Y	NS	Y
Harbaria	NS	NS	NS	N	NS	Y	Y	N	N	N	N	N	Y	NS
Akram Point	NS	NS	NS	N	NS	N	NS	Y	Y	Y	NS	NS	N	Y
Sarankhola	NS	NS	NS	N	NS	NS	N	N	N	N	NS	NS	NS	NS
Maidara River	Y	N	N	N	Y	Y	Y	N	Y	N	Y	N	NS	Y

Note: FT=Flood Tide, NT=Neap Tide, NS=Not Surveyed,
Occurrence Status: Y = Occurred, N = Not occurred



Map 9.2: Occurrence of Dolphin at Passur and Maidara River along the Project site (October 2015)

10 Sundarbans Forest Health Monitoring

10.1 Forest Health Monitoring Indicator

182. To oversee the probable impact of under implementation Rampal Thermal Coal Power Plant Project, CEGIS team is monitoring Sundarbans forest health and in this relation consultation meetings with Forest Department officials were held at times. During present survey, CEGIS survey team talked to field level officials of Dangmari forest station, forest petrol posts at Karamjal, Harbaria, Kokilmoni and Sutarkhali. CEGIS informed them about survey objectives and permanent sample plots establishment. The following indicators have been selected for the monitoring of Sundarbans forest health:

- a) Species richness, diversity, evenness, dominancy
- b) Regeneration, recruitment, seedling survival
- c) Canopy cover, tree height, diameter, pneumatophores and biomass,
- d) Disease and damage (Timber, branch, leaves)
- e) Soil nutrient and quality:
 - Soil nutrients - N, P
 - Bulk density, organic carbon
 - Soil pH, salinity

183. Monitoring frequency for different indicators is different. In this quarter, the following indicators were observed

- Seedling Regeneration
- Pneumatophore
- Crab hole density
- Lichen coverage
- Canopy cover

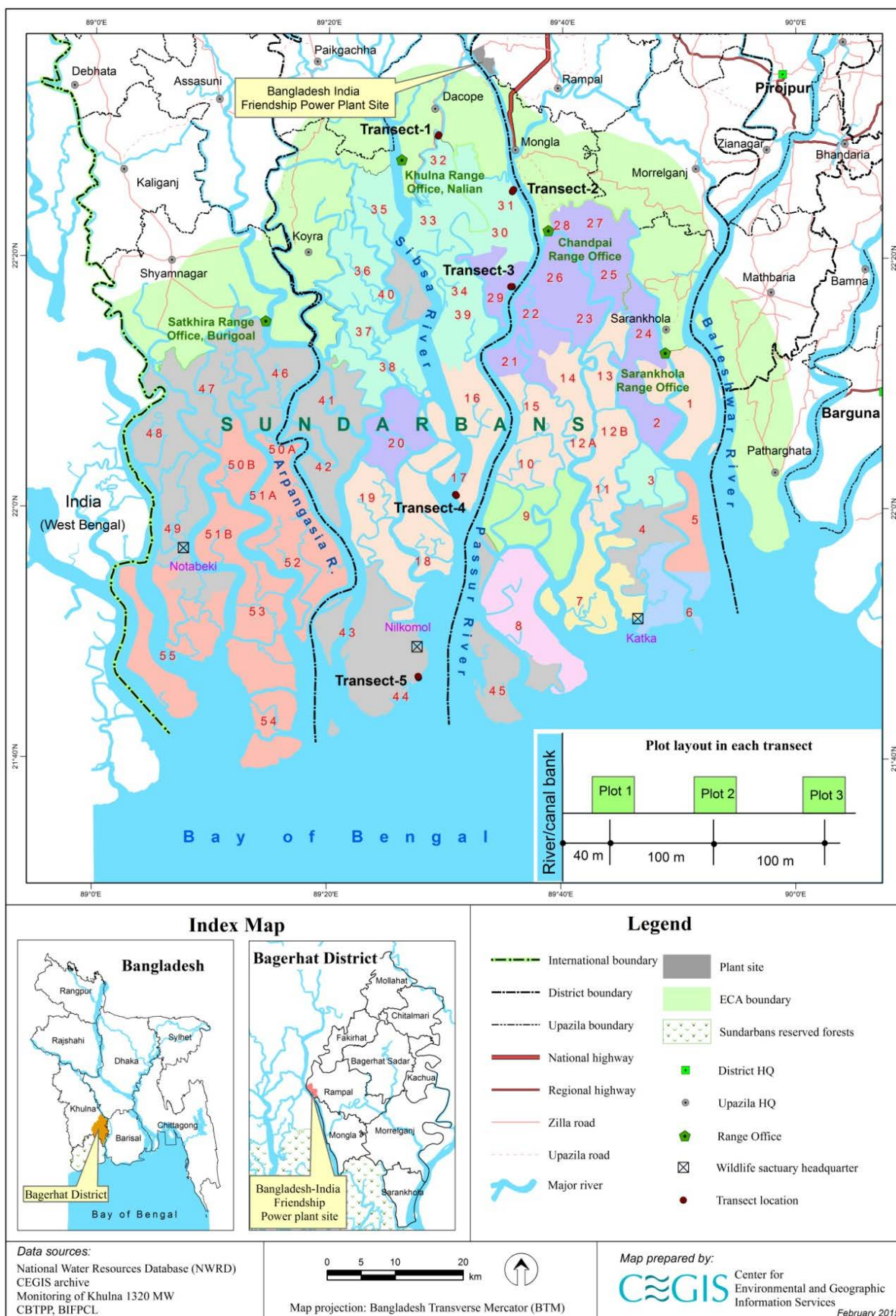
10.2 Forest Health Monitoring Location (Permanent Sample Plots Set Up)

184. Five sites were selected on the basis of the survey conducted from April 3 to 6, 2014 (Map 10.1). 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. Distance from the proposed Project site, coal transportation route, protection of the permanent sample plots, and consider the maximum vegetation types were the major criterias for site selection.

10.3 Methodology of Monitoring Forest Health Indicators

10.3.1 Sampling Design of Permanent Sample Plots (PSPs)

185. In each site, a transect line was laid out perpendicular to river or canal bank. Along, the transect line three circular nested subplots of 12.62 m radius were laid out at 100 m intervals in order to capture maximum tree species (Figure 10.2). Because of the variation in species composition in SRF observation plots were laid out from coast, river or canal side to landward zone (forest proper side). The location of the first subplot was 40 m away from ecotone (riverside) to inner ward of forest in order to save the subplot from river bank erosion.



Map 10.1: Location Map of Sundarbans Forest Health Monitoring Permanent Sample Plots (PSPs)

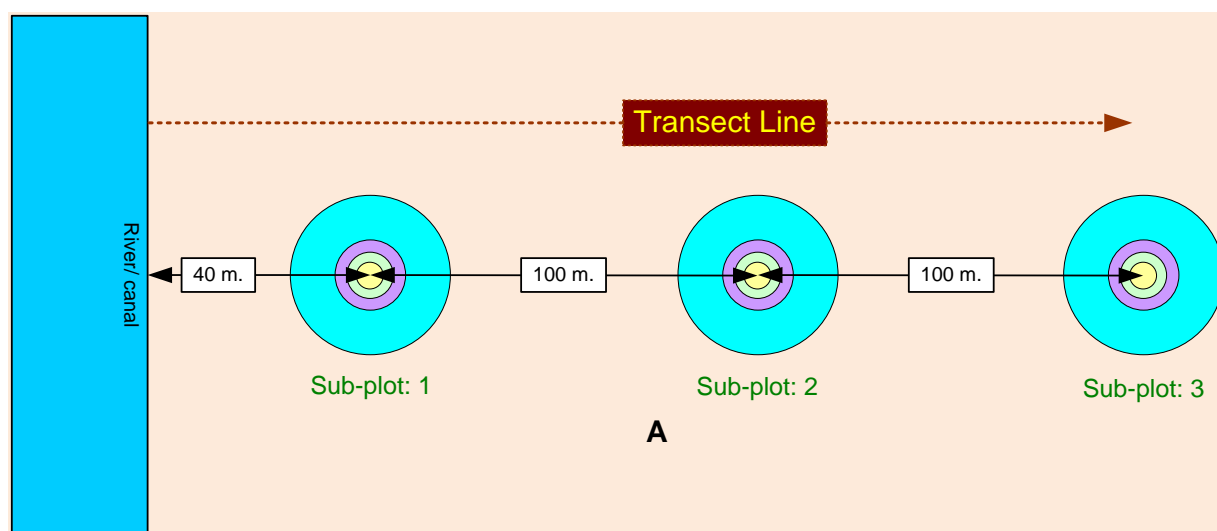


Figure 10.1: Layout of the subplots and transect line perpendicular from ecotone (river or canal bank)

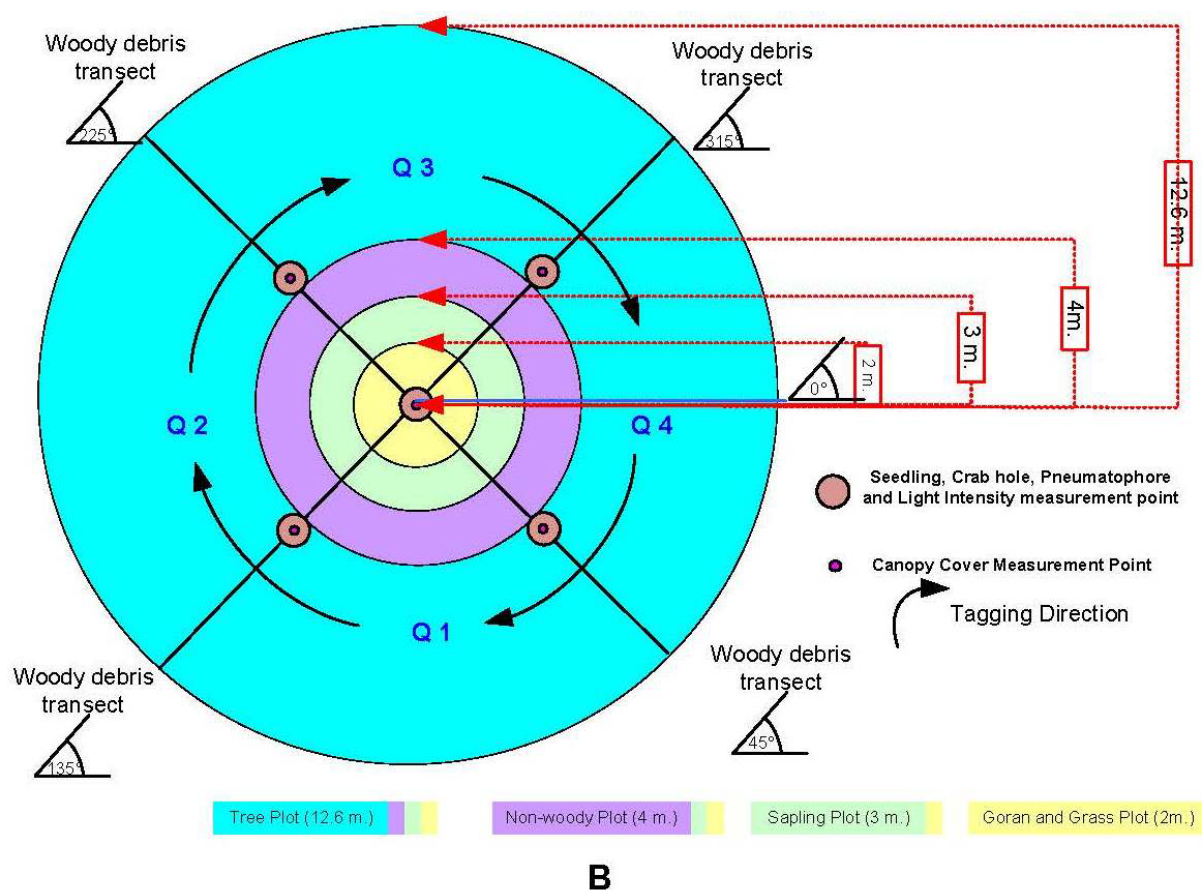


Figure 10.2: Layout of the survey activities in each subplot

10.3.2 Forest Health Survey

(a) Trees

186. The tag number of trees ($\text{DBH} \geq 5\text{cm}$ and lean angle greater than 45°) was monitored and rewritten if any shade was found within 12.62 m radius circle of Permanent Sample Plot (PSP).



Photo 10.1: CEGIS Professionals checking tree tag number and painting marks on different trees in the quadrate of subplot

(b) Sapling and seedling

187. Saplings ($\text{DBH} < 5\text{ cm}$ and height 1.37 m) and seedlings (height $< 1.37\text{ m}$) was assessed within 3m and 2m radius circle, respectively. Seedlings were counted species wise and there living status also recorded. For saplings species name, DBH and living status was documented well.



Photo 10.2: Surveyor counting seedlings and saplings in the subplot



Photo 10.3: Surveyor measuring the DBH of saplings in the subplot

(c) Non-tree vegetation

188. Any vegetation not meeting the requirements of the tree or sapling/seedling survey was treated as non-tree vegetation. The non-woody palms (e.g., *Nypa fruticans*), Kewa kata (*Pandanus spp.*), tiger fern, lianas and woody shrubs were also measured within 4 m radius circle. For Golpata (*Nypa fruticans*) clumps and the number of stems rooted in the subplot were counted, whereas in case of kewa kata and tiger fern the number of clumps (bunches of leaves/ bunches of stems) in the subplot was recorded. In case of woody shrubs, the individual stems were recorded as part of the sapling/seedling survey. Goran and herbaceous vegetation were measured within 2 m radius circle. The diameter was measured at the collar zone (base diameter) (Hossain, et al. 2012). Herbaceous vegetation was visually estimated and recorded as percent ground cover of herbs and grasses separately.

(d) Pneumatophore

189. Pneumatophores, the specialized root system in mangrove plays a vital role in root respiration by gas (oxygen) exchanging in this anaerobic condition of mangrove. During tidal inundation especially in the rainy season the forest floor goes under water. At five points of each of the subplots, within a circular area of 1 meter radius around each point, the total number of pneumatophores was recorded with its living status. The first one was laid out in the centre of each subplot and other four were in the midpoint of the four woody debris transects that were facing at 45°, 135°, 225° and 315°.



Photo 10.4: Surveyor counting pneumatophore on forest floor in the subplot

(e) Crab hole

190. Crab plays 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, in this study the crab hole were counted within an area of 1 m radius circle in each subplot's centre and in the midpoint of four woody debris transects (**Figure: 10.2**).



Photo 10.5: Surveyor counting crab hole in the subplot

(f) Lichen

191. The presence and absence of Lichen on tree species are important indicators of forest health because it is very sensitive to air pollution such as sulfur dioxide, fluoride etc. The Lichen cover percentage (%) on tree trunk was measured visually at breast height from 0-100%. The plot average percentage was calculated and status was evaluated following Path Finder Science standard (2006).



Photo 10.6: Lichen (white circle) on Gewa tree in the subplot

(g) Canopy Cover

192. Percentage (%) of canopy cover was estimated by a spherical densiometer which is a grided convex mirror that provides a simple and inexpensive approach of measuring canopy cover. The densiometer was 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. After levelling the instrument using the level bubble, the dots not occupied by canopy was systematically counted. In each subplot, the readings were taken at five points facing at north, south, east, and west direction including subplot centre point. First one was taken standing at subplot centre and the other four were taken at the middle point of the four transects between centre and periphery. The canopy cover was estimated by taking the average of these five readings.



Photo 10.7: Crew member taking canopy cover percentage

10.4 Monitoring Result and discussion of SRF Health

10.4.1 Seedling

193. In the Sundarbans, most of the mangroves seeds are dispersed 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. The seedlings density was found highest in this monitoring period in comparison to the other monitoring period (Figure.10.4). However, an increasing trend and good number of seedling survival were found in most of the sites but in Akram point the seedlings status were comparatively lower (Figure.10.3). Usually, in natural forest which is followed by the rule of natural selection, at the early stage seedlings die due to competition for nutrients as well as light intensity.

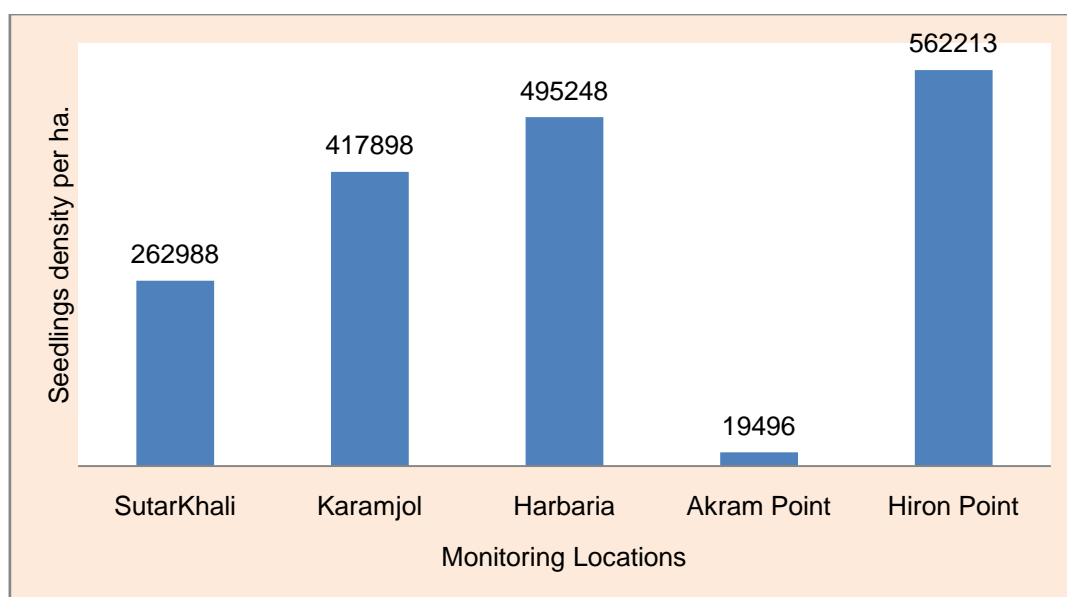


Figure 10.3: Mean seedlings density per ha. in the monitoring plots (PSPs)

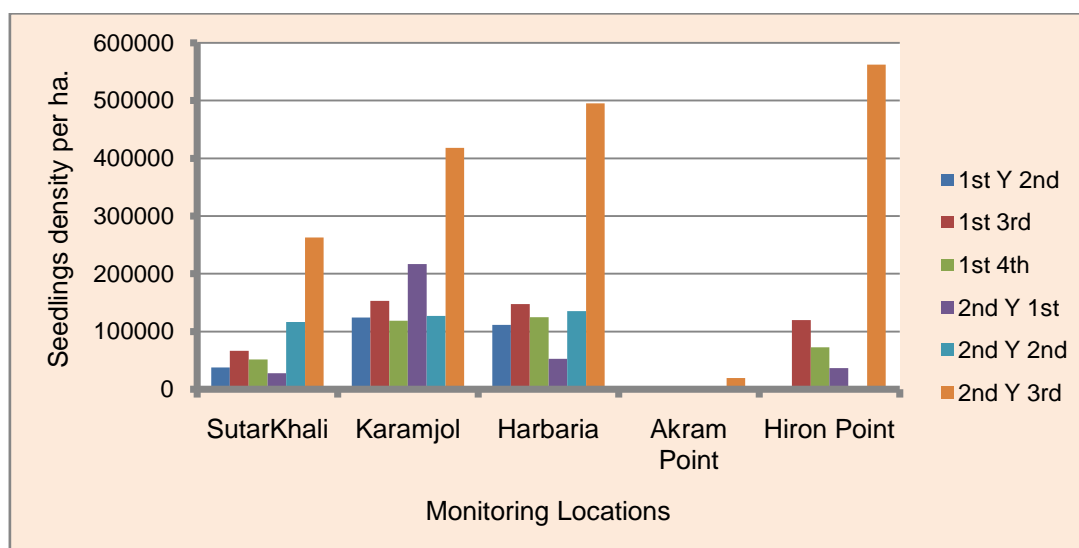


Figure 10.4: Mean seedlings density per ha. among the quarterly surveys in five monitoring sites

10.4.2 Pneumatophore

194. The mean density of pneumatophores has not significantly varied during the sixth monitoring periods in all of the study sites (Figure. 10.6). In the monitoring, it is usually found that Karamjal is mainly dominated by Baen tree, and it has numerous tender pneumatophores that usually dry up and die during dry season. For this reason, in this site, the pneumatophore density was found higher than the other sites (Figure. 10.5). The forest health study sites are mainly dominated by Sundri-Gewa-Goran tree species. In general, the mean pneumatophores density is found lower in number in Akram point and Heron point due to floristic composition (Gewa tree dominated).

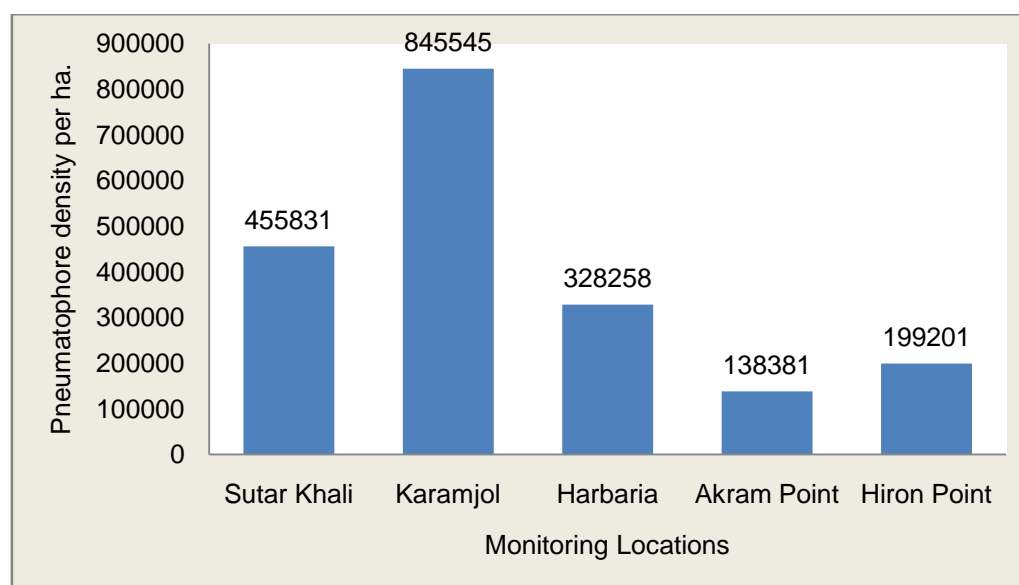


Figure 10.5: Mean pneumatophore density per ha. in the monitoring plots (PSPs) for 2nd year 3rd quarter monitoring

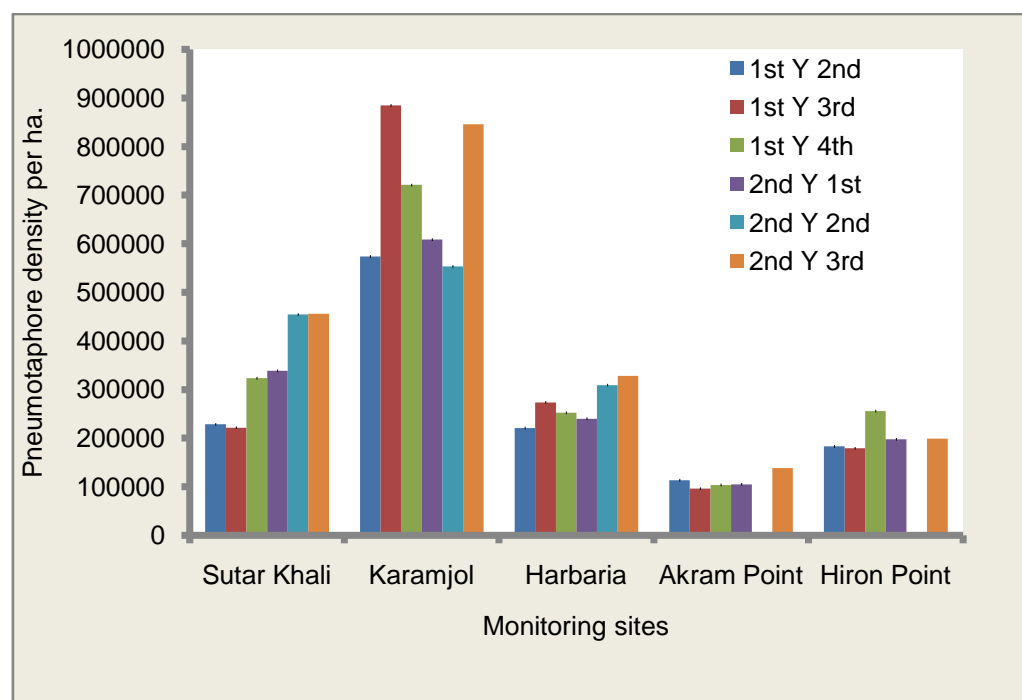


Figure 10.6: Mean pneumatophores density per ha. among the quarterly surveys in five monitoring sites

10.4.3 Crab hole

195. The crab hole density per hectare (the indicator of availability of crab in a site) has significantly varied among all the five monitoring sites (Figure 10.8). This result indicates that food chain has remained good in all the monitoring sites as crabs are the primary consumers of fallen leaves on forest floor that are source of nutrients in soil. The numbers of crab hole were found highest in Akram point and lowest in Hiron point (Figure 10.7).

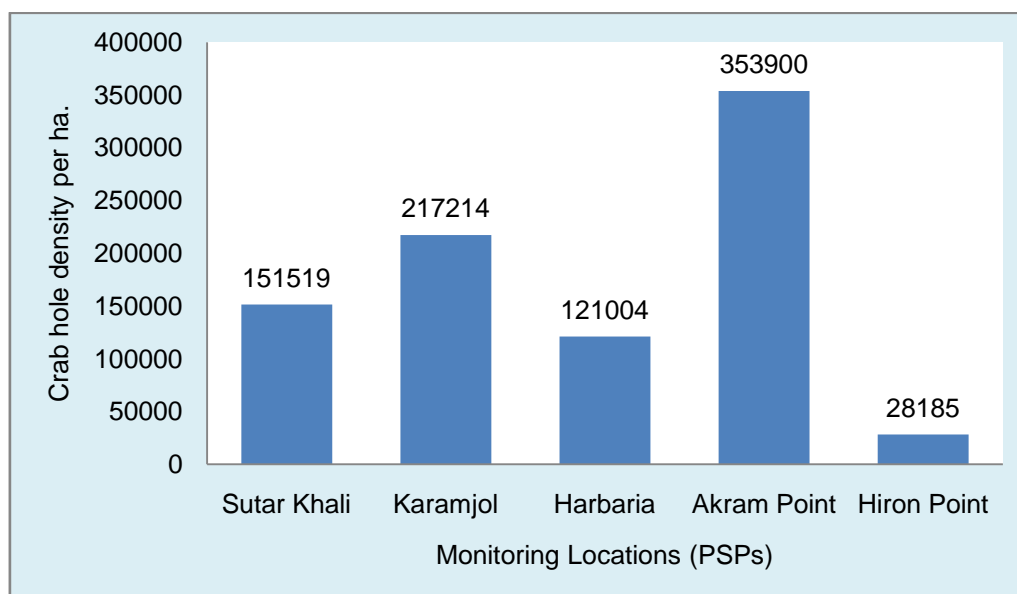


Figure 10.7: Mean crab hole density per ha. in the monitoring plots (PSPs) for 2nd year 3rd quarter monitoring phase

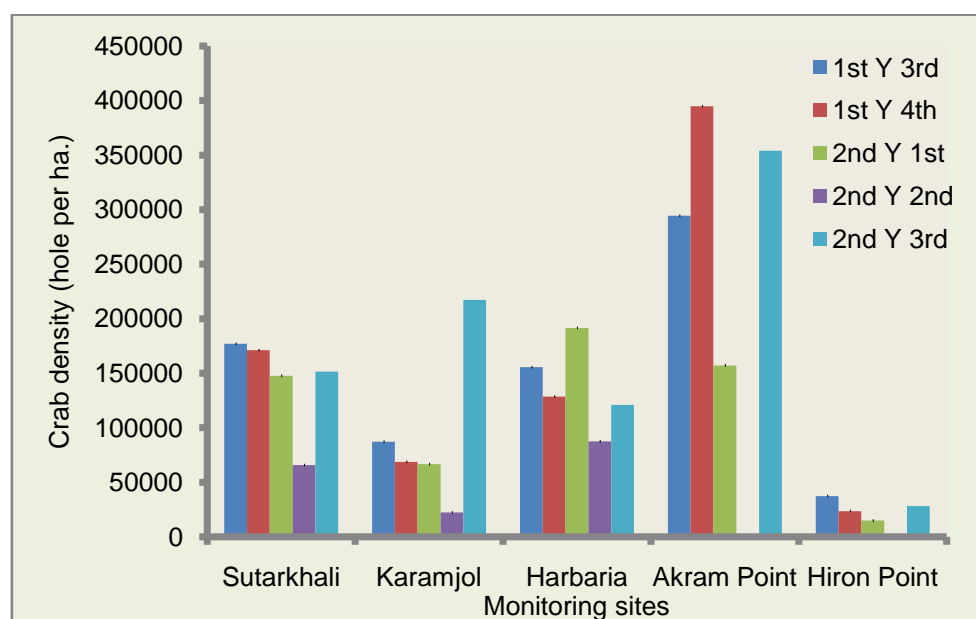


Figure 10.8: Mean crab hole density per ha. among the quarterly surveys in five monitoring sites

10.4.4 Lichen

196. The lichen coverage (percentage at breast height) on tree has gradually reduced in all of the five monitoring sites among the five quarters monitoring from July 2014 to October 2015. In SRF, environmental conditions (Temperature, humidity, salinity etc.) usually get worse in April and May. After that it gets improved for flora and fauna, and monsoon season

is congenial for floral growth and health. This could be the reason behind changes in lichen availability among the quarters in the monitoring sites of SRF. According to the Pathfinder Science standard (2006) (community with 5% is assumed that the ecosystem has abundant lichen), the lichen coverage was more satisfactory in Sutarkhali followed by Karamjal sites, while the other three sites were below that standard (**Figure 10.10**). This change indicates that salinity may have a detrimental role on lichen as Sutarkhali and Karamjal are close to landward side and the salinity, here, is lower than the other sites.

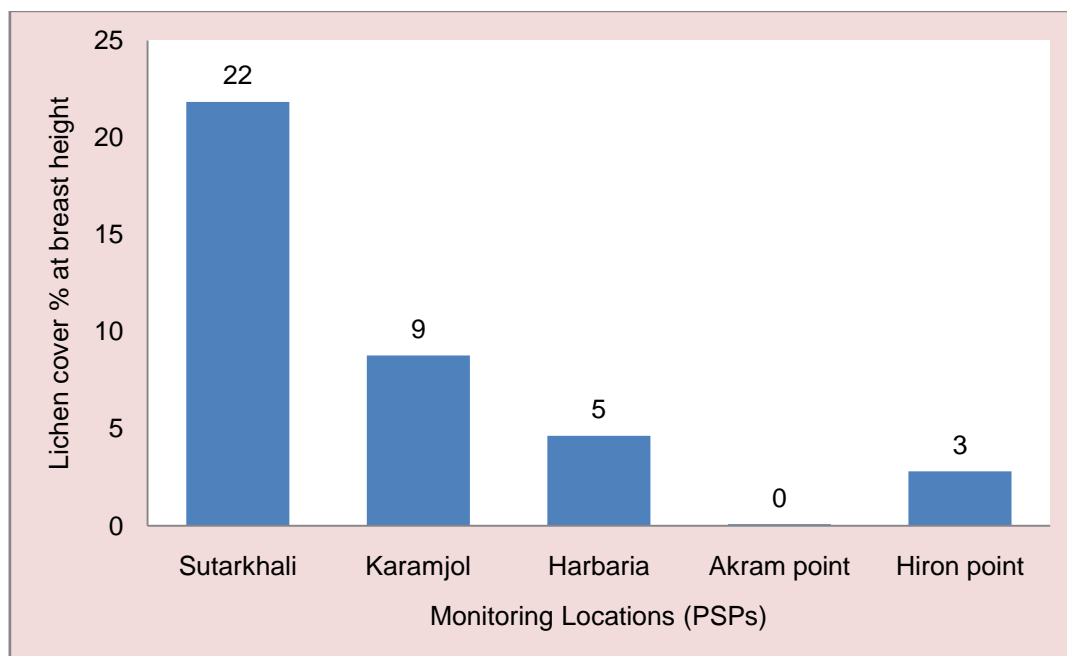


Figure 10.9: Mean Lichen cover % at breast height in the monitoring plots (PSPs) for 2nd year 3rd quarter monitoring event

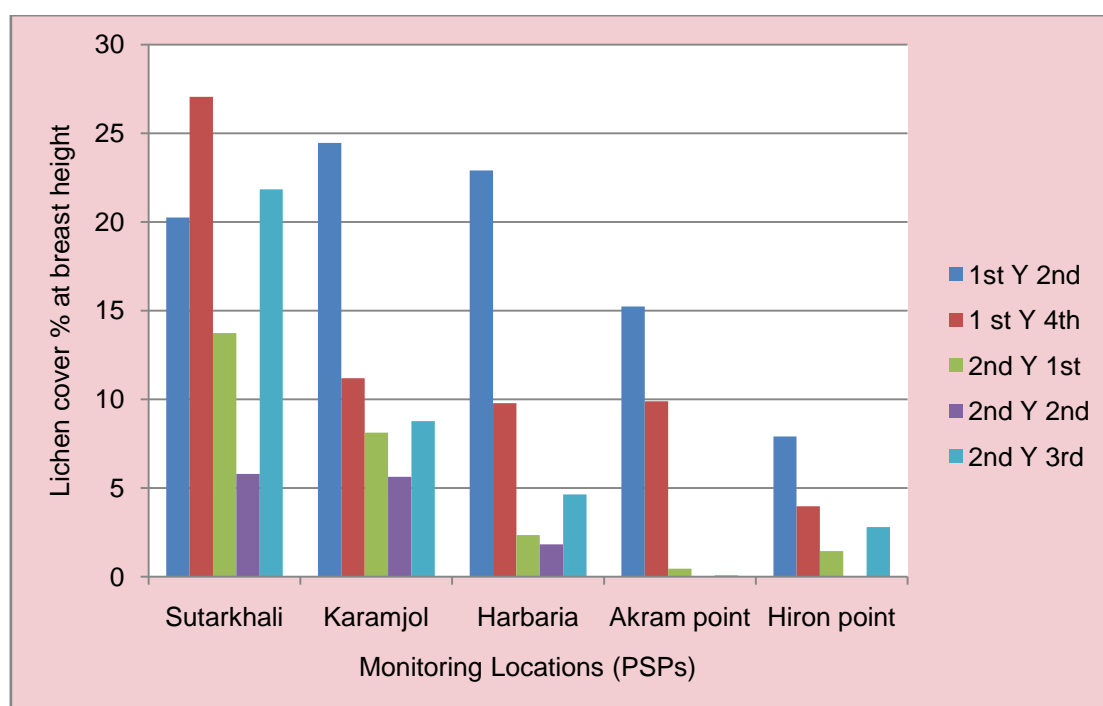


Figure 10.10: Mean Lichen cover % at breast height among the quarterly surveys in five monitoring sites

10.4.5 Canopy cover

197. In the monitoring plots, the canopy cover percentages have not varied significantly. It was found that the canopy cover percentages were similar among the monitoring sites (Figure 10.11). 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.

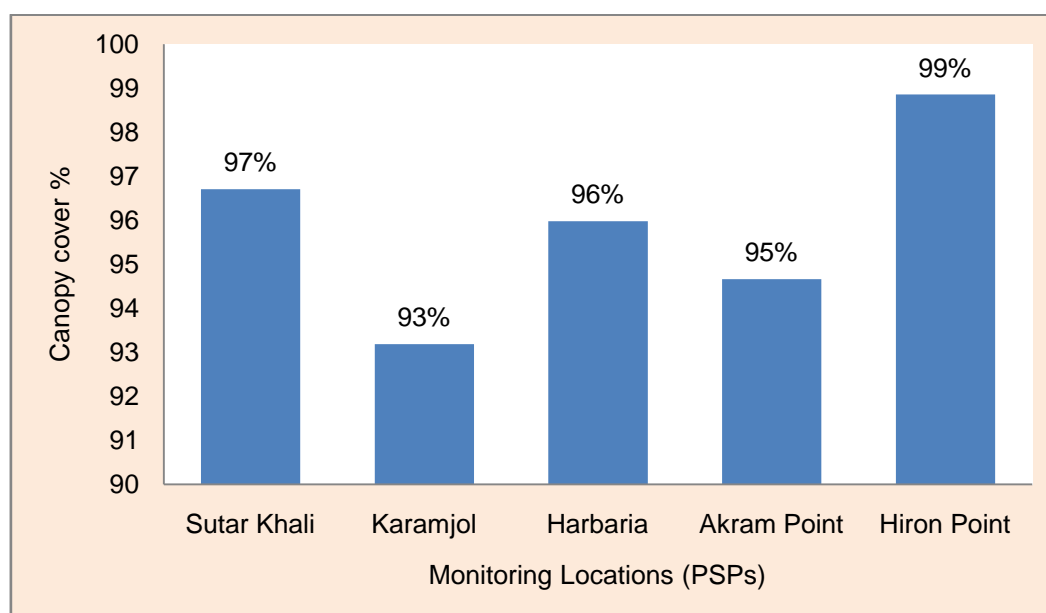


Figure 10.11: Mean canopy cover (%) in the monitoring plots (PSPs) for 2nd year 3rd quarter monitoring period

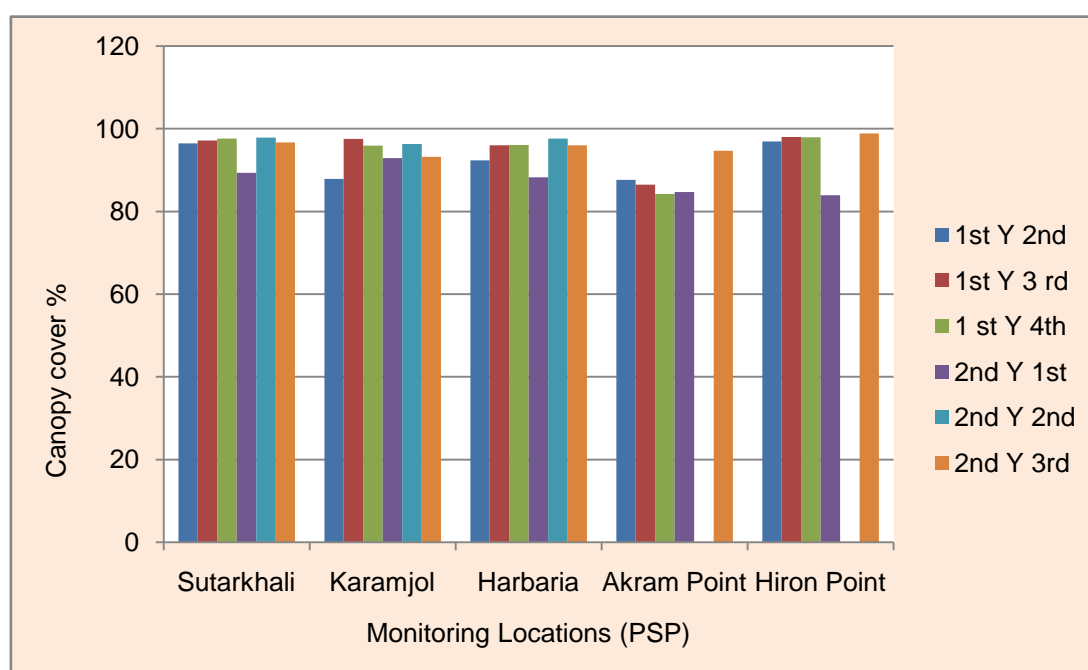


Figure 10.12: Mean canopy cover (%) among the quarterly surveys in five monitoring sites

10.4.6 Net canopy photosynthesis

198. Net photosynthesis of the five monitoring sites are given in the **Table 10.1**. The net canopy photosynthesis of the monitoring sites was more or less similar, however Karamjal Site shows comparatively lower value. This is because Karamjal has lower leaf area index.

Table 10.1: Net canopy photosynthesis among the quarterly surveys in five monitoring sites

Monitoring Sites	Leaf area index	Net canopy Photosynthesis (g C m ⁻² s ⁻¹)
Sutarkhali	4.17	2.70
Karamjal	2.69	1.74
Harbaria	4.09	2.65
Akram Point	3.12	2.02
Hiron Point	2.92	1.89

10.5 Conclusion

All the indicators of forest health in SRF were in good condition in the 2nd year's 3rd quarter monitoring program in October 2015. The result of the current monitoring will be used as a baseline for future forest health monitoring and evaluation.

11 Socio-economic Condition and Social Safeguard Monitoring

199. 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 7th Monitoring report (i.e. 3rd Quarter 2nd year-submitted Quarterly and initiated from 5th to 10th October, 2015) covering fourth phase of socio economic monitoring (six months interval) study and also updates environmental and social monitoring data to November, 2015.

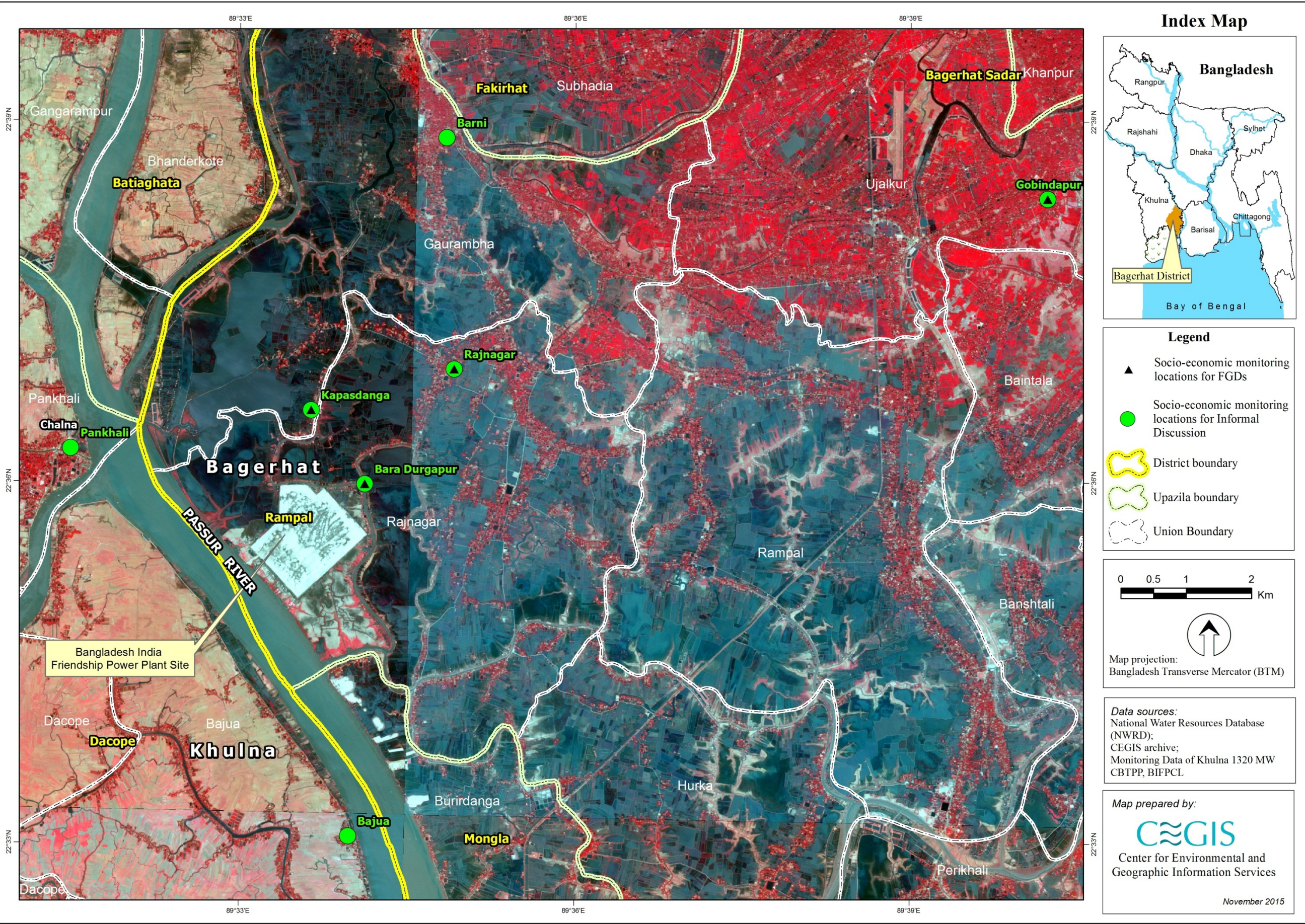
200. The socio-economic status changes gradually with time and as such the frequency this assessment is planned bi-annually and subsequently resumed during this current monitoring period.

11.1 Methodology

201. 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 April, 2015) such as Focus Group Discussion (FGD) and informal discussions.

202. Total 4 FGDs and 6 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 six (6) informal discussions, two were with Project Management and one with working labors; and the rest three (3) in Barni, Pankhali and Bajua mouzas with local people(**Map 11.1**).

203. 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 11.1: Socio-economic Monitoring Locations

11.2 Exploration of Monitoring Parameters

11.2.1 Compensation

204. 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 some land leasees are being compensated. Due to inadequate legal documents, some affected people did not receive compensation in the acquired land. Local people are expecting the involvement of Government/Project authority to resolve the issues as soon as possible.

205. It is observed that 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. Due to lack of proper 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 The Acquisition and Requisition of Immovable Property Ordinance, 1982.

11.2.2 Resettlement/Rehabilitation

206. Total 18 households have been resettled in Foyla Cluster Village without sufficient livelihood options. However, 4 allottees 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.

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

208. Land (6 decimal) has 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 re-settlers land document, where they are currently residing. As a result, the re-settlers still remained landless and fear of eviction anytime from the present residence is always there.

209. 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 opined 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.

210. After opening the Mongla-Ghasiakhali 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 re-settlers for easy access to the urban side.

211. The resettled populations 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.

11.2.3 Project Related Employment Generation

212. At this stage, the current activities of the Project include- constructing base office at Block A, brick crushing, tree plantation and land preparation at Block B etc. At this stage numbers of skilled migrated labors have been engaged in those activities. Therefore, involvement of local laborers is negligible.

213. 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.

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

215. 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.

11.2.4 Labor and Working conditions

216. 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 labor recruitment, contractors feel comfortable recruiting migrated labor (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.

217. 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 monsoon. The condition of these labor sheds urgently needs improvement. The respective authority assured that the conditions of these temporary sheds would be improved by the



Labor shed

EPC contractor when activities of the Power Plant will commence.

218. 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.

219. 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.

220. 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.

221. The labors alleged that there is no bonus in festivals (Eid, Puja etc); they get leave as “leave without pay” basis in festivals. The labors also mentioned about the 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.

222. It has been observed that the labor and their working conditions have been gradually improving since early 2014. However, the above mentioned conditions should be further improved based on the required standard.



Photo 11.1: A glimpse of labor and working condition

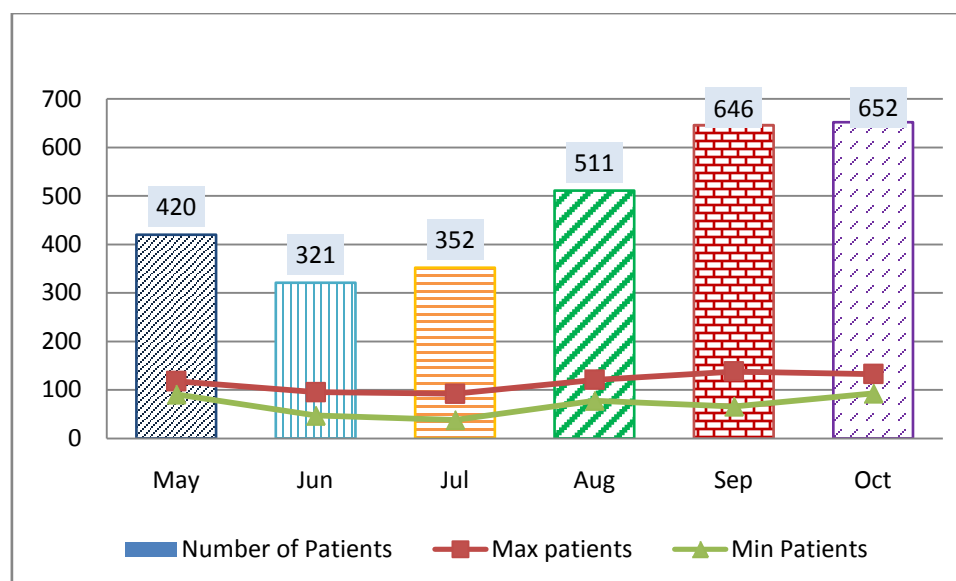
11.2.5 Community Health Safety and Security

223. 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 stated that the boundary wall would decrease the spread of dust. However, measures should be adopted at time during heavy wind blowing period e.g., water spray along the road way/walk way, major working area, labor sheds etc.

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

11.2.6 Activities under Corporate Social Responsibilities

225. Free medical service is being continued and 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 now takes 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: Field visit to Project office, CEGIS, 2015

Figure 11.1: Record of health service recipients under CSR program

226. From the record it was found that 2,902 people had received health services in the last six months. The highest recipients are in October-2015 (as it has 5 weeks) and the lowest is in June-2015 (Figure: 11.1). 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 11.1 that number of minimum recipients fluctuated more compared to the number of maximum recipients over last six months.

227. 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, 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.

228. The local people and the service recipients expressed satisfaction 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



Rajnagar



Interviewing an officer at Project Site



Environmental Specialists' Project Site visit

Photo 11.2: Photographs of stakeholder consultations



Photo 11.2: Photographs of stakeholder consultations

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Annex 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	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • 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)

SI no	Potential Impacts	Proposed EMP	Actual Implementation	Recommended Action	Compliance Status
		protected from wind and rain action <ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • Provision of onsite waste management system 			
5	Compensation and Resettlement	<ul style="list-style-type: none"> • 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 shiftable 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)

SI no	Potential Impacts	Proposed EMP	Actual Implementation	Recommended Action	Compliance Status
		<ul style="list-style-type: none"> Provision of monitoring the compensation and resettlement process 			
6	Livelihood and living	<ul style="list-style-type: none"> 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? 			
	Green House Gas Controlling Measures	<ul style="list-style-type: none"> 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

SI 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

SI no	Potential Impacts	Proposed EMP	Actual Implementation	Recommended Action	Compliance Status
1	Working Conditions and Management of Worker Relationship	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • 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 			

(continued)

SI no	Potential Impacts	Proposed EMP	Actual Implementation	Recommended Action	Compliance Status
		<p>the child's health or physical, mental, spiritual, moral, or social development.</p> <ul style="list-style-type: none"> No Force Labor 			
	Safety at site	<ul style="list-style-type: none"> 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 			

(continued)

SI no	Potential Impacts	Proposed EMP	Actual Implementation	Recommended Action	Compliance Status
	Occupational Health and Safety Procedure	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • 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 			
2	Grievance of local people	<ul style="list-style-type: none"> • Availability and operation of Grievance Redress Mechanism • Maintaining open communication channel with the local community 			
3	Risk of breaching Community Safety	<ul style="list-style-type: none"> • 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)

SI 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 poses 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.	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • No encroachment of inter-tidal flood plain area • No disturbance to Dolphin community • Monitoring of Ecosystem Health and 			Complied

(continued)

Sl no	Potential Impacts	Proposed EMP	Actual Implementation	Recommended Action	Compliance Status
		<p>Monitoring of Sundarbans Forest Health</p> <ul style="list-style-type: none"> • If required, embankment should be constructed considering a set back 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 			

Annex II: Photo Album

Environmental Monitoring of Rampal PP (October 2015)



Composition of Monitoring Team



Estimating Light Intensity by Lux Meter at Akram Point



Recording forest data condition at Harbaria site

(continued)



Plot Laying out at Harbaria

Estimating Tree Height by Laser Range
Finder at Akram Point

Fish Catch Assessment at Passur River



Observe Tree Canopy cover with Densiometer



Taking Tree DBH at Karamjal Site



Counting seedlings and crab holes at Karamjal

(continued)



Cross-checking of present data with previous



Taking Sapling DBH at Akram Point



Observing light intensity under tree canopy at Hiron Point



Measuring a large size tree DBH at Hiron Point

Annex 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	SO _x
	NO _x
	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.