Monitoring Report of First Quarter, Second year

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

May 2015

First Quarter Monitoring Report of Second year

Monitoring Period: March 2015 – May 2015

Bangladesh – India Friendship Power Company (Pvt.) Limited

(A joint Venture of NTPC Ltd and BPDB)

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Acknowledgement

The Center for Environmental and Geographic Information Services (CEGIS), a Public Trust under the Ministry of Water Resources, is indebted to Bangladesh India Friendship Power Company (Pvt) Limited (BIFPCL) for awarding the contract of "***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***" to CEGIS.

CEGIS is grateful to Mr. Monowar Islam NDC, Secretary, Ministry of Power, Energy and Mineral Resources (MoPEMR) and Chairman, BIFPCL for his exceptional leadership. CEGIS expresses its gratitude to Mr. Md Abduhu Ruhullah, Chairman, Bangladesh Power Development Board (BPDB) for his continuous inspiration and support in all respect. CEGIS is also thankful to Mr. V.S. Tamrakar, Ex-Managing Director, and Mr Bhattacharya, Managing Director of Bangladesh India Friendship Power Company (Pvt) Limited (BIFPCL) for his direction and guidance. CEGIS appreciates the support and instruction of Mr. Atanu Kumar Mitra, Deputy General Manager, BIFPCL, Mr. Anindya Majumder, Chief Technical Officer, BIFPCL and Engr. Dinesh Chandra Mistry, Executive Engineer, BIFPCL.

CEGIS is indebted to Mr Md. Alamgir Hossain, Junior Supervisor (Mech), BIFPCL for accompanying the team during carrying out monitoring in the Sundarbans.

CEGIS is also grateful for the contribution of the field officials of different Government and Non-Government organizations for sharing their ideas and views on the attitudes of the local people towards the Project and existing problems of the study area as well as their suggestions in solving the problems.

Last but not the least, the study team appreciates and acknowledges the concerns and perceptions of local people regarding the Project and their active participations during field visits.

Table of Contents

List of Tables

List of Figures

List of Photographs

List of Maps

Abbreviations and Acronyms

AECL	Adroit Environment Consultants Ltd
AAS	Atomic Absorption Spectrophotometer
BIFPCL	Bangladesh India Friendship Power Plant Company Ltd
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
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
PMU	Project Management Unit
PWD	Public Works Datum
QMR	Quarterly Monitoring Report
RRA	Rapid Rural Appraisal
RS	Remote Sensing
SRDI	Soil Resources Development Institute
SRF	Sundarbans Reserve Forest
ToR	Terms of References
TDS	Total Dissolved Solid
TS	Total Solid

Executive Summary

With the aim of complying with the given condition of Department of Environment and the environmental and social safeguarding rules of Bangladesh, 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. 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 implementation of EMP during pre-construction and construction phases. The results of the monitoring are quarterly reported to BIFPCL through Monitoring Report of each quarter.

Monitoring in four quarters in first year (2014) has already been completed and reported. In first quarter of second year, monitoring activities were carried out in April 2015. The monitoring activities involved:

- Monitoring Implementation of EMP and Environmental Compliance
- Monitoring of ambient air quality
- Monitoring of ambient noise
- Monitoring of ambient water quality
- Monitoring of soil quality
- Monitoring of fisheries resources covering fish habitats, biodiversity, migration and production
- Monitoring of ecosystem and biodiversity
- Monitoring of Sundarbans Forest Health
- Monitoring of Socio-economic Condition, Community Health, Safety and Security, and Labor and Working Conditions.

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

Monitoring of EMP during Pre-construction Activities

At present, the following pre-construction activities are in progress at project site:

- Construction of Embankment around the Project site
- Construction of pre-fabricated site office
- Slope Protection Work

The monitoring study also includes, monitoring of environmental compliance of these pre-construction activities and monitoring of implementation of Environmental Management Plan as suggested in the EIA report and later vetted by DoE. In general, the environmental due diligence covered the following components:

- Environmental and Social Management System and Action Plan

- Labour and Working Condition
- Community Health, Safety and Security
- Biodiversity and Sustainable Management of Living Natural Resources

The monitoring study found the pre-construction activities partially complied with the EMP. Being the Environmental Monitoring Consultant of the project, CEGIS makes the following suggestion that should be complied for ensuring environmental and social safeguarding of the project:

- Adequate water supply and sanitation throughout the project site should be ensured
- All aspects of OHS measures mentioned in the EIA should be ensured in all projects phases
- Slope protection work along the Maidara River should be completed on an urgent basis before rainy season come and the practice of Dumping of soil generated from slope formation and finishing work and excavation in the river should be stopped immediately
- Engineering design for slope protection should strictly be followed and adequate setback distance from the intertidal earthen shore with proper slope needed for fish and other aquatic flora and fauna of the river should be maintained
- Any crushing machine used for this project should have dust control system such as suction and filtering, soaking of brick with water before crushing and spraying water at dust emitting source
- Provide orientation training to workers about OHS
- 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.

Air Quality Monitoring

Similar to the earlier quarter monitoring, ambient air quality has been monitored at the same 11 locations. Prevailing wind direction was South-East. Weather was sunny in daytime. In this quarter concentration of SO_2, NO_2, $PM_{2.5}$, and PM_{10} were found within the standard in all of the locations. But SPM concentration was found above the standard in most of the points except Bajua and the 3 locations in Sundarbans.

Noise Monitoring

Ambient noise was monitored at the same 11 locations as of earlier monitoring. Around the Project area the ambient noise levels were found in between 41 dB to 73 dB. Maximum noise level was found at Khulna-Mongla highway near the Khan Jahan Ali Bridge and lowest was found within the project site. In Sundarbans, Noise levels were found in between 48 dB to 65dB. Within the Sundarbans highest noise level was seen at Harbaria and lowest was recorded in Hiron Point. Wind action on trees, river wave, bird's chirping, ship and fishing boats, etc are the source of noise observed in Sundarbans except Harbaria region. In Harbaria, ships are major source of noise.

Water Quality Monitoring

Same water quality parameters as tested in the earlier quarter were also considered for this quarter monitoring at the same sampling locations as of first quarter monitoring. In total two locations in Maidara rivers, 12 locations in Passur river and one location in Sibsha river were pre-selected. There are four hand pump tubewell selected for monitoring water quality at each quarter.

The insitu testing result shows that there are seasonal variation in salinity, pH`, DO and BOD. Collected water samples are being analyzed in the DPHE's laboratory. The laboratory analysis includes measurement of COD, As, Hg, Pb, Hardness, NO_3, PO_4, SO_4, TS, Turbidity, Na, K, Ca. Mg, Si, Fe, HCO_3, CO_3, Cl, EC, and oil & grease concentration. In Harbaria region of Sundarbans, Oil and Grease concentration was found abnormally higher which might be an impact of the recent incident of capsizing of an oil tanker in Shela river of Sundarbans.

Land Resources Monitoring

In this quarter, the composite soil samples were collected from five agricultural lands located within 10km radius of the Project site. Samples have been submitted to SRDI, Dhaka laboratory for analysis. Once the reports are available, those will be attached in the next monitoring report.

Agricultural Resources Monitoring

During the time of monitoring i.e. April 2015, the agricultural lands (selected from monitoring purpose since January 2014) were found fallow. The same was seen in April 2014 as well.

Fisheries Monitoring

Fisheries resources have been monitored at the same locations as of earlier quarter monitoring. The following are the key finding of the monitoring in first quarter second year:

- Habitat uses are supposed to be changed yearly (2014-2015). Moreover, through analysing Habitat Suitability Index (HSI) Sheolakhal at Chandpai has been found as the most suitable habitat for fish species among Passur River System and Chalna Point as the least.
- Shannon-Weiner index has been varied between 2014 and 2015. The highest index has been found at Akram Point (0.96). On the contrary, lowest evenness has been found at Mongla Point. Moreover, maximum FSR was obtained in Sheolakhal at Chandpai (n=5), while very low FSR was recorded in Passur river at Chalna point (n=1).
- Juveniles for fin fish and adults of prawn (particularly Golda) and fin fish species were more randomly distributed among the upper, middle and lower stretches of the Passur River.
- Fish species like Boiragi Chela attains the maximum abundance among the migratory fish species. Only four species like Banspata, Bele, Phessa and Pomashowed long range of distribution.
- Of the entire selected shrimp/fish farm seeds for Bagda stock are collected from the wild sources. The highest stocking rate and mortality have been observed in case of gher in BhekatkhaliKhal, Rajnagar.

- The highest productivity has been found inAkram Point, and lowest in the Mongla Point. Moreover, as expected lower productivity was observed in thisfirst quarter of 2015as compared to that in first monitoring year of 2014.The total catch through most frequently usedBer and CharpataJal is 7.5 kg. However, the total catch is lower in this monitoring year than that found in the first monitoring year.
- Only one gher, BhekatkhaliKhal, Rajnagar, has attained 1 kg horinachingri as their catch within the month of March-April.

Ecosystem and Biodiversity Monitoring

Plant health, plant canopy cover, bird habitat, lichen cover, butterfly occurrence and dolphin occurrence have been monitored for this monitoring season. Out of 4 monitoring sites two sites observed significantly deterioration of healthy trees due to increase of soil salinity at Rajnagar and Barni. Coverage of canopy followed slightly decrease for two of studied homesteads. Lichen cover on selected trees barks recorded low than previous monitoring due to lake of sufficient moisture. Two number of bird nest found at Borni and Chalkghona site. A total of 12 butterfly species have been recorded from all the monitoring sites and at Kalekarber site contains highest population of butterflies.

Occurrences of dolphins have been reduced at Passur river along the project site for having high salinity. Two Ganges River dolphins were occurred at confluence points of Passur-Maidara and Maidara-Ichamoti River during transect survey. Moreover Irrawaddy Dolphin groups have also been followed at Akram point.

Sundarbans Forest Health Monitoring

Forest health was monitored at four locations – Karamjal, Harbaria, Akrampoint, Hiron point and Sutarkhali. Forest health monitoring covered assessment of species diversity, richness, regeneration, recruitment, seedling survival, canopy cover diameter, biomass, and disease and damage. In this quarter, tree tagging done in earlier quarter was rechecked. Forest regeneration was monitored.

In this quarter, no significant difference in two subsequent monitoring was found in canopy cover and pneumatophores density in most of the monitoring plots. Only in Karamjal, pneumatophores density was found higher than the earlier monitoring.

All the indicators of forest health in SRF were in good condition except the lichen coverage percentage. In Sutar Khali and Hiron Point the canopy coverage percentage has decreased significantly but far above the minimum cover that used as a good canopy health. However, the in terms of lichen coverage, only Sutar Khali and Karamjol sites were good (though it also dereased) but Harbaria, Akram Point and Hiron Point were below minimum level of good lichen health condition. This could be due to the worse environmental condition in SRF that is a usual phenomenon, especially in April and May.

Socio-economic monitoring

Compensation

Compensation to the affected landowners was almost finished by the DC office Bagerhat. Few landowners are yet to get compensation due to inadequacy of land ownership documents.

Rehabilitation and Resettlement

18 households were found resettled in the Foyla Cluster village. As DC office was following existing laws of land acquisition, there was little scope of rehabilitation and resettlement. The local DC office only facilitate these households (illegal occupants in the lands acquired for the project) by allocating them house in cluster village.

Health

Fatigue, headache, pain in lower abdomen, coughing, acidity etc. are the common diseases for female in the community within the close vicinity of the project area. In case of male, common diseases are dysentery, coughing, fever etc.

Labor and working condition

Labor and working condition was not found complied with the EMP. Sanitation facilities for labor and workers are poor. Open Pit toilets were found at project site constructed for labor. Drinking water facilities have not been installed yet. Labors manage their own water. Safety was not found mandatory. No formal agreement was maintained in hiring labors.

The temporary labor sheds which are made of locally available thatching materials e.g. Golpata and bamboo are very poor place of living due to poor ventilation, lighting condition and vulnerable to wind and heavy rain. 300 people are living there.

Community Health, Safety and Security

People living within the close vicinity of the project area were complaining about dust generated from the newly filled land of the project area. Construction of boundary wall around the project is completed. An *Ansar* Camp has also been established in the Project site for ensuring security.

Corporate Social Responsibility

BIFPCL runs free weekly health camp for local people. So far 2,874 people received health facilities from that health program. The health camp offers free health consultation and limited medicine.

Hydro-morphological Monitoring

Hydromorphological monitoring included monitoring of drainage network, erosion, accretion and river bed material quality. A detail drainage network has been prepared from the analysis of satellite image (Acquired on 7 and 30 May 2014). Location of present eroding and accreting areas were identified on the basis of satellite image analysis and field observation. River bed sediments collected during first quarter monitoring were tested in the SRDI laboratory. The result of laboratory test has been provided in this second quarter monitoring report.

Land use and Land Cover Monitoring

The landcover and Land use of the study area have been identified from analyzing multispectral Rapid Eye satellite image of 5m resolution acquired on 7 and 3 May 2014. The image extracted data were further verified through ground truthing. Agricultural land is the dominating landcover that represents 59% of the study area. Agricultural land includes Current fallow and Agricultural Land Area, Seasonal Gher and Shrimp Aquaculture Pond/Gher. Shrimp aquaculture pond represents 21% of the study area.

1 Introduction

1.1 Study 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, the monitoring activities in first year (February 2014 – January 2015) has already been completed and reportedin four quarters (February 2014 - April 2014,May 2014 – July 2014 and August 2014 – October 2014). This time, the second year monitoring activities has been initiated. In first quarter of second year, the team carried our monitoring activities in March 2015 to April 2015.

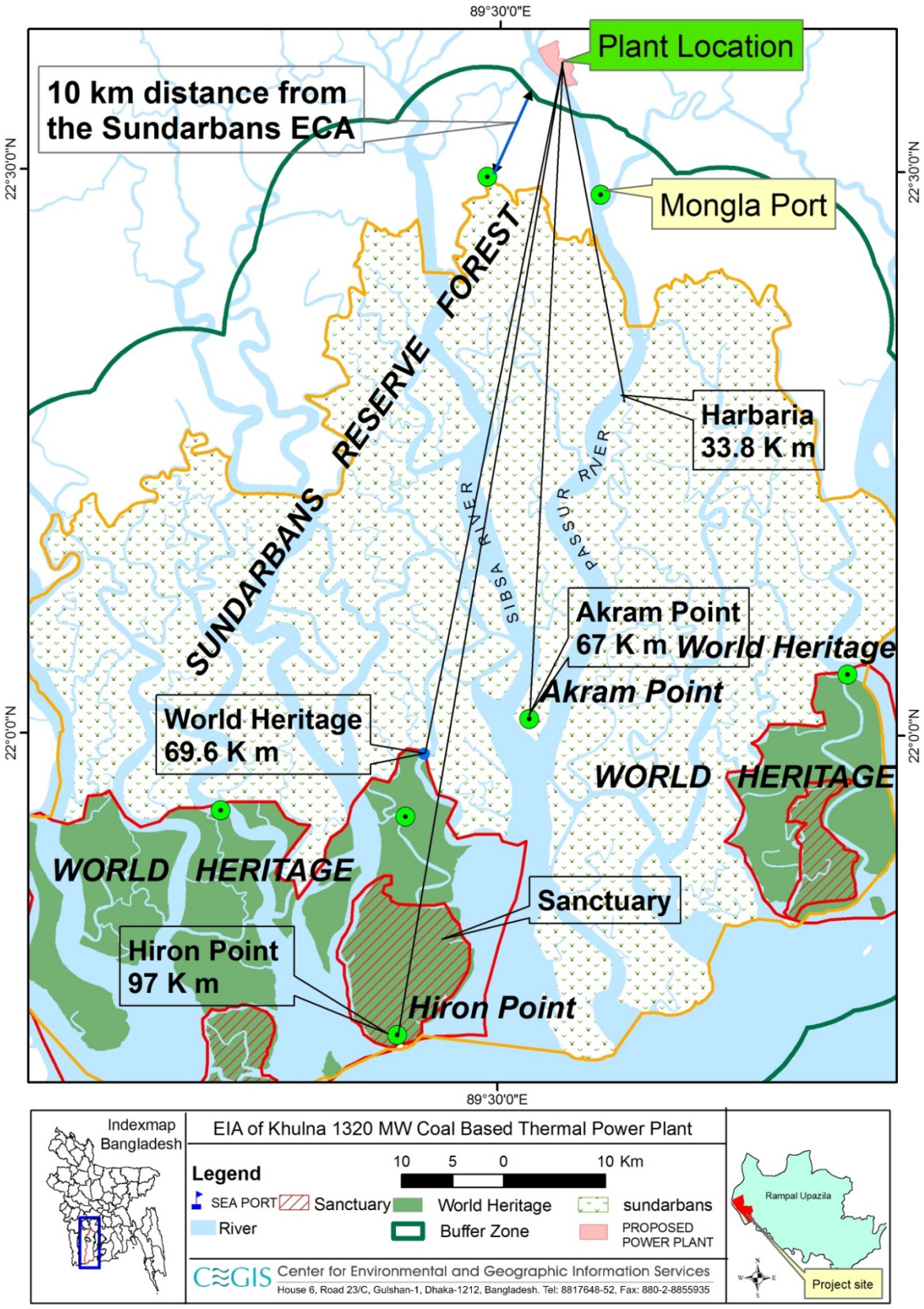
1.2 Objectives of Monitoring

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

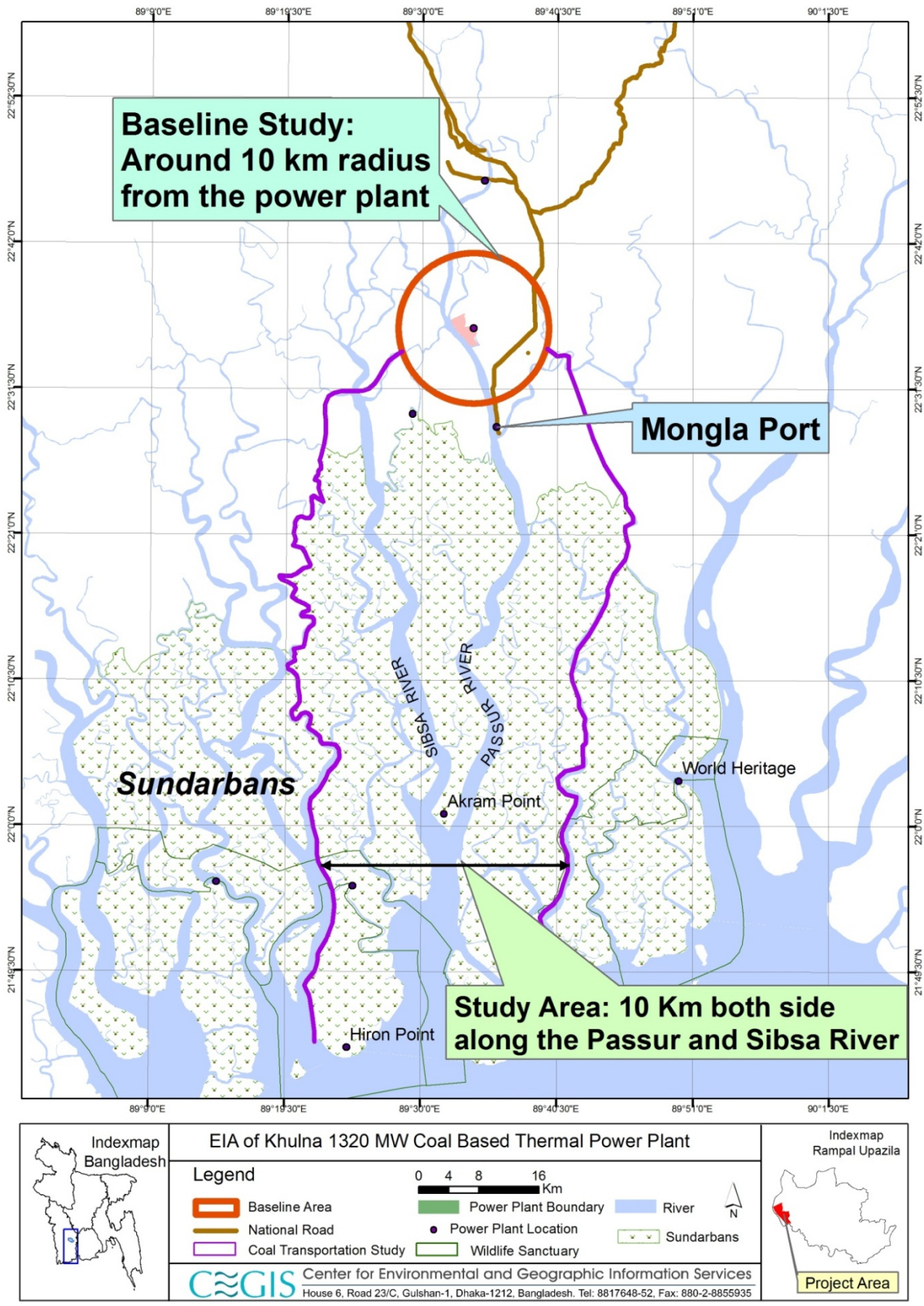
4. The aim of this quarter monitoring is to monitor the ambient state of environment that will be the baseline to compare the environmental condition in future when the Power Plant will bein operation phase. The monitoring activities also include monitoring of environmental compliance of power plant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

1.3 Project Location and Study Area

5. The Power Plant is located in between latitude 22^0 37' 0''N to $22^0$34'30''N and longitude $89^0$32'0''E to $89^0$34'5''E and at about 23km south from the Khulna City (**Map 1.1**) and 14 km north-westward from the Sundarbans. Location of the study area is presented in **Map 1.1**.The study area includes: i) area of 10 km radius from the Plant location, ii) 10km strip from the both bank of Passur and Shibsha rivers starting from Plant site to Hiron point (**Map 1.2**).



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



Map1.2: 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 to satisfy the conditions given 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 includes keeping close communication with Forest Department, submitting the monitoring report to Forest Department and inclusion of 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. As per the condition of the Forest Department, the monitoring team was formed. BIFPCL also forwarded a copy of earlierquarter 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.

2 Monitoring of Environmental Compliance during Pre-construction Activities

2.1 Background

9. Environmental Compliance monitoring has been carried out at two phases – third quarter (October 14) and fourth quarter (January 15). Land development in 426 acres area, construction of a pontoon, construction of overhead transmission line, temporary site office, heli pad, pontoon to site office road and some other activities were completed before engagement of CEGIS as environmental monitoring consultant.

10. The following activities were observed during the site visits:

- Landfill completed within area surrounded by boundary wall and to some extent outside the wall
- The entire land fill area presently is highly prone to dust generation due to wind and storm
- No plantation work was seen to be started
- Slope protection along the boundary wall has been completed
- Slope protection along portion of Moidara river have been going on
- Soil generated from slope protection and excavation found to be dumped in the bed and intertidal shore of Maidara river
- Soil eroded from the newly developed lands and disposal of slope protection work was found depositing in the Maidara river with rainfall runoff.
- Some excavation, construction work and concrete block making work were going on when workers were not useig any PPE
- The workers temporary sheds were unhealthy, covered by pp sheet and lack of proper ventilation
- Sanitary latrines and urinal facilities located far away from the working areas and seemed to be inadequate
- Crusher machines for making brick chips and khua have been generating huge dust and noise in the vicinity. The operators and workers were not using any kind of musk, shoes, ear plug, eye protecting goggles or any sorts of PPE
- There having no all-time emergency medical service in the project site. It was informed that workers have access to Health Camp run on weekly basis by project authority
- Drinking water supply was found limited
- Water in open tank for washing purpose near to the workplace was dirty.

2.2 Monitoring of Environmental Compliance

11. 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
- Labour and Working Condition
- Community Health, Safety and Security
- Biodiversity and Sustainable Management of Living Natural Resources

12. 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 data sheet are attached in Annex I. The details of the monitoring results of Community Health, Safety and Security, Living and Livelihood Condition and Labour and Working Condition are discussed in Chapter 12. Here, **Table 2.1, 2.2, 2.3 and 2.4** presents summary of the findings of the environmental compliance monitoring:

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

Sl No	Impacts	Mitigation Measures	Remarks on Due Diligence	Action to be taken
1	Generation of Dust from • land filled area • the area under land development process	• Installation of water spraying system to control dusts • Conducting dust monitoring and visual inspection around the site boundary • Fencing the construction site by drum sheet or Tarjja of any other fencing	• No measures taken so far to control dust • Construction of boundary wall is near to be finished. However, it prevents dust spreading to the adjacent area partially.	• Immediate action should be taken to control dust from the newly developed area • Green Plantation, development of vegetations e.g. grasses, bushes, etc should be started • Water spraying system should be installed • Any crushing machine used for this project should have dust control system such as suction and filtering, soaking of brick with water before crushing and spraying water at dust emitting source
2	Generation of Noise (moderate) from • Dredgers and sand carrying vessels involved in land filling activities • Excavator and other machineries involved in land	• Use efficient machineries fitted with noise control devices • Switching off/throttled downing of machines/equipments/generators which are not in use	• Partially complied by Switching off/throttled downing of machines/equipments/generators which are not in use • Excavators used in land leveling and site development activities produce minimum noise	• Vehicles, excavators and other construction equipments should be mainained in good order • Good housekeeping should be practiced

Sl No	Impacts	Mitigation Measures	Remarks on Due Diligence	Action to be taken
	leveling and site development • Other machineries e.g. brick crashing, piling, etc • Generator			
3	Generation of Greenhouse gases, SOx, NOx from Generators, dredgers, sand carrying vessels	• Use of efficient engines, machineries, generator in the construction activities • Regular maintenance of vehicles, generator and machinery in accordance with manufacturer's specifications • Switching off and throttling of machines/equipments/generators which are not in use	• Partially complied by Switching off/throttled downing of machines/equipments/generators which are not in use • Black smoke was noticed visually from the sand carrying vessels • Lack of regular maintenance of vehicles, generator and machinery in accordance with manufacturer's specifications	• Same as above
4	Water pollution from construction activities	• 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	• Partially Complied • No disposal of waste into the riverRain fall run off carries eroded soil and disposed to Maidara river • All the stockpiles are not protected from wind and rain actions	• Slope protection work along the Maidara River should be completed on an urgent basis before rainy season come and the practice of Dumping of soil generated from slope formation and finishing work and excavation in the river should be

Sl No	Impacts	Mitigation Measures	Remarks on Due Diligence	Action to be taken
		materials/spoil stored on river bank/slope • No disposal of waste and untreated waste water into the river	• Soil excavated from the river slope due to spole protection works found dumping near river bank that may easily go to river	stopped immediately • Engineering design for slope protection should strictly be followed and adequate setback distance from the intertidal earthen shore with proper slope needed for fish and other aquatic flora and fauna of the river should be maintained
5	Waste generation	• Provision of onsite waste management system • No disposal of waste and untreated waste water into the river • Proper management of sanitary waste	• conventional practice of managing domestic waste on site • On site toilet facilities	• Waste collection and disposing system should be developed
6	Improvement of Living and livelihood condition	• Development of Access Road for Project • Operation of Corporate Social Responsibilities • Prohibiting any activities which are subversive to society • Offer Employment opportunity to local people	• LGED will construct an access road for this project that might take time. Meanwhile, LGED will develop the existing rural road for communication. • BIFPCL is running a weekly health camp at site with an aim of extending it to nearby union parishad offices under the CSR program	No action required at this time

Sl No	Impacts	Mitigation Measures	Remarks on Due Diligence	Action to be taken
		• Having particular attention to the resettlers	• Local peoples are getting opportunity to work in construction related activities. BIFPCL is hiring labor through third party. The third party is instructed to give priority to locals. • No special plan for improving livelihood of resettlers was found	

Table 2.2: Monitoring Labour and Working Condition

Sl No	Issue	Measures	Remarks on Due Diligence	Action to be taken
1	Providing Safe Working Place and Working Condition	• Safe and Appropriate Sanitation and Water Supply System at Site • Installation/Construction of Safety Fence around the project area • Use of Personnel Protective Equipments (i.e. safety suit, safety goggles, ear plug, safety shoes, gloves, dust mask, etc.) • Safety trainings for workers (*i.e.* fire control, working at	• Overall Sanitation and Safety system was found unsatisfactory • The sanitation system was found very poor. Temporary toilets at remote construction site were found in adequate, unhygienic (open pit) and causing pollution to nearby water bodies. • Drinking water supply was found limited • Safety procedure was not found mandatory • Limited use of PPE by workers	• Sanitation facilities for labor should be developed immideately • Well designed laborshed should be constructed • Provide orientation training to workers about OHS • The mitigation measures and EMP proposed for ensuring occupation health and safety , and good labor and working condition should be implemented

Sl No	Issue	Measures	Remarks on Due Diligence	Action to be taken
		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.) • Provision of Health care facilities such as doctor, hospital etc available at/nearby the Plant construction site preparation and Follow of Emergency Response Plan • Adequate fire precautions in place (for example, fire extinguishers, escape routes) • 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	• Workers have access to weekly Health Camp running by the project authority	
2	Workers Well Being	• Establishment Grievance Mechanisms	• Labours have been engaged by third party • No complain about unfair	• Establish Grievance Redress Cell

Sl No	Issue	Measures	Remarks on Due Diligence	Action to be taken
		• Ensuring fair treatment, non discrimination and equal opportunity • Compliance of project's labour policy with the national labour law • No Child Labour • No incident of forced labour • Provision of Welfare facilities for Worker/Labour	treatment, discrimination were found • Involvement of public representative in selecting labour for the third party has two fold impacts. Their involvement ensures that the labour to be recruited is local. But some locals were blaming them for political biasness • No child labours and forced labour were found	

Table 2.3: Monitoring Community Health, Safety and Security

Sl No	Community Issue	Mitigation Measures	Remarks on Due Diligence	Action to be taken
	Community Safety and Security	• 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	• Partially complied. The project construction is at very initial stage. The grievance mechanism, training of security personnel, safe management of hazardous materials, etc are not yet implemented. However, an open communication channel with the local community is maintained. The project authority has	• Establish a grievance redress cell

Sl No	Community Issue	Mitigation Measures	Remarks on Due Diligence	Action to be taken
		the local community • Training and instruction to the security personnel about their behaviour and communication with the local people • Aware the security personnel about the right of the community people • Establishing a grievance mechanism for the community dwellers	recruited mobilized a social worker to maintain liaison with local community and to deal different social issues.	
	Community Health	• Provision of providing health service facilities to community if the project posses any health risk like sexually transmitted disease, communicable disease, vector-related • Implement all pollution mitigation measures to ensure safeguarding to community	• Partially Complied. • The BIFPCL has initiated weekly health camp. Each time roughly 150 plus people come to get health service. BIFPCL has plan to extend this service by organizing similar health camp at each nearby unions • Local community was complaining about dust generation from newly developed lands	• Implement dust contlol plan
	Youth Empowerment	• Providing training program for the local youth potential to get involved in the project related activities, (If yes, please write	• No such training has been initiated. However, the project authority is encouraging the locals through different meetings,	• The PMU should develop a plan for such training

Sl No	Community Issue	Mitigation Measures	Remarks on Due Diligence	Action to be taken
		down the number of the people received training in the remarks section)	community visit, etc to admit the youth in different technical training, vocational training program.	
	Public Communication, Consultation and Awareness	• Arranging public communication/consultation meeting held • Sharing of project information shared with local people • Organizing environmental and social awareness programs/meetings	• Complied • The project authority has installed different sign board, bill board, information display board at site. • The social worker of the project authority conduct regular community visit and discussion meeting in the nearby communities and villages • CEGIS which is engaged for environmental and social monitoring also conducts FGD, KII and informal discussion with the local people to disseminate project information and aware local about different environmental and social issues. • The public communication is also maintained through organizing regular health camp at site.	• This practice should be continuing • A communication strategy should be developed

Table 2.4: Monitoring Biodiversity and Sustainable Management of Living Natural Resources

Sl No	Impacts	Mitigation Measures	Remarks on Due Diligence	Action to be taken
1	Impacts on Fisheries	• Use of sediment fences, traps and basins for trapping the sediment, if required • Installation of proper run on/runoff drains • Availability of dispersants or other equipment to deal with accidental oil spillage • Avoiding fish breeding season (June – August) for sand extraction from river bed	Partially complied as: • Floating Oil (of approximately 5m x 5m area) was observed at jetty front • No facilities to deal with the spilled oil (e.g. Oil boom, oil absorbent, Peristaltic Pump, boom accessories, boom reels, etc) was found • Construction of boundary wall is in progress • Proper run on-run off drains	• Implement all the mitigation measures • Orientation training on oil spillage problem and avoiding practices should be provided to Local boat men and trawler men engaged for the project purposes
2	Impacts on Ecosystem Habitat	• No cutting/ felling of trees existing along the river bed • No encroachment of inter-tidal flood plain area • No disturbance to Dolphin community • Monitoring of Ecosystem Health and Monitoring of Sundarbans Forest Health	• Complied • Engagement of CEGIS for monitoring ecosystem health and Sundarbans Forest Health ensure the compliance to DoE's condition	• This practice should be continued

2.3 Compliance to Conditions of DoE

Sl no	Condition of DoE	Compliance	Remarks
1	This EIA Report is approved only for 1320 MW Khulna Coal based Power Plant. Any expansion or extension of this power plant will require obtaining further Environmental Clearance with additional EIA Study.	Not applied now	BPDB *will comply* with the condition prior to initiation of any extension/expansion.
2	The coal specification and power plant technology should be maintained as per EIA Report. In case of any changes in design, the proponent must obtain consent from DoE.	BIFPCL has engaged (PWC) as coal consultant. Once PWC finalizes the coal specifications, the technical report will be send to DoE	BIFPCL will comply with the condition or in case of any modification of coal specification they would duly inform the DoE.
3	Project Proponent may undertake activities for land development and infrastructural development of the project.	BIFPCL has started development activities	*Complied*
4	Project Proponent may open L/C (Letter of Credit) for importing machineries for the project which shall also include machineries relating to waste treatment plant and other pollution control devices	*	*
5	The activity under Proposed Khulna 3120 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	At present the Plant is under construction. BIFPCL engaged CEGIS for monitoring pre-construction and construction activities and for examining environmental impacts of these activities. During monitoring, dust	*Measures to stop dust generation, and sediment carrying by run off should be taken*

Sl no	Condition of DoE	Compliance	Remarks
	environment or natural resources.	generation from newly developed land, rain fall run off carrying eroded sediment from site was observed No impact has been reported yet by CEGIS. Therefore, this condition is complied	
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.	CEGIS, as an environmental consultant of BIFPCL is monitoring adoption of mitigation measures. Some mitigation measures has not been implemented yet	*Partially complied.* Mitigation measures for dust control from newly developed land, and safety measures for workers are partially adopted.
7	Any heritage sight, ecologically critical area, and other environmentally, religious and archaeologically sensitive places shall be kept protected during project construction phase.	Sundarbans is the only critical area of concern here. There is no religious, archaeological place in and around the site. The construction activities has been carrying out ensuring safeguarding to Sundarbans and ECA	*Complied*
8	Environment friendly construction and development practices shall be followed that minimize loss of habitats and fish breeding, feeding & nursery sites.	CEGIS reported few mitigation measures were not maintained properly but that didn't impact the fish habitat, breeding, etc.	*Partially 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.	Construction activities are limited to daytime only. BIFPCL is keeping close communication with local people	*Complied*

Sl no	Condition of DoE	Compliance	Remarks
10	Proper and adequate sanitation facilities shall be ensured in labour camps throughout the proposed project period.	CEGIS reported poor sanitation facilities at construction site, poor housing condition of labors. However, Site facilities are in development phase. Adequate and hygienic sanitation facilities will be ensured before starting of major construction works	*Partially 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.	Trucks, and other vehicles used at project area are not efficient , generating high noise and dust	*BIFPCL shul dtake immediate action on avoiding use of these vehicles*
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.	Insignificant amount of solid waste (mostly papers, construction waste, etc) is generated at site. No waste is burnt. Wastes are managed in conventional way. However, a proper system of waste collection and disposal system will be maintained at site when the major construction work will be started	*Partially complied*
13	Proper and adequate on-site precautionary measures and safety measures shall be ensured so that no habitat of any flora and fauna would be endangered or destructed.	Preconstruction and construction activities completed so far maintained pre-cautionary measures to safeguard flora and fauna.	*Complied*
14	All the required mitigation measures suggested in the EIA report along with the emergency response plan are to be strictly	BIFPCL has appointed a doctor for regular health check up of the workers. The monitoring of CEGIS finds no first aid facilities	*Partially Complied.* BIFPCL is to provide first aid facilities at site. They should develop and emergency preparedness

Sl no	Condition of DoE	Compliance	Remarks
	implemented and kept operative/functioning on a continuous basis.		
15	To control dust, spraying of water over the earthen materials should be carried out from time to time.	Water is sprayed in the area around the plant's site office to control dust. Construction of boundary wall is completed Wind driven dust is generated from the vast area of newly developd land.	*Partially Complied* *Measures as proposed in Table 2.1 should be implemented*
16	Storage area for soils and other construction materials shall be carefully selected to avoid disturbance of the natural drainage.	Construction materials have been stocked and piled far away from river bank and other water bodies But soil excavated from river bank slope for slope protection works are dumped near river bank that may easily reach the river	• Slope protection work along the Maidara River should be completed on an urgent basis before rainy season come and the practice of Dumping of soil generated from slope formation and finishing work and excavation in the river should be stopped immediately • Engineering design for slope protection should strictly be followed and adequate setback distance from the intertidal earthen shore with proper slope needed for fish and other aquatic flora and fauna of the river should be maintained
17	Adequate considerations should be given to facilitate drainage system for runoff water from rain/tidal surge.	Lack in proper run on/run off drainage	*Mitigation measures as proposed in the EIA and Table 2.1 bove as well should be adopted*
18	Adequate facilities should be ensured for silt trap to avoid clogging of drain/canal /water bodies	No stil trap was found to prevent wash off of sediment from newly developed land	*Proper drainage facilities and silt traps should be constructed*
19	The entire coal handling system should be	The Owner's Engineer is designing the coal	*In case of any modification, DoE should be duly informed*

Sl no	Condition of DoE	Compliance	Remarks
	designed as an enclosed (and not only covered) conveyor system. There should be integrated dust control system with dust extraction and bag filters at unloading areas and at each transfer points on the conveyor system.	handling plant considering this condition	
20	Coal plant should have high-efficiency bag filter for arresting dust emissions.	The Owner's Engineer is designing the coal handling plant considering this condition	*In case of any modification, DoE should be duly informed*
21	Coal should be stored in a covered storage yard.	The Owner's Engineer is designing the coal handling plant considering this condition	*In case of any modification, DoE should be duly informed*
22	The entire coal stockyard should be covered with water sprinkler provide with automated moisture sensor to control self-combustion.	The Owner's Engineer is designing the coal handling plant considering this condition	*In case of any modification, DoE should be duly informed*
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.	The Owner's Engineer is designing the coal handling plant considering this condition	*In case of any modification, DoE should be duly informed*
24	Integrated dry ash handling, loading, unloading and transportation system should be established.	The Owner's Engineer is designing the coal handling plant considering this condition	*In case of any modification, DoE should be duly informed*
25	There should be adequate and properly sized and designed dry ash silo with appropriate conveyor system.	The Owner's Engineer is designing the coal handling plant considering this condition	*In case of any modification, DoE should be duly informed*
26	Bottom ash should be	The Owner's Engineer is	*In case of any modification,*

Sl no	Condition of DoE	Compliance	Remarks
	extracted, crashed and stored in silos for utilization with proper collection and conveyor system.	designing the coal handling plant considering this condition	*DoE should be duly informed*
27	Resettlement and rehabilitation of the displaced population (including those who do not own land) should be done properly.	There were around 100 households (land less people) living at the site at the time of acquisition. As per the law of the land, there is no scope of resettlement of the PAPs who has no legal paper of ownership. However, the local DC office is helping the PAPs who want to have a house in the Government built shelter homes/village. As per CEGIS report, so far 20 HHs have been resettled in such places. CEGIS found 90% of the surveyed resettled PAPs are satisfied. BIFPCL has engaged third party for labour hiring with instruction of giving preference to local people/affected people and hiring through local chairman. However, CEGIS found some inadequacy in hiring local people as biasness of local chairman could not be possible to eliminate.	BIFPCL needs to ensure the affected person can get chances. CEGIS recommends to establish a grievance redress cell at plant site where local people or affected people can submit their complains.
28	Resettlement plan should be properly implemented and people should be adequately compensated.	Mentioned above	BPDB and GOB may take initiatives to resettle rest of the PAPs
29	Construction material should be properly disposed off after construction work is over.	Construction activities are ongoing. Disposal facilities for construction wastes will be used to dispose those materials properly.	Not possible to assess at this stage.

Sl no	Condition of DoE	Compliance	Remarks
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. CEGIS has completed first year of monitoring activities, and submitted four quarter monitoring reports which are available at BIFPCL web page. The monitoring indicators, location and frequencies were finalized through a discussion meeting among DoE, BIFPCL and CEGIS at CEGIS office. Later, the forest health monitoring indicators have been finalized after discussion with Forest Department. CEGIS also obtained permission from Forest Department for monitoring activities	*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 most of the EMP applicable at this stage. CEGIS, as an environmental consultant of BIFPCL is monitoring implementation of EMP. They reported most of the mitigation measures are adopted except dust control measures, run off/run on drainage system, and measure for safety of worker	*Partially 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	BIFPCL has engaged CEGIS for environmental monitoring in February 2014. CEGIS has completed first year of monitoring activities, and submitted four quarter monitoring reports, which are available at BIFPCL web page.	*Complied*

Sl no	Condition of DoE	Compliance	Remarks
	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.	BIFPCL duly submitted all reports to DoE	
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 by CEGIS	*Complied*
34	Air, water, soil, biological and social data should be monitored regularly with a network monitoring system with a view to assess the natural quality of the Sundarbans and other fragile ecosystem and report of monitoring results should be submitted to Bagerhat District Office, Khulna Divisional Office and Headquarters of the Department of Environment simultaneously.	CEGIS is monitoring air quality, soil quality, biological conditions, social conditions, etc. as suggested by DoE. The network monitoring system will be installed when the plant will be in operation.	*Partially Complied* The network monitoring system will be installed at operation phase.
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 webpage. CEGIS is regularly carrying out public consultation. The progress of the monitoring is regularly discussed in monthlyproject	*Complied*

Sl no	Condition of DoE	Compliance	Remarks
		implementation monitoring meeting Chaired by the Secretary, Ministry of Power, Energy and Mineral Resources in presence of PGCB, LGED, Bangladesh Army, BPDB, Coal Power Generation Company, Power Cell, CEGIS, etc. In addition, other parties like Owner's Engineer, PWC, etc are reviewing the reports and giving feedback to CEGIS.	
36	Online air and water quality monitoring system should be made functional throughout the life of the Plant.	The online monitoring system would be installed when the Plant will be in operation phase and will be continued for throughout the life time of the Plant.	*To be complied* at the time of operation of the Plant by BIFPCL
37	Management Information System (MIS) are to be developed for this coal based power plant. The scope of MIS services will obviously include representing the real time monitored data especially environmental parameters displaying at Bagerhat District Office, Khulna Divisional Office and Headquarters of the Department of Environment, BPDB and other concern agencies/Ministries. The MIS should be web based for accessing every individual to show the real time monitored records.	The MIS will be prepared before commissioning of Plant. The consultant for developing MIS will be engaged at least one year earlier. CEGIS has already submitted their proposal for providing consulting service to develop MIS	*To be Complied* before commissioning of the Plant. BIFPCL will engage consultant soon for development of MIS
38	JVC should provide all sort of logistics support to DoE and other	BIFPCL is ready to provide all the sort of service as and when required by DoE	*agreed to comply*

Sl no	Condition of DoE	Compliance	Remarks
	relevant agencies for monitoring environment related items/events.	for monitoring of Plant construction activities and environmental items/events.	
39	No ground water should be allowed to use for plant purposes.	No ground water has been used so far. And the plant has been designing considering use of surface water only.	*Complied*
40	Conduct stakeholder meetings on regular basis for better performance the project as a whole.	BIFPCL has appointed a social worker who regularly visits nearby community to consult with the local people. Besides, CEGIS, appointed as environmental monitoring consultant is carrying out consultation with locals.	*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.	*Complied*
42	The Environmental Management Plan under the EIA study shall strictly be implemented and kept functioning on a continuous basis.	BIFPCL is implementing EMP phase by phase and appointed CEGIS for monitoring it. CEGIS reported most of the EMP has been implemented except dust control measures and safety & sanitation of workers and resettlement & rehabilitation.	*Partially Complied* BIFPCL will implement all the EMP as suggested in EIA report and by DoE. BPDB/GOB should take initiative to resettle and rehabilitate the PAPs.
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	This information is not available with CEGIS	

Sl no	Condition of DoE	Compliance	Remarks
	to the Bagerhat District Office, Khulna Divisional Office and Headquarters of the Department of Environment simultaneously.		
44	Environmental Monitoring Reports according to specific format specified in the EIA Report shall be made available simultaneously to DoE Bagerhat District Office, Khulna Divisional Office and Headquarters on a monthly basis during the construction period of the project.	This information is not available with CEGIS	
45	The following records must be kept in respect if any samples required to be collected for the purpose of environmental monitoring activities: (a) the date(s) on which the sample was taken; (b) the time(s) at which the sample was collected; (c) the point at which the sample was taken; and (d) the name of the person who collected the sample.	The Monitoring report of CEGIS keeps records of all as suggested.	*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	*Complied*
47	In case of any emergency, the following	So far no such emergency has been happened.	*To be complied* by BIFPCL

Sl no	Condition of DoE	Compliance	Remarks
	information shall be immediately be reported to Bagerhat District Office, Khulna Divisional Office and Headquarters of the Department of Environment (DoE) simultaneously a) Nature of incident (oil spill, fire, accident. Collision, land slide, etc.) b) Personnel affected (injured, missing, fatalities, etc.) c) Emergency support available and its location (standby transport, medical facilities, etc.) d) Weather conditions e) Current operations (abandoning the site, fire fighting, etc.)	BIFPCL would establish a proper mechanism for recording such incident as suggested	
48	The project authority or its employees must notify the department of Environment of incident s causing or threatening material harm to the environment as soon as practicable after the person becomes aware of the incident.	So far no such incident has been happened. BIFPCL would establish a proper mechanism for recording such incident as suggested	*To be complied* by BIFPCL
49	All pollution incidents shall be reported immediately and simultaneously to the Bagerhat District Office,	So far no such incident has been happened. BIFPCL would establish a proper mechanism for recording such incident as	*Complied*

Sl no	Condition of DoE	Compliance	Remarks
	Khulna Divisional Office and Headquarters of the Department of Environment (DoE) in Dhaka.	suggested. CEGIS has been engaged to record such incident during pre-construction and construction period	
50	Appropriate permission would require to be obtained from the from the Forest Department in favour of cutting/felling on any plant/tree/sapling forested by any individual or government before doing such type of activity.	There will be no need of cutting/felling down of any trees. However, in future, if any such case would arise , BIFPCL would seek for appropriate permission	will be complied (if required)
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.	A MoU has been signed between Forest Department and BIFPCL	Plantation work should be started at earliest time
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.	*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.	PWC is carrying out another study that covers environmental issues related to coal transportation. As the Mongla Port Authority is the Implementing Agency for dredging, they are carrying out such EIA. Different interested consulting firm has already submitted proposal to MPA for carrying out morphological study including EIA in response to call for proposal by	*Complied*

Sl no	Condition of DoE	Compliance	Remarks
		MPA.	
54	A full-fledged institutional setup for EHS and CSR must be put in place before operation of the power plant.	OE has prepared a preliminary HR plan. The EPC Contractor will prepare a detail institutional setup	To be 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 ready to extend cooperation to DoE	Agreed to comply
56	Violation of any of the above conditions shall render this approval void.	BIFPCL and BPDB are agreeable with this condition. However, if any situation arises that may require modification of any condition, BIFPCL & BPDB would approach to DoE for approval.	Agreed
57	Any injunction on this project from the Honourable Supreme Court/High Court Division shall render this approval void.	This is a legal matter. BPDB and BIFPCL agree with it	Agreed
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	The detail designing of the plant is considering these 275m Chimney, FGD, highly efficient ESP, WWTP, API Oil Water Separation Unit, Low NOx Burner, etc for preventing pollution.	*In case of any modification or change, DoE should be informed duly*

Sl no	Condition of DoE	Compliance	Remarks
	proponent shall not start operation of the project.		
59	This EIA Approval has been issued with the approval of the appropriate authority.	BPDB and BIFPCL are thankful to the Authority.	

Photo Album of Environmental Compliance Monitoring Activities

DGM E&C&I briefing Project Information exhibited in the display board to the Monitoring Team

Monitoring Team having discussion with BIFPCL Personnel in site office


Open Pit Toilet installed at construction site, contaminating nearby water bodies


No/Limited use of PPE by the construction workers


No/Limited use of PPE by the construction workers


Temporary shed for labour at project site to take rest during day time

Temporary Labour Shed for Night Stay

Running of Health Camp at Project site office under CSR Program

Donating in different religious and social programme under CSR program

Construction of alternative Access Road by LGED

3 Air Quality Monitoring

13. The ambient air quality has been monitored in this **1st Quarter** of the **2nd year** at 11 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

14. With the aim of monitoring, the impact of the emission of particulate matter and gaseous pollutants from the Power Plant related activities, $PM_{2.5}$, PM_{10}, SO_X, and NO_X concentration in the ambient air, have been considered as parameter of monitoring. With relation to the Project related activities, model generated emission dispersion scenario and Environmental Monitoring Plan provided in the Environmental Impact Assessment report (CEGIS, 2013), eleven locations have been identified where concentrations of the aforementioned parameters have been monitored.

3.1.1 Method of Sampling and Laboratory Testing

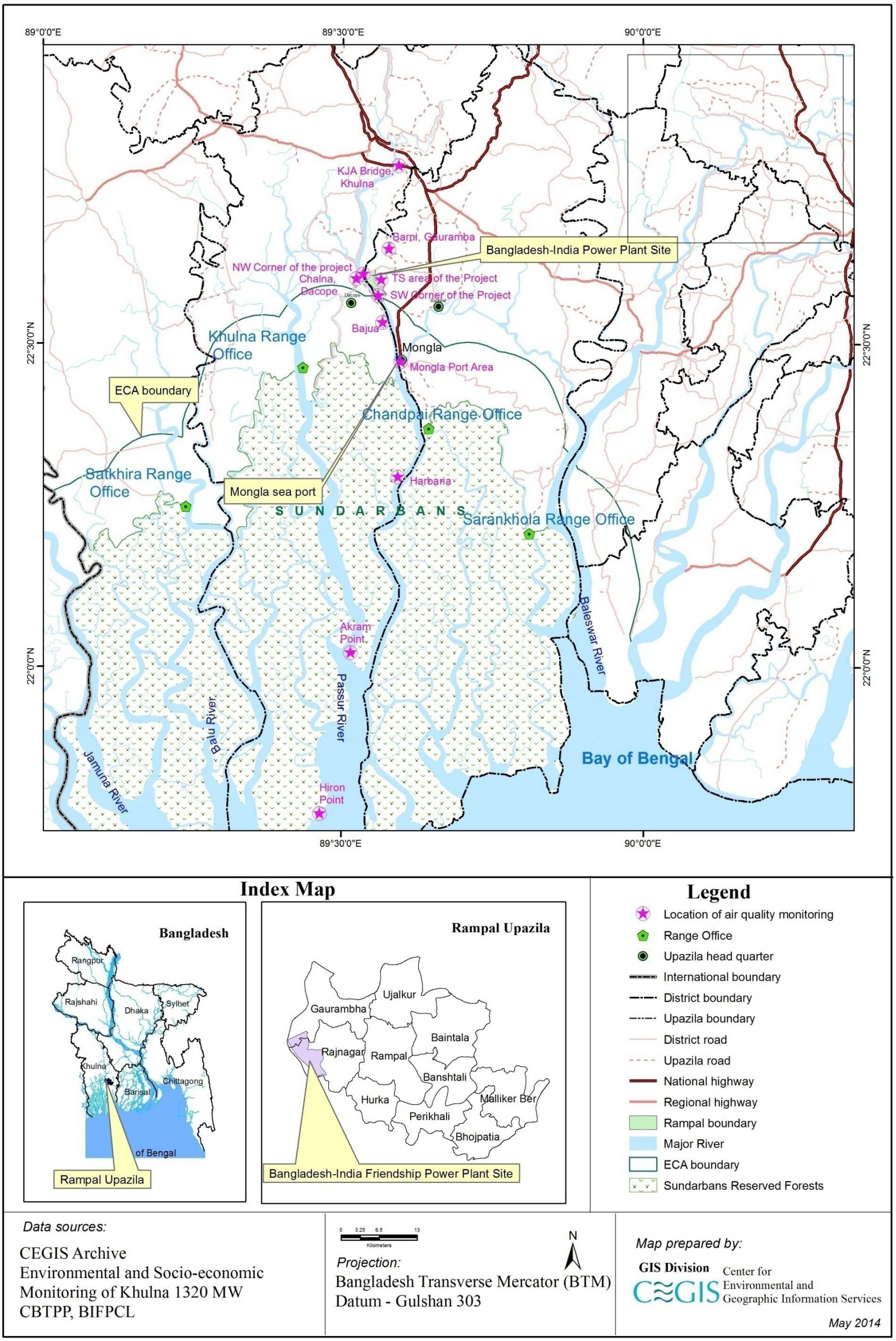
15. Respirable Dust Sampler (Model-Envirotech India APM-460BL) and Fine Particulate Sampler (Model-Envirotech India APM-550) have been used to collect the air sample. The $PM_{2.5}$, PM_{10}, and SPM have been tested by gravimetric method. The SO_2 has been absorbed and tested by West-Gaeke method. The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

3.1.2 Locations of air quality monitoring

16. Ambient air quality has been monitored during this quarterly (**1st Quarter** of the **2nd year)** monitoring phase in the same locations as monitored in earlier quarters. The locations of the air quality monitoring points have been shown in **Map 3.1**.

Table 3.1 Air Quality Monitoring Plan

Sl no	Monitoring Indicators	Locations	GPS	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 (April, July, October, January)	In situ field measurement provided with the facilities of outsourced laboratory. Method of testing SO_X: USEPA (2000) Method 6 or 6A or 6B or ISO (1998) Method 11632 (as appropriate) Method of testing NO_X: USEPA (2000) Method 7 or 7A or 7B or 7C or 7D or ISO (1993) Method 10396 (as appropriate). Method of testing $PM_{2.5}$: Gravimetric Method of testing PM_{10}: USEPA (1997) Method 201 or 201A (as appropriate)
2		Proposed township area near Chimney location, Mouza: Sapmari Katakhali	89°32'3.8"E, 22°36'32.5"N		
3		North West corner of the project boundary (Kaigar daskati)	89°33'51.8"E, 22°36'1.06"N		
4		Barni, Gaurambha union (4km North East from the chimney location)	89°34'37.7"E, 22°38'51.8"N		
5		Chunkuri-2, Bajua Union (4km South West from the chimney location)	89°34'01.1"E, 22°32'3.3"N		
6		Pankhali, Dacope, (4km North West from the Chimney location)	89°31'24.2"E, 22°36'6.7"N		
7		Mongla Port Area	89°35'50.4"E, 22°28'24.8"N		
8		Harbaria, Sundarbans	89°35'34.2"E, 22°17'43.1"N		
9		Akram point, Sundarbans	89°30'54.1"E, 22° 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 Location

3.2 Results of air quality monitoring

3.2.1 $PM_{2.5}$, PM_{10} and SPM

17. $PM_{2.5}$ and PM_{10} were found within the standard limit at each location. But, SPM was found exceeding the standard level at Chalna Bazar, the township, Kaigar Daskati and Gaurambha which were 299, 266, 244 and 236 respectively. In Mongla port area and in the Khan Jahan Ali Bridge, SPM was found slightly higher than the standard; high traffic 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 SO2

18. Concentration of Sulphur-di-oxide in the ambient air was found within the standard. In the Sundarbans reserve forest area, the SO_2 concentration is very low and ranged from 15 to 21 µg/m^3. In other areas, SO_2 varies in between 11 µg/m^3 to 31 µg/m^3. All the monitoring data of ambient air quality are given in **Table 3.2.**

3.2.3 NO2

19. Similar to SO_2, NO_2 concentration in the ambient air of Sundarbans was found very low, varying from 17 - 39 µg/m^3. In Project site and its adjoining areas, NO_2 concentrations were found a little bit higher than that of Sundarbans but still within the standard limit. Among the 11 locations, NO_2 concentration was highest, 39 µg/m^3, at North-West corner of the Project Boundary. The monitoring results are shown in **Table 3.2**.

3.2.4 CO and O3

20. CO and O_3 concentrations are also very low. CO concentration ranges from 136 µg/m^3 to 196 µg/m^3 in Project area and its adjoining areas, while in Sundarbans the concentration ranges in between 50 - 60 µg/m^3, in Akram Point CO concentration was recorded higher (163 µg/m^3) than the surrounding areas. The possible cases may be the increased activity due to the big ships' anchorage beside the sampling point and for the loading-unloading activity happened during recording of the parameters.

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	1st QM, April 2015	2nd QM, July 2015	3rd QM, October 2015	4th QM, January 2016	1st QM, April 2016	2nd QM, July 2016	3rd QM, October 2016	4th QM, January 2017	Bangladesh (DoE) Standard for ambient Air (ECR 2005)	IFC/WB Standard
Weather		Sunny	Rainy/ Cloudy	Sunny	Sunny	Sunny									
Wind Direction		SE	SE	SE	NW	SE to NW									
		Concentrations are in µg/m^3													
SW Corner of the PP area	$PM_{2.5}$	33	37	25	33	47								65	75
	PM_{10}	78	77	53	79	83								150	150
	SPM	207	239	190	200	177								200	NF
	SO_2	21	24	19	23	15								365	125
	NO_x	26	29	27	31	29								100	200
	CO	120	188	140	190	144								40000*	NF
	O_3	27	26	19	22	26								160*	160
Proposed Township area of the PP	$PM_{2.5}$	39	48	48	39	34								65	75
	PM_{10}	89	90	74	102	97								150	150
	SPM	217	263	217	274	266								200	NF
	SO_2	19	28	22	21	22								365	125
	NO_x	29	39	27	26	24								100	200
	CO	165	210	230	164	136								40000*	NF
	O_3	33	26	26	23	21								160*	160
NW Corner of the PP area	$PM_{2.5}$	37	44	19	42	59								65	75
	PM_{10}	67	78	56	98	91								150	150

Locations of Monitoring	Pollutants	1st QM, April 2014	2nd QM, July 2014	3rd QM, October 2014	4th QM, January 2015	1st QM, April 2015	2nd QM, July 2015	3rd QM, October 2015	4th QM, January 2016	1st QM, April 2016	2nd QM, July 2016	3rd QM, October 2016	4th QM, January 2017	Bangladesh (DoE) Standard for ambient Air (ECR 2005)	IFC/WB Standard
Weather		Sunny	Rainy/ Cloudy	Sunny	Sunny	Sunny									
Wind Direction		SE	SE	SE	NW	SE to NW									
		Concentrations are in µg/m^3													
	SPM	234	217	157	310	244								200	NF
	SO_2	19	22	18	27	21								365	125
	NO_x	23	28	22	32	39								100	200
	CO	110	178	110	210	140								40000*	NF
	O_3	25	19	17	36	44								160*	160
Barni, Gaurambha	$PM_{2.5}$	39	47	57	39	41								65	75
	PM_{10}	103	122	67	97	82								150	150
	SPM	233	244	183	277	236								200	NF
	SO_2	21	23	17	22	25								365	125
	NO_x	25	28	22	26	27								100	200
	CO	175	210	190	150	196								40000*	NF
	O_3	26	29	22	19	15								160*	160
Chunkuri-2, Dacope	$PM_{2.5}$	35	39	46	37	33								65	75
	PM_{10}	77	86	69	68	61								150	150
	SPM	117	113	162	183	188								200	NF
	SO_2	19	24	21	18	11								365	125
	NO_x	23	26	27	24	18								100	200
	CO	190	205	170	170	33								40000*	NF

Locations of Monitoring	Pollutants	1st QM, April 2014	2nd QM, July 2014	3rd QM, October 2014	4th QM, January 2015	1st QM, April 2015	2nd QM, July 2015	3rd QM, October 2015	4th QM, January 2016	1st QM, April 2016	2nd QM, July 2016	3rd QM, October 2016	4th QM, January 2017	Bangladesh (DoE) Standard for ambient Air (ECR 2005)	IFC/WB Standard
Weather		Sunny	Rainy/ Cloudy	Sunny	Sunny	Sunny									
Wind Direction		SE	SE	SE	NW	SE to NW									
		Concentrations are in µg/m^3													
	O_3	27	24	18	22	41								160*	160
Pankhali, Dacope	$PM_{2.5}$	47	49	57	41	39								65	75
	PM_{10}	119	127	139	101	105								150	150
	SPM	297	266	254	208	299								200	NF
	SO_2	28	31	31	24	30								365	125
	NO_x	41	39	36	26	27								100	200
	CO	230	217	250	188	177								40000*	NF
	O_3	49	38	36	27	11								160*	160
Mongla Port area	$PM_{2.5}$	47	55	39	41	26								65	75
	PM_{10}	139	174	77	82	35								150	150
	SPM	288	303	197	217	214								200	NF
	SO_2	27	28	26	24	14								365	125
	NO_x	44	39	33	27	17								100	200
	CO	230	320	220	211	24								40000*	NF
	O_3	57	52	37	26	09								160*	160
Harbaria, Sundarbans	$PM_{2.5}$	19	22	33	27	24								65	75
	PM_{10}	41	39	59	56	49								150	150
	SPM	111	117	129	139	109								200	NF

Locations of Monitoring	Pollutants	1st QM, April 2014	2nd QM, July 2014	3rd QM, October 2014	4th QM, January 2015	1st QM, April 2015	2nd QM, July 2015	3rd QM, October 2015	4th QM, January 2016	1st QM, April 2016	2nd QM, July 2016	3rd QM, October 2016	4th QM, January 2017	Bangladesh (DoE) Standard for ambient Air (ECR 2005)	IFC/WB Standard
Weather		Sunny	Rainy/ Cloudy	Sunny	Sunny	Sunny									
Wind Direction		SE	SE	SE	NW	SE to NW									
		Concentrations are in µg/m^3													
	SO_2	9	10	14	12	16								365	125
	NO_x	19	22	27	18	22								100	200
	CO	65	58	70	64	56								40000*	NF
	O_3	13	12	13	11	14								160*	160
Akram Point Sundarbans	$PM_{2.5}$	17	19	23	18	49								65	75
	PM_{10}	39	44	32	39	77								150	150
	SPM	114	133	97	88	102								200	NF
	SO_2	7	9	12	13	21								365	125
	NO_x	17	19	22	17	27								100	200
	CO	49	60	50	46	163								40000*	NF
	O_3	11	14	9	10	27								160*	160
Hiron Point Sundarbans	$PM_{2.5}$	15	23	19	17	28								65	75
	PM_{10}	44	38	34	41	60								150	150
	SPM	101	119	107	97	110								200	NF
	SO_2	8	7	13	14	15								365	125
	NO_x	18	18	19	22	20								100	200
	CO	52	62	65	60	60								40000*	NF
	O_3	14	13	11	9	23								160*	160

Locations of Monitoring	Pollutants	1st QM, April 2014	2nd QM, July 2014	3rd QM, October 2014	4th QM, January 2015	1st QM, April 2015	2nd QM, July 2015	3rd QM, October 2015	4th QM, January 2016	1st QM, April 2016	2nd QM, July 2016	3rd QM, October 2016	4th QM, January 2017	Bangladesh (DoE) Standard for ambient Air (ECR 2005)	IFC/WB Standard
Weather		Sunny	Rainy/ Cloudy	Sunny	Sunny	Sunny									
Wind Direction		SE	SE	SE	NW	SE to NW									
		Concentrations are in µg/m^3													
Khulna City, near Khan Jahan Ali Bridge	$PM_{2.5}$	54	39	52	42	55								65	75
	PM_{10}	139	117	91	84	75								150	150
	SPM	301	287	239	219	222								200	NF
	SO_2	33	29	33	28	31								365	125
	NO_x	49	41	39	36	33								100	200
	CO	330	370	330	296	101								40000*	NF
	O_3	59	67	57	39	21								160*	160

Note:

- Concentrations are in µg/m^3 DoE- Department of Environment, NF – Not found
- Fine Particulate Matter ($PM_{2.5}$), Respirable Dust Content (PM_{10}), Suspended Particulate Matter (SPM), Oxides of Nitrogen (NO_X). Sulphur-Di-Oxide (SO_2), Carbone Mono-Oxide (CO). & Ozone (O_3).
- All standards are for 24hr average except CO and O_3, standards for CO and O_3 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).

3.3 Pollution Sources

3.3.1 Pollution sources at Project area

21. 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

22. Mostly river traffics of Mongla Port area travelling across the Sundarbans are the sources of Suspended Particulate Matter (SPM), Oxides of Sulphur (SOx), Oxides of Nitrogen (NOx) and Green House Gas (GHG) in the Sundarbans. An inventory of the current emission sources in the study area with the types of emissions have been provided in **Table 3.3**.

Table 3.3: Baseline Emission Inventory

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

		Cement Industry	Petroleum Industry	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
	GHGs	×	×	×	✓	✓	✓	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	✓
Pankhali, Dacope	PM	✓	×	×	✓	✓	✓	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	✓	✓
	SOx	×	×	×	✓	✓	✓	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	✓
	NOx	×	×	×	✓	✓	✓	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	✓
	GHGs	×	×	×	✓	✓	✓	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	✓
Mongla Port area	PM	✓	✓	×	✓	✓	✓	✓	✓	✓	✓	×	×	×	×	×	×	×	×	×	✓	×	×	×	✓
	SOx	×	✓	×	✓	✓	✓	✓	✓	✓	×	×	×	×	×	×	×	×	×	✓	×	×	✓	✓
	NOx	×	✓	×	✓	✓	✓	✓	✓	✓	×	×	×	×	×	×	×	×	×	✓	×	×	×	✓
	GHGs	×	✓	×	✓	✓	✓	✓	✓	✓	×	×	×	×	×	×	×	×	×	✓	×	×	×	✓
Harbaria, Sundarbans	PM	×	×	×	×	✓	✓	✓	✓	✓	✓	×	×	×	×	×	×	×	×	×	×	×	×	×	×
	SOx	×	×	×	×	✓	✓	✓	✓	✓	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
	NOx	×	×	×	×	✓	✓	✓	✓	✓	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
	GHGs	×	×	×	×	✓	✓	✓	✓	✓	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
Akram Point Sundarbans	PM	×	×	×	×	✓	✓	×	×	×	✓	×	×	×	×	×	×	×	×	×	×	×	×	×	×
	SOx	×	×	×	×	✓	✓	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
	NOx	×	×	×	×	✓	✓	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
	GHGs	×	×	×	×	✓	✓	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
Hiron Point Sundarbans	PM	×	×	×	×	✓	✓	×	×	×	✓	×	×	×	×	×	×	×	×	×	×	×	×	×	×
	SOx	×	×	×	×	✓	✓	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
	NOx	×	×	×	×	✓	✓	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
	GHGs	×	×	×	×	✓	✓	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×

		Cement Industry	Petroleum Industry	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
Khulna City, near Khan Jahan Ali Bridge	PM	✓	✗	✓	✓	✓	✓	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✓
	SOx	✗	✗	✓	✓	✓	✓	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓
	NOx	✗	✗	✓	✓	✓	✓	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓
	GHGs	✗	✗	✓	✓	✓	✓	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓

Legend□ □□Absence of source or no emission, □□Presence of source, emission of pollutant

4 Noise Monitoring

23. Ambient noise levels were monitored as quarterly at eleven locations. Monitoring activities were carried out in March-14, July-14, October-14, January-15 and April-15. The detail of the monitoring plan is described in Table 4.1.

24. In this **1st Quarter** monitoring of the **2nd year**, the noise level was recorded little high; the same was observed in the first quarterly monitoring in the month of January'2014 too. The ambient noise is probably elevated during this period of time due to the wave surge in the rivers and increased river traffic; we have seen barges, trawlers and ships plying over the waterway frequently. For instance, at Harbaria the Noise level came up unusually high (~65 dB) whereas the day time standard is set to 45dB only) due to the noise coming from engine of one of the large vessels.

25. It has been found that the Noise generated from the common known sources like the rural vehicles (human howler/ Nosimon, auto-rickshaw) while working beside the roads, while in case of the monitoring spot in or around the waterways, the sources are trawler, ship, sometimes waves breaking against the shore, etc.

4.1 Methodology

26. Noise levels were measured for thrice in a day (morning, afternoon and evening) in each of the 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. Depending on the site condition and acoustic environment, the noise meter was set up and calibrated each time following the manufacturer's instruction manual.

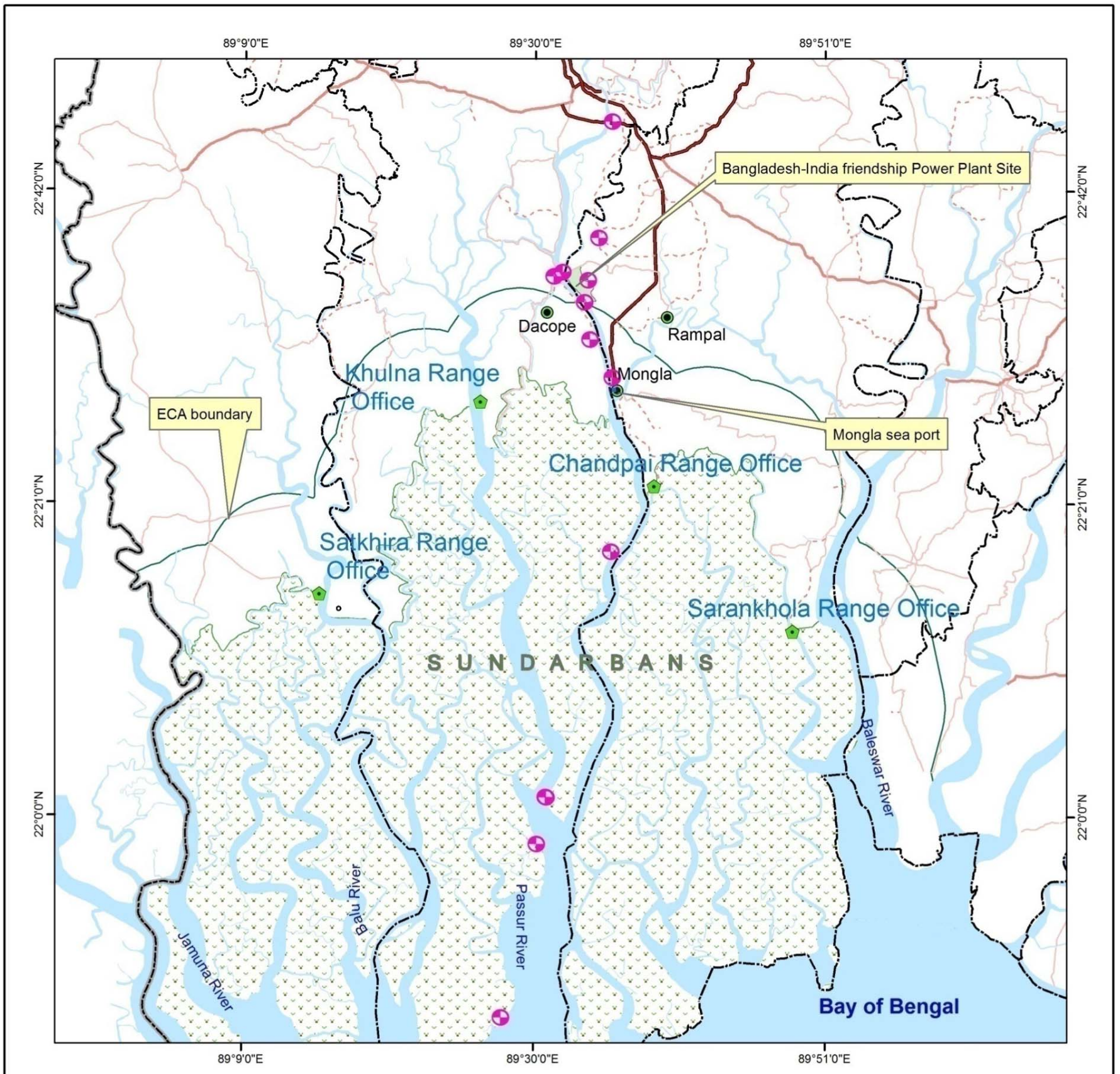
Photo 4.1: Specialists calibrating and setting up noise meter at site before use

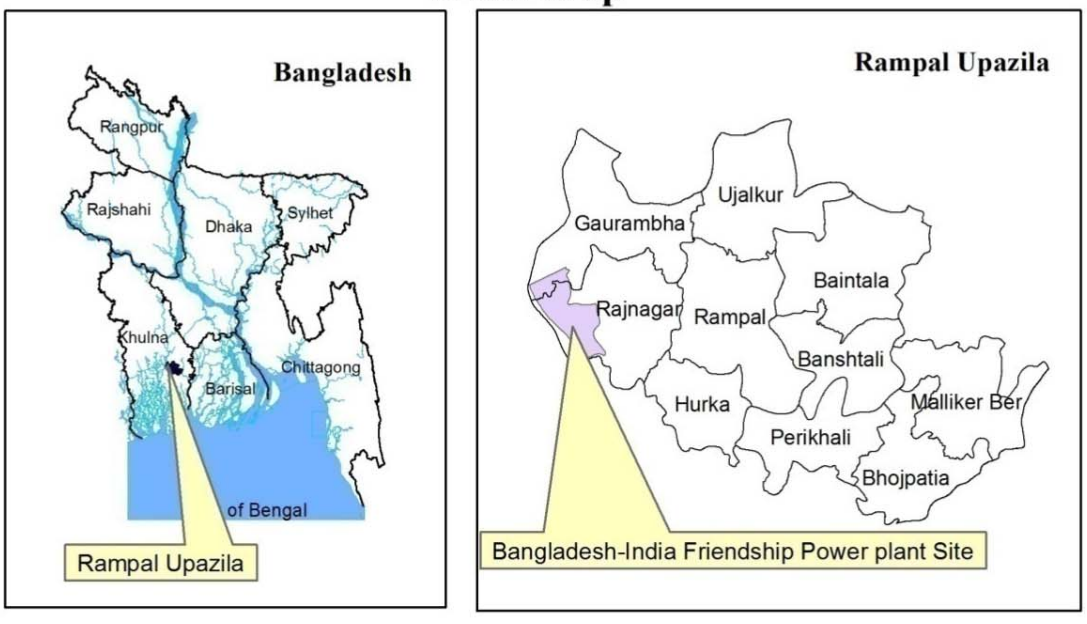
4.2 Locations of Noise Monitoring

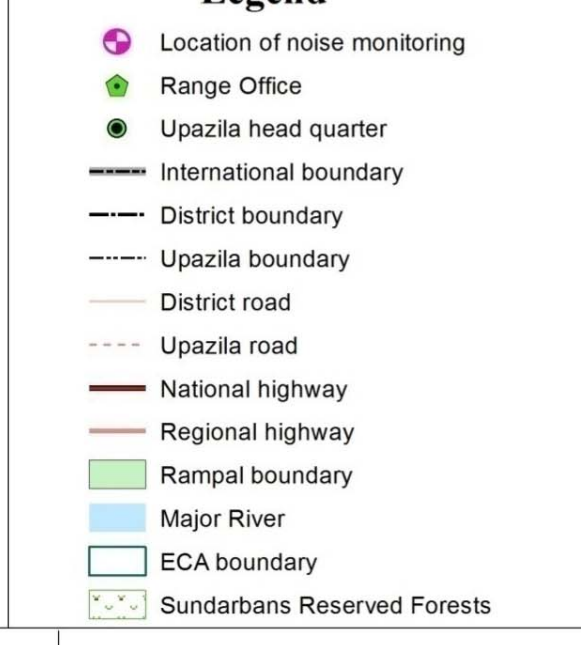
27. There are eleven locations for noise level monitoring. Three locations are inside the Sundarbans, six locations are in and around the Project site, one is at Khan Jahan Ali Bridge and one is at Mongla Port (Map 4.1).

Table 4.1: Noise Monitoirng Plan

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







Data sources:

CEGIS Archive
Environmental and Socio-economic Monitoring of Khulna 1320 MW CBTPP, BIFPCL

0 3 6 12
Kilometers

N

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

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

May 2014

Map 4.1: Noise Moniotring Locations

4.3 Results of Noise Monitoring

4.3.1 Noise at Dacope Upazila Parishad

28. The monitoring location was at Chalna Upazila Market 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 first quarter monitoring of the 2nd year is closer to the noise level of second, third and fourth quarter of 1st year and is still within the standard (Table 4.1).

29. 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 was comparatively much lower than that of first quarter of the 1st year of monitoring that eventually resulted in less noise.

4.3.2 Noise at North West Corner of the Project Area

30. 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 been monitored well within the standard.

4.3.3 Noise at Chunkuri-2, Bajua

31. This area is classified as residential where the standard maximum ambient noise level is 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 4.1) but similar to last quarter monitoring of 1st year, at this time of monitoring, it was found just within 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. which are very frequent here.

4.3.4 Noise at South West corner of the Project area

32. The South West corner of the Project area falls in Sapmari Katakhali mouza of Rajnagar union. The area also falls under residential class. ECR, 1997, which defines 50dB (A) as the standard maximum ambient noise level for this class at day time. Similar to the earlier monitoring, noise levels in this quarter monitoring were within standard limit (Table 4.1).

4.3.5 Noise at proposed township area of the Project

33. 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 of the noise standard where the standard of the maximum ambient day time noise is 50dB (A). Similar to the previous quarterly monitoring(s), noise levels were within standard limit in this quarter monitoring too (Table 4.2).

4.3.6 Noise at Barni, Gaurambha

34. This area also falls under residential class where the standard maximum ambient noise level is 50 dB (A) at day time. The noise levels were found higher than the standard noise level during morning and afternoon; the evening data couldn't be collected due to the seasonal storm (Kal-boishakhi) rushed in suddenly, disrupting the local electricity connection. Though this area falls under rural classification, the commercial activities like bazaar, local traffic, crowd etc. are increasing, thus the ambience is getting noisier.

4.3.7 Noise at Khan Jahan Ali Bridge, Khulna

35. 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 slightly higher than 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 morning when traffic load was also higher. It is expected that this road will be busier in coming days due to the increase of port activities.

4.3.8 Noise at Mongla Port area

36. 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 1st quarter monitoring of the 2nd year, noise levels were found within the standard level.

37. 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 Noise at Harbaria, Sundarbans

38. 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. But, the Noise level came up unusually high (~65 dB whereas the day time standard is set to 45dB only) due to the fact that engine of one of the large vessels was running beside our monitoring point for the whole day. We went 200 meter inside the forest from shoreline to suppress the sound, but noise level was almost similar.

39. Ships movement, 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 Noise at Akram point, Sundarbans

40. 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 Shibsha 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 much above (~55dB) the standard limit. Birds' chirping, stormy wind, wave and tree leaves are the main sources of noise here.

4.3.11 Noise at Hiron Point, Sundarbans

41. 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 afternoon; but at evening time it was not possible to stay as because the ship had to retreat with the high tides especially in this period of time while storm surges are very likely to happen. The ambient noise level was found above the standard limit. Birds, stormy wind, wave breaking on the sandy shore and tree leaves making rattling sound, are the main sources of noise here.

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

Sl 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	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

Table 4.2b: Summary of the ambient noise monitoring in Second Year

Sl 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	Day time AVG
1	Chalna, Dacope	57.27	54.31	59.65	57.08													70
2	NW Corner of the Project area	45.05	42.15	46.80	44.67													50
3	Chunkuri-2, Bajua	45.90	48.19	NM	47.05													50
4	SW corner of the project area	40.60	43.25	46.89	43.58													50
5	Proposed Township area, project site	41.49	39.55	43.37	41.47													50
6	Barni, Gaurambha	58.23	50.11	NM	54.17													50
7	Khan Jahan Ali Bridge, Khulna	75.20	72.75	72.42	73.45													70
8	Mongla Port area	46.02	49.29	49.15	48.15													75
9	Harbaria, Sundarbans	67.06	64.05	64.99	65.37													45
10	Akram Point, Sundarbans	53.35	56.37	NM	54.86													45
11	Hiron Point, Sundarbans	47.48	48.20	NM	47.84													45

Note: NM – Not Measure, *Std- Standard as defined in National Noise Control Rules 2006

5 Water Quality Monitoring

42. Water quality monitoring has been scheduled in each quarter of a year as per the contract. So, in the first year of monitoring, this component has been monitored for four (4) times. In 2015, the first (April 2015) quarterly monitoring of second year has been conducted recently. The details of the monitoring plan are shown in Table 5.1. Water quality monitoring is being conducted in both the ways of in-situ and ex-situ monitoring systems. Samples are brought into laboratory for analyses. In this report, both types of available data from first and second year monitoring has been illustrated only as because of the laboratory results for the specific samples are still awaiting for analysis.

5.1 Methodology

43. Monitoring of water quality directly depends on selection of water quality parameters, sampling points, sampling frequency, evaluation criteria etc. Standard practices have been followed for monitoring of water quality of Passur-Sibsha River System (RS). This study is measuring both surface and ground water quality parameters to reveal 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 1st quarterly monitoring of second year was scheduled from 6th to 16th April this year. In order to establish a strong baseline, the water quality monitoring results have not only been presented but also been compared with the national and international standards.

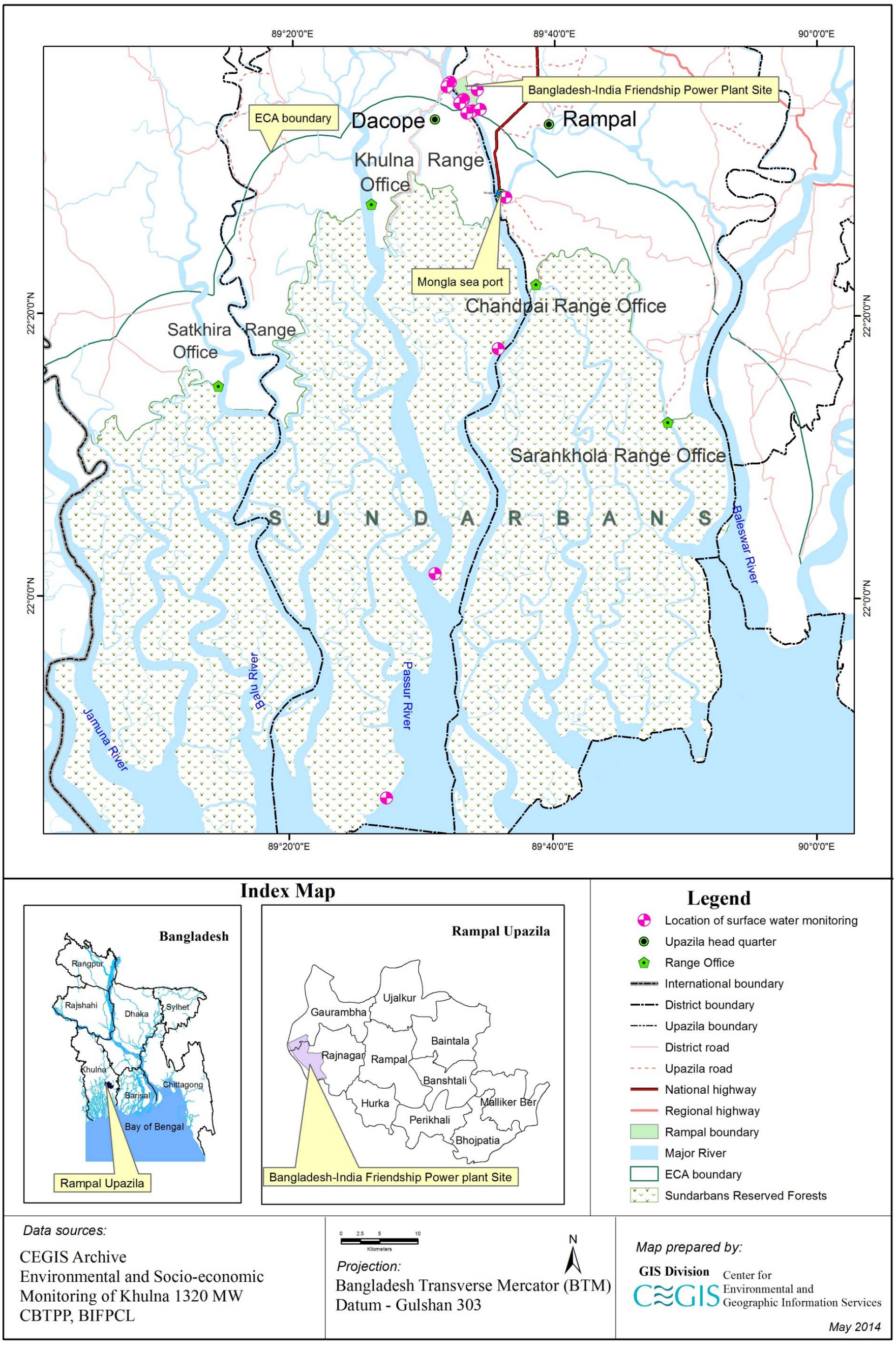
5.2 Sampling Location

44. Similar to previous completed quarterly monitoring, water samples were collected from pre-selected 15 points for surface water and 4 points for groundwater (Map 5.1 and 5.2). These sampling points were preliminary selected at inception stage and finalized during first quarter monitoring of this study. In future, samples will be collected from the same location as well.

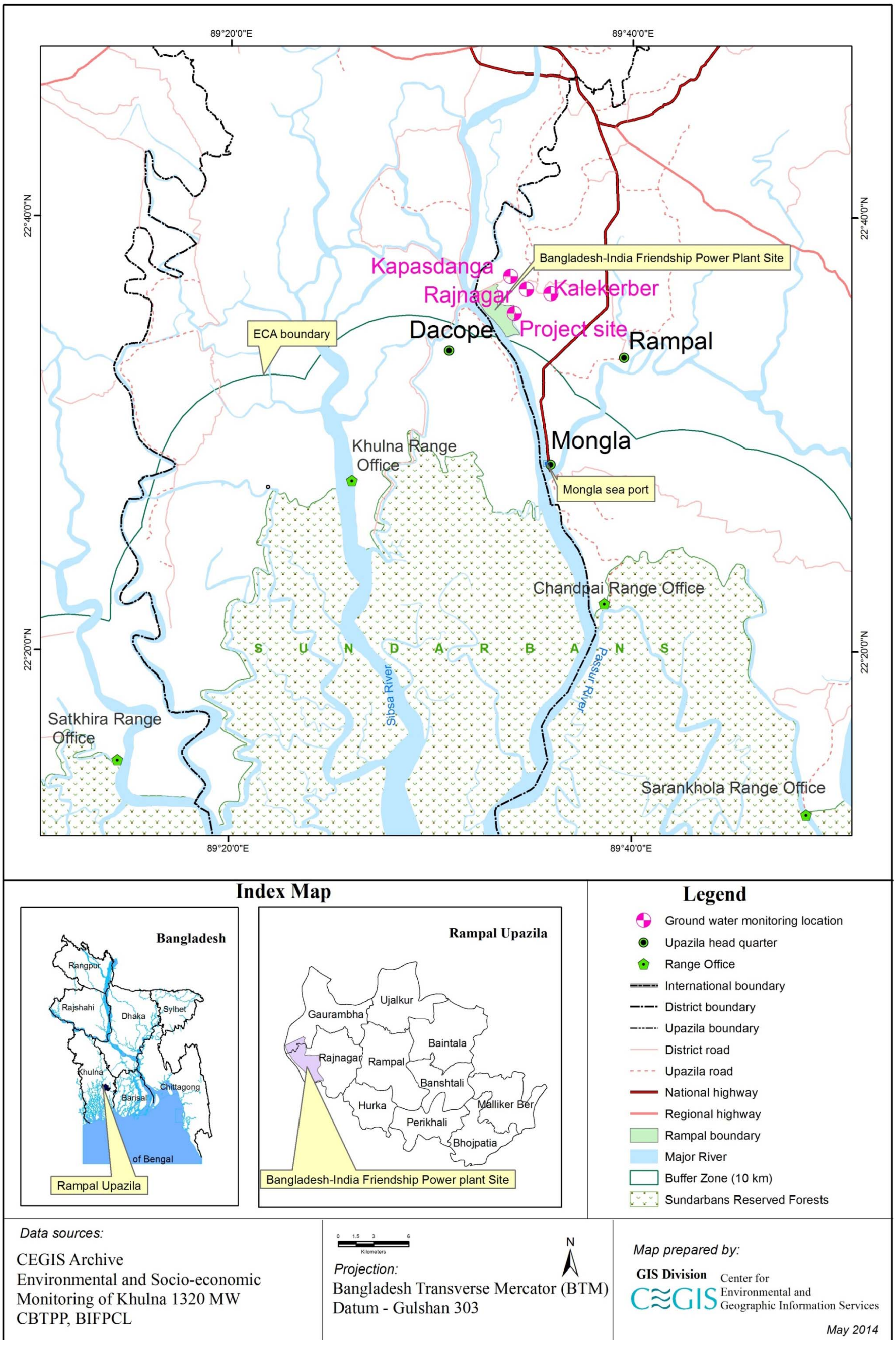
Table 5.1: Surface Water Quality Monitoring Parameters, Locations and Plan

Sl no	Monitoring Indicators	Locations	GPS (Decimal Degree)		Frequency	Methods/Tools/ Techniques
			Easting	Northing		
1	pH, Temperature, Salinity, DO, BOD, 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 (April, July, October, and January)	In-situ measurement and Laboratory analysis
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	22.575667	89.559861		

Sl no	Monitoring Indicators	Locations	GPS (Decimal Degree)		Frequency	Methods/Tools/ Techniques
			Easting	Northing		
		at South West corner from the Project boundary				
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 – Mongla confluence	22.473861	89.602361		
13		Passur river at Harbaria of Sundarbans	22.295250	89.593139		
14		Passur river at Akram ponit of Sundarbans	23.00653	89.515028		
15		Passur river at Hiron point of Sundarbans	22.29531	89.592833		



Map 5.1: Surfacewater Quality Monitoring Locations



Map 5.2: Groundwater Quality Monitoring Locations

5.3 Sampling Procedure

45. 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 will reduce the error as well as increase the level of confidence of the results.

46. 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.

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

48. 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.

5.3.1 Surface water quality

49. 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 Ground water quality

50. Four points have been selected for monitoring the ground water quality of the study area. Among them, one well is in the Project area near the proposed townships area and other three tube wells are located in the monitoring study area. Samples have been collected from the selected handpump tube wells. 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

Sl 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

51. Water quality parameters have been selected on the basis of potential impacts 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.

Table 5.3: Testing Methodology of Water Quality Parameter

Parameters	Unit	Methods
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)
Hg	ppm	Mercury Analyzer

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

53. (i) Physical and aggregate properties i.e. pH, Temperature, Salinity, Hardness, TDS, TS, Turbidity, Oil & Grease

(ii) Inorganic non-metallic constituents' i.e. DO, NO3-, PO43- and SO4^{2-}

(iii) Aggregate organic constituents i.e. BOD, COD

(iv) Heavy metals i.e. As, Pb and Hg

5.4 Results of surface water quality monitoring

5.4.1 In-situ parameters

(a) pH

54. In this pre-monsoon season of second year monitoring study, pH values in the Passur-Shibsha River System (RS) remained almost alike compare to the first year

monitoring study of the said season. In this monitoring pH values ranged in between 7.2 - 7.8 that are within the standard limit (6.5 – 8.5) of ECR'97 for inland surface waters. Highest (7.8) pH value was found at Right Bank of Passur River at 100m upstream of North West corner from the Project boundary. During first year monitoring, pH value was found to be within 7.1-7.9 at the same pre-monsoon season.

55. The monitoring results show that there is a seasonal variation in pH of the Passur-Shibsha RS. According to the five quarterly monitoring results, pH values of pre-monsoon and monsoon seasons were found to be comparatively lower than post-monsoon and winter seasons which were conducted in 2014 respectfully. The pH values found to be ranged in post-monsoon and monsoon seasons are 7.0 - 8.2 and 7.3 - 8.2 respectively. During post monsoon and winter seasons river water level normally goes down because of less rainfall and less upstream flow of Passur-Sibsha RS and make pH values little bit higher than pre-monsoon and monsoon seasons. In contrary, comparatively lower pH values in post monsoon and monsoon periods mainly for the high upstream flow and rain fall runoff.

56. The pH value found in pre-monsoon of second year is almost same in nature found in past monitoring. 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-Sibsha RS are presented in Table 5.4.

Table 5.4: pH Values of Passur River Water

Sl	Sampling Locations	pH Values					
		1st year				2nd Year	BD Standard
		April	July	Oct.	Jan.	April	
		1QM	2QM	3QM	4QM	1QM	
1	Left Bank of Passur River at 100m u/s of North West corner from the Project boundary	7.2	7.0	8.1	7.9	7.6	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	
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	
4	Left Bank of Passur River at Project site-Jetty	7.9	7.1	8.1	7.9	7.5	
5	Middle Passur River at Project site-Jetty	7.1	6.9	8.1	7.9	7.6	
6	Right Bank of Passur River at Project site-Jetty	7.1	6.9	8.2	7.9	7.7	
7	Left Bank of Passur River at South West corner from the Project boundary	7.4	7.0	8.1	7.6	7.5	
8	Middle of Passur River at South West corner from the Project boundary	7.4	6.9	8.0	7.5	7.2	
9	Right Bank of Passur River at South West corner from the Project boundary	7.3	6.8	8.0	7.8	7.3	
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	
11	Maidara river near proposed township area	7.4	6.8	8.1	7.3	7.6	
12	Passur river at Passur-Mongla confluence	7.3	6.8	7.4	8.2	7.5	
13	Passur river at Harbaria of Sundarbans	7.9	6.9	8.0	8.1	7.7	
14	Passur river at Akram point of Sundarbans	7.2	6.9	7.9	8.1	7.7	
15	Passur river at Hiron point of Sundarbans	7.2	7.0	7.0	8.1	7.7	

Source: *Field Survey- April, July and October 2014 and January 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)

(b) Temperature

57. The surface water temperature observed during second year first quarterly monitoring varied from 30oC - 31oC, which is very common in pre-monsoon season and in the same season temperature range was found exactly same in first year monitoring study. Therefore, no temperature variations ultimately found in these two consecutive yearly (2014-2015) monitoring studies.

58. The standard temperature for sustaining aquatic life is 20oC-30oC as per the Environment Conservation Rules 1997 of Bangladesh. The surface water temperature largely depends on daily weather condition. The normal river temperatures were measured during all the completed monitoring studies. Of them, winter was the cooler season than the pre-monsoon, monsoon and post-monsoon seasons as January is cooler period than April, July and October 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-Sibsha RS are presented in Table 5.5.

Table 5.5: Surface Water Temperature in Passur River

Sl	Sampling Locations	Temperature (°C)					
		1st Year				2nd Year	BD Standard
		Apr	Jul	Oct	Jan	Apr	
		1QM	2QM	3QM	4QM	1QM	
1	Left Bank of Passur River at 100m u/s of North West corner from the Project boundary	31	33	31	19	30	20 – 30 °C
2	Middle Passur River at 100m u/s of North West corner from the Project boundary	31	33	31	20	30	
3	Right Bank of Passur River at 100m u/s of North West corner from the Project boundary	31	33	30	20	30	
4	Left Bank of Passur River at Project site-Jetty	31	33	31	19	31	
5	Middle Passur River at Project site-Jetty	30	32	31	19	30	
6	Right Left Bank of Passur River at Project site-Jetty	30	32	31	19	30	
7	Left Bank of Passur River at South West corner from the Project boundary	31	32	30	20	31	
8	Middle of Passur River at South West corner from the Project boundary	31	31	29	19	30	
9	Right Bank of Passur River at South West corner from the Project boundary	31	31	29	19	31	
10	Maidara river of the South East corner of the Project at Ichamoti-Maidara confluence	30	31	28	19	30	

Sl	Sampling Locations	Temperature (°C)					
		1st Year				2nd Year	BD Standard
		Apr	Jul	Oct	Jan	Apr	
		1QM	2QM	3QM	4QM	1QM	
11	Maidara river near proposed township area	30	32	27	20	30	
12	Passur river at Passur-Mongla confluence	29	30	32	19	30	
13	Passur river at Harbaria of Sundarbans	30	30	27	22	30	
14	Passur river at Akram point of Sundarbans	29	29	30	21	30	
15	Passur river at Hiron point of Sundarbans	29	30	29	21	30	

Source: Field Survey- April, July, October 2014; January and April 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)

(c) Salinity

59. Water salinity at the selected sampling stations of Passur-Sibsha RS of five consecutive seasons is presented in Table 5.6. In first year pre-monsoon, water salinity ranged 9-23 ppt whereas in second year it ranged 9-25 ppt. This constancy indicates that river salinity of this system remains almost unchanged. Again, in the same season of the consecutive years (2014 and 2015), high salinity was observed in the river section from Akram point to further downstream. In pre-monsoon, freshwater flow from the upstream sources is insufficient to dilute the salinity intrusion from the sea. Nevertheless, salinity monitored in winter was also high from Aktam to Hiron point for the same reason of less freshwater flow from upstream.

60. According to monitoring results, salinity was found higher in winter and pre-monsoon seasons in the river system. High fresh water from upstream and rainfall in monsoon and post monsoon seasons, made river water almost fresh.

Table 5.6: Salinity (ppt) in Passur River

Sl	Sampling Locations	Salinity (ppt)				
		1st Year				2nd Year
		Apr	Jul	Oct	Jan	Apr
		1 QM	2 QM	3 QM	4QM	1QM
1	Left Bank of Passur River at 100m u/s of North West corner from the Project boundary	11.5	2.5	0.0	4.5	13
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
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
4	Left Bank of Passur River at Project site-Jetty	12.0	2.2	0.0	4.7	9
5	Middle of Passur River at Project site-Jetty	12.0	0.3	0.0	5.1	13
6	Right Bank of Passur River at Project site-Jetty	12.0	0.5	0.0	5.0	14
7	Left Bank of Passur River at South West corner from the	9.5	4.0	0.0	5.2	14

Sl	Sampling Locations	Salinity (ppt)				
		1st Year				2nd Year
		Apr	Jul	Oct	Jan	Apr
		1 QM	2 QM	3 QM	4QM	1QM
	Project boundary					
8	Middle of Passur River at South West corner from the Project boundary	9.0	0.0	0.0	5.2	13
9	Right Bank of Passur River at South West corner from the Project boundary	10.0	2.5	0.0	5.1	12
10	Maidara river of the South East corner of the Project at Ichamoti-Maidara confluence	10.0	0.5	0.0	5.2	10
11	Maidara river near proposed township area	9.0	4.5	0.0	4.5	9
12	Passur river at Passur-Mongla confluence	10.0	9.5	0.0	5.0	14
13	Passur river at Harbaria of Sundarbans	12.0	10.0	0.0	6.0	15
14	Passur river at Akram point of Sundarbans	19.0	15.0	1.0	16.0	20
15	Passur river at Hiron point of Sundarbans	23.0	19.5	2.0	23.0	25

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

(d) Dissolved Oxygen

61. During all the monitoring seasons, dissolved oxygen was found sufficient for sustaining the aquatic fisheries except one point (4.9 mg/L) of the middle of Passur river at 100 upstream of North West corner from the project boundary in pre-monsoon of first year monitoring study. On the contrary, in second year, it was found above the standard limit of Bangladesh for sustaining the aquatic fisheries. In addition, monsoon DO level fluctuated from 5.9 to 7.3 mg/L whereas in post monsoon it was varied from 5.6 to 8.0 mg/L. At winter period (January 2015) it ranged 5.5 - 6.9 mg/L. Maximum and minimum concentration of DO was measured in post monsoon and pre-monsoon periods.

62. 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): 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-Sibsha RS as salinity is decreasing from downstream to upstream of the same RS.

63. Seasonal variations of DO at the monitoring sites of Passur-Shibsha RS are shown in Table 5.7.

Table 5.7: Dissolve Oxygen in Passur River

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

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

64. During this last pre-monsoon monitoring, BOD5 values varied from 2.7 to 3.5 mg/L. In this monitoring, highest BOD5 was found at Middle of Passur River at Project site-Jetty while lowest BOD5 was observed at Passur river at Harbaria of Sundarbans. Including this last monitoring result, BOD5 of previously monitored four seasons fully complied with the BD standard (6 or less for sustaining fisheries) except Right Bank of Passur River at South West corner from the Project boundary (6.5) which was observed in first year pre-monsoon season.

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

Table 5.8: BOD_5 of Passur River Water

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

Source: Field Survey- April, July, October 2014; January and April 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)

5.4.2 Laboratory tested parameters

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

66. Similar to other coastal rivers in South-western region, sediment load in Passur is also high. Within the monitoring reach the TDS values varied from 12,400 to 21,500 mg/L in pre-monsoon season and 3,950 to 17,900 mg/L in winter season. On the other hand, in monsoon and post monsoon seasons, TDS concentrations in observed locations found to be in between 251 to 15,960 mg/L and 152 to 5,720 mg/L respectively which were very low compare to other two seasons.

67. Monitoring results confirmed that TDS concentrations of Passur river are comparatively higher than the recommended level of TDS in Bangladesh and in WHO (1000 mg/L) (WHO, 1993 & 2007) in most of the observed locations. Monitoring results also suggest that TDS are low in monsoon and post monsoon while very high in pre-monsoon and winter season in Passur and Shibsha rivers. In monsoon and post monsoon period the

Passur-Shibsha river system receives large volume of fresh water compare to pre-monsoon and winter period which reduces TDS drastically by mixing up with upstream freshwater (rainfall and surface runoff).

68. During four consecutive seasons monitoring, TDS was observed very low in upstream and very high in downstream of the said river system. Significant spatial variation was found, because of seawater and the erosion-accretion nature of the river. Moreover, rivers those are inter-connected directly to Bay of Bengal, receives huge amount of saline water and hence increase the ions (Ca2+, Mg2+, Sr2+ etc) of the water more than the upstream monitoring points.

69. In case of TH, during pre-monsoon, the water hardness in the sampling stations of Passur River was found to be ranged 2,500-13,060 mg/L, whereas it remarkably decreased and ranged 251–13,625 mg/L in monsoon and 216-1,440 mg/L in post monsoon season. Again it increased in winter season and ranged 870-2,690 mg/L. 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. Similar to TDS, TH has the same increasing pattern of hardness from upstream to downstream in all the seasons of Passur-Shibsha RS.

70. Total Suspended Solid (TSS) includes solid materials of organic and inorganic origins that are suspended in the water. Suspended matters in Passur and Shibsha Rivers are comprised by sand, clay, silt and loam. TSS obtained during pre-monsoon was 7-598 mg/L whereas in monsoon it ranged 24-310 mg/L. Except at Passur-Mongla confluence (310 mg/L) and Left bank of Passur river at 100 meter upstream of the North West corner from the project boundary (598 mg/L), TSS were found within the standard value (150 mg/L) suggested for Bangladesh (DOE, 1991) during both pre-monsoon and monsoon seasons. The TSS in rainy (pre-monsoon and monsoon) season was fairly low because of freshwater predominantly influences the water flow in the river. On the other hand, TSS concentration was found much higher in post monsoon and winter season than the previous two seasons at most of the observed locations except Akram point (28 mg/L) of Passur river. Due to less rainfall and upstream flow, TSS was found much higher in dry season mainly. During dry season (summer 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.

71. The TDS, TH and TSS of pre-monsoon, monsoon, and 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)			
		1St Year				1St Year				1St Year			
		Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan
		1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM
1	Left Bank of Passur River at 100m u/s of North West corner from the Project boundary	13060	251	176	4360	2900	250	216	930	598	126	234	180
2	Middle of Passur River at 100m u/s of North West corner from the Project boundary	12630	246	162	3950	2500	180	218	870	45	92	193	210

SL	Sampling Locations	TDS (mg/L)				TH (mg/L)				TSS (mg/L)			
		1St Year				1St Year				1St 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
3	Right Bank of Passur River at 100m u/s of North West corner from the Project boundary	12900	383	153	4330	2650	170	335	870	53	112	174	230
4	Left Bank of Passur River at Project site-Jetty	13190	445	169	4750	2550	175	390	940	54	99	227	450
5	Middle Passur River at Project site-Jetty	13330	353	156	4920	2600	275	340	990	60	100	232	250
6	Right Bank of Passur River at Project site-Jetty	13380	402	152	4870	2625	350	355	970	55	105	186	200
7	Left Bank of Passur River at South West corner from the Project boundary	13180	655	162	5040	2550	325	330	1045	24	116	185	300
8	Middle of Passur River at South West corner from the Project boundary	13390	587	153	5050	2800	350	345	1125	27	112	536	530
9	Right Bank of Passur River at South West corner from the Project boundary	13240	916	154	5130	2500	475	325	975	67	37	459	450
10	Maidara river of the South East corner of the project at Ichamoti-Maidara confluence	12400	455	214	5050	2500	450	350	980	7	65	798	280
11	Maidara river near proposed township area	10970	2510	257	4390	2400	725	330	970	9	24	389	206
12	Passur river at Passur - Mongla confluence	12800	6410	209	5130	3150	1400	377	1000	50	310	203	280
13	Passur river at Harbaria of Sundarbans	12280	9360	285	4780	2625	2150	345	970	65	90	869	400
14	Passur river at Akram point of Sundarbans	21500	15960	3400	12350	4500	3625	980	2380	115	99	28	103
15	Passur river at Hiron point of Sundarbans	21500	14050	5720	17900	4850	3050	1440	2690	91	72	267	200

Source: Field Survey- April, July and October 2014; January 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)

(b) Chemical Oxygen Demand

72. Generally, COD found to be higher in Passur-Shibsha RS. The river contain high load of organic content. Total Organic Content (TOC), 6.25 -7.91 mg/L found near project site, which is very high and it might be much higher in the Sundarbans region. This high organic content causes high COD. Moreover, a large scale industrial activity is taking place along the left bank of Passur River from Chalna to Harbaria, which may also contribute to the high COD.

73. The COD concentrations of pre-monsoon and winter seasons (dry) were found to be higher than monsoon and post-monsoon (rainy) 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

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

Source: Field Survey- April, July and October 2014; January 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).

(c) Nitrate, Sulphate and Phosphate

74. Nitrate concentrations as NO3-N in the Passur-Shibsha RS observed generally low and varied from 0.10 to 2.70 mg/L, 0.76 to 3.32 mg/L, 0.32 to 2.26 mg/L and 1.5 to 8.5 mg/L in four consecutive seasons of pre-monsoon, monsoon, post monsoon and winter respectively. Nitrate concentration in winter season is comparatively little bit higher than other three seasons but fully complied with the BD standards (10.0 mg/L). Generally, over the whole river system the nitrate is showing low concentration and irregular spatial variation in all observed points.

75. Naturally, SO42- is higher in sea water as well as river in coastal region. From the observed dataset, it is seen that SO42- is very high in pre-monsoon followed by winter season and ranged in between 1,120-2,600 mg/L and 450-1,500 mg/L respectively. In contrary, SO42- concentration found to be low in monsoon (ranged 20-1,400 mg/L) and post monsoon (ranged 27-2,360 mg/L) except Akram and Hiron points of Sundarbans. From Akram to Hiron points, SO42- concentrated in a range of 1,160-1,400 mg/L and 1,390-2,360

mg/L at monsoon and post monsoon seasons respectively. Usually, $SO4^{2-}$ concentration of Passur-Shibsha RS increases in the direction of upstream to downstream of the rivers. Comparatively lower SO42- in monsoon and post monsoon seasons is the dilution effect of upstream fresh water.

76. Like sulphate, PO42- concentration was found higher in pre-monsoon (ranged 0.52-7.51 mg/L) compare to monsoon (ranged 0.45-2.55 mg/L) and post monsoon (ranged 0.67-1.27 mg/L) seasons in observed locations. In winter season, PO42- concentration becomes very low in the said river system.

77. The observed NO32-, SO42- and PO42- concentrations at different monitoring locations of four consecutive seasons are presented in Table 5.11.

Table 5.11: NO_3^{2-}, SO_4^{2-} and PO_4^{2-} concentration of Passur River System

Sl	Sampling Locations	NO_3^{2-}(mg/L)				SO_4^{2-}(mg/L)				PO_4^{2-} (mg/L)			
		1st Year				1st Year				1st Year			
		Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan
		1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM
1	Left Bank of Passur River at 100m u/s of North West corner from the Project boundary	0.90	2.89	0.32	3	1840	20	26	580	0.52	2.23	0.67	0.32
2	Middle Passur River at 100m u/s of North West corner from the Project boundary	0.70	2.40	1.57	1.5	1320	23	28	450	0.50	1.99	1.12	0.61
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	1280	36	34	480	1.10	2.55	0.95	0.7
4	Left Bank of Passur River at Project site-Jetty	1.30	0.76	1.64	3.1	1360	45	33	550	2.10	0.45	0.92	0.43
5	Middle Passur River at Project site-Jetty	1.40	2.69	1.42	2.2	1040	32	30	520	2.20	2.13	1.11	0.41
6	Right Bank of Passur River at Project site-Jetty	1.10	2.98	1.33	8.5	1320	20	27	540	2.00	2.42	0.99	0.55
7	Left Bank of Passur River at South West corner from the Project boundary	0.75	2.13	1.85	2.7	1640	60	40	630	0.57	1.25	1.18	0.76
8	Middle of Passur River at South West corner from the Project boundary	1.10	2.43	2.09	1.8	1520	40	35	560	1.20	1.51	1.25	0.85
9	Right Bank of Passur River at South West corner from the Project boundary	1.20	2.05	2.21	1.9	1280	80	64	620	1.50	1.10	1	0.53

Sl	Sampling Locations	NO_3^{2-}(mg/L)				SO_4^{2-}(mg/L)				PO_4^{2-} (mg/L)			
		1st Year				1st Year				1st 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
10	Maidara river of the South East corner of the project at Ichamoti-Maidara confluence	0.30	2.18	2.26	6	1120	20	63	570	0.55	2.10	1.27	0.59
11	Maidara river near proposed township area	0.50	0.88	1.98	4	1320	210	63	460	1.10	0.53	1.04	0.64
12	Passur river at Passur - Mongla confluence	0.60	1.52	1.64	4.5	1360	620	44	630	1.30	0.35	0.86	0.42
13	Passur river at Harbaria of Sundarbans	1.40	1.75	1.67	2.7	1560	860	69	590	1.10	0.56	1.22	0.61
14	Passur river at Akram point of Sundarbans	2.70	3.32	0.59	1.5	2600	1400	1390	850	1.30	0.29	0.8	0.42
15	Passur river at Hiron point of Sundarbans	0.80	2.84	0.4	2	2080	1160	2360	1500	7.51	0.29	1.09	0.44

Source: Field Survey- April, July and October 2014; January 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).

(d) Heavy Metals

78. 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, Pb and Hg concentrations of four observed seasons are presented in Table 5.12.

Table 5.12: As, Pb and Hg concentration of Passur River System

Sl	Sampling Locations	As (mg/L)				Pb (mg/L)				Hg (mg/L)			
		1st Year				1st Year				1st Year			
		Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan
		1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM
1	Left Bank of Passur River at 100m u/s of North West corner from the Project boundary	0.002	0.003	0.004	0.003	0.053	0.004	0.002	0.104	<0.0015	<0.0015	<0.0015	<0.0015
2	Middle Passur River at 100m u/s of North West corner from the Project boundary	0.002	0.003	0.004	0.003	0.055	0.002	0.003	0.104	<0.0015	<0.0015	<0.0015	<0.0015
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	0.055	0.005	0.002	0.111	<0.0015	<0.0015	<0.0015	<0.0015
4	Left Bank of Passur River at Project site-Jetty	0.002	0.004	0.004	0.004	0.057	0.002	0.003	0.154	<0.0015	<0.0015	<0.0015	<0.0015
5	Middle Passur River at Project site-Jetty	0.002	0.004	0.004	0.003	0.060	0.002	0.002	0.139	<0.0015	<0.0015	<0.0015	<0.0015

Sl	Sampling Locations	As (mg/L)				Pb (mg/L)				Hg (mg/L)			
		1st Year				1st Year				1st 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
6	Right Bank of Passur River at Project site-Jetty	0.002	0.003	0.003	0.003	0.058	0.002	0.002	0.138	<0.0015	<0.0015	<0.0015	<0.0015
7	Left Bank of Passur River at South West corner from the Project boundary	<0.001	0.003	0.006	0.003	0.053	0.002	0.003	0.16	<0.0015	<0.0015	<0.0015	<0.0015
8	Middle of Passur River at South West corner from the Project boundary	<0.002	0.004	0.004	0.003	0.054	0.003	0.004	0.153	<0.0015	<0.0015	<0.0015	<0.0015
9	Right Bank of Passur River at South West corner from the Project boundary	0.002	0.003	0.006	0.003	0.056	0.005	0.004	0.139	<0.0015	<0.0015	<0.0015	<0.0015
10	Maidara river of the South East corner of the project at Ichamoti-Maidara confluence	<0.001	0.003	0.006	0.004	0.053	0.004	0.004	0.143	<0.0015	<0.0015	<0.0015	<0.0015
11	Maidara river near proposed township area	0.002	0.002	0.003	0.003	0.048	0.004	<0.002	0.133	<0.0015	<0.0015	<0.0015	<0.0015
12	Passur river at Passur - Mongla confluence	0.002	0.004	0.003	0.003	0.050	0.032	<0.002	0.141	<0.0015	<0.0015	<0.0015	<0.0015
13	Passur river at Harbaria of Sundarbans	0.004	0.003	0.004	0.004	0.043	0.044	0.004	0.137	<0.0015	<0.0015	<0.0015	<0.0015
14	Passur river at Akram point of Sundarbans	0.004	0.002	0.002	0.003	0.194	0.071	0.032	0.309	0.00020	<0.0015	<0.0015	<0.0015
15	Passur river at Hiron point of Sundarbans	0.003	0.002	0.003	0.002	0.224	0.050	0.007	0.309	0.00023	<0.0015	<0.0015	<0.0015

Source: Field Survey- April, July and October 2014; January 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) Oil and Grease

79. In order to measure the concentration of oil and grease on the course of Passur River, five samples have been collected during the low tide period at surface layer. The analysis has been conducted through standard testing method of APHA. **Table 5.13** shows the concentration of oil and grease presents in Passur River. During pre-monsoon, monsoon and post monsoon periods, the concentration of oil and grease was found negligible and all of the monitoring locations fully comply with the ECR' 1997 Standard. As the river is tidal in nature, the tidal mixing dilutes the spilled oil. However, Passur and Shibsha rivers were containing high concentration of oil and grease in winter period. This high concentration may be the reason of 2014 Sundarbans oil spill occurred on December 9th. An amount of 350,000 litres (Philips, 2014) of furnace oil was sunk in the river which spread over a 350 km^2 area (Welle, 2014).

Table 5.13: Oil and grease concentration of Passur River System

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

Source: Field Survey- April, July and October 2014; January 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).
**Drinking water quality standards, The Environment Conservation Rules, 1997*

5.5 Ground water quality monitoring

5.5.1 In-situ parameters

(a) pH and Temperature

80. Physical parameter pH and temperature in observed locations fully complied with the drinking water quality standards of ECR, 1997 for the consecutive five seasons. The pH values of second year first quarter monitoring (April 2015) found to be varied from 7.8 to 7.9 while temperature was found to be in between 28.6oC to 28.8oC (Table 5.14). It can be mentioned that ground water samples from township and Khalekharber was not collected because of temporarily closed and damaged water sources respectively. The five consecutive monitoring results of pH and temperatures of selected locations are presented in Table 5.14.

Table 5.14: pH and Temperature of Ground Water

Sl	Locations	Tube Well Type	pH value						Temperature (°C)					
			1st Year				2nd Year	BD Standard*	1st year				2nd Year	BD Standard*
			Apr	Jul	Oct	Jan	Apr		Apr	Jul	Oct	Jan	Apr	
			1 QM	2 QM	3 QM	4 QM	1 QM		1 QM	2 QM	3 QM	4 QM	1 QM	
1	Near Proposed Township	Deep (>600 ft)	7.6	7.7	7.9	8.0	TC	6.5-8.5	27.3	28.5	26.0	24.5	TC	20 – 30^0 C
2	Rajnagar	Deep (>600 ft)	7.6	7.8	8.0	8.2	7.8		29.6	29.9	28.0	22.5	28.6	
3	Kalekharber	Shallow (<250 ft)	6.3	6.5	NF	NF	NF		27.5	28.7	NF	NF	NF	
4	Kapasdanga	Deep (>600 ft)	7.6	7.7	8.0	8.1	7.9		29.2	28.9	28.0	25.1	28.8	

Source: Field Survey- April, July and October 2014; January and April 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).
NF=Non functional
TC=Temporarily closed
**Drinking water quality standards, The Environment Conservation Rules, 1997.*

(b) Salinity and Dissolved Oxygen

81. In all the observed locations, saline free groundwater was found during these five consecutive monitoring seasons. Sampling site which is located near proposed township area was found to be affected by salinity (1ppt) in post-monsoon season. In case of dissolved oxygen, observed DO levels were found to be in between 6.0 - 6.6 mg/L in this last monitoring study. ECR 1997 defines DO standard as 6 mg/L but it is not clearly mentioned whether it is maximum or minimum concentration. Actually, World Health Organization (WHO) does not consider DO as a regulatory parameter for drinking water quality standard.

82. In this second year first quarter monitoring study, hand pump of near township area was temporarily closed while water point of Kalekharber was found to be completely damaged. The five consecutive monitoring results of salinity and DO of selected locations are presented in Table 5.15.

Table 5.15: Salinity and DO in Groundwater

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

Source: Field Survey- April, July and October 2014; January and April 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).
NF=Non functional; N/A=Not Availability
TC=Temporarily closed
**Drinking water quality standards, The Environment Conservation Rules, 1997*

5.5.2 Laboratory tested parameters

(a) TDS and TSS

83. Ground water TDS and TSS value of five consecutive monitoring seasons has been presented in Table 5.16.

84. In pre-monsoon, TDS was found to be very high in the observed sources but in monsoon and winter, it was measured far below than the drinking water quality standard (1000 mg/L) except groundwater sources of township area. In post-monsoon, TDS value was not monitored timely.

85. TSS was measured in all the monitoring study except pre-monsoon season. TSS was found to be within the standard limit in monsoon except Kalekharber. TSS was found very high (48 mg/L) in the tube well of Kalekharber. This tube well was installed at shallow depth which might be a reason of high TSS. Moreover, TSS was found higher (19 mg/L) in

post monsoon than the standard limit (10 mg/L) in another point of near township area of the proposed project during post monsoon season.

Table 5.16: TDS and TSS concentrations in Groundwater

Sl	Locations	Type of tube wells	TDS (mg/L)					TSS (mg/L)				
			1st Year				BD Standard *	1st Year				BD Standard*
			Apr	Jul	Oct	Jan		Apr	Jul	Oct	Jan	
			1 QM	2 QM	3 QM	4 QM		1 QM	2 QM	3 QM	4 QM	
1	Township near project site	Deep (>600 ft)	1113	999	-	1021	1000 mg/L	-	6	19	40	10 mg/L
2	Rajnagar	Deep (>600 ft)	4090	371	-	378		-	6	2	28	
3	Kalekharber	Shallow (<250 ft)	1055	970	-	NF		-	48	NF	NF	
4	Kapasdanga	Deep (>600 ft)	643	635	-	600		-	8	6	32	

Source: Field Survey- April, July and October 2014; January 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).
NF=Non functional
**Drinking water quality standards, The Environment Conservation Rules, 1997*

(b) Total Hardness

86. Pre-monsoon to winter season, TH concentration was measured in all the monitored locations and presented in Table 5.17. Among the four observing water points, Kalekharber showed high TH concentration (780 mg/L) in pre-monsoon season because of its shallower depth compare to other water points. Now, TH of Khalekharber has not been monitoring since the third quarter monitoring due to physical damage of the hand pump.

Table 5.17: TH concentrations in Groundwater

SL	Locations	Type of tube wells	TH (mg/L)				
			1st Year				BD standard *
			Apr	Jul	Oct	Jan	
			1QM	2QM	3QM	4QM	
1	Township near project site	Deep (>600 ft)	425	250	300	235	200-500 mg/L
2	Rajnagar	Deep (>600 ft)	220	175	180	110	
3	Kalekharber	Shallow (<250 ft)	780	450	NF	NF	
4	Kapasdanga	Deep (>600 ft)	190	140	180	125	

Source: Field Survey- April, July and October 2014; January 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).
NF=Non functional
**Drinking water quality standards, The Environment Conservation Rules, 1997.*

(c) Chemical Oxygen Demand

87. The Bangladesh standard for COD in drinking water is only 4.0 mg/L. However, all the monitoring tube wells showed higher concentration of COD than the ECR'97 in all

monitored consecutive seasons. In pre-monsoon season, the concentration found in between 28-48 mg/L whereas in monsoon, post monsoon and winter it was observed in ranges of 28-36 mg/L, 8-34 mg/L and 16-20 mg/L respectively. The COD concentrations of all the monitoring locations are presented in Table 5.18.

Table 5.18: COD concentrations of monitored ground water locations

Sl	Locations	Tube Well Type	COD (mg/L)				
			1st Year				BD standard*
			Apr	Jul	Oct	Jan	
			1QM	2QM	3QM	4QM	
1	Township near project site	Deep (>600 ft)	32	32	34	20	4
2	Rajnagar	Deep (>600 ft)	28	28	18	16	
3	Kalekharber	Shallow (<250 ft)	32	36	NF	NF	
4	Kapasdanga	Deep (>600 ft)	48	32	34	20	

Source: Field Survey- April, July and October 2014; January 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).
NF=Non functional
**Drinking water quality standards, The Environment Conservation Rules, 1997.*

(d) Nitrate, Sulphate and Phosphate

88. Nitrate concentrations observed in pre-monsoon, monsoon and post monsoon at selected groundwater samples were found to be within the safe levels (10.0 mg/L) guided by the ECR' 1997 in the section of Bangladesh Standard for Drinking Water Quality. In contrary, NO32- concentration in winter season found to be high in each measured samples.

89. SO42-and PO42-concentrations monitoring of Passur-Shibsha RS have been appended in this study since second quarterly monitoring. SO42-and PO42- concentrations were also found to be within the safe limit of drinking water quality standard. It is here to be mentioned that concentrations monitoring of these two parameters was not possible in all quarter monitoring study.

90. The observed ground water NO32-, SO42-and PO42-concentrations are presented in Table 5.19

Table 5.19: NO3, SO4 and PO4 Concentrations in Ground Water

Sl	Locations	Type of tube wells	NO_3^{2-} (mg/L) *BD Standard (10 mg/L)				SO_4^{2-} (mg/L) *BD Standard (400 mg/L)				PO_4^{2-} (mg/L) *BD Standard (6.0 mg/L)			
			1st Year				1st Year				1st Year			
			Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan
			1 QM	2 QM	3 QM	4 QM	1 QM	2 QM	3 QM	4 QM	1 QM	2 QM	3 QM	4 QM
1	Township near project site	Deep (>600 ft)	0.20	0.48	<0.10	28	-	3	-	-	-	2.2	-	0.74
2	Rajnagar	Deep (>600 ft)	0.60	0.68	0.31	26	-	2	-	-	-	2.5	-	0.44
3	Kalekharber	Shallow (<250 ft)	0.40	0.56	NF	NF	-	3	NF	-	-	1.2	NF	NF
4	Kapasdanga	Deep (>600 ft)	0.80	0.40	0.80	13	-	10	-	-	-	6.2	-	0.48

Source: Field Survey- April, July and October 2014; January 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).
NF=Non functional
**Drinking water quality standards, The Environment Conservation Rules, 1997.*

(e) Arsenic, Lead and Mercury

91. As per Bangladesh Standard, the maximum acceptable concentration of Arsenic in groundwater is 0.05 mg/L. Among the four, tube wells of Kalekharber, which is installed at shallower depth, was found arsenic contaminated. All other tube wells were found to be free from arsenic contamination. In case of Pb and Hg, very low concentrations were detected and remained much below the highest acceptable limit of 0.05 mg/L and 0.001 mg/L respectively (Table 5.20).

Table 5.20: As, Pb and Hg concentrations (mg/L) of monitored ground water locations

Sl	Locations	As (mg/L) *BD Standard (0.05 mg/L)				Pb (mg/L) *BD Standard (0.05 mg/L)				Hg (mg/L) *BD Standard (0.001 mg/L)			
		1st Year				1st Year				1st 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	0.013	0.020	0.012	0.014	0.002	<0.002	0.004	0.023	<0.00015	<0.00015	<0.0005	<0.0005
2	Rajnagar	0.006	0.009	0.006	0.008	<0.002	<0.002	<0.002	0.016	<0.00015	<0.00015	<0.0005	<0.0005
3	Kalekharber	0.376	0.407	NF	NF	0.002	0.008	NF	NF	<0.00015	<0.00015	NF	NF
4	Kapasdanga	0.036	0.033	0.020	0.017	<0.002	0.004	<0.002	0.013	<0.00015	<0.00015	<0.0005	<0.0005

Source: Field Survey- April, July and October 2014; January 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).
NF=Non functional
**Drinking water quality standards, The Environment Conservation Rules, 1997*

6 Land Resources Monitoring

92. During the field visit on 3/4/15 to 6/4/15 soil samples were collected for dry season for the determination of pH, OM, EC, N, P, K, S, Ca, Mg, Na, Fe, Mn, Zn, B, Cl- . This time it was not possible to analyzeheavy metal i.e Pb. Cd by SRDI. In next monitoring, heavy metal needs to be analyze in laboratory of BARI or other government approved laboratory.

6.1 Methodology

6.1.1 Monitoring Indicators

93. Land use, soil fertility/nutrient status soil contamination with heavy metals and soil physical quality is the major monitoring indicators for land resources under this study. During the operation phase of power plant, it is assumed that ash may be deposited on the surrounding agriculture land. Therefore, monitoring of the selected indicators is very crucial for land resources monitoring in the study area.

6.1.2 Frequency

94. Soil samples for monitoring of soil fertility/nutrient status of soil contamination with heavy metals, samples of wet season were collected in the month of October, 2014 and results incorporated in the this (First quarter in second year) report. Dry season, soil samples were collected in April, 2015. Next wet season soil samples will be collected in October/November 2015.

6.1.3 Location

95. Five mouzas within the 10 Km radius of the power plant were selected for monitoring of land use, soil fertility/nutrient status of soil contamination with heavy metals. The selected mouzas are Baranpara, Chunkuri-2, Kapalirmet, Chalkghona and Basherhula. Locations of the soil samples collection is presented in the Map 6.1.

6.2 Process of soil samples collection

6.2.1 Land selection

96. Land was selected before 1st monitoring report through group discussion, especially with the land owners. Main emphasis was given to potential locations of dry/wet deposition of ash, SOx and NOx to be emitted from the Plant. All the selected areas were medium high (F1) land. The GPS readings were recorded on each location to facilitate the collection of soil samples from the exact locations in future. Details of the GPS information were presented in agriculture section.

Table 6.1: Land and Agricultural Resources Monitoring Plan

Sl no	Monitoring Indicators	Locations	GPS (Decimal Degree)		Frequency	Methods/Tools/ Techniques
			Easting	Northing		
1	Landuse, Soil fertility and Nutrient, Chemical Properties of Soil (pH, As, and Hg), Crop production, damage, Coconut plants/fruits damage	Mouza - Bashurhula, Union-Rajnagar, Upazila-Rampal	89.516417	22.632500	Twice crop season (May and October)	In situ field sampling and Laboratory Testing in SRDI,
2		Mouza - Chunkuri-2, Union – Bajua, Upazila - Dacope	89.538889	22.580833		
3		Mouza - Bidyarbon, Union – urirdanga, Upazila – Mongla	89.602444	22.538583		
4		Mouza: Kapalirmet , Buridmial, Union – Burirdanga, Upazila- Mongla	89.573694	22.571750		
			89.573611	22.603889		

6.2.2 Soil sample collection

97. Soil samples were collected from, five locations in three different depths ((0-15 cm, 15-30 cm and 30-45 cm) in the monitoring area on April, 2015.

98. Soil samples were collected following the standard practices of composite method. At each plot, soil samples were collected from three dug pit. From each pit, three soil samples were extracted from three different depths. Top soil from 0-15 cm depth, subsoil from 15-30 cm depth and sub stratum from 30-45 cm depth were collected using augur. The three top soil samples collected from three different pits were then mixed properly to make a composite sample and 500g of soil mass was taken and stored in an air tight protective poly bag for laboratory analysis. Similar approach was followed in collecting sub soil and sub stratum soil sample collection. To have more accurate results, it was ensured that the top, subsoil and substratum are taken from the same pit.

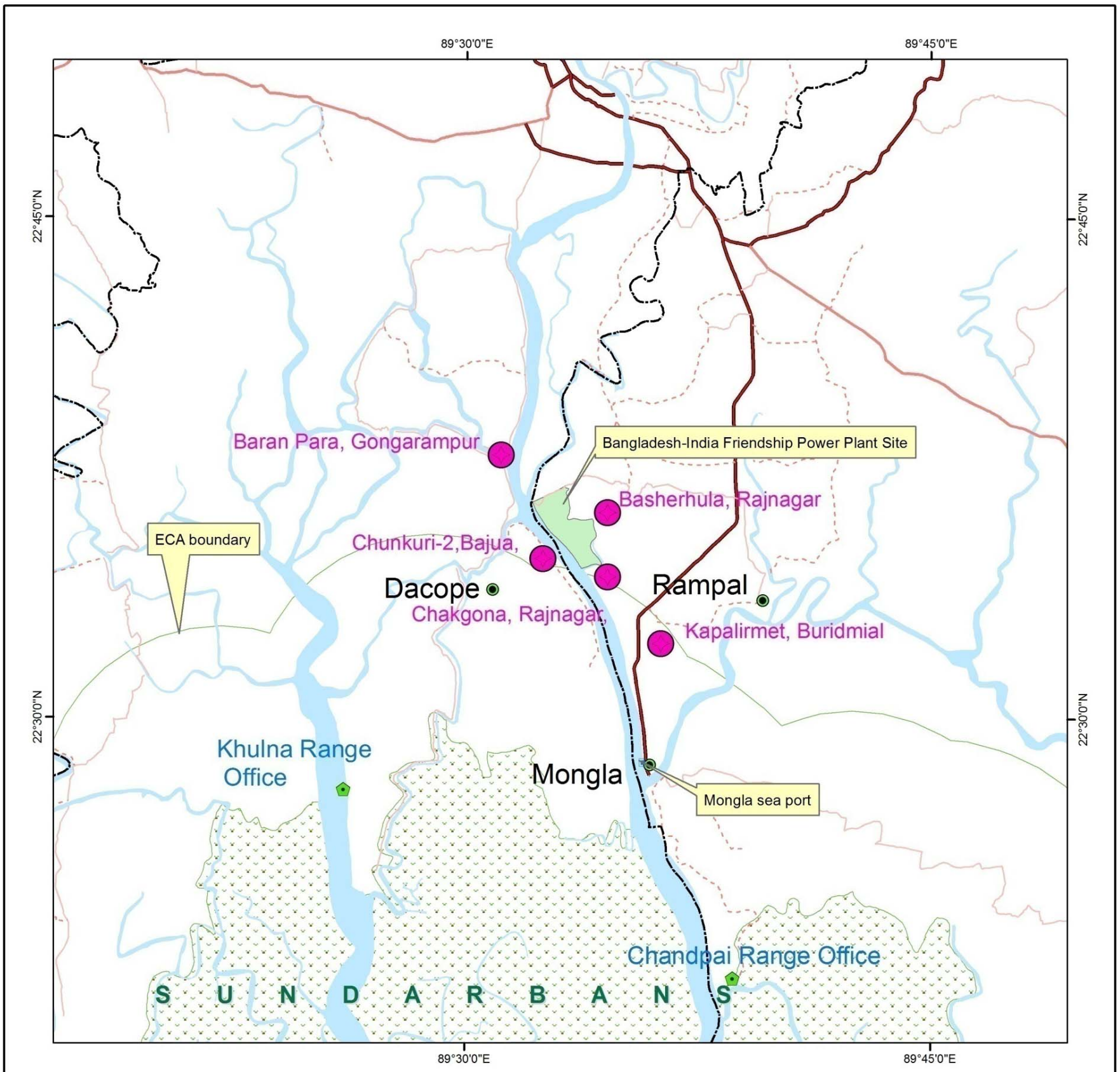
99. In the right hand picture at Kapalirmet, last year T.aman was cultivated. Farmers decided that this year he will go for shrimp or fish culture.

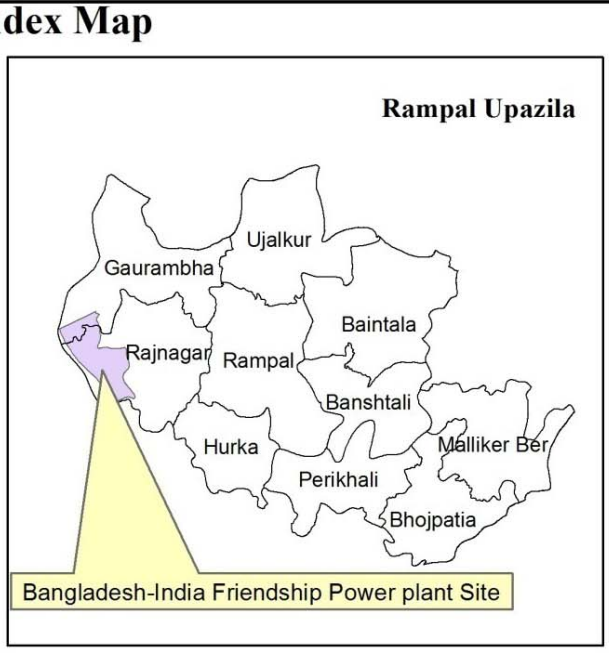
Photo 6.1: View of soil sample collection from monitoring land at Basherhula

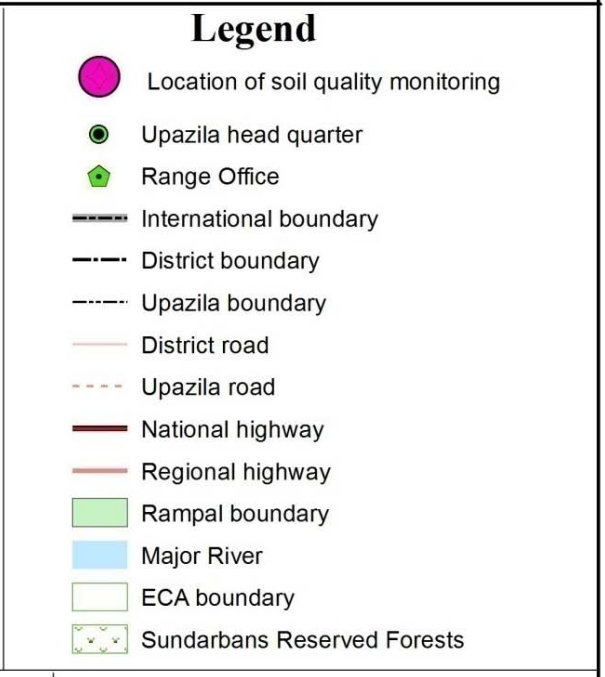
Photo 6.2: View of soil sample collection from monitoring land at Kapalirmet

6.2.3 Laboratory analysis

100. The collected soil samples have been handed over to the Soil Resource Development Institute (SRDI), Dhaka for laboratory analysis. Results will be presented in the next monitoring report after obtaining the same from SRDI.







Data sources:

CEGIS Archive
Environmental and Socio-economic Monitoring of Khulna 1320 MW CBTPP, BIFPCL

0 1.25 2.5 5 Kilometers

N

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

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

Map 6.1: Soil Quality Monitoring Locations

6.3 Results of Monitoring

101. In general, organic matter content of the soil is low in the coastal regions of Bangladesh. Thus in addition to salinity, plant nutrients in soils affect plant growth.

102. In general monitoring study area comprises under the Agro-Ecological Zone-13 (Ganges Tidal Flood Plain) (BARC, 2012). So, the analysis report of soils of monitoring land was compared to the AEZ physico-chemical properties of soil to understand the variation of the soil fertility status.

103. The soil quality information on dry and wet season of 2013-14 is presented in the Table 9.1. We are comparing dry and wet season analysis results in the 5th quarterly progress report.

104. We observed from the table that the dry season, soil salinity levels are 4.8-11.7 (ds/m) in the depth of 0-15 cm, 8.4-11.3 (ds/m) in 15-30cm and 9.6-10.9 (ds/m) in 30-45cm. It indicates that all locations suffer from slightly to moderately saline 2.0-12.0 (ds/m), which is a common scenario for the AEZ-13. The AEZ-13 area is suffers from slightly to highly saline 2.0->16.0 (ds/m), (SRDI, 2012). The wet season, soil salinity levels are 1.8- 8.5 (ds/m) in the depth of 0-15 cm, 2.0-7.0 (ds/m) in 15-30cm and 5.1-7.5 (ds/m) in 30-45cm. It was observed that salinity level decreased. It was also observed in wet season, the top and sub-surface soils of Baranpara, non saline with very slightly saline and rest are very slightly saline with some slightly saline. Rainfall effectively leached down the salts from the topsoil and subsoil to the substratum in all locations. The decrement of salinity might be due to dilution of salt as well as washout of soluble salts due to onset of monsoon rainfall in the concerned land.

105. The dry season, pH levels are 4.2-7.7 in the depth of 0-15 cm, 4.3 -7.7 in 15 to 30cm, and 5.7-7.7 in 30-45cm. Generally, pH ranges 4.5-8.4 in AEZ 13 (BARC, 2012) because, soil is acid sulphate. It indicates that, pH level of all lands are very strongly acidic to slightly alkaline (4.2-7.7) in nature and show no appreciable trend down in the depths. The wet season, pH levels are 6.4-8.3 in the depth of 0-15 cm, 6.4-8.2 in 15-30cm and 6.2-8.2 in 30-45cm. It was observed that, pH level increased significantly over the dry season in all areas. It indicates that, pH ranges from neutral to moderately alkaline in nature. However, at the peak of rainfall of September soil pH tends to increase down the sampling depths due to vertical movement or translocation of dissolved cations, as a result, soil pH increased down the depth.

106. The dry season, Organic Matter (OM %) are 1.5- 3.1 in the depth of 0-15 cm, 1.7-8.2 in 15-30cm and 1.5-2.9 in 30-45cm. It indicates that, OM status is low to medium (1.0-3.4%) in all the monitoring land (BARC, 2012) which is also very common in the AEZ-13. The wet season, Organic Matter (OM %) are 1.2 – 2.5 in the depth of 0-15 cm, 0.91-2.2 in 15-30cm and 1.0-1.4 in 30-45cm. It has been found from the table, OM status decrease down noticeably in all depths.

107. Concentration of Phosphorus (P) was found, 2.7-5.6(µg/g) in the depth of 0-15 cm, 2.7-13.6 (µg/g) in 15-30cm and 1.3-6.1(µg/g) in 30-45cm in dry season. Generally, P level is very low to low ≤5.25-10.5 (µg/g) in this AEZ area. But, the concentration of P in wet season was found, 7.3 – 14.3(µg/g) in the depth of 0-15 cm, 5.3-22.8 (µg/g) in 15-30cm and 5.8-19.5(µg/g) in 30-45cm. P level was trend up from the dry season in all depths and above the critical value (7.00 µg/g).

108. In case of Nitrogen (N) level, it was found that 0.08-0.16% in the depth of 0-15 cm, 0.09-0.16% in 15-30cm and 0.8-0.15% in 30-45cm in all locations of the soil in dry season. This range is compatible to the general condition of this AEZ area where N level is low as 0.091-0.18(%). The wet season N levels are 0.06-0.12% in the depth of 0-15 cm, 0.05-0.12% in 15-30cm and 0.06-0.08% in 30-45cm. The N level showed decrease down over dry season and it was very low to low level. It was observed, low level from optimum level (0.271to 0.36%) in both season as well as equivalent to critical limit (0.12%) some cases.

109. Potassium (K) level was found, 1.0-1.6(meq/100g) in the depth of 0-15 cm, 1.0-1.5 (meq/100g) in 15-30cm and 1.0-1.5(meq/100g) in 30-45cm in dry season. The Potassium level was very high level in all locations in the dry season. But, generally the K level of this AEZ is medium to optimum 0.181-0.36 (meq/100gm). The wet season, 0.6–1.7(meq/100g) in the depth of 0-15 cm, 0.7-1.6 (meq/100g) in 15-30cm and 0.6-1.6(meq/100g) in 30-45cm, which was remarkably very high level in depths. The wet season, K level increase up in all locations from the dry season as well as higher than optimum level (0.271to 0.36 meq/100g) in both season.

110. Calcium (Ca) level was found, 11.4–22.2(meq/100g) in the depth of 0-15 cm, 10.5-23.9 (meq/100g) in 15-30cm and 12.6-24.4 (meq/100g) in 30-45cm in dry season. The Ca level of dry season was higher than the general properties of soil in this AEZ. Generally, the Ca level of this AEZ-13 is optimum to high 4.51-7.5(meq/100g).The wet season, Ca levels are 12.9–31.4(meq/100g) in the depth of 0-15 cm, 14.3-32.6 (meq/100g) in 15-30cm and 14.4-34.4 (meq/100g) in 30-45cm which was higher than dry season as well as the general properties of soils in this AEZ. The Ca level was higher in both seasons from optimum level (4.51to 6.0 meq/100g).

111. The dry season, Magnesium (Mg) level was found, 9.8–11.9(meq/100g) in the depth of 0-15 cm, 7.1-16.3 (meq/100g) in 15-30cm and 10.4-15.9 (meq/100g) in 30-45cm. It was also observed that the dry season Mg levels varying from 7.1-16.3 (meq/100g) which was higher than the general properties of soil in this AEZ. Mg level of this AEZ-13 is medium to optimum 0.751-1.5(meq/100g) in nature. The wet season, Magnesium (Mg) level was found, 7.9–10.0(meq/100g) in the depth of 0-15 cm, 8.4-9.9 (meq/100g) in 15-30cm and 8.3-9 .7 (meq/100g) in 30-45cm. The Mg level was decreased down the depths and lower than the dry season. Mg level was observed, higher in both seasons than the critical value (0.50meq/100g).

112. The dry season, Sodium (Na) level was found, 5.5–12.0(meq/100g) in the depth of 0-15 cm, 5.0-8.6 (meq/100g) in 15-30cm and 6.0-8.5 (meq/100g) in 30-45cm. On the other hand, the wet season Na status was 2.7–11.9(meq/100g) in the depth of 0-15 cm, 2.7-9.9 (meq/100g) in 15-30cm and 3.7-9.6 (meq/100g) in 30-45cm.The Na status showed significant difference among the sampling depths. The Na status was lower than dry season.

113. In case of Sulphur (S) was found, 272.3 – 545.2(µg/g) in the depth of 0-15 cm, 280.5-513.7 (µg/g) in 15-30cm and 320.4-490.9(µg/g) in 30-45cm in dry season. The S level was much higher than the general soil properties of the AEZ13 in dry season. In AEZ 13, S level normally ranges from medium to optimum, 15.1-30.0 (µg/gm). The wet season S levels are 3.1– 41.4(µg/g) in the depth of 0-15 cm, 2.8-46.7 (µg/g) in 15-30cm and 5.6-32.8(µg/g) in 30-45cm. It is mentioned that, the wet season S level was very low to very high in nature and observed higher than optimum level (22.51-30.0 µg/gm) in both seasons.

114. The dry season Boron (B) levels are 0.5-1.2(µg/g) in the depth of 0-15 cm, 0.4-1.1 (µg/g) in 15-30cm and 0.7-1.4(µg/g) in 30-45cm and the B levels was medium to high as per SRDI, 2012. The B levels were little bit higher than the general properties of Soil of this AEZ. In the AEZ-13, B ranges from medium to optimum 0.31-0.6(µg/gm). The wet season Boron (B) levels are 0.6 – 1.3(µg/g) in the depth of 0-15 cm, 0.5-1.7 (µg/g) in 15-30cm and 0.7-1.5(µg/g) in 30-45cm.The wet season B level was optimum to high in nature.

115. The dry season, Iron (Fe) levels are 37.3 – 150.3(µg/g) in the depth of 0-15 cm, 39.1-124.1 (µg/g) in 15-30cm and 51.3-120.3 (µg/g) in 30-45cm. Iron (Fe) level was found very high as per the classification of SRDI in dry season. Besides this, the wet season, 189.0 – 258.7(µg/g) in the depth of 0-15 cm, 60.9-307.0 (µg/g) in 15-30cm and 113.9-247.9 (µg/g) in 30-45cm which showed very high from the dry season.

116. The dry season, Zinc (Zn) levels are 0.8 – 1.9(µg/g) in the depth of 0-15 cm, 0.9-1.8 (µg/g) in 15-30cm and 0.9-2.1 (µg/g) in 30-45cm. The level of Zn in dry season was higher than the general level of Zn in this AEZ in the dry season in all locations. Generally, Zn varies from 0.451-1.35(µg/gm) in this AEZ. The Zn level of wet season are 1.0 – 4.9(µg/g) in the depth of 0-15 cm, 0.5-3.3 (µg/g) in 15-30cm and 0.4-2.9 (µg/g) in 30-45cm. The wet season Zn levels increased over the dry season.

117. The dry season, manganese (Mn) levels are 3.4 – 7.3(µg/g) in the depth of 0-15 cm, 2.8-6.1 (µg/g) in 15-30cm and 2.7-3.9 (µg/g) in 30-45cm.The Mn levels was high but common in this AEZ 13. Generally, Mn level varies from 2.9 to 5.3(µg/gm) in this AEZ. The wet season, Mn concentration are 5.9 – 16.4(µg/g) in the depth of 0-15 cm, 5.9-13.8 (µg/g) in 15-30cm and 5.2-16.9(µg/g) in 30-45cm of the soils of monitoring locations. The Mn level was very high in all monitoring times over the dry season.

118. The presence of Chloride (Cl-) was found in all locations at all depth. It was found to be varying from 398.4 to 3741.9 (µg/gm), except the sub-surface and substratum layer of Kapalirmet, top soil of Chokgona, top and sub-surface soil of Chunkuri-2 where Cl- levels were found as zero (0.0). Very recently, SRDI has stopped the analysis of Chloride (Cl-) concentration. We made an agreement with SRDI that they will do Cl- analysis and result will be presented in the next monitoring report.

119. In the dry season,Pb concentration observed in 12.5-31.8(µg/gm) in 0-15 cm depth, 6.3-31.8 (µg/gm) in 15-30 cm depth and 6.3-37.8(µg/gm) in 30-45 cm depth.In the wet season,Pb concentration observed in 25.1-33.7(µg/gm) in 0-15 cm depth, 28.4-37.7 (µg/gm) in 15-30 cm depth and 22.2-31.5(µg/gm) in 30-45 cm depth

Table 6.2: Chemical Properties of Soil

Sl No	Location	Parameter	2013-2014				2014-2015				2015-2016			
			Dry season (April)	Remarks	Wet season (October)	Remarks	Dry season (March)	Remarks	Wet season (October)	Remarks	Dry season (March)	Remarks	Wet season (October)	Remarks
1.	Baran para	**Top soil(0-15cm)**												
		EC(ds/m)	9.1	Moderately saline	1.8	Non saline								
		pH	4.2	Very strongly acidic	6.7	Neutral								
		OM (%)	3.1	Medium	2.5	Medium								
		N (%)	0.16	Low	0.12	Low								
		K (%)	1.00	Very high	0.59	Very high								
		Ca (meq/100g)	11.3	Very high	14.3	Very high								
		Mg (meq/100g)	10.7	Very high	8.6	Very high								
		Na(meq/100g)	5.50	*	2.7	*								
		P(µg/gm)	2.7	Very low	14.3	Medium								
		S(µg/gm)	523.2	Very high	41.4	Very high								
		B(µg/gm)	0.45	Medium	0.55	Very high								
		Fe(µg/gm)	150.3	Very high	258.6	Very high								
		Mn(µg/gm)	7.2	Very high	11.3	Very high								
		Zn(µg/gm)	1.4	Medium	1.2	Medium								
		Lead(Pb) (µg/gm)	31.8	*	33.7	*								
		Chloride (Cl^-)(µg/gm)	762.2	*										
		Subsurface soil(15-30cm)												
		EC(ds/m)	8.4	Moderately saline	2.0	Non saline								
		pH	4.3	Very strongly acidic	6.9	Neutral								
		OM (%)	2.9	Medium	2.2	Medium								
		N (%)	0.15	Low	0.2	Medium								
		K (%)	1.0	Very high	0.61	Very high								
		Ca(meq/100g)	10.48	Very high	14.3	Very high								
		Mg(meq/100g)	8.8	Very high	8.2	Very high								
		Na(meq/100g)	5.00	*	2.7	*								

Sl No	Location	Parameter	2013-2014				2014-2015				2015-2016			
			Dry season (April)	Remarks	Wet season (October)	Remarks	Dry season (March)	Remarks	Wet season (October)	Remarks	Dry season (March)	Remarks	Wet season (October)	Remarks
		P(µg/gm)	2.9	Very low	22.8	High								
		S(µg/gm)	513.7	Very high	31.4	High								
		B(µg/gm)	0.36	Medium	0.49	Optimum								
		Fe(µg/gm)	39.1	Very high	60.9	Very high								
		Mn(µg/gm)	3.3	High	10.9	Very high								
		Zn(µg/gm)	1.5	Optimum	0.87	Low								
		Lead(Pb) (µg/gm)	31.8	*	32.1	*								
		Chloride (Cl^-)(µg/gm)	398.4	*										
		Substratum(30-45cm)												
		EC(ds/m)	9.6	Moderately saline	5.8	Very slightly saline								
		pH	5.7	Slightly acidic	6.9	Neutral								
		OM (%)	1.6	Low	1.1	Low								
		N (%)	0.08	Very low	0.06	Very low								
		K (%)	1.0	Very high	0.6	Very high								
		Ca(meq/100g)	12.6	Very high	16.3	Very high								
		Mg(meq/100g)	15.9	Very high	8.8	Very high								
		Na(meq/100g)	6.00	*	3.7	*								
		P(µg/gm)	2.00	Very low	13.3	Medium								
		S(µg/gm)	490.9	Very high	31.9	High								
		B(µg/gm)	0.73	High	0.77	Very high								
		Fe(µg/gm)	51.3	Very high	113.9	Very high								
		Mn(µg/gm)	3.9	Very high	5.2	Very high								
		Zn(µg/gm)	1.6	Optimum	0.49	Low								
		Lead(Pb) (µg/gm)	37.8	*	31.5	*								
		Chloride (Cl^-)(µg/gm)	692.9	*										
2.	Chunkuri-2	**Top soil (0-15cm)**												
		EC(ds/m)	11.2	Moderately saline	5.6	Very slightly saline								
		pH	6.1	Slightly acidic	6.4	Slightly acidic								

Sl No	Location	Parameter	2013-2014				2014-2015				2015-2016			
			Dry season (April)	Remarks	Wet season (October)	Remarks	Dry season (March)	Remarks	Wet season (October)	Remarks	Dry season (March)	Remarks	Wet season (October)	Remarks
		OM (%)	2.1	Medium	1.2	Low								
		N (%)	0.11	Low	0.06	Very low								
		K (%)	1.5	Very high	1.14	Very high								
		Ca(meq/100g)	12.3	Very high	12.9	Very high								
		Mg(meq/100g)	9.8	Very high	8.9	Very high								
		Na(meq/100g)	8.5	*	9.4	*								
		P(µg/gm)	2.7	Very low	12.8	Medium								
		S(µg/gm)	401.9	Very high	16.9	Medium								
		B(µg/gm)	0.57	Optimum	0.74	High								
		Fe(µg/gm)	60.2	Very high	223.6	Very high								
		Mn(µg/gm)	5.3	Very high	12.8	Very high								
		Zn(µg/gm)	1.7	Medium	2.5	Very high								
		Lead(Pb) (µg/gm)	0.00	*	29.2	*								
		Chloride (Cl^-)(µg/gm)	1957.6	*										
		Subsurface soil(15-30cm)												
		EC(ds/m)	9.1	Moderately saline	5.6	Very slightly saline								
		pH	6.7	Neutral	6.4	Slightly acidic								
		OM (%)	1.8	Low	0.95	Very low								
		N (%)	0.09	Very low	0.06	Very low								
		K (%)	1.6	Very high	1.1	Very high								
		Ca(meq/100g)	12.6	Very high	13.8	Very high								
		Mg(meq/100g)	9.5	Very high	8.9	Very high								
		Na(meq/100g)	8.5	*	9.9	Very high								
		P(µg/gm)	2.7	Very low	18.4	Optimum								
		S(µg/gm)	280.5	Very high	23.8	Optimum								
		B(µg/gm)	1.1	Very high	1.7	Very high								
		Fe(µg/gm)	133.9	Very high	193.3	Very high								
		Mn(µg/gm)	2.8	Optimum	11.6	Very high								
		Zn(µg/gm)	0.99	Medium	1.4	Optimum								
		Lead(Pb) (µg/gm)	0.00	*	29.9	*								
		Chloride	1472.5	*										

Sl No	Location	Parameter	2013-2014				2014-2015				2015-2016			
			Dry season (April)	Remarks	Wet season (October)	Remarks	Dry season (March)	Remarks	Wet season (October)	Remarks	Dry season (March)	Remarks	Wet season (October)	Remarks
		(Cl^-)(µg/gm)												
		Substratum(30-45cm)												
		EC(ds/m)	10.1	Moderately saline	5.3	Very slightly saline								
		pH	6.6	Neutral	6.2	Slightly acidic								
		OM (%)	1.9	Medium	1.4	Low								
		N (%)	0.09	Low	0.08	Low								
		K (%)	1.5	Very high	1.2	Very high								
		Ca(meq/100g)	13.7	Very high	34.4	Very high								
		Mg(meq/100g)	11.8	Very high	6.4	Very high								
		Na(meq/100g)	8.5	*	9.3	*								
		P(µg/gm)	1.3	Very low	19.5	Optimum								
		S(µg/gm)	320.4	Very high	32.8	High								
		B(µg/gm)	1.14	Very high	1.5	Very high								
		Fe(µg/gm)	125.3	Very high	175.5	Very high								
		Mn(µg/gm)	2.7	Optimum	12.2	High								
		Zn(µg/gm)	1.8	Optimum	0.5	Low								
		Lead(Pb) (µg/gm)	31.3	*	29.7	*								
		Chloride (Cl^-)(µg/gm)	1715.0	*										
3.	Kapalirmet	**Top soil(0-15cm)**												
		EC(ds/m)	4.8	Slightly saline	8.5	Slightly saline								
		pH	7.0	Neutral	7.6	Slightly alkaline								
		OM (%)	3.0	Medium	1.5	Low								
		N (%)	0.2	Low	0.07	Very low								
		K (%)	1.5	Very high	1.7	Very high								
		Ca(meq/100g)	18.2	Very high	19.9	Very high								
		Mg(meq/100g)	15.3	Very high	10.0	Very high								
		Na(meq/100g)	12.0	*	11.9	*								
		P(µg/gm)	3.2	Very low	7.3	Low								
		S(µg/gm)	545.2	Very high	20.8	Medium								
		B(µg/gm)	1.2	Very high	1.3	Very high								

Sl No	Location	Parameter	2013-2014				2014-2015				2015-2016			
			Dry season (April)	Remarks	Wet season (October)	Remarks	Dry season (March)	Remarks	Wet season (October)	Remarks	Dry season (March)	Remarks	Wet season (October)	Remarks
		Fe(µg/gm)	37.3	Very high	230.2	Very high								
		Mn(µg/gm)	3.8	Very high	6.6	Very high								
		Zn(µg/gm)	2.0	High	1.0	Low								
		Lead(Pb) (µg/gm)	12.5	*	28.9	*								
		Chloride (Cl^-)(µg/gm)	3741.9	*										
		Subsurface soil(15-30cm)												
		EC(ds/m)	11.1	Moderately saline	6.3	Very slightly saline								
		pH	7.2	Neutral	7.9	Moderately alkaline								
		OM (%)	2.6	Medium	1.3	Low								
		N (%)	0.2	Low	0.06	Very low								
		K (%)	1.5	Very high	1.6	Very high								
		Ca(meq/100g)	11.7	Very high	14.4	Very high								
		Mg(meq/100g)	7.1	Very high	9.9	Very high								
		Na(meq/100g)	8.5	*	9.8	*								
		P(µg/gm)	3.8	Very low	5.6	Low								
		S(µg/gm)	341.4	Very high	52.1	Very high								
		B(µg/gm)	0.86	Very high	1.6	Very high								
		Fe(µg/gm)	140.2	Very high	249.0	Very high								
		Mn(µg/gm)	3.7	High	5.9	Very high								
		Zn(µg/gm)	0.94	Medium	0.5	Low								
		Lead(Pb) (µg/gm)	0.00	*	29.3	*								
		Chloride (Cl^-) (µg/gm)	2217.4	*										
		Substratum(30-45cm)												
		EC(ds/m)	10.8	Moderately saline	7.5	Very slightly saline								
		pH	7.3	Neutral	7.8	Slightly alkaline								
		OM (%)	2.8	Medium	1.3	Low								
		N (%)	0.15	Low	0.06	Very low								
		K (%)	1.5	Very high	1.6	Very high								

Sl No	Location	Parameter	2013-2014				2014-2015				2015-2016			
			Dry season (April)	Remarks	Wet season (October)	Remarks	Dry season (March)	Remarks	Wet season (October)	Remarks	Dry season (March)	Remarks	Wet season (October)	Remarks
		Ca(meq/100g)	12.9	Very high	15.4	Very high								
		Mg(meq/100g)	10.4	Very high	9.7	Very high								
		Na(meq/100g)	8.5	*	9.6	*								
		P(µg/gm)	3.4	Very low	5.8	Low								
		S(µg/gm)	345.1	Very high	5.6	Very low								
		B(µg/gm)	1.4	Very high	1.1	Very high								
		Fe(µg/gm)	120.3	Very high	247.8	Very high								
		Mn(µg/gm)	2.9	Optimum	7.2	Very high								
		Zn(µg/gm)	0.88	Low	0.79	Low								
		Lead(Pb) (µg/gm)	0.00	*	27.6	*								
		Chloride (Cl^-) (µg/gm)	1801.6	*										
4	Chakgona	**Top soil(0-15cm)**												
		EC(ds/m)	11.5	Moderately saline	7.2	Very slightly saline								
		pH	7.7	Slightly alkaline	8.0	Moderately alkaline								
		OM (%)	1.5	Low	1.5	Low								
		N (%)	0.08	Low	0.08	Low								
		K (%)	1.5	Very high	1.4	Very high								
		Ca(meq/100g)	22.2	Very high	14.3	Very high								
		Mg(meq/100g)	11.7	Very high	9.4	Very high								
		Na(meq/100g)	8.5	*	8.4	*								
		P(µg/gm)	5.6	Very low	9.2	Low								
		S(µg/gm)	444.2	Very high	4.1	Very low								
		B(µg/gm)	0.98	Very high	1.2	Very high								
		Fe(µg/gm)	55.3	Very high	189.0	Very high								
		Mn(µg/gm)	4.3	High	16.4	Very high								
		Zn(µg/gm)	0.76	Low	4.8	Very high								
		Lead(Pb(µg/gm)	0.00	*	27.2	*								
		Chloride (Cl^-)(µg/gm)	1576.4	*										
		Subsurface soil(15-30cm)												
		EC(ds/m)	11.3	Moderately saline	6.2	Very slightly sine								

Sl No	Location	Parameter	2013-2014				2014-2015				2015-2016			
			Dry season (April)	Remarks	Wet season (October)	Remarks	Dry season (March)	Remarks	Wet season (October)	Remarks	Dry season (March)	Remarks	Wet season (October)	Remarks
		pH	7.7	Slightly alkaline	8.2	Moderately alkaline								
		OM (%)	2.6	Medium	1.3	Low								
		N (%)	0.13	Low	0.07	Very low								
		K (%)	1.5	Very high	1.1	Very high								
		Ca(meq/100g)	22.6	Very high	17.8	Very high								
		Mg(meq/100g)	16.3	Very high	8.3	Very high								
		Na(meq/100g)	8.5	*	8.6	*								
		P(µg/gm)	13.6	Medium	9.4	Low								
		S(µg/gm)	415.6	Very high	47.7	Very high								
		B(µg/gm)	0.66	High	0.97	Very high								
		Fe(µg/gm)	124.1	Very high	172.7	Very high								
		Mn(µg/gm)	6.1	Very high	13.8	Very high								
		Zn(µg/gm)	1.1	Medium	3.2	Very high								
		Lead(Pb(µg/gm)	6.3	*	28.4	*								
		Chloride (Cl^-)(µg/gm)	2113.5	*										
		Substratum(30-45cm)												
		EC(ds/m)	10.9	Moderately saline	5.1	Very slightly saline								
		pH	7.5	Slightly alkaline	8.2	Moderately alkaline								
		OM (%)	1.7	Low	1.0	Very low								
		N (%)	0.09	Very low	0.06	Very low								
		K (%)	1.5	Very high	0.95	Very high								
		Ca(meq/100g)	13.9	Very high	14.4	Very high								
		Mg(meq/100g)	11.1	Very high	7.2	Very high								
		Na(meq/100g)	8.5	*	6.7	*								
		P(µg/gm)	4.1	Very low	9.5	Low								
		S(µg/gm)	334.6	Very high	8.3	Low								
		B(µg/gm)	0.67	High	0.63	High								
		Fe(µg/gm)	75.3	Very high	160.0	Very high								
		Mn(µg/gm)	3.6	Very high	14.1	Very high								
		Zn(µg/gm)	1.7	Optimum	2.9	Very high								
		Lead(Pb) (µg/gm)	6.3	*	26.5	*								

Sl No	Location	Parameter	2013-2014				2014-2015				2015-2016			
			Dry season (April)	Remarks	Wet season (October)	Remarks	Dry season (March)	Remarks	Wet season (October)	Remarks	Dry season (March)	Remarks	Wet season (October)	Remarks
		Chloride (Cl^-)(µg/gm)	1715.0	*										
5.	Basherhula	**Top soil(0-15cm)**												
		EC(ds/m)	11.7	Moderately saline	6.0	Very slightly saline								
		pH	7.7	Slightly alkaline	8.3	Moderately alkaline								
		OM (%)	1.7	Low	1.2	Low								
		N (%)	0.09	Low	0.06	Very low								
		K (%)	1.5	Very high	1.2	Very high								
		Ca(meq/100g)	23.6	Very high	31.4	Very high								
		Mg(meq/100g)	11.9	Very high	7.9	Very high								
		Na(meq/100g)	8.5	*	8.1	*								
		P(µg/gm)	4.5	Very low	7.4	Low								
		S(µg/gm)	272.3	Very high	21.8	Medium								
		B(µg/gm)	0.94	Very high	1.1	Very high								
		Fe(µg/gm)	50.3	Very high	205.6	Very high								
		Mn(µg/gm)	3.4	High	5.9	Very high								
		Zn(µg/gm)	1.4	Medium	1.1	Medium								
		Lead(Pb(µg/gm)	18.8	*	25.1	*								
		Chloride (Cl^-)(µg/gm)	2442.6	*										
		Subsurface soil(15-30cm)												
		EC(ds/m)	10.7	Moderately saline	7.0	Very slightly saline								
		pH	7.7	Slightly alkaline	8.2	Moderately alkaline								
		OM (%)	1.5	Low	0.9	Low								
		N (%)	0.08	Very low	0.05	Very low								
		K (%)	1.0	Very high	1.2	Very high								
		Ca(meq/100g)	24.0	Very high	32.6	Very high								
		Mg(meq/100g)	11.7	Very high	8.4	Very high								
		Na(meq/100g)	7.0	*	10.1	*								
		P(µg/gm)	3.9	Very low	5.3	Low								
		S(µg/gm)	317.2	Very high	2.8	Very low								
		B(µg/gm)	0.71	High	1.0	Very high								

Sl No	Location	Parameter	2013-2014				2014-2015				2015-2016			
			Dry season (April)	Remarks	Wet season (October)	Remarks	Dry season (March)	Remarks	Wet season (October)	Remarks	Dry season (March)	Remarks	Wet season (October)	Remarks
		Fe(µg/gm)	121.4	Very high	307.0	Very high								
		Mn(µg/gm)	3.9	Very high	15.5	Very high								
		Zn(µg/gm)	1.8	Optimum	0.8	Low								
		Lead(Pb) (µg/gm)	18.8	*	23.7	*								
		Chloride (Cl^-) (µg/gm)	1611.1	*										
		Substratum(30-45cm)												
		EC(ds/m)	10.9	Moderately saline	6.3	Very slightly saline								
		pH	7.7	Slightly alkaline	8.2	Moderately alkaline								
		OM (%)	1.5	Low	1.0	Low								
		N (%)	0.08	Very low	0.06	Very low								
		K (%)	1.5	Very high	1.2	Very high								
		Ca(meq/100g)	24.4	Very high	32.1	Very high								
		Mg(meq/100g)	12.9	Very high	8.3	Very high								
		Na(meq/100g)	7.5	*	9.8	*								
		P(µg/gm)	6.1	Low	5.9	Low								
		S(µg/gm)	321.1	Very high	3.1	Very low								
		B(µg/gm)	0.63	High	0.85	Very high								
		Fe(µg/gm)	77.3	Very high	162.4	Very high								
		Mn(µg/gm)	3.2	High	16.9	Very high								
		Zn(µg/gm)	2.1	High	2.7	Very high								
		Lead(Pb) (µg/gm)	25.00	*	22.2	*								
		Chloride (Cl^-)(µg/gm)	1489.8	*										

7 Agriculture Resources Monitoring

120. Monitoring of Agriculture Resources has been scheduled twice a year as per the contract. Hence, in the first year of monitoring, survey has been conducted in April 2015.

7.1 Methodology

7.1.1 Monitoring Indicators

121. 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

122. 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 or other natural calamities induced impact as well as management practices and crop production in the selected locations of the monitoring area.

7.1.3 Frequency

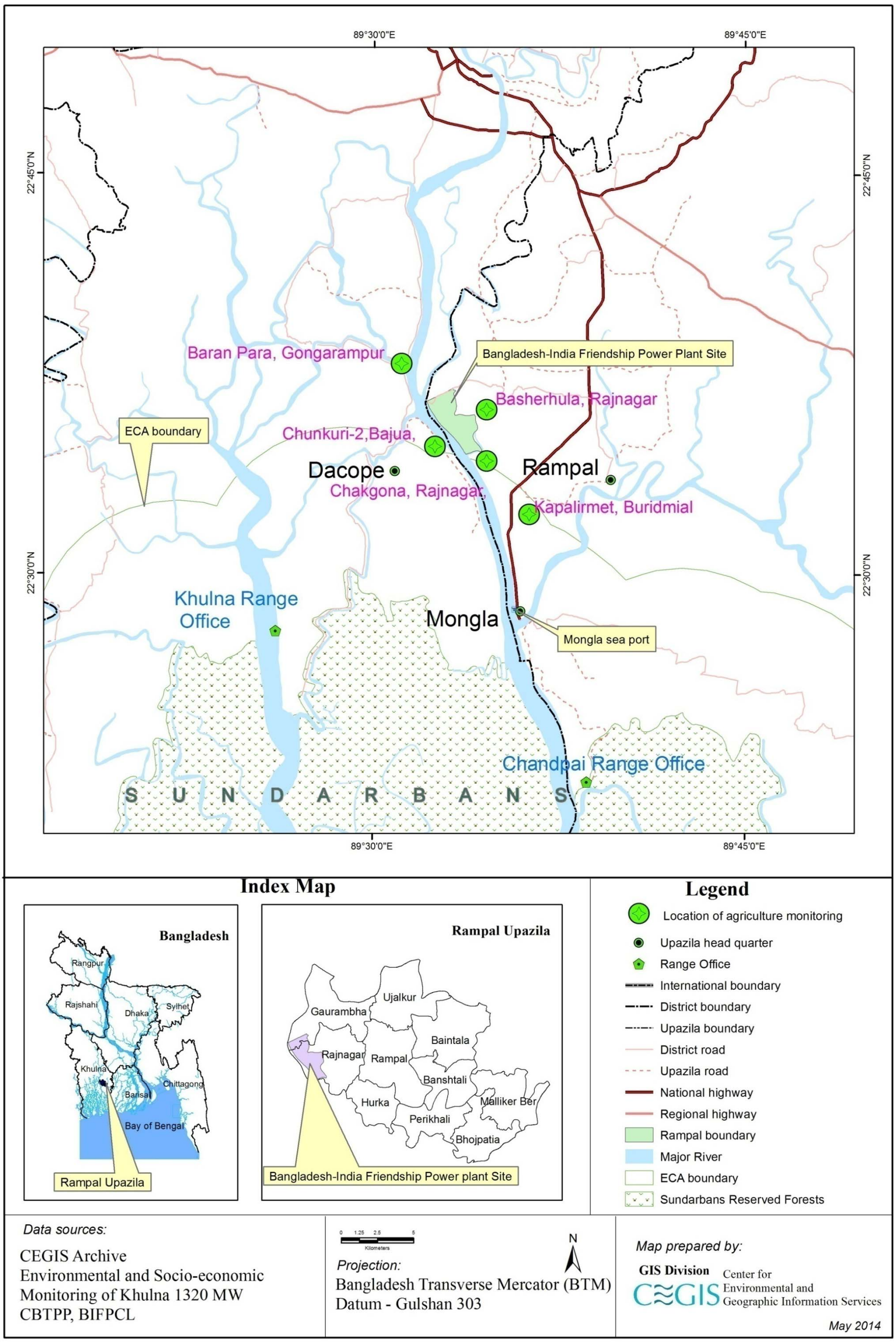
123. Land use, major crops area, major crop production and damage are monitored quarterly in a year. For the cropping season 2014-15, these data were collected in April, 2015. Crop production and damage information's were also collected from the same land.

7.1.4 Location

124. The same mouzas have been selected for land resources as well as agricultural resources monitoring. The selected mouzas are Baranpara, Chunkuri-2, Kapalirmet, Chalkghona and Basherhula.Locations of the monitoring agriculture lands are presented in the Map 7.1.

Table 7.1a: Agriculture Resources Monitoring Plan

Sl no	Monitoring Indicators	Locations	GPS (Decimal Degree)		Frequency	Methods/Tools/ Techniques
			Easting	Northing		
1	Landuse, Soil fertility and Nutrient, Chemical Properties of Soil (pH, As, and Hg), Crop production, damage, Coconut plants/fruits damage	Mouza - Bashurhula, Union-Rajnagar, Upazila-Rampal	89.516417	22.632500	Three crop season (May, July, October)	In situ field sampling and Laboratory Testing in SRDI,
2		Mouza - Chunkuri-2, Union – Bajua, Upazila - Dacope	89.538889	22.580833		
3		Mouza - Bidyarbon, Union – Burirdanga, Upazila – Mongla	89.602444	22.538583		
4		Mouza: Kapalirmet , Buridmial, Union – Burirdanga, Upazila- Mongla	89.573694	22.571750		



Map 7.1: Agricultural Resources Monitoring Locations

7.2 Agricultural Resources

7.2.1 Description of the selected agricultural land for monitoring

125. Detailed information of the selected land for lands and agriculture monitoring are presented in theTable 7.1b

Table 7.1b: Detailed information of the selected land

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: Chalkghona 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

Source: Field survey, 2015

7.2.2 Present cropping patterns

126. 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. Next cropping pattern of monitoring land will be collected in October 2015. Detailed cropping pattern are presented in the Table 7.2.

(a) Monitoring agriculture land-1

127. 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. 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.

128. 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. Detailed cropping pattern is shown in the Table 7.2

Photo 7.1: View of monitoring agriculture land at Baran para

Photo 7.2: View of monitoring agriculture land at Chunkuri-2

Photo 7.3: View of monitoring agriculture land at Kapalirmet (*Fallow-Shrimp/Fish culture)

Photo 7.4: View of monitoring agriculture land at Chalkghona (*Fallow-Shrimp/Fish culture)

Photo 7.5: View of monitoring agriculture land at Basherhula

(b) Monitoring agriculture land-2

129. 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. 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. Detailed cropping pattern is shown in the **Table 7.2**

(c) Monitoring agriculture land -3

130. 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. 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. Detailed cropping pattern is presented in the**Table 7.2**

(d) Monitoring agriculture land -4

131. This monitoring site is located at Chalkghona 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. 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. Detailed cropping pattern is presented in the **Table 7.2**

(e) Monitoring agriculture land-5

132. 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 (Benapol) in Karif-II season last year. 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. 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			
Monitoring agriculture land-2	Fallow	HYV Aman	Fallow	Fallow	Local Aman	Fallow			
Monitoring agriculture land-3	Fallow	Local Aman	Fallow	Fallow*	Fallow*	Fallow*			
Monitoring agriculture land-4	Fallow	Local Aman	Fallow	Fallow*	Fallow*	Fallow*			
Monitoring agriculture land-5	Fallow	Local Aman	Fallow	Fallow	Local Aman	Fallow			

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

7.2.3 Crop Production

133. 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 monitoring agriculture 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 Chokgona and Kapalirmet could not cultivate crops in 2014-15. Highest production (1.4 tons) observed in monitoring 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 (March – June)	Kharif II (July to Oct.)	Rabi (Nov. to Feb.)	Kharif I (March – June)	Kharif II (July to Oct.)	Rabi (Nov. to Feb.)	Kharif I (March – June)	Kharif II (July to Oct.)	Rabi (Nov. to Feb.)
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	-			

Monitoring Plots	Crop Production								
	2013-14			2014-15			2015-2016		
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*

7.2.4 Crop damage

134. There was no crop damage noticed in any monitoring land in 2013-14. The owners of the land-1(Baranpara), monitoring agriculture land-2(Chunkuri-2) and monitoring agriculture land-5(Basherhula) were cultivated HYV and Local Aman crops in this Kharif- II season (2014-15). The rest lands (Kapalirmet and Chalkghona) 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. The crop damage of the monitoring lands shall be monitored in April 2016. Detailed crop damage information is presented in **Table7.4**.

Table7.4: 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

135. Fisheries resources have been monitored quarterly in a year. After completion of first three quarters, the fourth quarter monitoring, has been conducted during the period of 3 to 17April, 2015. This chapter contains the results of first quarter monitoring in second year along with the results of earlier four quarters.

8.1 Monitoring Location

136. The monitoring activities were carried out at ten pre-selected locations -(i) Akram Point on the confluence of the Passur and the Shibsha, (ii) Haldikhali, (iii) Charpuntia, (iv) Bhadra, (v) Harbaria, (vi) Chandpai, (vii) Jongra, (viii) Mongla Point, (ix) Baro Durgapur and (x) Botiaghata, Chalna Point. The sampling sites are detailedin **Table8.1**. These sites were selected in inception stage and finalized during first quarter monitoring.

Table 8.1: The Sampling Locations for Fisheries Resources Monitoirng

Site	Habitat Location	North	East	Habitat	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	Baro Durgapur	22° 34′ 29.1′′	89° 33′ 28.4′′	Mouth of Maidara River	4
G	Botiaghata, Chalna Point	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

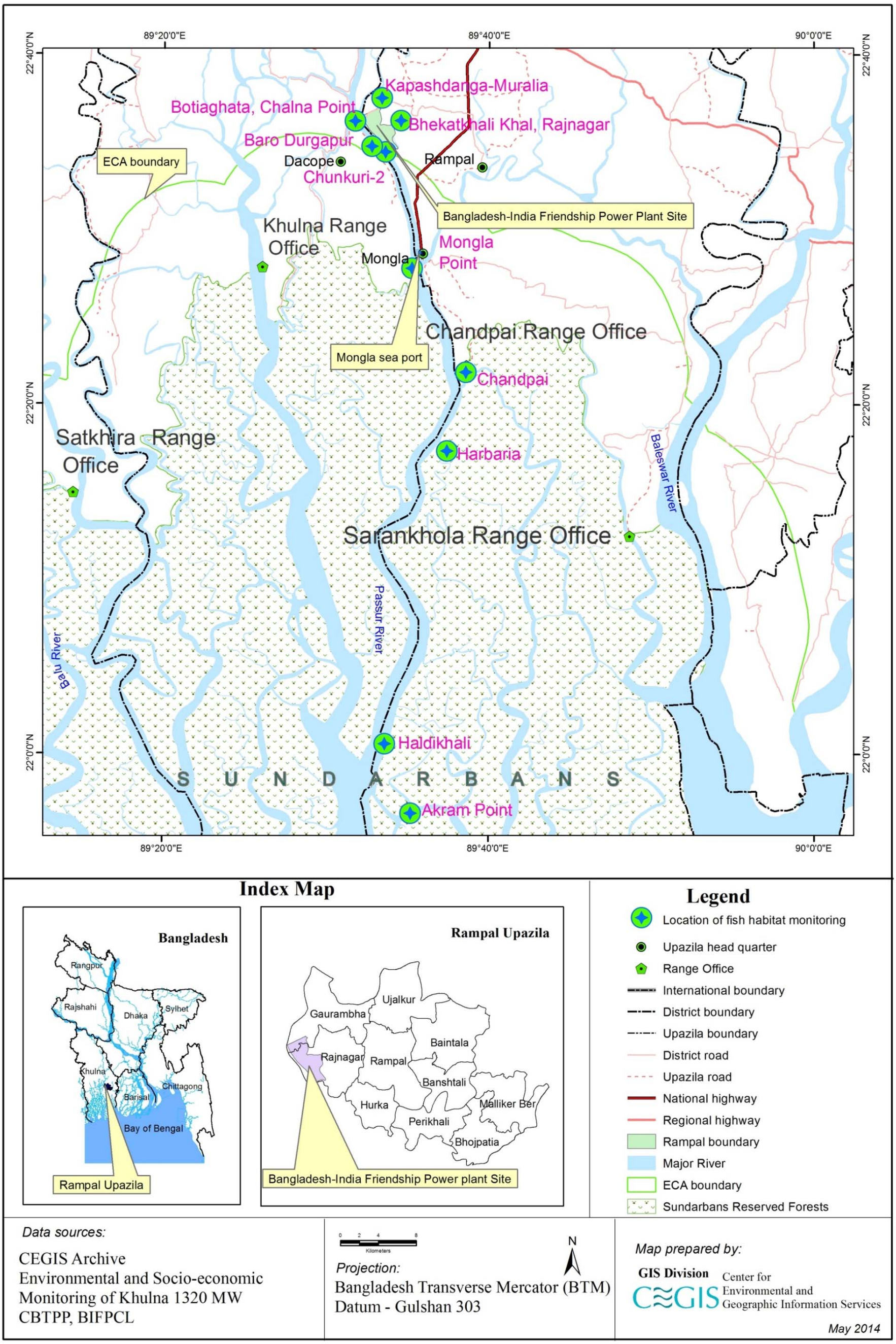
137. The following indicators have been monitored to understand the fish habitat status and quality: (i) water quality; (ii) bed material; (iii) hydrological condition; (iv) morphological aspects; (v) vegetation cover etc. These indicators would present the maximum natural

capability of habitats to produce healthy fish, safe for human consumption, or to support or produce aquatic organisms upon which fish depends. These issues are also important for understanding the condition of spawning and nursery grounds. The sampling sites have been analyzed by using length-wise distribution of different fish species to identify major behavioral fish habitat. 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 calculating the extent of similarity between pairs of data sets. The linkage distance was calculated with the similarity in species distribution.

138. Moreover, Habitat Suitability Index (HSI) has been determined for the year 2014, and later the same will be determined for the year 2015 and 2016. The data for basic life requirements for fish community shown in **Table8.2**that will be estimated at the end of each monitoring year**.** The HIS will be calculated from the data of basic life requirements for fish community for a complete year.

139. Once the monitoring of this second year is completed, the HSI value for 2015 will be calculated and then analyzed by plotting this data with the survival curve of the fish community structure. The acceptance goal 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).

[1]The 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 Locaitons

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 (%)							

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

140. The first associated information shown in the Table above has already been collected for the month of April, 2014, July 2014, October 2014, Januray 2015 and April 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 stage.

8.2.2 Fish Migration

141. Fish migration status has been observed at selected sites along the water ways used for carrying machinery and coal. Issues like migratory species diversity, migration pattern, migration purpose, period and extent of migration etc. has beeninvestigated.Migratory species have been identified by analyzing the common species found in the catch assessment surveysamples 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 among sampling sites.

8.2.3 Fish Biodiversity

142. Fish species diversity and composition has been selected as an indicator for fish monitoring. In the context of fish biodiversity, the critically endangered to vulnerable fish species (enlisted by IUCN), fish densities and catch composition of different strata (Vertical and Horizontal) in the selected habitat have been emphasized 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 calculated by analyzing Shannon-

Weiner Index[2]. This index has produced values between 0 and 1. According to 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 Diverisity (VHD)

143. Fish species richness (FSR) has been analyzed using the Sympson's Index producing two types of values. The first one includes values between 0 (having only one species in the sample) and 1 (having more than one species with same proportion) indicating general richness of the observed species distribution. The second one includes values that start from 1 (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

144. For monitoring shrimp/fish farm three farms within the direct impact zone of 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

145. Fish production for riverine fish has been surveyed through Catch per Unit Effort (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 Results ofMonitoring

146. Followed by the first quartile monitoring phase, first of the second quarter monitoring phase has been conducted during the period of 7 to 15 April, 2015..

8.3.1 Fisheries Resources

147. 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

[2]The 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 Diverisity (VHD).

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 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.

148. 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 issues of accessibility and safety.

8.3.2 Features to be considered

149. Following features are considered in conducting the fisheries monitoring:

- The Passur River System, the lone capture fishery, has been aggrading due to siltation
- Reduction of upstream flow since long back when polders were built
- Culture fish habitats are at stake of river bank erosion
- A number of fish died because of indiscriminate activities (e.g. during catching of PL of tiger shrimp many other fries are also damaged)
- Low water depth and flow velocity found in fourth monitoring phase as compared to other phases
- Fish diversity is highly dominated during lunar phase and tide condition.

8.3.3 Fish Habitat Status

(a) Habitat Classification

150. 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 stretch of the Passur River System consists of three major behavioural 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.

151. During 1st monitoring (April, 2014) fish habitat had been classified as the grazing ground (Akram Point and Harbaria), grazing and breeding ground (Haldikhali and confluence of the Passur river at Chalna Point) as well as spawning and nursery ground (Sheola khal at Chandpai, Passur River at Mongla Point and Maidara River). In the second quarter monitoring (June – July 2014) two habitats – i) Grazing ground, ii) Spawning and Nursery ground have been identified. However, during third quarter monitoring in the month of October 2014 the similarity of size group distribution of fish species among the habitats has been found to beshifted to some extent. In fourth monitoring phase in the month of January 2015 three habitats – i) Grazing ground, ii) Grazing and Breeding ground; and iii) Spawning, Nursery and Grazing ground have been identified.

152. During the 1st quarter (April, 2015) of the second monitoring phase three habitats – i) Grazing ground, ii) Nursery ground; and iii) Spawning and Nursery have been identified as shown in the **figure-8.1**.

Grazing Ground:

153. The Kukilmoni Khal (A) and Haldikhali Khal (B) respectively at Akram Point and Haldikhali have been identified as the grazing ground in the Passur River System.

Nursery:

154. Among the sampling sites, the Mongla Point of Mongla-Passure Confluence (E) and Chalna Point (G) are similar in the distribution of fry of maximum fish spcies found. These habitats are, therefore, classified as the spawning ground.

Photo 8.1a: Fish habitat in the Passur River System

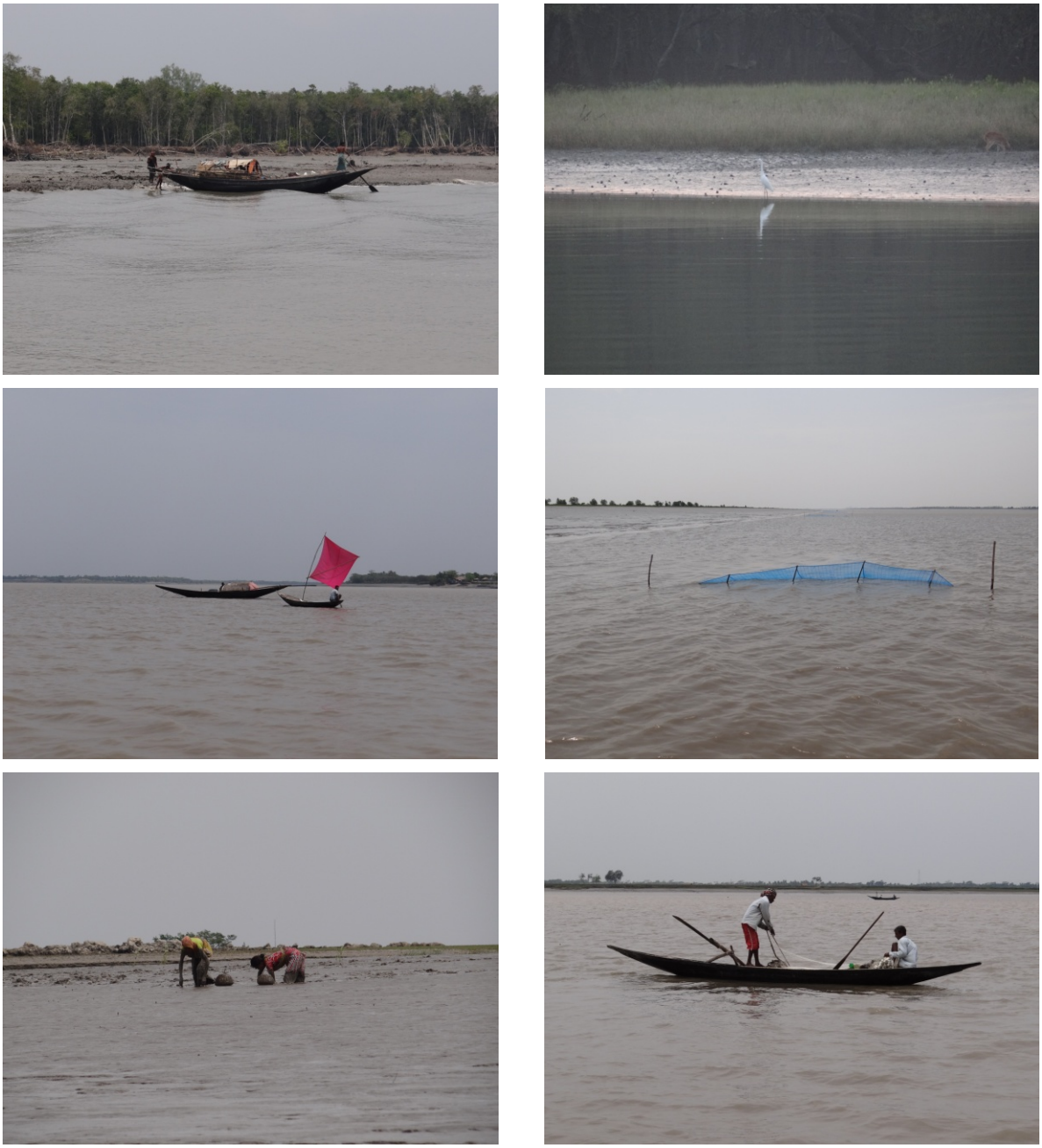
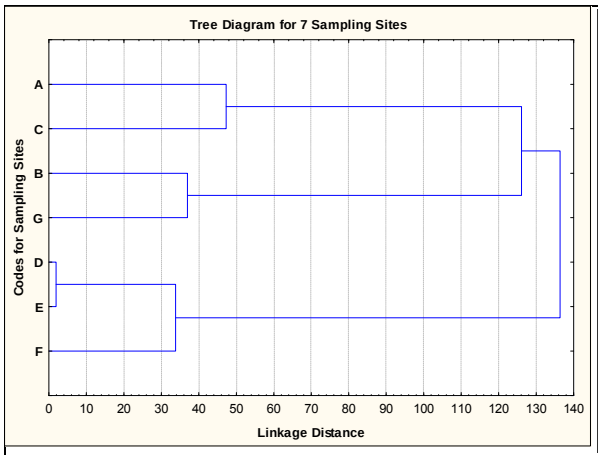
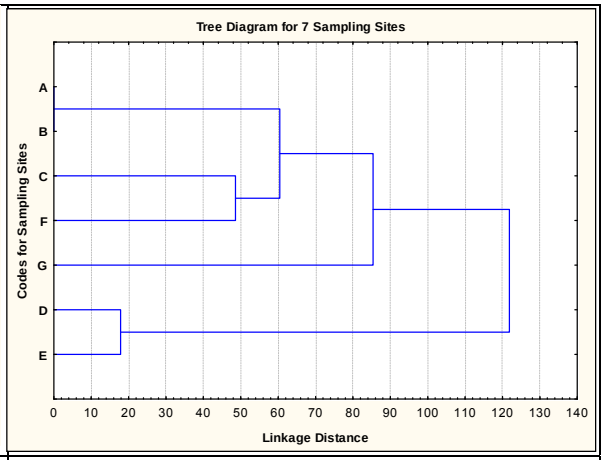


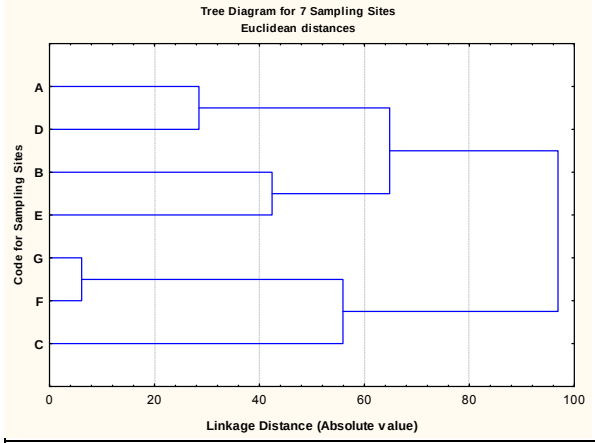
Photo 8.1b: Fish habitat in the Passur River System



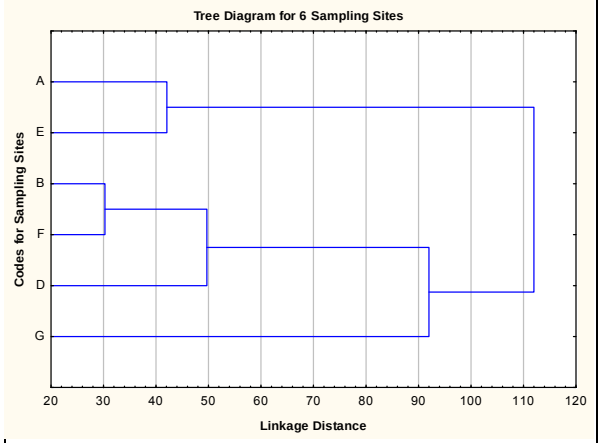
1st Quarter, 1st Year Monitoring, April, 2014



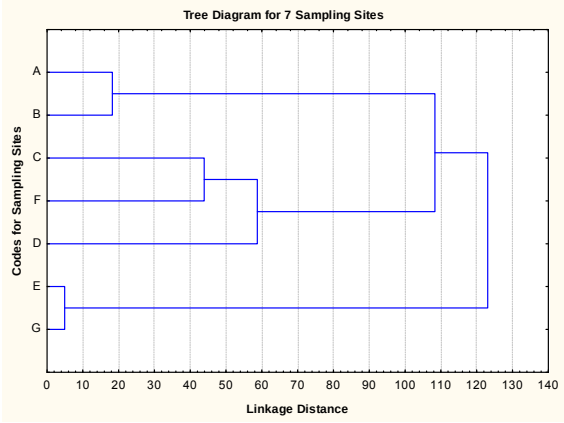
2nd Quarter, 1st Year Monitoring, July 2014



3rd Quarter, 1st Year Monitoring, October, 2014



4th Quarter, 1st Year Monitoring, January 2015

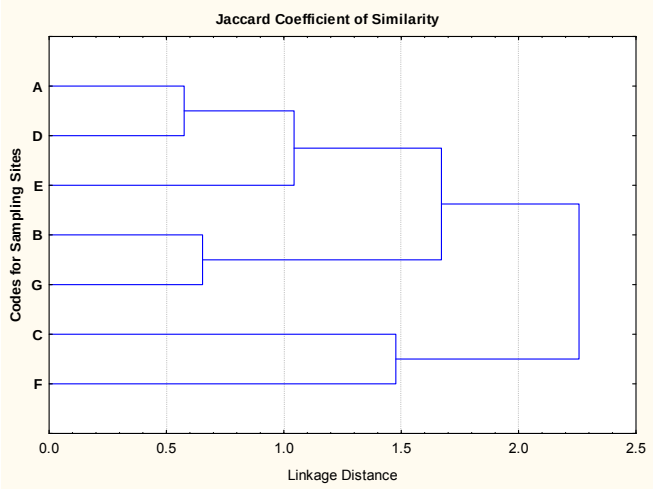


1st Quarter, 2nd Year Monitoring, April, 2015

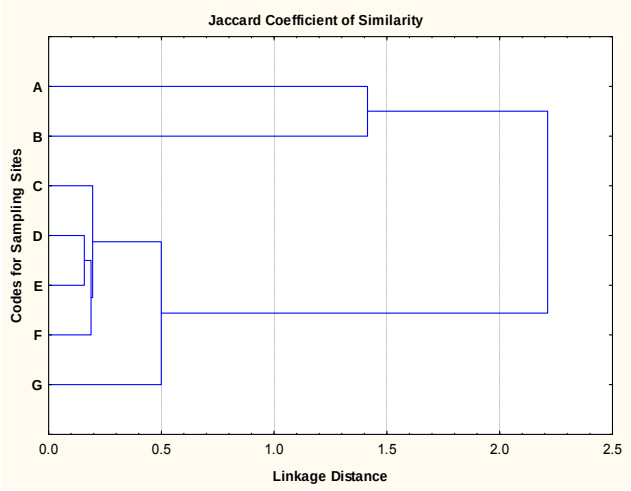
Note: Life stage is identified through length measurement of the fish individuals

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

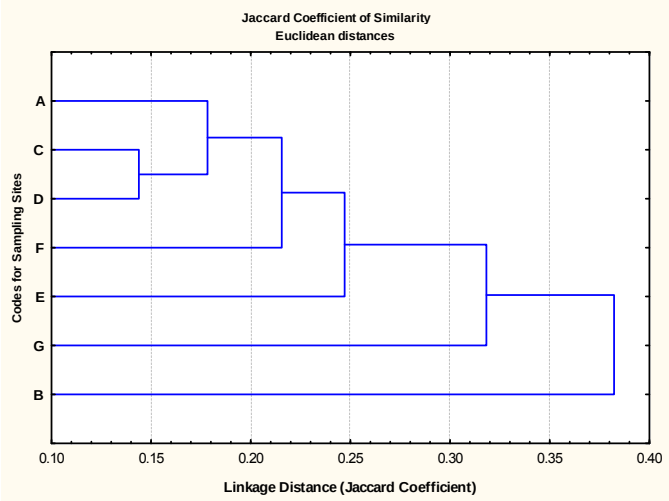
155. This figure analyses the distances among the JI (Jaccard Coefficient Index) indices which are opposite to the JI values. The length-wise distribution relationship among the sampling sites was found different among fourth, third, second and first quarter of the first monitoring year (2014). Furthermone, the JI value differes with different year (2014 and2015). In the first quarter of the year of 2015, the JI value between D and G sampling sites was the highest **(Figure 8.2)**.



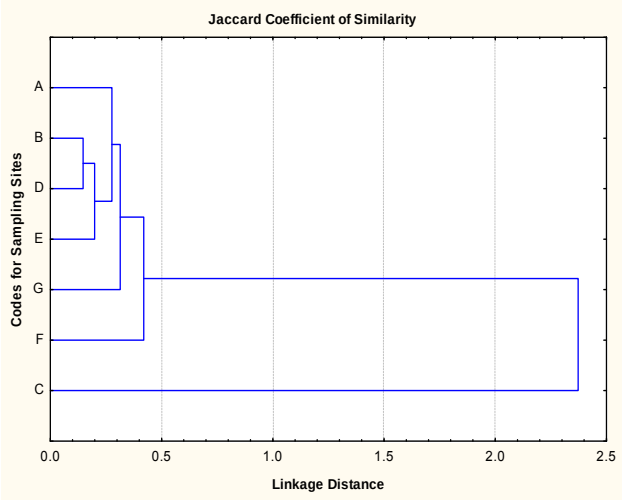
1st Quarter, 1st Year Monitoring, April, 2014



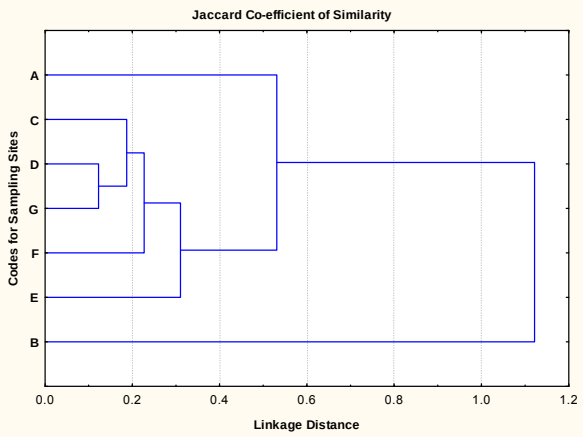
2nd Quarter, 1st Year Monitoring, July 2014



3rd Quarter, 1st Year Monitoring, October, 2014



4th Quarter, 1st Year Monitoring, January 2015



1st Quarter, 2nd Year Monitoring, April, 2015

Figure 8.2: Dendogram Showing Similarity in Binary Species Composition in seven samplingsites

(b) Habitat Suitability Index (HSI)

156. 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 Suitability analysis has been conducted by applying Iyengar and Sudarshan (1982) developed model. All considered data has been normalized through using UNDP developed normalization equation (UNDP, 2006).

157. Sheola khal at Chandpai has been found as the most suitable habitat for fish species among Passur River System which is 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 age structured population dynamics model

Note: The HIS is calculated on the basis of one year monitoring data

8.3.4 Fish Bio-diversity

158. Fish biodiversity has been surveyed by Catch Per Unit Effort (CPUE) method. Gears have been selected on the basis of on going fishing activities. Then the fish individuals were counted based on the length of each species from the samples. Diversity has been calculated by analyzing Shannon-Weiner Index.

a) Shannon-Weiner Index

159. In the first quarter of second fisheries monitoring year (2015), highest Shannon-Weiner index has been found at Akram Point (0.96) indicating most even diversity. On the contrary, lowest evenness has been found at Mongla Point (shown in the **Table 8.4**). This index has been varied between 2014 and 2015.

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

Site	Species No												Shannon-Weiner Index*											
	1st Q, Y1	2nd Q, Y1	3rd Q, Y1	4th Q Q, Y1	1st Q Q, Y2	2nd Q, Y2	3rd Q, Y2	4th Q Q, Y2	1st Q Q, Y3	2nd Q, Y3	3rd Q, Y3	4th Q Q, Y3	1st Q, Y1	2nd Q, Y1	3rd Q, Y1	4th Q Q, Y1	1st Q Q, Y2	2nd Q, Y2	3rd Q, Y2	4th Q Q, Y2	1st Q Q, Y3	2nd Q, Y3	3rd Q, Y3	4th Q Q, Y3
A	33	0	13	7	3								0.49	0	0.73	0.57	0.96							
B	12	0	24	14	0								0.85	0	0.57	0.39	0.00							
C	2	12	9	0	11								0.29	0.77	0.40	0.00	0.78							
D	12	22	15	26	27								0.31	0.78	0.73	0.51	0.65							
E	7	13	10	11	6								0.38	0.60	0.76	0.77	0.15							
F	3	13	6	4	10								0.82	0.77	0.54	0.60	0.67							
G	6	3	5	7	18								0.68	0.82	0.72	0.66	0.18							

*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)

160. Fish species richness has been identified through Simpson's Index[3]. Considerable difference was noticed in the fish species richness (FSR) in different habitat classes (**Table 8.5** and **Figure-8.3**).

161. In fourth monitoring phase, maximum FSR was obtained in Sheola khal at Chandpai (n=5), while very low FSR was recorded in Passur river at Chalna point (n=1). Among habitats in upstream portions of the Passur river, Mongla Point was home to a rich assemblage of Chami Chingri, Horina Chingri and Gusha Chingri; Maidara River at Baro Durgapur of Motka Chingri, Chaka Chingri, Chali Chingri and Paissa and Chalna point of Chali Chingri. Among habitats in lower stream portions, Chandpai was rich in Chami Chingri, Gagra Tengra, Bheda Bele, Motka Chingri and Paissa, Harbaria in Goda Chingri, Gagra Tengra, Bheda Bele and Motka Chingri and Akram point in Boiragi, Loitta and Vetki. No fish species has been found in the Haldikhali khal sampling site.

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							
B	Haldikhali	7	0	4	2	0							

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

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

Rupchanda in 1st Quarter Monitoring

Chela in 2nd Quarter Monitoring

Phesa, Chela, Hilsa, Gagla Tengra

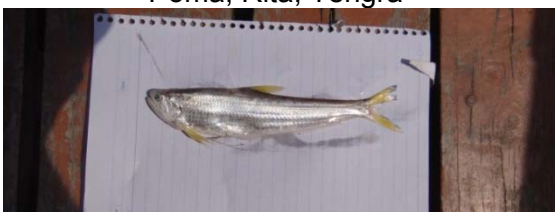
Harina Chingri

Lal Chewa

Crab

Poma, Rita, Tengra

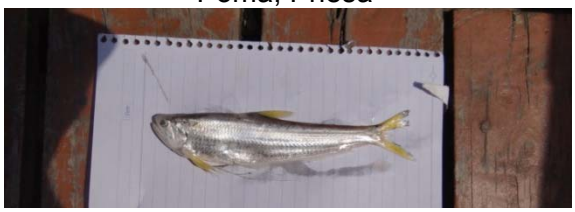
Poma, Rita, Tengra



Phessa

Poma, Phesa

Tapse



Phesa

Fish Species at 3rd Quarter Monitoring

Amadi Chela

Banspata

Chata Bele

PL of Bagda

Poma

Phessa, Poma and Horina Chingri

Fish Species in Upstream of Passur River at 4th Quarter Monitoring

Adult Poma in Chalna Point

Fry of Bagda at Chalna Point

A bulk of fish coming from nearby ghers to the river system

Tular Dandi, Meth Tengra, Maya Chela and Lal Chewa

Bele

Bheda Bele

Meth and Gagra Tengra

Gagra Tengra

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

Photo 8.2: Length-wise distribution of fish species

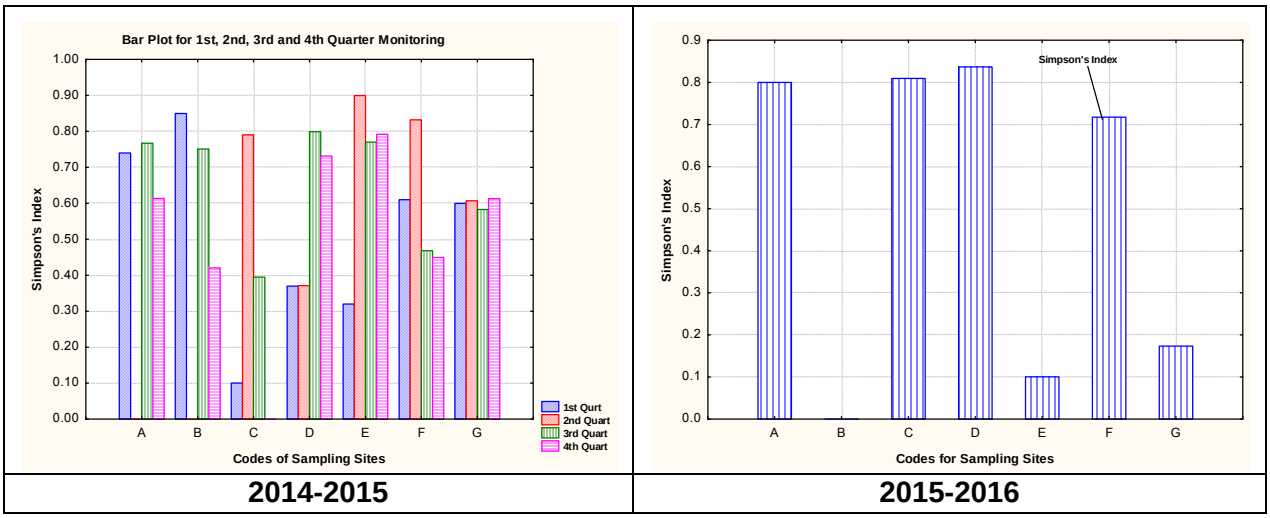


Figure 8.3: Site wise fish species richness (FSR) in the Passur River System. FSR is identified though Simpson's Index

162. Fish community structure has been analyzed through counting the length-wise fish individuals (**Photo 8.2**). The following table 9.6, -9.7 and figure 9.4 for first quarter of second monitoring year shows that juveniles for fin fish and adults of prawn (particularly Golda) and fin fish species were more randomly distributed among the upper, middle and lower stretches of the Passur River. Among these Bele, Phessa, Poma and Boiragi fish were widely distributed among the sampling sites. However, no brood fish has been observed in the fourth monitoring phase in the month of April.

Table 8.6: Occurrence of Species

Local Name	Scientific Name	Local Status*	1st Q, Y1	2nd Q, Y1	3rd Q, Y1	4th Q Q, Y1	1st Q Q, Y2	2nd Q, Y2	3rd Q, Y2	4th Q Q, Y2	1st Q Q, Y3	2nd Q, Y3	3rd Q, Y3	4th Q Q, Y3
Amadi Chela	*Chela sp.*	DD	-	-	+	+	+							
Hilsa	*Tenualosa ilisha*	NO	-	-	+	-	-							
Sagor Baim	*Anguilla bengalensis*		+	-	-	-	-							
Bacha	*Eutropiichthys vacha*	CR	+	-	-	-	-							
Bagda Chingri	*Penaeus monodon*	DD	+	+	+	+	+							
Banspata	*Brachypleura novae-zeelandiae*	NO	+	+	+	+	-							
Kukurjib	*Cynoglossus lingua*	NO	+	-	-	-	-							
Bele	*Glossogobius giuris*	NO	+	+	+	+	+							
Boiragi	*Coilia dussumieri*	NO	+	+	+	+	+							
Boishakhi Chingri		NO	-	+	-	-	+							
Chammu	*Metapenaeus brevicornis*	DD	+	+	+	-	+							

Local Name	Scientific Name	Local Status*	1st Q, Y1	2nd Q, Y1	3rd Q, Y1	4th Q Q, Y1	1st Q Q, Y2	2nd Q, Y2	3rd Q, Y2	4th Q Q, Y2	1st Q Q, Y3	2nd Q, Y3	3rd Q, Y3	4th Q Q, Y3
Chingri														
Chaka Chingri	*Penaeus indicus*	DD	+	+	-	+	+							
Ghora Chela	*Securicula gora*	-	+	-	-	-	-							
Chanda Chela			-	+	+	-	-							
Chitra			+	-	-	+	+							
Khayra Chela			-	+	-	-	-							
Sada Chewa	*Trepauchen vagina*	NO	+	-	+	-	-							
Lal Chewa	*Odontamblyopus rubicundus*	NO	+	+	+	+	+							
Chhuri	*Trichiurus muticus*	NO	+	-	+	-	-							
Sagor Chela	*Megalops cyprinoids*	NO	+	-	-	-	-							
Purabi Chela	*Thryssa purava*	NO	+	-	-	-	-							
Kabashi Tengra	*Mystus cavasius*	DD	+	-	-	-	-							
Gagra Tengra		DD	-	+	+	-	+							
Gulsha Tengra	*Mystus bleekery*	DD	+	+	-	+	-							
Harina Chingri	*Metapenaeus ensis*	DD	+	+	+	+	+							
Ekthuto	*Hyporhampus limbatus*	NO	+	-	+	+	-							
Kakila	*Xenentodon cancila*	NO	+	-	-	-	-							
Chapila	*Gudusia chapra*	NO	+	+	-	-	-							
Kuchia	*Monopterus cuchia*	DD	+	+	-	+	+							
Kain Magur		EN	-	+	+	+	+							
Loitta	*Harpodon nehereus*	NO	+	+	+	-	+							
Motka Chingri	*Macrobrachium villosimanusless*	DD	+	+	+	+	+							
Mud Crab	*Scylla serrata*	NO	+	-	+	+	+							
Tular Dandi	*Sillaginopsis panijus*	NO	+	-	+	-	+							
Paira Chanda	Scatophagus argus	DD	+	-	-	-	-							
Paissa	*Liza parsia*	NO	+	+	+	+	+							

Local Name	Scientific Name	Local Status*	1st Q, Y1	2nd Q, Y1	3rd Q, Y1	4th Q Q, Y1	1st Q Q, Y2	2nd Q, Y2	3rd Q, Y2	4th Q Q, Y2	1st Q Q, Y3	2nd Q, Y3	3rd Q, Y3	4th Q Q, Y3
Pangas	*Pangasius pangasius*	CR	+	-	+	-	-							
Tak Chanda	*Leiognathus equulus*	NO	+	-	-	-	-							
Phessa	*Setipinna phasa*	NO	+	+	+	+	+							
Teli Phessa	-	-	-	-	+	-	-							
Poma	*Poma poma*	NO	+	+	+	+	+							
Potka	*Chelonodon patoca*	NO	+	+	-	+	+							
Shilong	*Silonia silondia*	EN	+	-	+	-	-							
Tailla	*Eleutheronema tetradactylum*	-	+	-	-	-	-							
Tapse	*Polynemus paradiseus*	-	+	+	+	-	-							
Datina			-	-	-	+	-							
Jaba			-	-	-	+	-							
Shol	*Channa striatus*		-	-	-	+	-							
Magur	*Clarias batrachus*		-	-	-	+	-							
Koi	*Anabas testudineus*		-	-	-	+	-							
Vetki			-	-	-	+	+							
Gangania			-	-	-	+	+							

**Local Status Source: IUCN Red List*

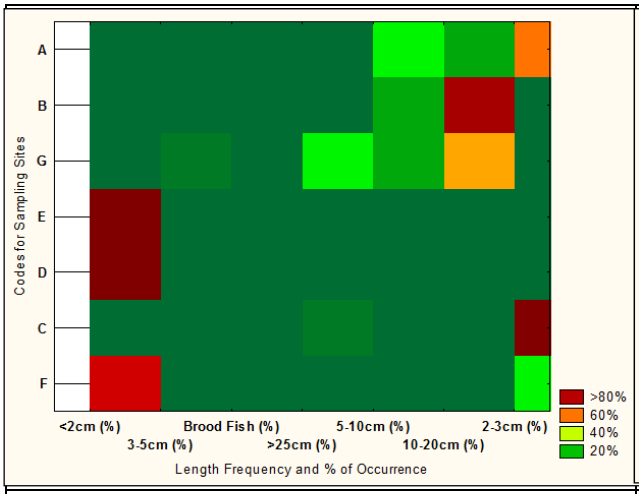
Table 8.7: Length-wise species distribution in sampling sites

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
Bagda	Chalna Point	100	0	0	0	0	0	0
	Chandpai	100	0	0	0	0	0	0
	Maidara	100	0	0	0	0	0	0
Banspata	Chandpai	0	0	0	0	100	0	0
Bele	Chalna Point	100	0	0	0	0	0	0
	Chandpai	100	0	0	0	0	0	0
	Harbaria	0	0	0	100	0	0	0
	Maidara	0	0	0	100	0	0	0
	Mongla Point	0	0	0	100	0	0	0
Bheda Bele	Harbaria	0	0	0	100	0	0	0
Boiragi	Akram Point	0	0	0	0	100	0	0

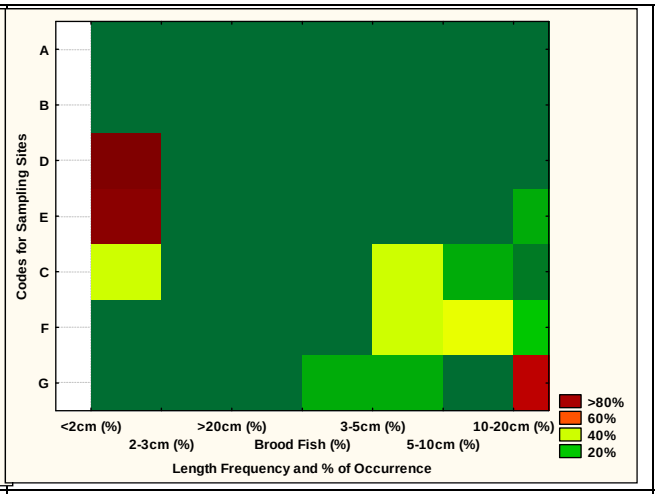
Fish Species	Site	L (< 2cm)	L (2 to 3cm)	L (3 to 5cm)	L (5 to 10cm)	L (10 to 20cm)	L (> 25cm)	Brood Fish
	Chalna Point	0	0	0	0	100	0	0
	Chandpai	0	100	0	0	0	0	0
Chaka Chingri	Chandpai	24	0	69	7	0	0	0
	Harbaria	0	100	0	0	0	0	0
	Maidara	0	100	0	0	0	0	0
Chali Chingri	Chalna Point	100	0	0	0	0	0	0
	Maidara	100	0	0	0	0	0	0
Chami Chingri	Chandpai	40	60	0	0	0	0	0
	Mongla Point	100	0	0	0	0	0	0
Chapila	Chandpai	0	0	0	100	0	0	0
Chata Baila	Chandpai	0	0	0	100	0	0	0
Chitra	Chandpai	0	94	0	6	0	0	0
Chuno	Chalna Point	0	0	100	0	0	0	0
Gagra Tengra	Chalna Point	0	0	0	0	100	0	0
	Chandpai	0	0	0	100	0	0	0
	Harbaria	0	0	0	0	100	0	0
Gang Tengra	Chandpai	0	0	0	100	0	0	0
Gangania	Chandpai	0	0	0	0	100	0	0
Goda Chingri	Harbaria	0	100	0	0	0	0	0
Golda	Chandpai	0	0	0	100	0	0	0
Golda Chingri	Maidara	100	0	0	0	0	0	0
Gusha Chingri	Chandpai	0	0	100	0	0	0	0
Horina Chingri	Chalna Point	30	50	20	0	0	0	0
	Chandpai	0	0	100	0	0	0	0
	Harbaria	0	100	0	0	0	0	0
	Maidara	0	100	0	0	0	0	0
	Mongla Point	99	1	0	0	0	0	0
Kain Magur	Chandpai	0	0	0	0	75	25	0
Kalo Bele	Chandpai	0	0	0	100	0	0	0
Khayra Ilish	Chalna Point	0	0	0	100	0	0	0
Kuchia	Chalna Point	0	0	0	0	0	100	0
	Chandpai	0	0	0	0	9	91	0
Lal Chewa	Chalna Point	0	0	0	0	0	100	0
	Chandpai	0	60	0	0	0	40	0
Loitta	Akram	0	0	0	0	100	0	0

Fish Species	Site	L (< 2cm)	L (2 to 3cm)	L (3 to 5cm)	L (5 to 10cm)	L (10 to 20cm)	L (> 25cm)	Brood Fish
	Point							
	Chalna Point	0	0	0	50	50	0	0
Mendi Bele	Chandpai	100	0	0	0	0	0	0
Menu	Chandpai	100	0	0	0	0	0	0
	Harbaria	0	0	0	100	0	0	0
Meth Tengra	Chalna Point	0	0	0	25	75	0	0
Motka Chingri	Chalna Point	0	0	100	0	0	0	0
	Harbaria	0	100	0	0	0	0	0
	Maidara	0	100	0	0	0	0	0
Nona Bele	Maidara	0	0	0	100	0	0	0
Not Found	Haldikhali	0	0	0	0	73	27	0
Paissa	Chandpai	100	0	0	0	0	0	0
	Harbaria	0	0	43	57	0	0	0
	Maidara	0	0	0	100	0	0	0
	Mongla Point	0	0	0	0	100	0	0
Phessa	Chalna Point	0	0	0	0	100	0	0
	Chandpai	0	0	0	67	0	33	0
Poma	Chalna Point	0	0	0	0	9	91	0
	Chandpai	0	0	0	0	75	25	0
Potka	Chandpai	100	0	0	0	0	0	0
	Mongla Point	100	0	0	0	0	0	0
Rosnai Chingri	Chalna Point	75	25	0	0	0	0	0
Sada Bele	Chandpai	0	0	0	18	82	0	0
Sada Chela	Chandpai	0	100	0	0	0	0	0
Tengra	Harbaria	0	0	0	100	0	0	0
Tigar Chingri	Chalna Point	0	88	12	0	0	0	0
	Mongla Point	5	95	0	0	0	0	0
Tow Paissa	Harbaria	0	0	0	0	100	0	0
Tular Dandi	Chalna Point	0	0	0	0	33	67	0
Vetki	Akram Point	0	0	0	0	0	100	0
	Maidara	100	0	0	0	0	0	0

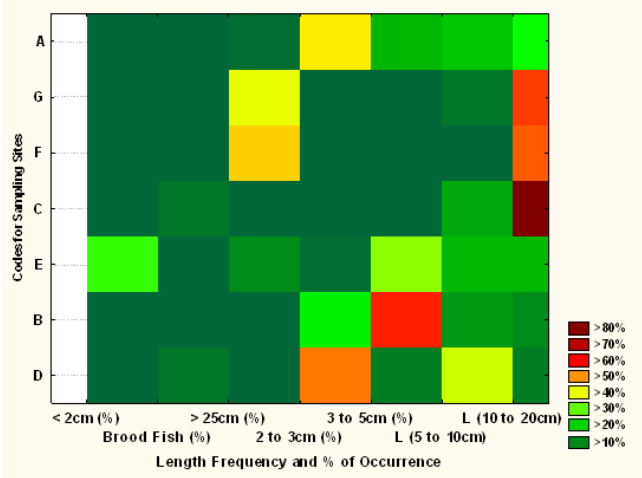
Source: CEGIS field survey, 2015



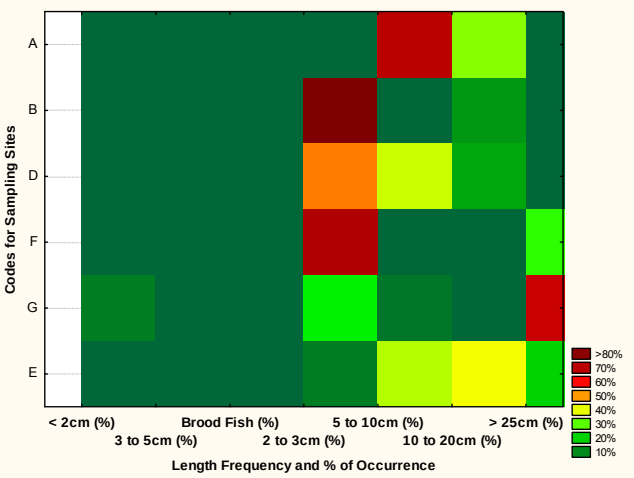
1st Quarter, 1st Year Monitoring, April, 2014



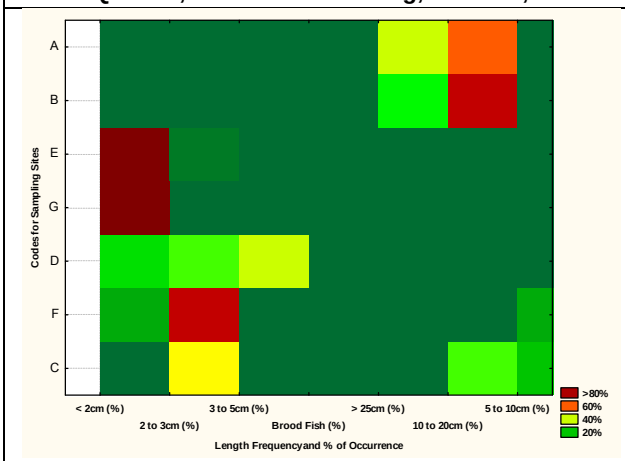
2nd Quarter, 1st Year Monitoring, July 2014



3rd Quarter, 1st Year Monitoring, October, 2014



4th Quarter, 1st Year Monitoring, January 2015



1st Quarter, 2nd Year Monitoring, April 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

163. Migratory species have been identified by analyzing the common species available in the regular catch from the sampling sites. Fish species like Boiragi Chela attains the maximum abundance among the migratory fish species observed in first quarter of second monitoring year. The availability of all other species was very low as compare as found in other monitoring phases. The relative abundance of the migratory species is give below in the **figure 8.5**.

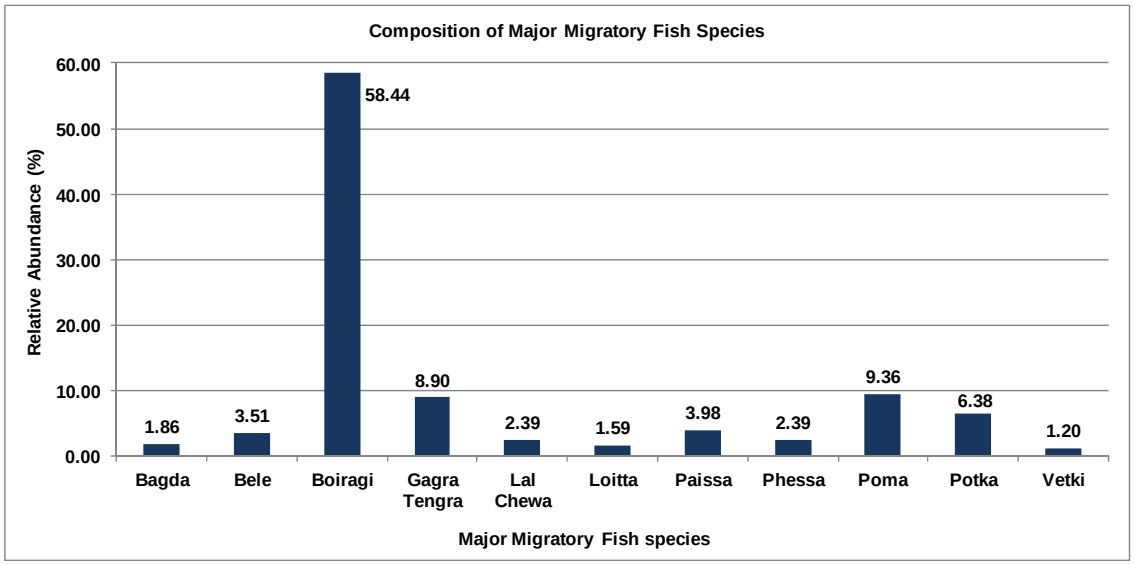


Figure 8.5: Relative abundance of migratory fish species in sampling sites

(b) Migration Extent, Time and Purpose

164. 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. Five (5) 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 four species have been observed in this range like Banspata, Bele, Phessa and Poma indicating long range of distribution (**Table 8.8**).

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 QMg (April, 2014)	2nd QM (July, 2014)	3rd QM (Oct, 2014)	4th QM (Dec, 2014)	1st QM(April, 2015)	2nd QM (July, 2015)	3rd QM (Oct, 2015)	4th QM (Dec, 2015)	1st QM (April, 2016)	2nd(July, 2016)	3rd QM (Oct, 2016)	4th QM (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	-	-	-	-							
	Chalna Point	Age-1 adult and Brood fish	Feeding and Growing	Spawning	-	-	-							
		Adult	-	-	Feeding and Growing	-	-							
	Harbaria	Juvenile and Age-1 adult	Feeding and Growing	Feeding and Growing		-	-							
		Adult and Brood Fish	-	-	Breeding and Spawning	-	-							
	Chandpai	Juvenile	-	-	Feeding and Growing	-	-							
	South-west of the Project	Age-1 adult	Feeding and Growing	Feeding and Growing	Feeding and Growing	-	-							
Boiragi	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	-							

Migratory Fish Species	Sampling Sites	Year Class*	Migration Purpose											
			1st QMg (April, 2014)	2nd QM (July, 2014)	3rd QM (Oct, 2014)	4th QM (Dec, 2014)	1st QM(April, 2015)	2nd QM (July, 2015)	3rd QM (Oct, 2015)	4th QM (Dec, 2015)	1st QM (April, 2016)	2nd(July, 2016)	3rd QM (Oct, 2016)	4th QM (Dec, 2016)
	Chalna Point	Juvenile and Age-1 adult	Feeding and Growing	-	-	-	Feeding and Growing							
	Harbaria	Juvenile	Feeding and Growing	-	-	-	-							
	Mongla Point	Fry	-	Nursing	-	Feeding	-							
	South-west of the Project	Juvenile	-	Feeding and Growing	-	-	-							
Chapila	Haldikhali	Juvenile	Feeding and Growing	-	-	-	-							
	Akram Point	Juvenile	Feeding and Growing	-	-	-	-							
	Mongla Point	Fry	-	Nursing	-	-	-							
	South-west of the Project	Age-1 adult	-	Feeding and Growing	-	-	-							
Loitta	Haldikhali	Juvenile and Age-1 adult	Feeding and Growing	-	Feeding and Growing	-	-							
	Akram Point	Juvenile	Feeding and Growing	-	-	-	Feeding and Growing							
	Akram Point	Age-1 adult	-	-	Feeding and Growing	-	Feeding and Growing							
	Chandpai	Juvenile	Feeding and Growing	-	-	-	-							
	Harbaria	Fry, Juvenile	-	Nursing, Feeding	-	-	-							

Migratory Fish Species	Sampling Sites	Year Class*	Migration Purpose											
			1st QMg (April, 2014)	2nd QM (July, 2014)	3rd QM (Oct, 2014)	4th QM (Dec, 2014)	1st QM(April, 2015)	2nd QM (July, 2015)	3rd QM (Oct, 2015)	4th QM (Dec, 2015)	1st QM (April, 2016)	2nd(July, 2016)	3rd QM (Oct, 2016)	4th QM (Dec, 2016)
		and Age-1 adult		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	-	-							
	Chandpai	Fry and Juvenile	Breeding and Spawning	Nursing	-	-	-							
	Chandpai	Juvenile	-	-	Feeding and Growing	Feeding	Feeding and Growing							
	Haldikhali	Fry and Juvenile	-	-	Nursing	-	-							
	Harbaria	Adult and Brood Fish	-	-	Breeding and Spawning	-	-							
	Mongla Point	Fry, Juvenile and Age-1 adult	-	-	Spawning, Feeding and Growing	-	-							
	Mongla Point	Adult	-	-		Feeding	-							
	South-west of the Project	Adult	-	-	Feeding	Feeding	-							
	Chalna Point	Juvenile, Adult and Brood Fish	Breeding and Spawning	-	-	-	-							

Migratory Fish Species	Sampling Sites	Year Class*	Migration Purpose											
			1st QMg (April, 2014)	2nd QM (July, 2014)	3rd QM (Oct, 2014)	4th QM (Dec, 2014)	1st QM(April, 2015)	2nd QM (July, 2015)	3rd QM (Oct, 2015)	4th QM (Dec, 2015)	1st QM (April, 2016)	2nd(July, 2016)	3rd QM (Oct, 2016)	4th QM (Dec, 2016)
	Chalna Point	Juvenile and Adult	-	-	Feeding and Growing	Feeding	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	-	-	-							
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	-	-							
	Harbaria	Adult	-	-	Feeding	-	Feeding and							

Migratory Fish Species	Sampling Sites	Year Class*	Migration Purpose											
			1st QMg (April, 2014)	2nd QM (July, 2014)	3rd QM (Oct, 2014)	4th QM (Dec, 2014)	1st QM(April, 2015)	2nd QM (July, 2015)	3rd QM (Oct, 2015)	4th QM (Dec, 2015)	1st QM (April, 2016)	2nd(July, 2016)	3rd QM (Oct, 2016)	4th QM (Dec, 2016)
							Growing							
Gulsha Tengra	Haldikhali	Adult	Feeding and Breeding	-	-	-	-							
	Akram Point	Adult	Feeding and Breeding	-	-	-	-							
	Chandpai	Age-1 adult	-	-	-	Feeding	-							
	Mongla Point	Age-1 adult	-	Feeding and Growing	-	Feeding	-							
Potka	Haldikhali	Adult	Feeding and Breeding	-	-	-	-							
	Chandpai	Fry	Spawning	Spawning and Nursing	-	-	-							
	Chandpai	Adult	-	-	-	Feeding	-							
	Mongla Point	Fry	Spawning	-	-	-	-							
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							
	Chandpai	Adult	-	-	-	Feeding	-							
	Haldikhali	Juvenile and Adult	-	-	Feeding and	-	-							

Migratory Fish Species	Sampling Sites	Year Class*	Migration Purpose											
			1st QMg (April, 2014)	2nd QM (July, 2014)	3rd QM (Oct, 2014)	4th QM (Dec, 2014)	1st QM(April, 2015)	2nd QM (July, 2015)	3rd QM (Oct, 2015)	4th QM (Dec, 2015)	1st QM (April, 2016)	2nd(July, 2016)	3rd QM (Oct, 2016)	4th QM (Dec, 2016)
					Growing									
	Harbaria	Juvenile and Adult	-	-	Feeding and Growing	-	-							
	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							
	Chandpai	Fry	Breeding and Spawning	Nursing	-	-	Nursing							
	Chandpai	Juvenile and Adult	-	-	Feeding and Growing	Feeding	-							
	Mongla Point	Fry	Breeding and Spawning	-	-	-	-							
	Mongla Point	Fry, Juvenile-1 and Juvenile			Nursing and Growing	-	-							
	Mongla Point	Juvenile and Adult	-	-	-	Feeding	Feeding and Growing							

Migratory Fish Species	Sampling Sites	Year Class*	Migration Purpose											
			1st QMg (April, 2014)	2nd QM (July, 2014)	3rd QM (Oct, 2014)	4th QM (Dec, 2014)	1st QM(April, 2015)	2nd QM (July, 2015)	3rd QM (Oct, 2015)	4th QM (Dec, 2015)	1st QM (April, 2016)	2nd(July, 2016)	3rd QM (Oct, 2016)	4th QM (Dec, 2016)
	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							
Tairel	Akram Point	Adult	Feeding	-	-	-	-							
	Mongla Point	Juvenile	Feeding	-	-	-	-							
Phessa	Akram Point	Adult	Feeding	-	-	-	-							
	Akram Point	Juvenile	-	-	Feeding and Growing	-	-							
	Haldikhali	Juvenile	-	-	Feeding and Growing	-	-							
	Haldikhali	Adult	-	-	-	Feeding	-							
	Chalna Point	Juvenile and Adult	Feeding	Feeding and Growing	-	-	-							
	Chalna Point	Adult	-	-	Feeding	Feeding	Feeding							
	Mongla Point	Adult	-	-	Feeding	Feeding	-							

Migratory Fish Species	Sampling Sites	Year Class*	Migration Purpose											
			1st QMg (April, 2014)	2nd QM (July, 2014)	3rd QM (Oct, 2014)	4th QM (Dec, 2014)	1st QM(April, 2015)	2nd QM (July, 2015)	3rd QM (Oct, 2015)	4th QM (Dec, 2015)	1st QM (April, 2016)	2nd(July, 2016)	3rd QM (Oct, 2016)	4th QM (Dec, 2016)
	Chandpai	Juvenile and Adult	Feeding	Feeding and Growing	-	-	Feeding and Growing							
	South-west of the Project	Juvenile and Adult	Feeding	Feeding and Growing	-	-	-							
	South-west of the Project	Adult	-	-	Feeding	Feeding	-							
Paissa	Akram Point	Juvenile and Adult	Feeding	-	Feeding and Growing	Feeding	-							
	Haldikhali	Juvenile and Adult	Feeding	-	Feeding and Growing	Feeding	-							
	Harbaria	Juvenile-1 and Juvenile	-	-	Feeding	-	Feeding and Growing							
	Chandpai	Fry	Breeding and Spawning	-	-	-	Nursing							
	Chandpai	Juvenile and Adult	-	-	Feeding and Growing	-	-							
	Mongla Point	Fry	Breeding and Spawning	-	-	-	-							
		Age-1 Adult	-	-	-	-	Feeding and Growing							
	South-west of the Project	Fry, Juvenile and Age-1 adult	Breeding and Spawning	Feeding and Growing	-	-	Feeding and Growing							
Banshpata	Chandpai	Juvenile	Feeding	-	-	-	-							

Migratory Fish Species	Sampling Sites	Year Class*	Migration Purpose											
			1st QMg (April, 2014)	2nd QM (July, 2014)	3rd QM (Oct, 2014)	4th QM (Dec, 2014)	1st QM(April, 2015)	2nd QM (July, 2015)	3rd QM (Oct, 2015)	4th QM (Dec, 2015)	1st QM (April, 2016)	2nd(July, 2016)	3rd QM (Oct, 2016)	4th QM (Dec, 2016)
	Chandpai	Adult	-	-	-	Feeding	-							
	Haldikhali	Juvnile and adult	-	-	Feeding and Growing	Feeding	-							
	Mongla Point	Fry and Adult	Feeding	Nursing	-	-	-							
	Mongla Point	Adult	-	-	-	Feeding	-							
	South-west of the Project	Adult	-	-	Feeding	Feeding	-							
	Chalna Point	Adult	-	-	Feeding	Feeding	-							
Hilsa	Haldikhali	Juvenile	-	-	Feeding and Growing	-	-							
	Mongla Point	Adult	-	-	Feeding	-	-							
Pangas	Haldikhali	Juvenile	-	-	Feeding and Growing	-	-							
	Mongla Point	Juvenile and Adult	-	-	Feeding	-	-							

Source: Field findings at different times

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

165. It is interpreted from the findings that in the month of April fish species migrate to the upper reaches of the Passur River for feeding purpose.

8.3.6 Shrimp/Fish Farm

166. For monitoring shrimp/fish farm, three farms situated in the direct impact zone of 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

167. 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. However, similar to the first year monitoring phase, most of the stocks are still collected from wild source of the Passur River in the third monitoring phase too.

168. In this monitoring year, the seeds for Bagda stock of the entire selected shrimp/fish farm are collected from the wild sources. The stocking density varies with the size of the ghers, socio-economic status of the gher owners and seed availability. The highest stocking rate has been observed in case of gher in Bhekatkhali Khal, Rajnagar (**Table 8.9**).

Table 8.9: Stocking Pattern of Fish/Shrimp farm

Location	Fish Species	Stocking Density (No/ha)	Stocking Date	Mortality Rate (%)	Food Item	Total Production (ton)
Bhekatkhali Khal, Rajnagar	Bagda	8,553	Last Week, Feb	30	Natural	**0**
	Horina Chingri	Natural Stocking		-		**1**
	Tengra					**0**
	Paissa					**0**
	Chela					**0**
	Vetki					**0**
Kapashdanga-Muralia	Bagda	3,475	mid-March	0		**0**
Chunkuri-2	Bagda	6,589	First-Jan	10		**0**

Source: Field Survey, 2014

(b) Shrimp/Fish Growth Rate and Mortality

169. During the first quarter of second monitoring year, the growth rate can not be assessed due to lack of catch data. The highest mortality has been reported in case of gher in Bhekatkhali Khal, Rajnagar (**Table 8.9**).

Table 8.10: Growth Rate and Mortality of Fish/Shrimp

Gher No.	1st QMg (April, 2014)		2nd QM (July, 2014)		3rd QM (Oct, 2014)		4th QM (Dec, 2014)		1st QM (April, 2015)		2nd QM (July, 2015)		3rd QM (Oct, 2015)		4th QM (Dec, 2015)		1st QM (April, 2016)		2nd (July, 2016)		3rd QM (Oct, 2016)		4th QM (Dec, 2016)	
	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														
2	0.3	30-35	0.3	94	0.25	10	-	-		-														
3	0.2	25-30	0.2	25	0.20	65	-	-		10														

Source: Field Survey, 2015

8.3.7 Fish Production

(a) Capture Fish Production

170. In first quarter of second monitoring year, the highest productivity has been found in Akram Point, and lowest in the Mongla Point **(Table 8.11**). Moreover, as expected lower productivity was observed in this first quarter as compared to that in first monitoring year of 2014.

171. The present study observed that Behundi, Charpata, Net, Ber and Khepla Jal are frequently used to catch fish. The total catch through both the Ber and Charpata Jal is 7.5 kg (**Table 8.11**). The following table also expresses that Ber Jal is used in lower reach and upper reach of the Passur River. Moreover, lining spear has been found in upper reaches of the Passur River. However, the total catch is lower in this monitoring year than that found in the first monitoring year (**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	Total Catch (kg)	kg/Haul
A	Akram Point	Kukilmoni Khal	Ber Jal	7	1	6	6.000
B	Haldikhali	Haldekhali Khal	-	-	-	-	0.000
C	Harbaria	Harbaria Khal	Khepla Jal	0.3	15	0.05	0.003
			Lining Spear	5.3	1	1	1.000
D	Chandpai	Sheola Khal	Baundi Jal	3	1	3	3.000
			Charpata Jal	12	1	7.5	7.500
			Net Jal	2	1	0	0.000
E	Mongla Point	Passur River	Khepla Jal	0.3	15	0.5	0.033
			Net Jal	2	1	0	0.000
F	Maidara	Mouth of Muidhara River	Khepla Jal	1	20	1.5	0.075
			Net Jal	0.3	1	0	0.000
G	Chalna Point	Passur River	Baundi Jal	4	1	1	1.000
			Ber Jal	0.3	1	1.5	1.500
			Mui Jal	0.01	3	0.3	0.100
			Net Jal	5.5	15.5	0.1	0.006

Table 8.12: Total Catch in the Sampling Sites

Sampling Site	Total Catch (kg)											
	1st QMg (April, 2014)	2nd QM (July, 2014)	3rd QM (Oct, 2014)	4th QM (Dec, 2014)	1st QM(April, 2015)	2nd QM (July, 2015)	3rd QM (Oct, 2015)	4th QM (Dec, 2015)	1st QM (April, 2016)	2nd(July, 2016)	3rd QM (Oct, 2016)	4th QM (Dec, 2016)
A	28*	0	3	28.7	6							
B	65	0	1	3.3	0							
C	1,559	0.5	8	8.7	1.05							
D	**	12	3	30.0	10.5							
E	**	0.6	5	0	0.5							
F	**	1.2	13	3.7	1.5							
G	**	1.6	4	0.7	2.9							

*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

172. The present study on shrimp/fish farm in the fourth quarter monitoring phase showed that only one gher of three selected ghers, Bhekatkhali Khal, Rajnagar, has attained 1 kg horina chingri as their catch within the month of March-April **(Table 8.13)**. As the gher owner reported that catch would be made the next one month later (May).

Table 8.13: The Present Catch in Three Sampling Ghers

Sampling Site	Total Catch (kg)																							
	1st QMg (April, 2014)		2nd QM (July, 2014)		3rd QM (Oct, 2014)		4th QM (Dec, 2014)		1st QM(April, 2015)		2nd QM (July, 2015)		3rd QM (Oct, 2015)		4th QM (Dec, 2015)		1st QM (April, 2016)		2nd(July , 2016)		3rd QM (Oct, 2016)		4th QM (Dec, 2016)	
	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	-														
	Vetki	1.57	Bele	0	Gusha Chingri	-			Horina Chingri	1														
	Bele	0.98	Cheng	0	Harina Chingri	-			Tengra	-														
	Harina Chingri	0.78	Bhangan	0	Rui (kg)	-			Paissa	-														
	Chali Chingri	0.11	Chali Chingri	0	Catla (kg)	-			Chela	-														
	Chaka Chingri	0.08			-	-			Vetki	-														
	Sub-total =	**8.52**		**6.42**		**4.8**					**1**													
2	Bagda	4	Bagda	1	Bagda	7			Bagda	-														
	Harina Chingri	2	HarinaHarina Chingri	0.33	Vetki	1			-	-														
	Chali Chingri	0.18	Chali Chingri	0.08	Paissa	10			-	-														
	-	-	Golda Chingri	0.01	Phessa	2.4			-	-														
	-	-	Bele	0.08	Bhangan	1.7			-	-														
	-	-	Tengra&Paissa	0.04	Golda Chingri	0.9			-	-														
	-	-	-		Gulsha Tengra	0.2			-	-														

Sampling Site	Total Catch (kg)																							
	1st QMg (April, 2014)		2nd QM (July, 2014)		3rd QM (Oct, 2014)		4th QM (Dec, 2014)		1st QM(April, 2015)		2nd QM (July, 2015)		3rd QM (Oct, 2015)		4th QM (Dec, 2015)		1st QM (April, 2016)		2nd(July, 2016)		3rd QM (Oct, 2016)		4th QM (Dec, 2016)	
	Sub-total =	**6.00**		**2.00**		**23**				-	**-**													
3	Bagda	1.38	Bagda	2.4	Bagda	1.5			Bagda	-														
	Harina Chingri	0.34	Harina Chingri	0.34	Paissa	10			-	-														
	Chali Chingri	0.17	Chali Chingri	0.17	Tengra	10			-	-														
	-	-	-	-	Bele	20			-	-														
	-	-	-	-	Tilapia	22			-	-														
	-	-	-	-	Rui	28			-	-														
	-	-	-	-	Vetki	-			-	-														
	-	-	-	-	Harina Chingri	-			-	-														
	-	-	-	-	Chami Chingri	-			-	-														
	-	-	-	-	Catla	56			-	-														
	-	-	-	-	Mrigel	50			-	-														
	Sub-total =	**1.89**		**2.91**		**197.5**				-	-													
	Grand-total =	**17.00**		**11.33**		**226.5**					**1**													

Source: Field Survey, 2015

9 Ecosystem and Biodiversity Monitoring

173. Ecosystem and biodiversity of the study area have been monitored quarterly as per the monitoring schedule. FIlowed by the earlier monitoring in four quarters, monitoring in the fisrt quarter of second year has been carried out in April 2015.

9.1 Indicators of Monitoring

174. Indicators for terrestrial and aquatic ecosystems have been selected through prior anticipation of probable impacts on ecological resources in different phases of the proposed Project.

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

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

177. Lichens often grow on trees and shrubs, absorbing nutrients from the atmosphere. Lichens are very sensitive to air pollution, particularly to sulphur dioxide, fluoride, and ammonia. The acidity of a tree's bark can also affect lichen abundance. Presence of lichen coverage on homestead trees would be a bio indicator for monitoring air quality standard of the study area.

178. Birds are important class in terrestrial faunal community which are very much sensitive to their habitat condition. Changes of environmental parameters, Land use and vegetation composition directly impact on bird's habitat of a locality. Broadly, two types of bird are found in an area; local and migratory. To observe local bird habitat suitability, number of bird nest and nesting bird species can be a good indicator. Number of wetlands where migratory birds come each year will be considered to observe migratory bird habitat suitability.

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

180. Benthos and planktons play important role as food and oxygen source for various aquatic biota. Phytoplanktons also have great contribution to ensure primary productivity of aquatic ecosystems. Good water quality is essential to support healthy benthic and plankton communities. Changes of any water quality parameters may have impact on benthic and planktonic composition and population. Dolphin is another important ecological indicator which indicates water quality as well as aquatic habitat suitability of an aquatic system. This aquatic mammal is still present in all the river systems of the study area. Any change of

water quality and river bed siltation may change occurrence of dolphin in a river system. Therefore, occurrence of dolphin is needed to be monitored.

181. Invasion of alien species may come with coal vessel from other countries. Alien species may be harmful to local aquatic ecosystem if they are highly aggressive in succession or reproduction. Alien invasion will therefore be observed regularly during Plant operation phase.

182. Followed by the above justification and rational, following indicators have been selected for regular monitoring what would be the base for identifying the impacts for proposed Power Plant in future.

Terrestrial Ecosystems

a) Plant Species composition and diversity
b) Plant health
c) Vegetation canopy
d) Lichen
e) Bird habitats
f) Butterfly occurrence

Aquatic Ecosystems

a) Dolphin

9.2 Location of Monitoring

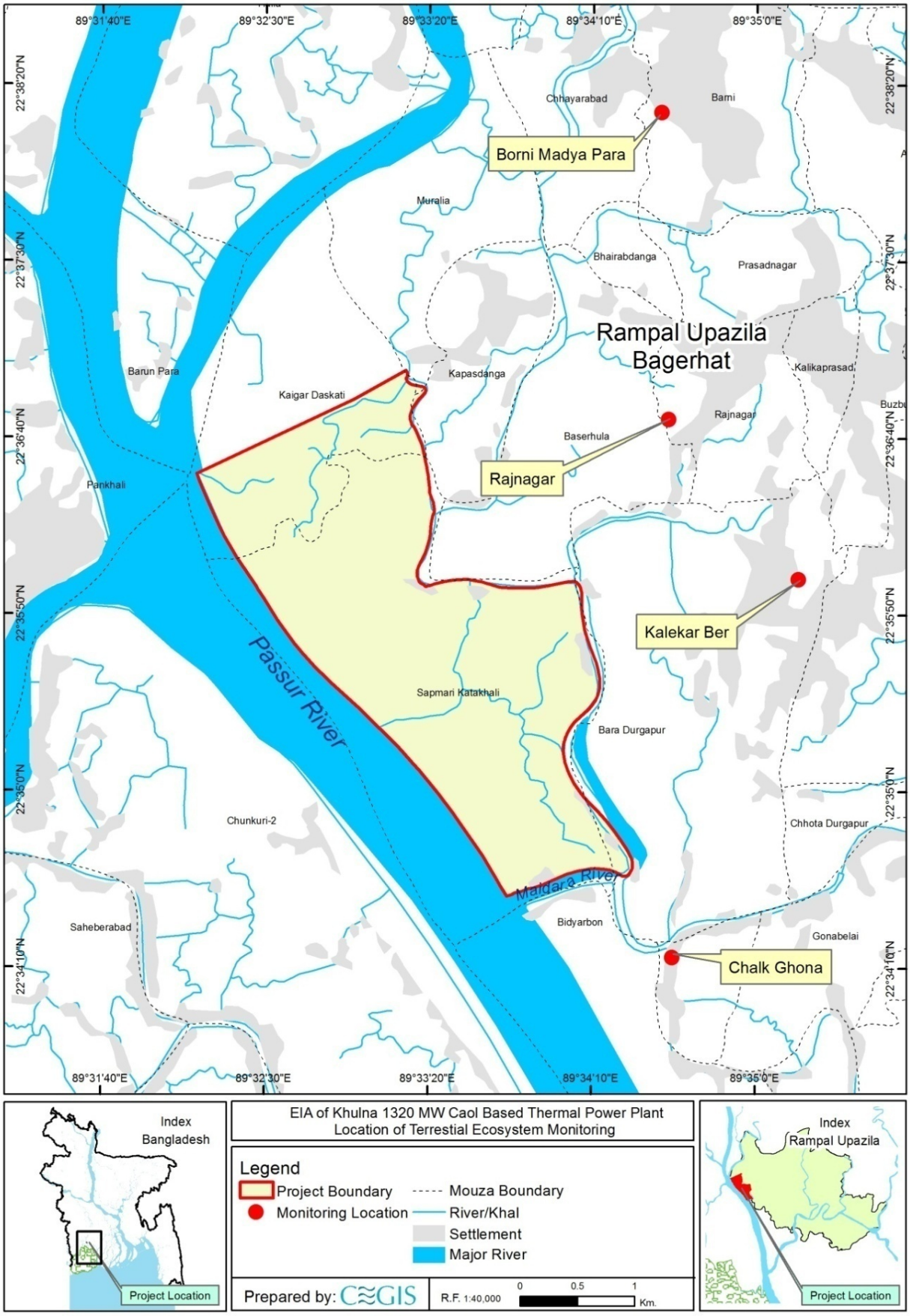
183. Fourhomesteads have been selected for monitoring indicators of terrestrial ecosystem inthe study area. Locations of the homesteads have been selected considering wind direction and possible spatial dispersion of air pollutants (if any) e.g. SO_x, NO_x, SPM, etc from the power plant in future.**Table 9.1**presents the selected locations, owners, homestead area and special direction from the Project boundary.

Table 9.1: Locations of Terrestrial Ecosystem Monitoring

Sl. No.	Homestead Location	Owner's Name	Homestead area in Decimal	Special direction from the Project boundary	GPS Coordinates
1	Village: Rajnagar, UP: Rajnagar, Upazila: Rampal	Alhaz Showkat Ali Hawlader	80	About 2.5 km. east from upper North-east boundary	22°36'45"N 89°34'33"E
2	Village: Kalekherber Dighi, Union: Rajnagar, Upazila: Rampal	Md. Akkel Ali Seikh	156	About 1.8 km. east from Middle-east boundary	22° 36'00"N 89°35'13"E
3	Village: Chalkghona, Union: Rajnagar, Upazila: Rampal	Monoz Das	152	About 0.5 km south from south-east boundary	22°34'21"N 89°34'28˝E

Sl. No.	Homestead Location	Owner's Name	Homestead area in Decimal	Special direction from the Project boundary	GPS Coordinates
4	Village: Barni Madyapara, Union: Gaurambha, Upazila: Rampal	Md. Titu Seikh	72	About 3.0 km north from north-east boundary	22^{O} 38'12"N 89^{O}34'31"E

Source; Field Survey, 2014



Map 9.1: Terrestrial Ecosystem Monitoring Locations

9.3 Monitoring of Terrestrial Ecosystem and Bio-diversity

184. 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.

9.3.1 Description of the selected homestead

185. The homestead in Rajnagar is located at 2.5 km. east from upper North-east boundary of the project site. This is situated inside the damp area as numerous small swamps exist inside and surround the homesteads. Water retention capacity of surface soil of this homestead is very low and for this reason very little number of grasses and other herbs are present. Land elevation of selected homestead at Kalekarber 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 its north side and saline water shrimp farms to its south periphery. Presence of shallow ditches and peripheral water bodies 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.

9.3.2 Species Composition of selected homestead vegetation

Homestead at Rajnagar

186. 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

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

Homestead at Chalkghona

188. 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.

Photo 9.1: A part of homestead vegetation at Barni

Homestead at Barni

189. This homestead contains 21 tree species. Except Narikel *(Cocos nucifera),* Khejur *(Phoenix sylvestris)* and Taal *(Borassus flabellifer)*, most of trees are young in age. The devastating cyclone Aila caused huge damge to the tree species. Then the house owner planted many timber and fruit yielding trees throughout the home yard. Detail plant species composition of this homestead has been mentioned in Table 9.2.

Table 9.2: Species Composition of studied homestead vegetation

Species Name	Local Name	Family	No. of Plants			
			Borni	Kalekar Ber Dighi	Chalk ghona	Rajna gar
Acacia moniliformes	Akashmoni	Leguminosae	6	-	-	3
Aegle marmelos	Bel	Rutaceae	-	-	2	-
Albizia richardiana	Chambol	Leguminosae	2	8	3	-
Albizia saman	Sirish/Rendi Koroi	Leguminosae	6	7	3	2
Anona squamosa	Ata	Anonaceae	-	1	-	-
Areca catechu	Supari	Palmae	10	18	-	-

Species Name	Local Name	Family	No. of Plants			
			Borni	Kalekar Ber Dighi	Chalk ghona	Rajna gar
Avecenia alba	Baen	Aviceniaceae	-	-	2	-
Azadirachta indica	Neem	Meliaceae	-	-	3	2
Borassus flabeliffer	Taal	Palmae	6	8	2	-
Carica papaya	Pepey	Caricaceae	-	-	5	-
Citrus medica	Kagoji Lebu	Rutaceae	-	-	2	-
Cocos nucifera	Narikel	Palmae	10	56	39	17
Cordia dichotoma	Bohal	Boraginaceae	-	-	1	-
Diospyrus pregrina	Deshi Gab	Ebenaceae	-	-	3	-
Dyospyros blancoi	Bilati Gab	Ebnaceae	-	12	-	-
Excoecaria agallocha	Gewa	Euphorbiaceae	8	6	36	100
Feronia lemonia	Kaotbel	Rutaceae	1	-	1	1
Ficus religiosa	Aswath	Moraceae	3	-	-	-
Ficus sp	Zeer Bat	Moraceae	2	-	-	-
Gardenia augusta	Gondhoraj	Rubiaceae	-	-	2	-
Hibiscus rosa sinensis	Jaba	Malvaceae	-	2	3	2
Hibiscus	Bola	Malvaceae	-	-	-	3
Herritiera fomes	Sundari	Sterculiaceae	-	-	-	1
Ixora coccinea	Rangan	Rubiaceae	1	-	1	-
Mangifera indica	Aam	Anacardiaceae	6	6	7	3
Manilkara zapota	Safeda	Zapotaceae	1	1	1	1
Mimusops elengii	Bakul	Zapotaceae	-	1	-	-
Moringa oleifera	Sazna	Moringaceae	-	-	2	-
Musa sp	Kola	Musaceae	6	-	10	-
Nypa fruticans	Gol	Palmae	-	-	2	-
Phoenix sylvestris	Khejur	Palmae	12	10	24	25
Phylanthus acidus	Naul/Orboroi	Euphorbiaceae	-	-	2	-
Pongamia sp	Koroj	Leguminosae	-	-	2	3
Psidium guajava	Peyara	Myrtaceae	2	8	17	2
Punica granatum	Dalim	Lythraceae	-	-	4	-
Quisqualis indica	Madhabilata	Combrataceae	-	-	4	-
Sonneratia apetala	Kewra	Lyrthaceae	-	-	3	-
Spondius pinnata	Amra	Anacardiaceae	1	-	-	-
Swietenia mehagoni	Mehogani	Meliaceae	11	17	1	2
Syzygium cumini	Jaam	Myrtaceae	-	2	2	-
Syzygium samarengense	Jamrul	Myrtaceae	1	-	-	-
Tamarindus indica	Tentul	Leguminosae	2	2	1	1
Terminalia catapa	Kathbadam	Combrataceae	5	-	1	-
Zizyphus mauritiana	Kul	Rhamnaceae	-	2	4	2
-	Palm Oil	Palmae	-	4	-	-
	Shewly		-	-	4	-

Source: Field Monitoring, April 2014 and June 2014

9.3.3 Species Diversity of homestead vegetation

190. 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 9.3.

Table 9.3: 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	*Cocos nucifera*	Narikel	Palmae	39	7.8	975
	2	*Excoecaria agallocha*	Gewa	Euphorbiaceae	36	7.2	720
	3	*Phoenix sylvestris*	Khejur	Palmae	24	4.8	600
	4	*Psidium guajava*	Peyara	Myrtaceae	17	3.4	567
	5	*Carica papaya*	Pepey	Caricaceae	5	1.0	500
Barni	1	*Swietenia mehagoni*	Mehogani	Meliaceae	11	2.2	550
	2	*Excoecaria agallocha*	Gewa	Euphorbiaceae	8	1.6	400
	3	*Areca catechu*	Supari	Palmae	10	2	333
	4	*Musa sp*	Kola	Musaceae	6	1.2	300
	5	*Phoenix sylvestris*	Khejur	Palmae	12	2.4	240
Kalekar Ber Dighi	1	*Cocos nucifera*	Narikel	Palmae	56	11.2	1120
	2	*Excoecaria agallocha*	Gewa	Euphorbiaceae	6	1.2	600
	3	*Swietenia mehagoni*	Mehogani	Meliaceae	17	3.4	567
	4	*Areca catechu*	Supari	Palmae	18	3.6	450
	5	*Dyospyros blancoi*	Bilati Gab	Ebnaceae	12	2.4	300
Rajnagar	1	*Excoecaria agallocha*	Gewa	Euphorbiaceae	25	5	1250
	2	*Phoenix sylvestris*	Khejur	Palmae	25	5	500
	3	*Cocos nucifera*	Narikel	Palmae	17	3.4	340
	4	*Psidium guajava*	Peyara	Myrtaceae	2	0.4	200
	5	*Pongamia pinnata*	Koroj	Leguminosae	3	0.6	150

Source: Field Monitoring

9.3.4 Diversity Index of Sampling homesteads vegetation

191. 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 9.4: Diversity Index of homestead plant species

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

Source: Vegetation Survey, April 2014 and June 2014

9.3.5 Plant health

192. 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 incretion of salinity of soils. For this reason, plant succession, growth and productivity have fallen down day by day.

9.3.6 Plant Diseases and symptoms in homestead vegetation

193. 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.

194. 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 in 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. Infection of fungal/bacterial is not remarkable all 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 date palm and coconut plant at studied homesteads in Rajnagar

Number of disease affected trees

195. Trees heath is observed significantly change in Rajnagar. *Cocos nucifera* and *Phoenix sylvestris* are the major victim species. Out of 17 *Cocos* and 25 *Phoenix* trees, this homestead followed 15 and 22 nos unhealthy respectively. These two palm species are suffered from lethal yellowing, trunk rot and manganese deficiency due to increase soil salinity. Growth of these plant stop and upper trunk are losing diameter. In the case of Chalkghona homestead, Cocos nucifera plants have also been observed health deterioration. Except aforementioned, the other studied homestead's plants are found insignificant change in terms of health.

Table 9.5: Proportion of healthy and unhealthy plants in studied homesteads

Location	Plant Name	Total No. of Plant	No. of Healthy Plant					No. of Unhealthy Plant				
			1st QM (Apr 2014)	2nd QM (Jun 2014)	3rd QM (Oct 2014)	4th QM (Jan 2015)	5th QM (Apr 2015)	1st QM (Apr 2014)	2nd QM (Jun 2014)	3rd QM (Oct 2014)	4th QM (Jan 2015)	5th QM (Apr 2015)
Rajnagar	*Cocos nucifera*	17	NS	7	11*	11	2	NS	10	5	5	15

Location	Plant Name	Total No. of Plant	No. of Healthy Plant					No. of Unhealthy Plant				
			1st QM (Apr 2014)	2nd QM (Jun 2014)	3rd QM (Oct 2014)	4th QM (Jan 2015)	5th QM (Apr 2015)	1st QM (Apr 2014)	2nd QM (Jun 2014)	3rd QM (Oct 2014)	4th QM (Jan 2015)	5th QM (Apr 2015)
	Phoenix sylvestris	25	NS	10	21	21	3	NS	15	4	4	22
	Manilkara zapota	1	NS	1	1	1	1	NS	0	0	0	0
	Albizia saman	2	NS	2	2	2	2	NS	0	0	0	0
	Excoecaria agallocha	100	NS	100	98*	98	100	NS	0	1	1	0
	Mangifera indica	3	NS	2	3	3	1	NS	1	0	0	2
	Psidium guajava	2	NS	0	2	2	0	NS	2	0	0	2
Barni	*Cocos nucifera*	10	3	7	10	10	7	7	3	0	0	3
	Phoenix sylvestris	12	12	7	8	8	9	0	5	4	4	3
	Borassus flabellifer	6	3	5	6	6	6	3	1	0	0	0
	Mangifera indica	6	3	3	5	5	2	3	3	1	1	4
	Excoecaria agallocha	18	18	18	18	18	18	0	0	0	0	0
	Swietenia mehogani	11	11	11	11	11	10	0	0	0	0	1
	Areca catechu	10	10	4	8	8	2	0	6	2	2	8
	Manilkara zapota	1	1	1	1	1	1	0	0	0	0	0
	Psidium guajava	2	0	1	2	2	3	2	1	0	0	-1
Kalekarber Dighi	*Cocos nucifera*	56	21	50	55	55	54	35	5	1	1	2
	Phoenix sylvestris	10	10	7	10	10	9	0	3	0	0	1
	Mangifera indica	5	3	5	5	5	5	1	1	0	0	0
	Manilkara zapota	2	1	1	1	1	2	0	0	0	0	-1
	Borassus flabellifer	8	8	8	8	8	8	0	0	0	0	0
	Zizyphus sp	1	1	1	1	1	1	0	0	0	0	0
	Psidium guajava	8	7	8	8	8	8	0	0	0	0	0
	Tamarindus indica	2	2	2	2	2	1	0	0	0	0	1
Chalkgho na	*Cocos nucifera*	39	35	20	34	34	5	25	19	5	5	34

Location	Plant Name	Total No. of Plant	No. of Healthy Plant					No. of Unhealthy Plant				
			1st QM (Apr 2014)	2nd QM (Jun 2014)	3rd QM (Oct 2014)	4th QM (Jan 2015)	5th QM (Apr 2015)	1st QM (Apr 2014)	2nd QM (Jun 2014)	3rd QM (Oct 2014)	4th QM (Jan 2015)	5th QM (Apr 2015)
	Phoenix sylvestris	24	24	14	23	23	18	0	10	1	1	6
	Albizia saman	3	1	3	3	3	2	0	0	0	0	1
	Excoecaria agallocha	36	36	36	35	35	36	0	0	1	1	0
	Manilkara zapota	1	1	1	1	1	1	0	0	0	0	0
	Psidium guajava	17	16	10	17	17	17	1	7	0	0	0
	Mangifera indica	7	5	6	7	7	7	2	1	0	0	0
	Borassus flabellifer	2	2	2	2	2	2	0	0	0	0	0

Note: NS = Not Surveyed

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

9.3.7 Vegetation canopy status

196. 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 monitor vegetation canopy status of the study area, canopy cover is monitoring in different time intervals.

Species representation in different canopy layers of homestead vegetation

197. *Cocos nucifera* occupied top canopy of all the studied homestead vegetation. *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 followed at studied homesteads.

Estimated Canopy cover in homestead vegetation of sampling sites

198. Canopy status have been minor changed all the studied homestead vegetation from the last monitoring time. In the case of Rajnagar site, *Excoecariaagallocha* (Gewa) tree contains major portions of the canopy cover and this species followed foliage condition during monitoring. Hence, overall canopy coverage found increasing at this site. *Cocos nucifera* (Narikel) and *Phoenix sylvestris* (Khejur) contribute maximum coverage of the vegetation canopy at Barni and Chalkghona monitoring sites. As most of the individuals of these plants are followed in unhealthy condition, and not natured in change foliage condition in a particular season, so canopy cover estimated lower than previous monitoring. Meanwhile, Kalekarber site followed very minor change as this site have mostly healthy plants.

199. Canopy coverage of the studied homesteads have been represent in following table.

Table 9.6: Vegetation Canopy Cover in different studied homesteads

Location	% of canopy Coverage				
	1st Quarter Year 1 (Apr 2014)	2nd Quarter Year 1 (Jun 2014)	3rd Quarter Year 1 (Oct 2014)	4th Quarter Year 1 (Jan 2015)	1st Q Year 2 (Apr 2015)
Rajnagar	NS	19	19	17	20
Barni	NS	26	18	18	12
Kalekarber	NS	20	24	25	23
Chalkghona	NS	13	24	22	17

Note: NS = Not Surveyed

9.3.8 Lichen cover

200. Alive lichen cover on tree barks have been observed lower than previous monitoring in October, 2014. The cause against this is for lowest moisture in tree barks that regulate lichen germination and propagations. However, *Areca catechu, Excoecaria aghalocha* and *Phoenix sylvestris* are mostly infected with lichen all of the monitoring sites. Table 9.6 refers average percentage of lichen coverage of the studied locations.

Table 9.7: Lichen Coverage on different tree barks at studied homestead vegetation

Location	% of Lichen Coverage			
	1st Quarter Year 1 (Apr 2014)	2nd Quarter Year 1 (Jun 2014)	3rd Quarter Year 1 (Oct 2014)	4th Quarter Year 1 (Jan 2015)
Raj Nagar	NS	5.1	2.5	1.4
Barni	NS	7.8	3.1	2.4
Kalekarber	NS	4.3	3.2	1.0
Chalkghona	NS	2.1	2.6	1.6

Note: NS = Not Surveyed

Photo 9.3: Lichen Coverage on different tree barks at studied homesteads

9.3.9 Bird Habitat

Local birds and their nesting behaviour

201. 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 favour good number of water dependent bird species in this area. Most of the birds are nesting on tall trees of homesteads. Coconut and Gewa followed top priority for nesting. Small bird like Tailor bird, prefer small bushy shrubs. Although, birds do not follow any local boundaries, a clear conception on available bird species have been gathered through discussions with studied homestead owners as well as physical observation. A list of local bird species is presented in Table 9.8.

Table 9.8: Local Bird Species of the study area

Scientific Name	Common Name	Local Name
Accipiter badius	Shikra	Shikra
Acridotheres fuscus	Jungle Myna	Jhuti Shalik
Acridotheres tristis	Common Myna	Bhat Shalik
Actitis hvpoleucos	Common Sandpiper	Chah Pakhi
Aegithina tiphia	Common Iora	Pati Fatikjal
Alcedo atthis	Common Kingfisher	Pati Machranga
Amaurornis phoenicurus	White-breasted Waterhen	Dholabook Dahuk
Ardeola grayii	Indian Pond Heron	Deshi Kanibok
Athene brama	Spotted Owlet	Khuruley Pencha
Bubulcus ibis	Cattle Egret	Go Boga
Butorides striatus	Little Heron	Choto Bok
Casmerodius albus	Great Egret	Jattha Bok
Centropus bengalensis	Lesser Coucal	Kana Kukka

Scientific Name	Common Name	Local Name
Copsychus saularis	Oriental Magpie-Robin	Udoi Doel
Cypsiurus balasiensis	Asian Palm Swift	Ashio Talbatashi
Dendrocygna bicolor	Fulvous Whistling-Duck	Boro Sarali
Dendrocitta vagabunda	Rufous Treepie	Khoira Harichacha
Dendrocygna javanica	Lesser Whistling Duck	Choto Sarali
Dendrocopos macei	Fulvos breasted woodpecker	Kathkurali
Dicrurus macrocercus	Black Drongo	Kala Fingey
Dinopium benghalense	Black ramped Frameback	-
Egretta garzetta	Little Egret	Choto Boga
Eudynamys scolopacea	Asian Koel	Kokil
Gallinula chloropus	Common Moorhen	Jolmurgi
Halcyon smyrnensis	White-throated Kingfisher	Dholagola Machranga
Haliastur indus	Brahminy Kite	Shonkho Chil
Ixobrychus cinnamomeus	Cinnamon Bittern	Nolkhoka
Ixobrychus sinensis	Yellow Bittern	-
Ketupa zeylonensis	Brown fish owl	Bhutum pecha
Lanus schach	Long-tailed Shrike	Lenja Latora
Macronous gularis	Striped Tit Babbler	-
Megalaima haemacephala	Coppersmith Barbet	Choto Boshonto Bauri
Merops orientalis	Green Bee Eater	Suichora
Motacilla maderaspatensis	White-browed Wagtail	-
Nectarinia asiatica	Purple Sunbird	Durgo Tuntuni
Netapus coromandelianus	Cotton pygmy goose	Bali Hansh
Oriolus xanthornus	Black-hooded Oriole	Kalamatha Benebou
Orthotomus sutorius	Common Tailorbird	Pati Tuntuni
Passer domesticus	House Sparrow	Charui
Phalacrocorax niger	Little Cormorant	Choto Pankouri
Porzana fusca	Ruddy-breasted Crake	Ranga Ulti
Porphyrio porphyrio	Purple Swamphen	Kalim
Pycnonotus cafer	Red Vented Bulbul	Bulbuli
Rhipidura albicollis	White-throated Fantail	Dholagola Chatighurani
Sterna albifrons	Little tern	Choto Gangchil
Streptopelia chinensis	Spotted Dove	Tila Ghughu
Streptopelia tranquebarica	Red Collared Dove	Penchi Ghughu
Sturnus contra	Asian pied starling	Go Shalik
Tachybaptus ruficollis	Little Grebe	Choto Duburi
Todiramphus chloris	Collared Kingfisher	Dholaghar Machranga
Treron bicincta	Orange-breasted Green Pigeon	-
Tyto abba	Barn owl	Laksmi pecha
Upupa epops	Hoopoe	Hudhud
Vanells indicus	Red-wattled Lapwing	Lal Hotiti

Source: Field Monitoring, April 2014

Migratory birds and their habitats

202. In this monitoring season, there is no migratory bird observed anymore. Hence no description of migratory birds and their habitats are mentioned here.

Bird species and number of Bird nests in sampling sites

203. Two bird nests have been found at Barni and Chalkghona village. One nest with pair of Spotted Dove chicks observed on *Borassus flabeliffer* (Taal) plant in studied homestead at Barni. Another one nest of Tailor bird is sighted on *Excoecaria agallocha* (Gewa) at monitoring site in Chalkghona village.

Table 9.9: Bird nest monitoring datasheet

Bird Name	No. of Bird Nest observed																			
	1st Quarter Year 1 (Apr 2014)				2nd Quarter Year 1 (Jun 2014)				3rd Quarter Year 1 (Oct 2014)				4th Quarter Year 1 (Jan 2015)				1st Q Year 2 (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	-	12	-	-		-	-	-	-	-	-	-	-	-	-	-	-
Little Egret	NS	-	NS	1	4	-	-		-	-	-	-	-	-	-	-	-	-	-	-
Asian Pied Starling	NS	1	NS	-	-	-	-	11	-	-	-	-	-	-	-	-	-	-	-	-
Tailor Bird	NS	-	NS	1		-	-		-	-	-	-	-	-	-	-	-	-	-	1
Spotted Dove	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-

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

9.3.10 Butterfly occurrence

204. A total of 12 butterfly species have been observed form different monitoring sites. Small Grass Yellow, Pale Grass Yellow and Evening Brown are recorded in highest abundance. Highest number of butterfly species occurred at Kalekarber site during field monitoring. Recorded butterfly species and their occurrences are listed in Table 8.9 below.

Photo 9.4: A Common Palmfly found at Barni

Table 9.10: Occurrences of Butterflies in the study area

Common Name	Scientific Name	Occurrence of Butterfly species																			
		1st Quarter Year 1 (Apr 2014)				2nd Quarter Year 1 (Jun 2014)				3rd Quarter Year 1 (Oct 2014)				4th Quarter Year 1 (Jan 2015)				1st Q Year 2 (Apr 2015)			
		R	B	K	C	R	B	K	C	R	B	K	C	R	B	K	C	R	B	K	C
Blue Tiger	*Tirumala hamata*	NS	NS	NS	NS						**	*									
Lime Butterfly	*Papilio demoleus*	NS	NS	NS	NS				*				*		*		*				
Chocolate Argus	*Junonia hedonia*	NS	NS	NS	NS	*		*						*							
Common albatross	*Appias albina*																			*	
Common Cerulean	*Jamides celeno*											*									
Common Crow	*Euploea core*	NS	NS	NS	NS	*		*	*	*	*		*				*		*		
Common Emigrant	*Catopsilia pomona*									*	*	**	*		*	*					
Common Gull	*Cepora nerissa*										*										
Common Leopard	*Papilo phalantha*										*	*									
Common palmfly	*Elymnias hypermnestra*										*	*			*		*		*		
Common Pierrot	*Castalius rosimon*										*		*			*					
Common Rose	*Pachliopta aristolochiae*												*					*			
Common Sailor	*Neptis hylas*																	*			
Dainty Grass-blue	*Zizula hylax*	NS	NS	NS	NS						*	*									
Danaid Eggfly	*Hypolimnas misippus*	NS	NS	NS	NS											*					
Evening Brown	*Melanitis leda*	NS	NS	NS	NS				*						*		*			***	
Foscus Swallowtail	*Papilio fuscus*	NS	NS	NS	NS																
Grey Pansy	*Junonia atlites*										*										
Indian sunbeam	*Curetis thetis*												*						*		
Lemon Pansy	*Junonia lemonius*										*					*					
Mangrove Jewel	*Hypochrysops epicurus*	NS	NS	NS	NS		*		**												
Stripped Tiger	*Danaus genutia*	NS	NS	NS	NS					*		*									
Orchard Swallowtail	*Papilio aegeus*	NS	NS	NS	NS	*	**													*	

Common Name	Scientific Name	Occurrence of Butterfly species																			
		1st Quarter Year 1 (Apr 2014)				2nd Quarter Year 1 (Jun 2014)				3rd Quarter Year 1 (Oct 2014)				4thQuarter Year 1 (Jan 2015)				1stQ Year 2 (Apr 2015)			
		R	B	K	C	R	B	K	C	R	B	K	C	R	B	K	C	R	B	K	C
Pale Grass Blue	*Pseudozizeeria maha*																		**	**	
Three spot Grass Yellow	*Eurema blanda*	NS	NS	NS	NS					*	**		*								
Peacock pansy	*Junonia almana*										**								*		
Rice Swift	*Borbo cinnara*										**	*	**				*				
Small Grass-yellow	*Eurema smilax*	NS	NS	NS	NS		**									*			*	**	
Spotted Pea-blue	*Euchrysops cnejus*	NS	NS	NS	NS																
Swamp Tiger	*Danaus affinis*	NS	NS	NS	NS												*			*	

Note: Occurrence Status; ''= Occasional, '**' = Common, '-'=Not Found 'R'=Rajnagar, 'B'=Barni, 'K'=Kalekarber, 'C'=Chalkghona*

9.4 Aquatic Ecosystem Monitoring

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

9.4.1 Monitoring Locations

206. 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 Sailtakhali and Ichamoti) exists as internal river system. Hence, status of benthos, planktons and aquatic mammals (Dolphin) in different locations of the study area has been monitored. 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.

9.4.2 Dolphin Occurrence

Dolphin migration route in study area

207. 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)* migrates from estuary regions to upstream connected rivers like Rupsha and Madhumoti. Though Irrawardi Dolphin *(Orcaella brevirostris)* is mostly habituated in estuary regions of Bangladesh, but this aquatic mammal is also sighted in Passur river. Ganges Dolphins also roam through Maidara river mainly during high tide. Siltation and narrowing of upstream branches is limiting the length of migration area of this river day by day.

Dolphin occurrence in Passur River

208. Occurrence of dolphin have been monitored by boat transect along about 8 km length of Passur River surround the project area. The transect was start from Chalna Bazar in mid ebb tide of the river. At middle of the transect survey, spring tide was start. The transect was end at Ichamoti river (Upstream of Maidara River). One individual of matured Ganges dolphin was occurred at the confluence point of Passur-Maidara River during continuing of spring tide. Except this, no dolphin was recorded in Passur river along the project site during transect survey. Dolphin occurrence is usually goes low due to high salinity of river water. Most of the Ganges River dolphins migrate to upstream during pick dry season (March-April) of the year.

209. Detail survey result is presented in Map 9.2.

210. Dolphin occurrences were also followed at Karomjal, Harbaria, Sarankhola and Akram Point while passing through downstream of Passur River. Two groups of Irrawaddy Dolphin containing 4-10 individuals was observed two nearer locations at Akram point (22˚01´31˝N 89˚29´52"E and 22˚59´29˝N 89˚31´51"E). However, the survey result is included in Table: 8.10.

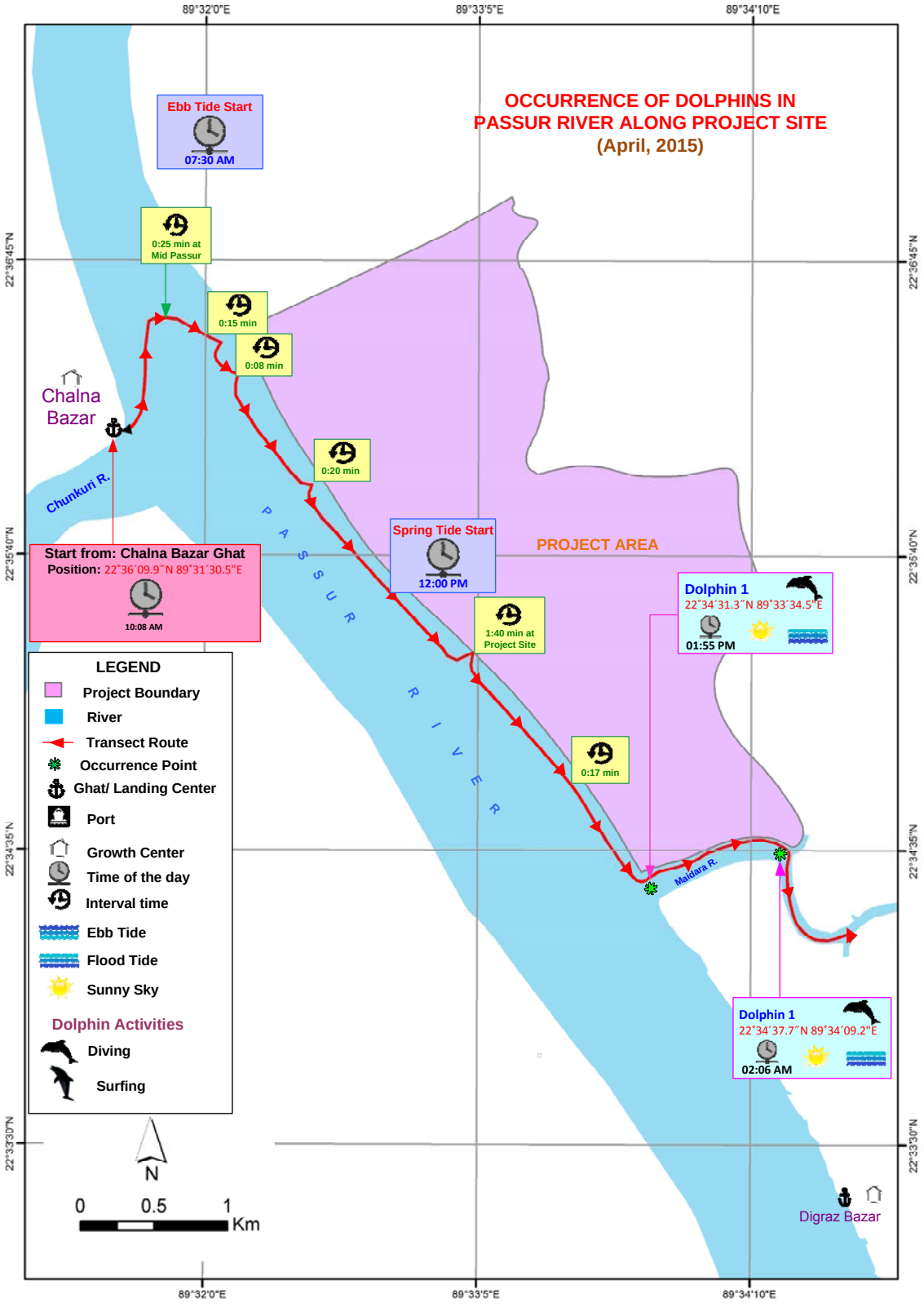
Dolphin occurrence in Maidara River

211. One individual of Ganges River Dolphins were recorded inside Maidara-Ichamoti confluence point during survey and this was sighted in diving mode. The river was in calm condition and spring tide was continuing when dolphin was occurred.

Table 9.11: Dolphin observation Datasheet

Location of River systems	Occurrence Status									
	1st Quarter Year 1 (Apr 2014)		2nd Quarter Year 1 (Jun 2014)		3rd Quarter Year 1 (Oct 2014)		4th Quarter Year 1 (Jan 2015)		1st Q Year 2 (Apr 2015)	
	F T	N T	F T	N T	F T	N T	F T	N T	F T	N T
Passur River Near Project Side	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Karamjal	NS	NS	NS	N	NS	Y	Y	Y	N	N
Harbaria	NS	NS	NS	N	NS	Y	Y	N	N	N
Akram Point	NS	NS	NS	N	NS	N	NS	Y	Y	Y
Sarankhola	NS	NS	NS	N	NS	NS	N	N	N	N
Maidara River	Y	N	N	N	Y	Y	Y	N	Y	N

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 (April 2015)

10 Sundarbans Forest Health Monitoring

10.1 Monitoring Indicator

212. The following indicators have been selected for the monitoring of Sundarbans Forest health:

i. Species richness, diversity, evenness, dominancy
ii. Regeneration, recruitment, seedling survival
iii. Canopy cover, tree height, diameter, pneumatophores and biomass,
iv. Disease and damage (Timber, branch, leaves)
v. Soil nutrient and quality:
    - Soil nutrients- macro, micro and heavy metal
    - Bulk density, organic carbon
    - Soil pH, salinity

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

- Regeneration and survival percentage
- Canopy cover, pneumatophores
- Crab hole density
- tree height,
- lichen presence and
- Ecosystem carbon stocks.
    i. Bulk density, organic carbon
    ii. Soil pH, salinity
    iii. N and P

10.2 Monitoring location

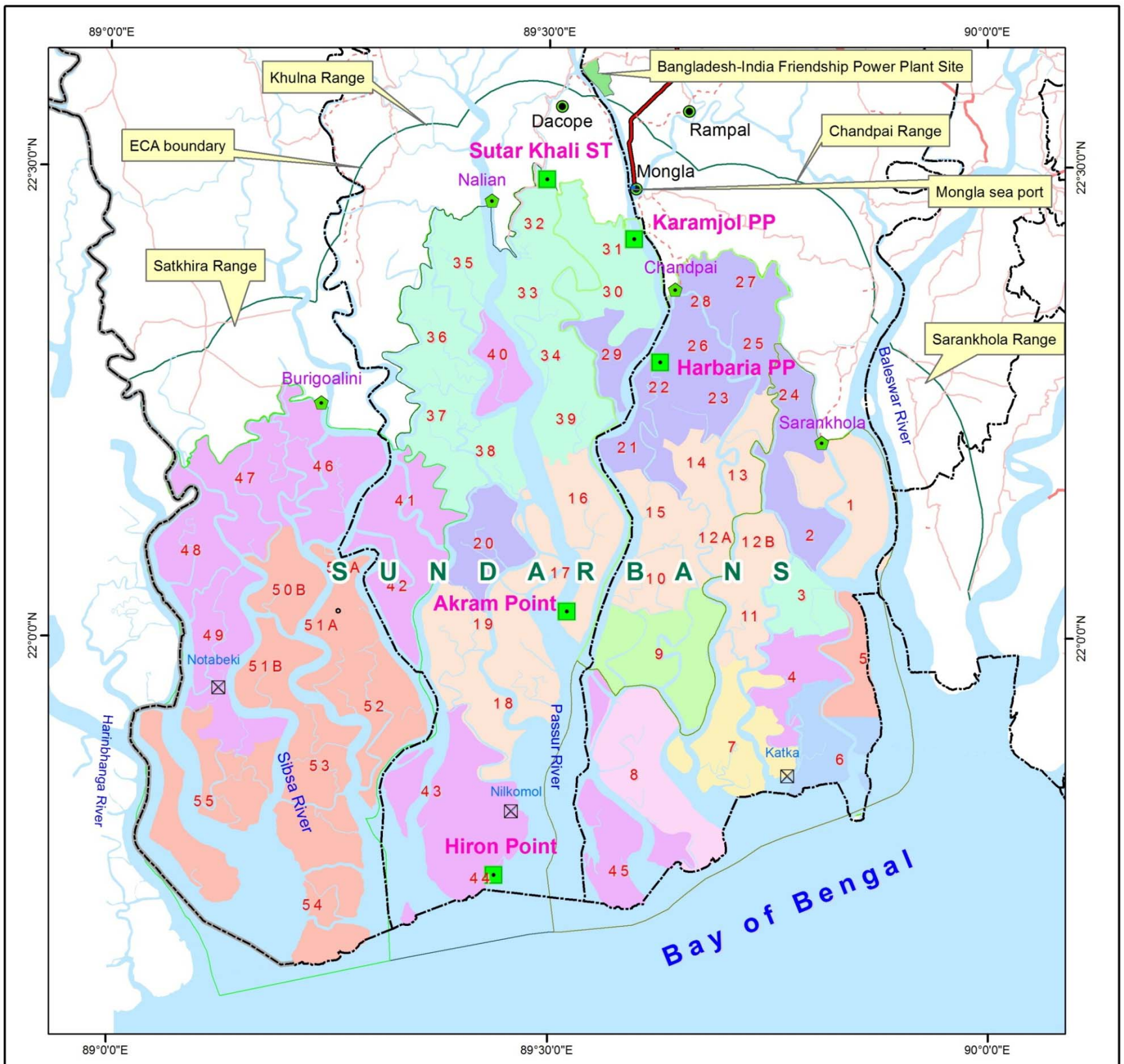
214. Five sites were selected on the basis of the survey conducted from April 3 to 6, 2014 (Map 10.1). Among them, four sites along the Passur River at Karamjal, Harbaria, Akram point and Hiron point and another near Sutarkhali forest office. Distance from the proposed Project site, coal transportation route, and protection of the permanent sample plot and cover the maximum vegetation types were the major criteria for site selection.

10.3 Method

10.3.1 Sampling design

215. 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 variation of

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.



Index Map

Legend

- Forest health monitoring location
- Range Office
- Wildlife Sactuary Headquarter
- Upazila head quarter
- International boundary
- District boundary
- Upazila boundary
- District road
- Upazila road
- National highway
- Regional highway
- Project boundary
- Major River
- ECA boundary
- Sundarbans Reserved Forests

Data sources:

CEGIS Archive
Environmental and Socio-economic Monitoring of Khulna 1320 MW CBTPP, BIFPCL

0 2.75 5.5 11
Kilometers

N

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

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

May 2014

Map 10.1: Location Map of Sundarbans Forest health Monitoring Plots

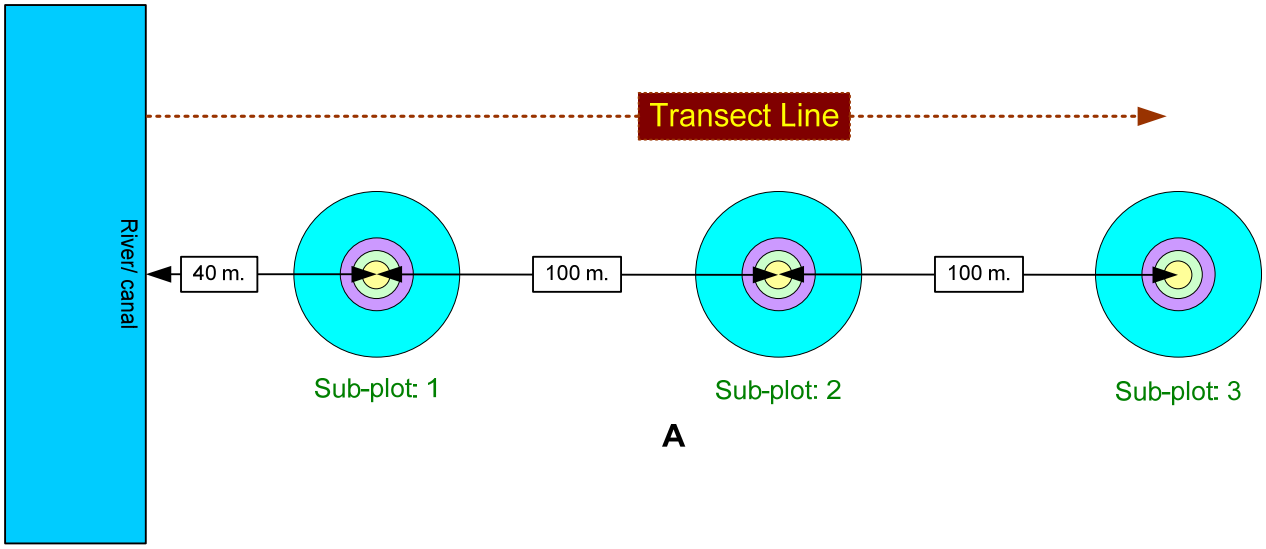


Figure 10.1: Layout of thye subplots and transect line perpendicular from ecotone (river or canal bank)

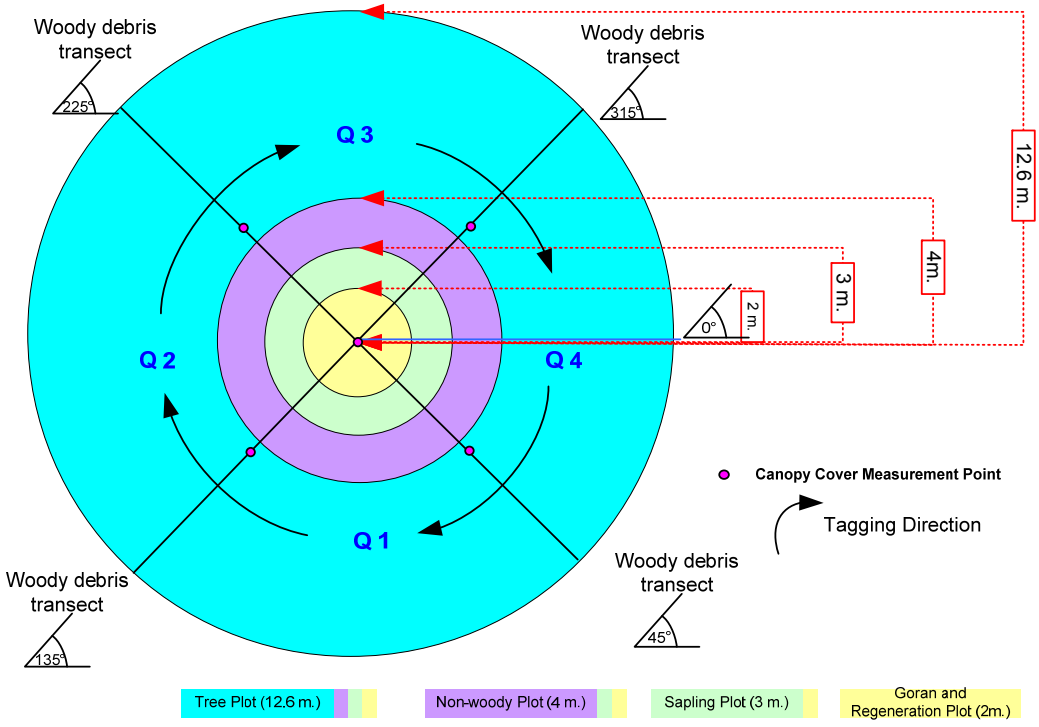


Figure 10.2: Layout of the survey sctivities in each subplot

10.3.2 Forest Health Survey

(a) Trees

216. The tag number of trees (DBH ≥ 5cm and lean angle greater than 450) was monitored and rewritten if any shade was found within 12.62 m radius circle.

Photo 10.1: Surveyor checking tree tag number in April 2015 monitoring

Pneumatophore

217. Pneumatophores, the specialized root system in mangrove plays a vital role in root respiration by gas exchanging in this anaerobic condition of mangrove. During tidal inundation it goes under water. So, if oil spill happen, the Pneumatophores will be affected by oil coat on its surface. That might hamper the gas (oxygen) exchange process which ultimately will affect the plant growth. Considering this issue; within a circular area of one meter radius, total number of pneumatophores was recorded with its living status whether live or dead.

Photo 10.3: Surveyor counting Pneumatophore of Heritiera fomes at Sutar Khali monitoring site

Crab hole

218. Crab plays important role in Mangrove ecosystems such as decomposing litter fall thereby increase 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 2 m radius circle in each subplot.

Photo 10.4: Surveyor counting crab hole with at Akram point site in SRF

Canopy cover

219. Canopy cover (%) was estimated by a spherical densiometer which is a gridded 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 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 10.5: Crew member taking canopy cover % at April Monitoring

Lichen

220. The presence and absence of Lichen in tree species is an important indicator of forest health because it is very sensitive to air pollution such as sulfur dioxide, fluoride etc. The lichen cover percentage on tree 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 10.5: Lichen (white circle) on Sundri tree in Hiron Point site

10.4 Statistical analysis

221. Different statistical analyzes were preformed for different indicators. A one way ANOVA analysis was tested for canopy cover, pneumatophores and seedling density in order to find out whether any difference was made. Tukey HSD multiple comparison test were performed whenever any significant change was marked in ANOVA.

10.5 Monitoring Result and discussion of SRF Health

10.5.1 Canopy

222. In Sutar Khali and Hiron Point, the canopy cover percentage was varied significantly ($P< 0.05$). From the Tukey HSD test (a multiple comparison test) it was found that the 2nd year 1st mentioning's canopy cover % was significant lower than other three quarters monitoring ($P<0.05$) while this figure was not significantly varied among the second, third and fourth quarter monitoring ($P>0.05$). However, the cover percentage was found similar in other three sites among the four monitoring period ($P> 0.05$; Figure 10.3). Though the canopy cover percentage was lower than three monitoring in Sutar Khali and Hiron Point, the foliage heath condition was good as canopy greater than 60% treat as healthy site.

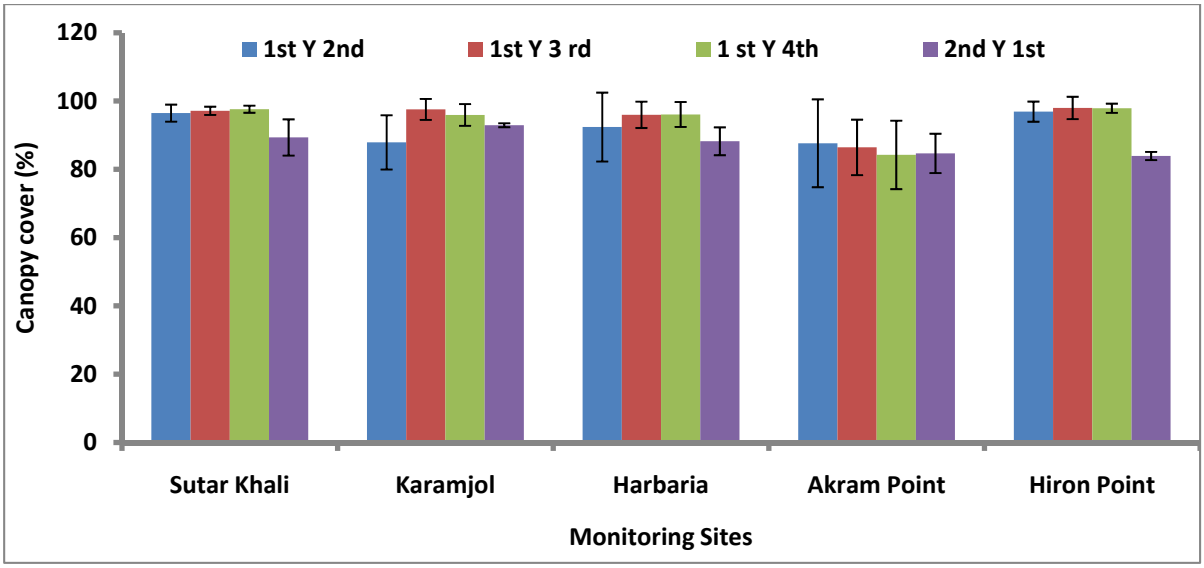


Figure 10.3: Mean (± 95% CI) canopy cover (%) between first and second quarter suervy in five monitoring sites of the SRF.

10.5.2 Pneumatophore

223. The mean density of pneumatophores was not significantly varied during the four monitoring periods in all of the study sites (P > 0.05; Figure. 10.4). As for example, in the third subplot in Karamjal site mainly dominated by Baen tree and it has numerous tender pneumatophores that usually dry up and die during dry season.

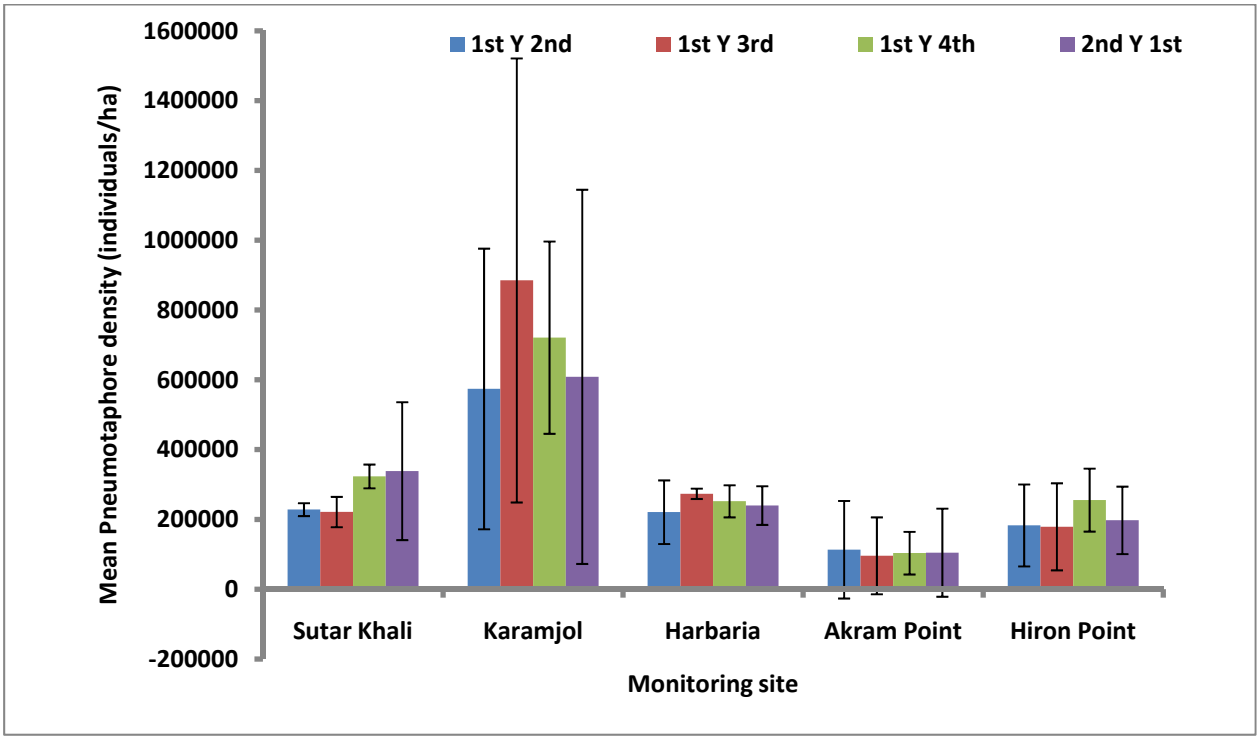


Figure 10.4: Average (± 95% CI) number of pneumatophores density among the quarter suervy in five monitoring sites of the SRF

10.5.3 Crab hole

224. The crab hole density, the indicator of availability of crab in a site, was not significantly varied among the three monitoring periods in all the five monitoring site (P<0.05; figure 10.5). In the all the all the sites. This result indicates that food chain has remain good in all the monitoring sites as crabs are primary consumer of fallen leave on forest floor that are source of nutrient in soil.

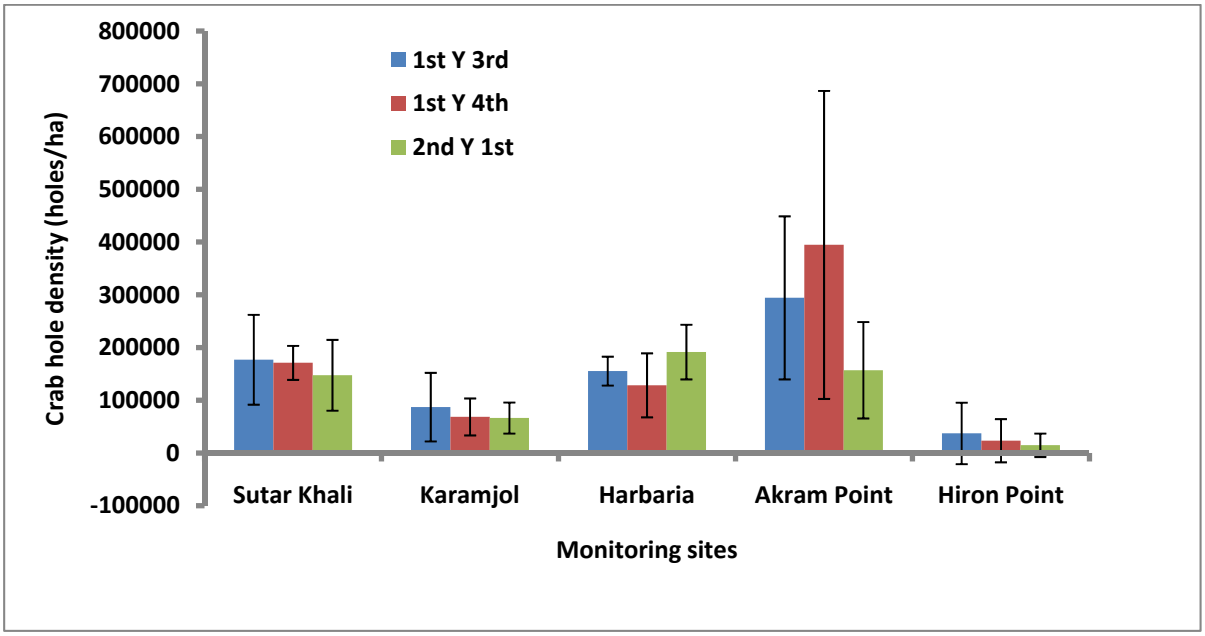


Figure 10.5: Mean (± 95% CI) crab hole density between first and second quarter survey in five monitoring sites of the SRF.

10.5.4 Seedling regeneration

225. The seedlings density among the four monitoring periods was not significantly varied in ANOVA analysis across the five monitoring sites (P > 0.05; Figure. 10.6). However, a decreasing trend of seedling survival was found in all sites except Karamjal. Usually, in natural forest which is followed by the rule of natural selection, at the early stage seedlings are died due to competition for energy (nutrients).

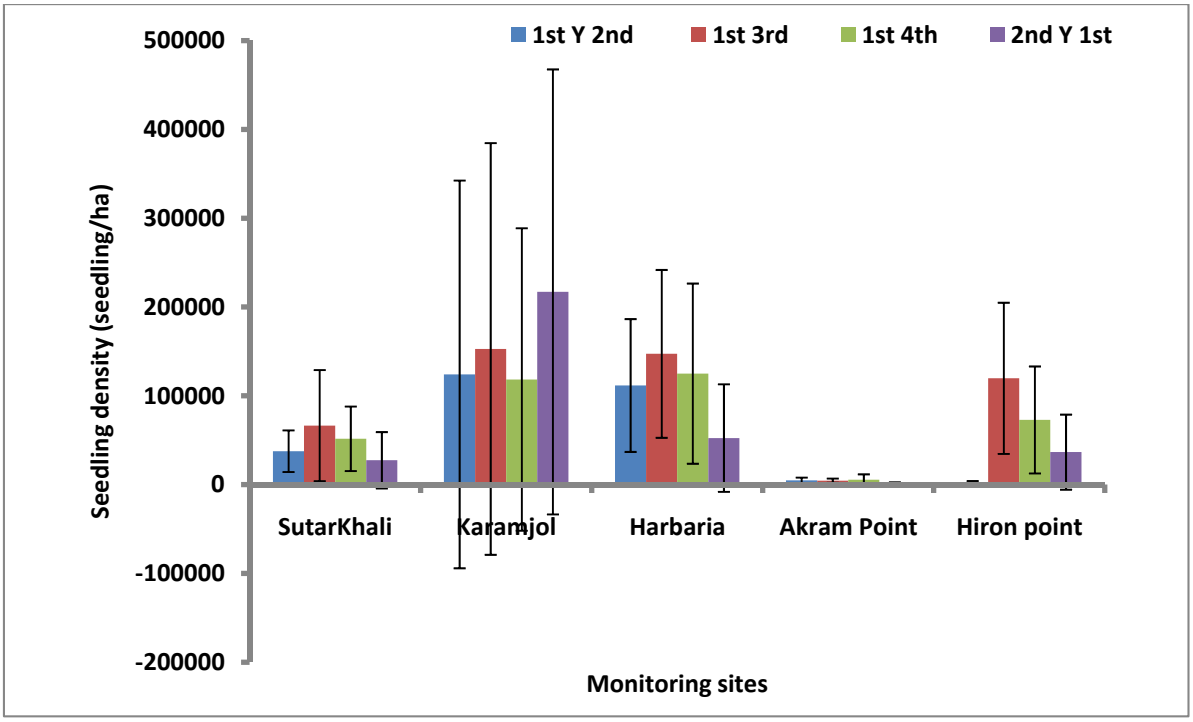


Figure 10.6: Mean (± 95% CI) seedlings density among second, third and fourth quarter survey in five monitoring sites of the SRF

10.5.5 Pest and insect

Lichen

226. The lichen coverage (percentage at DBH) on tree was gradually reduced in all of the five monitoring sites among the three quarters from July 2014 to April 2015 (P< 0.05; Table 11.1). In SRF, environmental conditions (Temperature, humidity, salinity etc.) usually get worse in April and May. After that it becoming improved for flora and fauna and in monsoon season it is congenial 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 (2006) standard (community with 5 % is assumed that the ecosystem has abundant lichen) the lichen coverage was satisfactory in Sutarkhali and Karamjal sites, while other three sites were below that standard (Table 10.9). This change indicates that salinity may have a detrimental role on lichen as Sutarkhali and Karamjal are close to landward side and other are close to seaward side.

Table11.1: Mean (± 95 % CI) percentage of changes in lichen availability among quarter survey in five monitoring sites of the SRF

Monitoring site	Monitoring quarter			Change in Lichen %		
	Apr-15	Jan-15	Jul-14	Apr-15- Jan-15	Apr-15-Jul-14	Jan-15-Jul-14
Sutarkhali	13.74±2.21	27.06±5.41	20.26±2.64	-13.33±3.91	-6.52±2.23	6.81±6.09
Karamjal	8.12±4.22	11.19±4.34	24.45±0.14	-3.07±1.02	-16.33±4.10	-13.26±4.21
Harbaria	2.34±2.06	9.79±5.15	22.91±3.15	-7.45±3.73	-20.57±3.40	-13.12±3.45

Monitoring site	Monitoring quarter			Change in Lichen %		
	Apr-15	Jan-15	Jul-14	Apr-15- Jan-15	Apr-15-Jul-14	Jan-15-Jul-14
Akram Point	0.44±0.37	10.08±7.08	14.54±2.88	-9.64±6.71	-14.10±2.52	-4.46±4.37
Hiron Point	1.49±1.99	4.13±5.38	7.95±4.07	-2.63±3.38	-6.46±2.08	-3.83±1.31

10.5.6 Ecosystem carbon stocks

227. The ecosystem carbon stock is not included in the current in this report because the soil carbon and nutrient analysis is under laboratory. It will be updated whenever the analysis report available.

10.5.7 Conclusion

228. All the indicators of forest health in SRF were in good condition in the second year first quarter monitoring at April 2015 except the lichen coverage percentage. In Sutarkhali and Hiron Point the canopy coverage percentage has decreased significantly but far above the minimum cover that used as a good canopy health. However, the in terms of lichen coverage, only Sutarkhali and Karamjal sites were good (though it also decreased) but Harbaria, Akram Point and Hiron Point were below minimum level of good lichen health condition. This could be due to the worse environmental condition in SRF that is a usual phenomenon, especially in April and May

11 Socio-economic Condition and Socio Safeguard Monitoring

11.1 Introduction

229. The third phase monitoring (six months interval) intends to explore the state of socio-economic condition of certain parameters with reference to the previous monitoring results. This section contains the changes occurred in monitored parameters.

11.2 Methodology

230. It is evident that all socio-economic parameters will not necessarily be changed due to project activities. As the monitoring is intended to portray the changes in terms of parameters with reference to the earlier condition, the only changed and important parameters were examined. In doing so, a change in methodology of monitoring is taken place for instance; household survey was replaced with Focus Group Discussion (FGD) and informal discussion.

231. Total 4 FGDs and 6 informal consultations were conducted both in project site and adjacent areas. One FGD in the project site was conducted comprising of labourers and the rest three were conducted in Foyla comprising of resettled populations, in Rajnagar and Chunkuri mouzas comprising of local inhabitants. Out of 6 informal discussions, two were with project Management and the rest 4 in Barni, Boro Durgapur, Kapasdanga and Bajua mouzas with local peoples.

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

11.3 Exploration of Monitoring Parameters

11.3.1 Compensation

233. In this third phase of monitoring, the consulted people stated that compensation to the losers is almost completed. The number of uncompensated people due to complicacy of legal documents found in second phase is gradually decreasing as found in third phase. The still uncompensated landowners are trying to resolve through proper channel.

11.3.2 Resettlement/rehabilitation

234. It is evident that 18 households were resettled in Foyla Cluster Village without any livelihood options for them. Even the authority does not have any plan for restoring their livelihood. After one and half year of monitoring a miserable condition was observed by the monitoring team. The resettled population stated that they did not predict the upcoming predicament rather were messed with illusion as committed preference for them to project activities wasnot fulfilled, providing ownership of land wasnot settled, committed alternative livelihood options wasnot generated.

235. These affected peoples are mainly landless and in-migrated here for harnessing livelihood from shrimp culture activities. As directly affected people, they were agitated at the very beginning of the land acquisition in front of government authority and they were photographed and marked out as agitators. They, therefore, were ill-treated invoking

assistance by the government authority and local political power-wielders. In the case of resettlement, they were not given any compensation for shifting their homesteads as well.

236. 6 decimal lands including homestead and surrounding buffer were allocated for each resettled household but still they did not get permission to pay tax. They, thus, apprehend that they are still landless and may be evicted anytime.

237. There were 3 persons from resettlers found to be involved in project activities for harnessing livelihood. They stated that these 3 persons also could not work every day as the sub-contractor usually preferred local people (living adjacent villages) to resettled one. The sub-contractors told them that as they were resettled elsewhere they are no more concern of the project.

238. The resettled people stated that they have very little scope of employment in Foyla as it is urban area and they are not necessarily accustomed to urban working pattern. Thus, it is difficult for them to change their occupation. Furthermore, their social relation with neighbours (other resettled populations) and the host communities is not fair enough therefore, host people did not trust them to give them scope of employment. On the other hand, they experienced that other resettled neighbours did not come to help them as all are strangers to each other.

239. In consultation with them, the resettled populations urged to be involved in project related activities suitable to them. As the resettled site is far from project site, they wanted to stay in the labour shed of the project for working. They expected special attention to them; otherwise their survival will be difficult.

A Case Study on Resettled Family in Cluster Village

Mr. Dalil Uddin, a 73 years old household head living with his wife in the resettled cluster village. His two sons along with their wives are still living in the bank of Maidara river (in the project part) hoping to get work opportunity in the project. He also stated that it is not possible for them to live with him as one unit room is allocated for his entire family. Mr. Uddin is now unemployed due to his disability and thereby dependent on his sons' income. However, his two sons could not work every day as the subcontractor prefers local people to the resettled one. Therefore, they could not support their own families let alone their dependents. The part in which they are living is also under acquisition and they are to be evicted anytime. Mr. Uddin stated that if they could not stay there, last hope of employment will be dismissed as they have to migrate elsewhere. The allocated 6 decimal land is still not under taxation system by his name and therefore, he apprehended that he along with other resettled populations would be evicted further. Within four years of living in this resettled village, he and other resettlers (resettled from same areas) could not make trust to the local host people and also to the other resettled neighbours (resettled from other areas). He frequently visited the respective government offices and political leader aiming to get a little bit assistance for survival but all efforts were ended into fiasco. He stated with disappointment that "*amader dekhar keo nei*" (there is nobody to take care of us).

11.3.3 Project Related Employment Generation

240. At this stage, the current activities of the project include- constructing remaining boundary wall; brick crushing; land preparation etc. Unlike the first and second phase monitoring, a considerable number of local peoples engaged in these activities. Here, local people refer to the people living in adjacent unions. However, the number of in-migrated labour found at this phase of monitoring is negligible.

241. The main contractor contracted with local sub-contractors on the basis of work volume accomplishment. The sub-contractors called *Sarder* hired labours from locality and beyond (other districts). Each labour is paid Tk. 290 per day and Tk. 10 per head is received as commission by *Sarder*. In recruiting, contractors mainly consider the availability of labours, suitability of work and payment condition. They depend on local Sarders for recruiting and in some cases, representatives of local government authority suggest the contractors to recruit their preferred labours.

242. The local people expressed happiness in the case of recruitment but also wanted it to be continued in future project related work.

11.3.4 Labour and Working conditions

243. In recruiting, no formal written agreement is made with labours. Therefore, verbal agreement is considered as ultimate both in recruitment and dismissal.

244. A considerable number of labours (about 300) are staying in the labour sheds those are made with *golpata* and bamboo. These sheds are considered as “temporary” by the project authority. However, the monitoring team found these shelters as vulnerable to heavy wind. The labours stated that when heavy wind blows the sheds are swayed, they felt themselves unsafe and tried to protect from damage with supplementing bamboo and ropes.

245. These considerable numbers of labours are facilitated with only two latrines; therefore, they are to defecate in open spaces. The only one deep tube well is the main drinking water source for labours. The monitoring team found one pucca cistern nearby the labour shed filed with groundwater used for bathing and cooking. However, algal bloom was seen growing in this cistern which is detrimental to hygienic living.

246. In the case of occupation health and safety, no safety equipments were found to be used by the labours. The labours stated that they were not provided any safety shoes, musk, hand gloves and glass. Although a few helmets was given which are below quality (most of the helmets were damaged within few days) but are not worn by the labours. Several cases of injuries were found in the project site while consulting with the labourers. However, first aid medicines are available in the project site and labours also can receive treatment facility and free medicines in health services provided by the project (held on Wednesday under CSR program).

247. In the field, it was found that dusts are spreading widely due to heavy wind (when heavy wind is blown) throughout the project area and also to the adjacent villages (namely Kapasdanga and Geronkhali). It eventually affects the labours as they have no glass, musk and helmets. This may bring occupational health hazard as dust is one of the main sources causing respiratory and skin diseases. No water sprinkle system was found in the project site. However, the project management stated that this wide area is not possible to cover under water sprinkle system.

248. The labours stated that there is no one to take care of them. The project management never talked with them rather contractor is the ultimate authority to communicate. No grievance redress cell is found in the project too.

Photos 11.1: A glimpse of labour and working condition

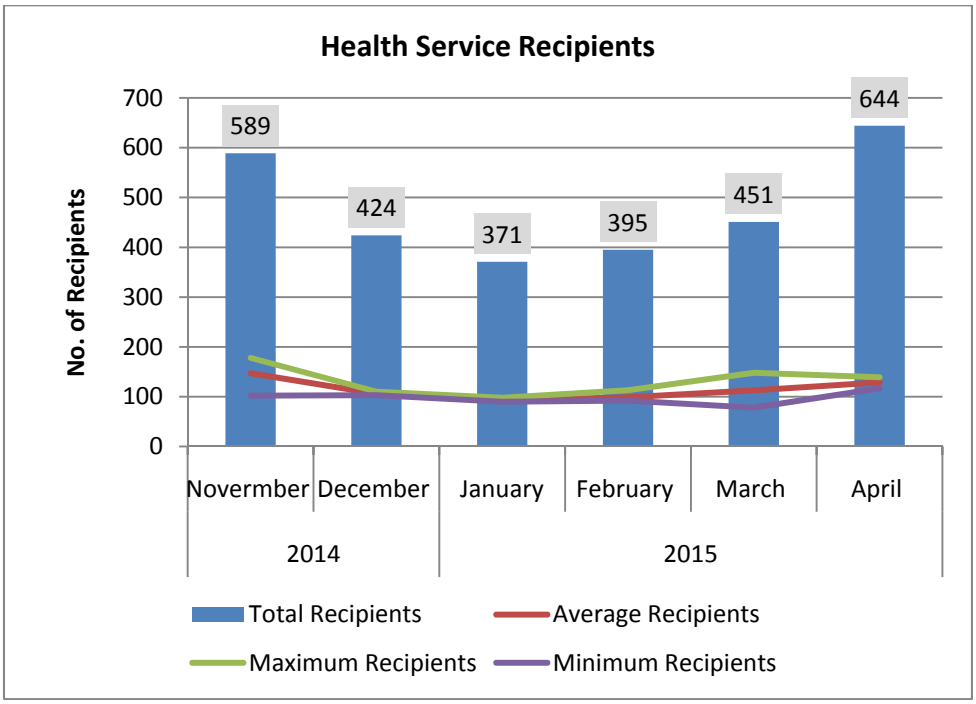
11.3.5 Community Health Safety and Security

249. In the case of community health, people living in the adjacent area particularly Kapasdanga and Geronkhali objected to dust. The spreading dust hampered their daily lives

as it makes food, cloths, body etc. dirty. The project authority posited that the boundary wall decreased the dust spreading but as no measure is available it spread if heavy wind is blown.

11.3.6 Activities under Corporate Social Responsibilities

250. The earlier free medical service in the name of Corporate Social Responsibility (CSR) is continuing. This service is provided in the project site on every Wednesday from 10:00 am to the presence of last service recipient. Unlike earlier, it now takes institutional form: a separate room for service providing, separate self for keeping medicines and other particulars, a bed for check-up etc. A record including receivers' address and diseases is maintained.



Source: Field visit to project office, CEGIS, 2015

Figure 11.1: Record of health service recipients under CSR program

251. From the record it was found that 2,874 people were received health services in the last six months. The highest recipients are in April-2015 (as it has 5 weeks) and the lowest is in January-2015 (Figure: 11.1). The above figure also shows the average, maximum and minimum recipients on monthly basis. It is apparent that the number of maximum, minimum and average recipients varies in November and March but it appears almost similar in December, January and February months.

252. In analyzing gender of recipients it was found that females are the predominant. They received medical facilities for sufferings from fatigue, headache, pain in lower abdomen, coughing, acidity etc. Conversely, the dominant male recipients are project labours mainly received facilities for sufferings from dysentery, coughing, fever etc.

253. The local people and the service recipients expressed satisfaction for having such opportunity. However, it was observed that the recipients were to walk a long way for receiving health services due to poor communication system that is troublesome particularly for women.

Photographs of stakeholder consultations



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Annex I: Checklist of Monitoring Environmental Compliances

SL	Category	Measures	Due Diligence		Remarks
			Complied	Not complied	
PS 1: Assessment and Management of Environmental and Social Risks and Impacts					
1.1	Noise Control Measures	Regular conduction of noise survey around and inside the site boundary by EPC contractor			
		Monitoring Noise with country's ambient standards, and occupational health and safety standards by EPC contractor			
		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			
1.2	Air Quality Measures	Conduct Air Quality survey in the Project area by EPC contractor			
		Monitoring Air Quality with country's ambient standards, and occupational health and safety standards by EPC contractor			
1.3	Dust Control Measures	Conducting dust monitoring and visual inspection around the site boundary			
		Fencing the construction site by drum sheet or Tarjja of any other fencing			
		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			
1.4	Water Quality	Fencing the construction site by drum sheet or Tarjja			

SL	Category	Measures	Due Diligence		Remarks
			Complied	Not complied	
	Controlling	of any other fencing			
		Arrangement of runoff drainage for reducing any water logging			
		Location of backfilling stockpile in safe area and protected from wind and rain action			
		No storing of backfilling materials/spoil stored on river bank/slope			
		No disposal of waste and untreated waste water to river or canal			
1.5	Waste Management System	Provision of onsite waste management system			
		Disposal of waste and treated waste management in a designated area/canal/channel			
		No burning of solid waste			
1.6	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 shiftable structures			
		Retention of salvageable materials?			
		Compensation for loss of trading income?			
		One time moving assistance			
		Grant to cover loss of regular wage income			
		Provide/take extra care/caution for the disadvantaged/vulnerable group/s (i.e. women, children, widow, ethnic minorities, indigenous people			

SL	Category	Measures	Due Diligence		Remarks
			Complied	Not complied	
		etc.)			
		Provision of monitoring the compensation and resettlement process			
1.7	Livelihood and living	No impacts on livelihoods living standards which has been consider in Social and Monitoring Plan			
		Development of policy which prioritizes the local labourers in employment opportunities			
		Proper management of Project traffic sign, speed limit signal etc.			
		Provision ofseparate water and sanitation facilities for the construction workers in the project area.			
1.8	Others	Carry out technically and financially feasible alternative study			
		The Project concerned about local heritage or culturally important site.			
		If yes, has the company taken/will the company take any mitigative measures?			
		Are the mitigative measures satisfactory?			
		Will the project disturb any ecologically critical area?			
		If yes, has the company taken/will the company take any mitigative measures?			
		Are the mitigative measures satisfactory?			
1.9	Green House Gas Controlling Measures	Use of efficient machineries 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 of machines/equipments/generators which are not in use			

SL	Category	Measures		Due Diligence		Remarks
				Complied	Not complied	
PS 2.Labour working Condition						
2.1	Safety Management	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				
		Preparation and Follow of Emergency Response Plan				
		adequate fire precautions in the project area.				
		extinguishers, escape routes)				
		documentation and reporting of occupational accidents, diseases, and incidents				
		policies and procedures for				

SL	Category	Measures		Due Diligence		Remarks
				Complied	Not complied	
		managing and monitoring the performance of third party employers in relation to OHS				
2.2	Workers Well Being	Establishment Grievance Mechanisms				
		Ensuring fair treatment, non discrimination and equal opportunity				
		Compliance of project's labour policy with the national labour law				
		No Child Labour				
		No incident of forced labour				
		Provision of Welfare facilities for Worker/Labour				
PS 4. Community Health, Safety and Security (Construction Phase)						
4.1	Community Safety and Security	Installation/Construction of Safety Fence around the project area				
		Risks and impacts on the health and safety of the community (i) before construction (ii) during construction, (iii) after construction				
		Engagement of Community in Risk Assessment Process				
		Consideration of Community Health and Safety in Designing infrastructure and equipments				
		Establishing Risk Based Criteria for Assessment of Community Health and Safety of Power Plant				
		Practicing safe management for hazardous materials which may pose threat to the community				
		Available common natural hazards				

SL	Category	Measures	Due Diligence		Remarks
			Complied	Not complied	
		in the community			
		Availability Emergency Response Plan by EPC contractor			
		Maintaining open communication channel with the local community			
		training and instruction to the security personnel about their behaviour and communication with the local people			
		Aware the security personnel about the right of the community people			
		Respect between Project security personnel and community people			
		Social conflict diminish mechanism for the community dwellers			
4.2	Community Health	Provision of providing health service facilities to community if the project posses any health risk like sexually transmitted disease, communicable disease, vector-related			
4.3	Youth Empowerment	Providing training program for the local youth potential to get involved in the project related activities.			
4.4	Public Communication, Consultation and Awareness	Disclosure of EIA Report			
		Organised stakeholder consultation meeting			
		Sharing of project information shared with local people,			
		Organizing environmental and social awareness programs/meetings			
PS 6. Biodiversity and Sustainable Management of Living Natural Resources (Construction Phase)					

SL	Category	Measures	Due Diligence		Remarks
			Complied	Not complied	
6.1	Management of Impacts on Fisheries	Conduction of construction work and dredging during fish breeding season (June-August)			
		Use of sediment fences, traps and basins for trapping the sediment, if required			
		Installation of proper run on/runoff drains			
		Availability of dispersants for controlling accidental oil spillage			
6.2	Management of Impacts on Birds Habitat	Steps to protect birds' habitats in project areas, if the construction activities impact bird colony, habitat			
		Introduce bird conservation program (if the construction activities impact bird colony)			
6.3	Conservation of Ecosystem	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			
		Creation any alternate passage for wildlife movement (if required)			
		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			

SL	Category	Measures		Due Diligence		Remarks
				Complied	Not complied	
		No plantation of non-native species				
		Retaining top soil for future habitat restoration				
		No degradation of critical habitat?				

Annex II: Photo Album

Environmental Monitoring of Rampal PP (January 2015)

Team Composition

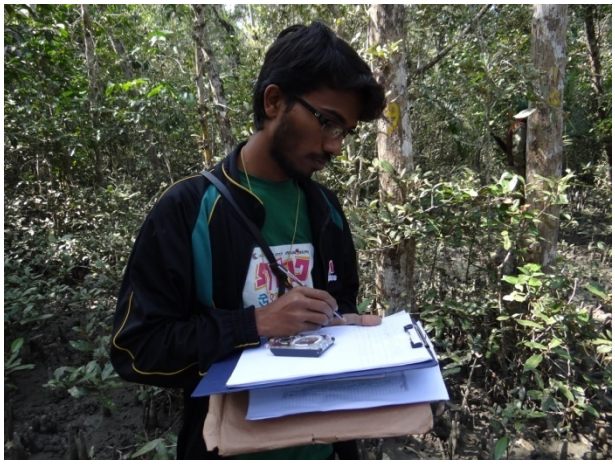
Organizing the Layout of sampling sites at Karamjal and Harbaria

Estimating Canopy density by Densiometer

Measuring DBH of tree at Karamjal and Akram Point sites

Measuring Sapling DBH

On site Air quality sampling at Akram Point



Record tree information at Harbaria

Checking previous data

Measuring tree height with The Haga altimeter

Taking measurement of standing dead tree stem

Counting pneumatophores and crab holes at Akram Point

Collecting of soil samples from forest ground

Observing Foliage health at Akram Point

Measuring Woody debris at Hiron Point

Fish Catch Assessment at Passur River

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

Monitoring Parameter	Indicators
	Total Hardness, Hg, NO3 and PO4
	River Morphology,
	Tidal inundation
	Drainage Network
	Erosion and Accretion
	Ground water quality
Air quality	SOx
	NOx
	SPM (PM10 and PM2.5)
	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.