Monitoring Report of Third Quarter, First 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

November 2014.

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Monitoring Period: September 2014 – October 2014

Bangladesh – India Friendship Power Company (Pvt.) Limited

(A joint Venture of NTPC Ltd and BPDB)

SUBMITTED BY

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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.

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. Accordingly, the report on first quarter monitoring was submitted in April 2014 and the second quarter monitoring was submitted in August 2014. Following the monitoring schedule, the third quarter monitoring activities were carried out in the field in two phases, first in 20 September to 3rd October and second from 15 October 2014 to 29 October 2014.The third quarter 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 ambient transportation condition
- 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:

- Land development of the remaining 580 acre of land
- Construction of Embankment around the Project site
- Construction of Boundary wall
- Construction of 2 x 200 KV Transformers
- Construction of pre-fabricated site office
- Installation of Drinking Water supply Facilities, etc.

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.

Air Quality Monitoring

Similar to the earlier quarter monitoring, ambient air quality has been monitored at the same 11 locations. Prevailing wind direction was same, South-East, as of first quarter monitoring. During third quarter monitoring weather was sunny in daytime and fog was observed in morning. In this quarter concentration of SO_2, NO_2, $PM_{2.5}$, PM_{10} and SPM were found within the standard in most of the locations. Only in Pankhali and at Khan Jahan Ali Bridge, SMP concentration was found above the standard.

Noise Monitoring

Ambient noise was monitored at the same 11 locations as of first quarter monitoring. Similar to the earlier noise monitoring results, this time noise level was found above the standard in Sundarbans. Wind action on trees, river wave, bird's chirping, ship and fishing boats, etc are the source of noise observed in Sundarbans.

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. Once the laboratory analysis report of this quarter is available, it will be submitted BIFPCL. However, the earlier laboratory reports were provided in chapter 5.

Transportation Monitoring

Transportation monitoring included monitoring of traffic volume in Khulna-Mongla high way and access road to Project site at the same five locations as of earlier quarter monitoring. This time traffic volume was found higher than earlier in morning and afternoon.

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

The existing cropping pattern was found during monitoring as Fallow – HYV Aman/Local Aman-Fallow in three monitoring plots out of five. No crop damage was found in agricultural resources monitoring.

Fisheries Monitoring

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

- Seasonal variation in classification of habitats

- As per Jaccard similarity index the length frequency of different fish species were more homogenously distributed among the sampling sites in case of third quarter monitoring phase in the month of October than that of first and second quarter monitoring
- Evenness in fish diversity (as defined by Shannon-Weiner Index) is almost homogenous from down stream to up stream. River condition, food availability and spawning migration are the possible reasons for this.
- Fish species richness (FSR) varies at different locations. Poma, Phessa, Bele, Banshpata, Tapsi, Hilsa, Golda and different prawnp are dominating species in upstream of Sundarbans. And Tapsi, Bele, Chewa, Loitta, Chela, Chanda Chela and Motka chingri are dominating species in the Sundarbans.
- Among migratory fish species Poma, Lal Chewa and Gang Tengra are dominating migratory species. Among the migratory species, Hilsa, Poma and Banshpata migrate long range for their spawning and feeding behaviour.
- As found in the second quarter monitoring phase, the highest productivity has been found in Sheola Khal at Chandpai of Passur River System. But lowest productivity has been found in Akram point of Passure River. Moreover, as expected higher productivity was observed in the third monitoring phase as compared to that of the second monitoring.
- In case of shrimp/fish farm, the highest production comes from the shrimp farm of Chunkuri-2 and lowest from that of Bhekatkhali. Moreover, the production from all the sampling Ghers is higher in third monitoring phase as compared to the first two consecutive monitoring phases.

Ecosystem and Biodiversity Monitoring

Plant health, plant canopy cover, lichen cover, bird habitat and dolphin occurrence have been monitored for this monitoring season. Homestead plants were followed improved in terms of overall heath situation. Nevertheless, coconut and date palm has sighted unhealthy of all at Rajnagar and Chalkghona village. Canopy status of the sample homestead vegetation remains unchanged except Chalkghona. Lichen coverage showed in decreasing for most of the plant barks. No bird nest was found at examined homesteads.

A total of 28 butterfly species have been recorded from the study area. Rice Swift, Common Crow, Grass-yellow, Common Emigrant, Blue Tiger are the common butterflies of the study area frequently found in the study area.

Dolphin occurrences follow an increasing trend at Passur river along Project site. A total of 13 individuals of Ganges River dolphin has sighted during transect survey and river confluence point shows highest occurrence. This aquatic mammal was also found at Maidara River and other monitoring locations of Passur River near Karamjal and Harbaria.

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.

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. However, local people made statement in other way. 56% of the surveyed HHs stated they received full compensation which was 47% in earlier monitoring and 44% claimed they did not receive full compensation money.

Rehabilitation and Resettlement

In general, local peoples are not satisfied with rehabilitation and resettlement process. DC office gives priority to the evicted HHs from the acquired area in Government's shelters (gucchhogram).

Health

During survey, local peoples ranked Influenza/fever as highest occurring disease. In general, Fever, Cough/cold, hypertension, Gastric, etc are common diseases. Skin disease and Asthma were ranked as lowest occurring diseases.

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.

Community Health, Safety and Security

BIFPCL runs weekly health camps for locals. Construction of safety wall around the Project site is in progress. An *Ansar* Camp has also been established in the Project site for ensuring security.

Livelihood and occupation

In this quarter, more peoples were found engaged in agriculture, fishery and service than earlier.

Income

Average Households income was found little bit higher in this quarter.

Migration

In this quarter, 2% In-migration was found in the project nearby areas. Employment opportunity in BIFPCL's project influences people to in-migrate.

Corporate Social Responsibility

BIFPCL runs free weekly health camp for local people. The health camp offers free health consultation and limited medicine.

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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

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 during first and second quarter was carried out during the period in March 2014 - April 2014 and June 2014 – July 2014. The Monitoring Reports were submitted in May 2014 (First Quarter) and August 2014 (Second Quarter). Followed by the second quarter monitoring, the third quarter monitoring period was September 2014 – October 2014. The field monitoring activities have been carried out from 28th September to 2nd October 2014 and 15 October to 29 October 2014.

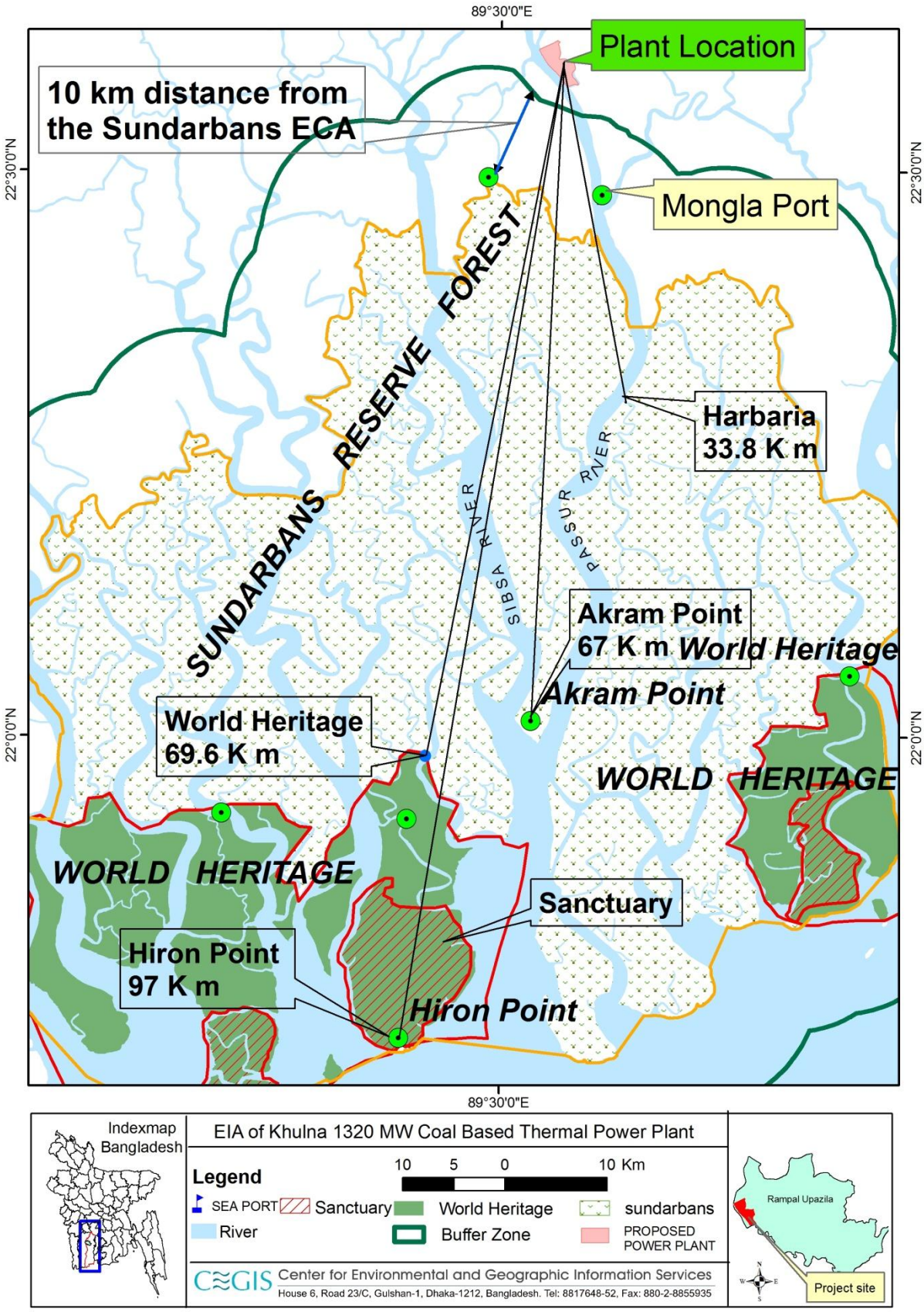
1.2 Objectives of third Quarter Monitoring

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.

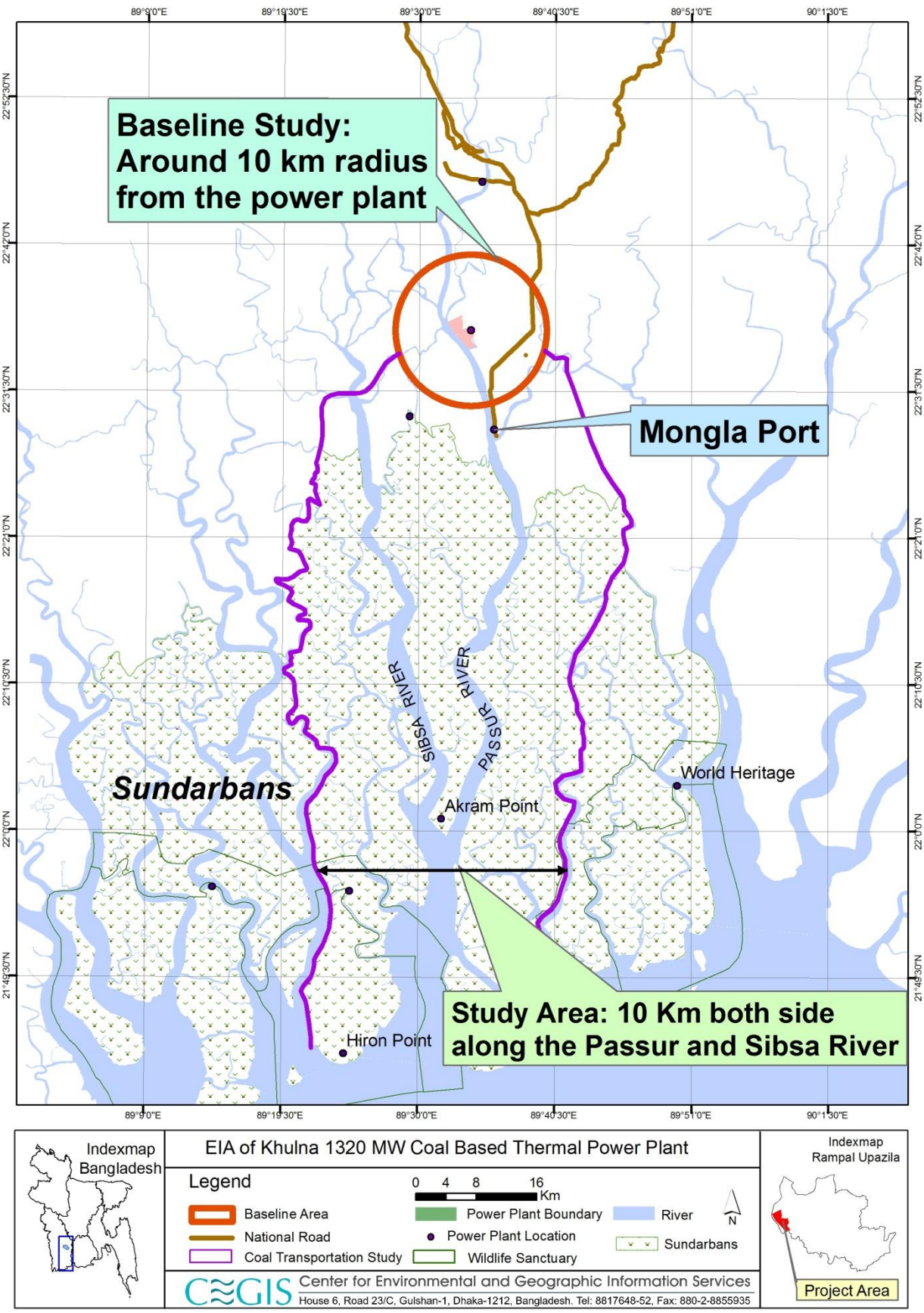
4. The aim of this third quarter monitoring is to monitor the ambient state of environment that will be the baseline to compare the environmental condition in future when the Power Plant will be in operation phase. The third quarter monitoring activities also include monitoring of environmental compliance of power platn 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 **Map1.1**. The study area includes: i) area of 10 km radius from the Plant location, ii) 10km strip from the both bank of Passur and Sibsa rivers starting from Plant site to Hiron point (**Map 1.2**).



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



Map1.2: Area under the Interest of Environmental and Socio-economic Monitoring

1.4 Collaboration with Forest Department

6. The monitoring 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, Ingrowth (Seedlings), Diseases and Pests (if necessary carry out laboratory analysis),
- Monitroing of Soil Nutrients (macro, Micro) and Heavy Metals,
- Monitroing of Floral Diversity, Species Richness and Dominancy,
- Above ground and below ground carbon measurement, and
- Impacts on Canopy Cover, Leaves Phenology, Flowers Behaviour, Pneumotaphore Condition

8. As per the condition of the Forest Department, the monitoring team was formed. BIFPCL also forwarded a copy of second quarter monitoring report to the Chief Conservator of Forest, Bangladesh Forest Department, Agargaon, Dhaka and Conservator of Forest, Khulna Circle, Boyra, Khulna. Similarly this third quarter monitoring report will also be forwarded to the Forest Department.

2 Monitoring of Environmental Compliance during Pre-construction Activities

2.1 Background

9. 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. At present the following activities are in progress:

- Land development of the remaining 580 acre of land
- Construction of Embankment around the Project site
- Construction of Boundary wall
- Construction of 2 x 200 KV Transformers
- Construction of pre-fabricated site office
- Drinking Water supply, etc.

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 Labor 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 Dilligence
1	Generation of Dust from • land filled area • the area under land development process, and	• 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 in progress
2	Generation of Noise (moderate) from • Dredgers and sand carrying vessels involved in land filling activities • Excavator and other machineries involved in land leveling and site development • Other machineries e.g. brick crashing, piling, etc • Generator	• 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 • However, the conventional dredgers used in land filling activities are producing huge noise at project site.
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	• 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

		• Switching off and throttling of machines/equipments/generators which are not in use	• Lack of regular maintenance of vehicles, generator and machinery in accordance with manufacturer's specifications
4	No 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 materials/spoil stored on river bank/slope • No disposal of waste and untreated waste water into the river	• Complied • Construction of runoff drainage system in the land filled site is in progress • All the stockpiles are protected from wind and rain actions • No storage of backfilling materials/construction materials on river slope • No disposal of waste into the river •
5	Waste gereration	• 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 • Labors use open toilets • spiling from toilet pit was noticed
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 • 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

Table 2.2: Monitoring Labor and Working Condition

Sl No	Issue	Measures	Remarks on Due Dilligence
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 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	• 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 • Workers have access to weekely Health Camp running by the project authority

2	Workers Well Being	• Establishment Grievance Mechanisms • Ensuring fair treatment, non discrimination and equal opportunity • Compliance of project's labor policy with the national labor law • No Child Labor • No incident of forced labor • Provision of Welfare facilities for Worker/Labor	• Labors have been engaged by third party • No complain about unfair treatment, discrimination were found • Involvement of public representative in selecting labor for the third party has two fold impacts. Their involvement ensures that the labor to be recruited is local. But some locals were blaiming them for political biasness • No child labors and forced labor were found

Table 2.3: Monitoring Community Health, Safety and Security

Sl No	Community Issue	Mitigation Measures	Remarks on Due Dilligence
	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 the local community • training and instruction to the security personnel about their behavior and communication with the local people • Aware the security personnel about the right of the community people • Establishing a grievance mechanism for the community dwellers	• Partially complied. The project construction is at very initial stage. The grievence 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 recruited mobilized a social worker to maintain liason with local community and to deal different social issues.
	Community Health	• Provision of providing health service facilities	• Complied. The BIFPCL has initiated weekly

		to community if the project posses any health risk like sexually transmitted disease, communicable disease, vector-related	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
	Youth Empowerment	• Providing training program for the local youth potential to get involved in the project related activities, (If yes, please write down the number of the people received training in the remarks section)	• No such training has been initiated. However, the project authority is encouraging the locals through different meetings, 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 dissiciminate project information and aware local about different environmental and social issues. • The public communication is also maintained thorugh organizing regular health camp at site.

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

Sl No	Impacts	Mitigation Measures	Remarks on Due Dilligence
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 for controlling accidental oil spillage • Avoiding fish breeding season (June – August) for sand extraction from river bed	Partially complied as: • Construction of boundary wall is in progress • Construction/installation of proper run on-run off drains are in progress • No dispersants are available at site office to mitigate oil spillage (if happen)
2	Impacts on Ecosystem Habitat	• No cutting/ felling of trees existing along the river bed • No anchrochment 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 monitoinrg ecosystem health and Sundarbasn Forest Health ensure the compliance to DoE's condition

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 labor at project site to take rest during day time


Temporary Labor Shed for Night Stay


Running of Health Camp at Project site office under CSR Program

Donnating in different relisious and social programm under CSR program

Construction of alternative Access Road by LGED

3 Air Quality Monitoring

3.1 Methodology

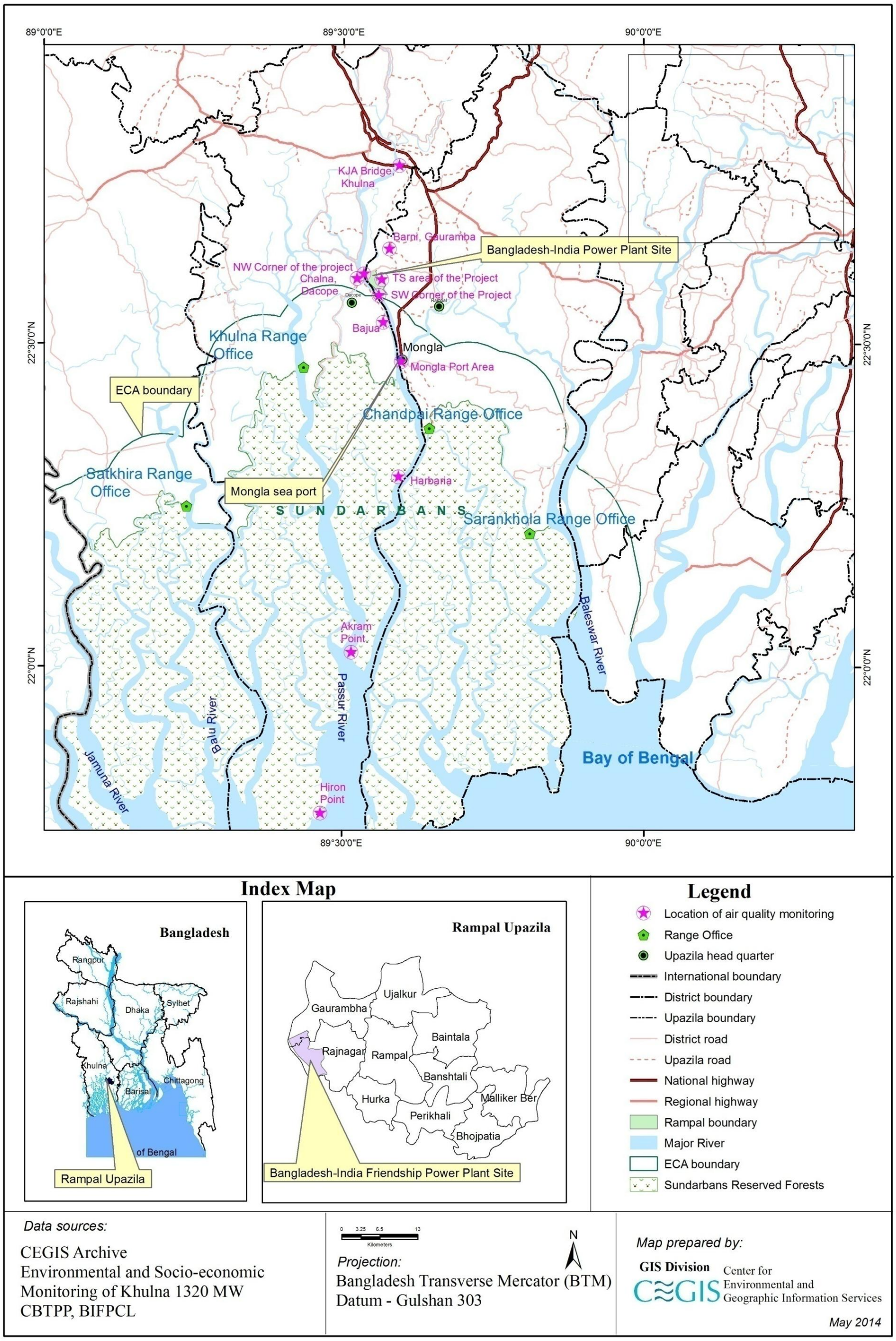
13. With the aim of monitoring the impact of the emission of particulate matter and gaseous pollutants from the Power Plant related activities, $PM_{2.5}$, PM_{10}, SOx, and NOx concentration in the ambient air, have been considered as parameter of monitoring. With relation to the Project related activities, 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

14. 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 PM2.5, 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

15. Ambient air quality has been monitored during this thrid quarter monitoring phase in the same locations as moniotored in earlier quarter. The locations of the air quality monitoring points have been shown in **Map 3.1**.



Map 3.1: Air Quality Monitoring Locations

3.2 Results of air quality monitoring

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

16. $PM_{2.5}$ and PM_{10} were found within the standard limit at each location. SPM was found exceeding the standard level at the Khan Jahan Ali Bridge. High traffic might be the source of SPM there. In Mongla, SPM was found very close to the standard. Industires especially Cement Industries, road traffic and on going dredging operation of of Mongla Port Authority in Passur river might be the sources of SPM there. All the monitoring data of ambient air quality are given in **Table 3.1.**

3.2.2 SO_2

17. Concentration of Sulfur 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 12 to 14 µg/m^3. In other areas, SO_2 varies in between 19 µg/m^3 to 28 µg/m^3. All the monitoring data of ambient air quality are given in **Table 3.1.**

3.2.3 NO_2

18. Similar to SO_2, NO_2 concentration in the ambient air of Sundarbans was found very low, varyin from 19 - 27 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, 41 µg/m^3, at Khan Jahan Ali Bridge. The monitoring results are shown in **Table 3.1**.

3.2.4 CO and O_3

19. CO and O_3 concentrations are also very low. CO concentration ranges from 110 µg/m^3 to 330 µg/m^3 in Project area and its adjoining areas, while in Sundarbans the concentration ranges 50 µg/m^3 to 70 µg/m^3.

Table 3.1: Ambient Air Quality Monitoring Results

Locations of Monitoring	Pollultants	1st QM, April 2014	2nd QM, July 2014	3rd QM, October 2014	4th QM, January 2015	5th QM, April 2015	6th QM, July 2015	7th QM, October 2015	8 QM, January 2016	9th QM, April 2016	10th QM, July 2016	11th QM, October 2016	12th QM, January 2017	Bangladesh (DoE) Standard for ambient Air (ECR 2005)	IFC/WB Standard
Weather		Sunny	Rainy/ Cloudy	Sunny											
Wind Direction		SE	SE	SE											
		Concentrations are in µg/m^3													
SW Corner of the PP area	$PM_{2.5}$	33	37	25										65	75
	PM_{10}	78	77	53										150	150
	SPM	207	239	190										200	NF

Locations of Monitoring	Pollultants	1st QM, April 2014	2nd QM, July 2014	3rd QM, October 2014	4th QM, January 2015	5th QM, April 2015	6th QM, July 2015	7th QM, October 2015	8 QM, January 2016	9th QM, April 2016	10th QM, July 2016	11th QM, October 2016	12th QM, January 2017	Bangladesh (DoE) Standard for ambient Air (ECR 2005)	IFC/WB Standard
Weather		Sunny	Rainy/ Cloudy	Sunny											
Wind Direction		SE	SE	SE											
		Concentrations are in µg/m^3													
	SO_2	21	24	19										365	125
	NO_x	26	29	27										100	200
	CO	120	188	140										40000*	NF
	O_3	27	26	19										160*	160
Proposed Township area of the PP	$PM_{2.5}$	39	48	48										65	75
	PM_{10}	89	90	74										150	150
	SPM	217	263	217										200	NF
	SO_2	19	28	22										365	125
	NO_x	29	39	27										100	200
	CO	165	210	230										40000*	NF
	O_3	33	26	26										160*	160
NW Corner of the PP area	$PM_{2.5}$	37	44	19										65	75
	PM_{10}	67	78	56										150	150
	SPM	234	217	157										200	NF
	SO_2	19	22	18										365	125
	NO_x	23	28	22										100	200
	CO	110	178	110										40000*	NF
	O_3	25	19	17										160*	160
Barni, Gauramba	$PM_{2.5}$	39	47	57										65	75
	PM_{10}	103	122	67										150	150
	SPM	233	244	183										200	NF
	SO_2	21	23	17										365	125
	NO_x	25	28	22										100	200
	CO	175	210	190										40000*	NF
	O_3	26	29	22										160*	160

Locations of Monitoring	Pollultants	1st QM, April 2014	2nd QM, July 2014	3rd QM, October 2014	4th QM, January 2015	5th QM, April 2015	6th QM, July 2015	7th QM, October 2015	8 QM, January 2016	9th QM, April 2016	10th QM, July 2016	11th QM, October 2016	12th QM, January 2017	Bangladesh (DoE) Standard for ambient Air (ECR 2005)	IFC/WB Standard
Weather		Sunny	Rainy/ Cloudy	Sunny											
Wind Direction		SE	SE	SE											
		Concentrations are in µg/m^3													
Chunkuri-2, Dacope	$PM_{2.5}$	35	39	46										65	75
	PM_{10}	77	86	69										150	150
	SPM	117	113	162										200	NF
	SO_2	19	24	21										365	125
	NO_x	23	26	27										100	200
	CO	190	205	170										40000*	NF
	O_3	27	24	18										160*	160
Pankhali, Dacope	$PM_{2.5}$	47	49	57										65	75
	PM_{10}	119	127	139										150	150
	SPM	297	266	254										200	NF
	SO_2	28	31	31										365	125
	NO_x	41	39	36										100	200
	CO	230	217	250										40000*	NF
	O_3	49	38	36										160*	160
Mongla Port area	$PM_{2.5}$	47	55	39										65	75
	PM_{10}	139	174	77										150	150
	SPM	288	303	197										200	NF
	SO_2	27	28	26										365	125
	NO_x	44	39	33										100	200
	CO	230	320	220										40000*	NF
	O_3	57	52	37										160*	160
Harbaria, Sundarbans	$PM_{2.5}$	19	22	33										65	75
	PM_{10}	41	39	59										150	150
	SPM	111	117	129										200	NF
	SO_2	9	10	14										365	125

Locations of Monitoring	Pollultants	1st QM, April 2014	2nd QM, July 2014	3rd QM, October 2014	4th QM, January 2015	5th QM, April 2015	6th QM, July 2015	7th QM, October 2015	8 QM, January 2016	9th QM, April 2016	10th QM, July 2016	11th QM, October 2016	12th QM, January 2017	Bangladesh (DoE) Standard for ambient Air (ECR 2005)	IFC/WB Standard
Weather		Sunny	Rainy/ Cloudy	Sunny											
Wind Direction		SE	SE	SE											
		Concentrations are in µg/m^3													
	NO_x	19	22	27										100	200
	CO	65	58	70										40000*	NF
	O_3	13	12	13										160*	160
Akram Point Sundarbans	$PM_{2.5}$	17	19	23										65	75
	PM_{10}	39	44	32										150	150
	SPM	114	133	97										200	NF
	SO_2	7	9	12										365	125
	NO_x	17	19	22										100	200
	CO	49	60	50										40000*	NF
	O_3	11	14	9										160*	160
Hiron Point Sundarbans	$PM_{2.5}$	15	23	19										65	75
	PM_{10}	44	38	34										150	150
	SPM	101	119	107										200	NF
	SO_2	8	7	13										365	125
	NO_x	18	18	19										100	200
	CO	52	62	65										40000*	NF
	O_3	14	13	11										160*	160
Khulna City, near Khanjahan Ali Bridge	$PM_{2.5}$	54	39	52										65	75
	PM_{10}	139	117	91										150	150
	SPM	301	287	239										200	NF
	SO_2	33	29	33										365	125
	NO_x	49	41	39										100	200
	CO	330	370	330										40000*	NF
	O_3	59	67	57										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 (NOX). Sulphur Di-Oxide (SO2), 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

20. 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

21. Mostly river traffics of Mongla Port area traveling across the Sundarbans are the sources of Suspended Particulate Matter *(*SPM), Oxides of Sulfur (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 3.2**.

Table 3.2: Baseline Emission Inventory

		Cement Industry	Petrolium Industry	Brick Field	Road Traffic	Small vessels, engine boat	Inland Water Cargo vessel	Sea going Mother Vessel (MV)	Flyash Carrier	Klinker 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, Gauramba	PM	✗	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✓
	SOx	✗	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓
	NOx	✗	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓
	GHGs	✗	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓
Chunkuri-2, Dacope	PM	✓	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓
	SOx	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓
	NOx	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓
	GHGs	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓

		Cement Industry	Petrolium Industry	Brick Field	Road Traffic	Small vessels, engine boat	Inland Water Cargo vessel	Sea going Mother Vessel (MV)	Flyash Carrier	Klinker 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
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	✕	✕	✕	✕	✓	✓	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕
Khulna City, near Khanjahan Ali Bridge	PM	✓	✕	✓	✓	✓	✓	✕	✓	✓	✓	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✓	✓
	SOx	✕	✕	✓	✓	✓	✓	✕	✓	✓	✓	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✓
	NOx	✕	✕	✓	✓	✓	✓	✕	✓	✓	✓	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✓

		Cement Industry	Petrolium Industry	Brick Field	Road Traffic	Small vessels, engine boat	Inland Water Cargo vessel	Sea going Mother Vessel (MV)	Flyash Carrier	Klinker 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	✕	✕	✓	✓	✓	✓	✕	✓	✓	✓	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✓

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

4 Noise Monitoring

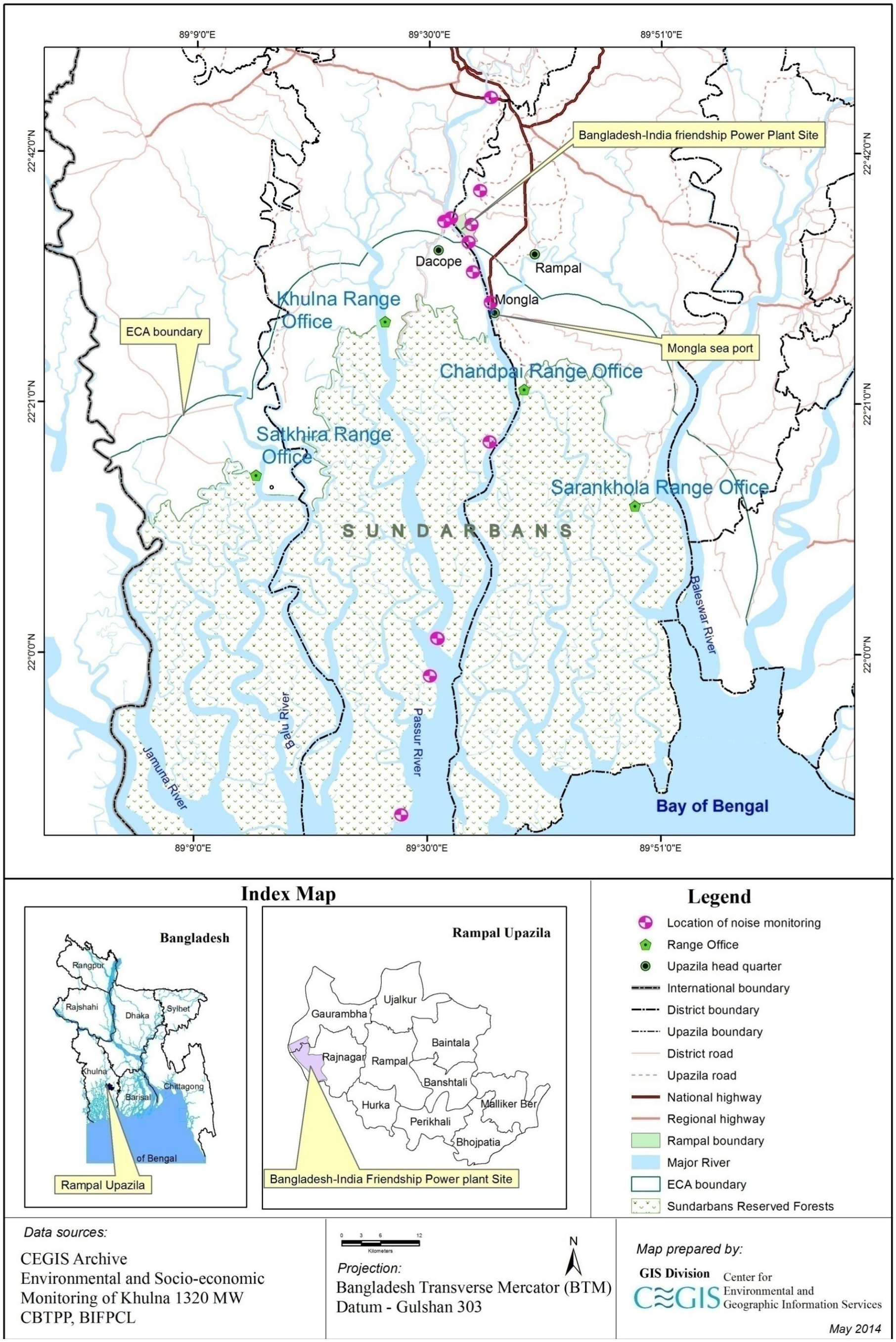
4.1 Methodology

22. 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 intervals 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

23. 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 Khanjahan Ali Bridge and one is at Mongla Port (Map 4.1).



Map 4.1: Noise Moniotring Locations

4.3 Results of Noise Monitoring

4.3.1 Noise at Dacope Upazila Parishad

24. 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 monitoring data shows that noise level of third quarter monitoring are higher than the noise level of second quarter but still are within the standard (Table 4.1).

25. There, the significant noise sources were road traffic and people's crowd. The road traffics were mostly from locally made engine van (locally called as Nosimon), motor bike, easy bike (battery operated tri-cycle), etc. Traffic load was comparatively lower than that of first quarter monitoring due to rain fall that eventually resulted the less noise.

4.3.2 Noise at North West Corner of the Project Area

26. The North West (NW) corner of the Project area falls in Kaigar daskati mouza of Gauramba union. The monitoring location was nearby Gucchagram (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 due to rough weather the noise level could not be monitored during the field visit.

4.3.3 Noise at Chunkuri-2, Bajua

27. This area is classified as residential where the standard maximum ambient noise level is 50dB (A) at day time (ECR, 1997). Similar to first quarter monitoring, noise levels during the second quarter monitoring were also found exceeding the standard limit (**Table 4.1**). The significant noise sources are 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

28. 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, 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

29. 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 first quarter monitoring, noise levels were within standard limit in this quarter monitoring also (**Table 4.1**).

4.3.6 Noise at Barni, Gaurambha

30. 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 a little bit higher than the

standard noise leve during morning and day, however, the average noise level was found within the standard level. Though this area falls under rural classification, the commercial activities like bazaar, local traffic, crowd etc are increasing.

4.3.7 Noise at Khan Jahan Ali Bridge, Khulna

31. The monitoring location is near 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 the noise levels were found within the standard limit. Here the road traffic is the main source of noise. In the day of monitoring, Noise was found higher during morning and evening where traffic load was also higher. In morning, the noise was found above the standard. It is expected, this road will be busier in coming days due to increase of port activities.

4.3.8 Noise at Mongla Port area

32. 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 3rd quarter monitoring noise levels were found within the standard level.

33. 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

34. 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. The ambient noise levels were found above the standard. Ships movement, Ship Salvage operation, engines of anchored ships, wind, birds, wave, and wicn action on tree leaves were the main sources of noise in this locaion.

4.3.10 Noise at Akrampoint, Sundarbans

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

4.3.11 Noise at Hiron Point, Sundarbans

36. Hiron point falls under wildlife sanctuary zone of Sundarbans. As per the Noise Control Rules, 2006, the appropriate standard for this zone would be 45dB(A). Noise level was recorded during morning only. The ambient noise level was found above the standard limit. Birds, stormy wind, wave breaking on the sandy shore and tree leaves are the main sources of noise here.

37. The recorded noise was above the standard level. High wave breaking on the shore was the main source of noise.

Table 4.1: Summary of the ambient noise monitoring

Sl No	Location	QM1 (Noise Level in dB (A))				QM2 (Noise Level in dB (A))				QM3 (Noise Level in dB (A))				Std*
		Morning (9:00)	Afternoon (13:00)	Evening (18:00)	Day time AVG	Morning (9:00)	Afternoon (13:00)	Evening (18:00)	Day time AVG	Morning (9:00)	Afternoon (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	57.00	54.63	70.00
2	NW Corner of the Project area	55.23	53.00	47.43	51.89	NM	NM	NM	NM	42.67	41.73	41.37	41.92	50.00
3	Chunkuri-2, Bajua	62.69	57.19	53.39	57.76	54.61	51.14	51.90	52.55	52.26	51.14	50.76	51.39	50.00
4	SW corner of the project area	49.20	NM	NM	49.20	44.55	48.94	49.33	47.60	45.56	45.10	47.18	45.95	50.00
5	Proposed Township area, project site	47.80	49.70	NM	48.75	46.15	47.21	NM	46.68	42.67	41.73	41.37	41.92	50.00
6	Barni, Gauramba	64.95	50.93	60.65	58.84	48.73	50.37	50.75	49.95	50.18	50.89	48.27	49.78	50.00
7	Khan Jahan Ali Bridge, Khulna	76.12	66.72	72.25	71.70	55.97	64.68	61.75	60.80	72.24	58.30	68.30	66.28	70.00
8	Mongla Port area	69.38	54.55	59.79	61.24	54.75	54.20	52.58	53.84	66.80	55.20	59.50	60.50	75.00
9	Harbaria, Sundarbans	39.24	NM	42.51	40.88	59.25	60.52	48.62	56.13	54.08	56.51	NM	55.30	45.00
10	Akram Point, Sundarbans	40.95	41.98	39.90	40.94	48.95	46.86	NM	47.90	45.27	42.69	NM	43.98	45.00
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	45.00

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

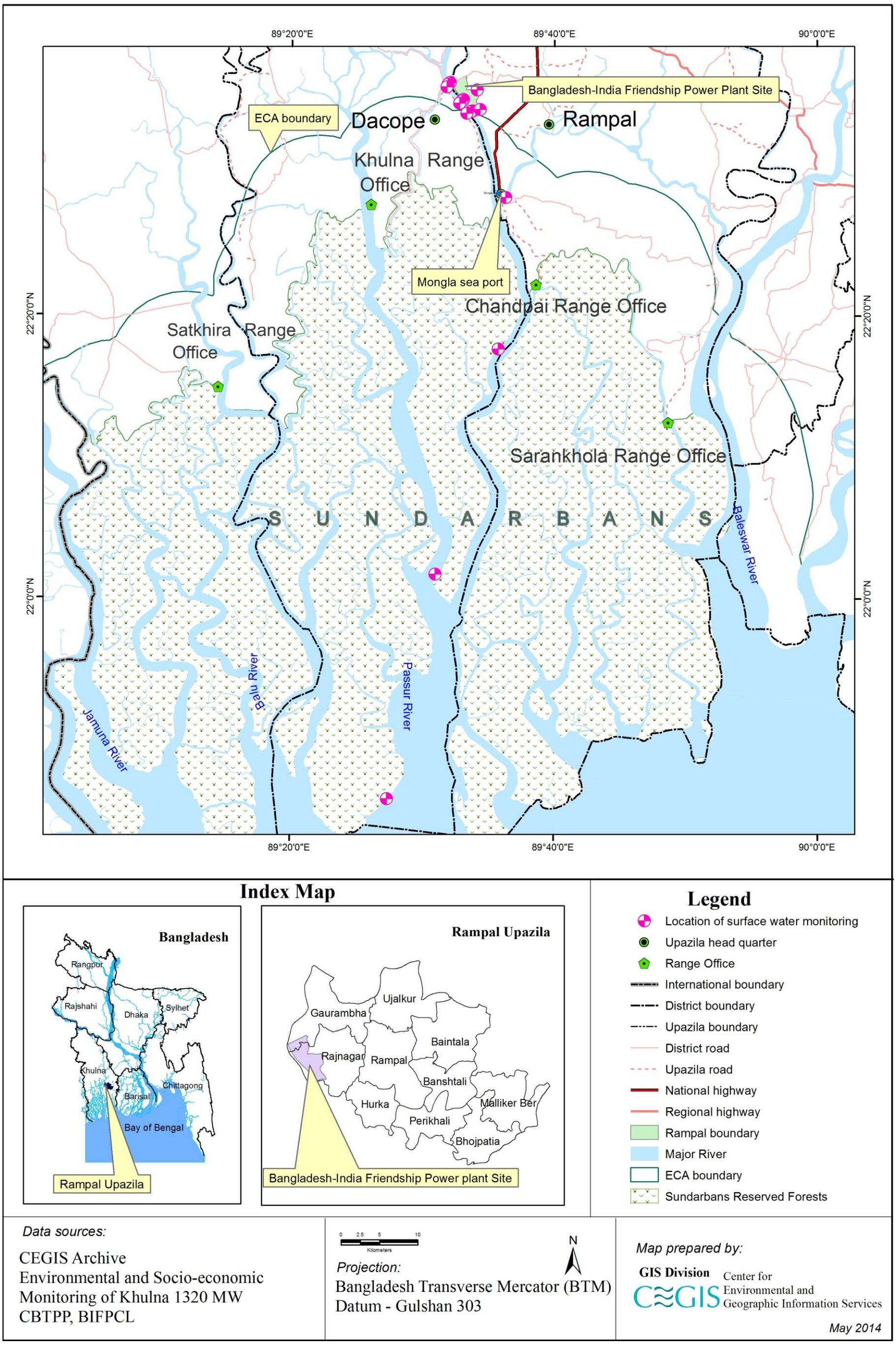
5 Water Quality Monitoring

5.1 Methodology

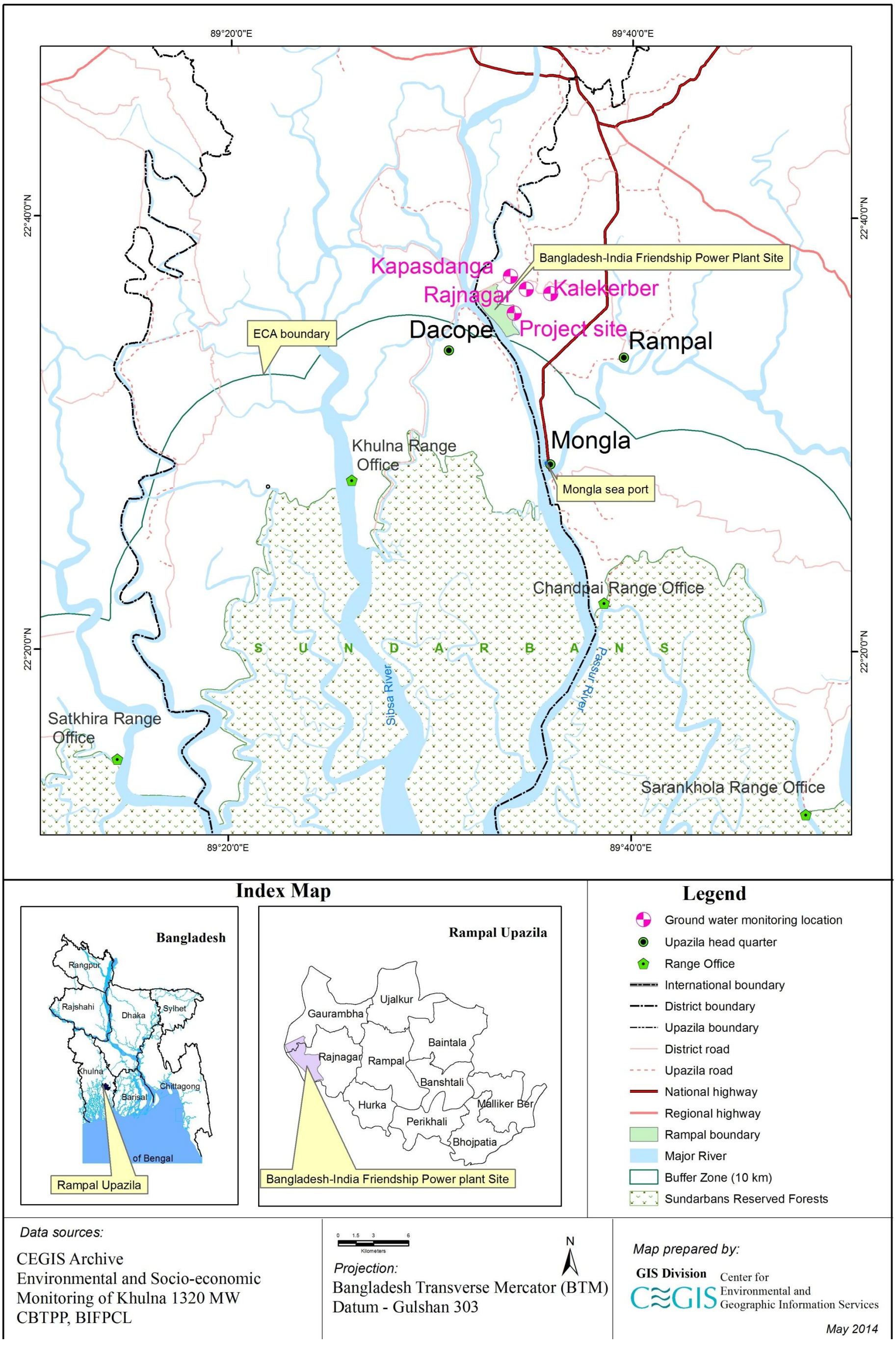
38. Monitoring of water quality directly depends on selection of water quality parameters, sampling points, sampling frequency, evaluation criteria etc. Standard practices have been followed for monitoring of water quality of Passur Sibsha River System (RS). This study is measuring both surface and ground water quality parameters to reveal the present water quality status in the surroundings of Rampal Power Plant and the Sundarbans. Monitoring will be carried out at every three months interval (quarterly) and first, second and third monitoring was performed in April, July and October 2014 respectively. As a part of entire monitoring activities, sample collection for third monitoring schedule was started from 19th to 27th October this year. In future, the same parameters in the same area will be monitored as per the monitoring schedule to observe the changes (if any). In order to establish a strong baseline, the water quality monitoring results are not only been presented but also have been compared with the national and international standards.

5.2 Sampling Location

39. Similar to the first and second quarter 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. In future, samples will be collected from the same location as well.



Map 5.1: Surfacewater Quality Monitoring Locations



Map 5.2: Groundwater Quality Monitoring Locations

5.3 Sampling Procedure

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

41. 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 sampling samples were collected from the river surface.

42. 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. Acidified sampling bottles were used for heavy metal (As, Hg, Pb) sampling and wrinkle bottles were used for BOD_5 sampling. Samples were preserved as per standard practices.

43. 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

44. The selected parameters for water quality monitoring includes Dissolved Oxygen (DO), Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Heavy Metals (As, Hg, Pb), pH, Salinity, Hardness, Nitrate (NO_3), Total Dissolve Solids (TDS), Total Hardness (TH), Turbidity, Temperature, 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.

Table 5.1: Surface Water Quality Monitoring Parameter and Location

Parameters	Locations of Sampling
DO, BOD, COD, Heavy Metals (As, Hg, Pb), pH, Salinity, Hardness, NO_3, PO_4, SO_4, TDS, Temperature, Oil and Grease	1. Right Bank of Passur River at 100m u/s of North West corner from the Project boundary 2. Middle of the Passur River at 100m u/s of North West corner from the Project boundary 3. Left Bank of Passur River at 100m u/s of North West corner from the Project boundary 4. Right Bank of Passur River at the Jetty location of the Project boundary 5. Middle of the Passur River at the Jetty location of the Project boundary 6. Left Bank of Passur River at the Jetty location of the Project boundary

Parameters	Locations of Sampling
	7. Right Bank of Passur River at South West corner from the Project boundary 8. Middle of the Passur River at South West corner from the Project boundary 9. Left Bank of Passur River at South West corner from the Project boundary 10. Maidara river at the township area of the Project 11. Maidara river of the South East corner of the Project at Ichamoti-Maidara confluence 12. Maidara river of the South East corner of the Project at Ichamoti-Maidara confluence 13. Passur river at Harbaria point 14. Sibsha river at Akram point 15 Passur river at Hiron point

5.3.2 Ground water quality

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

Table 5.2: Ground Water Quality Monitoring Parameter and Location

Parameter	Location of Sampling
DO, COD, Heavy metals (As, Pb, Hg), pH, salinity, TH, NO_3, TDS	1. Deep tube well near the township 2. Deep tube well at Rajnagar 3. Shallow tube well at Kalikerber 4.Deep tube well at Kapashdanga

5.3.3 Water quality analysis procedure

46. 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 of Water Quality Parameter

Parameters	Unit	Methods
Temperature	^0C	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 20^0C
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)
Hg	ppm	Mercury Analyzer
Pb	ppm	Atomic Absorption Spectrophotometers – Graphite Furnace (AAS-GF)

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

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

(ii) Inorganic non-metallic constituents i.e.DO, NO_3^-, PO_4^{3-} and SO_4^{2-}

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

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

5.4 Results of surface water quality monitoring

5.4.1 On-site tested parameters

(a) pH

48. In October (post monsoon season), pH values in the Passur-Sibsha River System varied from 7.0 to 8.2 that are within the standard limit (6.5 – 8.5) of ECR'97 for inland surface. Highest (8.2) pH value was found at Right Bank of Passur River at Project site-Jetty and Middle of Passur River at 100 meter North-West corner of the project boundary. In rest of the places, it varies from 7.0 to 8.1 where second highest pH value (8.1) was found at most of the sampling points in this third quarterly monitoring.

49. The monitoring results show that there is a seasonal variation in pH of the river water. This time (October, 2014), the pH values were found to be higher than the first and

second quarter monitoring which were conducted in April (Pre-monsoon season) and July (Monsoon season), 2014 respectively. During post monsoon, (October-November) river water level normally goes down because of low rainfall and less upstream flow of Passur-Sibsha River system and which was the main reason behind observed high pH values during third quarter monitoring interest.

50. After all, compare to first and second quarter monitoring results, the pH value found in the third quarter monitoring has been increased slightly in the river system. The measured pH values of selected monitoring locations during first, second and third quarterly monitoring of Passur-Sibsha River System (RS) are presented i**n Table 5.4.**

Table 5.4: pH Values of Passur River Water

SI	Sampling Locations	pH Values			
		1QM	2QM	3QM	BD Standard
1	Left Bank of Passur River at 100m u/s of North West corner from the Project boundary	7.2	7.0	8.1	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	
3	Right Bank of Passur River at 100m u/s of North West corner from the Project boundary	7.2	6.9	8.0	
4	Left Bank of Passur River at Project site-Jetty	7.9	7.1	8.1	
5	Middle Passur River at Project site-Jetty	7.1	6.9	8.1	
6	Right Bank of Passur River at Project site-Jetty	7.1	6.9	8.2	
7	Left Bank of Passur River at South West corner from the Project boundary	7.4	7.0	8.1	
8	Middle of Passur River at South West corner from the Project boundary	7.4	6.9	8.0	
9	Right Bank of Passur River at South West corner from the Project boundary	7.3	6.8	8.0	
10	Maidara river of the South East corner of the Project at Ichamoti-Maidara confluence	7.4	6.9	8.1	
11	Maidara river near proposed township area	7.4	6.8	8.1	
12	Passur river at Passur-Mongla confluence	7.3	6.8	7.4	
13	Passur river at Harbaria of Sundarbans	7.9	6.9	8.0	
14	Passur river at Akram of Sundarbans	7.2	6.9	7.9	
15	Passur river at Hiron point of Sundarbans	7.2	7.0	7.0	

Source: Field Survey- April, July and October 2014

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

(b) Temperature

51. The surface water temperature observed during third quarterly monitoring varies from 27°C to 32°C, which is very common in coastal region. The standard temperature for sustaining aquatic life is 20°C -30°C 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 in third quarter monitoring and found little bit lower than the second was as October is cooler period than July according to the seasonal weather condition of Bangladesh. The measured temperature values of selected monitoring locations during first, second and third quarterly monitoring of Passur-Sibsha RS are presented in **Table 5.5.**

Table 5.5: Surface Water Temperature in Passur River

SI	Sampling Locations	Temperature (^oC)			
		1QM	2QM	3QM	BD Standard
1	Left Bank of Passur River at 100m u/s of North West corner from the Project boundary	31	33	31	20 – 30 ^oC
2	Middle Passur River at 100m u/s of North West corner from the Project boundary	31	33	31	
3	Right Bank of Passur River at 100m u/s of North West corner from the Project boundary	31	33	30	
4	Left Bank of Passur River at Project site-Jetty	31	33	31	
5	Middle Passur River at Project site-Jetty	30	32	31	
6	Right Left Bank of Passur River at Project site-Jetty	30	32	31	
7	Left Bank of Passur River at South West corner from the Project boundary	31	32	30	
8	Middle of Passur River at South West corner from the Project boundary	31	31	29	
9	Right Bank of Passur River at South West corner from the Project boundary	31	31	29	
10	Maidara river of the South East corner of the Project at Ichamoti-Maidara confluence	30	31	28	
11	Maidara river near proposed township area	30	32	27	
12	Passur river at Passur-Mongla confluence	29	30	32	
13	Passur river at Harbaria of Sundarbans	30	30	27	
14	Passur river at Akram of Sundarbans	29	29	30	
15	Passur river at Hiron point of Sundarbans	29	30	29	

Source: Field Survey- April, July and October 2014

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

(c) Salinity

52. Water salinity at the selected sampling stations of Passur-Sibsha RS of consecutive three seasons is presented in **Table 5.6.** In this quarter (October), no salinity was found in the river water from project site to Harbaria. Low salinity was observed in the river section from Akram point to further downstream.

53. In October, freshwater flow from the upstream sources is still significant that confronts the salinity intrusion from the sea. Freshwater influence was dominating in the upstream of Akram point area whereas seawater influence was dominating further downstream of Akram Point.

Table 5.6: Salinity (ppt) in Passur River

SI	Sampling Locations	Salinity (ppt)		
		1 QM	2 QM	3 QM
1	Left Bank of Passur River at 100m u/s of North West corner from the Project boundary	11.5	2.5	0.0
2	Middle Passur River at 100m u/s of North West corner from the Project boundary	11.5	0.3	0.0
3	Right Bank of Passur River at 100m u/s of North West corner from the Project boundary	11.5	0.2	0.0
4	Left Bank of Passur River at Project site-Jetty	12.0	2.2	0.0

Sl	Sampling Locations	Salinity (ppt)		
		1 QM	2 QM	3 QM
5	Middle Passur River at Project site-Jetty	12.0	0.3	0.0
6	Right Bank of Passur River at Project site-Jetty	12.0	0.5	0.0
7	Left Bank of Passur River at South West corner from the Project boundary	9.5	4.0	0.0
8	Middle of Passur River at South West corner from the Project boundary	9.0	0.0	0.0
9	Right Bank of Passur River at South West corner from the Project boundary	10.0	2.5	0.0
10	Maidara river of the South East corner of the Project at Ichamoti-Maidara confluence	10.0	0.5	0.0
11	Maidara river near proposed township area	9.0	4.5	0.0
12	Passur river at Passur-Mongla confluence	10.0	9.5	0.0
13	Passur river at Harbaria of Sundarbans	12.0	10.0	0.0
14	Passur river at Akram of Sundarbans	19.0	15.0	1.0
15	Passur river at Hiron point of Sundarbans	23.0	19.5	2.0

Source: Field Survey- April, July and October 2014

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

(d) Dissolved Oxygen

54. Passur-Sibsha RS indicated the concentration to be between 4.9 to 7.9 mg/L at pre-monsoon period whereas during monsoon, DO level fluctuated from 5.9 to 7.3 mg/L. Post monsoon observation at the measuring stations recorded DO level to be between 5.6 to 8.0 mg/L. Maximum and minimum concentration of DO was measured in post monsoon and pre-monsoon periods respectively.

55. 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.

56. The measured DO values at different locations during first, second and third quarterly monitoring of Passur-Sibsha RS are presented in **Table 5.7**.

Table 5.7: Dissolve Oxygen in Passur River

SL	Sampling Locations	Dissolve Oxygen (mg/L)			
		1QM	2QM	3QM	BD Standard
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 or more (standard for sustaining fisheries)
2	Middle Passur River at 100m u/s of North West corner from the Project boundary	4.9	6.8	7.7	
3	Right Bank of Passur River at 100m u/s of North West corner from the Project boundary	5.2	6.7	7.7	
4	Left Bank of Passur River at Project site-Jetty	5.7	6.8	7.6	
5	Middle Passur River at Project site-Jetty	5.9	6.9	7.2	
6	Right Bank of Passur River at Project site-Jetty	5.8	6.6	8.0	

SL	Sampling Locations	Dissolve Oxygen (mg/L)			
		1QM	2QM	3QM	BD Standard
7	Left Bank of Passur River at South West corner from the Project boundary	6.6	7.3	5.6	
8	Middle of Passur River at South West corner from the Project boundary	6.5	7.1	5.6	
9	Right Bank of Passur River at South West corner from the Project boundary	6.5	7.2	5.8	
10	Maidara river of the South East corner of the Project at Ichamoti-Maidara confluence	6.0	6.5	8.0	
11	Maidara river near proposed township area	6.7	6.8	8.0	
12	Passur river at Passur-Mongla confluence	5.3	6.2	7.0	
13	Passur river at Harbaria of Sundarbans	5.4	5.9	7.0	
14	Passur river at Akram of Sundarbans	7.9	6.4	7.7	
15	Passur river at Hiron point of Sundarbans	7.5	6.5	7.8	

Source: Field Survey- April, July and October 2014

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

(e) Biochemical Oxygen Demand

57. During third quarterly monitoring, BOD_5 values varied from 1.7 mg/L to 5.5 mg/L. The highest BOD_5 was found at Ichamoti-Maidara confluence (5.5 mg/L) while lowest BOD_5 observed at Passur-Mongla confluence of Passur River. Beside Ichamoti-Maidara confluence, in some points BOD_5 was little bit high compare to other locations which are Middle Passur River at 100m upstream of North West corner from the project boundary (4.1 mg/L), Left Bank of Passur River at project site-Jetty (4.0 mg/L) and Maidara river near proposed township area (4.0 mg/L). BOD_5 of post monsoon season of the Passur-Sibsha RS fully complies with the BD standard (6 or less for sustaining fisheries).

58. The measured BOD_5 values at different monitoring locations during first, second and third quarterly monitoring of Passur-Sibsha RS are presented in Table 5.8.

Table 5.8: BOD_5 of Passur River Water

SL	Sampling Locations	Biochemical Oxygen Demand (mg/L)			
		1QM	2QM	3QM	BD Standard
1	Left Bank of Passur River at 100m u/s of North West corner from the Project boundary	3.4	2.2	1.9	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	
3	Right Bank of Passur River at 100m u/s of North West corner from the Project boundary	2.2	2.8	3.4	
4	Left Bank of Passur River at Project site-Jetty	3.2	3.1	4.0	
5	Middle Passur River at Project site-Jetty	3.0	2.5	3.5	
6	Right Left Bank of Passur River at Project site-Jetty	5.8	3.5	3.6	
7	Left Bank of Passur River at South West corner from the Project boundary	3.9	2.8	2.6	
8	Middle of Passur River at South West corner from the Project boundary	3.8	3.3	2.8	
9	Right Bank of Passur River at South West corner from the Project boundary	6.5	3.8	2.9	
10	Maidara river of the South East corner of the Project at Ichamoti-Maidara confluence	3.2	3.3	5.5	

SL	Sampling Locations	Biochemical Oxygen Demand (mg/L)			
		1QM	2QM	3QM	BD Standard
11	Maidara river near proposed township area	4.1	3.7	4.0	
12	Passur river at Passur-Mongla confluence	2.3	2.2	1.7	
13	Passur river at Harbaria of Sundarbans	2.2	2.5	2.6	
14	Passur river at Akram of Sundarbans	5.0	2.9	3.7	
15	Passur river at Hiron point of Sundarbans	4.3	2.7	3.9	

Source: Field Survey- April, July and October 2014

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

5.4.2 Laboratory tested parameters

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

59. Similar to other coastal rivers in South-western region, sediment load in Passur is also high. Within the monitoring reach the TDS values vary from 12,400 mg/L to 21,500 mg/L in pre-monsoon season. In contrary, during monsoon season it reduces a lot and ranging 251 mg/L - 15,960 mg/L. These results confirmed that the TDS concentrations of the Passur river are comparatively higher than the recommended level of TDS in Bangladesh and in WHO (1000 mg/L) (WHO, 1993 & 2007). Monitoring results also suggest that TDS are low in monsoon and very high in pre-monsoon season in Passur and Sibsha rivers. In monsoon period the Passur-Sibsha river system receives large volume of fresh water compare to pre-monsoon period and hence the river water TDS reduces drastically by mixing up with upstream freshwater (rainfall and surface runoff).

60. During pre-monsoon and monsoon period, the TDS was observed low in upstream and very high in downstream of the said river system. Significant spatial variation was found, because of seawater and the area might be influenced by 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 (Ca^{2+}, Mg^{2+}, Sr^{2+} etc) of the water more than the upstream monitoring points.

61. During the pre-monsoon period, the water hardness in the sampling stations of Passur River was found to be ranged 2,500 mg/L - 13,060 mg/L, whereas it remarkably decreased to 251 mg/L (ranged 251 – 13,625 mg/L) in monsoon season. Availability of large volume of fresh water from upstream of the river mainly influenced to reduce the hardness of the water. Similar to TDS, TH has the same increasing trend of hardness from upstream to downstream in both pre-monsoon and monsoon season of the Passur-Sibsha RS.

62. Total Suspended Solid (TSS) includes solid materials of organic and inorganic origins that are suspended in the water. There are many suspended matters in the water of the Passur-Sibsha RS. The particles may be sand, clay, silt and loam. TSS obtained from this monitoring study was 7 - 598 mg/L during the pre-monsoon season 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 of this year of monitoring.

63. The TDS, TH and TSS of pre-monsoon and monsoon 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)	
		1QM	2QM	1QM	2QM	1QM	2QM
1	Left Bank of Passur River at 100m u/s of North West corner from the Project boundary	13060	251	2900	250	598	126
2	Middle Passur River at 100m u/s of North West corner from the Project boundary	12630	246	2500	180	45	92
3	Right Bank of Passur River at 100m u/s of North West corner from the Project boundary	12900	383	2650	170	53	112
4	Left Bank of Passur River at Project site-Jetty	13190	445	2550	175	54	99
5	Middle Passur River at Project site-Jetty	13330	353	2600	275	60	100
6	Right Bank of Passur River at Project site-Jetty	13380	402	2625	350	55	105
7	Left Bank of Passur River at South West corner from the Project boundary	13180	655	2550	325	24	116
8	Middle of Passur River at South West corner from the Project boundary	13390	587	2800	350	27	112
9	Right Bank of Passur River at South West corner from the Project boundary	13240	916	2500	475	67	37
10	Maidara river of the South East corner of the project at Ichamoti-Maidara confluence	12400	455	2500	450	7	65
11	Maidara river near proposed township area	10970	2510	2400	725	9	24
12	Passur river at Passur - Mongla confluence	12800	6410	3150	1400	50	310
13	Passur river at Harbaria of Sundarbans	12280	9360	2625	2150	65	90
14	Passur river at Akram of Sundarbans	21500	15960	4500	3625	115	99
15	Passur river at Hiron point of Sundarbans	21500	14050	4850	3050	91	72

Source: Field Survey- April and July 2014

Note: 1QM= First Quarterly Monitoring (April, 2014), 2QM = Second Quarterly Monitoring (July, 2014)

(b) Chemical Oxygen Demand

64. In general COD was found higher in Passur-Sibsha River system. The river contain high load of Organic Content. Total Organic Content, 6.25 mg/L -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.

65. The COD concentration of pre-monsoon and monsoon seasons at different monitoring locations are presented in **Table 5.10**. In Monsoon (July), COD was found lower than the pre-monsoon (April). In July, higher discharge dilutes the COD load in the river

Table 5.10: COD of Passur River System

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

Source: Field Survey- April and July 2014

Note: 1QM= First Quarterly Monitoring (April, 2014), 2QM = Second Quarterly Monitoring (July, 2014)

(c) Nitrate, Sulphate and Phosphate

66. Nitrate concentrations as NO_3-N in the Passur-Sibsha RS were generally low and varied from 0.10 to 2.70 mg/L in pre-monsoon season. During monsoon season, nitrate was ranged 0.76 - 3.32 mg/L. Nitrate concentration in monsoon season is comparatively little bit higher than the season pre-monsoon in each of the monitored locations except left bank of Passur River at project site jetty (pre-monsoon, 1.30 mg/L and monsoon, 0.76 mg/L).

67. Generally, over the whole river system the nitrate is showing low concentration and irregular spatial variation in both pre-monsoon and monsoon season.

68. Naturally Sulphate is higher in sea water and river water in coastal region. From the observed dataset, it is seen that generally Sulphate concentration increases from upstream to downstream.

69. The highest SO_4^{2-} concentration was observed in pre-monsoon (ranged 1120 - 2600 mg/L) season whereas it is lower in monsoon (ranged 20 - 1400 mg/L) due to dilution effect.

70. The monitoring result shows concentration of phosphate as PO_4-P ranges from 0.50 to 7.51 mg/L in pre-monsoon season. During monsoon, phosphate concentration becomes low due to dilution effect and varies from 0.29 to 2.42 mg/L

71. The observed NO_3^{2-}, SO_4^{2-} and PO_4^{2-} concentration at different locations during pre-monsoon and monsoon 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)	
		1QM	2QM	1QM	2QM	1QM	2QM
1	Left Bank of Passur River at 100m u/s of North West corner from the Project boundary	0.90	2.89	1840	20	0.52	2.23
2	Middle Passur River at 100m u/s of North West corner from the Project boundary	0.70	2.40	1320	23	0.50	1.99
3	Right Bank of Passur River at 100m u/s of North West corner from the Project boundary	0.10	3.20	1280	36	1.10	2.55
4	Left Bank of Passur River at Project site-Jetty	1.30	0.76	1360	45	2.10	0.45
5	Middle Passur River at Project site-Jetty	1.40	2.69	1040	32	2.20	2.13
6	Right Bank of Passur River at Project site-Jetty	1.10	2.98	1320	20	2.00	2.42
7	Left Bank of Passur River at South West corner from the Project boundary	0.75	2.13	1640	60	0.57	1.25
8	Middle of Passur River at South West corner from the Project boundary	1.10	2.43	1520	40	1.20	1.51
9	Right Bank of Passur River at South West corner from the Project boundary	1.20	2.05	1280	80	1.50	1.10
10	Maidara river of the South East corner of the project at Ichamoti-Maidara confluence	0.30	2.18	1120	20	0.55	2.10
11	Maidara river near proposed township area	0.50	0.88	1320	210	1.10	0.53
12	Passur river at Passur - Mongla confluence	0.60	1.52	1360	620	1.30	0.35
13	Passur river at Harbaria of Sundarbans	1.40	1.75	1560	860	1.10	0.56
14	Passur river at Akram of Sundarbans	2.70	3.32	2600	1400	1.30	0.29
15	Passur river at Hiron point of Sundarbans	0.80	2.84	2080	1160	7.51	0.29

Source: Field Survey- April and July 2014

Note: 1QM= First Quarterly Monitoring (April, 2014), 2QM = Second Quarterly Monitoring (July, 2014)

(d) Heavy Metals

72. As, Pb and Hg concentrations were found very low in river water in both pre-monsoon and monsoon seasons. The observed As, Pb and Hg concentration at different locations during pre-monsoon and monsoon seasons are presented in **Table 5.12.**

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

SI	Sampling Locations	As (mg/L)		Pb (mg/L)		Hg (mg/L)	
		1QM	2QM	1QM	2QM	1QM	2QM
1	Left Bank of Passur River at 100m u/s of North West corner from the Project boundary	0.002	0.003	0.053	0.004	<0.00015	<0.00015
2	Middle Passur River at 100m u/s of North West corner from the Project boundary	0.002	0.003	0.055	0.002	<0.00015	<0.00015
3	Right Bank of Passur River at 100m u/s of North West corner from the Project boundary	0.001	0.003	0.055	0.005	<0.00015	<0.00015
4	Left Bank of Passur River at Project site-Jetty	0.002	0.004	0.057	0.002	<0.00015	<0.00015
5	Middle Passur River at Project site-Jetty	0.002	0.004	0.060	0.002	<0.00015	<0.00015
6	Right Bank of Passur River at Project site-Jetty	0.002	0.003	0.058	0.002	<0.00015	<0.00015
7	Left Bank of Passur River at South West corner from the Project boundary	<0.001	0.003	0.053	0.002	<0.00015	<0.00015
8	Middle of Passur River at South West corner from the Project boundary	<0.002	0.004	0.054	0.003	<0.00015	<0.00015
9	Right Bank of Passur River at South West corner from the Project boundary	0.002	0.003	0.056	0.005	<0.00015	<0.00015
10	Maidara river of the South East corner of the project at Ichamoti-Maidara confluence	<0.001	0.003	0.053	0.004	<0.00015	<0.00015
11	Maidara river near proposed township area	0.002	0.002	0.048	0.004	<0.00015	<0.00015
12	Passur river at Passur - Mongla confluence	0.002	0.004	0.050	0.032	<0.00015	<0.00015
13	Passur river at Harbaria of Sundarbans	0.004	0.003	0.043	0.044	<0.00015	<0.00015
14	Passur river at Akram of Sundarbans	0.004	0.002	0.194	0.071	0.0020	<0.00015
15	Passur river at Hiron point of Sundarbans	0.003	0.002	0.224	0.050	0.0023	<0.00015

Source: Field Survey- April and July 2014

Note: 1QM= First Quarterly Monitoring (April, 2014), 2QM = Second Quarterly Monitoring (July, 2014)

(e) Oil and Grease

73. In ordered 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 and monsoon period, the concentration of oil and grease was found negligible, below 5 **mg/L**. As the river is tidal in nature, the tidal mixing dilutes the spilled oil. The results of the laboratory analysis are shown in **Table 5.13**.

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)
		1QM	2QM		
1	Left Bank of Passur River at South West corner from the Project boundary	<5	<5	10	10
2	Mongla-Passur Confluence	<5	<5		
3	Passur river at Harbaria of Sundarbans	<5	6.3		
4	Passur river at Hiron point of Sundarbans	<5	<5		
5	Akram Point of Sundarbans	<5	<5		

Source: Field Survey- April and July 2014

Note: 1QM= First Quarterly Monitoring (April, 2014), 2QM = Second Quarterly Monitoring (July, 2014)
*Drinking water quality standards, The Environment Conservation Rules, 1997

5.5 Ground water quality monitoring

5.5.1 On-site tested parameters

(a) pH and Temperature

74. Physical parameter pH and temperature of the monitored samples fully comply with the drinking water quality standards of ECR, 1997 for three seasons. The pH values of third quarter monitoring (October 2014) found to be varying from 7.9 to 8.0 while temperature was found to be in between 26.0^{o}C to 28.0^{o}C (Table 6.14). The first, second and third monitoring results of four 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 (^{o}C)			
			1QM	2QM	3QM	BD Standard*	1QM	2QM	3QM	BD Standard*
1	Near Proposed Township	Deep (>600 ft)	7.6	7.7	7.9	6.5-8.5	27.3	28.5	26.0	20 – 30^{0} C
2	Rajnagar	Deep (>600 ft)	7.6	7.8	8.0		29.6	29.9	28.0	
3	Kalekharber	Shallow (<250 ft)	6.3	6.5	NF		27.5	28.7	NF	
4	Kapasdanga	Deep (>600 ft)	7.6	7.7	8.0		29.2	28.9	28.0	

Source: Field Survey- April, July and October 2014

Note: 1QM= First Quarterly Monitoring (April, 2014), 2QM = Second Quarterly Monitoring (July, 2014), 3QM = Third Quarterly Monitoring (October, 2014), **Non-functional tube well
*Drinking water quality standards, The Environment Conservation Rules, 1997

(b) Salinity and Dissolved Oxygen

75. The hand pump tube wells from which the samples were collected in pre-monsoon, monsoon and post monsoon seasons are fully free from salinity (0 ppt). DO level were found in between 6 mg/L to 7.7 mg/L. ECR 1997 defines DO standard as 6mg/L but it is not clearly mentioned whether it is maximum or minimum concentration. WHO does not consider DO as regulatory parameter for drinking water quality standard.

Table 5.15: Salinity and DO in Groundwater

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

Source: Field Survey- April, July and October 2014

Note: 1QM= First Quarterly Monitoring (April, 2014), 2QM = Second Quarterly Monitoring (July, 2014), 3QM = Third Quarterly Monitoring (October, 2014)
*Drinking water quality standards, The Environment Conservation Rules, 1997
**Non-functional tube well
**Not availability

5.5.2 Laboratory tested parameters

(a) TDS, TSS and TH

76. Ground water TDS, TSS and TH value of first (pre-monsoon) and second (monsoon) quarter monitoring have been presented in **Table 5.16.**

77. During first quarter monitoring (April), TDS was found above the drinking water quality standard in three handpump tube wells. In second quarter (July), which was in monsoon, the TDS was found lower and within the drinking water quality standard.

78. TSS was found within the standard in this quarter. However, TSS was found very higher in the tube well in Kalekarber. This tube well was installed at shallow depth which might be a reason of higher TSS.

Table 5.16: TDS and TH concentrations in Groundwater

SL	Locations	Type of tube wells	TDS (mg/L)			TSS (mg/L)			TH (mg/L)		
			Tested results		BD standard *	Tested results		BD standard*	Tested results		BD standard *
			1QM	2QM		1QM	2QM		1QM	2QM	
1	Township near project site	Deep (>600 ft)	1113	999	1000 mg/L	-	6	10 mg/L	425	250	200-500 mg/L
2	Rajnagar	Deep (>600 ft)	4090	371		-	6		220	175	
3	Kalekharber	Shallow (<250 ft)	1055	970		-	48		780	450	
4	Kapasdanga	Deep (>600 ft)	643	635		-	8		190	140	

Source: Field Survey- April, July and October 2014

Note: 1QM= First Quarterly Monitoring (April, 2014), 2QM = Second Quarterly Monitoring (July, 2014)
*****Bangladesh Standard for Drinking Water (ECR, 1997)

79. TH was found below the standard in Rajnagar and Kapasdanga. Among the four observation tube well, Kalekharber shows higher TH may be due to its shallower depth.

(b) Chemical Oxygen Demand

80. The Bangladesh standard for COD in drinking water is only 4.0 mg/L. However, all the monitoring wells showed higher concentration of COD than the ECR'97 during both in pre-monsoon and monsoon season. In pre-monsoon season, the concentration found in between 28-48 mg/L whereas in monsoon it was 28-36 mg/L. The COD concentrations of first and second quarter monitoring are presented in **Table 5.17.**

Table 5.17: COD concentrations of monitored ground water locations

Sl	Locations	Tube Well Type	COD (mg/L)		
			1QM	2QM	BD standard
1	Township near project site	Deep (>600 ft)	32	32	4
2	Rajnagar	Deep (>600 ft)	28	28	
3	Kalekerber	Shallow (<250 ft)	32	36	
4	Kapasdanga	Deep (>600 ft)	48	32	

NB. Bangladesh Standard for Drinking Water (ECR, 1997)

c. Nitrate

81. Nitrates in all the observed groundwater samples are within the safe levels (10.0 mg/l) guided by the ECR 1997 in the section of Bangladesh Standard for Drinking Water Quality. The observed ground water NO_3^{2-} SO_4^{2-} and PO_4^{2-} concentrations are presented in **Table 5.18**.

Table 5.18: NO_3, SO_4 and PO_4 Concentrations in Ground Water

Sl	Locations	Type of tube wells	NO_3^{2-} (mg/L)			SO_4^{2-} (mg/L)			PO_4^{2-} (mg/L)		
			Tested results		BD standard*	Tested results		BD standard*	Tested results		BD standard *
			1QM	2QM		1QM	2QM		1QM	2QM	
1	Township near project site	Deep (>600 ft)	0.20	0.48	10.0	-	3	400	-	2.2	6.0
2	Rajnagar	Deep (>600 ft)	0.60	0.68		-	2		-	2.5	
3	Kalekharber	Shallow (<250 ft)	0.40	0.56		-	3		-	1.2	
4	Kapasdanga	Deep (>600 ft)	0.80	0.40		-	10		-	6.2	

Source: Field Survey- April, July and October 2014

Note: 1QM= First Quarterly Monitoring (April, 2014), 2QM = Second Quarterly Monitoring (July, 2014)
*****Bangladesh Standard for Drinking Water (ECR, 1997)

82. SO_4^{2-} and PO_4^{2-} concentrations monitoring have been appended in this study from the second quarter monitoring. SO_4^{2-} and PO_4^{2-} were found within the drinking water quality standard.

(d) Arsenic, Lead and Mercury

83. As per the Bangladesh Standard, the maximum acceptable concentration of Arsenic in groundwater is 0.05 mg/L. Among the four tubewell, Kalekherber tubewell, which is installed at shallower depth, was found Arsenic contaminated. Pb and Hg concentration were found very low and much below the highest acceptable limit (**Table 5.19**).

Table 5.19: As, Pb and Hg concentrations (mg/L) of monitored ground water locations

SI	Locations	As (mg/L)			Pb (mg/L)			Hg (mg/L)		
		Tested results		BD standard*	Tested results		BD standard*	Tested results		BD standard *
		1QM	2QM		1QM	2QM		1QM	2QM	
1	Township near project site	0.013	0.020	0.05	0.002	<0.002	0.05	<0.00015	<0.00015	0.001
2	Rajnagar	0.006	0.009		<0.002	<0.002		<0.00015	<0.00015	
3	Kalekharber	0.376	0.407		0.002	0.008		<0.00015	<0.00015	
4	Kapasdanga	0.036	0.033		<0.002	0.004		<0.00015	<0.00015	

Source: Field Survey- April, July and October 2014

Note: 1QM= First Quarterly Monitoring (April, 2014), 2QM = Second Quarterly Monitoring (July, 2014)
*****Bangladesh Standard for Drinking Water (ECR, 1997)

6 Transportation Monitoring

6.1 Location of Traffic Survey

84. The 3rd quarter of first year traffic volume computation survey was conducted on October 20, 2014 (Monday) at five pre-selected monitoring locations which are shown in **Map 7.1**.

85. The selected sites were Babur Bazar, Rupsha Bridge, Bagha Bazar, Babu Bari (access road) and Katakhali. The day on which the survey was conducted, was sunny which ensured normal plying of vehicles on the roads.

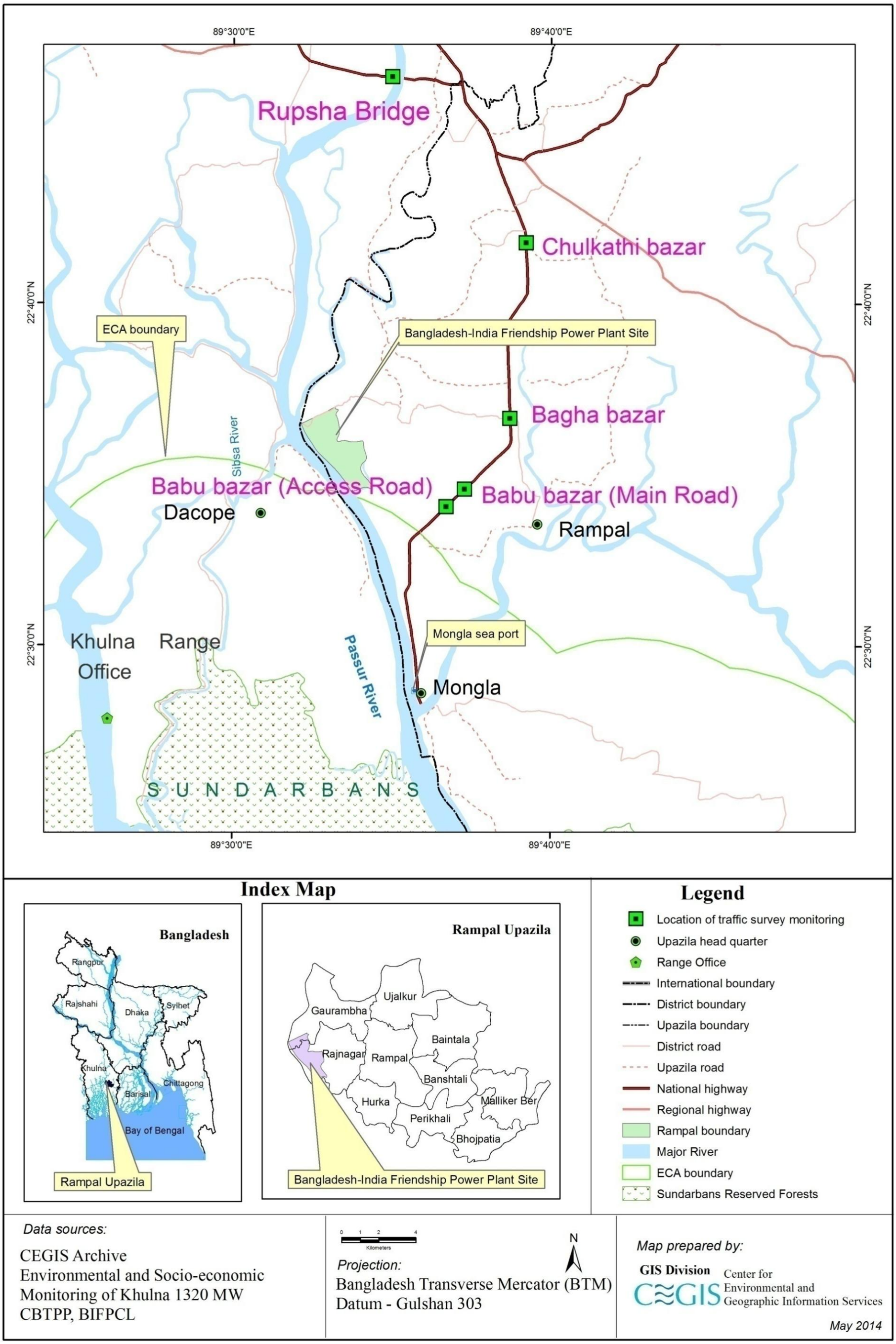
6.2 Traffic Volume Calculation

86. The survey results were used in computing the traffic volume in Passenger Car Unit (PCU). PCU is a matrix used in Transportation Engineering, to assess traffic-flow rate on roadways. A PCU is essentially the impact that a mode of transport has on traffic variables (such as headway, speed, density) compared to a single car. While calculating the traffic volume in PCU, vehicle conversion factors suggested by the Indian Road Congress were used as mentioned in **Table 6.1**.

Table 6.1: Factors Used for PCU Calculation

Mode	Factor
Auto Rickshaw	0.75
Non Motorized Vehicles	0.50
Bus	3.0
Utility Vehicle	1.0
Micro Bus	1.75
Motor Cycle	0.75
Passenger Car	1.0

**Source: Indian Road Congress*



Map 6.1: Traffic Monitoring Locations

6.3 Results of Monitoring

87. The summary results of vehicular movements at five different locations are shown in **Table 6.2** below considering 1st, 2nd and 3rd quarterly monitoring survey. Surveys were carried out at three distinct time periods (8.30 AM to 9.30 AM; 12.30 PM to 1.30 PM; and 4.30 PM to 5.30 PM). The computed values of 3rd quarterly monitoring PCU/hour suggest that the location selected at *Rupsha Bridge* occupies the largest number of vehicles, compared to all other roads and the value comprises was 801 PCU/hr from 4.30 PM to 5.30 PM. Very low traffic was observed at the access road of Babur Bazar (access road) with values ranging from 35 to 50 PCU/ hr. The value of PCU in 3rd quarter monitoring has been found almost similar to 2nd quarter monitoring.

Table 6.2: Calculated PCU in Five Locations at Three Different Time Period

Location	8.30 AM to 9.30 AM			12.30 PM to 1.30 PM			4.30 PM to 5.30 PM		
	1st QM	2nd QM	3rd QM	1st QM	2nd QM	3rd QM	1st QM	2nd QM	3rd QM
Babur Bazar (Access Road)	30	13	41.5	23	21	34.25	24	25	46
Rupsha Bridge	700	566	655.25	836	829	637.25	841	719	801
Babur Bazar (High Way)	287	249	237.25	316	341	366	387	373	359.25
Bagha Bazar	330	299	373.75	376	429	464	389	493	457.5
Chilkathi	445	523	680.5	501	634	692	508	733	715.25

Source: Field Survey, April, 2014, June 2014 and October 2014

88. The vehicular movements observed during the surveys were mostly for the regular activities. If the Power Plant starts functioning, traffic volume at the access road of Babur Bazar may increase significantly. The detail survey findings regarding the traffic volume surveys as well as the detail calculations are attached in **Annex - II** (**Table A to Table E**).

7 Land Resources Monitoring

89. During field visit in April 2014, baseline information on land and agriculture resources was collected. From the field, soil samples were collected for determining soil quality and fertility. pH, OM, EC, N, P, K, S, Ca, Mg, Na, Fe, Mn, Zn, B, Cl^- and Pb were considred as soil quality and fertility parameters.

7.1 Methodology

7.1.1 Monitoring Indicators

90. Land use, soil fertility/nutrient, status of soil contamination with heavy metals are 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 in the surrounding agriculture land and plants on the homestead area which will impact the crop production and fruit bearing in the coconut plants. Therefore, monitoring of the selected indicators is very crucial for land resources monitoring in the study area.

7.1.2 Frequency

91. Land use monitoring data were collected in October, 2014. Soil samples for monitoring of soil fertility/nutrient status of soil contamination with heavy metals, samples of wet season were also collected in the month of October, 2014. Next dry season soil samples will be collected in March, 2015.

7.1.3 Location

92. 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, Chakgona and Basherhula.

7.2 Process of soil samples collection

7.2.1 Land selection

93. Group discussion was held during collection of the soil samples, especially with the land owners. Monitoring locations have been selected considering the potential locations of dry/wet deposition of ash, SOx and NOx to be emitted from the Plant.The GPS readings were recorded on each location to facilitate the collection of soil samples from the exact locations in future.

7.2.2 Soil sample collection

94. 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.

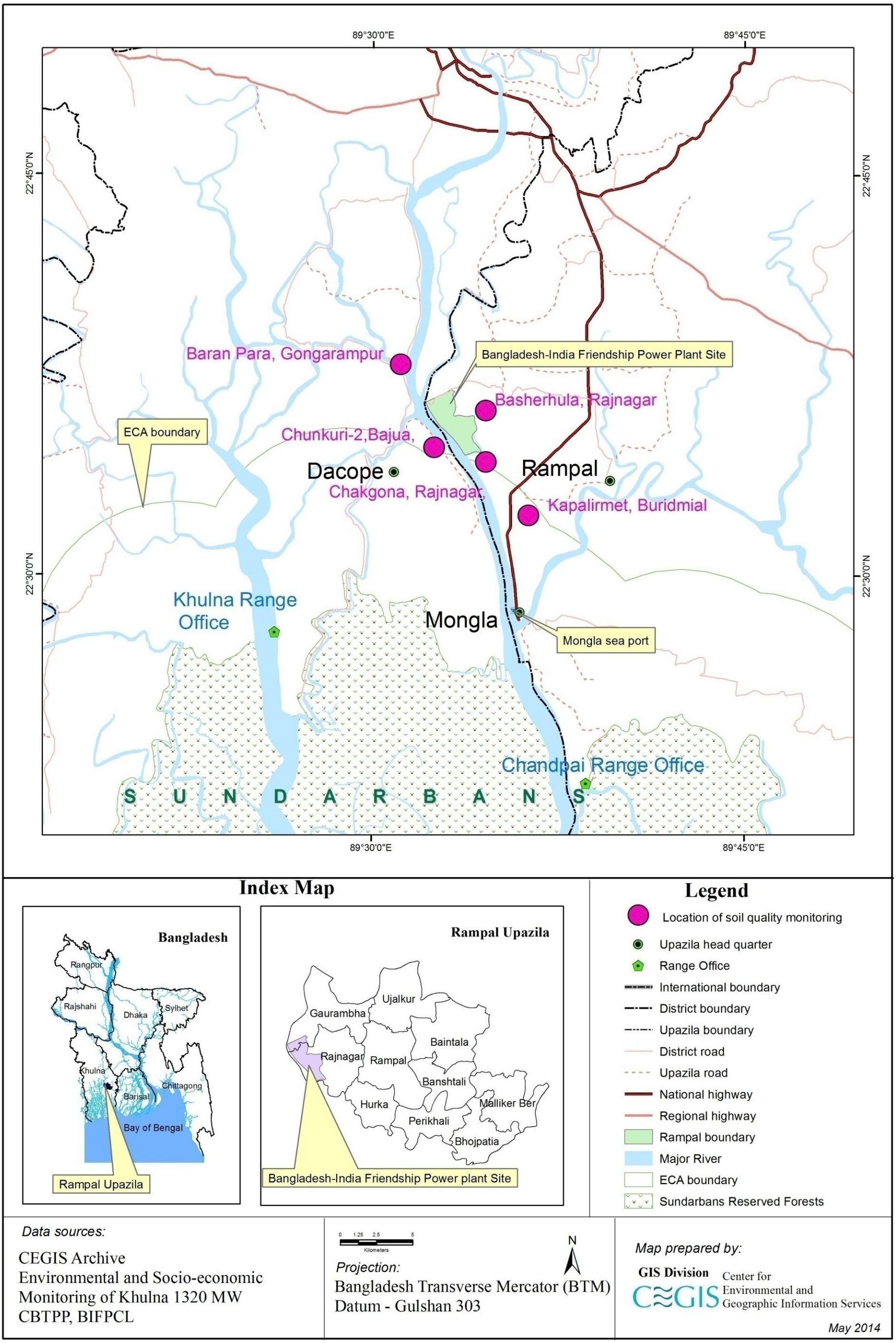
95. In the right hand picture at Kapalirmet, last year t.aman was cultivated. Farmers decided that this year he will go for shrimp or fish culture.

Photo 7.1: View of soil sample collection from monitoring land at Basherhula

Photo 7.2: View of soil sample collection from monitoring land at Kapalirmet

7.2.3 Laboratory analysis

96. 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.



Map 7.1: Soil Quality Monitoring Locations

7.3 Results of Monitoring

97. The samples have been submitted to SRDI Laboratory in Dhaka for analysis. The parameter considered for earlier monitoring will be same this quarter as well. The result of the first quarter monitoring which was also presented in 2nd quarter report has also been provided in the **Table 7.1** again for use in future.

Table 7.1: Chemical Properties of Soil

Sl No	Location	Parameter	2014				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										
		pH	4.2	Very strongly acidic										
		OM (%)	3.1	Medium										
		N (%)	0.16	Low										
		K (%)	1.00	Very high										
		Ca (meq/100g)	11.3	Very high										
		Mg (meq/100g)	10.7	Very high										
		Na(meq/100g)	5.50	*										
		P(µg/gm)	2.7	Very low										
		S(µg/gm)	523.2	Very high										
		B(µg/gm)	0.45	Medium										
		Fe(µg/gm)	150.3	Very high										
		Mn(µg/gm)	7.2	Very high										
		Zn(µg/gm)	1.4	Medium										
		Lead(Pb) (µg/gm)	31.8	*										
		Chloride (Cl^-)(µg/gm)	762.2	*										
		Subsurface soil(15-30cm)												
		EC(ds/m)	8.4	Moderately saline										
		pH	4.3	Very strongly acidic										
		OM (%)	2.9	Medium										
		N (%)	0.15	Low										
		K (%)	1.0	Very high										
		Ca(meq/100g)	10.48	Very high										
		Mg(meq/100g)	8.8	Very high										
		Na(meq/100g)	5.00	*										
		P(µg/gm)	2.9	Very low										
		S(µg/gm)	513.7	Very high										
		B(µg/gm)	0.36	Medium										
		Fe(µg/gm)	39.1	Very high										
		Mn(µg/gm)	3.3	High										
		Zn(µg/gm)	1.5	Optimum										
		Lead(Pb) (µg/gm)	31.8	*										
		Chloride (Cl^-)(µg/gm)	398.4	*										
		Substratum(30-45cm)												

Sl No	Location	Parameter	2014				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**
		EC(ds/m)	9.6	Moderately saline										
		pH	5.7	Slightly acidic										
		OM (%)	1.6	Low										
		N (%)	0.08	Very low										
		K (%)	1.0	Very high										
		Ca(meq/100g)	12.6	Very high										
		Mg(meq/100g)	15.9	Very high										
		Na(meq/100g)	6.00	*										
		P(µg/gm)	2.00	Very low										
		S(µg/gm)	490.9	Very high										
		B(µg/gm)	0.73	Very high										
		Fe(µg/gm)	51.3	Very high										
		Mn(µg/gm)	3.9	High										
		Zn(µg/gm)	1.6	Optimum										
		Lead(Pb) (µg/gm)	37.8	*										
		Chloride (Cl^-)(µg/gm)	692.9	*										
2.	Chunkuri-2	**Top soil (0-15cm)**												
		EC(ds/m)	11.2	Moderately saline										
		pH	6.1	Slightly acidic										
		OM (%)	2.1	Medium										
		N (%)	0.11	Low										
		K (%)	1.5	Very high										
		Ca(meq/100g)	12.3	Very high										
		Mg(meq/100g)	9.8	Very high										
		Na(meq/100g)	8.5	*										
		P(µg/gm)	2.7	Very low										
		S(µg/gm)	401.9	Very high										
		B(µg/gm)	0.57	Optimum										
		Fe(µg/gm)	60.2	Very high										
		Mn(µg/gm)	5.3	Very high										
		Zn(µg/gm)	1.7	Medium										
		Lead(Pb) (µg/gm)	0.00	*										
		Chloride (Cl^-)(µg/gm)	1957.6	*										
		Subsurface soil(15-30cm)												
		EC(ds/m)	9.1	Moderately saline										
		pH	6.7	Neutral										
		OM (%)	1.8	Low										
		N (%)	0.09	Very low										
		K (%)	1.6	Very high										

Sl No	Location	Parameter	2014				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)	12.6	Very high										
		Mg(meq/100g)	9.5	Very high										
		Na(meq/100g)	8.5	*										
		P(µg/gm)	2.7	Very low										
		S(µg/gm)	280.5	Very high										
		B(µg/gm)	1.1	Very high										
		Fe(µg/gm)	133.9	Very high										
		Mn(µg/gm)	2.8	Optimum										
		Zn(µg/gm)	0.99	Medium										
		Lead(Pb) (µg/gm)	0.00	*										
		Chloride (Cl^-)(µg/gm)	1472.5	*										
		Substratum(30-45cm)												
		EC(ds/m)	10.1	Moderately saline										
		pH	6.6	Neutral										
		OM (%)	1.9	Medium										
		N (%)	0.09	Low										
		K (%)	1.5	Very high										
		Ca(meq/100g)	13.7	Very high										
		Mg(meq/100g)	11.8	Very high										
		Na(meq/100g)	8.5	*										
		P(µg/gm)	1.3	Very low										
		S(µg/gm)	320.4	Very high										
		B(µg/gm)	1.14	Very high										
		Fe(µg/gm)	125.3	Very high										
		Mn(µg/gm)	2.7	Optimum										
		Zn(µg/gm)	1.8	Optimum										
		Lead(Pb) (µg/gm)	31.3	*										
		Chloride (Cl^-)(µg/gm)	1715.0	*										
	Kapalirmet	**Top soil(0-15cm)**												
		EC(ds/m)	4.8	Slightly saline										
		pH	7.0	Neutral										
		OM (%)	3.0	Medium										
		N (%)	0.2	Low										
		K (%)	1.5	Very high										
		Ca(meq/100g)	18.2	Very high										
		Mg(meq/100g)	15.3	Very high										
		Na(meq/100g)	12.0	*										
		P(µg/gm)	3.2	Very low										
		S(µg/gm)	545.2	Very high										
		B(µg/gm)	1.2	Very high										
		Fe(µg/gm)	37.3	Very high										
		Mn(µg/gm)	3.8	Very high										

Sl No	Location	Parameter	2014				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**
		Zn(µg/gm)	2.0	High										
		Lead(Pb) (µg/gm)	12.5	*										
		Chloride (Cl^-)(µg/gm)	3741.9	*										
		Subsurface soil(15-30cm)												
		EC(ds/m)	11.1	Moderately saline										
		pH	7.2	Neutral										
		OM (%)	2.6	Medium										
		N (%)	0.2	Low										
		K (%)	1.5	Very high										
		Ca(meq/100g)	11.7	Very high										
		Mg(meq/100g)	7.1	Very high										
		Na(meq/100g)	8.5	*										
		P(µg/gm)	3.8	Very low										
		S(µg/gm)	341.4	Very high										
		B(µg/gm)	0.86	Very high										
		Fe(µg/gm)	140.2	Very high										
		Mn(µg/gm)	3.7	High										
		Zn(µg/gm)	0.94	Medium										
		Lead(Pb) (µg/gm)	0.00	*										
		Chloride (Cl^-) (µg/gm)	2217.4	*										
		Substratum(30-45cm)												
		EC(ds/m)	10.8	Moderately saline										
		pH	7.3	Neutral										
		OM (%)	2.8	Medium										
		N (%)	0.15	Low										
		K (%)	1.5	Very high										
		Ca(meq/100g)	12.9	Very high										
		Mg(meq/100g)	10.4	Very high										
		Na(meq/100g)	8.5	*										
		P(µg/gm)	3.4	Very low										
		S(µg/gm)	345.1	Very high										
		B(µg/gm)	1.4	Very high										
		Fe(µg/gm)	120.3	Very high										
		Mn(µg/gm)	2.9	Optimum										
		Zn(µg/gm)	0.88	Medium										
		Lead(Pb) (µg/gm)	0.00	*										
		Chloride (Cl^-) (µg/gm)	1801.6	*										
4	Chakgona	**Top soil(0-15cm)**												
		EC(ds/m)	11.5	Moderately saline										

Sl No	Location	Parameter	2014				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										
		OM (%)	1.5	Low										
		N (%)	0.08	Low										
		K (%)	1.5	Very high										
		Ca(meq/100g)	22.2	Very high										
		Mg(meq/100g)	11.7	Very high										
		Na(meq/100g)	8.5	*										
		P(µg/gm)	5.6	Very low										
		S(µg/gm)	444.2	Very high										
		B(µg/gm)	0.98	Very high										
		Fe(µg/gm)	55.3	Very high										
		Mn(µg/gm)	4.3	High										
		Zn(µg/gm)	0.76	Low										
		Lead(Pb(µg/gm)	0.00	*										
		Chloride (Cl^-)(µg/gm)	1576.4	*										
		Subsurface soil(15-30cm)												
		EC(ds/m)	11.3	Moderately saline										
		pH	7.7	Slightly alkaline										
		OM (%)	2.6	Medium										
		N (%)	0.13	Low										
		K (%)	1.5	Very high										
		Ca(meq/100g)	22.6	Very high										
		Mg(meq/100g)	16.3	Very high										
		Na(meq/100g)	8.5	*										
		P(µg/gm)	13.6	Very low										
		S(µg/gm)	415.6	Very high										
		B(µg/gm)	0.66	High										
		Fe(µg/gm)	124.1	Very high										
		Mn(µg/gm)	6.1	Very high										
		Zn(µg/gm)	1.1	Medium										
		Lead(Pb(µg/gm)	6.3	*										
		Chloride (Cl^-)(µg/gm)	2113.5	*										
		Substratum(30-45cm)												
		EC(ds/m)	10.9 saline	Moderately										
		pH	7.5	Slightly alkaline										
		OM (%)	1.7	Low										
		N (%)	0.09	Very low										
		K (%)	1.5	Very high										
		Ca(meq/100g)	13.9	Very high										
		Mg(meq/100g)	11.1	Very high										
		Na(meq/100g)	8.5	*										

Sl No	Location	Parameter	2014				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)	4.1	Very low										
		S(µg/gm)	334.6	Very high										
		B(µg/gm)	0.67	High										
		Fe(µg/gm)	75.3	Very high										
		Mn(µg/gm)	3.6	Very high										
		Zn(µg/gm)	1.7	Optimum										
		Lead(Pb) (µg/gm)	6.3	*										
		Chloride (Cl^-)(µg/gm)	1715.0	*										
5.	Basherhula	**Top soil(0-15cm)**												
		EC(ds/m)	11.7	Moderately saline										
		pH	7.7	Slightly alkaline										
		OM (%)	1.7	Low										
		N (%)	0.09	Low										
		K (%)	1.5	Very high										
		Ca(meq/100g)	23.6	Very high										
		Mg(meq/100g)	11.9	Very high										
		Na(meq/100g)	8.5	*										
		P(µg/gm)	4.5	Very low										
		S(µg/gm)	272.3	Very high										
		B(µg/gm)	0.94	Very high										
		Fe(µg/gm)	50.3	Very high										
		Mn(µg/gm)	3.4	High										
		Zn(µg/gm)	1.4	Medium										
		Lead(Pb(µg/gm)	18.8	*										
		Chloride (Cl^-)(µg/gm)	2442.6	*										
		Subsurface soil(15-30cm)												
		EC(ds/m)	10.7	Moderately saline										
		pH	7.7	Slightly alkaline										
		OM (%)	1.5	Low										
		N (%)	0.08	Very low										
		K (%)	1.0	Very high										
		Ca(meq/100g)	24.0	Very high										
		Mg(meq/100g)	11.7	Very high										
		Na(meq/100g)	7.0	*										
		P(µg/gm)	3.9	Very low										
		S(µg/gm)	317.2	Very high										
		B(µg/gm)	0.71	High										
		Fe(µg/gm)	121.4	Very high										
		Mn(µg/gm)	3.9	Very high										
		Zn(µg/gm)	1.8	Optimum										
		Lead(Pb)	18.8	*										

Sl No	Location	Parameter	2014				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**
		(µg/gm)												
		Chloride (Cl^-) (µg/gm)	1611.1	*										
		Substratum(30-45cm)												
		EC(ds/m)	10.9	Moderately saline										
		pH	7.7	Slightly alkaline										
		OM (%)	1.5	Low										
		N (%)	0.08	Very low										
		K (%)	1.5	Very high										
		Ca(meq/100g)	24.4	Very high										
		Mg(meq/100g)	12.9	Very high										
		Na(meq/100g)	7.5	*										
		P(µg/gm)	6.1	Very low										
		S(µg/gm)	321.1	Very high										
		B(µg/gm)	0.63	High										
		Fe(µg/gm)	77.3	Very high										
		Mn(µg/gm)	3.2	High										
		Zn(µg/gm)	2.1	High										
		Lead(Pb) (µg/gm)	25.00	*										
		Chloride (Cl^-)(µg/gm)	1489.8	*										

8 Agriculture Resources Monitoring

8.1 Methodology

8.1.1 Monitoring Indicators

98. 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.

8.1.2 Method

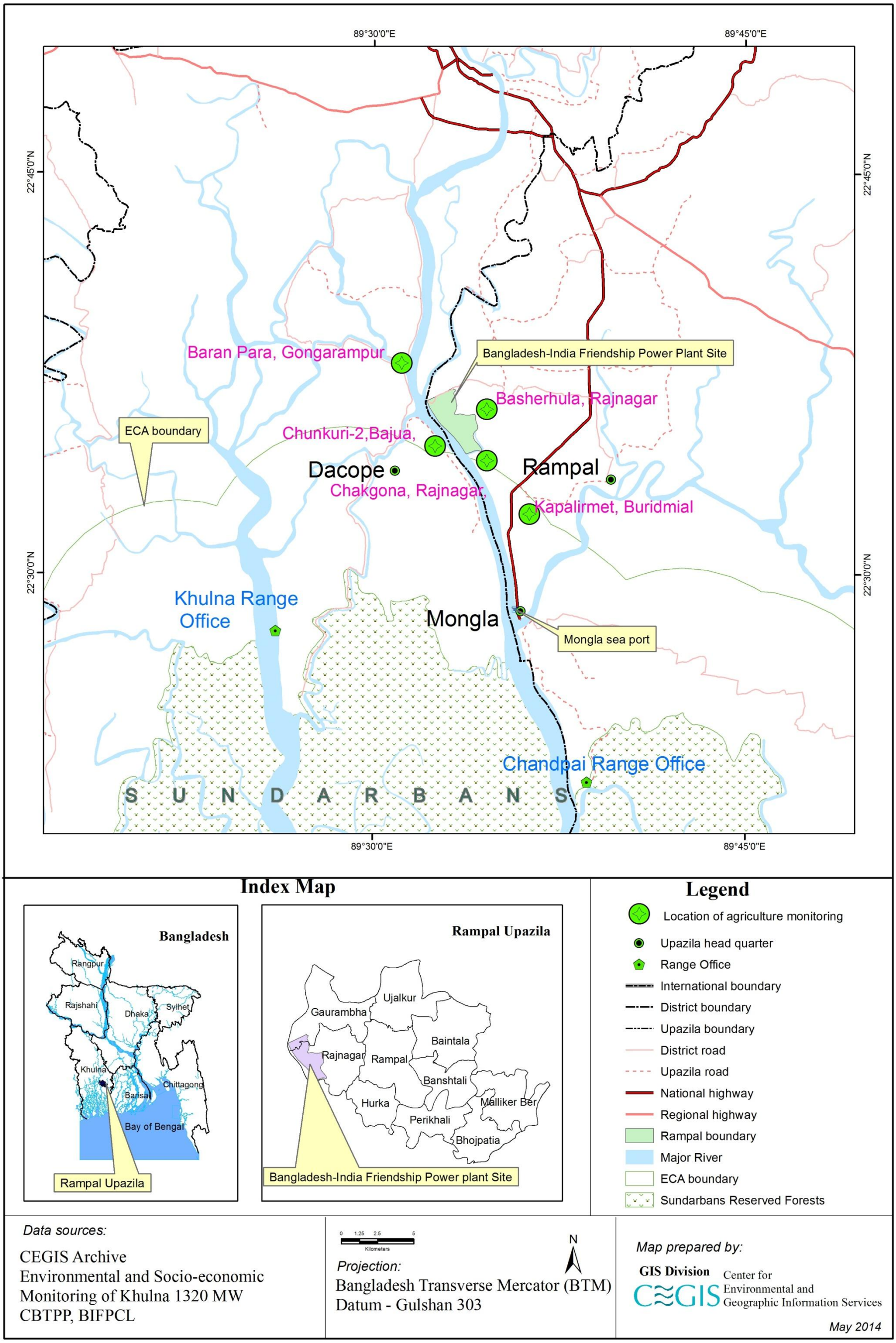
99. During field visit, extensive consultations/group discussion were made with local people to know the existing inputs use, present cropping patterns by land type, crop damage due to drainage congestion/water logging, salinity or other natural calamities induced impact as well as management practices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

8.1.3 Frequency

100. Land use, major crops area, major crop production and damage are monitored quarterly in a year. For the cropping season 2013-14, these data were collected in April, 2014. Crop production and damage information's were also collected from the same land. Samples were collected in October for Kharif-II (July) in 2014-15. Production and damage data will be collected in the year 2014-15 in March, 2015. It is clearly mentioned that single crop is grown all most everywhere.

8.1.4 Location

101. The same mouzas have been selected for land resources as well as agricultural resources monitoring. The selected mouzas are Baranpara, Chunkuri-2, Kapalirmet, Chakgona and Basherhula. Locations of the monitoring agriculture lands are presented in the **Map 8.1**.



Map 8.1: Agricultural Resources Monitoring Locations

8.2 Agricultural Resources

8.2.1 Description of the selected agricultural land for monitoring

102. Detailed information of the selected land for lands and agriculture monitoring are presented in the **Table 8.1**

Table 8.1: 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: Chakgona Union:Rajnagar Upazila:Rampal District:Bagerhat	E-89° 34′25.3″ N-22° 34′18.3″	About 1.0	About 0.28	Name: Manoj Das Father: Mahendra Nath Das
5	Mouza: Basherhula Union:Rajnagar Upazila:Rampal District: Bagerhat	E-89° 34′25.0″ N-22° 36′14.0″	About 1.0	About 0.47	Name: Amjad Hajra Father: Chirman Ali Hajra

Source: Field survey, 2014

8.2.2 Present cropping patterns

103. 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. Data on cropping patterns were collected in October 2014 for 2014-15. Detailed cropping pattern are presented in the **Table 8.2.**

(a) Monitoring agriculture land-1

104. This land is located at Baranpara and the size of the unit plot is about 0.4 ha. Farmer of the plot cultivated Local Aman (Kumragur) in last Kharif-II season. Chemical fertilizer and liquid pesticides are being used 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 was observed in his land.

105. 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 8.2**

Photo 8.1: View of monitoring agriculture land at Baranpara

Photo 8.2: View of monitoring agriculture land at Chunkuri-2

Photo 8.3: View of monitoring agriculture land at Kapalirmet (*Fallow-Shrimp/Fish culture)

Photo 8.4: View of monitoring agriculture land at Chakgona (*Fallow-Shrimp/Fish culture)

Photo 8.5: View of monitoring agriculture land at Basherhula

(b) Monitoring agriculture land-2

106. This monitoring site is located at Chunkuri-2 and the size of the plot is about 0.93 ha. Farmer of the 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 was observed in his land. Chemical fertilizer and pesticides are being used in the land for crop production. Chemical fertilizer used were, Urea: 125kg/plot, TSP: 42kg/plot and MP: 20kg/plot. To protect crop from pest infestation liquid pesticide Karate 2.5 EC was applied @700ml/plot. Detailed cropping pattern is shown in the **Table 8.2**

(c) Monitoring agriculture land -3

107. This monitoring site is located at Kapalirmet and the size of the plot is about 0.14 ha. Farmer of the plots is practicing Local Aman (Chapsail) in Kharif-II season last year. In Kharif-I and Rabi season, shrimp is being cultured in this plot every year. Chemical fertilizer and liquid pesticides are being used in the land for crop production. In 2014-15, this land remained 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/wash 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 Aman crops in their land. But most of the crop lands are damaged by saline water. However, the plot owner culture shrimp/fish in his land in this Kharif-II season. He could not cultivate 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 8.2**

(d) Monitoring agriculture land -4

108. This monitoring site is located at Chakgona and the size of the plot is about 0.28 ha. Farmer of the plot practiced Local Aman (Chapsail) in Kharif-II season last year. In Kharif-I and Rabi season, shrimp is cultured 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 (2014-15). He also stated that he will cultivate next Kharif-II season. Detailed cropping pattern is presented in the **Table 8.2**

(e) Monitoring agriculture land-5

109. This monitoring site is located in Basherhula and the size of the plot is about 0.47 ha. Farmer of the plot is practicing Local Aman (Benapol) in Karif-II season last year. In 2014-15, the farmer of this monitoring land cultivated Local aman variety Sada mota. Pest like Stem borer infestation was observed in his land. Chemical fertilizer and pesticides are being used in the land for crop production. Chemical fertilizer used were, Urea: 5kg/plot, TSP: 15kg/plot and MP: 10kg/plot. To protect crop from pest infestation liquid pesticide Karate 2.5 EC was applied @500ml/plot. Detailed cropping pattern is shown in the **Table 8.2**

Table 8.2: 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*

8.2.3 Crop damage

110. No crop damage was noticed in any monitoring land in 2013-14. The owners of monitoring agriculture land-1 (Baranpara), monitoring agriculture land-2 (Chunkuri-2) and monitoring agriculture land-5 (Basherhula) cultivated HYV and Local Aman crops in this Kharif-II season (2014-15). The rest monitoring lands (Kapalirmet and Chakgona) remains fallow due to adverse impact of salinity. The crop damage of this season shall be monitored in coming quarter of the monitoring study. Detailed crop damage information is presented in **Table 8.3**

Table 8.3: 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	-						
Monitoring agriculture land-3	-	*Not found	-						
Monitoring agriculture land-4	-	*Not found	-						
Monitoring agriculture land-5	-	*Not found	-						
Total	-	-	-						

Source: *Based on field information, April 2014, A: water logging due to heavy rainfall, B: water logging due to internal river water, C: water logging, D: Salinity, E: Other*

9 Fisheries Resources Monitoring

111. Followed by the second quarter monitoring, the third quarter monitoring has been conducted in between 15 October June to 29 October 2014.

9.1 Monitoring Location

112. The monitoring activities were carried out at ten pre-selected locations - (i) Akram Point on the confluence of the Passur and the Sibsha, (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 detailed in **Table 9.1**. These sites were selected in inception stage and finalized during first quarter monitoring.

Table 9.1: 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 Moidhara 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**

9.2 Methods, Tools and Techniques of Monitoring

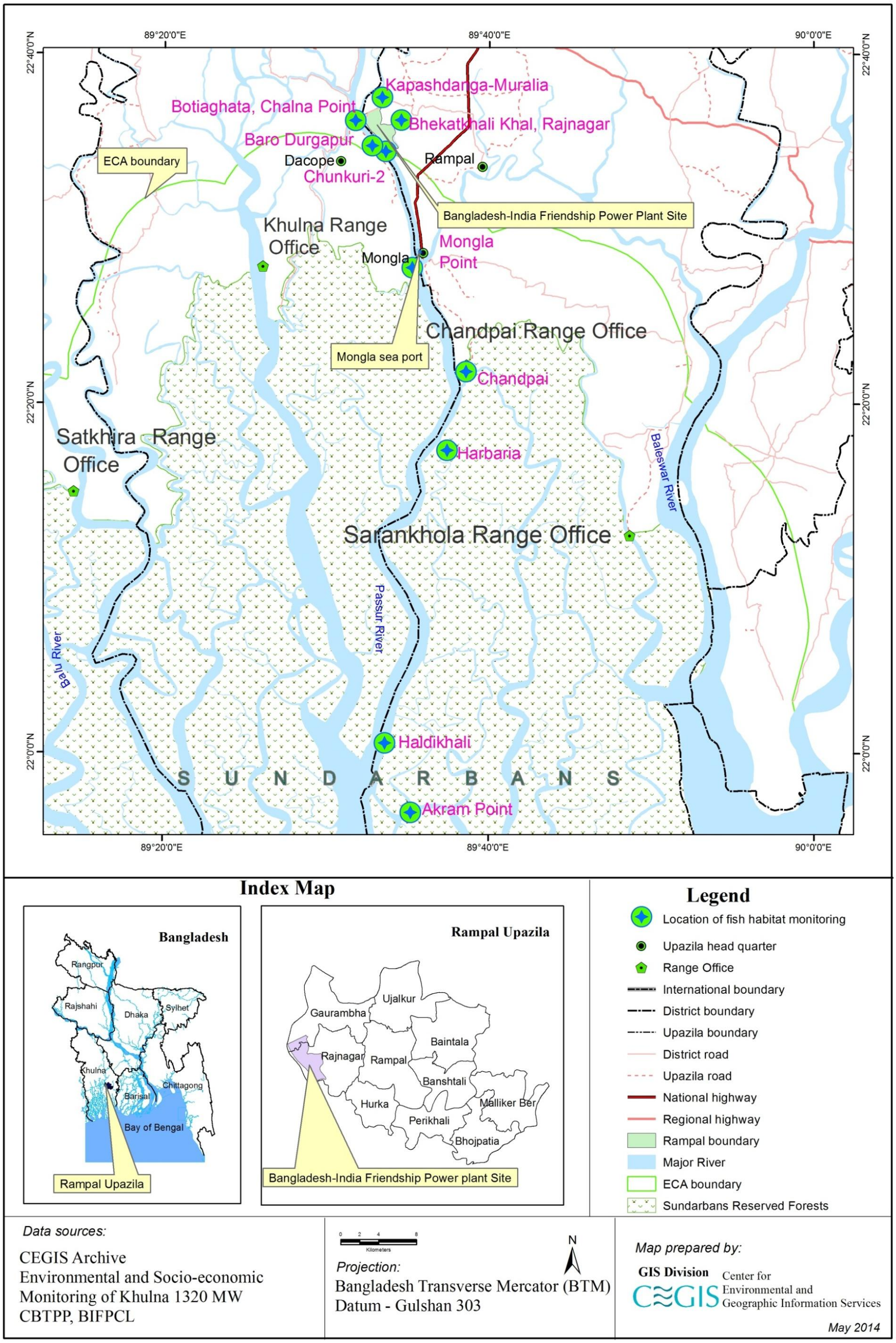
9.2.1 Fish Habitat Status Monitoring

113. 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.

114. Moreover, Habitat Suitability Index (HSI) will be determined for the year 2014, 2015 and 2016. The data for basic life requirements for fish community shown in **Table 9.2** 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. Once the monitoring of the fourth quarter is completed, the HSI value will be calculated and then analyzed by plotting this data with the survival curve of the fish community structure. The 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 9.1: Fisheries Resources Monitoring Locaitons

Table 9.2: 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							

Life Requirements	Variable Sl.	Habitat Variables	A	B	C	D	E	F	G
	V6	Dissolved Oxygen (DO)							
	V7	pH							
	V8	Salinity							
2016-2017									
Food (C_F)	V1	Phytoplankton (%)							
	V2	Zooplankton (%)							
Water Quality (C_{WQ})	V3	Turbidity							
	V4	TDS							
	V5	Surface water temperature							
	V6	Dissolved Oxygen (DO)							
	V7	pH							
	V8	Salinity							
Reproduction (C_R)	V1	Phytoplankton (%)							
	V2	Zooplankton (%)							
	V3	Turbidity							
	V4	TDS							
	V5	Surface water temperature							
	V6	Dissolved Oxygen (DO)							
	V7	pH							
	V8	Salinity							

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

9.2.2 Fish Migration

116. 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 been investigated. Migratory species have been identified by analyzing the common species found in the catch assessment survey samples 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.

9.2.3 Fish Biodiversity

117. 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 –

i. 0-0.30: Low diversity/equally distribution (VH)

ii. 0.31-0.50: Moderate Diversity (M)

iii. 0.51-0.80: High Diversity (HD), and

iv. 0.80-1.0: Very High Diverisity (VHD)

118. 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.

9.2.4 Fish-Shrimp Culture Practice

119. 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.

9.2.5 Fish Production

120. 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.

[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).

9.3 Results of Monitoring

121. Followed by the first and second quarter monitoring, the third quarter monitoring has been conducted in between 15 October to 25 October 2014.

9.4 Results of 3rd Monitoring

9.4.1 Fisheries Resources

122. Fisheries resources for the monitoring study are identified as riverine habitats, 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 fish habitats. 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 future. The culture fish habitat is about 164 ha in total. The fishing activities in the Passur River System (shown in **Photo 9.1**) 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.

123. Fishes are not usually available 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.

9.4.2 Features to be considered

- Following features are considered in conducting the fisheries monitoring:
- The Passur River System, the lone capture fishery, has been aggrading due to siltation
- Reduction of upstream flow since long back when polders were built
- Culture fish habitats are at risk 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)
- Fish diversity is highly dominated during lunar phase and tide condition.

9.4.3 Fish Habitat Status

(a) Habitat Classification

124. 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 behavioral habitats. The sampling sites have been classified (shown in the **Figure 9.1**) on the basis of abundance of different life stages of fish species in those habitats.

125. 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 these habitats has been found to beshifted to some extent.

126. In the third quarter monitoring (October, 2014) three habitats – i) Grazing ground, ii) Grazing and Breeding ground; and iii) Spawning, Nursery and Grazing ground have been identified as shown in the **figure-9.1**.

I. ***Grazing Ground:*** The Kukilmoni Khal (A) and Sheola Khal (D) respectively at Akram Point and Chandpai have been identified as the grazing ground in the Passur River System.

II. ***Grazing and Breeding Ground:*** The linkage distance matrix among the Harbaria Khal (C), Sheola Khal at Chandpai (D), Maidara-Passur confluence (F) and Chalna point of the Passur River (G) shows that the behavioral habitat is the grazing and breeding ground. The most similar sampling sites are F and G in different length frequency for different fish species.

III. ***Spawning, Nursery and Grazing Ground:*** Among the sampling sites, the Haldikhali Khal (B) and the Passur River at Mongla point (E) respectively are similar in the distribution of life stages from fry to brood fish. These habitats are classified as the spawning, nursery and grazing ground.

Photo 9.1: Fish habitat in the Passur River System

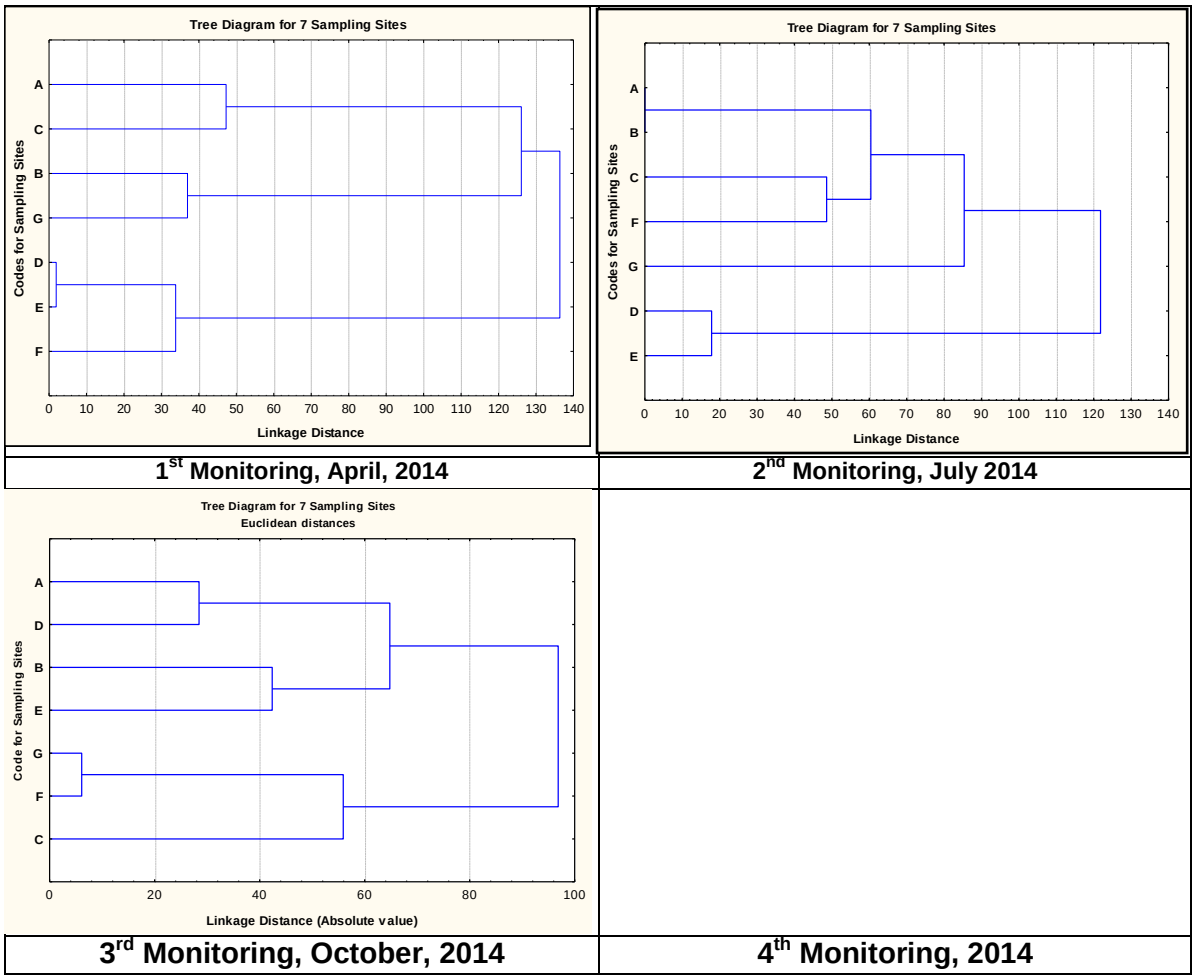
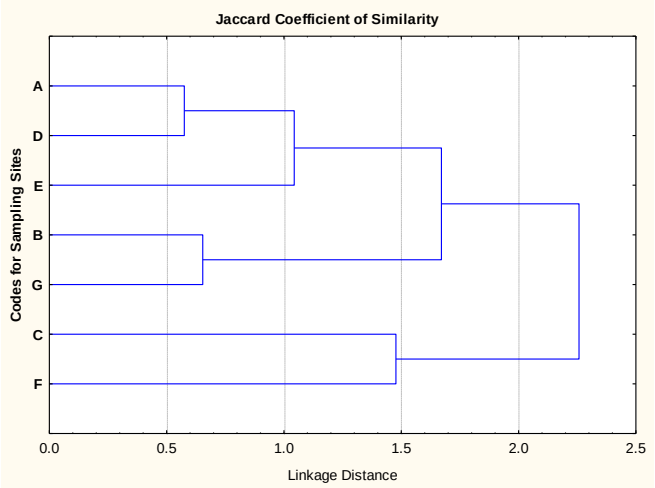


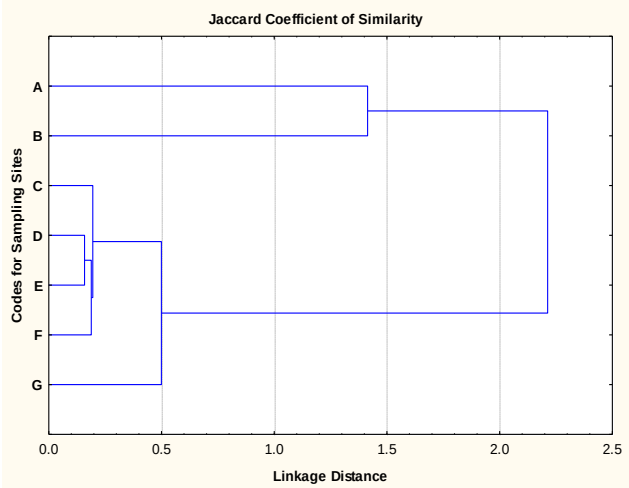
Figure 9.1: Habitat Classification on the basis of Different Life Stages of Fish Species

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

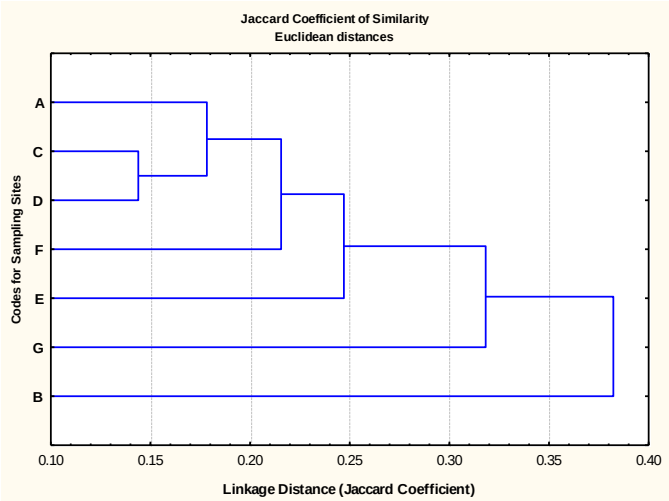
127. This figure analyse the distances among JI (Jaccard Coefficient Index) indices which are opposite to the JI values. The length-wise distribution relationship among the sampling sites was found different during third, second and first quarter monitoring. Such as, the JI value between site A and D was the highest in the first monitoring but in second monitoring this value became highest between D and E sites. However, in third quarter monitoring highest JI value was found between C and D sampling sites. Because, different length group of different fish species use their habitat for their morphological and physiological suitability in respect of food coverage, water quality and reproductive performance. It has also been found that the length frequency of different fish species were more homogenously distributed among the sampling sites in case of third quarter monitoring phase in the month of October than that of first and second quarter monitoring **(Figure 9.2)**.



1st Monitoring, April, 2014



2nd Monitoring, July 2014



3rd Monitoring, October, 2014

4th Monitoring, 2014

Figure 9.2: Dendogram Showing Similarity in Binary Species Composition in seven sampling sites

(b) Habitat Suitability Index (HSI)

128. Habitat Suitability Index (HSI) will be determined for 2014, 2015 and 2016. The data for basic life requirements (food coverage, water quality, reproductive performance, etc.) shown in the following T**able 9.3** for a fish community will be collected from water and ecological resources sections. HSI value will then be analyzed by plotting this data with the survival curve of the fish community structure after one year.

Table 9.3: Habitat Suitability Index (HSI) for selected spot in the study area

Sampling Sites	Location	HSI* (2014-2015)	HSI (2015-2016)	HSI (2016-2017)
A				
B				
C				

Sampling Sites	Location	HSI* (2014-2015)	HSI (2015-2016)	HSI (2016-2017)
D				
E				
F				
G				

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

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

9.4.4 Fish Bio-diversity

129. 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 according to the length of each species from the samples. Diversity has been calculated by analyzing Shannon-Weiner Index.

a) Shannon-Weiner Index

130. In the third fisheries monitoring, highest Shannon-Weiner index has been found at Mongla-Passur confluence point (0.76) indicating most even diversity. On the contrary, lowest evenness has been found at Herbaria (shown in the **Table 9.4**). In first monitoring, however, very high diversity in species composition was found in Haldikhali and Maidara River sampling sites, and low diversity in the Harbaria, Chandpai and Mongla Point sampling sites. While during second quarterly monitoring phase, high diversity has been found in Chalna Point, Chandpai, Harbaria and Maidara River.

Table 9.4: Site Wise Species Diversity using Shannon–Weiner Index

Site	Species No												Shannon-Weiner Index*											
	1st QM (April, 2014)	2nd QM (July, 2014)	3rd QM	4th QM	5th QM	6th QM	7th QM	8th QM	9th QM	10th QM	11th QM	12th QM	1st QM	2nd QM	3rd QM	4th QM	5th QM	6th QM	7th QM	8th QM	9th QM	10th QM	11th QM	12th QM
A	33	0	13										0.49	0	0.73									
B	12	0	24										0.85	0	0.57									
C	2	12	9										0.29	0.77	0.40									
D	12	22	15										0.31	0.78	0.73									
E	7	13	10										0.38	0.60	0.76									
F	3	13	6										0.82	0.77	0.54									
G	6	3	5										0.68	0.82	0.72									

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

b) Fish Species Richness (FSR)

131. 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 9.5** and **Figure-9.3**). In third monitoring phase, maximum FSR was obtained in Chandpai (n=5), while very low FSR was recorded in Harbaria, Maidara River at Baro Durgapur and in Chalna Point of the Passur river (n=2). Moderate FSR was observed at Akram point, Haldikhali and Mongla-Passur confluence point (n=4). Among habitats in upstream portions of the Passur river, Mongla Point was home to a rich assemblage of Baila, Golda Chingri, Harina Chingri and Poa; Maidara River at Baro Durgapur and Chalna point were rich in Phesa and Poa. Among habitats in lower stream portions, Chandpai was rich in Amadi Chela, Chami Chingri, Motka Chingri, Paissa and Tengra, Harbaria in Paissa and Poma; Haldikhali in Lal Chewa, Loitta, Motka Chingri and Poma and Akram point in Chanda Chela, Gagra Tengra, Loitta and Motka Chingri.

Table 9.5: 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									
B	Haldikhali	7	0	4									
C	Harbaria	1	5	2									
D	Chandpai	2	2	5									
E	Mongla Point	1	10	4									
F	Baro Durgapur	3	6	2									
G	Botiaghata, Chalna Point	3	3	2									

[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 to measure the species richness in the sampling sites.

Rupchanda in 1st Quarter Monitoring

Chela in 2nd Quarter Monitoring

Phesa, Chela, Hilsa, Gagla Tengra

Harina Chingri

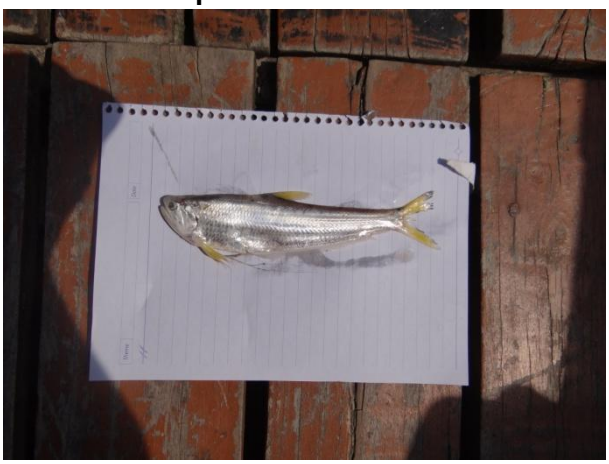
Lal Chewa

Crab

Poma, Rita, Tengra

Poma, Rita, Tengra

Fish Species in Downstream of the Passur River at 3rd Quarter Monitoring



Phesa

Poma, Phesa

Kukur Jib

Poma, Phesa

Tapse Phesa

Fish Species in Upstream of Passur River at 3rd Quarter Monitoring

Photo 9.2: Length-wise distribution of fish species

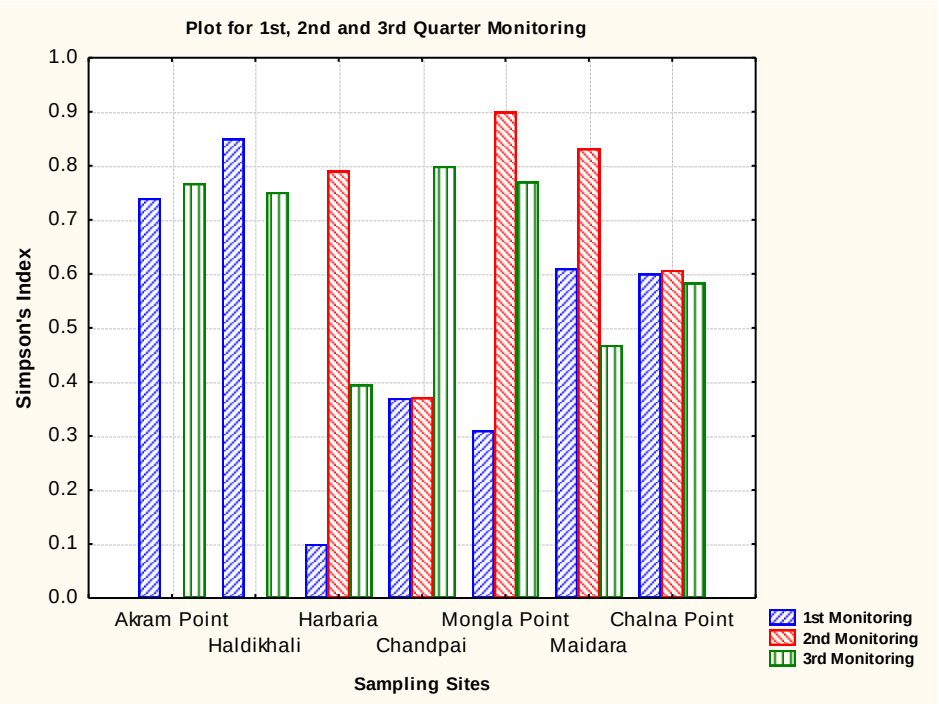


Figure 9.3: Site wise fish species richness (FSR) in the Passur River System. FSR is identified though Simpson's Index

c) Fish Community Structure

132. Fish community structure has been analyzed through counting the length-wise fish individuals (**Photo 9.2**). The following **table 9.6, -9.7 and figure 9.4** for third monitoring shows that juveniles of maximum species were more dominant in the lower stretches of the Passur River. Moreover, larval stage has been observed in higher percentage in Mongla point and Haldikhali. Among these Golda, Poma and Chewa (especially Lal Chewa) species were frequently observed. Adult fish were also found in the upper stretches (Maidara River at Baro

Durgapur and Chalna Point) of the river. Brood fish has only been observed in case of Hilsa, Banspata and Golda species in the Mongla point, Haldikhali and Harbaria of Passur river.

Table 9.6: Occurrence of Species

Local Name	Scientific Name	Local Status *	1st QM (April, 2014) %	2nd QM (July, 2014) %	3rd QM % (Oct, 2014)	4th QM %	5th QM %	6th QM %	7th QM %	8th QM %	9th QM %	10th QM %	11th QM %	12th QM %
Amadi Chela	*Chela sp.*	DD	-	-	+									
Hilsa	*Tenualosa ilisha*	NO	-	-	+									
Sagor Baim			+	-	-									
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 Chingri	*Metapenaeus brevicornis*	DD	+	+	+									
Chaka Chingri	*Penaeus indicus*	DD	+	+	-									
Ghora Chela	*Securicula gora*	-	+	-	-									
Chanda Chela			-	+	+									
Khayra Chela			-	+	-									
Sada Chewa	*Trepauchen vagina*	NO	+	-	+									
Lal Chewa	*Odontamblyopus rubicundus*	NO	+	+	+									
Chhuri	*Trichiurus muticus*	NO	+	-	+									
Sagor Chela	*Megalops cyprinoids*	NO	+	-	-									
Purabi Chela	*Thryssa purava*	NO	+	-	-									
Kabashi Tengra	*Mystus cavasius*	DD	+	-	-									
Gagra Tengra		DD	-	+	+									
Gulsha Tengra	Mystus bleekery	DD	+	+	-									
Harina Chingri	*Metapenaeus ensis*	DD	+	+	+									
Ekthuto	*Hyporhampus limbatus*	NO	+	-	+									
Kakila	*Xenentodon cancila*	NO	+	-	-									
Chapila	*Gudusia chapra*	NO	+	+	-									
Kuchia	*Monopterus cuchia*	DD	+	+	-									
Kain Magur		EN	-	+	+									
Loitta	*Harpodon nehereus*	NO	+	+	+									
Motka Chingri	*Macrobrachium villosimanusless*	DD	+	+	+									
Mud Crab	*Scylla serrata*	NO	+	-	+									
Tular Dandi	*Sillaginopsis panijus*	NO	+	-	+									
Paira Chanda	Scatophagus argus	DD	+	-	-									
Paissa	*Liza parsia*	NO	+	+	+									
Pangas	*Pangasius pangasius*	CR	+	-	+									
Tak Chanda	*Leiognathus equulus*	NO	+	-	-									
Phessa	*Setipinna phasa*	NO	+	+	+									
Teli Phessa	-	-	-	-	+									
Poma	*Poma poma*	NO	+	+	+									
Potka	*Chelonodon patoca*	NO	+	+	-									
Shilong	*Silonia silondia*	EN	+	-	+									
Tailla	*Eleutheronema tetradactylum*	-	+	-	-									
Tapse	*Polynemus paradiseus*	-	+	+	+									

*Local Status Source: IUCN Red List

Table 9.7: 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
Amadi Chela	Chandpai	0	0	0	67	33	0	0
Banspata	Botiaghata, Chalna Point	0	0	0	0	0	100	0
	Haldikhali	0	0	0	40	30	0	30
	Maidara	0	0	0	0	50	50	0
Bele	Haldikhali	0	0	0	0	100	0	0
	Harbaria	0	0	33	50	17	0	0
	Mongla Point	3	3	87	8	0	0	0
	Maidara	0	0	0	50	50	0	0
Boiragi Chela	Chandpai	0	0	0	100	0	0	0
	Haldikhali	0	0	20	80	0	0	0
Chakkhu Dhela	Haldikhali	0	0	67	33	0	0	0
Chami Chingri	Chandpai	0	100	0	0	0	0	0
Chanda Chela	Akram Point	0	0	0	100	0	0	0
	Chandpai	0	0	100	0	0	0	0
Chela	Haldikhali	0	0	78	22	0	0	0
Chhuri	Akram Point	0	0	0	0	0	100	0
	Haldikhali	0	0	0	0	0	100	0
Ekthuto	Akram Point	0	0	0	0	100	0	0
Golda Chingri	Chandpai	0	0	0	0	100	0	0
	Harbaria	0	0	0	0	0	0	100
	Mongla Point	87	0	4	9	0	0	0
Hilsa	Haldikhali	0	0	0	50	50	0	0
	Mongla Point	0	0	0	0	29	57	14
Harina Chingri	Akram Point	0	0	100	0	0	0	0
	Chandpai	0	100	0	0	0	0	0
	Haldikhali	0	100	0	0	0	0	0
	Mongla Point	17	0	67	17	0	0	0
Kain Magur	Mongla Point	0	0	0	0	0	100	0
Lal Chewa	Chandpai	0	0	56	13	31	0	0
	Haldikhali	0	61	37	2	0	0	0
Loitta	Akram Point	0	0	0	0	100	0	0
	Haldikhali	0	1	3	14	82	0	0
Maya Chela	Haldikhali	0	0	6	94	0	0	0
Motka Chingri	Akram Point	0	100	0	0	0	0	0
	Chandpai	0	100	0	0	0	0	0
	Haldikhali	0	0	100	0	0	0	0
	Harbaria	0	100	0	0	0	0	0
Paissa	Akram Point	0	0	0	100	0	0	0
	Chandpai	0	0	0	60	40	0	0
	Haldikhali	0	0	0	50	50	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
	Harbaria	0	2	0	53	45	0	0
Pangas	Haldikhali	0	0	0	67	33	0	0
	Mongla Point	0	0	0	83	0	17	0
Phessa	Akram Point	0	0	50	50	0	0	0
	Botiaghata, Chalna Point	0	0	0	0	40	60	0
	Haldikhali	0	0	0	0	100	0	0
	Mongla Point	0	0	0	0	0	100	0
	Maidara	0	0	0	0	44	56	0
Poma	Akram Point	0	0	50	0	25	25	0
	Botiaghata, Chalna Point	0	0	0	9	68	23	0
	Chandpai	0	0	100	0	0	0	0
	Haldikhali	4	33	46	17	0	0	0
	Harbaria	0	0	0	0	99	0	1
	Mongla Point	31	6	0	19	41	3	0
	Maidara	0	0	0	0	55	45	0
Sada Chewa	Haldikhali	0	0	0	56	44	0	0
Tapse	Botiaghata, Chalna Point	0	0	0	0	67	33	0
	Chandpai	0	0	0	100	0	0	0
	Haldikhali	0	0	0	100	0	0	0
	Harbaria	0	0	0	0	0	33	67
	Maidara	0	0	0	0	100	0	0
Teli Phessa	Haldikhali	0	0	0	100	0	0	0
Gang Tengra	Chandpai	0	0	0	97	3	0	0
	Haldikhali	0	0	0	100	0	0	0
	Harbaria	0	0	0	100	0	0	0
	Chandpai	0	0	100	0	0	0	0
	Haldikhali	0	0	0	100	0	0	0
Tular Dandi (Nona bele)	Botiaghata, Chalna Point	0	0	0	0	0	100	0
	Maidara	0	0	0	0	50	50	0
Vetki	Mongla Point	0	0	0	0	50	50	0

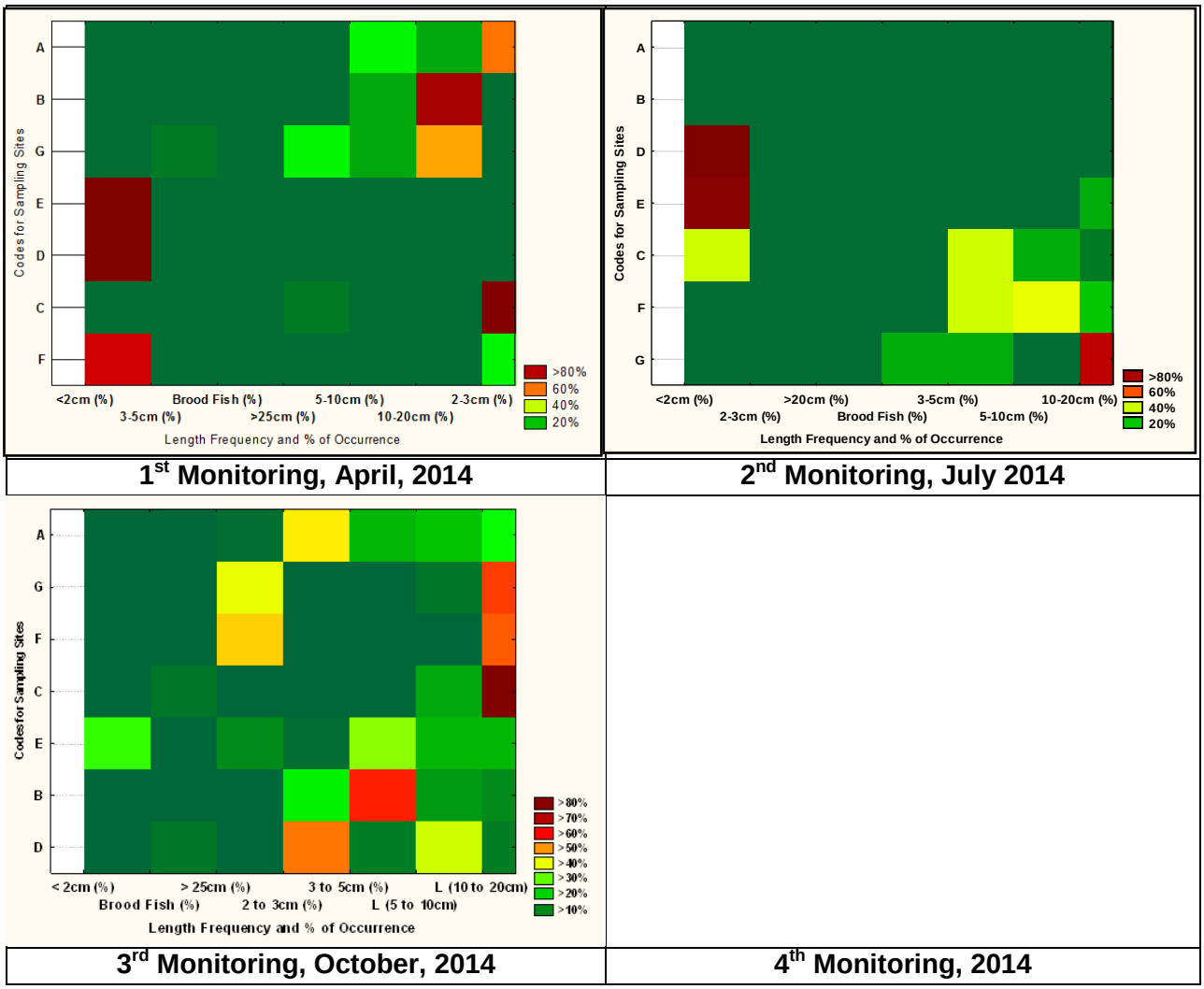


Figure 9.4: Habitat Distribution of Different Life Stages of Fish Species

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

9.4.5 Fish Migration

(a) Migratory Species Diversity

133. Migratory species have been identified by analyzing the common species available in the regular catch from the sampling sites. Fish species like Poma, Lal Chewa and Gang Tengra attain the maximum abundance among the migratory fish species observed in the third quarter monitoring. The availability of all other species found in this quarter is same as previous. The relative abundance of the migratory species is given in F**igure 9.5** below**.**

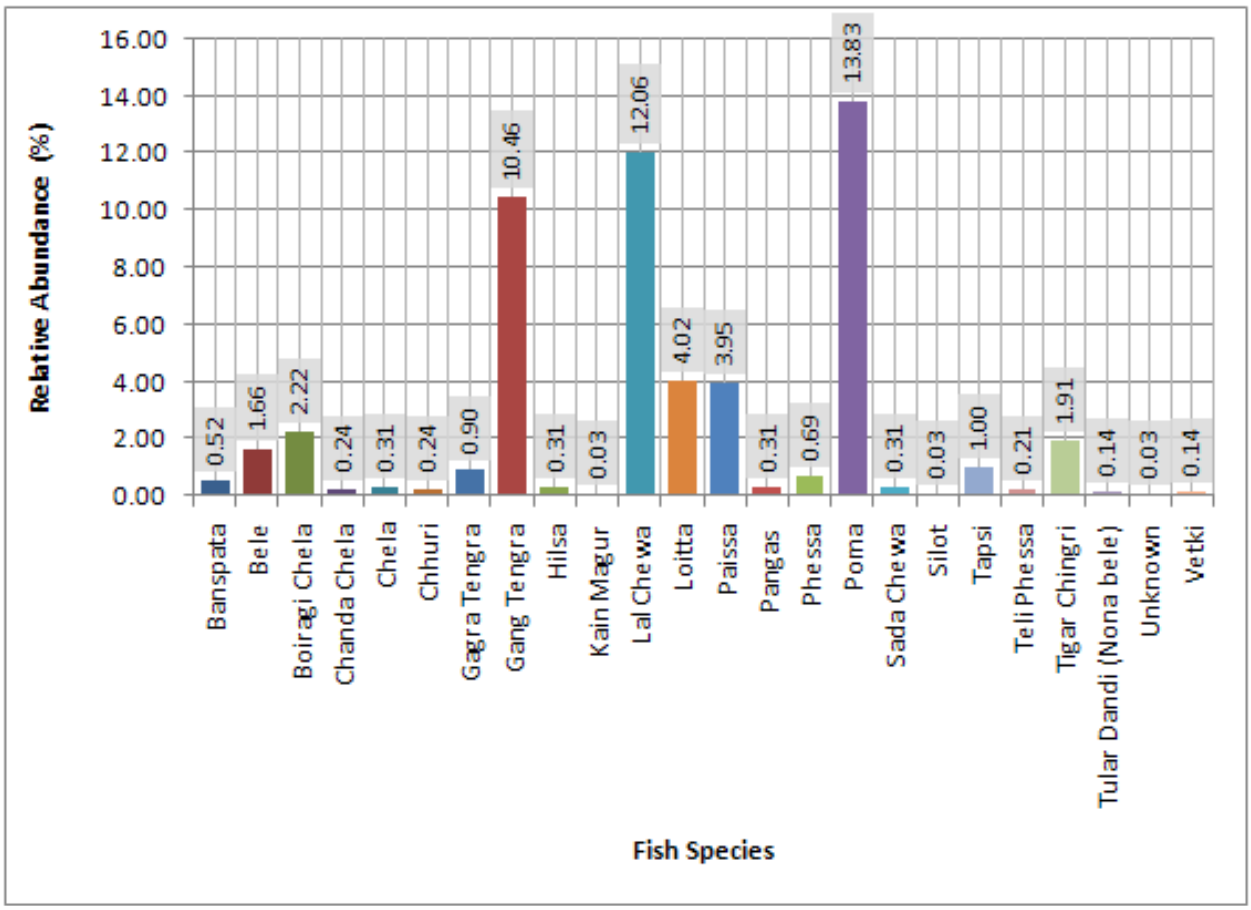


Figure 9.5: Relative abundance of migratory fish species in sampling sites

(b) Migration Extent, Time and Purpose

134. Major fish species showed interesting pattern in distribution for exploiting different purposes mentioned in the Table 9.8 through out the sampling sites. This means such fish species are migratory in nature. Sixteen (16) fish species were found common in most of the sites. The longest distance from site to site is from the Akram Point to the Chalna Point in the study reach. Only five species have been observed within this range like Tapse, Boiragi, Poma, Baila, Tular Dandi (Nona Bele), Hilsa and Phesa indicating long range of distribution (**Table 9.8**). However, the Chhuri species showed very limited distribution and collected only from two nearest location (Akram Point and Haldikhali).

Table 9.8: Purpose, timing and extent of migration for different year-class of migratory fish species

Migratory Fish Species	Sampling Sites	Year Class*	Migration Purpose											
			1st QM (April, 2014)	2nd QM (July, 2014)	3rd QM (Oct, 2014)	4th QM	5th QM	6th QM	7th QM	8th QM	9th QM	10th QM	11th QM	12th QM
Tapse	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	-	-									
	Chandpai	Fry	Breeding and Spawning	Breeding and Spawning	Feeding and Growing									
	Chalna Point	Juvenile and Age-1 adult	Feeding and Growing	-	-									
	Harbaria	Juvenile	Feeding and Growing	-	-									
	Mongla Point	Fry	-	Nursing	-									
	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	Feeding	-	Feeding									

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

Migratory Fish Species	Sampling Sites	Year Class*	Migration Purpose											
			1st QM (April, 2014)	2nd QM (July, 2014)	3rd QM (Oct, 2014)	4th QM	5th QM	6th QM	7th QM	8th QM	9th QM	10th QM	11th QM	12th QM
Gang Tengra	Haldikhali	Adult	Feeding	-	Feeding									
	Akram Point	Adult	Feeding and Breeding	-	-									
	Harbaria	Adult	-	-	Feeding									
	Chandpai	Adult	-	-	Feeding									
Gagra Tengra	Chandpai	Juvenile and 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									
Gulsha Tengra	Haldikhali	Adult	Feeding and Breeding	-	-									
	Akram Point	Adult	Feeding and Breeding	-	-									
	Mongla Point	Age-1 adult	-	Feeding and Growing	-									
Potka	Haldikhali	Adult	Feeding and Breeding	-	-									
	Chandpai	Fry	Spawning	Spawning and Nursing	-									
	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									
	Haldikhali	Juvenile and Adult	-	-	Feeding and Growing									
	Harbaria	Juvenile and Adult	-	-	Feeding and Growing									
	Mongla Point	Juvenile	-	Feeding and Growing	-									
	South-west of the Project	Juvenile	-	Feeding and Growing	-									
Bele	Akram Point	Adult	Feeding	-	Feeding									
	Haldikhali	Juvenile-1,	-	-	Nursing									

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

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

135. It has been interpreted from the Table 9.8 that in the month of October Brood fish of Hilsa species migrate to the upper reaches for spawning. Some species like Paissa, Poma, Tapse and Banspata migrate to the upper reaches of the Passur River for feeding purpose.

9.5 Shrimp/Fish Farm

136. For monitoring shrimp/fish farm, three farms has been selected within the 10km radius of the proposed power plant. 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 achieving more economical output from the farms. So, stocking pattern, growth rate and mortality rate and its causes have been surveyed intensively.

(a) Stocking Pattern

137. It is reported by the farmers of the shrimp farms that availability of wild seed (PL) has been declining over the years. For which, most of the farmers are compelled to stock hatchery produced seeds along with some wild seeds in their farms. However, similar to the first and second monitoring phase, most of stocks are collected from wild source of the Passur River in the third monitoring phase also. However, stocking densities were lower than that of the second monitoring in all the shrimp farms (**Table 9.9**). The last stocking period starts from June and continues up to September.

Table 9.9: Stocking Pattern of Fish/Shrimp farm

Location	Distance from Plant (km)	Fish Species	Stocking Density (No./ha)	Stocking Date	Stocking Source	
					Natural	Hatchery
Bhekatkhali Khal, Rajnagar	0.5	Bagda	5,702	mid-Aug	Passur River	Jessore
		Gusha Chingri	Natural Stocking	April-September		-
		Harina Chingri				
		Rui (kg)	5	First-Sept		-
		Catla (kg)	2	First-Sept		-
Kapashdanga-Muralia	1	Bagda	2,593	First-July	-	Jessore
		Vetki	Natural Stocking	April-September	Passur River	-
		Paissa				
		Phessa				
		Bhangan				
		Golda Chingri				
		Gulsha Tengra				
Chunkuri-2	0.8	Bagda	11,532	First-June	Passur River	Jessore
		Paissa	Natural Stocking	April-September		-
		Tengra				
		Bele				
		Tilapia (kg)	40	Last August	-	Jessore
		Rui (kg)	40	Last August	-	
		Vetki	Natural Stocking	April-September	Passur River	-
		Harina Chingri				

Location	Distance from Plant (km)	Fish Species	Stocking Density (No./ha)	Stocking Date	Stocking Source	
					Natural	Hatchery
		Chami Chingri				
		Catla (kg)	13	Last August	-	Jessore
		Mrigel (kg)	13	Last August	-	

Source: Field Survey, 2014

(b) Shrimp/Fish Growth Rate and Mortality

138. **Table 9.10** shows that the growth rate of Bagda has decreased in case of Chhoto Charer Gher in Rajnagar and increased in Gher of Kapashdanga-Muralia but remained same in Gher of Chunkuri-2 between second and third quarter monitoring. The mortality rate is highest in in the Gher in Chunkuri-2 and lowest in the Gher in Kapashdanga-Muralia. The mortality mainly occurs due to viral infection and is mostly experienced in the farms which do not maintain water quality. Sometimes viral infection may take place from the nearby affected Gher.

Table 9.10: Growth Rate and Mortality of Fish/Shrimp

Gher No.	1st QM (April, 2014)		2nd QM (July, 2014)		3rd QM (Oct, 2014)		4th QM		5th QM		6th QM		7th QM		8th QM		9th QM		10th QM		11th QM		12th QM	
	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																		
2	0.3	30-35	0.3	94	0.25	10																		
3	0.2	25-30	0.2	25	0.20	65																		

Source: Field Survey, 2014

Table 9.11: Total Catch in the Sampling Sites

Sampling Site	Catch Per Unit Effort (kg/haul)											
	1st QM (April, 2014)	**2nd QM (July, 2014)**	**3rd QM**	**4th QM**	**5th QM**	**6th QM**	**7th QM**	**8th QM**	**9th QM**	**10th QM**	**11th QM**	**12th QM**
A	142	0	0.28									
B	6	0	1.25									
C	4	0.2	3.15									
D	*	4	3.82									
E	*	0.2	0.02									
F	*	0.5	1.46									
G	11	0.4	3.50									

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

9.5.1 Fish Production

(a) Capture Fish Production

139. In third monitoring phase, the highest productivity has been found in Sheola Khal at Chandpai of the Passur River System, and lowest in the Akram Point **(Table 9.11**). Moreover, as expected higher productivity was observed in the third monitoring phase as compared to that of the second monitoring. However, during the month of October the lower reach of the river (Haldikhali and Akram point) has mainly been observed as the ideal home of fry which are not included in production measure.

140. During this quarterly monitoring it is observed that Ber and Behundi Jal are frequently used to catch fish. The total catch through Ber and Behundi Jal is 14.4 and 6.7 kg respectively (**Table 9.12**). The following table also expresses that Ber Jal is used in lower reach and upper reach of the Passur River. Moreover, spear has been found in upper, middle and lower reaches of the Passur River. However, the total catch is found to be higher in third quarter monitoring than that found in the second quarter monitoring (**Table-9.13**).

Table 9.12: Total Catch in Different Gears in the Sampling Sites

Site	Gear	Houl Duration (hour)	Haul No	Total Weight (Kg)
A	Ber Jal	2:30	1	2.3
	Spear	6:00	8	0.2
B	Current Jal	1:00	1	1.3
C	Behundi Jal	6:00	1	3.5
	Charpata Jal	7:37	1	4.1
D	Behundi Jal	5:00	1	3.2
E	Jhaki Jal	3:00	50	1.4
	Spear	6:00	252	3.5
F	Ber Jal	2:00	1	8.6
	Spear	1:00	8	4.6
G	Ber Jal	4:00	1	3.5

Table 9.13: Total Catch in the Sampling Sites

Sampling Site	Total Catch (kg)											
	1st QM (April, 2014)	2nd QM (July, 2014)	3rd QM	4th QM	5th QM	6th QM	7th QM	8th QM	9th QM	10th QM	11th QM	12th QM
A	28*	0	3									
B	65	0	1									
C	1,559	0.5	8									
D	**	12	3									

Sampling Site	Total Catch (kg)											
	1st QM (April, 2014)	2nd QM (July, 2014)	3rd QM	4th QM	5th QM	6th QM	7th QM	8th QM	9th QM	10th QM	11th QM	12th QM
E	**	0.6	5									
F	**	1.2	13									
G	**	1.6	4									

*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

141. During this third quarterly monitoring on shrimp/fish farm it is found that the highest production comes from the shrimp farm of Chunkuri-2 and lowest from Gher in Bhekatkhali (**Table 10.14**). Moreover, the production from all the sampling Ghers is found higher in third monitoring phase as compared to the first and second quarter monitoring.

Table 9.14: The Present Catch in Three Sampling Ghers

Sampling Site	Total Catch (kg)																							
	1st QM (April, 2014)		2nd QM (July, 2014)		3rd QM		4th QM		5th QM		6th QM		7th QM		8th QM		9th QM		10th QM		11th QM		12th QM	
	Species	ton	Species	ton	Species	ton	Species	ton	Species	ton	Species	ton	Species	ton	Species	ton	Species	ton	Species	ton	Species	ton	Species	ton
1	Bagda	5	Bagda	6.42	Bagda	4.8																		
	Vetki	1.57	Bele	0	Gusha Chingri	-																		
	Bele	0.98	Cheng	0	Harina Chingri	-																		
	Harina Chingri	0.78	Bhangan	0	Rui (kg)	-																		
	Chali Chingri	0.11	Chali Chingri	0	Catla (kg)	-																		
	Chaka Chingri	0.08			-	-																		
Sub-total =		**8.52**		**6.42**		**4.8**																		
2	Bagda	4	Bagda	1	Bagda	7																		
	Harina Chingri	2	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																		
Sub-total =		**6.00**		**2.00**		**23**																		
3	Bagda	1.38	Bagda	2.4	Bagda	1.5																		
	Harina Chingri	0.34	Harina Chingri	0.34	Paissa	10																		
	Chali Chingri	0.17	Chali Chingri	0.17	Tengra	10																		
	-	-	-	-	Bele	20																		

Sampling Site	Total Catch (kg)																							
	1st QM (April, 2014)		2nd QM (July, 2014)		3rd QM		4th QM		5th QM		6th QM		7th QM		8th QM		9th QM		10th QM		11th QM		12th QM	
	-	-	-	-	Tilapia	22																		
	-	-	-	-	Rui	28																		
	-	-	-	-	Vetki	-																		
	-	-	-	-	Harina Chingri	-																		
	-	-	-	-	Chami Chingri	-																		
	-	-	-	-	Catla	56																		
	-	-	-	-	Mrigel	50																		
Sub-total =		**1.89**		**2.91**		**197.5**																		
Grand-total =		**17.00**		**11.33**		**226.5**																		

Source: Field Survey, 2014

10 Ecosystem and Biodiversity Monitoring

10.1 Indicators of Monitoring

142. 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.

143. 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 changed due to change in environmental parameters like temperature, composition of gaseous components, soil salinity, humidity and nutrients, air particulate, dust etc. Plant diseases and proportion of healthy/ unhealthy plant is needed to observe for assessing the plant health condition.

144. 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.

145. Lichens often grow on trees and shrubs, absorbing nutrients from the atmosphere. Lichens are very sensitive to air pollution, particularly to sulfur 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.

146. 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 yeach year will be considered to observe migratory bird habitat suitability.

147. 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.

148. 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.

149. 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.

150. Followed by the above justification and rational, following indicators have been selected for regular monitoring what would be the base for dentifying 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) Benthos

b) Planktons

c) Dolphin

10.2 Location of Monitoring

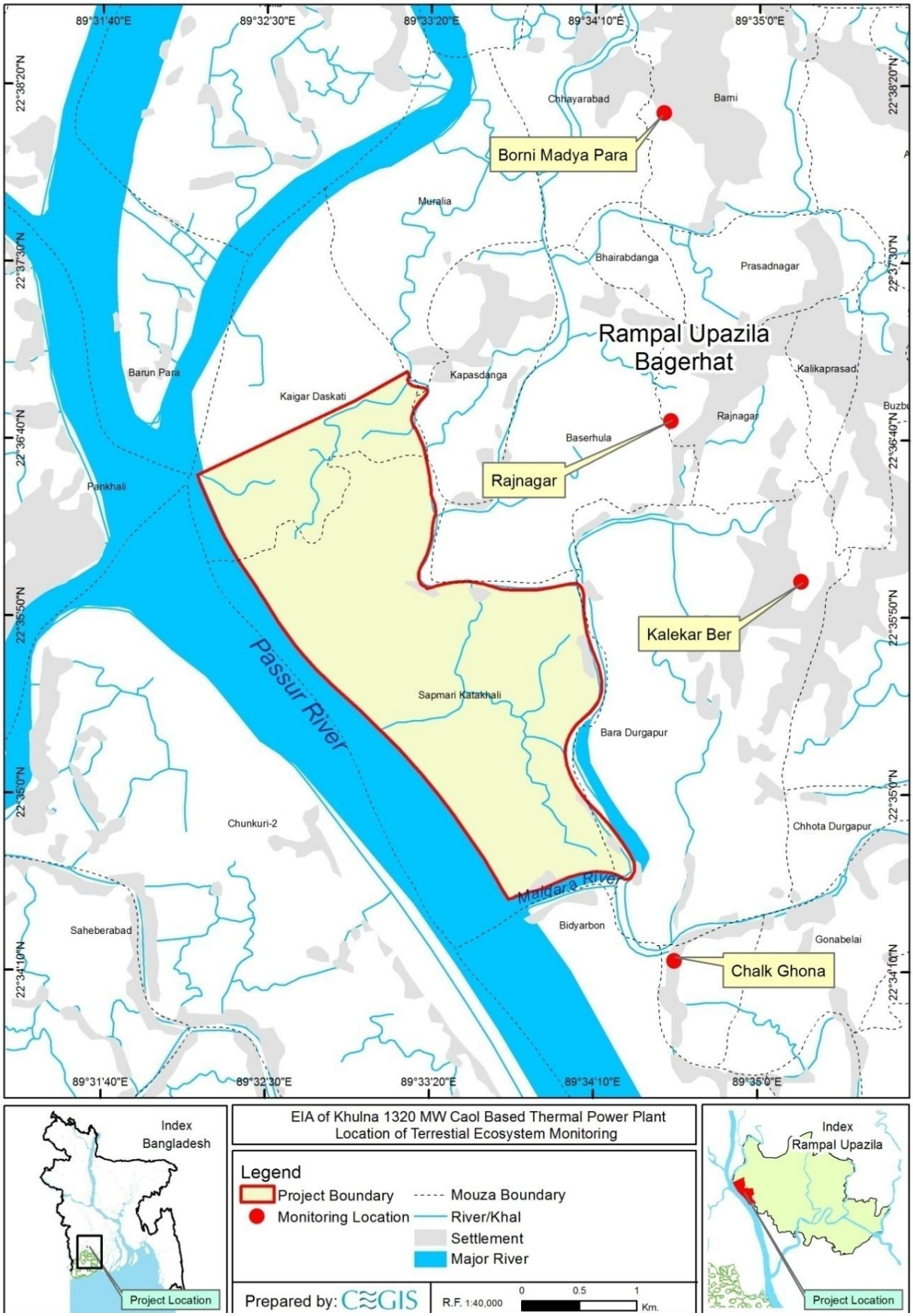
(a) Terrestrial Ecosystems

151. Four homesteads have been selected for monitoring indicators of terrestrial ecosystem in the 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 10.1** presents the selected locations, owners, homestead area and special direction from the Project boundary.

152. Table 10.1: 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
4	Village: Barni Madyapara, Union: Gaurambha, Upazila: Rampal	Md. Titu Seikh	72	About 3.0 km north from north-east boundary	22° 38'12"N 89°34'31"E

Source; Field Survey, 2014



Map 10.1: Terestrial Ecosystem Monitoring Locations

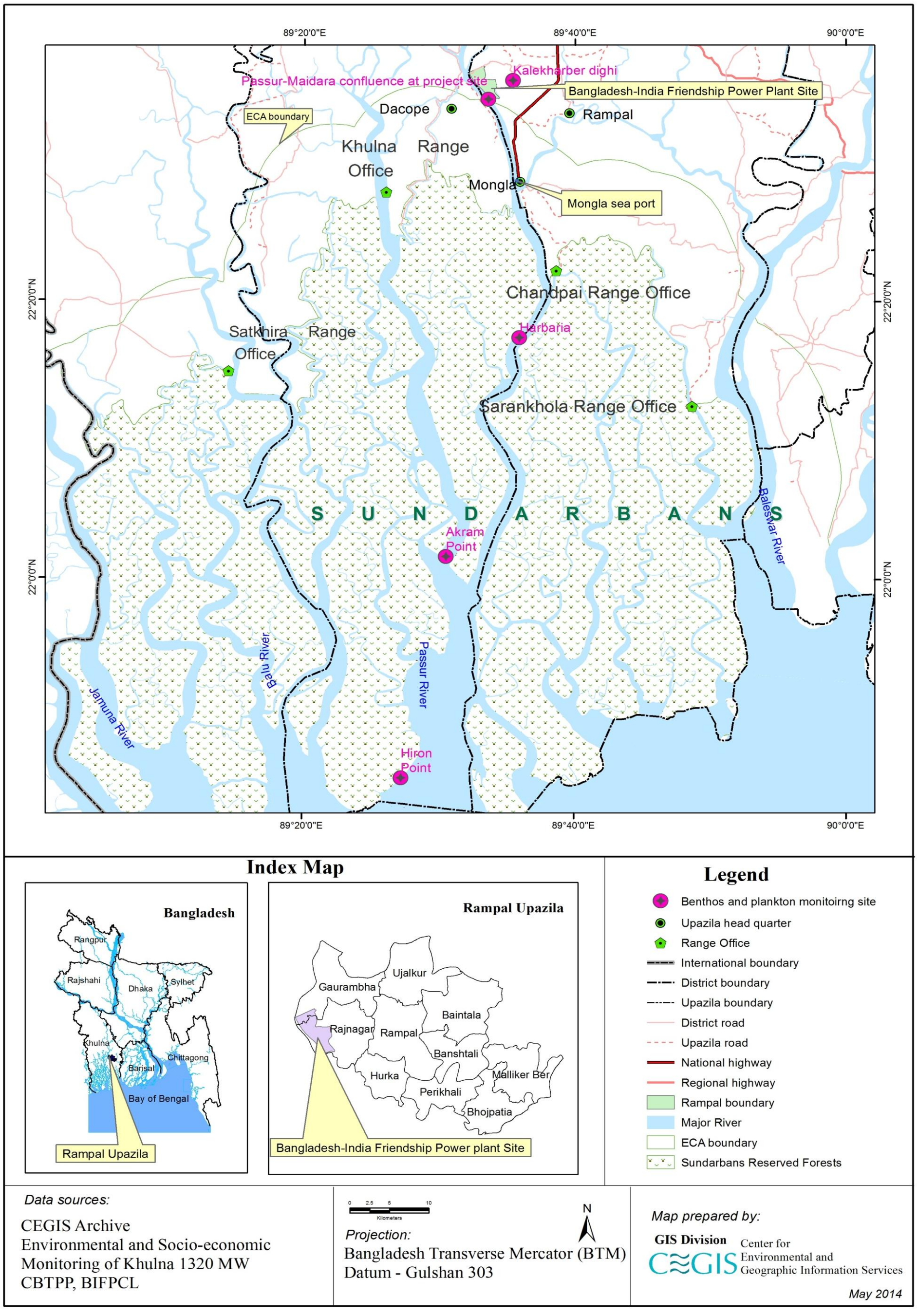
(b) Aquatic Ecosystems

153. Different locations of river systems as well as lentic waterbodies have been selected to observe the changes in the three selected indicators: benthos, plankton and Dolphin occurrence for aquatic ecosystem monitoring. In addition, to monitor the stagnant water ecosystem condition, two ponds have been selected. Only Benthos and planktonic species have only been monitored in these ponds. Monitoring locations of aquatic ecosystems is presented in **Table 10.2**.

Table 10.2: Location of Aquatic Indicators Monitoring

Indicator	Location	GPS Coordinate
Benthos and Plankton species composition in river system	Passur-Maidara confluence point	22°34'34"N 89°33'37"E
	Project Jettyghat at Passur river	22˚35'21"N 89° 32'51"E
	Passur River near Harbaria	
	Passur River near Akram Point	21˚59'33"N 89°31'54"E
Benthos and Plankton species composition in stagnant waterbody	Kalekherber Dighi	22 ^{O}36'00"N 89° 35'13"E
	Kaigardaskanthi Gucchagram Pond	22 ^{O}36'35"N 89° 32'05"E
Dolphin occurrence of River systems	6 locations of Passur River Channel from Chalna Bazar to Akram point (Passur River along Project site, Karamjal, Harbaria, Sharankhola, Akrampoint, Sibsa river near Akram Point)	22˚36'33"N 89° 32'00"E
	Along Maidara River from Passur-Maidara confluence point to upstream reach	From 22 ^{O}34'34"N 89° 33'37"E to last reaches of two river branches (Ichamoti ; Near Chalkghona village and Maidara-Saltakhali near Salitakhali village

Source: CEGIS Selection through field surey, 2014



Map 10.2: Benthos and Plankton Monitoring Locations

10.3 Baseline of Ecosystem and Bio-diversity

10.3.1 Terrestrial Ecosystem

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

a. Description of the selected homestead

155. The homestead in Rajnagar is located at a distance of 2.5 km east from the upper North-east boundary of the project site. This is situated in a low lying area and numerous small swamps exist inside and surrounding the homesteads. Water retention capacity of surface soil of this homestead is very low for which very little number of grasses and other herbs are present.

156. Land elevation of selected homestead at Kalekar Ber dighi village is comparatively flood free. This is located at about at 1.8 km east from Middle-east boundary of the project.

157. Chalkghona village is located at 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 waterbodies support to grow staple coverage of saline tolerant plant species.

158. 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 the Rajnagar site. Vegetation of this homestead have been severely been damaged by during Cyclone Aila.

b. Species Composition of selected homestead vegetation

Homestead at Rajnagar

159. Among the trees, Gewa *(Excoecharia 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. Three Bola *(Hibiscus tiliaceus)* three and one Sundari (*Heritiera fomes)* tree are also found. The homestead has no grasses or undergrowth vegetation.

Homestead at Kalekar Ber dighi

160. 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 with 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

161. Similar to the above homesteads, Narikel is the dominating tree species occupying the top canopy in the selected homestead at Chalkghona. As the homestead is near the peripheries of river and shrimp gher, soil salinity supports luxurious growth of mangrove plant Gewa (Excoecharia agallocha). This homestead has two shallow ditches which contain brackish water throughout the year and 2 Gol *(Nipa fruticans)* bushes are also 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 10.1.**

Photo 10.1: A part of homestead vegetation at Kalekarber

Homestead at Barni

162. This homestead contains 21 types of 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. The house owner then planted many timber and fruit yielding trees in the home yard. Detail plant species composition of this homestead has been mentioned in **Table 10.3**.

Table 10.3: Species Composition of studied homestead vegetation

Species Name	Local Name	Family	No. of Plants			
			Barni	Kalekar Ber Dighi	Chalkghona	Rajnagar
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	Ata	Anonaceae	-	1	-	-

Species Name	Local Name	Family	No. of Plants			
			Barni	Kalekar Ber Dighi	Chalkghona	Rajnagar
squamosa						
Areca catechu	Supari	Palmae	10	18	-	-
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	2	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

Species Name	Local Name	Family	No. of Plants			
			Barni	Kalekar Ber Dighi	Chalkghona	Rajnagar
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

c. Species Diversity of homestead vegetation

163. 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 briefly described in following **table 10.4.**

Table 10.4: 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

Location	Sl. No.	Species Name	Local Name	Family	Total Number of individuals	Density	Abundance
	5	*Phoenix sylvestris*	Khejur	Palmae	12	2.4	240
Kalekar Ber Dighi	1	*Cocos nucifera*	Narikel	Palmae	56	11.2	1120
	2	*Excoecharia 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	*Excoecharia 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, April 2014 and June 2014

d. Diversity Index of Sampling homesteads vegetation

164. 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 10.5: Diversity Index of homestead plant species

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

Source: Vegetation Survey, April 2014 and June 2014

e. Plant health

165. Plant health of this area is not satisfactory. Vegetation structure of this area is tree dominant. Random saline shrimp farming is a major threat to plant health of this area. Starting of shrimp farming in this area triggered incretion of salinity of soils. For this reason, plant succession, growth and productivity have fallen down in this area.

Plant Diseases and symptoms in homestead vegetation

166. 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 the study area. In this regards, 5 different plant species (Cocos nucifera, Manilkara zapota, Mangifera indica, Borassus flabellifer and Psidium guajava) have been observed in each homesteads.

167. Leaf spot, leaf blast, nut fall, spot canker on fruits are common diseases of the plants in the study area. A brief discussion was conducted with house owners about the diseases of selected economic plants which exist in their homesteads. Most symptoms of 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 spot canker on fruits is the common

symptoms of Cocos nucifera. In addition, diameter loss at top portion of this monocot is also common symptom of this plant. In case of Mangifera indica, leaf blast is also found at Chalkghona village. Most of the homesteads plants are affected by fungal or bacterial pathogens. To observe fungal diseases symptom clearly, post wet season is the best time as most of the fungal pathogen germinate and penetrate in moist condition.

Photo10.2 : Disease affected Coconut and Date palm plants of the studied homesteads (Upper photos are Rajnagar and lower both have been taken from Chalkghona)

Number of disease affected trees

168. Disease affected plants has recivered and become more lively green than previous monitoring season in June 2014. However, still some unhealthy plants on each studied homestead were seen in this quarter. Coconut *(Cocos nucifera)* and Date palm *(Phoenix sylvestris)* are the main victim species of disease infection. Sample homestead at Rajnagar and Chalkghona are found having higher numbers of infected plants of said victim species. Diameter of these two monocots species have been reduced at upper portions, and canopy coverage and fruit production have been reduced as well. Immature death of leaves is another common symptom. Excess saturation and salinity of soil may be main reason for this symptom. Height of homestead platforms of Rajnagar and Chalkghona are comparatively lower than other portions of the study area. Moreover, existence of surrounding shrimp farms is another reason for increase of soil salinity.

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

Table 10.6: 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)	1st QM (Apr 2014)	2nd QM (Jun 2014)	3rd QM (Oct 2014)
Rajnagar	*Cocos nucifera*	17	NS	7	11*	NS	10	5
	Phoenix sylvestris	25	NS	10	21	NS	15	4
	Manilkara zapota	1	NS	1	1	NS	0	0
	Albizia saman	2	NS	2	2	NS	0	0
	Excoecaria agallocha	100	NS	100	98*	NS	0	1
	Mangifera indica	3	NS	2	3	NS	1	0
	Psidium guajava	2	NS	0	2	NS	2	0
Barni	*Cocos nucifera*	10	3	7	10	7	3	0
	Phoenix sylvestris	12	12	7	8	0	5	4
	Borassus flabellifer	6	3	5	6	3	1	0
	Mangifera indica	6	3	3	5	3	3	1
	Excoecaria agallocha	18	18	18	18	0	0	0
	Swietenia mehogani	11	11	11	11	0	0	0
	Areca catechu	10	10	4	8	0	6	2
	Manilkara zapota	1	1	1	1	0	0	0
	Psidium guajava	2	0	1	2	2	1	0
Kalekarber Dighi	*Cocos nucifera*	56	21	50	55	35	5	1
	Phoenix sylvestris	10	10	7	10	0	3	0
	Mangifera indica	5	3	5	5	1	1	0
	Manilkara zapota	1	1	1	1	0	0	0
	Borassus flabellifer	8	8	8	8	0	0	0
	Zizyphus sp	1	1	1	1	0	0	0
	Psidium guajava	8	7	8	8		0	0
	Tamarindus indica	2	2	2	2	0	0	0
Chalkghona	*Cocos nucifera*	39	35	20	34	25	19	5
	Phoenix sylvestris	24	24	14	23	0	10	1
	Albizia saman	3	1	3	3	0	0	0
	Excoecaria agallocha	36	36	36	35	0	0	1
	Manilkara zapota	1	1	1	1	0	0	0
	Psidium guajava	17	16	10	17	1	7	0
	Mangifera indica	7	5	6	7	2	1	0
	Borassus flabellifer	2	2	2	2	0	0	0

Note: NS = Not Surveyed

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

f. Vegetation canopy status

170. Canopy status of terrestrial vegetation indicates plant health and biomass properties of an area. Vegetation canopy structure may be changed for any change in plant growth rate due to soil properties change, plant physiological disorders for the 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

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

Estimated Canopy cover in homestead vegetation of sampling sites

172. Overall canopy cover is found unchanged except in Chalkghona site. Vegetative growth of each plant by the influence of rain water is the reason for this improvement. In addition, Plantation of new saplings is an additive factor. Following table represent the % of canopy coverage of the studied homesteads.

Table 10.7: Vegetation Canopy Cover in different studied homesteads

Location	% of canopy Coverage		
	1st QM (Apr 2014)	**2nd QM (Jun 2014)**	**3rd QM (Oct 2014)**
Rajnagar	NS	19	19
Barni	NS	26	18
Kalekarber	NS	20	24
Chalkghona	NS	13	24

Note: NS = Not Surveyed

g. Lichen cover

173. The decreasing trend of lichen coverage has been observed on plant bark in the studied homestead vegetation. After the rainy season, lichen is found in vegetative stage but the affected area of plant is not axpanding. However, on average, vegetation at Kalekarber recorded highest lichen coverage as there are larger numbers of long trees with denser canopy than other locations. **Table 10.8** refers average percentage of lichen coverage of the studied locations.

Table 10.8: Lichen Coverage in different studied homestead vegetation

Location	% of Lichen Coverage					
	1st QM (Apr 2014)	2nd QM (Jun 2014)	3rd QM (Oct 2014)	4th QM	5th QM	6th QM
Raj Nagar	NS	5.1	2.5			
Barni	NS	7.8	3.1			
Kalekarber	NS	4.3	3.2			
Chalkghona	NS	2.1	2.6			

Note: NS = Not Surveyed

Photo 10.3 : Lichen on an Chambol tree at Kalekarber and Gewa tree trunks at Chalkghona

h. Bird Habitat

Local birds and their nesting behavior

174. The study area supports numerous local bird species. Most of which, dwell in homestead vegetation. Existence of vast shrimp farms as well as canals and rivers also 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 boundary, 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 10.9**

Table 10.9: 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
Copsychus saularis	Oriental Magpie-Robin	Udoi Doel

Scientific Name	Common Name	Local Name
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

Photo10.4: Some local birds of the study area

Migratory birds and their habitats

175. According to local knowledgeable people, different species of migratory birds are observed in shrimp ghers and other large waterbodies during winter. To evaluate habitat suitability from the next year, number of wetlands inside the study area will be considered where migratory birds usually come.

176. Information on migratory birds and their habitats along the study area will be presented after visiting the study area during next monitoring. However, a brief discussion has been made with local knowledgeable persons during previous monitoring (June 2014) to know about the locations of migratory birds' wetland/habitat. The name and locations of the wetlands inside the study area which favour migratory birds have been mentioned in following table.

Table 10.10: Location of wetland for Migratory bird habitat inside the study area

Location Name	Mouza	Wetland type	Approximate distance from project Boundary (Km.)
Choto Charargher	Boro Durgapur	Saline Water Shrimp Farm	0.10
Boro Charargher	Boro Durgapur	‘’	0.10
Putimari Gher	Boro Durgapur	‘’	1.10
Golbunia Gher	Boro Durgapur	‘’	0.1
Shukariar Gher	Basherhula	‘’	1.25
Koigar Daskati Gher	Koigar Daskati and Muralia	‘’	0.25
Badyamari Gher	Bidyarbon	‘’	1.00
Chalkghonar Beel	Chalkghona	‘’	1.50

Source: Field Monitoring, June 2014

Bird species and number of Bird nests in sampling sites

177. No bird nest has been observed in the 4 studied homesteads during this monitoring season.

Table 10.11: Bird nest monitoring datasheet

Bird Name	No. of Bird Nest observed																							
	1st QM (Apr 2014)				2nd QM (Jun 2014)				3rd QM				4th QM				5th QM				6th QM			
	R	B	K	C	R	B	K	C	R	B	K	C	R	B	K	C	R	B	K	C	R	B	K	C
Little Cormorant	NS	-	NS	-	12	-	-		-	-	-	-												
Little Egret	NS	-	NS	1	4	-	-		-	-	-	-												
Asian Pied Starling	NS	1	NS	-	-	-	-	11	-	-	-	-												
Tailor Bird	NS	-	NS	1		-	-		-	-	-	-												

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

i. Butterfly occurrence

178. A total numbers of 28 butterfly species have been recorded from the study area. Among which, 5 species were not directly sighted during field visit in this monitoring period but were identified through public discussion. Rice Swift, Common Crow, Grass-yellow, Common Emigrant, Blue Tiger are the common butterflies in the study area frequently seen along the flowering plants, near marshes and bushes. Recorded butterfly species and their occurrences are listed in **Table 10.12** below.

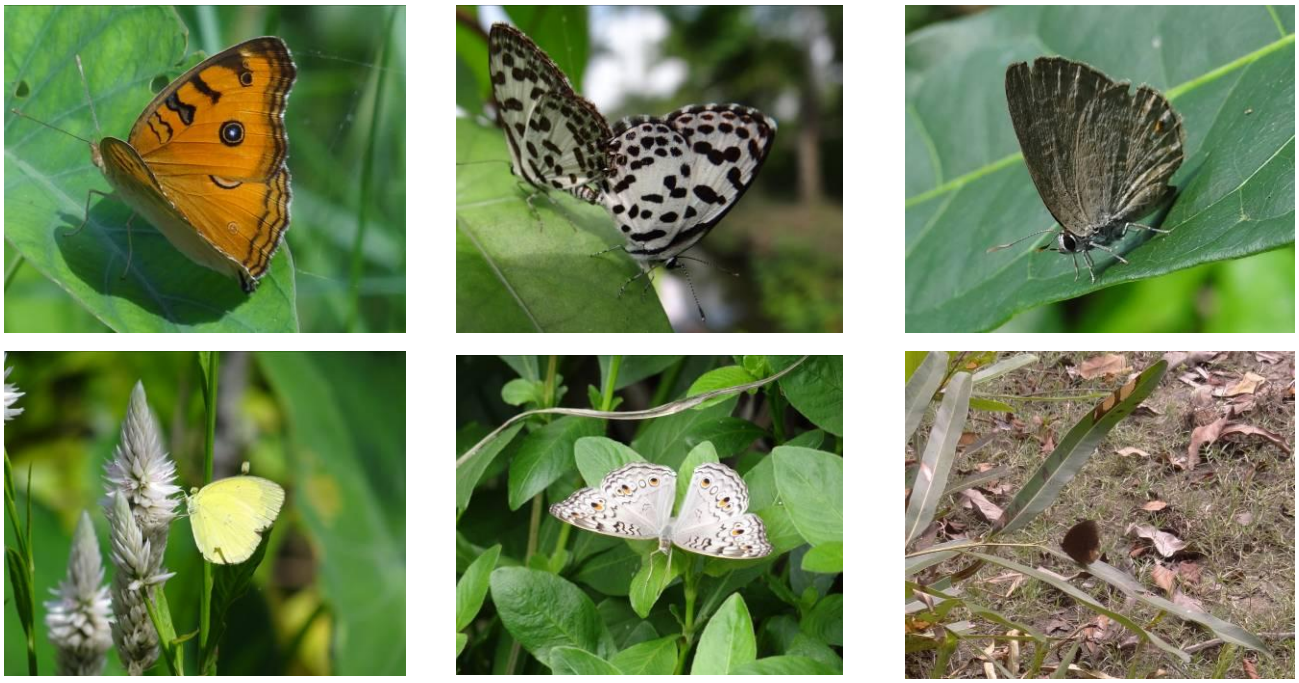
Table 10.12: Occurrences of Butterflies in the study area

Common Name	Scientific Name	Occurrence of Butterfly species											
		1st QM (Apr 2014)				2nd QM (Jun 2014)				3rd QM (Oct 2014)			
		R	B	K	C	R	B	K	C	R	B	K	C
Rice Swift	*Borbo cinnara*					-	-	-	-	-	**	*	**
Common Pierrot	*Castalius rosimon*					-	-	-	-	-	*	-	*
Common Emigrant	*Catopsilia pomona*					-	-	-	-	*	*	**	*
Common Gull	*Cepora nerissa*					-	-	-	-	-	*	-	
Indian sunbeam	*Curetis thetis*					-	-	-	-	-	-	-	*
Swamp Tiger	*Danaus affinis*					-	-	-	-	-	-	-	-
Stripped Tiger	*Danaus genutia*					-	-	-	-	*	-	*	-
Common palmfly	*Elymnias hypermnestra*					-	-	-	-	-	*	*	-
Spotted Pea-blue	*Euchrysops cnejus*					-	-	-	-	-	-	-	-
Common Crow	*Euploea core*					*	-	*	*	*	*	-	*
Papuan Grass-yellow	*Eurema blanda*					-	-	-	-	*	**	-	*
Small Grass-yellow	*Eurema smilax*					-	**	-	-	-	-	-	-

Common Name	Scientific Name	Occurrence of Butterfly species											
		1st QM (Apr 2014)				2nd QM (Jun 2014)				3rd QM (Oct 2014)			
		R	B	K	C	R	B	K	C	R	B	K	C
Danaid Eggfly	*Hypolimnas misippus*					-	-	-	-	-	-	-	-
Common Cerulean	*Jamides celeno*					-	-	-	-	-	-	*	-
Peacock pansy	*Junonia almana*					-	-	-	-	-	**	-	-
Grey Pansy	*Junonia atlites*					-	-	-	-	-	*	-	-
Chocolate Argus	*Junonia hedonia*					*	-	*	-	-	-	-	-
Lemon Pansy	*Junonia lemonius*					-	-	-	-	-	*	-	-
Evening Brown	*Melanitis leda*					-	-	-	-	-	-	-	-
Common Rose	*Pachilopta aristolochiae*					-	-	-	-	-	-	-	-
Common Rose	*Pachliopta aristolochiae*					-	-	-	-	-	-	-	*
Orchard Swallowtail	*Papilio aegeus*					*	**			-	-	-	-
Lime Butterfly	*Papilio demoleus*					-	-	-	*	-	-	-	*
Foscus Swallowtail	*Papilio fuscus*					-	-	-	-	-	-	-	-
Common gull	*Papilio nerissa*					-	-	-	-	-	-	*	-
Common Leopard	*Papilo phalantha*					-	-	-	-	-	*	*	-
Blue Tiger	*Tirumala hamata*					-	-	-	-	-	**	*	-
Dainty Grass-blue	*Zizula hylax*					-	-	-	-	-	*	*	-

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

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



Picture 10.5 : Common butterflies of the study area

10.4 Aquatic Ecosystem Monitoring

179. Rivers, canals, ponds and saline water shrimp farms are the main wetlands in the study area. Of which, river bears the flowing/ lotic and pond bears the stagnant/lentic water systems. Shirmp farmers have unauthorizedly merged the canals surrounding the shrimp farm into the shrimp aquaculture pond. Therefore, canals no longer remain as flowing or stagnant water system.

10.4.1 Monitoring Locations

180. 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.

181. Benthos and planktons have been monitoring for two seasons (Dry and Wet) of each year. According to that, dry season monitoring for these indicators will be monitored in next monitoring period.

10.4.2 Dolphin

Dolphin migration route in study area

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

Dolphin occurrence in Passur River

183. Dolphins were observed different locations throughout the Passur Channel from Chalna Bazar to Akram Point. In this monitoring, more occurrences has been sighted in the selected monitoring locations.

184. A total numbers of 13 Ganges River dolphins have sighted during 20 km transect at Passur River near project sight. The survey was conducted during continuing ebb tide of the river in calm situation and a minor time during starting of flood tide. Dolphin occurrences were high at confluence points of Passur- Maidara and Passur-Mungla River. Detail survey result is presented in figure 10.1.

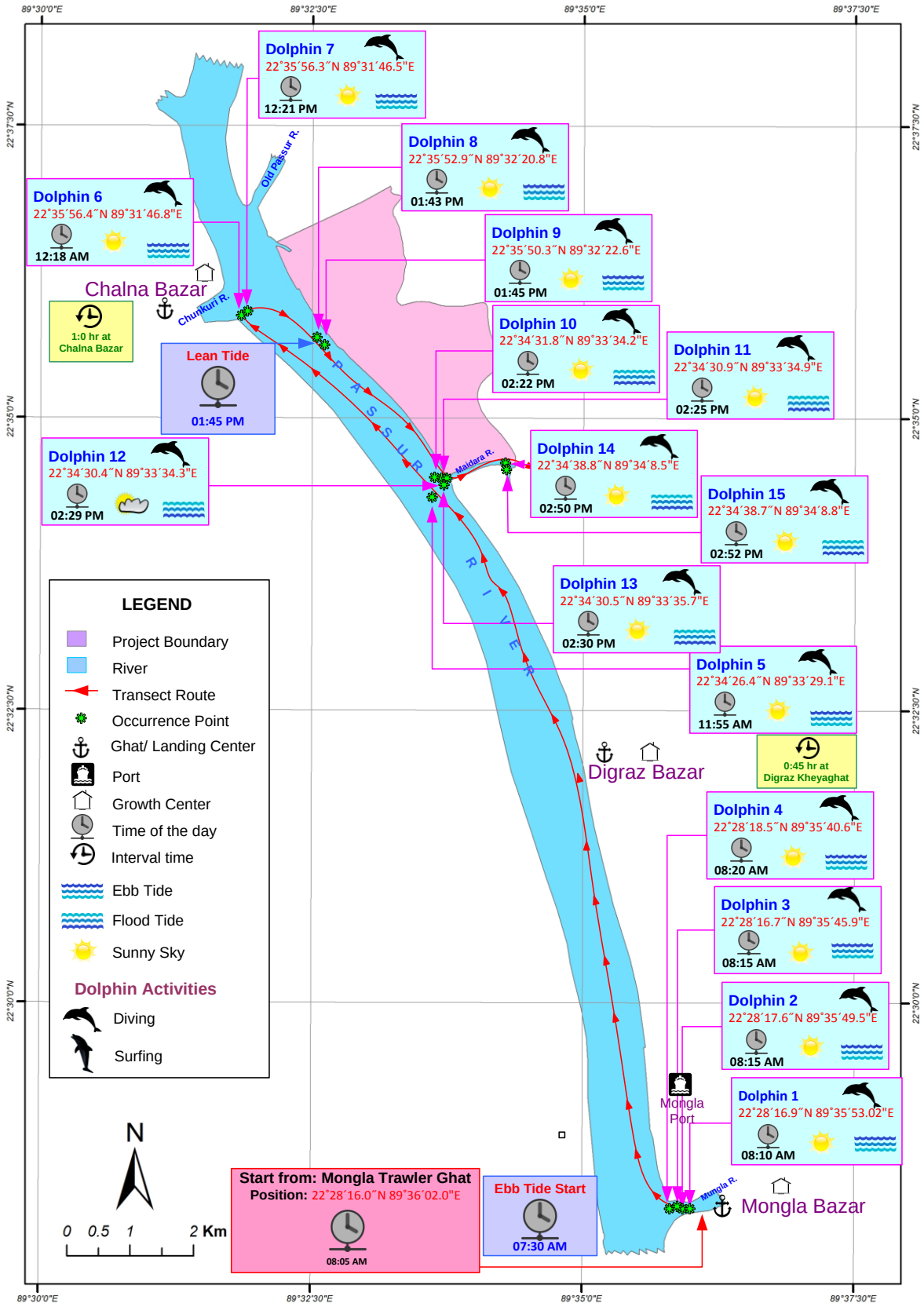


Figure 10.1: Occurrence of Dolphin at Passur and Maidara River along the project site (October 2014)

185. Another short survey was conducted Karamjal, Harbaria and Akram Point while passing the river. Dolphins were followed both at Karamjal and Harbaria. However, the survey result is included in **Table: 10.13.**

Dolphin occurrence in Maidara River

186. In parallel to the survey in Passur river, Dolphin survey was conducted in Maidara River as well, during initial stage of flood tide. 4 dolphin individuals have been sighted at mouth of Maidara River (Passur-Maidara confluence point) which is already mentioned earlier. Beside this, another 2 individuals have been sighted at Maidara-Ichaamoti confluence point a distance about 2 km upstream from the mouth of Maidara River.

Table 10.13: Dolphin observation Datasheet

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

Note: FT=Flood Tide, NT=Neap Tide, NS=Not Surveyed,

Occurrence Status: Y = Occurred, N = Not occurred

11 Sundarbans Forest Health Monitoring

11.1 Monitoring Indicator

187. 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, pneumotaphore 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

188. Monitoring frequency for different indicators are different. In this quarter, the following indicators were observed

- Regeneration and recruitment
- Canopy cover, pneumotaphore
- Crab hole density

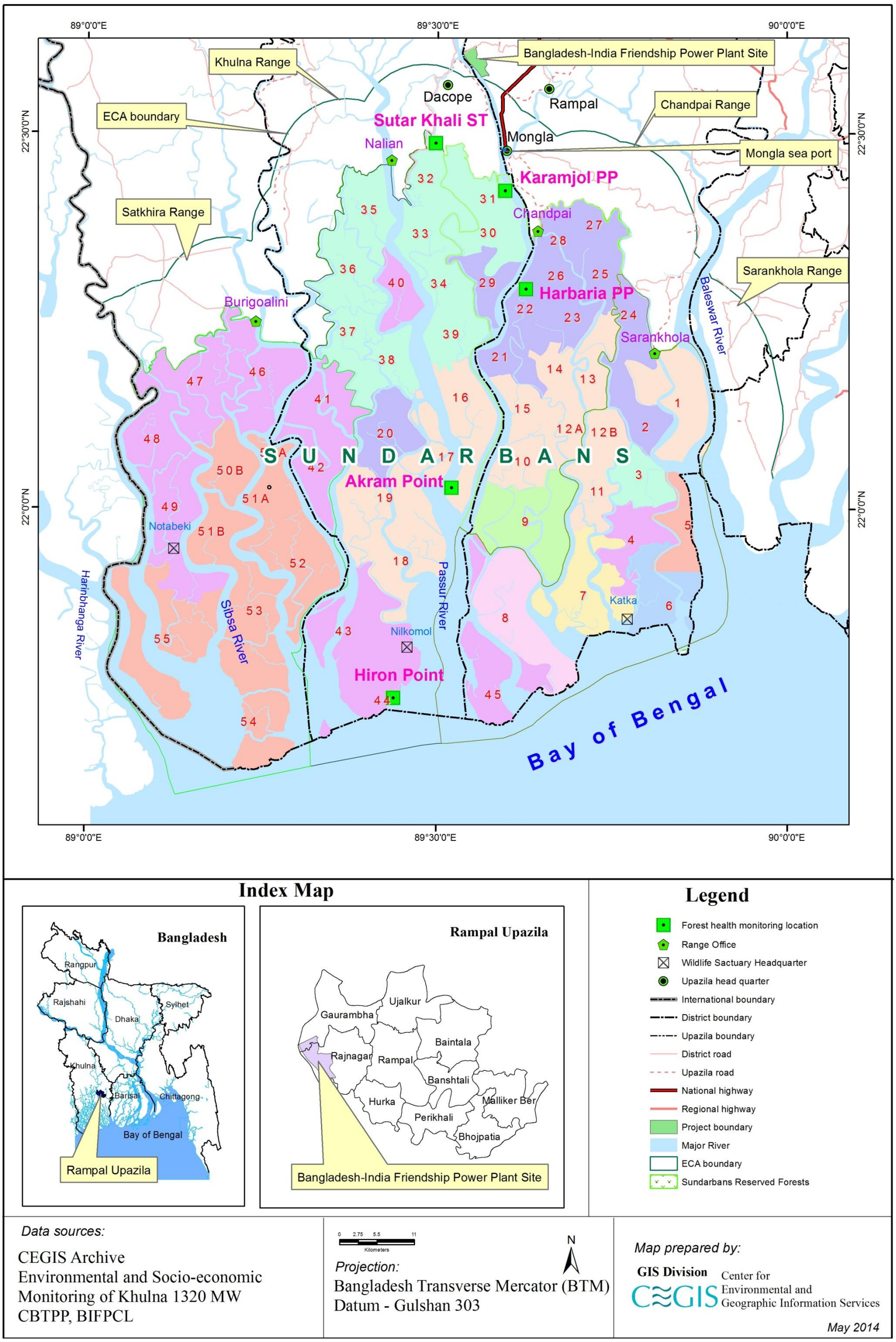
11.2 Monitoring location

189. Five sites were selected on the basis of the survey conducted from April 3 to 6, 2014 (Map 11.1). Among them, four sites along the Passur River at Karomjol, 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 majon criteria for site selection.

11.3 Method

11.3.1 Sampling design

190. 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 11.2). 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.



Map 11.1 : Location Map of Sundarbans Forest health Monitoring Plots

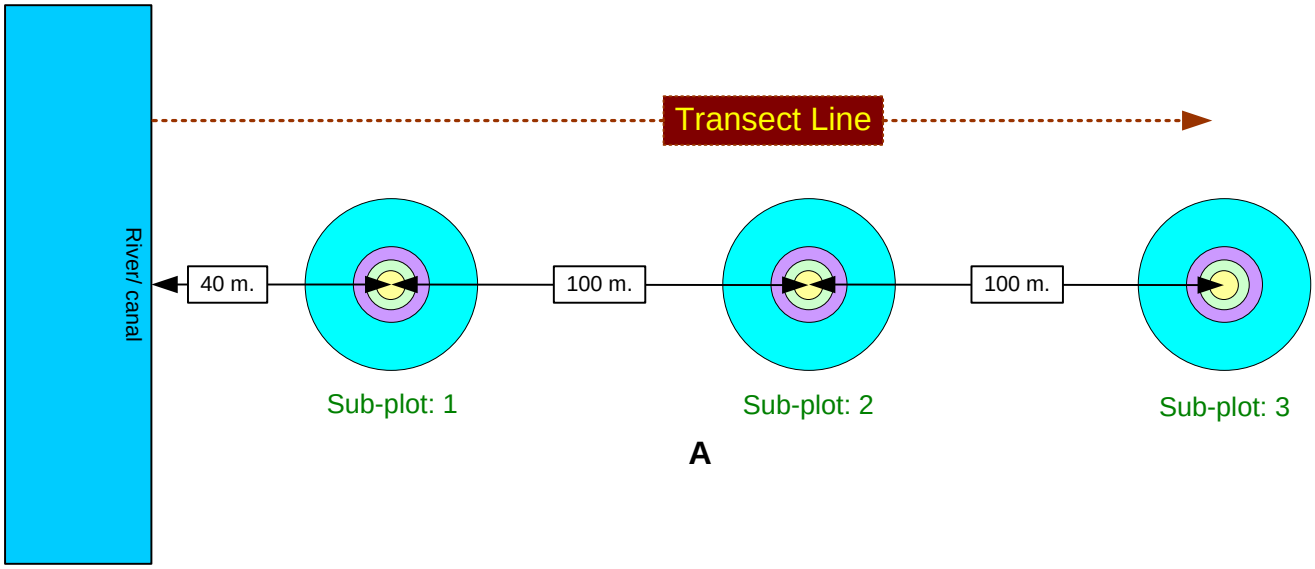


Figure 11.1: Layout of thye subplots and transect line perpendicular from ecotone (river or canal bank)

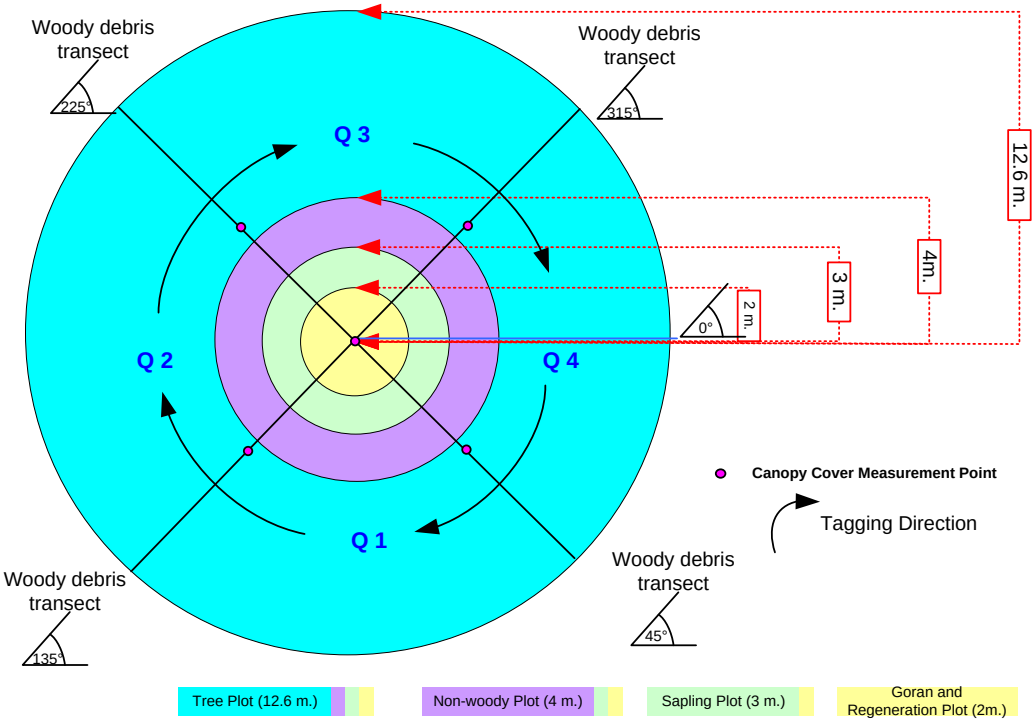


Figure 11.2: Layout of the survey sctivities in each subplot

11.3.2 Forest Health Survey

(a) Trees

191. As tree growth parameters were planned to assess half yearly detail measurement was not carried out in this monitoring period. However, in this survey, the tag number of each plant was checked and marked again (if required).

Photo 11.1: Tag number on July 2014 Monitoring

Photo 11.2: Repainted on October 2014 monitoring

Sapling and seedling

192. Saplings (DBH < 5 cm and height 1.37 m) were not measured in this survey because it will be monitored half yearly. Seedlings (height < 1.37 m) were assessed within 2m radius circle. Seedlings were counted species wise and there living status also was recorded. For saplings species name, DBH and living status were measured and documented.

Non-tree vegetation

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

Pneumatophore

194. Pneumatophore, 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 Pneumatophore 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 pneumatophore was recorded with its living status whether live or dead.

Photo 11.3: Surveyor counting Pneumatophore of *Heritiera fomes* in Harbaria monitoring site

Crab hole

195. 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 a area of 2 m radius circle in each subplot.

Photo 11.4: Surveyor counting pneummotaphore at Hiron point site in SRF

(b) Canopy cover

196. 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 leveling 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 center point. First one was taken standing at subplot centre and other four were taken at the middle point of the four transects between center and periphery. The canopy cover was estimated by taking the average of these five readings.

11.4 Monitoring Result and discussion of SRF Health

11.4.1 Canopy cover

197. The canopy cover percentage was found to remain same in subsequent two monitoring in SRF ($P < 0.05$). This insignificant difference in canopy cover percentage reveals that the foliage condition of all the monitoring sites were very good and having less insect damage.

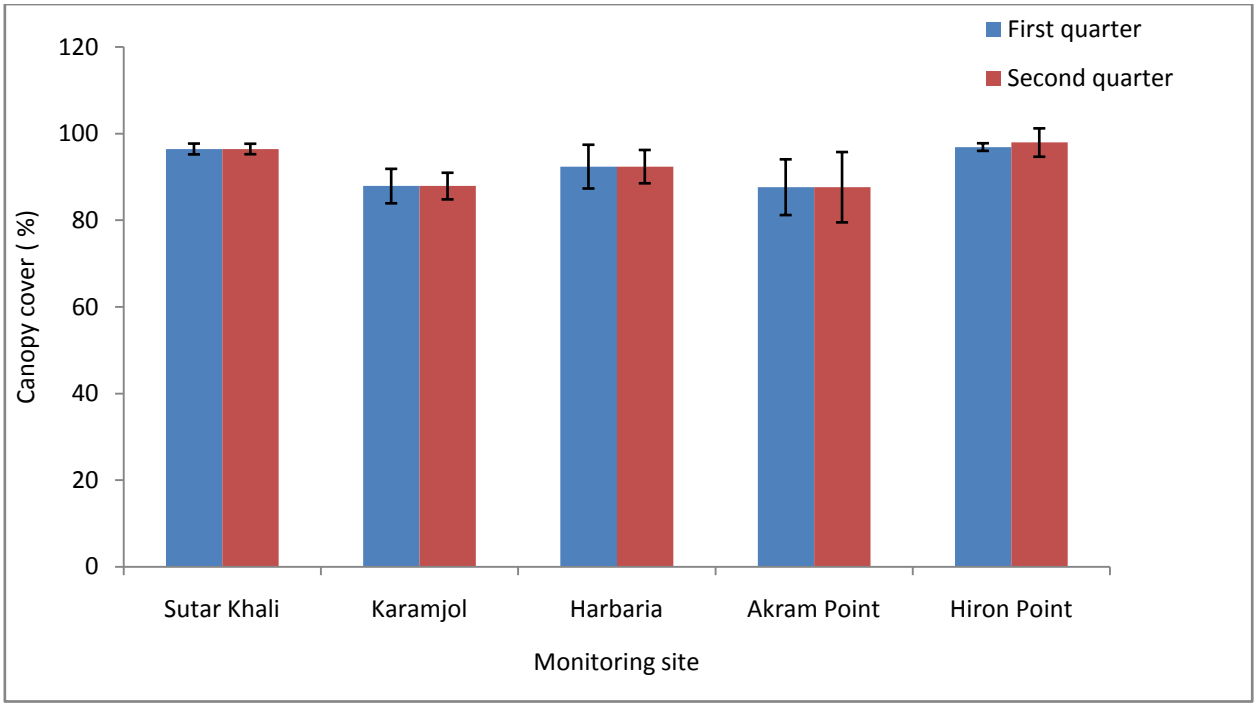


Figure 11.3: Mean (± 95% CI) canopy cover (%) between first and second quarter suervy in five monitoring sites of the SRF.

11.4.2 Pneumatophore

198. Mean pneumatophores density did not significantly varied between the two subsequent monitoring (P>0.05) in each of the five monitoring sites. A similar trend was found at Sutar Khali, Harbaria, Harbaria and Akram point site. However, though huge difference was detected in Karamjol between the two surveys, in paired t-test, no significant change was made. The higher 95% CI in Karamjor could be responsible for such invariability.

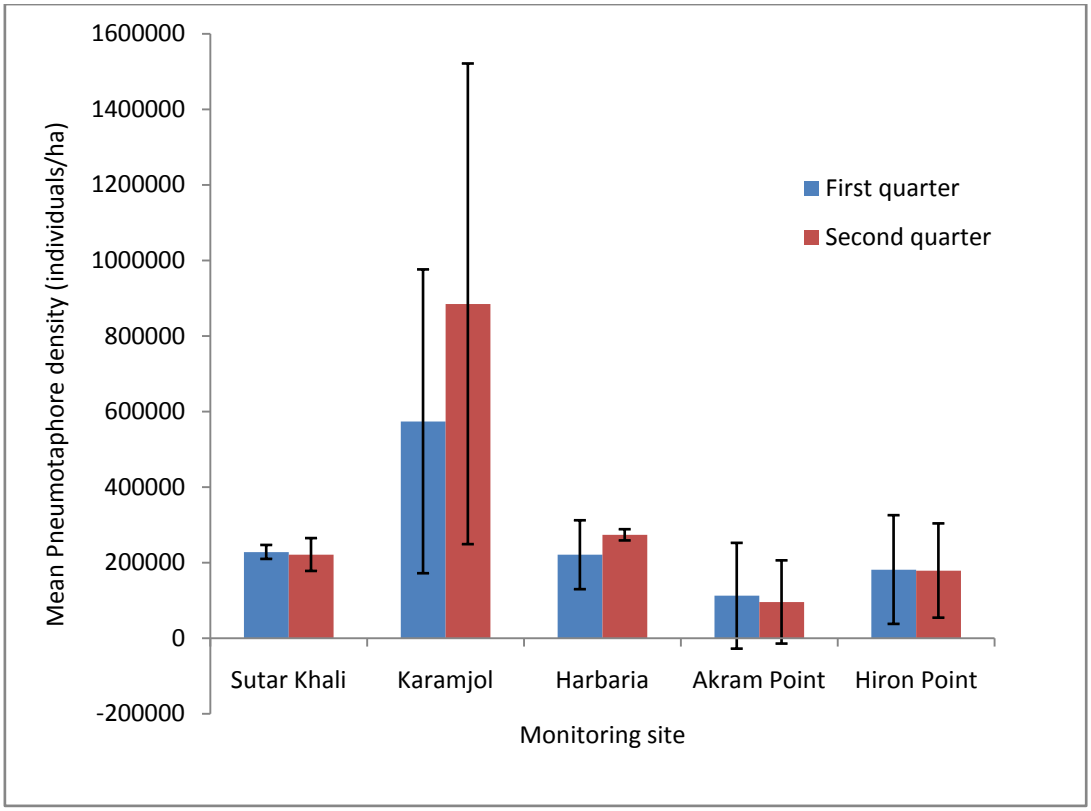


Figure 11.4: Average (± 95% CI) number of pnematophores between first and second quarter suervy in five monitoring sites of the SRF.

11.4.3 Crab hole

199. Crab hole density was highest at Akram point, while this figure was found lowest at Hiron Point. In Sutar Khali and Harbaria, the density of crab hole were found similar (Figure 11.5).

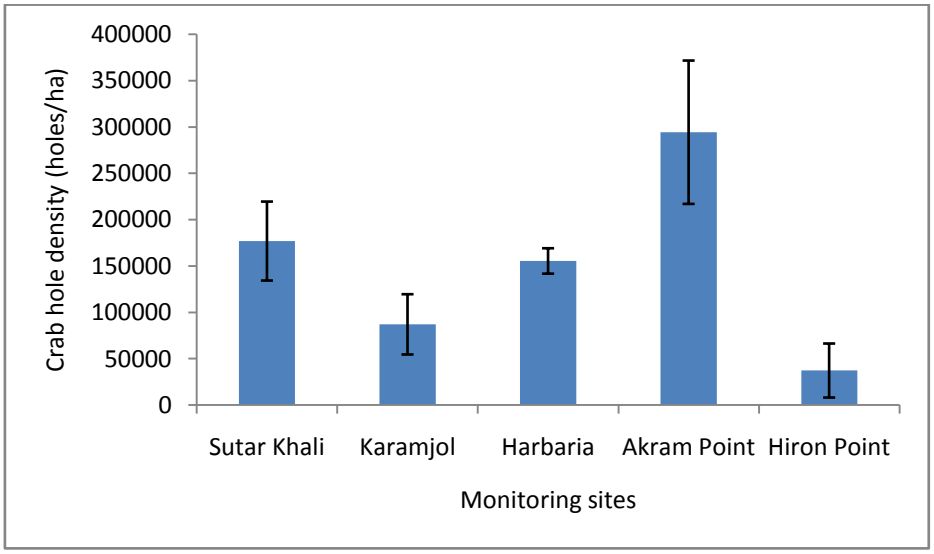


Figure 11.5:

Table 11.1: Mean (± 95% CI) crab hole density between first and second quarter suervy in five monitoring sites of the SRF.

Monitoring site	Crab density (holes ha^{-1})	95% CI
Sutar Khali	176949.89	42578.94
Karamjol	87150.47	32489.35
Harbaria	155493.39	13690.23
Akram Point	294298.40	77289.46
Hiron Point	37350.20	29115.57

11.4.4 Regeneration status

200. Statistically, no significant variation has been found in the sapling sites ($P < 0.05$) in case of seedling regeneration (Figure 11.8). However, an increasing trend of seedling recruitment was found in all sites except Akram Point (Table 11.2). Lower abandonee of pneumatophores, higher crab hole density, and salinity may be responsible for this negative seedling recruitment in Akarm point because these factors have played an important role in seedling regeneration and survival.

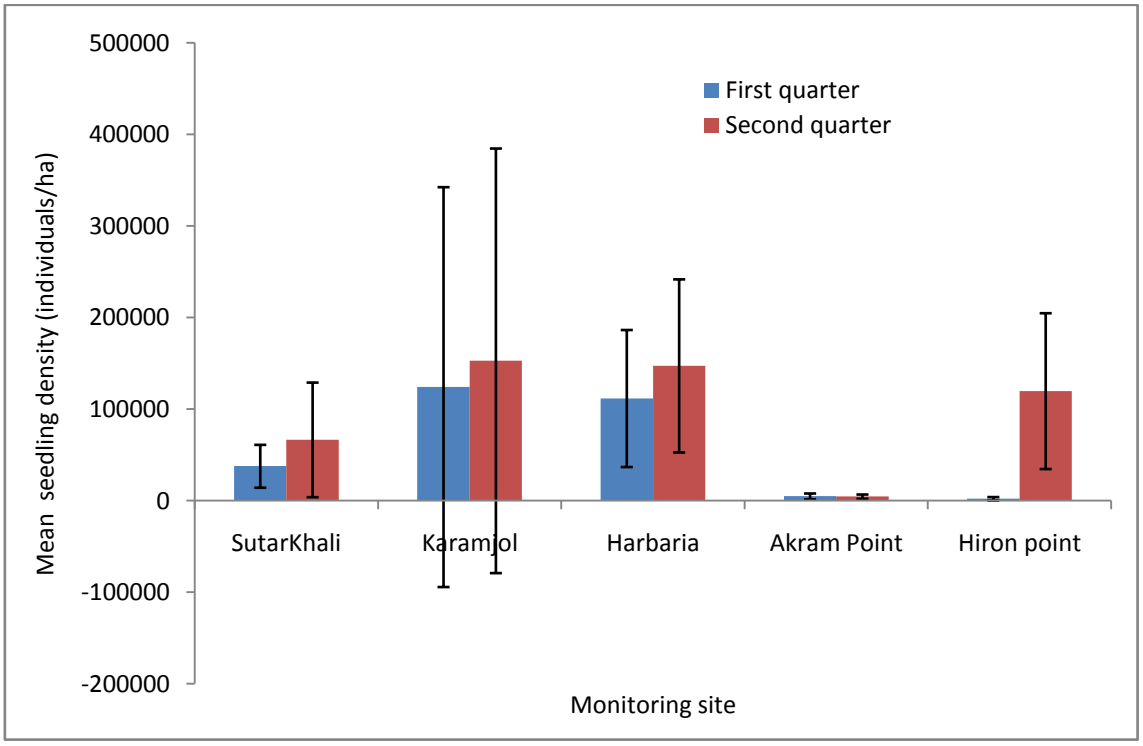


Figure 11.8: Mean (± 95 % CI) seedling density between first and second quarter suervy in five monitoring sites of the SRF.

Table 11.2: Mean (± 95 % CI) Seedling recruitment between first and second quarter suervy in five monitoring sites of the SRF.

Site	Seedling recruitment (New individual ha^{-1})	95 % CI
SutarKhali	28873.56	52202.47
Karamjol	28873.56	22743.98
Harbaria	35760.83	19872.43
Akram Point	-264.895	1401.693
Hiron point	106222.9	92949.1

11.5 Conclusion

201. This monitoring has exhibited with an insignificant difference in all sorts of forest health indicators. However, in Akram point, the negative seedling recruitment has been found which is the consequence of the site quality such as high salinity and high crab hole density. Based on the study findings during the three month time interval, it can be concluded that the construction programme of the proposed coal based power plant at Rampal has no adverse effect on SRF forest health.

12 Socio-economic Condition and Socio Safeguard Monitoring

12.1 Introduction

202. The third quarter monitoring intends to explore the state of socio-economic condition in respect to the 6 months prior first quarter monitoring. Similar to the first quarter, the entire data for this phase is extracted from Household Survey and consultations. These findings will also be explored and verified in upcoming third phase monitoring.

12.2 Methodology

203. In third quarter monitoring a total number of 116 households from 7 mouzas were surveyed. Of them, 96 households were selected from both directly and indirectly affected stakeholders. Here directly affected refers to those entitled households who lost their lands and have rights to be compensated and or rehabilitated; conversely, indirectly affected refers to those who are not inclusive to Resettlement Action Plan but have chance to be impacted by the project activities during construction and operation period of the project. However, the rest 20 households were selected from resettled village located at Gobindapur village, Shelter-4. Comparing with the first quarter monitoring, two additional households were found in resettled location and thereby considered for survey. Therefore, the total surveyed households in third quarterare 116 which was 114 in the first quarter monitoring.

204. Separate monitoring tools were applied for accomplishing the monitoring, for instance; semi-structured questionnaire for Household Survey, and separate checklists for consultations. Checklists and questionnaires were formulated accompanying with the guideline of International Finance Corporation (IFC) on “Performance Standards on Environmental and Social Sustainability”.

12.3 Salient features of the households

Household and population

205. The demographic features of monitoring households vary slightly in surveying mouzas between two phases of monitoring cycle. Due to increased number of household (116) in third quartermonitoring survey, the changes found in comprising male and female numbers compared to the first quarter of survey are shown in **Table 12.1**. Therefore, males 54% and female 46% found in third quarter survey which were 56% and 44% respectively in first quarter of survey **(Table 12.1)**.

Table 12. 1: Household and population by mouza in quarters

Name of Mouza	HHs by quarters		Population (%) by quarters					
			Male		Female		Total	
	1st	3rd	1st	3rd	1st	3rd	1st	3rd
Bajua	16	16	8	8	6	6	14	14
Bara Durgapur	16	16	8	8	5	6	13	14
Barni	22	22	11	11	10	9	21	20
Gobindapur[4]	18	20	6	6	5	6	11	12
Kapasdanga	16	16	9	8	9	8	17	16
Pankhali	16	16	9	9	6	7	16	16
Rajnagar	10	10	5	4	3	4	8	8
Total	**114**	**116**	**56**	**54**	**44**	**46**	**100**	**100**

[4] In Gobindapur resettled village it was found that two (2) households were resettled newly at. Therefore, these two new households were considered in the third quartermonitoring.

Source: HH survey, CEGIS, 2014
[Note: 1st=First quarter monitoring; 3rd =Third quarter monitoring]

206. In third quarter of monitoring the average male-female ratio has decreased about 18% (**Figure 12.2)** from the first quarter of monitoring and stands on 115% which is higher than the national figure of sex ratio is 100.3% (BBS 2011).

207. The average household size is 4.6 (**Figure 12.1**), which is a bit higher than that of the first quarter **of** survey as well as the national household size of 4.50 (HIES 2010[5]). Some common factors i.e. marriage, live-birth, and death during last six months may be th**e** cause of such variation in household size.

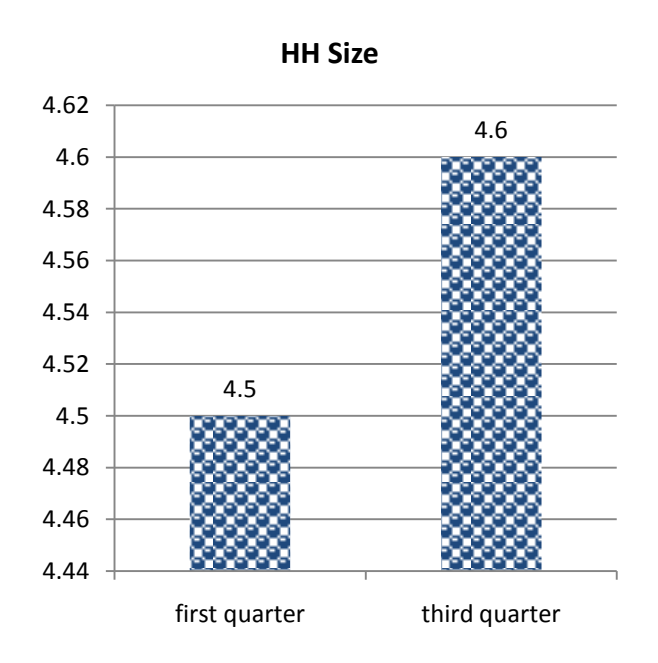


Figure 12.1: Household size in both quarters

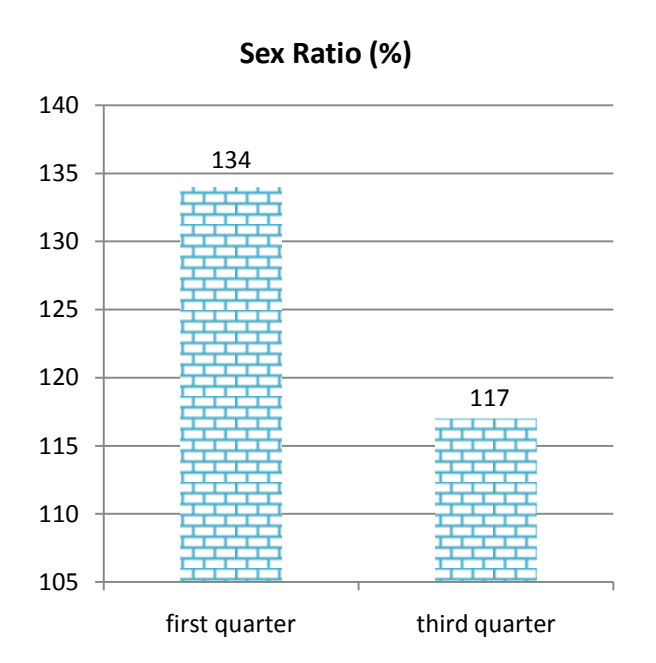


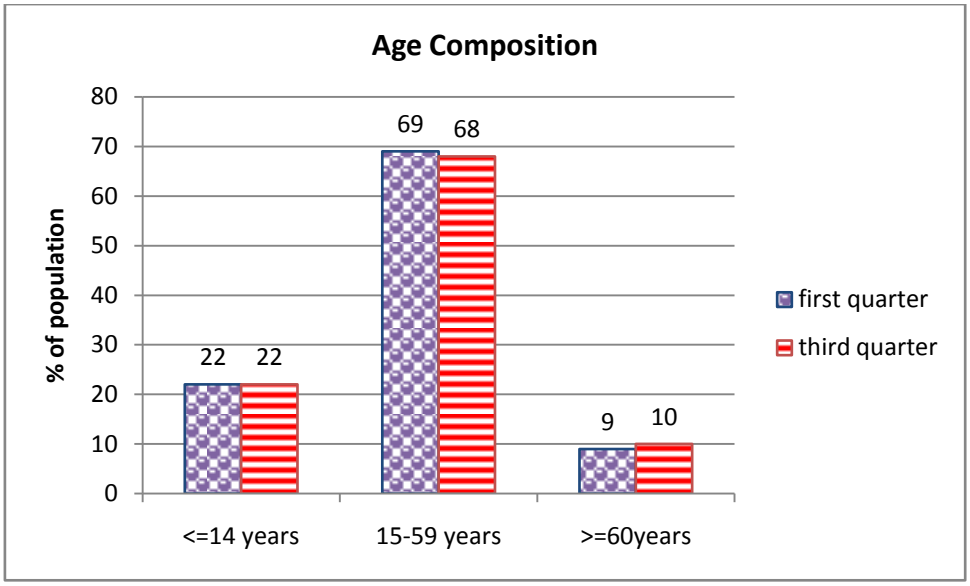
Figure 12.2: Sex Ratio in both quarters

Source: HH survey, CEGIS, 2014

Age composition

208. The age composition of population is presented in the following figure 12.3. It is found that population within the age group of 15-59 years has decreased by about 1% in third quartersurvey than that the in first quarter survey. In contrast, 1% of population has increased in 60 years and above old age group while 0-14 year's old age group's member remained constant in third quarter survey. The variation found is for adding new households which comprised of higher number of elderly people.

[5] HIES 2010 refers to Household Income and Expenditure Survey conducted by the Bangladesh Bureau of Statistics (BBS) in 2010.

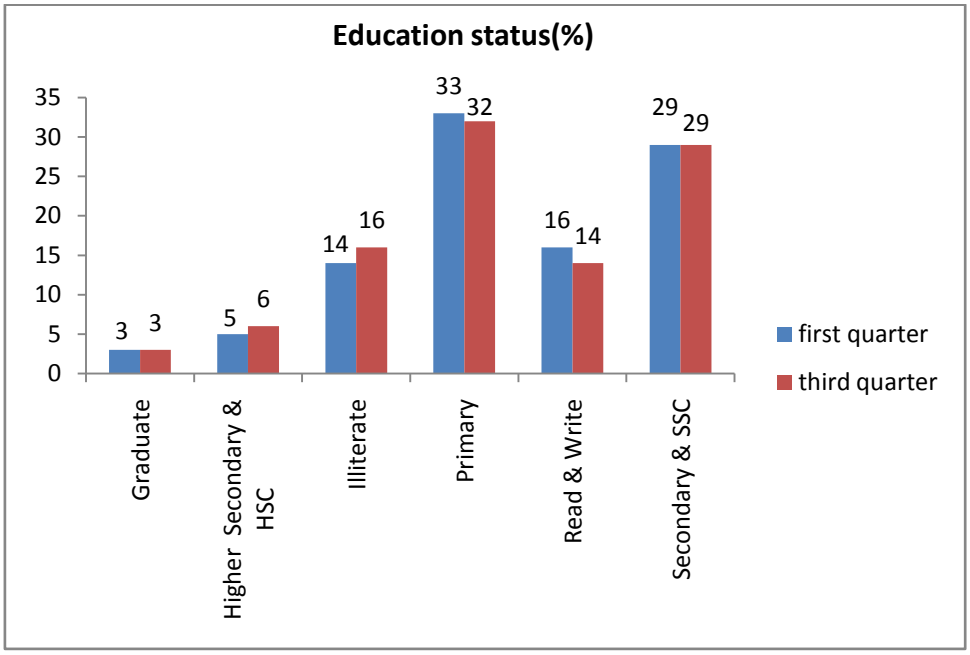


Source: HH survey, CEGIS, 2014

Figure 12.3: Age composition in both quarters of survey

Education and literacy status

209. Educational and literacy status shows almost same feature except a little change and are shown in **Figure12.4**. It is found that the highest percentages of population comprise in primary level education in both (first & second) phases of monitoring survey with a decrease of about 1% in the third phase. The percentages of illiterate and Higher secondary educated population have increased but in case of the able to read and write population, it has decreased in third quarter of monitoring.



Source: HH survey by CEGIS, 2014

Figure 12.4: Educational status of surveyed population

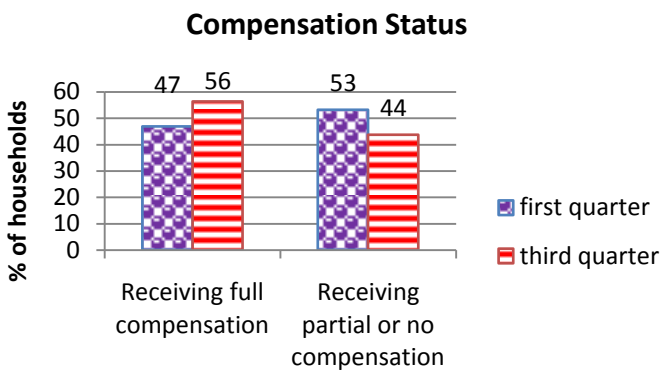
12.4 Exploration of Monitoring Indicators

12.4.1 Compensation

210. The local people informed that the compensation process has almost been finished only a few households remained to receive their compensation. The unfinished compensation implies the complicacy of documents of land owners for instances; problems in shared ownership, indentifying hereditary descendants, and problems in legal issues etc. Same status is also found during third monitoring. People demanded for authentic grievance redress committee to solve the land related problems and clear their dues. In third quarterof monitoring eight more households were found as directly affected by the project who were absent in first quarter of survey. **Table 12.2** below shows the compensation scenario of affected surveyed households.

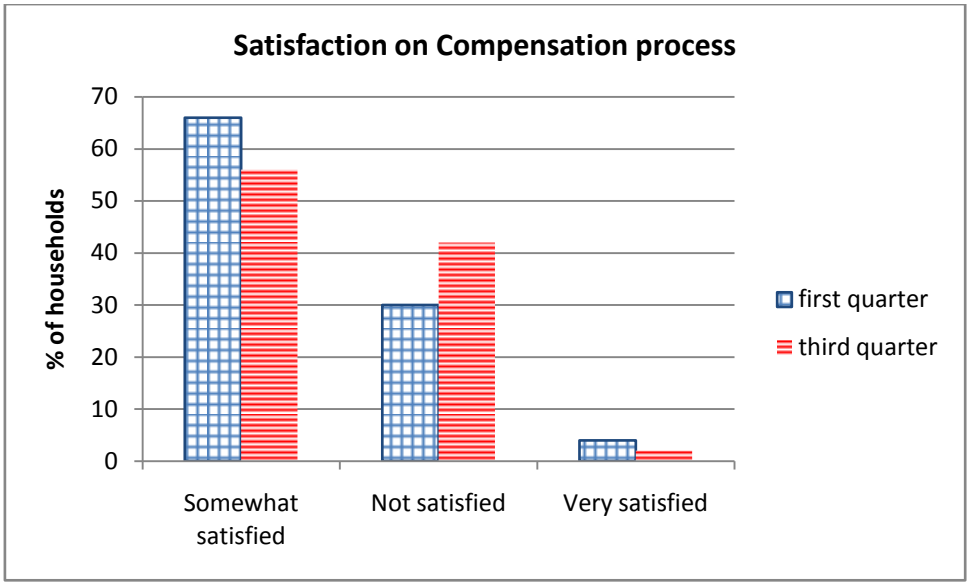
Table 12.2: Directly affected households and their compensation status

Mouza	Directly affected surveyed HHs (By monitoring quarters)	
	1st	3rd
Bara Durgapur	10	15
Kapasdanga	20	16
Barni	16	21
Rajnagar	1	3
Total	47	55



Source: HH survey by CEGIS, 2014

211. The percentage of receiving compensation has increased in the third quarterbut the receiving amount is not satisfactory for them under present circumstances. The satisfactory levels of affected households which are eligible to get compensation are given in **figure 12.5.** In third quarter, about 58% of entitled household are satisfied (including somewhat and very satisfied) about the compensation process which was 70% in first quarter monitoring survey. Most of the newly surveyed eligible households showed dissatisfaction about the compensation process additional with the household having due of compensated money.

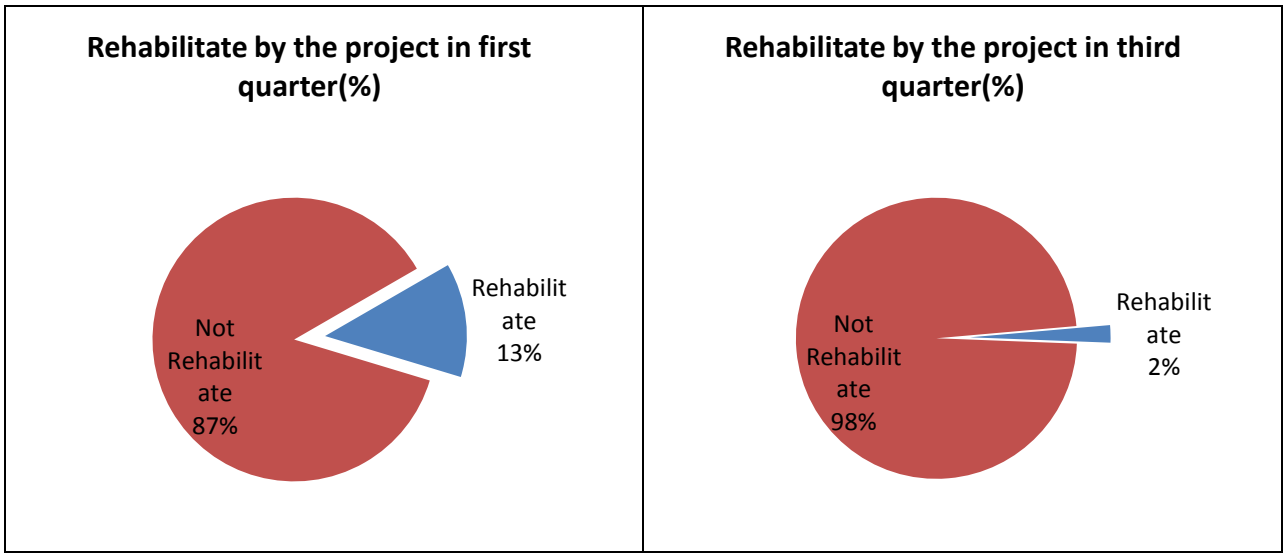


Source: HH survey by CEGIS, 2014

Figure 12.5: Opinion of directly affected households on compensation

12.4.2 Rehabilitation

212. The rehabilitation status has also been justified by the population of 55 directly affected surveying households. During third quarterof survey, less directly affected members are rehabilitated by the project. Local people alleged that the project authority recruited a number of laborers as per the concern of local leaders. Therefore most of the really affected members could not avail the chance of laboring in project site whereas the indirectly affected members having link with those leaders got chance for laboring. People also alleged that the project authority terminated the labors without any prior formal notice which aggravated their economic condition.



Source: HH survey by CEGIS, 2014

Figure 12.6: Rehabilitation status of directly project affected people

213. Due to undefined recruitment process following by project authority, the satisfaction level of directly affected people has deteriorated and most of the affected households (about 93%) showed dissatisfactory opinion to the project authority during third quarterof monitoring survey (**Figure 5 &**

6). Though, a number of recruitment played an important role in rehabilitation yet actual deserving people did not get this support by the project authority.

12.4.3 Resettlement

214. In terms of resettlement, 20 resettled households have been found in the third quartermonitoring survey at Gobindapur Shelter Home which was 18 in the first quarter survey. A number of households have taken temporary shelter to their relatives or reside in others houses on by rental basis which would be about 100 in number. The remaining households (about 10 in number) are still living at the edge of project boundary. The Shelter Home of Gobindapur has been extended and some more households will get the opportunities to resettle there. Some households from the project have already completed the formal procedures to be resettled in Gobindapur Shelter Home.

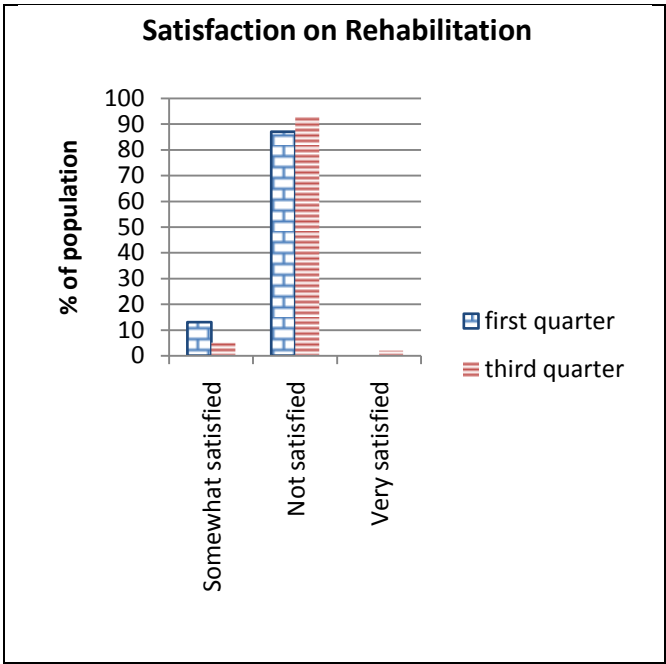


Figure 12.7: State of satisfaction on rehabilitation

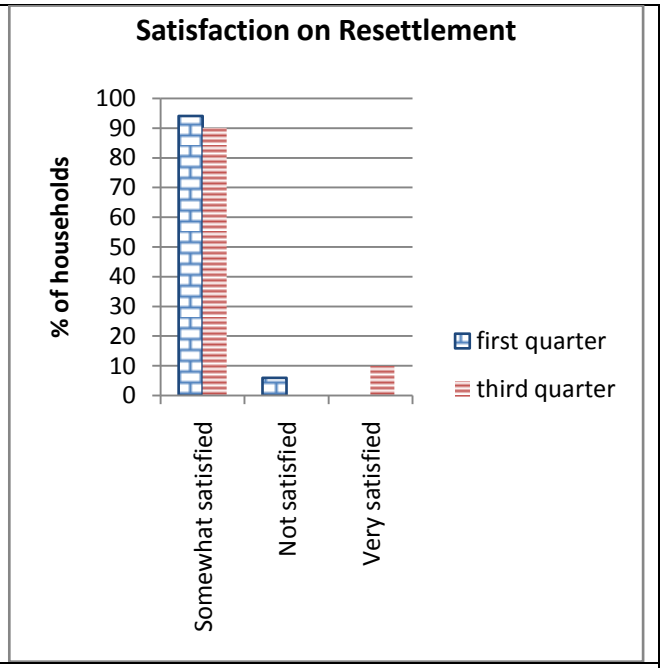


Figure 12.8: State of satisfaction on rehabilitation resettlement

215. As per opinion of 20 resettled households, all of them are satisfied and trying to cope themselves in the surroundings of Shelter Home. In third quartersurvey, none of the resettled households expressed themselves as dissatisfactory by the project and most of the household found as somewhat satisfactory condition.

12.4.4 Health

216. In third quarter monitoring, the overall disease profile of households were found to be similar to that of the first quarter monitoring which is presented below by ranking. According to the observation, almost similar disease profiles have been found in all the surveyed mouzas. The affect of skin disease and asthma which could be the major indicator for monitoring the impact of project in diseases profile is almost unseen in first quarter of survey.

Table12. 3: Common diseases profile of surveyed mouzas

Sl No	Disease	Ranking
1	Influenza/Fever	1
2	Cough/cold	2
3	Gastric	4
4	Diabetes	5
5	Diarrhea	6
6	Asthma	8
7	Skin disease	7
8	Hypertension	3

Source: HH survey by CEGIS, 2014

12.4.5 Labor and Working conditions

217. The project authority stated that they are trying to prepare better working condition/environment for the labors. As such, permanent and temporary labor sheds have been constructed in the project site for residing and taking respite purposes. The sanitary latrines have been made for the labors. The project authority has also provided transportation support for the labors; therefore they started boat service for the labors where the labors do not have to pay rent for boat. In terms of labors wage, it has been consider Tk. 360 per head from the project authority but the labors received Tk. 290 while remaining money has been taken by the *Sardars* who provide labors to the project site. The local people claimed that for earning this amount each labor has to work over 9 hours per day though they have verbally contracted to work for 8 hours per day.

218. The labors informed that there have no written contractsregarding their engagement with the project authority; therefore they do not know about the right which they deserve. Moreover, in terms of dismissal no formal procedures have been maintained yet. In most cases, the influence of political leaders played important roles for labors recruitment and dismissal. The labors are restricted to form any type of labor organization by the project authority as well as *Sardars*.

219. The project authority alleged that they are trying to provide all sorts of supports to the labors from their side. Their medical team provides medical supports to the labors and they also rehabilitate the labors if injured in any case during by the project site work. Also, following the International Labor Rules no children have been engaged in any types of project work however they were not able to maintain gender balance in laboring work because the women surrounding the project site are not engaged in any wage laboring activities except the homestead works.

Photo12.1 : Labourers using safety measures

Photo 12.2 : Temporary shelter during work

Photo 12.3: Safe water supply during work

Photo 12.4 : Sanitation for worker

Photo 12.5 : Temporary accomodation for workers

12.4.6 Community Health Safety and Security

220. Concerning the issues of community health safety and security, the project area has been protected through boundary wall all-around the project site and there will be only two gates in the project site. During third quarterof monitoring the construction work of boundary wall was found in progress and about 40% of which has so far been completed. An *Ansar* Camp has also been established in the project site for ensuring security and safety. No road communication has been established between project site and outer areas yet; therefore there is no risk of any road accident and no accident occured during last 6 month after first quarter survey. However a labor was injured during project work so the project authority established a departmental store for him by its own fund.

221. The project authority informed that they have opened a medical camp in the project area where they provide treatment and medical facilities to the local community as well as their labors. This camp is opened once in a week and over 150 people get treatments in each week by this camp.


Photo 12.6 : Construction of boundary wall

12.4.7 Livelihood and occupation

222. It is found that a significant proportion of the heads of households (over 62%) are directly involved in fishery related primary occupation (fishery, fish and other small business, agriculture labor etc.) which has little increased in third quarter survey than that of the first quarter. The reason for such increase may be that it has the peak time of fish capturing while a large number of the family members might be involved in that occupation. Details of primary occupation of households head is presented in **Figure 12.9 & 12.10.**

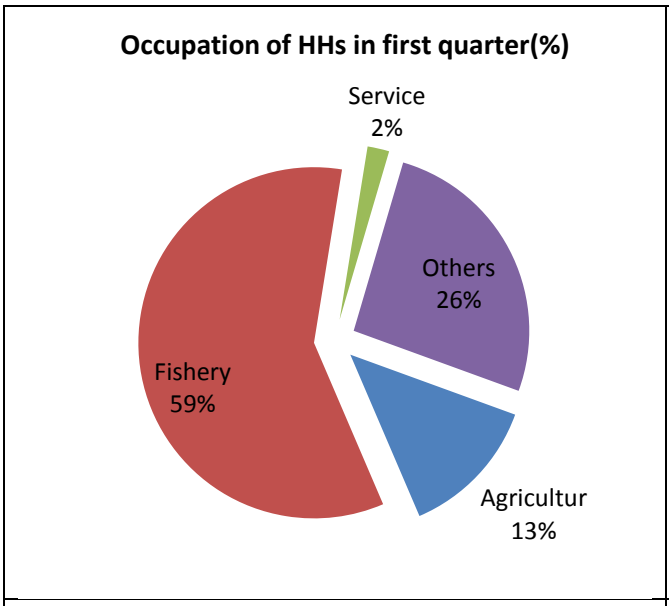


Figure 12.9: Main occupation of HHs in first quarter

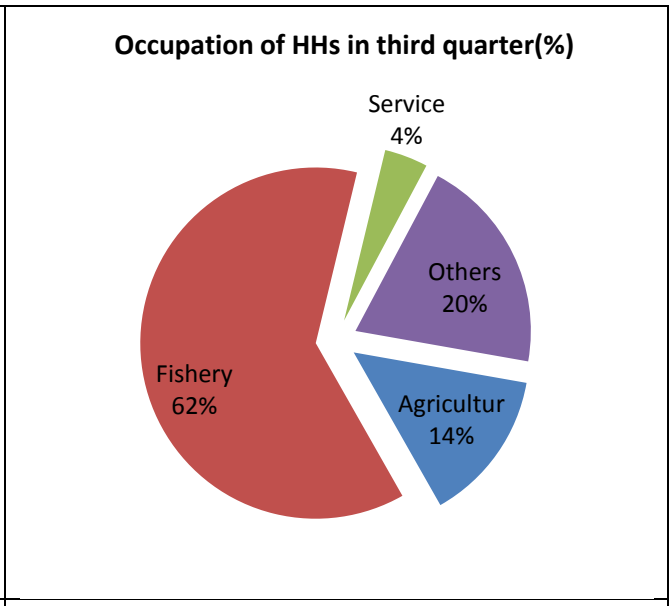


Figure 12.10: Main occupation of HHs in third quarter

Source: HH survey by CEGIS, 2014

12.4.8 Land ownership and Land price

223. Land ownership pattern is an important indicator for determining social status. None of the affected household involved in land purchasing activities during last six months of third quarter

monitoring survey. Therefore, no changes were found in land ownership pattern of the studied mouzas.

224. Land price is one of the main indicators for finding out the socio-economic development. During third quarter survey, no major changes have been observed in the land prizes compared to the first quarter of survey. The price increased by about 2% in Baradurgapur and Kapasdanga mouza while those of other 5 mouzas remained unchanged.

Table12. 4: Land price per acre

Sl No	Mauza	Price per acre (taka in lakh)		
		Before Project	April, 2014	October, 2014
1	Bajua	380,000	380,000	380,000
2	Bara Durga pur	160,000	320,000	330,000
3	Barni	260,000	340,000	340,000
4	Kapasdanga	240,000	340,000	360,000
5	Pankhali	400,000	400,000	400,000
6	Rajnagar	280,000	310,000	310,000

Source: HH survey by CEGIS, 2014

12.4.9 Household income

225. The monthly income of the household members who are engaged in seasonal fish capturing occupation has increased than the monthly income of the first quarter. The people informed that the period from the end of August to the end of November is the peak time for capturing fish in local rivers, canals, khals etc. for which the income of the people engaged in this occupantion has increased during this time. Apart from this, resettled households residing at Shelter Home in Gobindapur mouza are trying to cope up with social amenities of that mouza. By this time some of them have been able to get themselves involved in sustainable earning sources, as such, the income of some resettled household has increased than that of the first quarter. **Table12.5** shows that about 61% of households can be the highest percentage of households among all income levels are in the income level of Tk.10,000-Tk.20,000 per month whereas in first quarter survey, the highest about 43% of household had the income level ofTk.5,001tk-Tk.10,000 monthly.

Table 12.5: Households income level

Mauza Name	Average monthly Income	
	1st Quarter	3rd Quarter
Bajua	11583	15840
Bara Durgapur	5895	6340
Barni	13043	12732
Gobindapur	6017	8200
Kapasdanga	14406	13517
Pankhali	12313	8943
Rajnagar	9773	9857
Average	10433	10775

Source: HH survey by CEGIS, 2014

12.4.10 In and out migration

226. Seasonal labors in-migration has increased in third quarter of the monitoring survey with an increase of wage laborers by 4% working in the project site. The labors of project site are migrated

from Koyra, Protapnagar and Satkhira. No changes have been found in case of fishery and agricultural in-migrants as well as out migrant workers. Percentages of migrant labors/workers are presented in **Table 12.6**.

Table 12.6: Status of temporary in/out-migration as percentage of workable population

Migration types	Quarters (%)		Reason	Area
	1st	3rd		
In-migration	5	5	Harvesting paddy/Gher	Faridpur, Gopalgang
	2	4	Plantation of paddy/ Fish capturing	Koyra, Protapnagar
	-	2	Wage labors in project site	Koyra, Protapnagar, Satkhira etc.
Sub total	**7**	**11**	-	-
Out-migration	2	2	Seasonal laboring	Khulna, Bagerhat, Dhaka

Source: Informal discussion by CEGIS, 2014

12.4.11 Coraporate social activities

227. The project authority of Rampal power plant has started to involve themselves in corporate social activities. During the third quarterof socio-economic monitoring the study team found these activities in progress.

Free Health Services and Facilities

228. As corporate social activities, the project authority provides free medical facilities in the project site. About 150 beneficiaries of which 70% female and 30% male received medical support from that center which remains opened once in a week (every Wednesday). Medicines are also provided by this center in free of cost. People of Rajnagar, Baradurgapur, Barni and Bajua mouzas mainly came for having medical support but the number of beneficiaries of this center is expanding from areas which are at a considerable distance from the centre. The local people opined that they have received effective medical facilities for many diseases i.e. cold-cough, fever, dysentery, back-pain, lower abdominal pain and pressure. People are pleased for such benefits but urged for sufficient number of physician and supporting staffs for intensive medical support.


Photo 12.6: Free health services and faciliteis in the project

Donation in Cultural and Religious Festivals

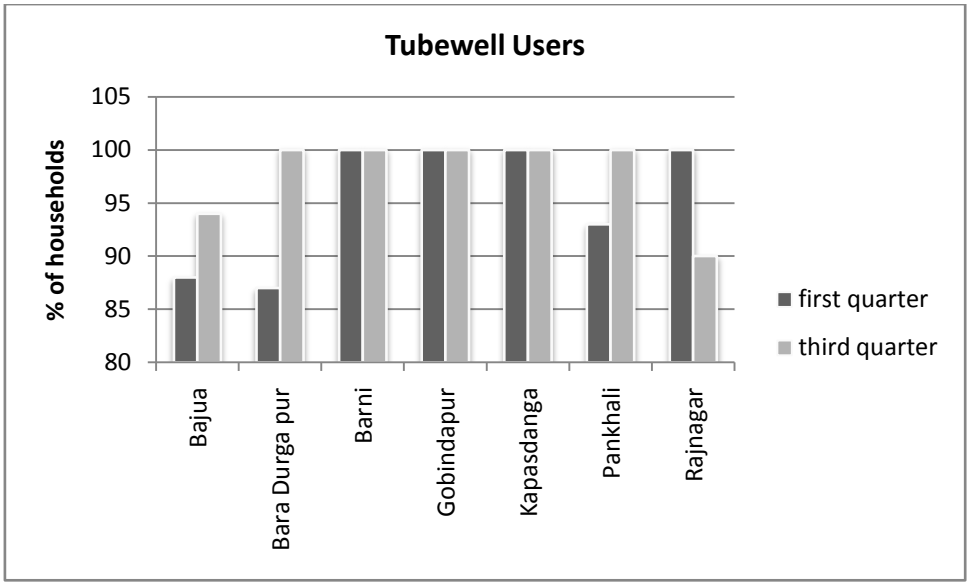
229. The project authority has also involved themselves in social activities by donating money in the cultural and religious festivals in the mouzas around the project site. So far, they donated money in four Puja Mandaps for observing Durga puja. The project authority alleged that they will try to contribute in most of the cultural and religious activities in the surrounding mouzas as per their ability.

Photo 12.7: Project authority donated for puja

12.4.12 State of Social Amenities

Drinking water

230. Data has been collected for understanding the provision and access to water for drinking and other domestic purposes. Figure 12.11 indicates that during third quarterof monitoring the number of tubewell users are increasing in most of the mouzas except Rajnagar compared to that of the first quarter monitoring survey. Sharing of tubewell has increased the percentages of its users. The water quality of the tubewell is not good, as such, the project authority have planned to arrange fresh drinking water for the local community by establishing tubewell or rain harvesting tanks.

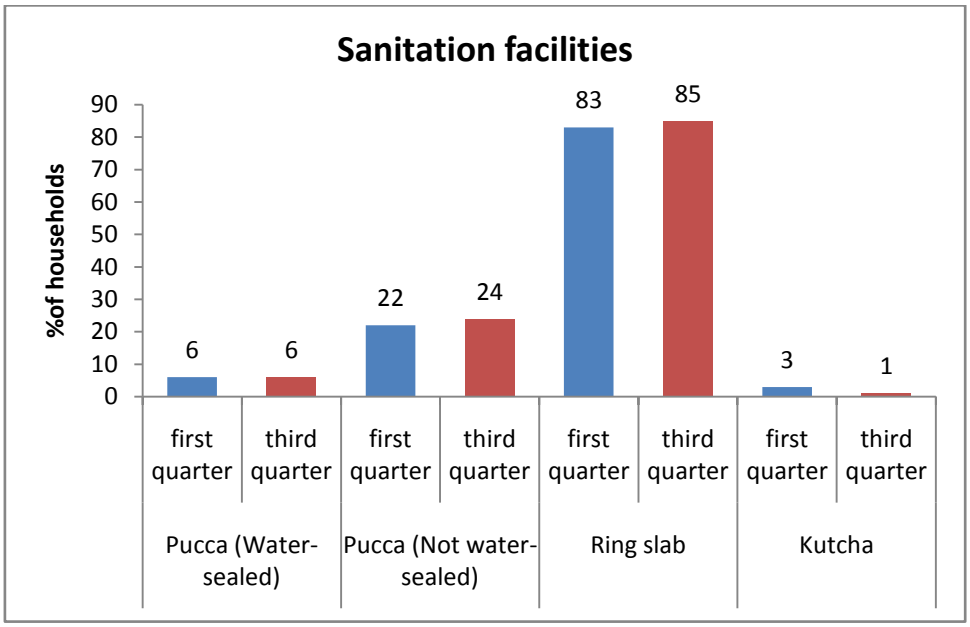


Source: HH survey by CEGIS, 2014

Figure12. 11: Drinking water status by using tubewell

Sanitation

231. Sanitation facilities have been assessed in terms of the availability of *pucca* or ring-slab latrines (**Figure 12.12)**. In third quarterof monitoring the sanitation facilities has insignificantly improved by increasing number of pucca (nit water-sealed) and ring slab latrines.



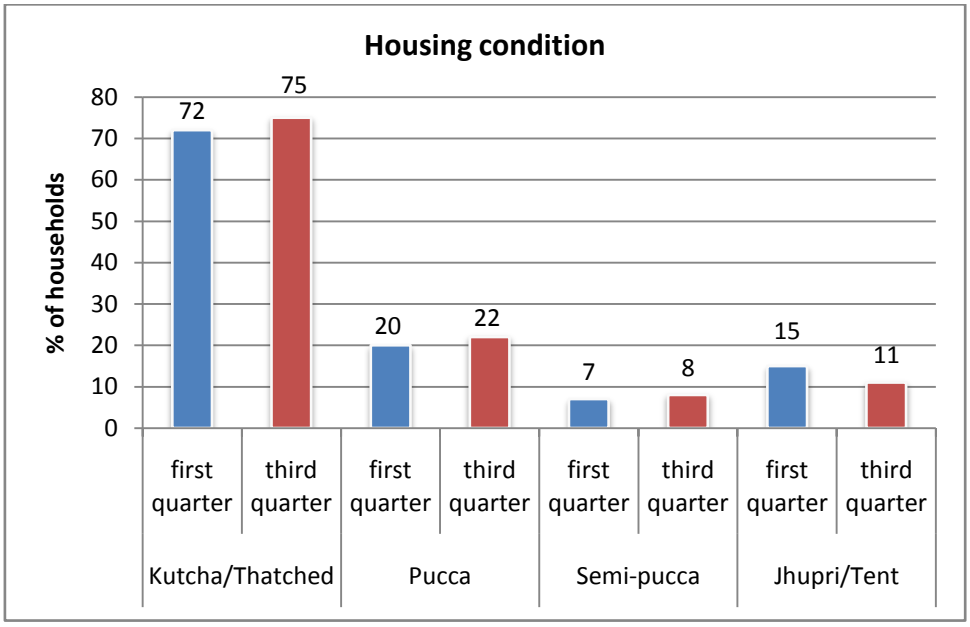
Source: HH survey by CEGIS, 2014

Figure 12.12 Availability of Pucca and Ringslab latrines

Housing condition

232. Housing condition reflects the economic and social status of the households. Because of being saline prone area people of this area are not eager to invest huge amount for constructing pucca houses as well as more amounts required to maintain them. In third quarterof monitoring survey, insignificant changes have been found in the number of dwelling houses compared to that

of the first quarter (**Figure 12.13).** All types of houses depict a little increased trend except the jhupri/tent houses.

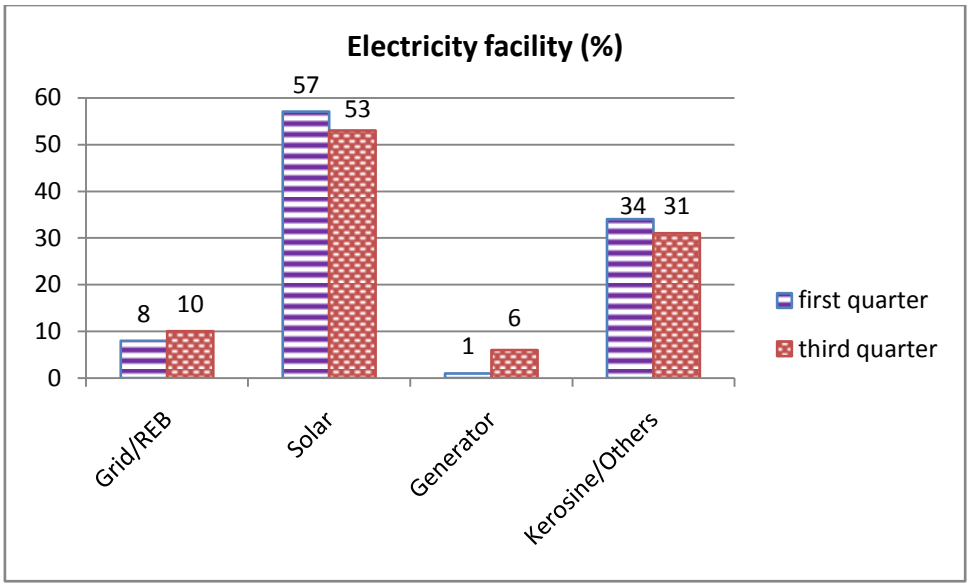


Source: HH survey by CEGIS, 2014

Figure 12.13 Type of main dwelling house

Electricity coverage and fuel consumption

233. Electricity coverage and fuel consumption can be highly supported after the project. There is no Grid/REB coverage in most of the studied mouzas though the electricity connection has been covered in some area of Rajnagar mouza but the supply has not yet been started. The main source of electricity is solar whose coverage has been decreased about 4% in the third quarterof monitoring compared to that of the first quarter; however the coverage of Grid/REB and generator has increased by about 2% to 5%. Regarding fuel consumption, all households show invariable dependency on local materials (straw, wood, leaf etc.) same as previous survey. Details of electricity facilities in the studied mouzas are presented in **Figure 12.14**.



Source: HH survey by CEGIS, 2014

Figure 12.14: Electricity facilities of study mouzas

12.5 Conclusion

234. In terms of socio-economic condition, the status is found to be almost similar in both phases with a slight variation in few cases. However, the project authority has taken several initiatives for instance, free-medical services and donations for religious festivities which increased it popularity. They also intended start similar corporate social works in future and being appreciated and welcomed by the local as well as adjacent people. It was stated that, as the study area is undeveloped and poverty rate is higher any initiative with an intention to standardize socio-economic condition of the local people is highly desirable.

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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/throttled downing 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			

SL	Category	Measures	Due Diligence		Remarks
			Complied	Not complied	
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 Controlling	Fencing the construction site by drum sheet or Tarjja of any other fencing			
		Arrangement of runoff drainage for reducing any water logging			
		Location of backfilling stockpile in safe area and protected from wind and rain action			
		No storing of backfilling materials/spoil stored on river bank/slope			
		No disposal of waste and untreated waste water to river or canal			
1.5	Waste Management System	Provision of onsite waste management system			

SL	Category	Measures	Due Diligence		Remarks
			Complied	Not complied	
		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			

SL	Category	Measures	Due Diligence		Remarks
			Complied	Not complied	
		Provide/take extra care/caution for the disadvantaged/vulnerable group/s (i.e. women, children, widow, ethnic minorities, indigenous people 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			
		Developent of policy which prioritizes the local laborers in employment opportunities			
		Proper management of Project traffic sign, speed limit signal etc.			
		Provision of separate 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?			

SL	Category	Measures	Due Diligence		Remarks
			Complied	Not complied	
		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			
PS 2. Labor 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.)*			

SL	Category	Measures	Due Diligence		Remarks
			Complied	Not complied	
		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 managing and monitoring the performance of third party employers in relation to OHS			
2.2	Workers Well Being	Establishment Grievance Mechanisms			

SL	Category	Measures	Due Diligence		Remarks
			Complied	Not complied	
		Ensuring fair treatment, non discrimination and equal opportunity			
		Compliance of project's labor policy with the national labor law			
		No Child Labor			
		No incident of forced labor			
		Provision of Welfare facilities for Worker/Labor			
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 in the community			

SL	Category	Measures	Due Diligence		Remarks
			Complied	Not complied	
		Availability Emergency Response Plan by EPC contractor			
		Maintaining open communication channel with the local community			
		training and instruction to the security personnel about their behavior and communication with the local people			
		Aware the security personnel about the right of the community people			
		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	Disclosure of EIA Report			
		Organised stakeholder consultation meeting			

SL	Category	Measures	Due Diligence		Remarks
			Complied	Not complied	
	Awareness	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)					
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			

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

Annex II: Traffic Volume Survey Datasheet

Table A: Traffic Volume Survey at *Babur Bari (Access Road)*

Date: October 20, 2014 (Monday)

Vehicles	8:30 AM to 9:30AM				12:30 PM to 1:30PM				4:30 PM to 5:30PM			
Direction	**To Main Road**	**To Project Site**	**Factor**	**PCU**	**To Main Road**	**To Project Site**	**Factor**	**PCU**	**To Main Road**	**To Project Site**	**Factor**	**PCU**
Bus	0	0	3	0	0	0	3	0	0	0	3	0
Truck	0	0	3	0	0	0	3	0	0	0	3	0
Private Car	0	0	1	0	0	0	1	0	0	0	1	0
Microbus/ Jip	0	0	1.75	0	0	0	1.75	0	0	0	1.75	0
CNG	0	0	0.75	0	0	0	0.75	0	0	0	0.75	0
Auto Rickshaw	0	0	0.75	0	0	0	0.75	0	0	0	0.75	0
Nosimon	10	12	1	22	5	16	1	21	7	8	1	15
Utility Vehicle	0	0	1	0	0	0	1	0	0	0	1	0
Motor Cycle	12	10	0.75	16.5	7	8	0.75	11.25	15	15	0.75	22.5
Rickshaw	0	0	0.5	0	0	0	0.5	0	0	0	0.5	0
Bi-cycle	3	3	0.5	3	1	1	0.5	1	5	9	0.5	7
Non Motorized Vehicle	0	0	0.5	0	0	0	0.5	0	0	0	0.5	0
Van	0	0	0.5	0	0	2	0.5	1	2	1	0.5	1.5
			Total	41.5				34.25				46

Table B: Traffic Volume Survey at *Rupsha Bridge*

Date: October 20, 2014 (Monday)

Vehicles	**8:30 AM to 9:30AM**				**12:30 PM to 1:30PM**				**4:30 PM to 5:30PM**			
Direction	**From Khulna**	**To Khulna**	**Factor**	**PCU**	**From Khulna**	**To Khulna**	**Factor**	**PCU**	**From Khulna**	**To Khulna**	**Factor**	**PCU**
Bus	18	20	3	114	28	21	3	147	20	23	3	129
Truck	39	42	3	243	38	42	3	240	41	61	3	306
Private Car	13	9	1	22	11	9	1	20	18	12	1	30
Microbus/ Jip	21	26	1.75	82.25	16	17	1.75	57.75	29	26	1.75	96.25
CNG	2	7	0.75	6.75	4	3	0.75	5.25	3	1	0.75	3
Auto Rickshaw	1	4	0.75	3.75	2	3	0.75	3.75	3	2	0.75	3.75
Nosimon	1	1	1	2	0	0	1	0	3	0	1	3
Utility Vehicle	11	17	1	28	16	12	1	28	7	16	1	23
Motor Cycle	63	87	0.75	112.5	64	62	0.75	94.5	118	94	0.75	159
Rickshaw	2	3	0.5	2.5	1	1	0.5	1	1	1	0.5	1
Bi-cycle	7	8	0.5	7.5	14	21	0.5	17.5	21	31	0.5	26
Non Motorized Vehicle	19	43	0.5	31	13	32	0.5	22.5	17	25	0.5	21
Van	0	0	0.5	0	0	0	0.5	0	0	0	0.5	0
			Total	655.25			Total	637.25			Total	801

Table C: Traffic Volume Survey at *Bagha Bazar*

Date: October 20, 2014 (Monday)

Vehicles	8:30 AM to 9:30AM				12:30 PM to 1:30PM				4:30 PM to 5:30PM			
Direction	**To Mongla**	**From Mongla**	**FACTOR**	**PCU**	**To Mongla**	**From Mongla**	**FACTOR**	**PCU**	**To Mongla**	**From Mongla**	**FACTOR**	**PCU**
Bus	12	11	3	69	13	13	3	78	11	14	3	75
Truck	15	10	3	75	22	24	3	138	17	12	3	87
Private Car	7	4	1	11	7	3	1	10	2	5	1	7
Microbus/ Jip	5	1	1.75	10.5	11	2	1.75	22.75	9	6	1.75	26.25
CNG	20	13	0.75	24.75	16	9	0.75	18.75	23	9	0.75	24
Auto Rickshaw	2	3	0.75	3.75	6	7	0.75	9.75	6	2	0.75	6
Nosimon	17	34	1	51	18	21	1	39	42	25	1	67
Utility Vehicle	4	1	1	5	7	6	1	13	12	1	1	13
Motor Cycle	49	38	0.75	65.25	52	63	0.75	86.25	57	56	0.75	84.75
Rickshaw	0	0	0.5	0	0	0	0.5	0	0	0	0.5	0
Bi-cycle	11	13	0.5	12	3	10	0.5	6.5	11	13	0.5	12
Non Motorized Vehicle	30	41	0.5	35.5	29	27	0.5	28	52	45	0.5	48.5
Other Motorized Vehicle	4	7	1	11	4	10	1	14	4	3	1	7
			TOTAL	**373.75**			**TOTAL**	**464**			**TOTAL**	**457.5**

Table D: Traffic Volume Survey at *Babur Bazar*

Date: June 30, 2014 (Monday)

Vehicles	**8:30 AM to 9:30AM**				**12:30 PM to 1:30PM**				**4:30 PM to 5:30PM**			
Direction	**Babur Bazar to Khulna**	**Khulna to Babur Bazar**	**Factor**	**PCU**	**Babur Bazar to Khulna**	**Khulna to Babur Bazar**	**Factor**	**PCU**	**Babur Bazar to Khulna**	**Khulna to Babur Bazar**	**Factor**	**PCU**
Bus	10	8	3	54	10	11	3	63	9	13	3	66
Truck	14	3	3	51	24	24	3	144	26	14	3	120
Private Car	4	3	1	7	7	4	1	11	2	4	1	6
Microbus/ Jip	7	3	1.75	17.5	8	8	1.75	28	5	7	1.75	21
CNG	0	0	0.75	0	0	0	0.75	0	0	0	0.75	0
Auto Rickshaw	0	0	0.75	0	0	0	0.75	0	0	1	0.75	0.75
Nosimon	27	21	1	48	24	19	1	43	36	26	1	62
Utility Vehicle	0	0	1	0	0	0	1	0	0	0	1	0
Motor Cycle	41	34	0.75	56.25	46	48	0.75	70.5	56	50	0.75	79.5
Rickshaw	0	0	0.5	0	0	0	0.5	0	0	0	0.5	0
Bi-Cycle	0	0	0.5	0	0	0	0.5	0	0	0	0.5	0
Non Motorized Vehicle	4	0	0.5	2	0	0	0.5	0	0	0	0.5	0
Van	1	2	0.5	1.5	6	7	0.5	6.5	4	4	0.5	4
			Total	**237.25**			**Total**	**366**			**Total**	**359.25**

Table E: Traffic Volume Survey at *Chulkati*

Date: October 200, 2014 (Monday)

Vehicles	**8:30 AM to 9:30AM**				**12:30 PM to 1:30PM**				**4:30 PM to 5:30PM**			
Direction	**Mongla to Khulna**	**Khulna to Mongla**	**FACTOR**	**PCU**	**Mongla to Khulna**	**Khulna to Mongla**	**FACTOR**	**PCU**	**Mongla to Khulna**	**Khulna to Mongla**	**FACTOR**	**PCU**
Bus	13	12	3	75	13	11	3	72	13	14	3	81
Truck	12	20	3	96	20	25	3	135	17	28	3	135
Car	8	15	1	23	10	20	1	30	20	9	1	29
Microbus/ Jip	9	12	1.75	36.75	11	6	1.75	29.75	12	8	1.75	35
CNG	2	1	0.75	2.25	3	4	0.75	5.25	1	2	0.75	2.25
Auto Rickshaw	27	30	0.75	42.75	26	31	0.75	42.75	34	35	0.75	51.75
Nosimon	4	5	1	9	2	3	1	5	8	4	1	12
Utility Vehicle	8	7	1	15	6	5	1	11	3	4	1	7
Motor Cycle	93	82	0.75	131.25	97	84	0.75	135.75	95	82	0.75	132.75
Rickshaw	1	0	0.5	0.5	0	0	0.5	0	0	0	0.5	0
Bi-cycle	80	77	0.5	78.5	50	64	0.5	57	64	48	0.5	56
Non Motorized Vehicle	30	25	0.5	27.5	31	24	0.5	27.5	34	37	0.5	35.5
Other Motorized Vehichle	79	64	1	143	75	66	1	141	78	60	1	138
			TOTAL	**680.5**			**TOTAL**	**692**			**TOTAL**	**715.25**

Annex III: Photo Album

Sundarbans Forest Health Monitoring Team

Plot layouting at Akram Point

Estimation of canopy cover at Karamjal

Tree re-marking with paint at Sutarkhali and Karamjal

Assessment of Fish Catch

Consultation with fishermen at Harbaria

Taking Tree Diameter at Breast Height (DBH)

Counting seedlings and pneumatophores

Canopy Coverage

Team discussion to find the monitoring location

Taking Noise Level at Hiron Point

Taking Noise Level at Akram Point

Fish species identification and Catagorization

Fish length measurement

Catagorization of fishes according to length at Hiron Point

Consultation with a crab catcher at Akram Point

Dolphin activities in Maidara River near project site

Annex IV: Terms of References (ToR)

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

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

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

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

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

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

The specific objectives of the monitoring program are:

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

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

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

- Update baseline data as per monitoring schedule and location.
- Monitor and provide the environmental parameters during pre construction activities.
- Provide technical assistance to the client for implementation of the EMP at different sector of construction activities.
- Monitor the environmental aspects during construction of the Project.
- Review the EIA document to evaluate the EMP measures incorporated in the contract to mitigate different social and environmental hazards and risks during construction of the Project
- Submit progress reports to the client.

- Render any other related services as and when requested.

The scope of the services can be specified as bellows.

Monitoring Parameter	Indicators
Socio-economy	Livelihood and Occupation
	Income and expenditure
	Displacement and Migration
	Cultural and heritage
	Health and sanitation
	Risks and accidental assessment
	Transportation and communication
	Public and private Infrastructure development
Ecology and Biodiversity	Bio-indicator Assessment
	Movement of indigenous/ native species
	Envision of exotic species and regime dominance
	Species composition (Flora and Fauna)
	Assessment the services of dependent ecosystem
Agriculture	Land use and canopy coverage
	Soil quality (Salinity, pH, OM,)
	Cropping pattern and crop intensities
	Irrigation and crop production
	Farmers survey result
Fisheries	Fish diversity and specification
	Fish production and availability
	Fisher survey result
Noise level	Sound level at the sensitive zone
Water resources	DO, BOD, COD, Salinity , TDS, TS, pH, Hg, Pb
	Total Hardness, Hg, NO3 and PO4
	River Morphology,
	Tidal inundation
	Drainage Network
	Erosion and Accretion
	Ground water quality
Air quality	SOx
	NOx

Monitoring Parameter	Indicators
	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.