People's Republic of Bangladesh
Ministry of Power, Energy and Mineral Resources

Coal Power Generation Company Bangladesh Limited (CPGCBL)

Environmental Impact Assessment (EIA)

On

Proposed 6.5 km Long embankment Cum Road Construction from Rajghat Bridge, Matarbari to Mohiraghona, Dhalghata Under Matarbari 2x600 MW USC Coal-Fired Power Project

At,
Matarbari, Moheshkhali Cox's Bazar

OCTOBER, 2015

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Abbreviations

AEZs	Agro-ecological Zones
BBS	Bangladesh Bureau of Statistics
BGS	Geological Survey of Bangladesh
BMD	Bangladesh Metrological Department
BUET	Bangladesh University of Engineering & Technology
BWDB	Bangladesh Water Development Board
CPGCBL	Coal Power Generation Company Bangladesh Limited
DC	Deputy Commissioner
DEM	Digital Elevation Model
DO	Dissolve Oxygen
DOE	Department of Environment
EA	Executing Agency
ECA	Environmental Critical Areas
ECC	Environmental Clearance Certificate
ECR	Environmental Conservation Rules
EIA	Environmental Impact Assessment
EISA	Environmental Impact and Social Assessment
ETP	Effluent Treatment Plant
ERP	Emergency Response Plan
EHS	Environmental Health and Safety
EMP	Environmental Management Plan
ESMP	Environmental and Social Management Plan
EWAPDA	East Pakistan Water and Power Development Authority
FS	Feasibility Study
GAD	Gender and Development
GAP	Gender Action Plan
GHG	Green House Gasses
GIS	Geographic Information System
GOB	Government of Bangladesh
GW	Ground Water
HTW	Hand Pump Tube well
IECs	Important Environmental Components
IEE	Initial Environmental Examination
IUCN	International Union for Nature Conservation
JICA	Japan International Cooperation Agency
LAP	Land Acquisition Plan
LARAP	Land Acquisition and Resettlement Action Plan

M&E	Monitoring and Evaluation
MOEF	Ministry of Environment and Forests
MDGs	Millennium Development Goals
NGO	Non-Governmental Organization
NEMAP	National Environmental Management Action Plan
O&M	Operation and Maintenance
PIU	Project Implementation Unit
PMO	Project Monitoring Office
PWD	Public Works Datum
RAP	Resettlement Action Plan
RRA	Rapid Rural Appraisal
SCC	Site Clearance Certificate
TDS	Total Dissolved Solids
TOR	Terms of Reference
UNO	Upazila Nirbahi Officer
USC	Ultra Super Critical
WB	World Bank

Terms of References

Government of the People's Republic of Bangladesh
Department of Environment
Head Office, Paribesh Bhaban
E-16 Agargaon, Sher-e-Bangla Nagar, Dhaka-1207
www.doe.gov.bd

Memo No: DoE/Clearance/5440/2015/ 210 Date: 19 /05/2015

Subject: Approval of Terms of Reference (ToR) for Environmental Impact Assessment (EIA) of proposed 6 km long Embankment cum road Construction under 2x600 MW Matarbari Coal Based thermal power plant Construction Project.

Ref: Your Application dated 12/04/2015.

With reference to your letter dated 12.04.2015 for the subject mentioned above, the Department of Environment hereby gives approval of ToR for Environmental Impact Assessment (EIA) of the proposed 6 km long Embankment cum road Construction under 2x600 MW Matarbari Coal Based thermal power plant Construction Project at Matarbari, Maheshkhali under Cox's Bazar District.

I. The project authority shall submit a comprehensive Environmental Impact Assessment (EIA) considering the overall activity of the proposed Project in accordance with the ToR and time schedule submitted to the Department of Environment (DOE).
II. The EIA report should be prepared in accordance with following indicative outlines:

Executive Summary
1.0 Introduction
- 1.1 Background
- 1.2 Rationale of the Project
- 1.3 Objective of the Study
- 1.4 Scope of Study/Work
- 1.5 Approach and Methodology
- 1.6 The EIA Team
- 1.7 Structure of the Report/Report Format

2.0 Legal, Policy and Administrative Framework
- 2.1 Introduction
- 2.2 Relevant National Policies and Legislations
- 2.3 Compliance with DOE EIA Guidelines

3.0 Project Description
- 3.1 Introduction
- 3.2 Project Objective
- 3.3 Project Options
- 3.4 Interventions under Selected Options
- 3.5 Project Plan, Design, Standard, Specification, Quantification, etc.

4.0 Environmental and Social Baseline
- 4.1 Meteorology
  - 4.1.1 Temperature
  - 4.1.2 Humidity
  - 4.1.3 Rainfall
  - 4.1.4 Evaporation
  - 4.1.5 Wind Speed
  - 4.1.6 Sun Shine Hours

Mr. Safique 24.5.2015

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III. Without obtaining approval of EIA report by the Department of Environment, the project authority shall not be allowed to conduct earth filling or any kind of physical intervention in the proposed project site and also not be able to start the physical activity of the project.
IV. This approval of the Terms of Reference (TOR) would not mean any acceptance or site clearance of the project.
V. The proposed EIA study would not establish any claim, right in favour of the proponent for getting site clearance or environmental clearance.
VI. Without obtaining Environmental Clearance, the project authority shall not be able to start the operation of the project.
VII. The project authority shall submit the EIA along with a filled-in application for Environmental Clearance in prescribed form, the applicable fee in a treasury Chalan, the no objection certificates (NOCs) from the local authority, NOCs from forest department (if it is required in case of cutting any forested plants/trees of private or public) and NOC from other relevant agencies for operational activity etc. to the Cox's Bazar District Office of DOE at Cox's Bazar with a copy to the Head Office of DOE in Dhaka.

14.05.2015

(Syed Nazmul Ahsan)
Director (Environmental Clearance, c.c)
Phone # 02-8181778

Managing Director
Proposed 6 km long Embankment cum road
Construction under 2x600 MW Matarbari
Coal based thermal power plant Construction Project
Coal Power Company limited
Unique Heights (Level-17)
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Copy Forwarded to :

1) The Secretary, Ministry of Environment and Forests, Bangladesh Secretariat, Dhaka.
2) Director, Department of Environment, Chittagong Divisional Office, Chittagong.
3) Deputy Director/Officer In-charge, Department of Environment, Cox's Bazar District Office, Cox's Bazar.
4) Assistant Director, Office of the Director General, Department of Environment, Head Office, Dhaka.

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Executive Summary

Background of the Project

Government of Bangladesh has been implementing Matarbari 600 x 2 MW Ultra Super Critical (USC) thermal power plant by BPDB. The project is financed by JICA. EIA study for the Matarbari power project and associated facilities has been completed by JICA and approved by DOE.

Matarbari island is under Moheshkhali Upazilla of Cox's bazzar district is surrounded by embankment, which was constructed during 1962 by EPWAPDA to protect the area from saline water. Currently sluice gate stands for using of saline water for shrimp culture by the local inhabitants, Due to construction of Power plant and associated facilities there will create huge potential for area development through land clearing and land filling and as a result, geo-morphological and hydrological dimension of the proposed project and surrounding area will likely be affected. For the demand of the local people and for the protection of the Matarbari project area, the Project authority is planning to rehabilitate the east part of existing embankment for use as a road for the local inhabitants. Proposed 6.5 km long embankment from Rajghat, Matarbari to Mohiraghona, Dhalghata site is located east of the Matarbari project along the west bank of the river Kohelia.

To examine the potential Environmental, Hydrological and Social Impact and fulfilling the requirement of the Department of Environment requirement and regulatory compliance, the project authority has engaged Geo *Associate Bd,* a local consulting firm, to conducted this EIA Study including Hydrological /Mathematical Modeling for the proposed project.

Objectives of the EIA Study

The objective of this Environmental Impact Assessment (EIA) study has been to produce an environmental impact document for CPGCBL that follows Bangladeshi regulations as well as "JICA Guidelines for Environmental and Social Consideration (April, 2010)".

Hence, Geo-Associate Bd study team on behalf of CPGCBL carried out EIA to fulfill the requirement of the DOE. The main objectives of the EIA study were:

- Describing the existing environment of the area;
- Assessment of the potential environmental , Hydrological and Social impacts, including residual impact of the proposed project;
- Identifying mitigation measures to minimize the impact;
- Preparing an Environmental Management and Monitoring Program etc.

Methodology

The major task of preparing the EIA report consisted with the following sequential components:

>Identification and screening of the environmental parameters relevant to the proposed project through a scoping process;

>Assessment of the magnitude of the potential negative impacts for relevant environmental parameters;

>Formulation of avoidance/mitigation measures to address the potential negative impacts, and preparation of a monitoring program during the period of project implementation.

Policy, Legal and Administrative Framework

According to the national environmental legislation of Bangladesh all development projects are governed by some legal and institutional requirements. As such, assessment of relevant legal provisions, policies, strategies and institutional issues are very important for any project proponent or developer before execution of a program or plan. The proponent has to be well aware of these requirements and comply with the provisions as applicable and necessary. Before initiating any development project, it is hence required to obtain environmental clearance from DOE. Regarding the activities of the proposed development road for the network connection from Matarabari to Dhalghata as associated facilities of coal fired power plant fall under the 'red' category according to the Bangladesh Environment Conservation Rules (ECR) 1997 and therefore, need to conduct EIA study to obtain environmental clearance from the DOE.

The following activities have been carried out under the EIA study:

- Identification of national legal obligations in relation to the interventions which will be required to review under the EIA study of the embankment cum road under the power plant;
- Exploration of the national legislative provisions and policy guidelines on environmental sectors;
- Identification of the international legal obligations and relevant provisions of multilateral environmental agreements related to the access road project;
- Exploration of national and international legal provisions on road and bridge sector; and
- Identification of the standard guidelines at regional and international level related to the road and bridge setup.

Project Description

The proposed 6.5 km embankment cum road from Rajghat Bridge, Matarbari to Mohiraghona, Dhalghata will be constructed on the existing embankment of BWDB. This is a Red category project under ECR 1997.

The design shall be in compliance with the relevant regulations of Bangladesh, American/European Road Standards (AASHTO/TRRL) and Japanese Road Structure Ordinance. In Bangladesh, for designing road, structure like culvert, bridge, etc, AASHTO LRDF latest version is followed in every department like RHD, LGED, RAJUK etc. Specifically, the design Standard of RHD shall be adopted in this project as a basic criteria.

In addition, for the new road constructed on BWDB embankment the road standard mentioned above will be adopted to pavement, and BWDB design standard will be adopted to basement (embankment) and other specific structures in embankment such as sluice gate and regulator.

The total cost of the project is roughly estimated to be Tk. 956000,000.69. (Tk. Ninety five crore sixty lacs only)

Environmental and Social Baseline

The region has a tropical climate with three main seasons–the hot and humid summer, the rainy season and the mild and relatively dry winter. The average minimum temperature in Bangladesh lies within November to February which varies generally from 6.2°C to 13.4°C while the maximum temperature is seen in May which is around 39.5°C. The maximum annual rainfall in the last ten year the project area is about 3171mm. About 80% of the total rainfall has been recorded (e.g. 2793.69 mm) during monsoon. The average yearly humidity in the region varied from 84% to 90% depicted data of the last ten years. The project area falls in the fifth river system (figure 4.3) of Bangladesh. The project area covers Matamuhuri, Uzantia, Kohelia and Masgona rivers. The area is a disaster prone area as many cyclones and tidal bores affected the area in the past. During the years 1960 to 2015, Bangladesh was hit by 55 severe cyclones, 33 of which were accompanied by storm surges. The height of the surges is limited to a maximum of 10 meters in the bay. Such type of tropical cyclones severely damaged the human property and loss of life. The project area experiencing two types of flood like tidal and storm surge flood. The proposed road is very adjacent to the salinity wave front. The proposed embankment cum road is an existing polder (no. 70) of BWDB which protect saline water intrusion to the land areas. Drainage congestion and water logging are not prominent in the study area.

Based on the analyses carried out with the HEC-RAS model, it can be concluded that there would not be any significant impact of the proposed embankment-cum-road on flood and drainage in the concerned area. The site is highly vulnerable for bank erosion. The proposed embankment cum road along the west of Kohelia River of Matarbari Island shall be made very strong and permanent to save the island from cyclone, tidal waves and erosion along with Sedimentation. Thus, erosion protection measures would be needed throughout the river. The existing protection work through bank revetment seen around the Kohelia Bridge in South Rajghat may help guide the design and construction of the protection work of the proposed embankment-cum-road.

The project area falls in the agro-ecological region of the Chittagong Coastal Plains (AEZ-6). The whole area is mainly divided into two physiography i.e. tidal floodplains and Sandy beaches. Tidal flood plains is tidally flooded, very poorly drained, finely stratified now silty to clayey alluvium. Beach sands soils are mainly grey in colour and sandy in texture. They are tidally flooded and strongly saline. The surrounding areas along the road have been mostly cultivated into production fields, salt fields, residential areas, market areas, ponds or channels with low biodiversity. Salt and shrimp fields are the most abundant.

Fish resources of the Project area are diversified with different fresh and brackish water habitats. Open water fish habitat of the Project area including surrounding rivers and khal,

acting as major arteries of fish migration into and within the Project area. These water bodies play a vital role in maintaining fish productivity of internal open water. There is no fishery based community association found in the study area.

According to the IUCN, 25 Bio-ecological Zones (*Nishat et al, 2002*) in the context of physiographic and biological diversity the study area has fallen under two bio-ecological zones of Coastal Floodplain and coastal marine water. In the proposed project influence zone surrounding, there is no ECA area or even any protected area.

In all, 77 species in the rainy season and 71 species in the dry season were recorded at the site, the majority of which are angiosperms. No threatened species, as designated by IUCN status declaration of 2012, were recorded. Common bird species such as pied starling, house sparrows, house crows, drongos, pigeons, wagtails, swallows are seen throughout the area. The wide wet areas, that is, rice fields, ponds and channels provide habitat of water fowls such as herons, egrets and kingfishers.

Density of population in the locality is not very high compare to other densely populated parts of Bangladesh. Local people are both from educated and non-educated. Farmers do not go for land cultivation as that is not profitable to them. As a result, leasing out of land on annual rent basis is a common practice in the area. For salt cultivation each Kani (40 decimals) is leased out at BDT 12,000 (US$ 1=80) to 18,000 where for shrimp cultivation at BDT 2,000-3,000. Shrimp is less profitable than salt cultivation due to modern technique used for salt production at less cost. With the modern technique salt production per hactare has gone very high and thereby profit also increased, in return, land lease value has also increased. Per decimal arable land price is BDT 7000-8000 (US$ 90-100) or per hactare BDT 250,000-300,000. Land price along the road varies widely depending on the location where in some places per decimal is BDT 15,000-20,000. In the case of homestead land it is about BDT 30,000-35,000. Some 20% households have migrant members outside the country, who are dependent on remittances. According to the poverty map of Bangladesh 2010 prepared by BBS/WFP/ World Bank, the project area falls under 28%-38% category. In case of extreme poverty it is 7-15% category. Women do not work in the field very often. Sometimes poor women, widows, divorcees work as day labourer in the field as well as road maintenance workers of LGED.

The prevailing air conditions are generally typical of rural Bangladesh, which implies generally good conditions. The principal source of pollutants in the region is from vehicular traffic and some small industries. Matamuhuri and Koheli rivers chlorine result observed very high than the other river water. The saline water is captured adjacent to the river bank land areas for salt cultivation. Due to high Saline and TDS content the EC found very high in the Matamuhuri and Koheli rivers. The prevailing noise conditions are generally typical of rural Bangladesh, which implies generally good conditions.

Identification and Analysis of Key Environmental Issues

The proposed road project area is environmentally sensitive due to the geographical location. All the environmentally sensitive issues were investigated by a selected consultants group

through carrying out primary and secondary data analysis. The main hindrance of the proposed project sustainability is natural calamity like storm surges, cyclones, Tsunami etc. Design consultants should consider this sensitive issue in the design structure to make project sustainable. The structure should be maintained adequate height against storm surges, cyclones, Tsunami flooding. Adequate tree plantation will be required along the right of way of the embankment.

Environment and Social Impacts

Environmental impacts assessment was carried out considering present environmental setting of the project area, and nature and extent of the proposed activities. Potential environmental impacts associated with the proposed project activities are classified as: (i) impacts during design and construction phase and ii) impacts during operation phase.

Some of the important impacts associated with the proposed project will be associated with land use (land acquisition), land stability (soil erosion), soil compaction and contamination, water availability, water quality of river/stream/canal, ground water contamination, waste and wastewater disposal, ambient air quality, ambient noise levels, vegetation, tree cutting (including social forestry tree), fauna (terrestrial and aquatic), drainage pattern, hydrology, climate change, socio economic, places of social/cultural importance (religious structures, community structure), construction material sourcing and occupational health and safety. Adequate mitigation measures are devised to mitigate/minimize all likely environmental impacts and the same have been presented along with the impacts.

At the proposed site where the road will be constructed, about 25-30 households and 10-12 shops including tea stall will be directly affected by the project implementation who own, rent or use private land within the proposed alignment site. A resettlement plan will be developed for mitigation the social impact as well as sustainable implementation of the project.

During the field study, consultations were also held with people in the locality including those presently living in the project areas, NGOs and Government authorities like Forests Departments, RHD, and Fisheries. Outcome of these consultations were used in impact assessment and devising mitigation measures.

Public Consultation and Disclosure

Public consultation is one of the key components of the environmental assessment. The EA team conducted public consultations in several spots of the project road. The approach involved a mix of conventional as well as participatory/ rapid rural appraisal (PRA), focus group discussions (FGD) and one-to-one interviews. Accordingly, as first step, the literature and secondary data was reviewed. Local people from different socio economic backgrounds in the villages along the alignment, NGOs and concerned Govt. officials were consulted. Public consultations were held during the different site visits of EIA report preparation.

Environmental Management Plan

Environmental Management Plan has been developed for addressing all adverse impacts pertaining to the implementation of the project. The plan presented in tabular form includes

impacts, their sources of occurrence, their mitigation measures, actors responsible for implementation of mitigation measures and their responsibilities.

Environmental Monitoring Plan has incorporated key environmental components and parameters to be monitored their indicators, frequency, timing and locations of monitoring and also the actors responsible for carrying out such monitoring.

RHD/CPGCBL is the Executing Agency, responsible for overall project implementation and will establish a Project Management Unit (PMU) to manage the project on their behalf. This will be headed by a Project Director (PD), supported by technical staff including Design and Supervision Consultants (DSC), who will design the infrastructure, manage selection of Contractors, and supervise construction.

Mitigation is the responsibility of CPGCBL/RHD. The EPC contractor engaged by the project authority will implement the EMP along with mitigation measures, as part of the contractual obligation, and the DSC will supervise the work. The cost for Environmental Mitigation Measures and Monitoring will be included in the DPP and allocated of fund will made accordingly.

Conclusion and Recommendation

On the basis of the field reconnaissance and secondary information collected from different authorities, it may be concluded that the project stands environmentally sound and sustainable when the recommended mitigation measure and environmental management processes are adopted properly.

Severe weather conditions would have an impact on the road construction activities. The construction activities may even have to be stopped during these storms. So it is recommended that commencing construction in early winter season may help to reap the benefit of full dry spell of the season. Further,

- A resettlement plan along with livelihood restoration plan will be developed for deprived poor households lived on the proposed 6.5 km embankment cum road at Rajghat point before start of the construction. CPGCBL/RHD will be responsible for the resettlement plan along with livelihood restoration plan.
- To reduce hydrological impact, adequate regulators and culverts should be provided to the road and proper management should also be established
- In order to enhance the occupational health and worker safety during the construction period, construction equipment would have to be kept in good order. Adequate safety measures should be taken and safety related equipment including personal protective and safety equipments (PPE), firefighting equipment etc. must be provided in order to reduce the potential for accidents.
- Solid waste will be generated during the construction period from excavation and refuse from construction camps.
- The major issue is the need to minimize disturbance to the local population in the areas of road construction. Effort should be put in to arrive at a fair and equitable

level of compensation for farmers, residents and other individuals affected by land taken (permanent and temporary) for the project. A positive policy of employing local people during the construction phase should be adopted.

- In the post construction phase, the environmental impact of the project will be some loss of land utility along the road alignments and any accidents. The former can be mitigated by adoption of a fair compensation policy and the latter by adequate maintenance and monitoring.
- Since the implementation of the proposed project will bring about huge benefit through help meet countries power demand for development, certain minor environmental impacts of the associated road project will have to be compromised for the better interest of the country. However, the anticipated impacts are mostly of short duration and relatively minor in nature.
- In view of the above considerations and the fact that the executing agency (RHD/CPGCBL) will maintain standard quality of implementation of the program with due consideration to other standing rules and regulations including but not limited to updated ECA 1995 and ECR 1997 the project may be recommended for implementation.

Chapter 1 Introduction

1.1 Background of the Project

Government of Bangladesh has been implementing Matarbari 2 x 600 MW Ultra Super Critical thermal power plants by BPDB. The project is financed by JICA. EIA study for the Matarbari power project and associated facilities has been completed by JICA and approved by DOE.

Matarbari island is under Moheshkhali upazilla of cox's bazzar district is surrounded by embankment, which was constructed during 1962 by EPWAPDA to protect the area from saline water. Currently sluice gate stands for using of saline water for shrimp culture by the local inhabitants, Due to construction of Power plant project and associated facilities huge area has been developed through land filling and Hydrological dimension of the proposed project and surrounding likely to be affected.

For the demand of the local people and for the protection of the Matarbari project, Project authority is planning to rehabilitate the east part of existing embankment (Figure 1.1 and 1.2) for use as a road for the local inhabitants. Proposed 6.5 km long embankment from Rajghat, Matarbari to Mohiraghona, Dhalghata site is located east of the project along the west bank of the river.

To examine the potential Environmental, Hydrological and Social Impact and fulfilling the requirement of the Department of Environment requirement and regulatory compliance, the project authority has engaged *Geo Associate Bd,* a local consulting firm, to conducted this EIA Study including Hydrological /Mathematical Modeling for the proposed project.

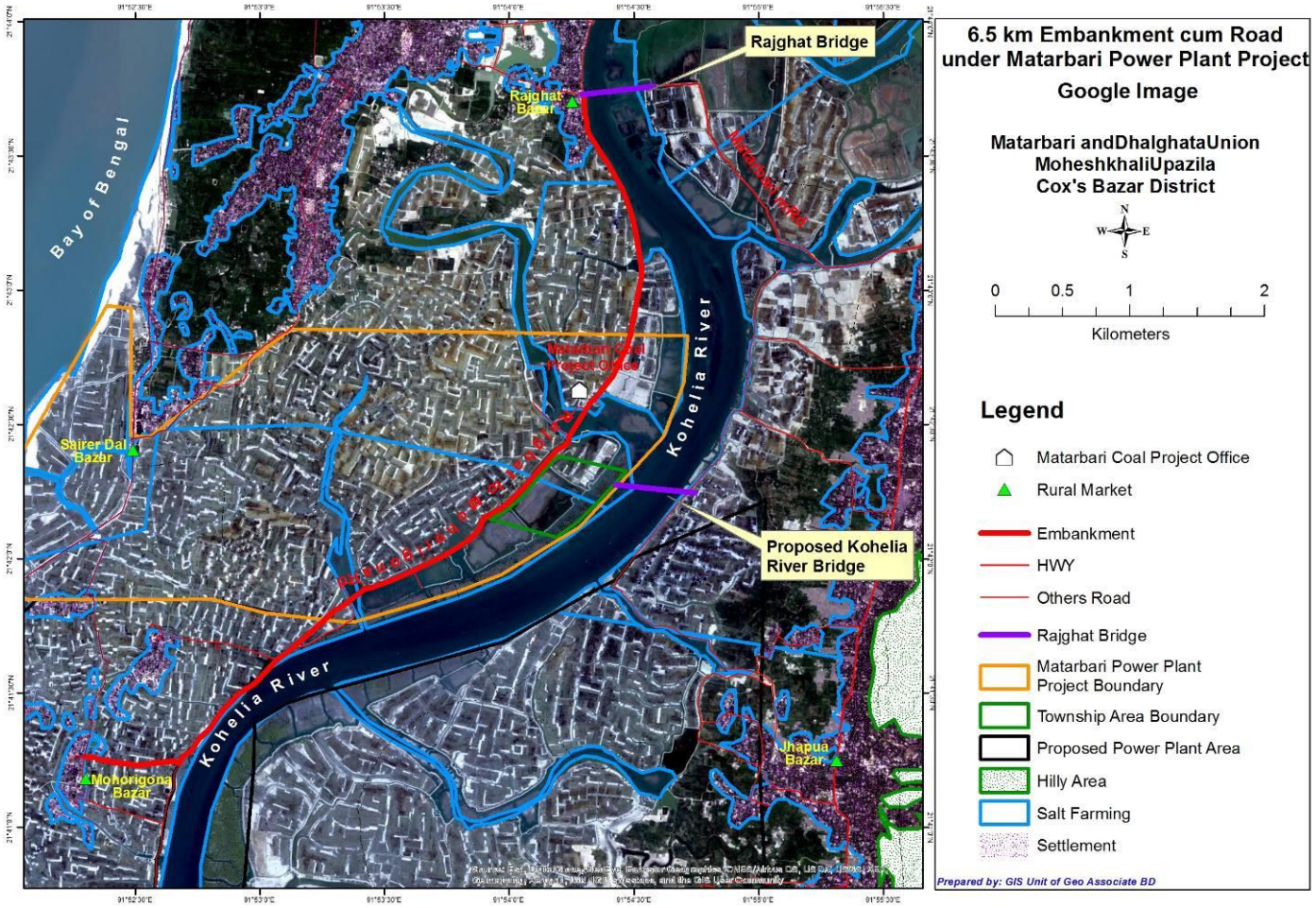


Figure 1.1: Location of the proposed project in Google earth image from Rajghat Bridge, Matarbari to Mohiraghona, Dhalghata

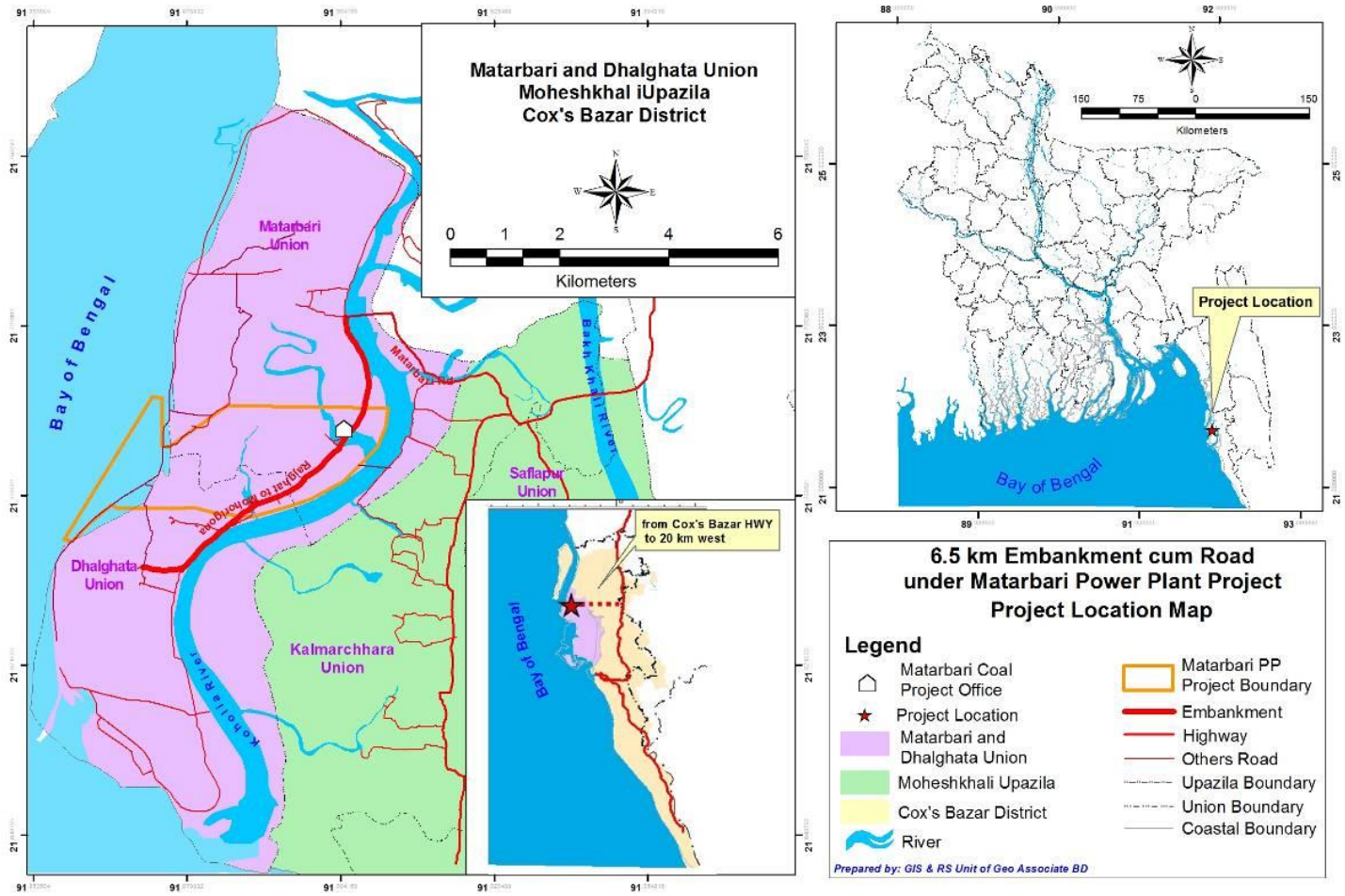


Figure 1.2: Location of the proposed project in GIS image from Rajghat Bridge, Matarbari to Mohiraghona, Dhalghata

1.2 Rationale of the Project

The main rationale of the project is connecting two unions from Rajghat point, Matarbari to Mohiraghona, Dhalghata by constructed embankment cum road. The important of the project is to transport construction materials during developmental works carried out. The proposed power plant will add 1,200MW electricity to the national grid that will improve the present electricity generation significantly and as well as trigger the national economic development. Not only that, industrial development will be initiated after implementation. Additionally, it will create employment opportunity to the local people and improve transportation system in the project area, which will ultimately play an important role in poverty reduction and develop social safety net condition.

This embankment cum road shall protect the power project from external flooding of Koheli River acting as a dyke.

The project is the left bank of Koheli River and the site is highly eroded. This embankment cum road shall also protect the area from erosion.

1.3 Objectives of the EIA Study for the proposed embankment cum Road

The objective of this Environmental Impact Assessment Examination (EIA) is to produce an environmental impact document for CPGCBL that follows Bangladeshi regulations and "JICA Guidelines for Environmental and Social Consideration (April, 2010)".

Hence, Geo-Associate Bd study team on behalf of CPGCBL carried out EIA to fulfill the requirement of the DOE. The main objectives of the EIA study were:

- Describing the existing environment of the area;
- Assessment of the potential environmental, Hydrological and Social impacts, including residual impact of the proposed project;
- Identifying mitigation measures to minimize the impact;
- Preparing an Environmental Management and Monitoring Program etc.

The scope of EIA includes both natural and socio-economic environments of specific concern is the nature of human use of resources and how this changes as a result of the proposed embankment cum road interventions. EIA aims to predict induced change as a result of the proposed 6.5 km embankment road, so that any negative impacts can be avoided or minimized and positive impacts can be enhanced. Of specific concern is the degree of negative impacts that cannot be avoided or mitigated for and that these be greatly outweighed by the predicted positive impacts of the project. The major works of the Matarbari to Dhalghata connecting

road will comprises of earth filling for embankment cum road and drainage channel construction,. The environmental impacts are thus expected to be limited and localized. Hence, an Environmental Impact Assessment (EIA) was carried out during the project preparation stage in accordance with Bangladeshi policies and guidelines of the Department of Environment (DOE), the "JICA Guideline for Environmental and Social Considerations (2010 April)" (JICA Guideline), and World Bank Operational Manual.

1.4 Scope of Study/Work

The proposed 6.5 km embankment cum road will be utilized for the purposes of connecting Matarbari to Dhlaghata Union for transporting needed equipment and materials, and for the movement of parties involved in the construction of the power plant.

The scope of the EIA included:

- A hydrological / Mathematical Modeling / Detailed Hydrological Impact Analysis considering baseline situation, development of 6.5 km embankment cum road, under Matarbari power plant project and associated facilities
- Review of the policies of the Government of Bangladesh and JICA Guideline
- Examination of the salient biophysical and socioeconomic conditions of the project area;
- Identification of the relevant environmental parameters in the project area through scoping and literature review;
- Assessment of the magnitude of the potential impacts of the project actions
- Environmental Management Plan with Mitigation and enhancement Plan

1.5 Approach and Methodology

The EIA study was carried out using reconnaissance survey, field visits, consultation with stakeholders, NGOs, review of existing data, assessment to identify adverse impacts and preparation of EMP and post-project Environmental Monitoring Programme. Hydrological modeling tools were used to analyze the hydrological impact of proposed project activities. Physical assessments were made for entire corridors with respect to terrestrial and aquatic aspects.

The task of preparing the EIA report consisted of the following sequential components:
>Identification and screening of the environmental parameters relevant to the proposed project through a scoping process;

>Assessment of the magnitude of the potential negative impacts for relevant environmental parameters;
>Formulation of avoidance/mitigation measures to address the potential negative impacts, and preparation of a monitoring program during the period of project implementation;

Scoping and field visits to the project sites identified the environmental parameters/components (relevant to the project actions) which are susceptible to be affected. The field visit also included participatory approach, which involved discussions with local people in order to determine the perceptions and priorities of the stakeholders in the Project area. Apart from the local people, information were also obtained from the Upazila Engineers and other related government officials.Information were also derived from secondary sources like different reports, journals, Satellite Image Analysis, research papers, NGO, government officials etc.

1.6 Structure of the Report

The report fulfills the requirements of EIA under ECR, 1997 and has been prepared in accordance with the TOR. The report contains ten chapters and the chapter details are discussed below:

- Chapter 1 describes the introduction containing background, rationale, objectives of the EIA study, scope of the study, approach methodology and team members of EIA study.
- Chapter 2 is on policy, legal and administrative framework describing the relevant policy and legal frameworks for the EIA process.
- Chapter 3 contains detailed project description including the all the aspects of the proposed road like design of the preliminary road, flood control structure and bridge.
- Chapter 4 describes environmental and social baseline condition with details on physical environment, land resources, agricultural resources, fisheries, ecosystem, socio-economic condition and social characteristics of the area.
- Chapter 5 describes identification of key environmental issues.
- Chapter 6 presents the impacts of project during pre-construction, construction and post-construction phase and describes mitigations measures for minimizing the effect of the negative impacts and enhancement measures for increasing the benefits of the positive impacts.
- Chapter 7 describes public consultation discussion with local stakeholders with their ideas, views about the project through knowledge sharing

- Chapter 8 describes the environmental management plan (EMP) and monitoring plan along with the monitoring indicators.
- Chapter 9 includes the costing of the mitigation measures and monitoring plan.
- Chapter 10 concluding the EIA report along with the recommendations.

1.7 The EIA Study Team

Geo-Associate Bd, a local up growing consultancy firm has formed a multidisciplinary team of EIA experts having experience of conducting Environmental Impact Assessment of large scale industrial and infrastructural development projects. Table 1.1 presents the professionals' names with their positions.

Table 1.1: The EIA Study Team

No.	Name	Assignment
1	Mohammad Ikbal Hossain	Team Leader (Environmental & Resettlement Specialist)
2	Dr. Shahjahan Mondal	Hydrological / Mathematical Modeling Expert
3	S.M. Sanaul Kafi	Environmental Specialist
4	Golam Mohiuddin	Environmental lawyer
5	Md. Mozammel Haque	Socio-economist
6	Ms. Ismot Ara	GIS & RS Specialist

Chapter 2 Policy, Legal and Administrative Framework

According to the national environmental legislation of Bangladesh all development projects are governed by some legal and institutional requirements. As such, assessment of relevant legal provisions, policies, strategies and institutional issues are very important for any project proponent or developer before execution of a program or plan. The proponent has to be well aware of these requirements and comply with the provisions as applicable and necessary. Before initiating any development project, it is hence required to obtain environmental clearance from DOE. Regarding the activities of the proposed development road for the network connection from Matarabari to Dhalghata as associated facilities of coal fired power plant fall under the 'red' category according to the Bangladesh Environment Conservation Rules (ECR) 1997 and therefore, need to conduct IEE and EIA studies to obtain site and environmental clearance from the DOE.

The following activities have been carried out under the EIA study:

- Identification of national legal obligations in relation to the interventions which will be required to review under the EIA study of the access road for the power plant;
- Exploration of the national legislative provisions and policy guidelines on environmental sectors;
- Identification of the international legal obligations and relevant provisions of multilateral environmental agreements related to the access road project;
- Exploration of national and international legal provisions on road and bridge sector; and
- Identification of the standard guidelines at regional and international level related to the road and bridge setup.

2.1 Provision under national law and by-laws

2.1.1 Provisions under the Environmental Legislations

National laws, by-laws and official resolutions relevant to road and bridge construction, operation and maintenance and associated activities have been identified under this study.

The ***Bangladesh Environment Conservation Act of 1995*** is the key legislation in relation to environment protection in Bangladesh. This Act is promulgated for environment conservation, standards, development, pollution control, and abatement. It has repealed the Environment Pollution Control Ordinance of 1977. The Act has been amended in 2000, 2002, 2007 and has been proposed for amendments in the year 2010. The main objectives of the Act are:

- Conservation and improvement of the environment; and
- Control and mitigation of pollution of the environment.

The main strategies of the Act can be summarized as:

- Declaration of ecologically critical areas and restriction on the operations and processes, which can or cannot be carried/initiated in the ecologically critical areas;

- Regulations in respect of vehicles emitting smoke harmful for the environment;
- Environmental clearance;
- Regulation of the industries and other development activities' discharge permits;
- Promulgation of standards for quality of air, water, noise and soil for different areas for different purposes;
- Promulgation of a standard limit for discharging and emitting waste; and
- Formulation and declaration of environmental guidelines.

Before any new project/development interventions by the government or by non government agencies can go ahead, as stipulated under the Environment Conservation Rules 1997, the project promoter must obtain Environmental Clearance from the Director General of DOE. An appeal procedure does exist for those promoters who fail to obtain clearance. Failure to comply with any part of this Act may result in punishment of imprisonment or fine or both. The DOE executes the Act under the leadership of the Director General.

The Bangladesh Environment Conservation Act (Amendment), 2000 focuses on: (1) ascertaining responsibility for Compensation in cases of damage to ecosystems, (2) increased provision of punitive measures both for fines and imprisonment and (3) fixing authority on cognizance of offences.

The Bangladesh Environment Conservation Act (Amendment), 2002 elaborates on: (1) restriction on polluting automobiles, (2) restriction on the sale and production of environmentally harmful items like polythene bags, (3) assistance from law enforcement agencies for environmental actions, (4) break up of punitive measures and (5) authority to try environmental cases.

The Bangladesh Environment Conservation Rules, 1997 is the first set of rules, promulgated under the ECA 95 (so far there have been three amendments to this set of rules - February and August 2002 and April 2003). The Environment Conservation Rules of 1997 has provided categorization of industries and projects and identified types of environmental assessments needed against respective categories of industries or projects.

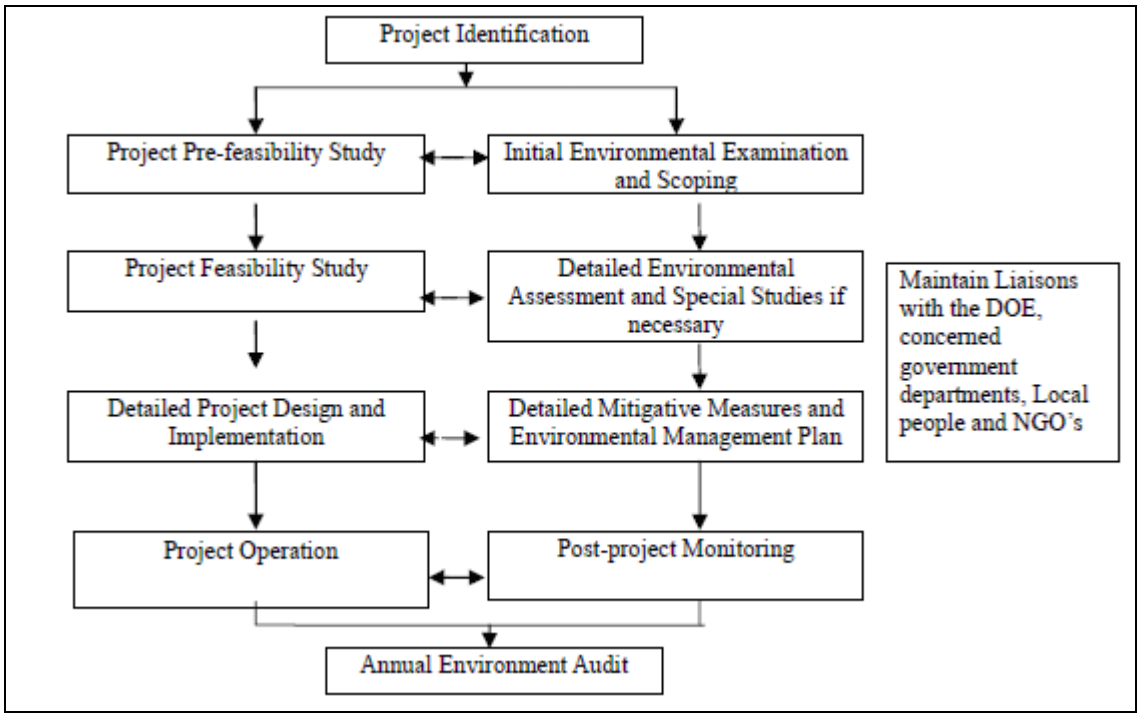
Among other things, these rules set (i) the National Environmental Quality Standards for ambient air, various types of water, industrial effluent, emission, noise, vehicular exhaust etc., (ii) the requirement for and procedures to obtain environmental clearance, and (iii) the requirement for IEE and EIA's according to the categories of industrial and other development interventions.

2.1.2 Compliance with DOE's EIA Guidelines

As bridge construction/ reconstruction over 200 m length fall under the 'red' category according to the Environment Conservation Rules 1997, it is mandatory to carry out EIA including Environmental Management Plan (EMP) and to develop a Resettlement Action Plan where required, for getting environmental clearance from the DOE. The DOE has issued EIA Guidelines for Industries (this document was released in December 1997) and addresses the IEE and EIA for several industrial sectors and activities. Each Project Proponent shall conduct an IEE or EIA and is expected to consult and follow the DOE

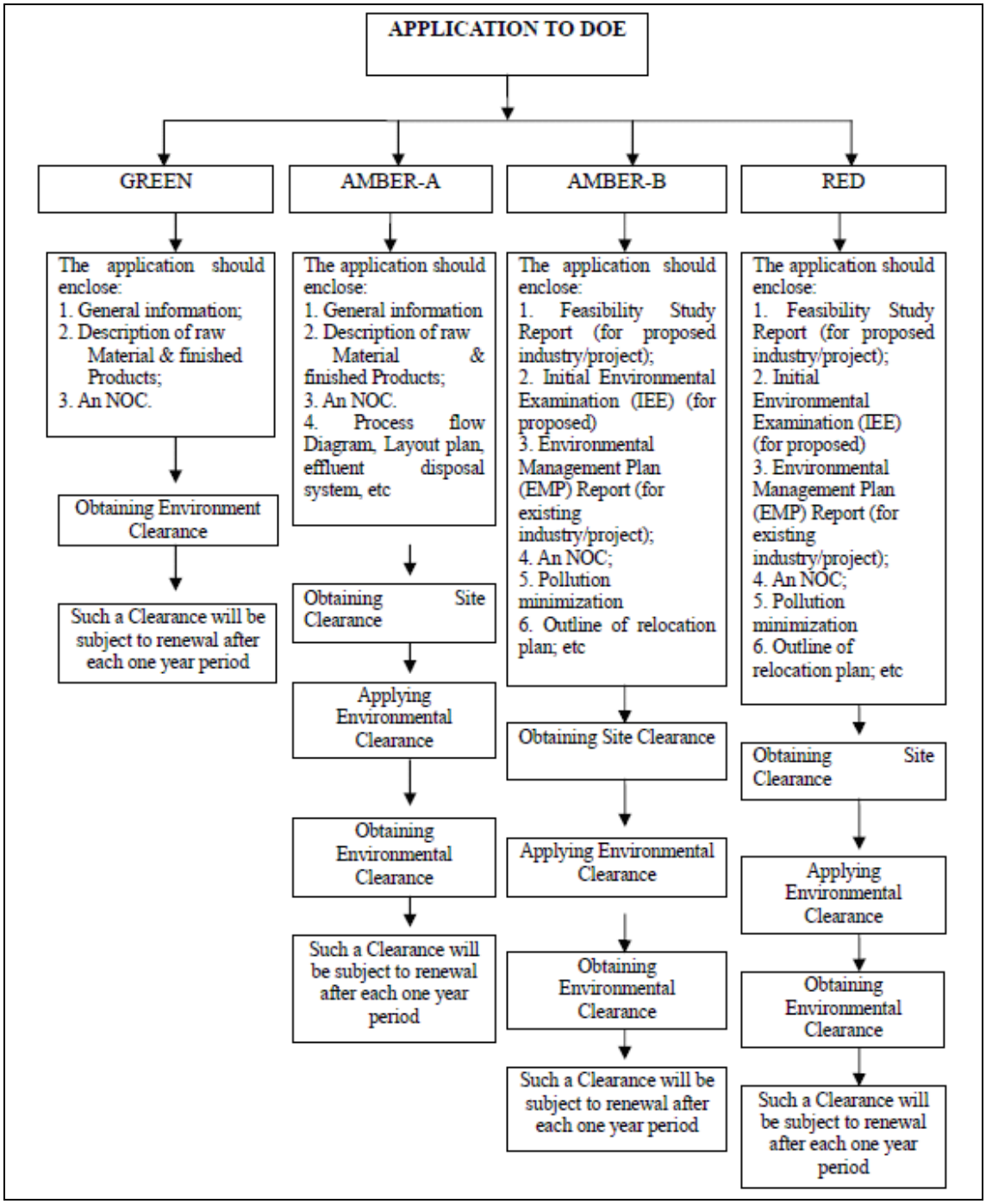
guidelines (Figure 2.1). Under this study the provisions of the environment legislations and the EIA guidelines of the DOE will be painstakingly reviewed.

The DOE has issued application procedure for obtaining site/environmental clearance. Figure 2.2 shows the application procedure of all four categories:



(Source: EIA Process, EIA Guideline for Industries, Department of Environment, 1997)

Figure 2.1: Flow Chart of EIA Process



(Source: EIA Process, EIA Guideline for Industries, Department of Environment, 1997)

Figure 2.12: Process of obtaining clearance certificate from DOE

2.1.3 Compliance under the National Laws

Wildlife (protection and safety) Act 2012

The Wildlife (protection and safety) Act 2012, passed in Parliament on 8th July, 2012. Under this act, the hunting, trapping, killing of wildlife are strictly prohibited. After the establishment of this Act, a board will

be formed with the concerned members recommended by the Government. There are certain provisions kept in this Act, e.g. entrance, management, rules and regulation of the protected area etc. If any person without license performs any kind of trade, he will be jailed for at least a year. The details of the Act shall be further discussed in the EIA report.

The Forest Act, 1927 and Amendment Act 2000

The Forest Act of 1927 provides for reserving forests over which the government has an acquired property right. This act has made many types of unauthorized uses or destruction of forest produce punishable. The Government may assign any village community its right to or over any land, which has constituted a reserved forest.

According to the Act the government may prohibit certain activities in the declared reserved forest area such as any intervention kindles, keeps or carries any fire; trespasses or pastures cattle, or permits cattle to trespass; causes any damage by negligence in felling any tree or cutting or dragging any timber; etc.

Along the Kohelia River between Matarbari Island and Moheskhali Island, transplanted mangrove forests are distributed.

Therefore, the access road construction complies with this requirement of legislation. During the EIA study this Act and related rules and regulations will be reviewed to explore whether the activities of the access road violates any provisions of the Forest Act.

The Supplementary Rules of 1959 empowered the concerned governmental bodies to restrict totally and for a specified period, the shooting, hunting or catching of various birds, animals and reptiles in the controlled and vested forests. The Private Forest Ordinance of 1959 provides for the conservation of private forests and for the forestation, in certain cases, of wastelands in Bangladesh.

The Penal Code, 1860

The Penal Code of 1860 has some valid provisions related to pollution management, environment protection and protection of health and safety. Some of these are: Section 277: Falling Water or Public Spring or Reservoir; Section 278: Making Atmosphere Noxious to Health; Section 284: Negligent Conduct with Respect to Poisonous Substance; Section 285: Negligent Conduct with Respect to Fire or Combustible Matter; and Section 286: Negligent Conduct with Respect to Explosive Substance. (Chapter XIV of offences affective Public health, safety, convenience, decency and morals).

The Acquisition and Requisition of Immovable Property Ordinance (1982)

This Ordinance has replaced the Land Acquisition Act of 1894 and the East Bengal (Emergency) Requisition of Property Act of 1948. The Ordinance governs acquisition and requisition by the government of immovable property for any public purpose or in the public interest. It may be noted that contrary to the previous Acts (i.e. Act XIII of 1948), this Ordinance deals only with immovable property.

The Ordinance has well-defined procedures regarding payment of compensation for an acquired piece of land. If, for example, the land is used for rice growing, then an amount equivalent to approximately 1.5 times the market value of a given variety of rice (e.g., paddy) that is currently being (or could be) produced annually is fixed as a yearly lease value. In case of outright purchase (carried out on a 99-year lease), the

compensation-value of acquired land varies widely according to the locality, soil fertility, and access to transportation and related infrastructure factors. The current compensation and resettlement provisions are however inadequate both in terms of timing of payments and quantum. The procedures involved are cumbersome and time consuming and often causes hindrance to the smooth execution of the project. Legal provisions covering adequate compensation to the project affected persons, particularly disadvantaged groups such as women and squatters and such other vulnerable groups are yet to be framed.

The Protection and Conservation of Fish Rules, 1985

These are a set of rules in line with the overall objectives of the Fish Act. Section 5 of the Rules requires that "No person shall destroy or make any attempt to destroy any fish by explosives, gun, bow and arrow in inland waters or within coastal waters". Section 6 of the Rules states:-"No person shall destroy or make any attempt to destroy any fish by poisoning of water or the depletion of fisheries by pollution, by trade effluents or otherwise in inland waters". Therefore, the new bridge construction will need to be carried in such a manner that the activities do not cause damage to the inland waters or within coastal waters fisheries.

The Embankment and Drainage Act, 1952

The *East Bangle Act No. 1,* 1952 was amended in 1953 which has been adapted by the People Republic of Bangladesh, by the Bangladesh Order (adaptation of Existing Laws), 1972 (President's Order No. 48 of 1972). The Act consolidates the laws relating to embankments and drainage providing provision for the construction, maintenance, management, removal and control of embankments and water courses for the better drainage of lands and for their protection from floods, erosion or other damage by water.

The specific Sections and Articles relevant to the Project are mentioned below:

- Section 4 (1) of the Act states that the embankment, water-course, and tow-path, earth, pathways, gates, berms and hedges of the embankments shall vest in the Government of the Authority (BWDB).
- Section 56 (1) states that, person will be subject to penalty (500 taka or other imprisonment if he erects, or causes of willfully permits to be erected, any new embankment, or any existing embankment, or obstructs of diverts, or causes or willfully permits to be obstructed or diverted, any water course.
- Section 15 allows for the engineer (engineer in charge of Divisional level BWDB) for constructing new embankment or enlarging, lengthening or repairing existing embankments.
- The other sections of the Act give powers and access to the Government or Authority or Engineers to commence necessary Project activities, for land acquisition (through the Deputy Commissioner), and site clearing activities including removal of trees or houses (if necessary).

The Water Resources Planning Act, 1992

An Act made to ensure the development and balanced use of water resources or it is expedient to make

provisions in order to ensure the development and balanced use of water resources.

Under this act water resources planning institutions conduct the general planning of environmentally balanced water resources for the purpose of developing water resources; to determine the methods for the scientific utilization and preservation of water resources; provide advice to other institutions involved in the development, utilization and preservation of water resources; co-operate any organization for the development, utilization and preservation of water resources and to conduct any special investigations on any matter relating thereto; evaluate and review any matter for development, utilization and preservation of water resources; training relating to, and to raise the professional standard in the utilization of water resources and review information on the utilization of water resources, and provide assistance for their publication;

2.2 Policy guidance

Under the study a number of sectoral national policies will be reviewed to identify the guiding principles which are relevant to the access road construction, operation and maintenance activities. The sector policies will include environment, communication, forest, etc.

National Environment Policy

The National Environment Policy of 1992 sets out the basic framework for environmental action, together with a set of broad sector action guidelines. The Policy provides the broader framework of sustainable development in the country. It also stated all major undertakings, which will have a bearing on the environment; (including setting up of an industrial establishment) must undertake an IEE and EIA before initiation of the project.

The Policy delineates DOE, as the approving agency for all such IEE and EIA studies to be undertaken in the country.

National Environment Management Plan 1995

The National Environment Management Action Plan (NEMAP) is a wide ranging and multi-faceted plan, which builds on and extends the statements set out in the National Environment Policy (NEP). NEMAP was developed to address the issues and management requirements for a period between 1995and 2005 and set out the framework within which the recommendations of the National Conservation Strategy (NCS) are to be implemented.

NEMAP has the following broad objectives:

- Identification of key environmental issues affecting Bangladesh;
- Identification of actions necessary to halt or reduce the rate of environmental degradation;
- Improvement of the natural and built environment
- Conservation of habitats and biodiversity;
- Promotion of sustainable development; and
- Improvement in the quality of life of the people.

The National Forest Policy (1994)

The National Forestry Policy of 1994 is the revised version of the National Forest Policy of 1977 in the light of the National Forestry Master Plan. The major targets of the Policy are to conserve the existing forest areas; bring about 20% of the country's land area under the forestation program, and increase the reserve forest land by 10% by the year 2015 through coordinated efforts of GO-NGOs and active participation of the people.

The need for amendments of the existing forestry sector related laws and adopt new laws for sector activities has been recognized as important condition for achieving the policy goals and objectives. The Forest Policy also recognizes the importance of fulfilling the responsibilities and commitments under international multilateral environmental agreements.

The National Water Policy (1999)

The National Water Policy of 1999 was adopted to ensure efficient and equitable management of water resources, proper harnessing and development of surface and ground water, availability of water to all concerned and institutional capacity building for water resources management. It has also addressed issues like river basin management, water rights and allocation, public and private investment, water supply and sanitation and water needs for agriculture, industry, fisheries, wildlife, navigation, recreation, environment, preservation of wetlands, etc.

Bangladesh Climate Change Strategy and Action Plan (2008 and revised in 2009)

The GOB also prepared the Bangladesh Climate Change Strategy and Action Plan (BCCSAP) in 2008 and revised in 2009. This is a comprehensive strategy to address climate change challenges in Bangladesh. Bangladesh Climate Change Strategy and Action Plan built on and expanded the NAPA. It is built around the following six themes:

- Food security, social protection and health
- Comprehensive disaster management
- Infrastructure
- Research and Knowledge management
- Mitigation and low carbon development
- Capacity building and Institutional strengthening

There are 44 specific programs proposed in the BCCSAP under the above six themes.

2.3 International legal obligations

Bangladesh is signatory to a number of Multilateral Environmental Agreements (MEAs) and also some bilateral instruments. Some of them are very important in context of environmental protection. The legal obligations and provisions of MEAs related to the proposed project interventions will be reviewed; (***Convention on Biological Diversity; Convention on Wetlands of International Importance Especially as Waterfowl Habitat; United Nations Convention on the Law of the Sea; Convention concerning the Protection of the World Cultural and Natural Heritage).***

Bangladesh has already had accessed to, ratified or signed a number of important MEAs related to environment protection and conservation of natural resources which shall have to be complied with during implementation of the project. The pertinent ones of these are highlighted below:

Rio Declaration

The 1992 United Nations Conference on Environment and Development (UNCED) adopted the global action program for sustainable development called 'Rio Declaration' and 'Agenda 21'.

Principle 4 of the Rio Declaration, 1992, to which Bangladesh is a signatory along with a total of 178 countries, states as, "In order to achieve sustainable development, environmental protection should constitute an integral part of the development process and cannot be considered in isolation from it".

Convention on Biological Diversity (1992)

The Convention on Biological Diversity, Rio de Janeiro, 1992 was adopted on 5 June 1992 and entered into force on 29 December, 1993. Bangladesh ratified the Convention on 20 March, 1994.

The Contracting Parties of the Convention have committed to:

- Introducing appropriate procedures requiring environmental impact assessments of its proposed projects that are likely to have significant adverse effects on biodiversity, with a view to avoiding or minimizing such effects, and where appropriate allow for public participation in such procedures; and
- Introducing appropriate arrangements to ensure that environmental consequences of its programs and policies, that are likely to have significant adverse impacts on biodiversity, are duly taken into account.

Obligation has been placed on State parties to provide for environmental impact assessments of projects that are likely to have significant adverse effects on biological diversity (art. 4).

Convention on Wetlands of International Importance Especially as Waterfowl Habitat, Ramsar (1971)

This convention is also known as the Ramsar Convention. It was adopted on 2 February, 1971 and entered into force on 21 December, 1975. Bangladesh has ratified the Convention on 20 April, 2002. This provides a framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. There are 127 Parties with 1085 wetland sites designated as Wetlands of International Importance'.

This is an intergovernmental treaty, which provides the framework for international co-operation for the conservation of wetlands habitats. Obligations for Contracting Parties include the designation of wetlands to the "List of Wetlands of International Importance', the provision of wetland considerations within their national land use planning, and the creation of Natural Reserves. Part of Sundarbans Reserved Forest (Southwest of Bangladesh) is the one of the Ramsar Site.

United Nations Convention on the Law of the Sea, Montego Bay, (1982)

This Convention was adopted on 10 December 1982 at Montego Bay, Jamaica. Bangladesh has ratified this Convention.

Main objectives of the convention are:

- To set up a comprehensive new legal regime for the sea and oceans, as far as environmental provisions are concerned, to establish material rules concerning environmental standards as well as

enforcement provisions dealing with pollution of the marine environment; and

- To establish basic environmental protection principles and rules on global and regional cooperation, technical assistance, monitoring, and environmental assessment, and adoption and enforcement of international rules and standards and national legislation with respect to alt sources of marine pollution.

The International Convention for the Prevention of Pollution from Ships (MARPOL) Annex I to V) (1973 to 1978)

The MARPOL Convention was adopted on 2 November 1973 at IMO (International Marine Organization). The Protocol of 1978 was adopted in response to a spate of tanker accidents in 1976-1977. As the 1973 MARPOL Convention had not yet entered into force, the 1978 MARPOL Protocol absorbed the parent Convention. The combined instrument entered into force on 2 October 1983. In 1997, a Protocol was adopted to amend the Convention and a new Annex VI was added which entered into force on 19 May 2005. MARPOL has been updated by amendments through the years. Bangladesh concluded the MARPOL treaty in 1978.

The Convention includes regulations aimed at preventing and minimizing pollution from ships - both accidental pollution and that from routine operations - and currently includes six technical Annexes. Special Areas with strict controls on operational discharges are included in most Annexes.

- Annex I; Regulations for the Prevention of Pollution by Oil (entered into force 2 October 1983)
- Annex II; Regulations for the Control of Pollution by Noxious Liquid Substances in Bulk (entered into force 2 October 1983)
- Annex III; Prevention of Pollution by Harmful Substances Carried by Sea in Packaged Form (entered into force 1 July 1992)
- Annex IV; Prevention of Pollution by Sewage from Ships (entered into force 27 September 2003)
- Annex V Prevention of Pollution by Garbage from Ships (entered into force 31 December 1988)

2.4 Development Agency's Guidelines

Under the study health and safety guidelines of few development agencies will be reviewed. This will include "JICA Guidelines for Environment and Social Consideration" (April, 2010) and "Environmental, Health, and Safety Guidelines of the International Finance Corporation Guideline (IFC/EHS Guideline)".

JICA Guidelines for Environment and Social Consideration

JICA, which is responsible for ODA, plays a key role in contributing to sustainable development in developing countries. The inclusion of environmental and social costs in development costs and the social and institutional framework that makes such inclusion possible are crucial for sustainable development. Internalization and an institutional framework are requirements for measures regarding environmental and social considerations, and JICA is required to have suitable consideration for environmental and social impacts.

The objectives of the guidelines are to encourage Project proponents etc. to have appropriate consideration for environmental and social impacts, as well as to ensure that JICA's support for examination of environmental and social considerations are conducted accordingly. The guidelines outline JICA's responsibilities and procedures, along with its requirements for project proponents etc., in order to facilitate the achievement of these objectives. In doing so, JICA endeavors to ensure transparency, predictability, and accountability in its support for examination of environmental and social considerations.

IFC/EHS Guideline

The EHS Guidelines are technical reference documents with general and industry-specific examples of Good International Industry Practice, as defined in IFC's Performance Standard 3 on Pollution Prevention and Abatement.

2.5 Environmental Regulations

Details of the environmental standards applicable in Bangladesh are described in ECR. Regulated Areas spread to all industries, and regulated items are air quality, water quality (surface water, drink water), noise (boundary, source), emissions from motor vehicles or ships, odor, sewage discharge, waste from industrial units and industrial effluents or emissions. Items and standards, which are related to the construction and operation of access road, are listed below. Tables and annotations of environmental regulation are described as textual description of ECR.

ECR is currently in the process of amendment. There is a possibility that the environmental regulation of the following items will be amended, but the current regulation is applied until the amendment process is completed.

2.5.1 Air Quality

Table 2.1 shows the air quality standard in Bangladesh. Air quality standard adhere to World Health Organization (WHO) guidelines is also mentioned in the Table below.

Table 2.1: Standards for Air quality in Bangladesh[1]

No.	Parameter	Concentration (mg/m^3)		Exposure Time
		ECR	IFC Guideline (General: 2007)*	
a)	Carbon Mono-oxide	10	-	8 hours
		40	-	1 hour
b)	Lead (Pb)	0.5	-	Year
c)	Nitrogen Oxide	0.1	0.04	Year
		-	0.2	1 hour
		-	0.2	1 hour
d)	Suspended Particulate Matter (SPM)	0.2	-	8 hours
e)	Particulate Matter 10µm (PM_{10})	0.05	0.02	Year
		0.15	0.05	24 hours
f)	Particulate Matter 2.5um ($PM_{2.5}$)	0.015	0.01	Year

[1] Not exceed one time in year

No.	Parameter	Concentration (mg/m^3)		Exposure Time
		ECR	IFC Guideline (General: 2007)*	
		0.065	0.025	24 hours
g)	Ozone	0.235	-	1 hour
		0.157	0.160	8 hours
h)	Sulfur Dioxide	0.08	-	Year
		0.365	0.125	24 hours

Notes: * Air quality standard of IFC Guideline is quoted from WHO Guideline.
(Source: Bangladesh Gazette July 19, 2005, IFC Environmental Health and Safety Guidelines 2007

2.5.2 Water Quality

Table 2.2 shows ambient water quality standard (inland surface water), and Table 2.3 shows environmental water quality standard (drinking water).

Table 2.2: Ambient water quality standards (inland surface water)[2]

No.	Best Practice Based Classification	pH	BOD mg/1	Dissolved Oxygen (DO), mg/l	Total Coliform Bacteria quantity/ml
a)	Potable water source supply after bacteria freeing only	6.5-8.5	2 or less	6 or above	50 or less
b)	Water used for recreation purpose	6.5-8.5	3 or less	5 or above	200 or less
c)	Potable water source supply after Conventional processing	6.5-8.5	3 or less	6 or above	5000 or less
d)	Water used for pisci-culture	6.5-8.5	6 or less	5 or above	5000 or less
e)	Industrial use water including chilling & other processes	6.5-8.5	10 or less	5 or above	
f)	Water used for irrigation	6.5-8.5	10 or less	5 or above	1000 or less

(Source : The Environmental Conservation Rules, 1997)

Table 2.3: Environmental water quality standards (drinking water)

No.	Parameter	Unit	Standard Limit	WHO Guidelines
1	Aluminum	mg/l	0.2	0.2
2	Ammonia (NH_3)	mg/l	0.5	-
3	Arsenic	mg/l	0.05	0.01
4	Barium	mg/l	0.01	0.7
5	Benzene	mg/l	0.01	0.01
6	BOD_5 20ºC	mg/l	0.2	-
7	Boron	mg/l	1.0	0.5
8	Cadmium	mg/l	0.005	0.003
9	Calcium	mg/l	75	-
10	Chloride	mg/l	150-600	-
11	Chlorinated Alkanes			-
	Carbon Tetrachloride	mg/l	0.01	-
	1.1 Dichloroethylene	mg/l	0.001	-
	1.2 Dichloroethylene	mg/l	0.03	-
	Tetrachloroethylene	mg/l	0.03	-

[2] Textual annotations are as follows.
(1) Maximum amount of ammonia presence in water are 1.2 mg/l (as nitrogen molecule) which is used for pisciculture.
(2) For water used in irrigation Electrical Conductivity-2250 micro mho/cm (at 25oC). Sodium less than 26 mg/l, Boron less than 2 mg/l

No.	Parameter	Unit	Standard Limit	WHO Guidelines
	Trichloroethylene	mg/l	0.09	-
12	Chlorinated Phenols			-
	Pentachlorophenol	mg/l	0.03	-
	2.4.6 Trichlorophenol	mg/l	0.03	-
13	Chlorine (residual)	mg/l	0.2	-
14	Chloroform	mg/l	0.09	0.3
15	Chromium (hexavalent)	mg/l	0.05	-
16	Chromium (total)	mg/l	0.05	0.05
17	COD	mg/l	4	-
18	Coliform (fecal)	n/100 ml	0	-
19	Coliform (total)	n/100 ml	0	-
20	Color	Huyghens unit	15	-
21	Copper	mg/l	1	-
22	Cyanide	mg/l	0.1	-
23	Detergents	mg/l	0.2	-
24	DO	mg/l	6	-
25	Fluoride	mg/l	1	1.5
26	Hardness (as $CaCO_3$)	mg/l	200-500	-
27	Iron	mg/l	0.3-1.0	-
28	Nitrogen (Total)	mg/l	1	-
29	Lead	mg/l	0.05	0.01
30	Magnesium	mg/l	30-35	-
31	Manganese	mg/l	0.1	0.4
32	Mercury	mg/l	0.001	0.006
33	Nickel	mg/l	0.1	0.07
34	Nitrate	mg/l	10	3
35	Nitrite	mg/l	Less than 1	-
36	Odor		Odorless	-
37	Oil & Grease	mg/l	0.01	-
38	pH		6.5-8.5	-
39	Phenolic compounds	mg/l	0.002	-
40	Phosphate	mg/l	6	-
41	Phosphorus	mg/l	0	-
42	Potassium	mg/l	12	-
43	Radioactive Materials (gross alpha activity)	Bq/l	0.01	-
44	Radioactive Materials (gross beta activity)	mg/l	0.1	-
45	Selenium	mg/l	0.01	-
46	Silver	mg/l	0.02	-
47	Sodium	mg/l	200	-
48	Suspended particulate matters	mg/l	10	-
49	Sulfide	mg/l	0	-
50	Sulfate	mg/l	400	-
51	Total dissolved solids	mg/l	1000	1000
52	Temperature	℃	20-30	-
53	Tin	mg/l	2	-
54	Turbidity	JTU	10	-
55	Zinc	mg/l	5	-

(Source: The Environmental Conservation Rules 1997, Guidelines for Drinking-water Quality WHO 2008)

2.5.3 Noise

As for noise, the standard limit is set for every category of zone class. Table 2.4 shows the Noise standard in Bangladesh.

Table 2.4: Standards for Noise[3]

No	Zone Class	Limits in dBA			
		ECR		IFC/EHS Guideline (General: 2007)	
		Day	Night	Day	Night
a)	Silent Zone	45	35	55	45
b)	Residential Zone	50	40		
c)	Mixed Zone (this area is used combining residential, commercial and industrial purposes)	60	50	70	70
d)	Commercial Zone	70	60		
e)	Industrial Zone	70	70		

(Source: The Environmental Conservation Rules, 1997 IFC Environmental Health and Safety Guidelines 2008)

2.6 Protected area and environmentally controlled area

Classification of Protected areas and environmentally-controlled areas in Bangladesh are shown in Table 2.5. Those areas are declared as National Park, Wildlife Sanctuary, Game Reserve, Botanical gardens and Eco-parks under the Wildlife (Preservation) Order, Reserved Forests and Protected Forests under the Forest Act and Ecologically Critical Areas (ECA) notified under the Environmental Conservation Act.

Table 2.5: Classification of Protected area, environmentally controlled area

Classification		Competent Authority	Governing law
A	National Parks	Department of Forest	Wildlife (Preservation) Order
B	Wildlife Sanctuaries		
C	Game Reserves		
D	Botanical Gardens, Eco-parks		
E	Reserved Forests, Protected Forests		Forest Act
F	Ecologically Critical Areas	Department of Environment	Environmental Conservation Act

(Source: Power System Master Plan 2010

There are fifteen National parks, thirteen wildlife sanctuaries, five botanical gardens and eco-parks in Bangladesh notified under the Wildlife (Preservation) Order, having total area of 2,702.2 km^2. List of Protected areas and environmentally-controlled areas declared under the Wildlife (Preservation) Order are shown in

Table 2.6. There are nine ECA, and the total area is 8,063.2 km^2 excluding the Gulshan – Banani - Baridhara Lake in Dhaka. Table 2.7 shows a list of ECA designated under the Environmental Conservation Act. The Environmental Conservation Act has provision for ECA declarations by the Director General of the Department of Environment in cases where ecosystem or biodiversity of area is

[3] Textual annotations are as follows.
(1) The day time is considered from 6 a.m. to 9 p.m. and the night time is from 9 p.m. to 6 p.m.
(2) From 9 at night to 6 morning is considered night time.
(3) Area within 100 meters of hospital or education institution or educational institution or government designated / to be designated / specific institution / establishment are considered Silent Zones. Use of motor vehicle horn or other signals and loudspeaker are forbidden in Silent Zone.

considered to be threatened to reach a critical state. Along with the ECA declaration, each ECA has notification declared in which specific activities to be restricted in that ECA is specified.

Table 2.6: List of Protected area, environmentally controlled area

Item	No	Name	Place	Size (km^2)
A	1	Bhawal National Park	Gazipur	50.2
	2	Modhupur National Park	Tangail/ Mymensingh	84.4
	3	Ramsagar National Park	Dinajpur	0.3
	4	Himchari National Park	Cox's Bazar	17.3
	5	Lawachara National Park	Moulavibazar	12.5
	6	Kaptai National Park	Chittagong Hill Tracts	54.6
	7	Nijhum Dweep National Park	Noakhali	163.5
	8	Medha Kachhapia National Park	Cox's Bazar	4.0
	9	Satchari National Park	Habigonj	2.4
	10	Khadim Nagar National Park	Sylhet	6.8
	11	Baraiyadhala National Park	Chittagong	29.3
	12	Kuakata National Park	Patuakhali	16.1
	13	Nababgonj National Park	Dinajpur	5.2
	14	Shingra National Park	Dinajpur	3.1
	15	Kadigarh National Park	Mymensingh	3.4
B	1	Rema-Kalenga Wildlife Sanctuary	Hobigonj	18.0
	2	Char Kukri-Mukri Wildlife Sanctuary	Bhola	0.4
	3	Sundarban (East) Wildlife Sanctuary	Bagerhat	312.3
	4	Sundarban (West) Wildlife Sanctuary	Satkhira	715.0
	5	Sundarban (South) Wildlife Sanctuary	Khulna	369.7
	6	Pablakhali Wildlife Sanctuary	Chittagong Hill Tracts	420.9
	7	Chunati Wildlife Sanctuary	Chittagong	77.6
	8	Fashiakhali Wildlife Sanctuary	Cox's Bazar	32.2
	9	Dudh Pukuria-Dhopachari Wildlife Sanctuary	Chittagong	47.2
	10	Hazarikhil Wildlife Sanctuary	Chittagong	29.1
	11	Sangu Wildlife Sanctuary	Bandarban	57.6
	12	Teknaf Wildlife Sanctuary	Cox's Bazar	116.2
	13	Tengragiri Wildlife Sanctuary	Barguna	40.5
D	1	National Botanical Garden	Dhaka	0.8
	2	Baldha Garden	Dhaka	-
	3	Madhabkunda Eco-Park	Moulavibazar	2.7
	4	Sitakunda Botanical Garden and Eco-park	Chittagong	8.1
	5	Dulahazara Safari Parks	Cox's Bazar	6.0

(Source: http://www.bforest.gov.bd/conservation.php, accessed January 2011)

Table 2.7: List of Environmental Critical Areas

Item	No	Name	Place	Size (km^2)
F	1	The Sundarbans	Bagerhat, Khulna, Satkhira	7,620.3
	2	Cox's Bazar (Teknaf, Sea beach)	Cox's Bazar	104.7
	3	St. Martin Island	Cox's Bazar	5.9
	4	Sonadia Island	Cox's Bazar	49.2
	5	Hakaluki Haor	Moulavi Bazar	183.8

Item	No	Name	Place	Size (km^2)
	6	Tanguar Haor	Sumamganj	97.3
	7	Marjat Baor	Jhinaidha	2
	8	Gulshan-Banani-Baridhara Lake	Dhaka	-
	9	Buriganga, Turag, Sitalakhya and Balu	Dhaka	-

(Source: Biodiversity National Assessment and Programme of Action 2020, DOE Bangladesh, 2010)

Chapter 3 Project Description

3.1 Introduction

Under the Environmental Conservation Rules (1997) a classification system was established for development projects and industries on basis of the location, the size and the severity of potential pollution. There are four categories of projects: green, amber A, amber B and red with respectively no, minor, medium and severe environmental impacts. For the red category of projects a full EIA is required.

The existing embankment of BWDB is the proposed 6.5 km road. This road shall be connected with local road at Rajghat bridge point. The existing proposed road also shall be connected with the Regional Chokoria highway R172 through construction of proposed bridge on Kohelia River, Badarkhali Bridge, Upazila road, Matarbari Road Bridge, Matarbari Bridge and Union road to the Power Plant Site. The existing road network of the project area is given in Figure 3.1. The new road constructed on the BWDB embankment can fall in red category.

The Environmental Impacts Assessment should include the prediction, evaluation and mitigation of environmental impacts caused, based on the characteristics of project, and an Environmental Management Plan (EMP) shall be prepared. The approval of the EIA and EMP is required before submitting an application for an Environmental Clearance Certificate (ECC).

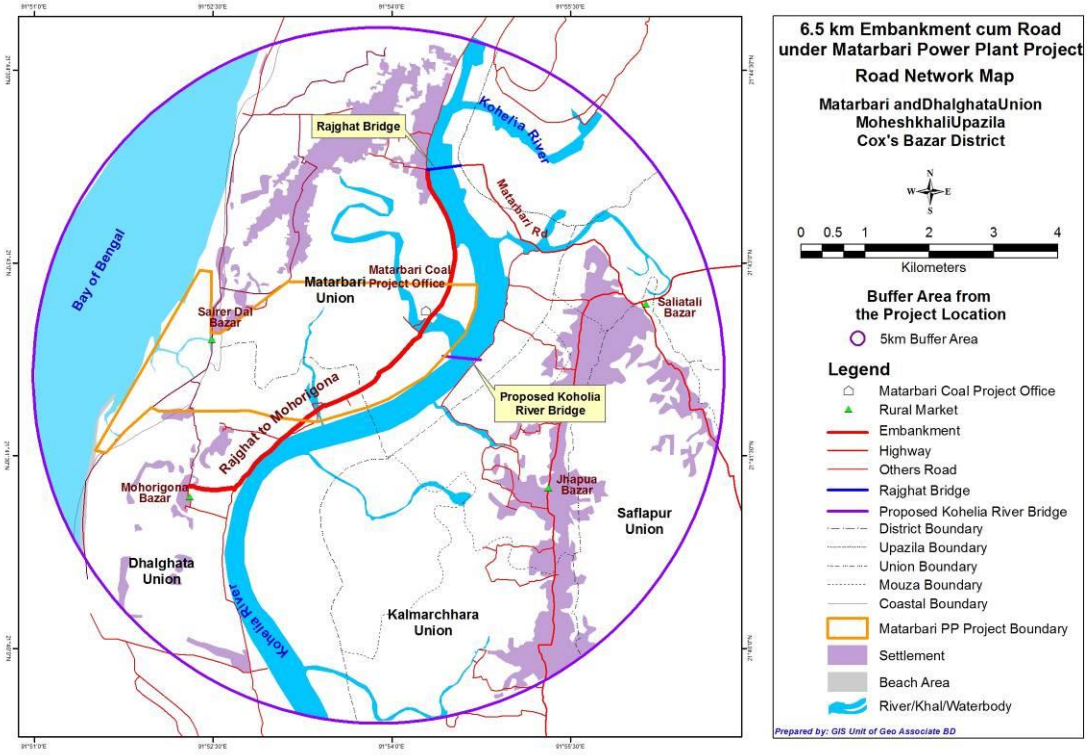


Figure 3.1: Existing road network of the project area

3.2 Project Objectives

The main objective of the project is connecting two unions from Rajghat point, Matarbari to Mohiraghona, Dhalghata by constructed embankment cum road. The important of the project is to transport construction materials during developmental works carried out. The other supplemental service objective generated from the project is to protect the land area from external flooding of Kohelia River acting as a dyke.

3.3 Project Options

The project generated lot of opportunities to the local economy of the area. The options of the project are as follows.

- Local transport facilities improvement
- Improve standard of life
- Protect local area from external flooding
- Land acquisition, resettlement &rehabilitation with livelihood restoration
- Land filling/ Land development
- Enhanced capture and culture fisheries
- Eco friendly development by planting trees alignment of the road

3.4 Interventions under Selected Options

Interventions are made for developmental activities. The impact of the interventions can be positive or negative to the society. For any developmental works interventions which have minimal impact or no impact to the society are to be addressed. The project interventions under selected options are as follows

- **Land acquisition and resettlement**

Few households are inhabitants near to the alignment of the embankment. There is some poor shops in the alignment of the embankment. Hence, there is an issue for resettlement of the local poor. A Resettlement and Rehabilitation plan with livelihood restoration plan will be prepared for PAPs

- **Land filling**

Land filling can disrupt natural drainage facility of the area. It also destroys the local natural habitat of the ecosystem flora and fauna. During the earth filling of the embankment have to be more careful about disturbances of the local environment.

- **Plantation**

Plantation of road side trees both side alignment of the road can protect the primary erosion of the side slopes of embankment.

3.5 Road Component

3.5.1 Design and Construction Concept

The design shall be in compliance with the relevant regulations of Bangladesh, American/European Road Standards (AASHTO/TRRL) and Japanese Road Structure Ordinance. In Bangladesh about the design of

road structure like culvert, bridge, etc, AASHTO LRDF latest version is followed in every department RHD, LGED, RAJUK etc. Specifically, the design Standard of RHD shall be adopted in this project as a basic criteria.

In addition, for the new road constructed on BWDB embankment the road standard mentioned above will be adopted to pavement, and BWDB design standard will be adopted to basement (embankment) and other specific structures in embankment such as sluice gate and regulator.

Design and construction concept is shown in Table 3.1, and the adopted standard cross-section is shown in Figure 3.2. Figure 3.3 shows a typical cross section of BWDB embankment restoring in Matarbari. Overview of road construction and rehabilitation is shown in Table 3.2. The total land area of the existing 6.5 km embankment cum road proposed for development from Rajghat, Matarbari to Mohiraghona, Dhalghata under access road construction component of Matarbari ultra super critical (USC) Coal Fired Power Project is about 29.9 hectare or 73.88 acre.

Table 3.1: Design Concept for the Road Component of 6.5 km proposed embankment cum Road

Item	Description
Road Design	
Crest Width	9.80 m
Carriage Way Width	5.50 m
Shoulder	2.15 m (Hard: 1.25 m, Soft: 0.90 m) x 2
Surge Load in the Coastal Area	4.26 m (14 feet) from Mean Sea Level (MSL)
Crest Level of road on embankment	4.54 m from MSL (PWD standard)
Maximum Vehicle	Medium Truck (Category 2 in RHD guideline)

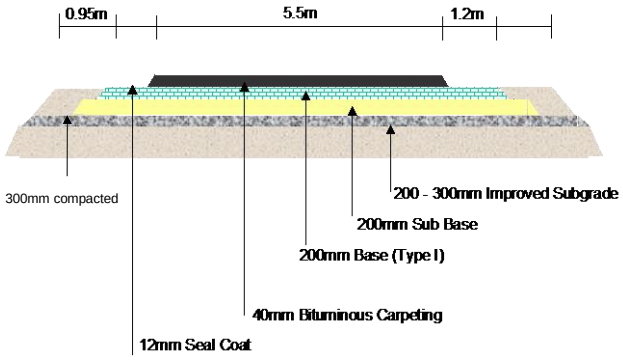


Figure 3.2: Standard cross-section for normal road

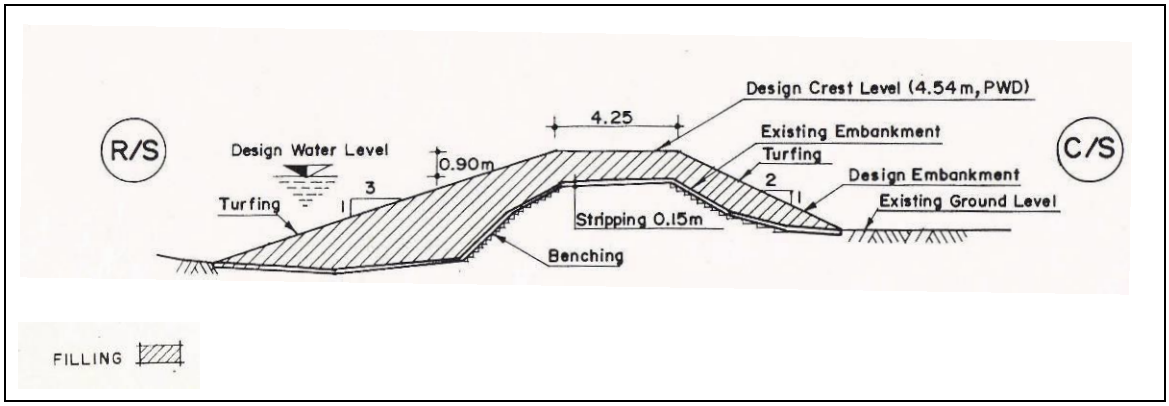


Figure 3.3: Typical Cross Section of BWDB Embankment Restoring in Matarbari

(Source: BWDB)

Table 3.2: Overview of Road Construction and Rehabilitation

Section	Current Jurisdiction	Distance	Major Construction/ Rehabilitation	Land Acquisition
New road		6.5 km		
Embankment	BWDB	6.50 km	1) Reconstruction of BWDB embankment according to BWDB Standards 2) Pavement of crest of embankment according to RHD Standards 3) Uniform Overlay Finishing	NOT necessary but few poor household's and poor shops are residing on the embankment. This poor HHs required to be resettled.
TOTAL		6.5 km		

3.5.2 Road Construction and Rehabilitation Works

(1) Outline of Works

1) Make-up and repair shoulders

Sometimes earthen shoulders do not have correct slopes and levels. It require little filling, re-compaction and bring back to correct slopes and provision of turfing.

2) Restore damaged slopes

Sometimes existing slope loses correct shape due to sliding and rain cut. It requires clearing &Grubbing, earth filling and compaction and turfing.

3) Surface sealing

Normally before the monsoon starts it requires sealing the asphaltic surface. It is done by providing 12 mm seal coat.

4) Repair large defective area (potholes/depression patching)

Sometimes potholes, depressions and rut forms on road surface. It requires patch repairing by bituminous materials (up to 75 mm) and filling of road-base materials followed by patching with bituminous materials. If holes depth greater than 75 mm.

5) Bituminous overlay

When the asphaltic surface in the carriageway develops cracks of larger width and looks hungry due to insufficient bitumen binder it requires asphaltic overlay. Normally it is done of 40- 50 mm thickness.

(2) Relative Major Structures

Relative major structures are considered as follows.

1) Box Culverts in Matarbari

- In the salt field of the government land at least two box culvert should be constructed to keep seawater flow.
- In the salt field of the private land one box culvert should be constructed to keep seawater flow and drain rainwater from hill(west) side.

2) Regulator

A new regulator should be constructed for flood control in the BWDB embankment.

3) Sluice Gate

A new sluice gate should be constructed to keep seawater exchange.

3.5.3 Materials Used for Construction

The construction of the project will require a considerable quantities of construction materials of various types and quantities.

Embankment Fills

The proposed embankment cum road is the existing embankment of BWDB. The embankment was breached various places due to proper maintenance. Earth filling would be required to rehabilitate the embankment. The GOB has adopted a policy to encourage construction of roadway embankments with river sand rather than clayey agricultural soil. The project authority can also be used the dredged soil derived for the development of the channel Matarbari Coal fired power project as an earth filling materials. So there is no provision for interruption of river Kohelia further, appropriate mitigation measures should be undertaken for control the erosion. But river sand is a good fill material with higher CBR value. It is quite abundant in the various riverbeds in the project area. Sand is easily compactable to a high degree of compaction but will require protection against erosion by cladding with a layer of cohesive soil.

If the existing condition considers, the total volume of the earth/soil in the embankment is 0.74 million cubic meters. But the proposed road condition considering 12 m height, the total volume of the earth/soil in the embankment will require 2.23 million cubic meters. The additional volume of soil/earth will be required for the proposed project 2.4 million cubic meters. The calculation details of the earth filling are given below.

Existing condition of the embankment:

Top width: 4.27 m
Height: 5.49 m
Side slope: 3:1
Length: 6.5 km

So, total volume of the earth/soil in the embankment = 0.74 million cubic meter

Proposed condition of the embankment:

Top width: 4.27 m
Height: 12 m
Side slope: 3:1
Length: 6.5 km
So, total volume of the earth/soil in the embankment = 3.14 million cubic meter

Thus the additional sand/soil that would require to rehabilitate the embankment = 2.40 million cubic meter.

Concrete Aggregate

Stone aggregates are commonly used for the manufacture of normal and high strength concrete and it is proposed to be used for these roads as well. The major concreting operation for Jamuna Bridge was undertaken using stone aggregate.

Cement and Steel Reinforcement

Bangladesh produces different classes of EN and ASTM standard cement and high strength deformed bar of 40, 60 and 75 grades. These materials are readily available in the project area.

Bitumen

Bitumen will be imported. Commonly used bitumen in the road construction industry in Bangladesh are 60-70 and 80-100 penetration grade bitumen. For Bangladesh temperatures 60-70 grade is better suited but the supply of this grade is limited:

Recycled Pavement Materials

The preliminary design envisages recycling pavement materials by milling the existing asphalt concrete and re-using the product. This recycled asphalt concrete mixed with unbound base and sub-base materials shall be used in the sub-base or lower base of the new carriageways.

3.5.4 Estimated Cost of the project

The total estimated cost of Matarbari to Dhalghata Union 6.5 km road under access road construction component of Matarbari ultra super critical (USC) Coal Fired Power Project is given in the following table 3.3. The total cost of the project is ninety five crore and sixty lacs in Tk.

Table 3.3: Estimated cost of the 6.5 km embankment cum road project

SI No.	Description	Amount in Tk.
1	Earth Work	308000000.11
2	Flexible Pavement	161000000.23
3	Protective work	487000000.35
	Total Amount	**956000000.69**

In word: Tk. Ninety Five crore and Sixty Lac Only

Chapter 4 Environmental and Social Baseline

4.1 Meteorology

The region has a tropical climate with three main seasons–the hot and humid summer, the rainy season and the mild and relatively dry winter. The climate of Bangladesh exhibits pronounced seasonal variability associated with monsoon winds predominantly from the southeast during summer, from the northeast during winter and light and variable during spring and autumn. Climatic data for the project area was obtained from the meteorological station located in Kutubdia and maintained by the Bangladesh Meteorological Department (BMD). Meteorological data collected include temperature, humidity, rainfall, Evaporation, Wind Speed and Sunshine Hours. This information is summarized below.

4.1.1 Temperature

The average minimum temperature in Bangladesh lies within November to February which varies generally from 6.2°C to 13.4°C while the maximum temperature is seen in May which is around 39.5°C. Table below shows the yearly average maximum and minimum temperature at Kutubdia stations for the last ten years. The Climatic Data of the Project Area (Kutubdia Station) are given in table 4.1.

Table 4.1: Climatic Data of the Project Area (Kutubdia Station)

Year	Max Temp (^{O}C)	Min temp (^{O}C)	Humidity %	Rainfall Mm	Wind speed m/s	Sunshine hour
2000	34.8	13.2	89	3138	1.4	6.2
2001	34.8	11.5	89	2320	0.8	6.6
2002	34.5	10.2	90	2389	0.9	6.7
2003	36.4	10.5	89	2495	1.0	6.2
2004	35.8	12.5	86	2541	1.2	5.9
2005	37.5	13.4	88	2727	1.6	6.5
2006	34.6	6.2	86	2967	1.5	6.4
2007	34.7	12.2	87	3162	1.4	6.2
2008	34.7	11.7	87	3171	1.3	6.3
2009	35.7	12.2	86	2658	2.2	6.4
2010	35.3	12.7	84	2702	2.1	6.0

(Source: Bangladesh Meteorological Department)

4.1.2 Humidity

As seen from Table-4.1 the average yearly humidity in the region varied from 84% to 90% depicted data of the last ten years. In general, the relative humidity of the study area is the lowest in January to April and from May there is a steady increase until November and then December decrease is observed down to January again.

4.1.3 Rainfall

The maximum annual rainfall in the last ten year the project area is about 3171mm. About 80% of the total rainfall has been recorded (e.g. 2793.69 mm) during monsoon. The peak one day highest rainfall is 360 mm and has been recorded in June, 2008. However, July is the highest rainfall recorded month in a year when the average monthly rainfall is 925.17 mm as well as the least monthly dry days is 5.47mm. Subsequently, the average rainfall gradually decreases as the average dry spell in a month increases. An insignificant amount of rain fall has been recorded in winter where the lowest found as 5.27 mm.

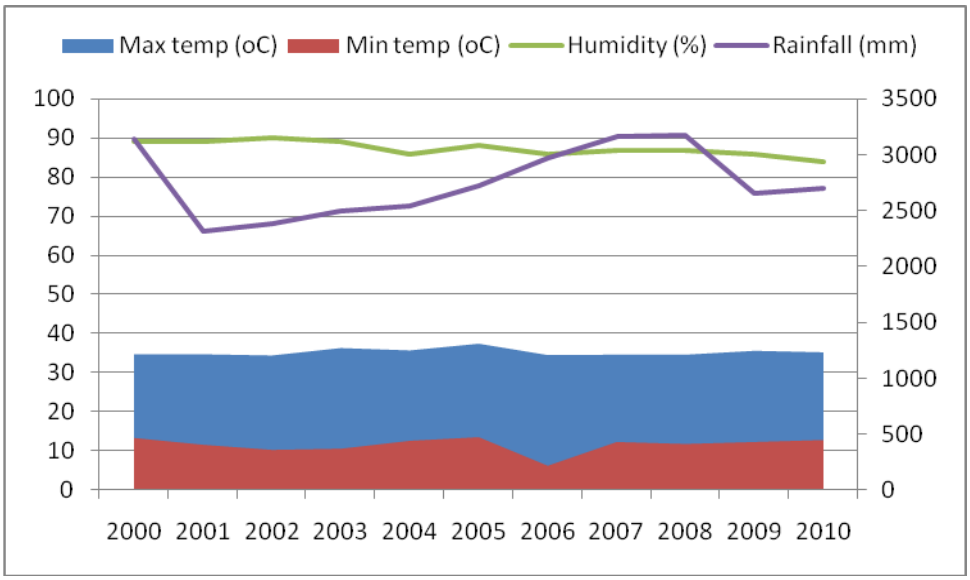


Figure 4.1: Graphical representation of temperature, Humidity and Rainfall in Kutubdia Station

4.1.4 Evaporation

Evaporation is the process by which water changes from a liquid to a gas or vapor and back into the water cycle as atmospheric water vapor. The atmosphere of coastal zone always enrich with humidity because of high evaporation over the sea surface. Solar radiation and evaporation are maximum during the pre-monsoon periods compared to the rest of the year. During high temperature in March-April, the evaporation from the soil also became high

which further increased the soil salinity. A significant rainfall during this period could help mitigate the salinity problem.

4.1.5 Wind speed

In Kutubdia, Northerly winds are dominant in January and February, and no significant high wind speed was observed in specific wind direction. Southerly winds become dominant from March, especially from April to September. In July and August, there is a tendency of slightly higher wind speed in southwesterly winds, otherwise no significant high wind speed was observed in any specific wind direction. Wind direction shifts from southerly winds to northerly winds in October, and there is a tendency of high wind speed of southwesterly winds. Northerly winds are dominant in November and December, but high wind speed tends to occur in southwesterly winds.

4.1.6 Sunshine hour

Sunshine hour refers to the duration of solar insolation over a specific region in a day. Cloud coverage directly influence the sunshine hour. December-March is the longest sunshine hour containing maximum days after analysis of data from Bangladesh Meteorological Department (2000 to 2010). It varies slightly up to May but significantly decline from June up to August. Intensive cloudy situation during monsoon is responsible for reducing the penetration of solar insolation. As a result only average 4.2 hours per day is recorded as average duration of getting sunlight at Maheshkhali region representing July as the most swampy or humid month in a year. The sunshine hour relatively increases in September. An average daily sunshine recorded 8.6 hour during autumn. Afterwards, the sunshine hour declines as the season forwards to winter.

4.2 Water Resources

4.2.1 Surface Water System

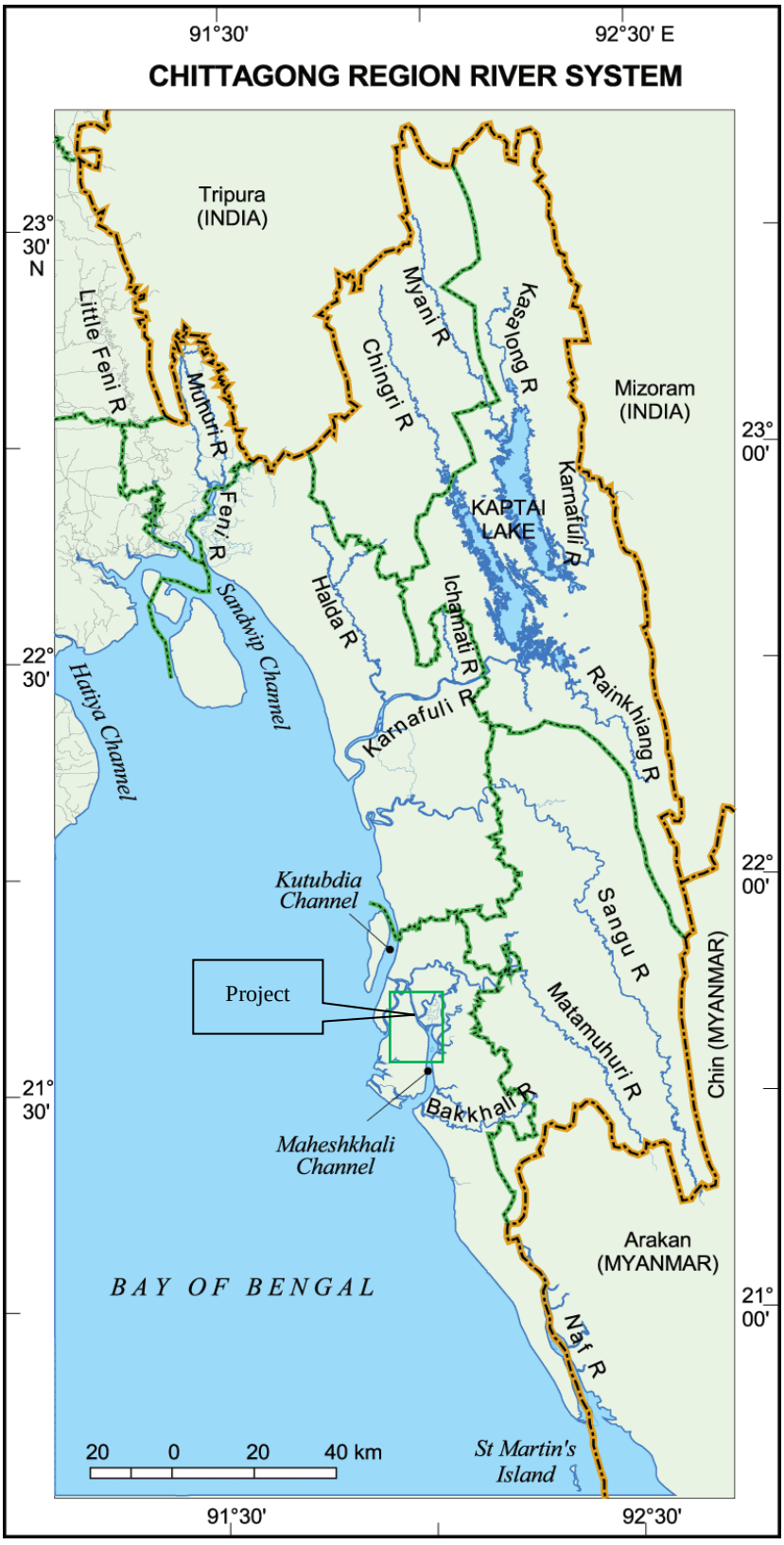
The rivers of Bangladesh mark both the physiography of the nation and the life of the people. About 700 in number, these rivers generally flow south. The larger rivers serve as the main source of water for cultivation and as the principal arteries of commercial transportation. Rivers also provide fish, an important source of protein. Flooding of the rivers during the monsoon season causes enormous hardship and hinders development, but fresh deposits of rich silt replenish the fertile but overworked soil. The rivers also drain excess monsoon rainfall into the Bay of Bengal. Thus, the great river system is at the same time the country's principal resource and its greatest hazard. The profusion of rivers can be divided into five major

networks.

- The Jamuna-Brahmaputra
- The second system is the Padma-Ganges
- The third network is the Surma-Meghna system.
- The fourth river system--the Padma-Meghna
- A fifth river system, unconnected to the other four, is the Karnaphuli.

The project area falls in the fifth river system (figure 4.2) of Bangladesh. The project area covers Matamuhuri, Uzantia, Kuhelia and Masgona rivers.

Flowing through the region of Chittagong and the Chittagong Hills, it cuts across the hills and runs rapidly downhill to the west and southwest and then to the sea. The Feni, Karnaphuli, Sangu, and Matamuhari--an aggregate of some 420 kilometres are the main rivers in the region. The port of Chittagong is situated on the banks of the Karnaphuli. The Karnaphuli Reservoir and Karnaphuli Dam are located in this area. The dam impounds the Karnaphuli River's waters in the reservoir for the generation of hydroelectric power. Figure 4.3 shows the existing river network map of the project area.



(Source: National Encyclopedia of Bangladesh, Banglapedia, CD Edition February 2006)

Figure 4.2: Fifth River System Map

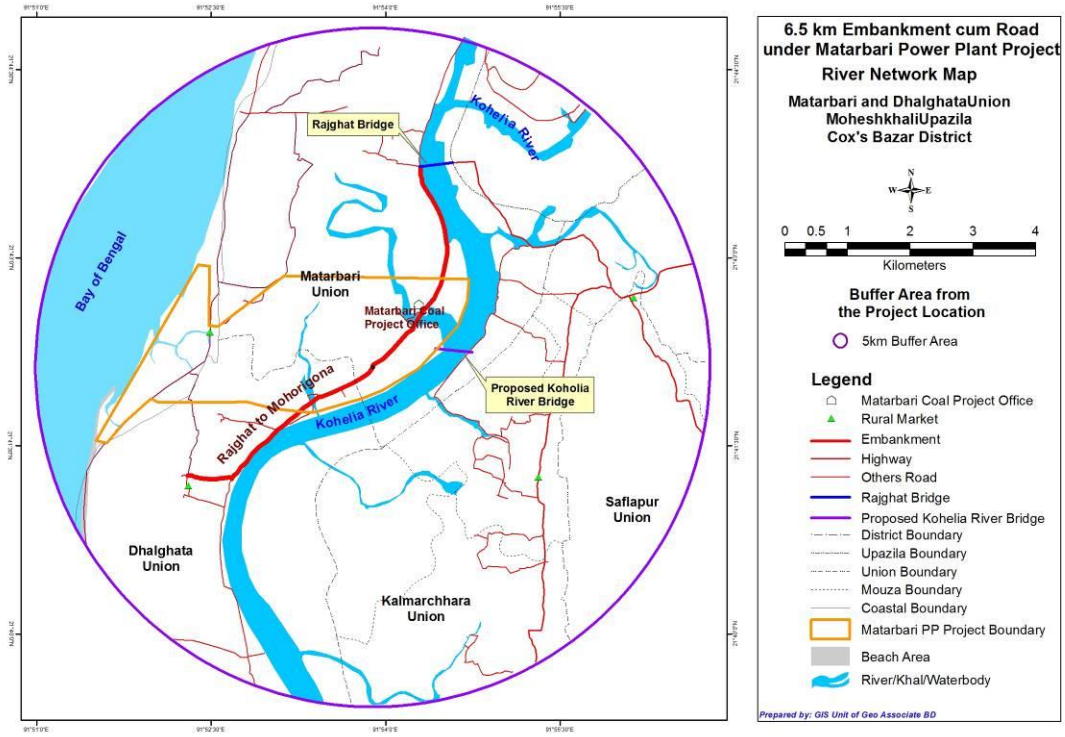


Figure 4.3: Project Area River Network map of project area

4.2.2 Tropical Cyclones and Tidal Flooding

The area is a disaster prone area as many cyclones and tidal bores affected the area in the past. During the years 1960 to 2015, Bangladesh was hit by 55 severe cyclones, 33 of which were accompanied by storm surges. The height of the surges is limited to a maximum of 10 meters in the bay. Such type of tropical cyclones severely damaged the human property and loss of life.

The project area experiencing two types of flood like tidal and storm surge flood. Tidal flooding experienced in project areas two times in a day. During this flooding river water level is higher than normal level. Storm Surges is a type of flood in which the project site is located, mostly occurred along the coastal areas of Bangladesh which has a coast line of about 800km along the southern part of the Bay of Bengal. This coastal area is shallow and the coastal line in the eastern portion is conical in shape. Therefore, Storm Surges are likely to occur due to flood tides of cyclones and southwestern monsoon winds.

4.2.3 Salinity

Saline water intrusion is highly seasonal in Bangladesh. Salinity and its seasonal variation are dominant factors for the coastal eco-system, fisheries and agriculture. Therefore, any change in the present spatial and temporal variation of salinity will affect the biophysical system of the coastal area. The changes in salinity in the coastal area of Bangladesh have been assessed by IWM & CEGIS, 2007 on Coastal Communities and their Livelihoods in Bangladesh. Based on the study results, the isosaline lines of 1&5 ppt for base condition and 1, 5 &15 ppt have been drawn for 2050s conditions (Figures 4.4 and 4.5). These figures indicate that in base condition about 10% areas are under 1 ppt salinity and 16% under 5 ppt salinity and this area will increase to 17.5% (1 ppt) and 24% (5 ppt) by 2050s. From the figures, it is clear that the proposed road is very adjacent to the salinity wave front. The proposed embankment cum road is a polder (no. 70) of BWDB which protect saline water intrusion to the land areas.

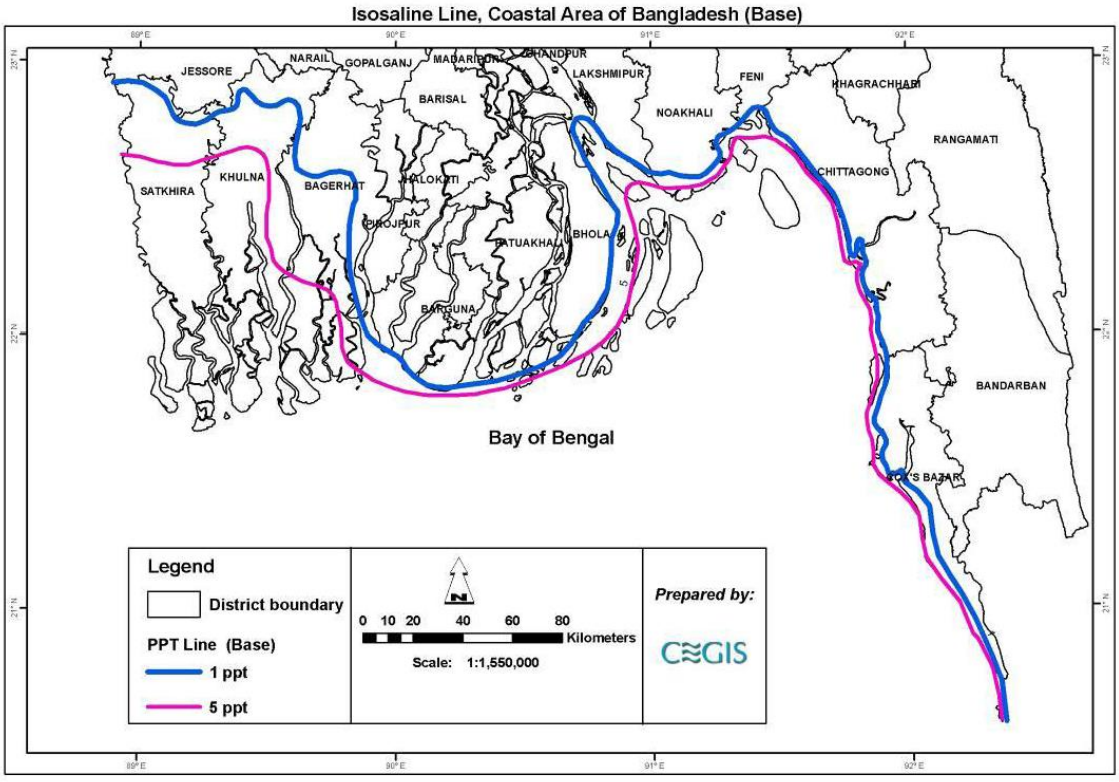


Figure 4.4: Salinity condition in coastal area (for base condition)

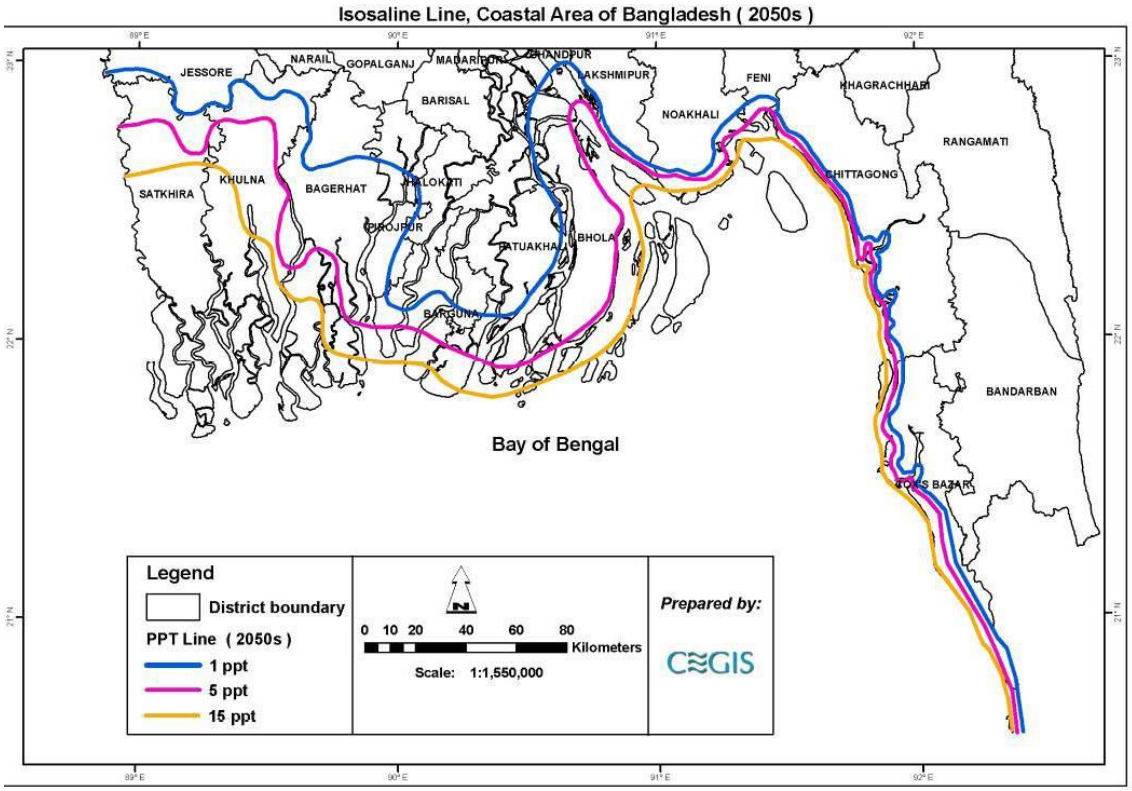


Figure 4.5: Salinity condition in coastal area (for 2050)

4.2.4 Drainage congestion and water logging

Drainage congestion and water logging are not prominent in the study area. The project area has already been bounded by water development board embankment on Koheli River (figure 4.6). Few part of the embankment was breached. During high tide, water frequently enter to the project area through Kohelia River breaching embankment and Bara Matamuhuri khal and other connecting khals meanwhile it inundates the lowland. Accordingly, during ebb tide, water drain out properly so drainage congestion is not found the study area. During monsoon period, most of the low land becomes full of water.

Based on the analyses carried out with the HEC-RAS model, it can be concluded that there would not be any significant impact of the proposed embankment-cum-road on flood and drainage in the concerned area. This is mainly due to the fact that the BWDB polder already exists and it will only be improved under the current proposal. (Details given in chapter 6)

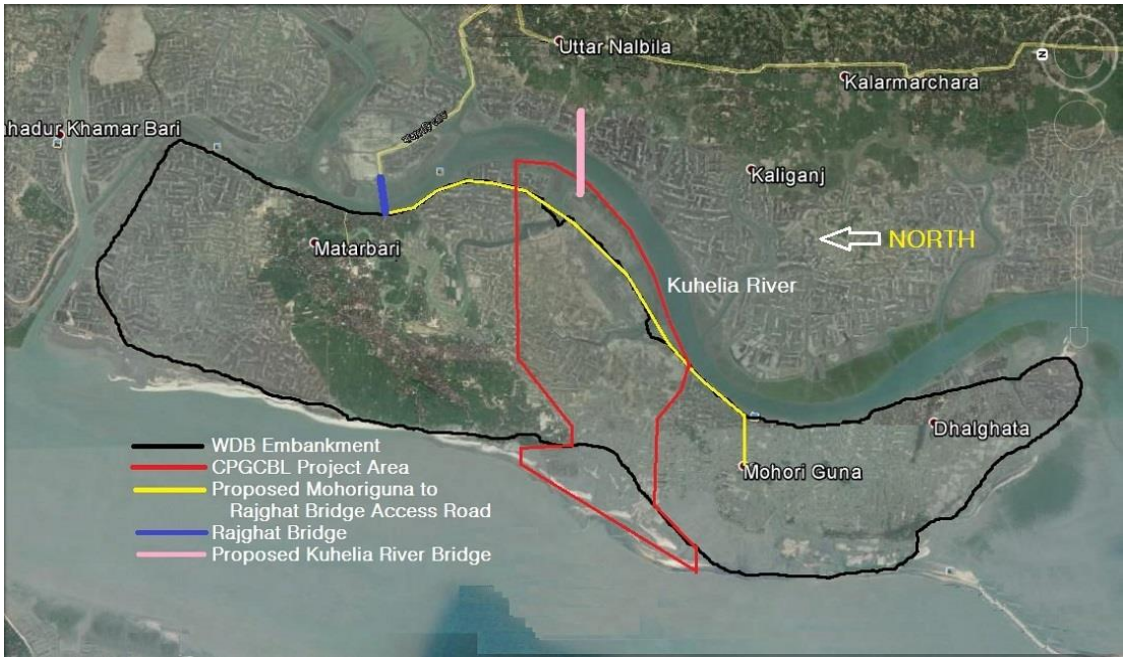


Figure 4.6: Water Development Board protection embankment

4.2.5 Erosion and Sedimentation

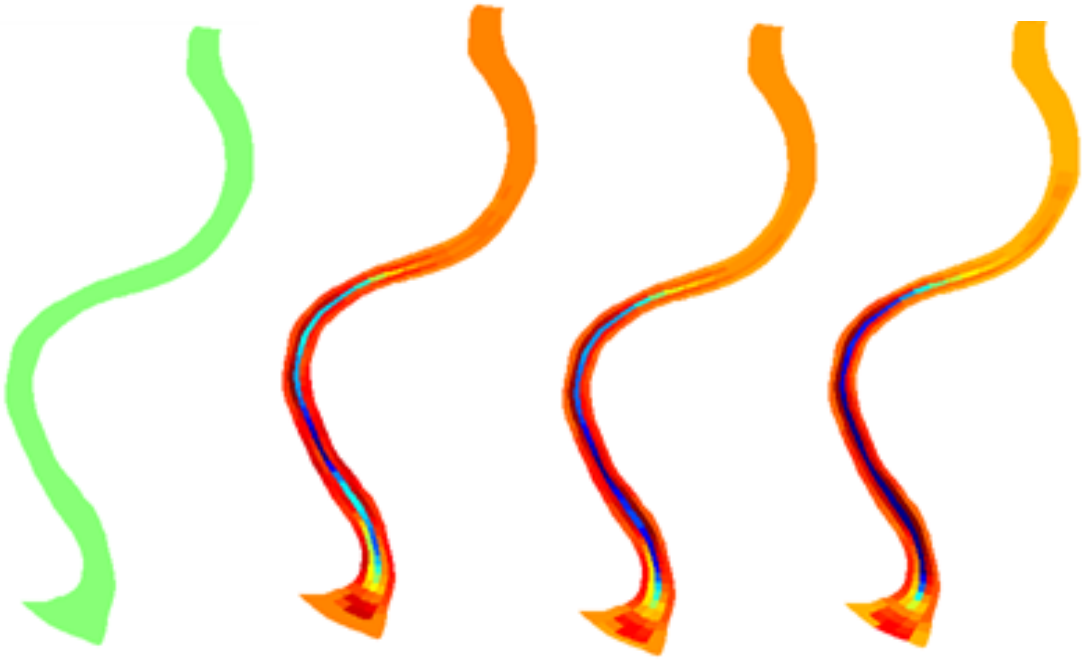
Proposed 6.5 km long embankment site is located east of the project along the west bank of the river (Kohelia River also called access road). The site is highly vulnerable for bank erosion. The erosion activity is being lower down the river bed of Kohelia through sedimentation of materials. The proposed embankment cum road along the west of Kohelia River of Matarbari Island shall be made very strong and permanent to save the island from cyclone, tidal waves and erosion along with Sedimentation.

4.2.6 River Morphology

The terms river morphology used to describe the shapes of river channels and how they change over time. The morphology of a river channel is a function of a number of processes and environmental conditions, including the composition and erodibility of the bed and banks (e.g., sand, clay, bedrock); vegetation and the rate of plant growth; the availability of sediment; the size and composition of the sediment moving through the channel; the rate of sediment transport through the channel and the rate of deposition on the floodplain, banks, bars, and bed; and regional aggradation or degradation due to subsidence or uplift.

The Delft 3D model can be used for morphological change prediction purpose. The Flow Module of the model with the sediment and morphology components enabled was used to predict morphological changes in the Kohelia River. As the embankment-cum-road is already

in place and its alignment would be more or less the same under the proposed condition, the model was run a number of times with the grid and bathymetry setup earlier for base condition. The information on sediment characteristics was derived based on the data provided in JICA et al. (2013). Figure 4.7 shows the cumulative erosion/sedimentation scenarios for both base condition and three future time horizons (5, 10 and 20 years later). The overall results indicate that the morphological changes may be more in the lower reaches of the river than that in the upper reaches. These lower reaches may show both erosion and deposition in the future. The main channel between the downstream end and the middle reach may become deeper in future due to bed erosion. Both sides of the deeper channel show a pattern of siltation due to low velocity in the short to medium terms (5-10 years). In the long term (10-20 years), the banks of the river show a tendency of erosion. It is to be noted that embankment erosion was observed during the field visit on September 10, 2015. Thus, erosion protection measures would be needed throughout the river. The existing protection work through bank revetment seen around the Kohelia Bridge in South Rajghat may help guide the design and construction of the protection work of the proposed embankment-cum-road.



Base 5 years 10 years 20 years

Figure 4.7: Simulated time series maps of erosion-sedimentation in the Kohelia River with the Delft 3D model (Note: The deep blue color indicates erosion, the deep red sedimentation and others indicate more or less no change)

4.2.7 Navigation

Major rivers include Matamuhuri river, Uzantia, Kuhelia, Masgona rivers and Maheshkhali channel is adjacent to the project area which would be utilized for transportation of construction materials of the infrastructure of the project. This river is enough depth of navigability for river transportation especially cargo, steamer etc. The water of the Kohelia River which is located east side of the road is used mainly for the transportation of cash crops like (salt and shrimp) and fishing by non-engine and engine driven country boats. The erosion material is being deposited in the river bed leading to somewhat low navigable depth. But navigation of the rivers is now still active.

4.2.8 Ground Water System

Bangladesh is located over a subsiding basin of tectonic origin with a great thickness of sedimentary strata. This is an unconsolidated alluvial deposit of Recent to sub-Recent age overlying marine sediments. The recent delta and alluvial plains of the Ganges, Brahmaputra and the Meghna Rivers constitute the upper formation. The near surface Quaternary alluvium contains good aquifer characteristics (transmission and storage coefficients). The groundwater storage reservoir has three divisions; upper clay and silt layer, a middle composite aquifer (fine to very fine sand) and a main aquifer consisting of medium to coarse sand.

Groundwater table fluctuations indicate the recharge and discharge to the groundwater reservoir. The highest groundwater table occurs in the study area during the month of August-September when the aquifer recharges fully and the lowest is during February-March due to natural discharge and groundwater use for domestic and irrigation purposes.

Groundwater is abundant in Bangladesh and the aquifers are highly productive. The sediments are predominantly non-indurated and easy to drill by hand, at least to shallow levels. Water tables vary across the country but are typically shallow at around 1–10 m below the ground surface. These factors have made groundwater an attractive and easily accessible resource and have led to a rapid proliferation in the use of groundwater over the last few decades. Today, 97% of the population relies on groundwater for potable supplies and groundwater is also an important source for irrigation and industry. Groundwater levels across Bangladesh become depressed during the dry season, but the aquifers replenish fully during the monsoon. Exceptions occur beneath the major cities, especially Dhaka, where large-scale abstraction has led to long-term drawdown of the water table.

The number of tubewells in Bangladesh is not known but estimates put the number at around

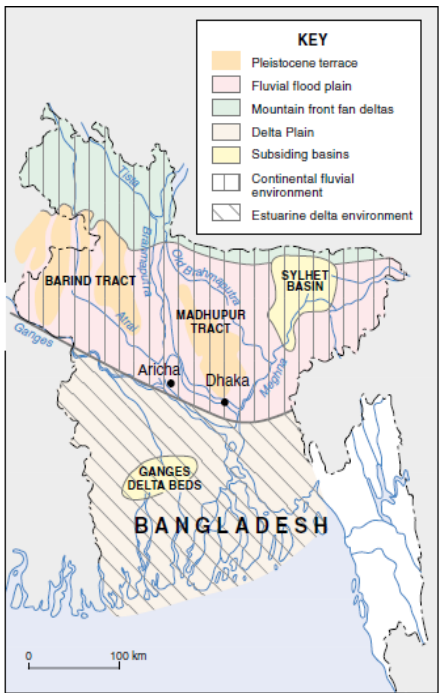
6–11 million. The vast majority of these are private tubewells, which penetrate the shallow alluvial aquifers to depths typically of 10–60 m. Irrigation boreholes typically tap deeper aquifers in the region of 70–100 m depth. In some areas, notably the south and the Sylhet Basin of north-east Bangladesh, deep tubewells abstract groundwater from depths of 150 m or more. In the south, the deep tubewells have been installed to avoid high salinity at shallower levels (BGS and DPHE, 2001). Shallow hand-dug wells occur in some areas, though they are much less common than tube-wells. In the project area more than 90% people use ground water as a source of drinking water.

It is observed from the ground water analysis that Arsenic, Iron, Manganese and Total Dissolve Solids content in the ground water of the project area exceeded the Bangladesh Standard and Testing Institutes (BSTI) standard. Table 4.2 below shows the use of ground water of the project area.

Table 4.2: Ground water use in the project area

Sl. No.	District	Upazila	Use of Ground Water
1	Cox's Bazaar	Chakaria / Pekua	94.83%
2		Maheshkhali	92.3%

Source: Community Series, Chittagong and Cox's Bazaar, Bangladesh Bureau of Statistice2001



(Source: British Geological Survey, NERC2001)

Figure 4.8: Simplified Geology and Geomorphology of Bangladesh

4.3 Land Resource

4.3.1 Agro-ecological Region

Thirty agro-ecological zones and 88 sub-zones have been identified by adding successive layers of information on the physical environment which are relevant for land use and assessing agricultural potential. These layers are: 1) Physiography (land forms and parent materials), 2) Soils, 3) Depth and duration of seasonal flooding and 4) Agro-climatology, comprising four elements: length of Kharif and Rabi growing seasons, length of pre-Kharif transition period, number of days below certain winter critical temperatures (<150C) and number of days with extremely high summer temperature (>400C)].

The project area falls in the agro-ecological region of the Chittagong Coastal Plains (AEZ-6). The locations of agro-ecological zones are shown in figure 4.9. It is a compound unit of piedmont, river, tidal and estuarine floodplain landscapes. The major problem in these soils is high salinity during the dry season (October to May). Grey silt loams and silty clay loam soils are predominant. Acid sulphate soils occur in mangrove tidal floodplains. General fertility level of the soils is medium, but N and K are limiting. Organic matter content is low to moderate.

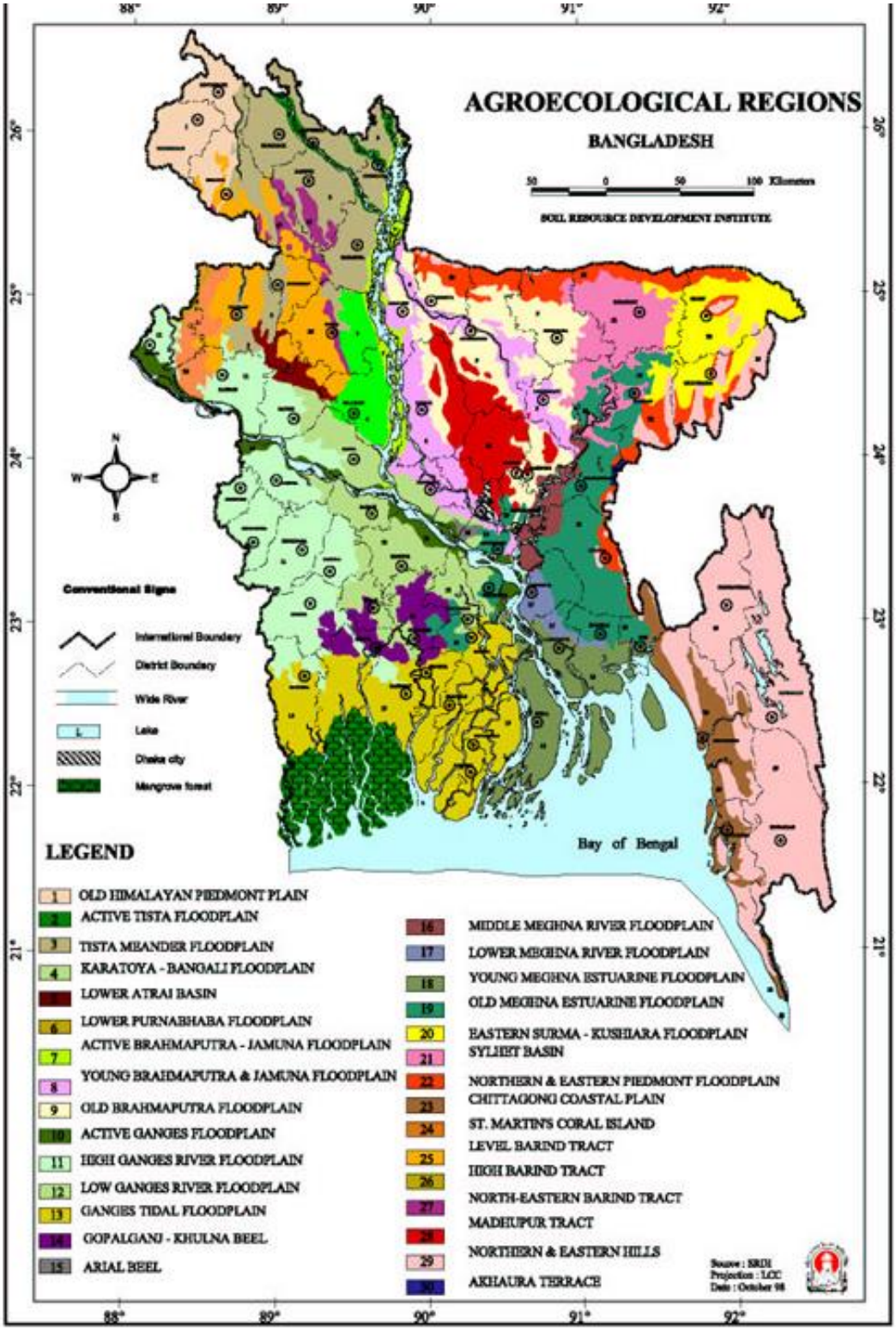


Figure 4.9: Agro-ecological regions of Bangladesh

4.3.2 Land Types

Land type classification is based on depth of inundation during monsoon season. In terms of depth of flooding, five classes of land type are recognized (SRDI, 1988), these are High land (above flood level), Medium highland (flooding depth 0-90 cm), Medium lowland (flooding depth 90-180 cm), Low land (flooding depth 90-270 cm) and Very lowland (flooding depth >270 cm). However, the land type characteristics are not uniform within the study area. About 85% of the cultivable areas belong to medium to Low land with the rest 15% being very low land. Figure 4.10 shows the inundation land types map of Bangladesh

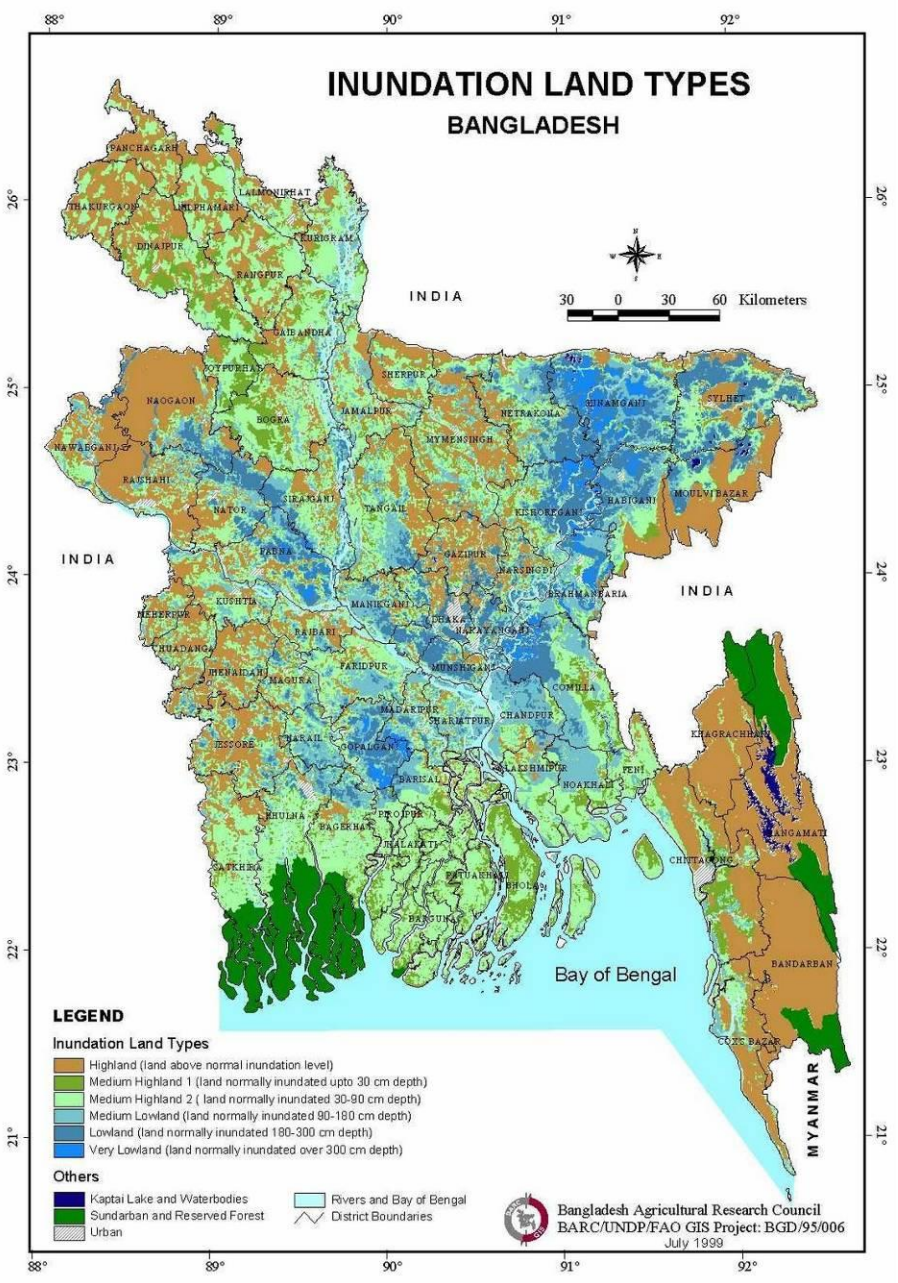


Figure 4.10: Inundation land types map of Bangladesh

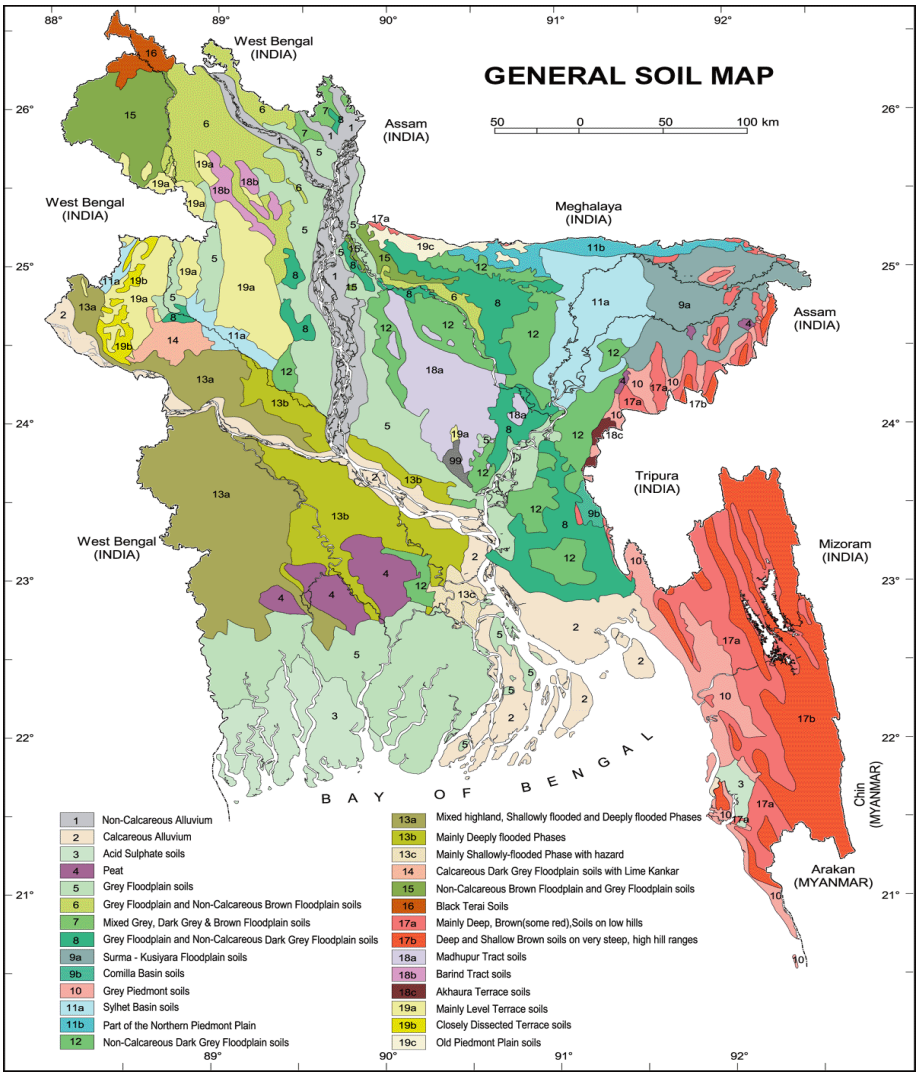
4.3.3 Soil texture

Soils of the project area are mainly formed from recent alluvial sediments. The area has a wide variation in geology and landforms due to variation of sediment deposits or deposited in different times from Karnaphuli, Sangu, Matamuhuri, Banshkhali and Naf Rivers. On the basis of broader characteristics of the alluvia, the whole area is mainly divided into two physiography i.e. tidal floodplains and Sandy beaches.

Tidal flood plains is tidally flooded, very poorly drained, finely stratified now silty to clayey alluvium. They are occurring on tidal mud flats, regularly tidally flooded and remain wet throughout the year. The alluvium are mostly moderately to strongly saline. Mangrove tidal floodplains are grey colored, silty clay loam to clayey non-saline soils are occurring in high to medium highlands. Some medium lowlands are seasonally moderately deeply flooded. Soils in this type of lands are grey colored, moderately fine textured and strongly saline (often used for salt bed). This type of soils is mainly occurring in in the Moheshkhali area especially in the Kuhelia river bank side.

Beach sands soils are mainly grey in colour and sandy in texture. They are tidally flooded and strongly saline.

Food and Agricultural Organization (FAO) conducted a number of surveys classification presents a series of 28 general soil classes of Bangladesh (figure 4.11). The project survey area falls in the soil tract group 3, 10, 17a & 17b which are acid Sulphate soil; Grey Piedmont Soils; Mainly Deep, Brown (some red), Soils on low hills and Deep and Shallow Brown soils on very steep, high hill ranges respectively.



(Source: National Encyclopedia of Bangladesh, Banglapedia)

Figure 4.11: General Soil type map of Bangladesh

4.3.4 Land use

Land use in the project area are fully depends on the surface water availability, quality etc. In the Maheshkhali area 2073.4 hectares of land are used for salt production. Around 80% land is irrigable due to abundant surface water in and the project area. Maheshkhali land uses: total cultivable land 5275.36 hectares, salt production 2073.4 hectares, shrimp cultivation 2105.69 hectares, fallow land 1715.21 hectares. Only 23% land is used for agricultural use. The land use map of the project area is shown in Figure 4.12.

Chakoria land uses: total cultivable land 27142 hectares, fallow land 180 hectares; single crop 27.6%, double crop 61.66%, triple crop 10.74%. Cultivable land under irrigation is 79.18%.

In the Cox's Bazaar 25.64% people are directly involve in agricultural activities. Rice, potato, pulse, onion, garlic, ginger, betel leaf, betel nut, wheat, sugarcane, ground nut, tobacco, rubber,

corn, turmeric, tea, peanut, mustard, patol (heap), brinjal, cucumber and vegetables are main crops in Cox's Bazaar.

Table 4.3: Upazila wise agricultural activities in the project area

Sl. No.	District	Upazila	% of Agricultural activities
1	Cox's Bazaar	Chakaria	29.55%
2		Maheshkhali	22.99%

(Source: Community Series of Chittagong and Cox's Bazaar, BBS, 2001)

The surrounding areas along the road have been mostly cultivated into production fields, salt fields, residential areas, market areas, ponds or channels with low biodiversity. Salt and shrimp fields are the most abundant.

Large area close to Kohelia River and Bay of Bengal is used as salt pans which are turned into shrimp farms during rainy season. Rivers, channels, creeks, ponds, puddles and some swamps create open surface of fresh water which local residents use as water resource. Around the site of new bridge is salt fields and mud flats. In the urban areas both sides of the road are lined with stores and shops with few or no vegetation.

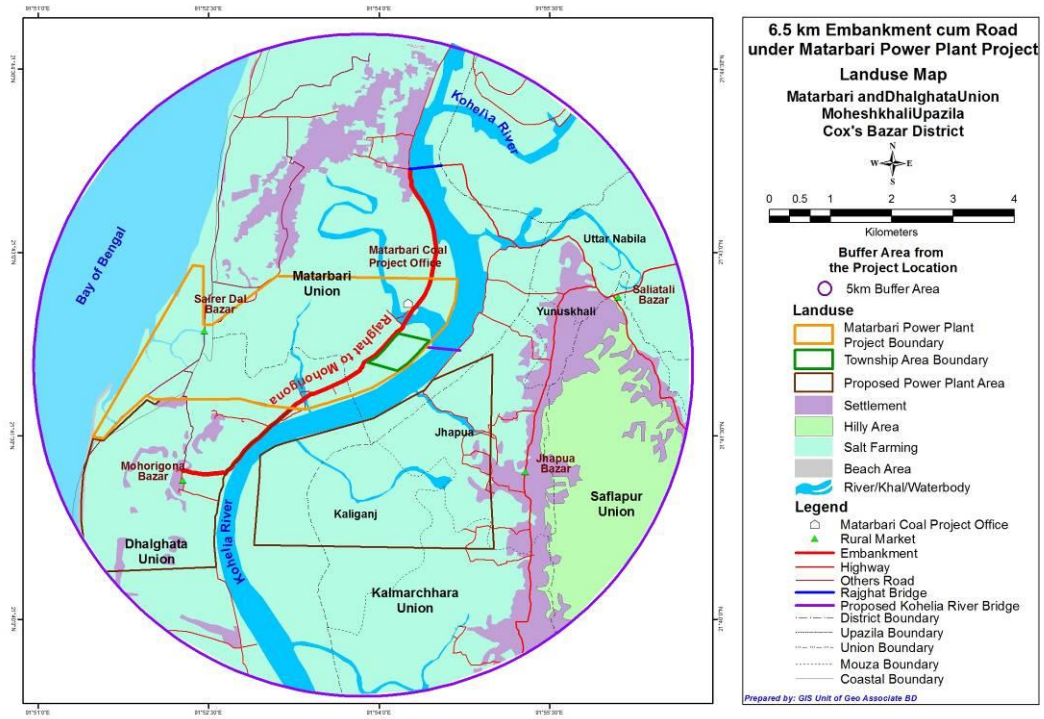


Figure 4.12: Land use map of the project area within 5 km buffer area

The following vegetation types were identified along the proposed road.

Table 4.4: Types of Vegetation of project area

No.	Type	Notes
1	Salt Field	Salt field.
2	Secondary Forest	Tall tree forest on low hills
3	Mangrove Patch	Patches of mangrove trees on the bank along Kuhelia River
4	Open Water	Rivers, channels and large ponds
5	Mud Flat	Mostly seen along Kuhelia River.
6	Residential Area	Houses and gardens with planted tall fruit trees
7	Urban Area	Market Areas, paved roads

(Source: Preparatory Survey on Chittagong Area Coal Fired Power Plant Development Project in Bangladesh Interim Report on Access Road Engineering)

Rice field

Salt field

Mangrove patched along Kuhelia River

Open water of Kuhelia River

Mud Flat along Kuhelia River

Residential Area

Figure 4.13: Types of Vegetation of project area

4.4 Agriculture Resources

4.4.1 Farming Practices

People are mainly farmers and fishers. Some are also involved with trade and commerce. Many people are having business in the Cox's Bazaar. No industry or other major economic enterprises were set up in the project area.

Local level employment is mainly in the agriculture sector. Land ownership pattern also shows that more than 60% are landless or marginal famers who work either as land labour, salt labour or boat labour. Among the rest only 10% are rich farmers and rest are small, middle or substantial farmers. Most of them are being own small plots of land.

Various types of farming practices occurred in the proposed project area are prominent as namely dairy, crop, fish farming etc. which is run by individually or combined or mixed. Mixed farming is a common practice in the study area.

4.4.2 Cropping Pattern and Intensity

Existing main cropping pattern of the project area is shrimp and salt cultivation. There are mainly three cropping pattern season exists. Kharif-I covers Mar-Jun. Kharif-II covers Jul-Oct. Rabi season covers Nov-Feb. Cropping pattern of the area is fallow - high yield variety (HYV) rice. The second prominent cropping pattern is fallow - local rice - pulses.

The cropping intensity of the study area is about 215%. The single, double and triple cropped area is about 25%, 60% and 15% of the NCA.

4.4.3 Cropped area

Total cropped area covered by the both sides of the project is about 150 ha. The project will not have aconsiderable positive impact on agricultural development yet the farmers will be benefited indirectly by protecting unusual flooding for proposed embankment cum road project.

4.4.4 Crop Production

The main crop of the project is shrimp and salt. Most of the people are earning money by cultivation and working of salt and shrimp field. Other *crops are* Paddy, potato, mustard, pepper, maize, sugarcane, wheat, groundnut, betel, tobacco, watermelon, vegetables in the study area. *Crop production especially for* Paddy, wheat and potato in the study area is not a full satisfactory trend.

4.4.5 Crop Damage

Crop production are damaged by different climatic threats like food, drought, heavy rainfall, untimely rainfall, tornado, cyclone, river bank erosion etc. Within the threats, flood and cyclone are main objects that can damage the crops seriously. Every year, almost one-third of Bangladesh is flooded. However, because of topographical characteristics, the regions of the country experience the degree of flooding; some parts may be under deep flood water, others unaffected. Flooding is beneficial only within certain limits of timing, duration and magnitude. In the project area, mostly flood and cyclone with tidal surge are main responsible to damage the crops. So, the project should have scope to do required management in the project area.

4.4.6 Main Constraints of Crop Production

Main constraints of crop production in the study area are non-introducing the new high yielding varieties, lack of enough supply of irrigation water (in winter), fertilizers, pesticides, quality seed and unavailability of credits. Other climatic constraints are Flood, Cyclone and somewhat riverbank erosion etc.

4.5 Livestock and Poultry

Livestock and poultry, being an essential element of integrated farming system, play an important role in the economy of the Polder area. Livestock provides significant draft power for cultivation, threshing and crushing of oil seeds; cow dung as a source of manure and fuel; a ready source of funds; and meat, milk and eggs for household consumption.

Most of the households in the Project area raise poultry and livestock, a practice that significantly reduces poverty through generating income and employment. The common livestock and Poultry found in the Project area is Cow/bullock, Buffalo, Goat, Sheep, Duck, Chicken etc.

4.5.1 Feed and Fodder shortage

The owners of the livestock are facing problems in respect of fodder availability during March to December due to shortage of grazing lands. In the kharif-I and kharif-II seasons, the lands are generally covered with rice crop in the area. Rice straw is the main fodder for cattle. Bran of wheat and rice, oil cakes, and powder of cereal crops are the other common fodders, but the availability of these feeds in the Project area is limited. Shortage of grazing land throughout the year aggravates the feed problem for the livestock. Poultry population at family level survives by scavenging and generally no feed supplements are provided. However, at times kitchen waste becomes feed for the poultry.

4.5.2 Livestock/Poultry diseases

Livestock and poultry in the area are mainly constrained due to diseases and death of the population. Outbreak of disease is causing a considerable economic loss in livestock and poultry farming. Every year livestock population is affected by different diseases like foot and mouth disease, anthrax, torka, and diarrhea. The cyst in head is a common disease of goat. Major poultry diseases are duck plague, paralysis, new castle, fowl pox, and dysentery. The most vulnerable period is between July and October (rainy season) for spreading diseases to livestock and poultry. The duck plague generally occurs in summer. However, some diseases prevail round the year. During monsoon season, the wet condition of the animal shelter promotes various kinds of diseases to the bullocks and cows. The unhygienic condition of the courtyards during this season may also spread the diseases to the poultry birds.

4.6 Fisheries

4.6.1 Introduction

Fish resources of the Project area are diversified with different fresh and brackish water habitats. Open water fish habitat of the Project area including surrounding rivers and khal, acting as major arteries of fish migration into and within the Project area. These water bodies play a vital role in maintaining fish productivity of internal open water. Bulk of the commercial fish production is coming from culture fish habitats while the main catch of capture/open water habitats comes from different seasonal and perennial khals particularly

during wet season. The numbers of fish area is decreasing due to shrinkage of open water fish habitat, loss of khal-river connectivity, presence of water regulatory structures on the khals and their improper operations, and the corresponding decrease of fish catch. On the other hand, aquaculture is developing in suitable ponds of congestion free highland area within the Polder.

4.6.2 Problems and Issues

Fish biodiversity is a decreasing trend because of morphological changes, obstruction to spawning migration, natural and anthropogenic drying up of wild fish habitats, indiscriminate fishing, and loss of river-khal connectivity and water regulatory structures on khals. Aquatic environmental quality is satisfactory though some pollutants are released from cultivation fields affecting fish production. The water quality of internal khals is likely to be degraded particularly during dry season due to improper management of water regulators. The key fisheries problems and issues identified during baseline survey are as follows:

- Indiscriminate fishing using monofilament gill net, and overexploitation of fishes by using huge number of narrow meshed estuarine set bag nets for fishing;
- Siltation of internal khals, causing loss to the year round river-khal connectivity;
- Indiscriminate harvest of post larvae shrimp by local dwellers;
- Hindrances to fish migration and movement due to improper management and mal-functioning of the water regulatory structures along with encroachment and barriers;
- Lack of quality fish seed and feed for the improved aquaculture practices.
- Increasing of salinity which adversely affects pond fish culture;
- Insufficient loan facilities for aquaculture practices; and
- Insufficiently trained farmers in the Polder area.

4.6.3 Habitat Description

Fish habitat of the area can be classified under two broad categories: capture fisheries and culture fisheries. Internal *khals* are considered under capture fish habitat; whereas the ponds are classified under culture fisheries, comprising of four types including prawn ponds (*galda gher*), shrimp pond (*bagda gher*), homestead ponds and commercial ponds. Fish habitat in internal *khals* occupies about 10 percent of the total fish habitat whereas culture fish ponds occupy about 90 percent of the water bodies of the Polder area.

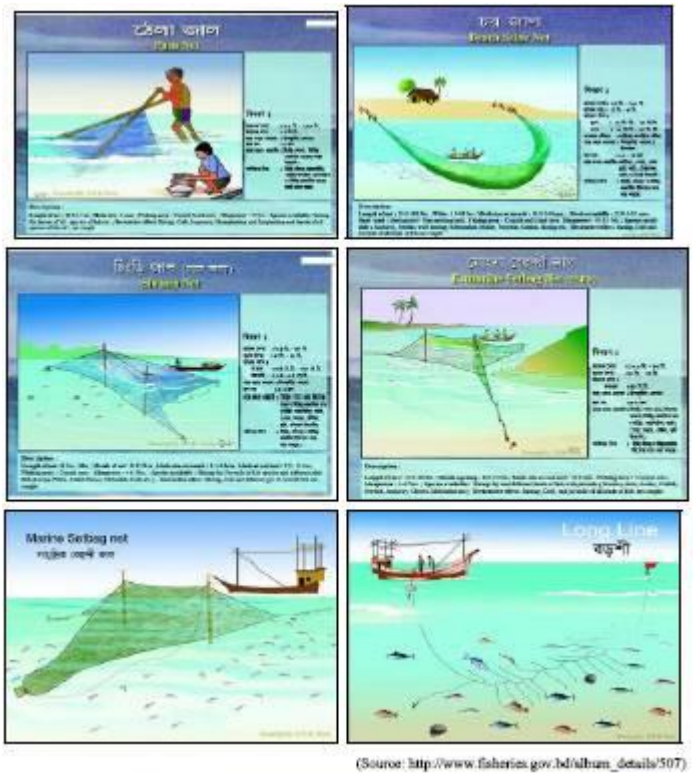
4.6.4 Fish production and effort

The estimated total fish production of the Project area is about 99 percent comes from culture fisheries while the rest comes from capture fisheries habitats. Fish production trend from

capture/open water fisheries is declining in the Project area. The production is declining mostly due to obstacles to fish migration and shrinkage of fish habitat. Aquaculture is expanding gradually in the area by converting the cultivated land, as well as the medium low lands of the area.

It is reported during the field investigation and consultations with the local people very few households are engaged in commercial fishing while about few households are involved in part time fishing activity in and around the area. Fishermen are mostly Muslim. They usually catch fish in the nearby tidal floodplain, rivers and khals. The available fisheries occupations of the area are mainly fishermen, fish traders, and fish farmers. Women of the traditional fishermen families are also involved in collection of post larvae shrimp in the area.

Fishing in the project area, fishermen is mostly carried out with the help of push nets, beach seine nets, shrimp nets, estuary setbag nets, marine setbag nets and long lines. The structures of the three net types, i.e., shrimp nets, estuary setbag nets and marine setbag nets, are basically the same, although the water depths for those nets to be set up are different. Fishing gears used by local fishermen in project area are described in the Figure 4.14.



(Source: http://www.fisheries.gov.bd/album_details/507)

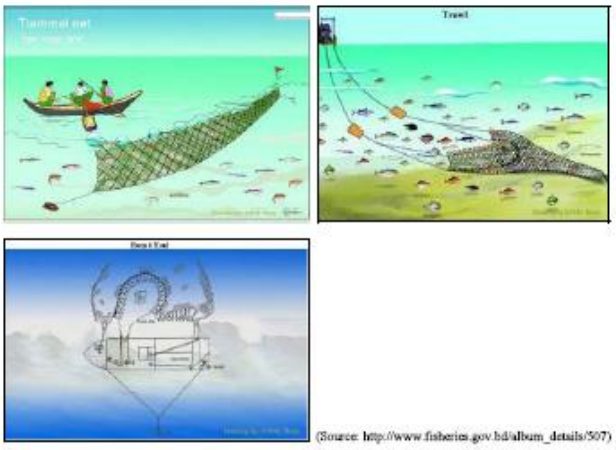


Figure 4.14: Fishing gear used by local fishermen in Matarbari Island, Kutubdia Island and Maheshkhali Upazila

Fishing season corresponding to the use of each fishing gear is shown below in Table 4.5, according to the information obtained from local fishermen in Matarbari and Kutubdia Islands and the Environmental Officer of Maheshkhali Upazila.

The push net is used to target shrimp fly for shrimp cultivation; therefore, push nets are not used during the dry season, which is when salt cultivation is conducted instead of shrimp cultivation. Most of the fishing gear is used throughout the year.

Table 4.5: Fishing Season by Fishing Gear

Fishing Gear	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Push Net												
Beach Seine Net												
Shrimp Net												
Estuary Setbag Net												
Marine Setbag Net												
Long Line Fishing												
Trammal Net												
Trawl												
Round Haul												

Note: Highlighted yellow areas indicate fishing season.

(Source: JICA Study Team)

4.6.5 Fish Migration

The riverine fish species migrate for spawning and feeding through open and regulated khals are used as feeding and shelter ground of most of the open water fishes. Fish species such as Phaisa, Betki, Bagda, Golda, Horina Chingri, Tengra, Gulsha, Khorsula, and Sotka Chingri migrate horizontally to these water bodies as part of their life cycle. Due to sedimentation channel bed and water control structures hamper the migration of fish and other aquatic biota. Local people within the area report that overall fish migration status is poor to moderate in the Project area.

4.6.6 Fish Biodiversity

The Project area is moderate in fish biodiversity though biodiversity of fishes has been declining over the years. Obstruction in fish migration routes, morphological changes of internal khals, siltation of fish habitats, squeezing of spawning and feeding grounds and further expansion of both culture fishery are some of the causes of gradual declining of fish abundance and biodiversity.

There are about more than 100 species of fish and shrimp. Among the saline and brackish water fishes like Hilsa, Choikka, Loitya, Surma, Puka (Poa), Keda/Chamfula, Pairsa (Chouka), Dome Machh, Bhara, Kauwa, Tek Chanda, Ayer Chanda, Foilya/Rupchanda, Bagda, Lobster, Chhuri, Koral, Sada Datina, Chiring etc. are abundant in the study area. Fish species like Koral, Bata (Kharul), Gula Tengra (Guillya), Bhol, etc and shrimp species such as Chaka Chingri, Loilya Chingri, and Bagda PL are regularly caught in different nets set at the confluence of the Jal Kadar Khal and Kutubdia Channel. Bagda post larvae (PL) are still abundant in the Channel and sea shore. Crabs are also harvested from the Kutubdia Channel using bamboo made small cages locally called chai/doghair. The crab harvesters set crab trap in spring tide and harvest crab in the neap tide. Crabs are caught largely in warm weather while less in the cold weather. Small fish species like Punti, Kholisha, Bele, Kakila, Taki, Shingh etc. are the main species of the khals and chharas which are mainly concentrated in the southern part of the study area along with the Maheshkhali Channel. Fishes are mostly harvested during therainy season in the study area. It is also observed that exotic carp and perch (Tilapia) species are available in the culture system in the study area.

The dominating fish species of the open water habitat around the proposed plant site are Ilisha megaloptera, Hilsa kelee, Chanos chanos, Harpadon nehereus, Mystus gulio, Mugil cephalus, Epinephelus sp., Leiognathus brevirostris, Gerres filamentosus, Acanthopagrus latus, Acanthopagrus berda, Acanthopagrus latus, Polydactylus sextarius etc. Fish species found

using each fishing gear is shown in Table 4.6.

Table 4.6: Species Targeted for Fishery by Fishing Gear

Fishing Gear	Target Species
Push Net	Shrimp fly, larvae of all species of fish, etc.
Beach Seine Net	*Coilia* sp., Engraulidae, Mugilidae, Hemiramphidae, Platycephalidae, Latidae, Sillaginidae, Gerreidae, Sparidae, Eleutheronema tetradactylum, *Otolithoides pama*, Terapontidae, Scatophagidae, Cynoglossidae, *Penaeus merguiensis*, *Penaeus monodin*, etc.
Shrimp Net	*Scoliodon laticaudus*, *Coilia* sp., Engraulidae, *Tenualosa ilisha*, *Harpadon nehereus*, Mugilidae, Hemiramphidae, Sillaginidae, *Alepes* sp., Lutjanidae, *Eleutheronema tetradactylum*, *Otolithoides pama*, Terapontidae, Scatophagidae, Trichiuridae, Cynoglossidae, *Penaeus merguiensis*, *Penaeus monodin*, *Macrobrachium rosenbergii*, etc.
Estuary Setbag Net	*Scoliodon laticaudus*, *Coilia* sp., Engraulidae, *Tenualosa ilisha*, *Harpadon nehereus*, Mugilidae, Hemiramphidae, Platycephalidae, Latidae, Sillaginidae, *Alepes* sp., Carangidae, Lutjanidae, Sparidae, *Eleutheronema tetradactylum*, *Otolithoides pama*, Terapontidae, Scatophagidae, Sphyraenidae, Trichiuridae, *Pampus argenteus*, Cynoglossidae, Tetraodontidae, *Penaeus merguiensis*, *Penaeus monodin*, *Macrobrachium rosenbergii*, etc.
Marine Setbag Net	*Scoliodon laticaudus*, *Coilia* sp., Engraulidae, Chanidae, *Tenualosa ilisha*, *Pangasius pangasius*, *Harpadon nehereus*, Mugilidae, Hemiramphidae, Platycephalidae, Sillaginidae, Carangidae, *Secutor* sp., *Alepes* sp., Lutjanidae, Sparidae, *Eleutheronema tetradactylum*, Sciaenidae, *Otolithoides pama*, Terapontidae, Scatophagidae, Sphyraenidae, Trichiuridae, *Pampus argenteus*, Cynoglossidae, Tetraodontidae, *Penaeus merguiensis*, *Penaeus monodin*, *Macrobrachium rosenbergii*, etc.
Long Line Fishing	*Scoliodon laticaudus*, *Coilia* sp., *Pangasius pangasius*, Plotosidae, Platycephalidae, Latidae, Serranidae, Sillaginidae, Lutjanidae, Lobotidae, *Eleutheronema tetradactylum*, Sciaenidae, *Otolithoides pama*, Uranoscopidae, *Pampus argenteus*, Cynoglossidae, Tetraodontidae, *Penaeus merguiensis*, etc.

(Source: JICA Study Team)

Species of Conservation Significance

Fish species variety which are locally unavailable for last 10 to 15 years or have become rare as reported by the local fishers and concerned elderly people are given in the following Table 4.7.

Table 4.7: List of species of conservation significance

Sl	Local Name	Scientific Name	Local Status	
			Rare	Unavailable
1	Boal	*Wallaguattu*		✓
2	Pabda	*Ompok pabda*		✓
3	Gojer	*Channa marulius*		✓
4	Tara Biam	*Macrognathus aculeatus*		✓
5	Bata	*Labeo bata*	✓	
6	Rita	*Rita rita*	✓	
7	Khalla	*Liza parsia*	✓	

Area of Conservation Significance

Some deep parts of *Bara Matamuhuri khal* other important fish migrationkhalsand the deepest portions of the seasonal *beels* of the project area have the conservation significance.

4.6.7 Fisheries Management

There is no fishery based community association found in the study area. Fishing right on existing fish habitats is limited. Enforcement of fisheries regulation is also weak. No fish sanctuary is found in the study area.

4.7 Ecological Resources

4.7.1 Bio-ecological Zone

IUCN, The World Conservation Union, has divided Bangladesh into 25 Bio-ecological Zones (*Nishat et al, 2002*) in the context of physiographic and biological diversity. The study area has fallen under two bio-ecological zones of Coastal Floodplain and coastal marine water. The area (both directly and indirectly impacted area) occupies terrestrial as well as aquatic ecosystems. Each of the bio-ecological zones represents the overall ecological situation of an area of the country. A map of the Bio-ecological zone is presented in the figure 4.15.

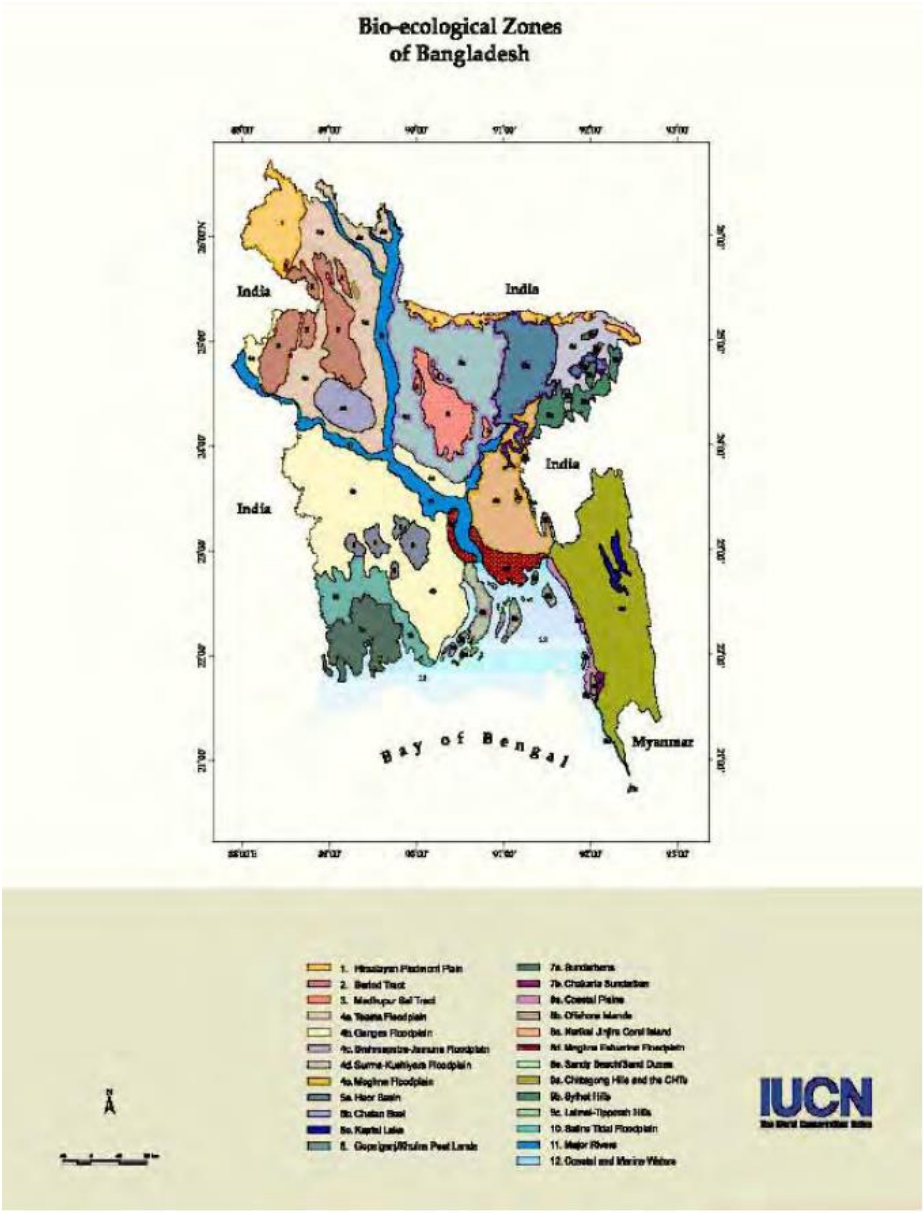


Figure 4.15: Bio-ecological Zones of Bangladesh

4.7.2 Ecologically Critical Areas (ECA's)

Based on the significance and ecological sensitivity, Ministry of Environment & Forest (MOEF) has declared a number of areas as" ECAs "and "Protected Areas", but there is not much information or study on the Ecologically Sensitive Area (ESA's) of different coastal and marine Ecosystem and its habitat as in Figure 4.16.

Ecologically Sensitive Areas are:

- Mangroves
- Coral Reefs
- Sandy Beaches and Sand Dunes

- Mudflats
- Marine Wildlife Protected Areas
- Coastal freshwater bodies
- Salt Marshes
- Turtle Nesting Grounds
- Horseshoe crab Habitats
- Sea grass Bed
- Seaweed bed
- Nesting Ground of Bird

In the proposed project influence zone surrounding, there is no ECA area or even any protected area. Sonadia ECA is about 15 km far from the project site. There is a mangrove forest, which is large scale and artificially established, is located near Koheli River. Appropriate protective measures will be taken to save the mangrove forest from anticipated impacts during construction.

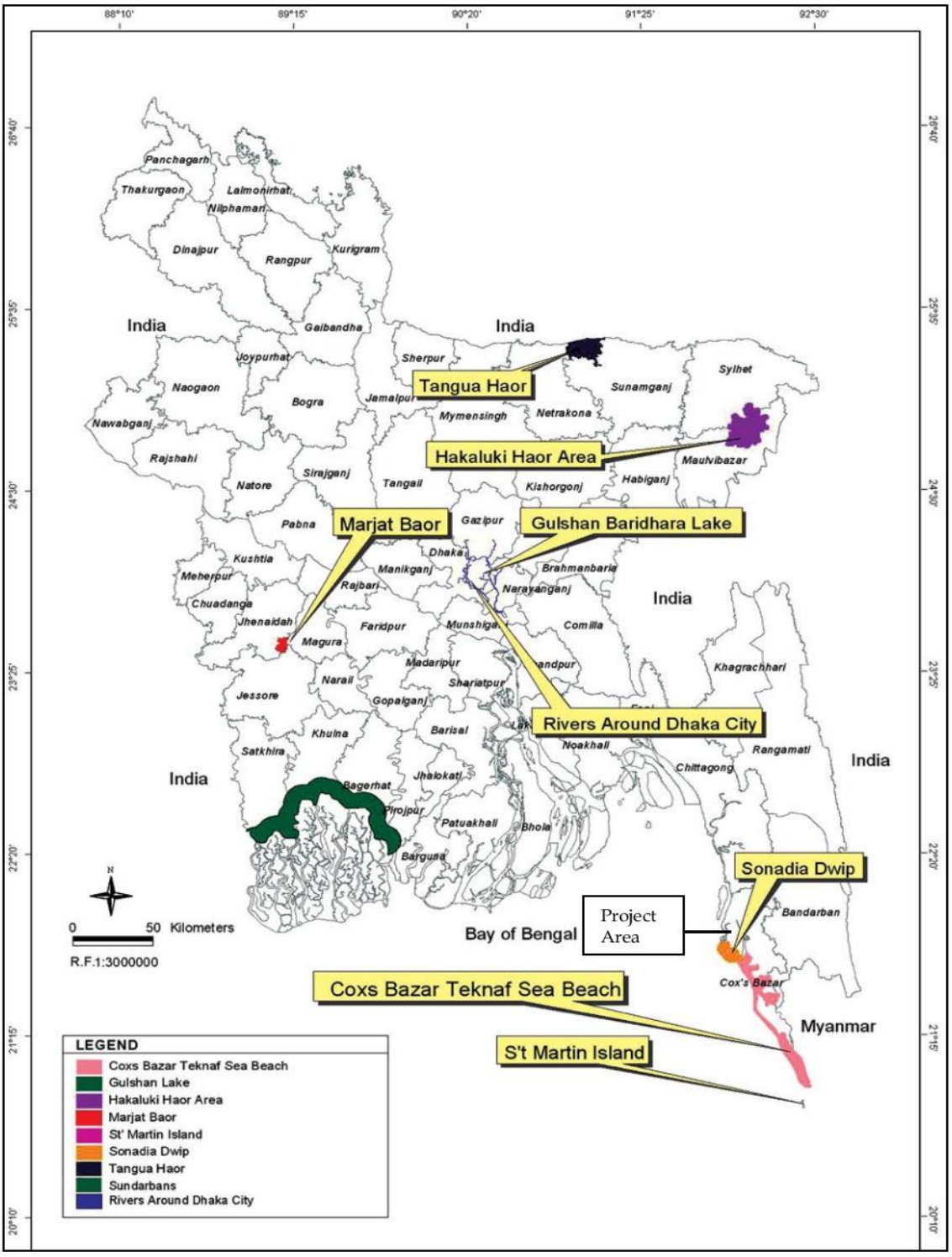


Figure 4.16: Government Gazette ECA Area

4.7.3 Common Flora and Fauna

a. Flora

Humans have impacted much of the land area of the Project site, particularly by shifting shrimp farming and salt pans to the area over several generations. The project area now has species generally associated with secondary and pioneer communities, secondary scrubs, grasslands, poor vegetation cover, and little cash crop in its fringe areas.

In all, 77 species in the rainy season and 71 species in the dry season were recorded at the site, the majority of which are angiosperms. No threatened species, as designated by IUCN status declaration of 2012, were recorded. Three species (*Calamus guruba* Buch-Ham, *Trihosanthes cordata* Roxb, and *Lepisanthes rubiginosa*) which are considered as threatened species under local status by scientist groups in Bangladesh were recorded, but these species have wide distributions and are common in the region (Biologist-group's views of Chittagong University).

Large area close to Kuhelia River is used as salt fields which are turned into shrimp farms during rainy season. On the bank along the Kuhelia River, there were some patches of mangrove trees.

Rivers, channels, creeks, ponds, puddles and some swamps create open surface of fresh water which local residents use as water resource as well as cattle and birds. Very wide mud flats appear along Kuhelia River at low tide level where water fowls such as herons and egrets were found being feed on benthos.

b. Fauna

Mammal

No wild mammal but only domestic animals such as cattle, buffalos, goats, sheep, dogs and cats were seen.

Amphibians

A kind of frog was found at rice field in village road.

Reptile

A dead snake was found near Kuhelia River in village.

Bird

Common bird species such as pied starling, house sparrows, house crows, drongos, pigeons, wagtails, swallows are seen throughout the area. The wide wet areas, that is, rice fields, ponds and channels provide habitat of water fowls such as herons, egrets and kingfishers. Along the

mud flats along Kuhelia River, snipes, plovers and cormorants are also found. Domestic fowls and ducks are seen throughout the area.

Pied Starling

House sparrow

Drongo

Wagtail

Great Egret

Little Egret

Common Redshank

Marsh Sandpiper

Black-capped Kingfisher

Pied Kingfisher

Red-necked Stint

Common Sandpiper

Whimbrel

Wood Sandpiper

Little Cormorant

White-winged Tern

4.7.4 Ecosystem Services and Function

The project site consists of land used for salt farms and other purposes, and not primeval forests or tropical rain forests. A sandy beach is located in front of the proposed project site, however there are no mangrove forests or tidal flats. The area is the presumed habitat of birds, dolphins, and sea turtles on the IUCN Red list (endangered species, etc.), and construction work may have a possible impact on the rare species and ecosystem.

Within the project area, there is no habitat of precious species of flora designated by IUCN. Three species (*Calamus guruba Buch-Ham, Trihosanthes cordata Roxb*, *Lepisanthes rubiginosa*) which are considered by Bangladesh biologist as threatened species were observed in the project area, but they are commonly seen over broad areas and the impact of the project on these species will be insignificant.

As for precious species of animals designated by IUCN, the Spoon-billed Sandpiper (*Eurynorhynchus pygmeus*) and Hawksbill turtle (*Eretmochelys imbricate*) classified as CR

(Critically Endangered), three turtles species (*Geoclemys hamiltonii, Chelonia mydas, Caretta caretta*) classified as EN (Endangered) and one turtle species (*Lepidochelys olivacea*) classified as VU (Vulnerable) were observed within the project site and the front beach. There were no other precious species of insects, amphibians, reptiles, mammals or birds that were designated by IUCN.

Regarding the Spoon billed Sandpiper, the frequency with which this species uses the Matabari Peninsula as a wintering ground is relatively very low in comparison with the nearby offshore island of Sonadia. Many previous survey results point out that Matabari Peninsula beach is not a main migratory habitat for migratory birds, especially the Spoon billed Sandpiper in Bangladesh; this is also supported by other experts and reports. However, for the purpose of protecting the species, construction workers will be instructed to strictly comply with hunting and capturing restrictions prescribed by law.

Five species of reptiles (*Calotes versicolor, Mabuya mabuya, Gekko gecko, Panghura tentoria, Naja naja*) which are considered by Bangladesh researchers as threatened species, and 2 species of birds (Arachnothera magna, Ketupa zeylonensis) considered as threatened species were observed at the project site, however they are commonly seen over broad areas and the impact of the project on these species is expected to be insignificant.

Spawning takes place at nighttime when human activity is low, however the light and noise of any nighttime construction may have adverse effects on these species. Consequently, night construction activity in the spawning season should be avoided as much as possible, and should be conducted under minimum light. Lighting colors that do not affect the spawning (e.g., red or yellow) should be selected. The careful monitoring of spawning status is necessary.

4.8 Socio Economic Condition

4.8.1 Socio Economic Condition

Density of population in the locality is not very high compare to other densely populated parts of Bangladesh. Local people are both from educated and non-educated. The area has many primary and secondary schools and set up of a college is under process. Huge number of Madrasha (religious schools) is there along with mosques where religious educations are offered. Many primary schools are there in the multipurpose shelter houses constructed in the area to address the emergency needs of cyclones and tidal bores. The area is a disaster prone area as many cyclones and tidal bores affected the area in the past.

Farmers do not go for land cultivation as that is not profitable to them. As a result, leasing out of land on annual rent basis is a common practice in the area. For salt cultivation each Kani (40 decimals) is leased out at BDT 12,000 (US$ 1=80) to 18,000 where for shrimp cultivation

at BDT 2,000-3,000. Shrimp is less profitable than salt cultivation due to modern technique used for salt production at less cost. With the modern technique salt production per hactare has gone very high and thereby profit also increased, in return, land lease value has also increased. Per decimal arable land price is BDT 7000-8000 (US$ 90-100) or per hactare BDT 250,000-300,000. Land price along the road varies widely depending on the location where in some places per decimal is BDT 15,000-20,000. In the case of homestead land it is about BDT 30,000-35,000.

Some 20% households have migrant members outside the country, who are dependent on remittances. They are mainly working in Saudia, Dubai, Malaysia, Oman, etc. These people have less dependency on farming; as a result, affect to the family income would be less due to land acquisition or other interventions from the project side.

Presence of NGOs is there in the locality including all national level NGOs. The area is also known for operation of Muslim NGOs who were rendering services specifically to Rohinga refugees and other local Muslim people. All kinds of welfare activities are done by those NGOs. People in the area are also positive to the NGO activities. Other local level institutions are also there about which more detail to be investigated.

4.8.2 Income and Poverty

The main income source of the project area people is salt and shrimp cultivation. Land lease is another kind of earning source of the area. As a result, leasing out of land on annual rent basis is a common practice in the area. For salt cultivation each Kani (40 decimals) is leased out at BDT 12,000 (US$ 1=80) to 18,000 where for shrimp cultivation at BDT 2,000-3,000. Shrimp is less profitable than salt cultivation due to modern technique used for salt production at less cost. According to the poverty map of Bangladesh 2010 prepared by BBS/WFP/ World Bank, the project area falls under 28%-38% category (figure 4.17). In case of extreme poverty it is 7-15% category.

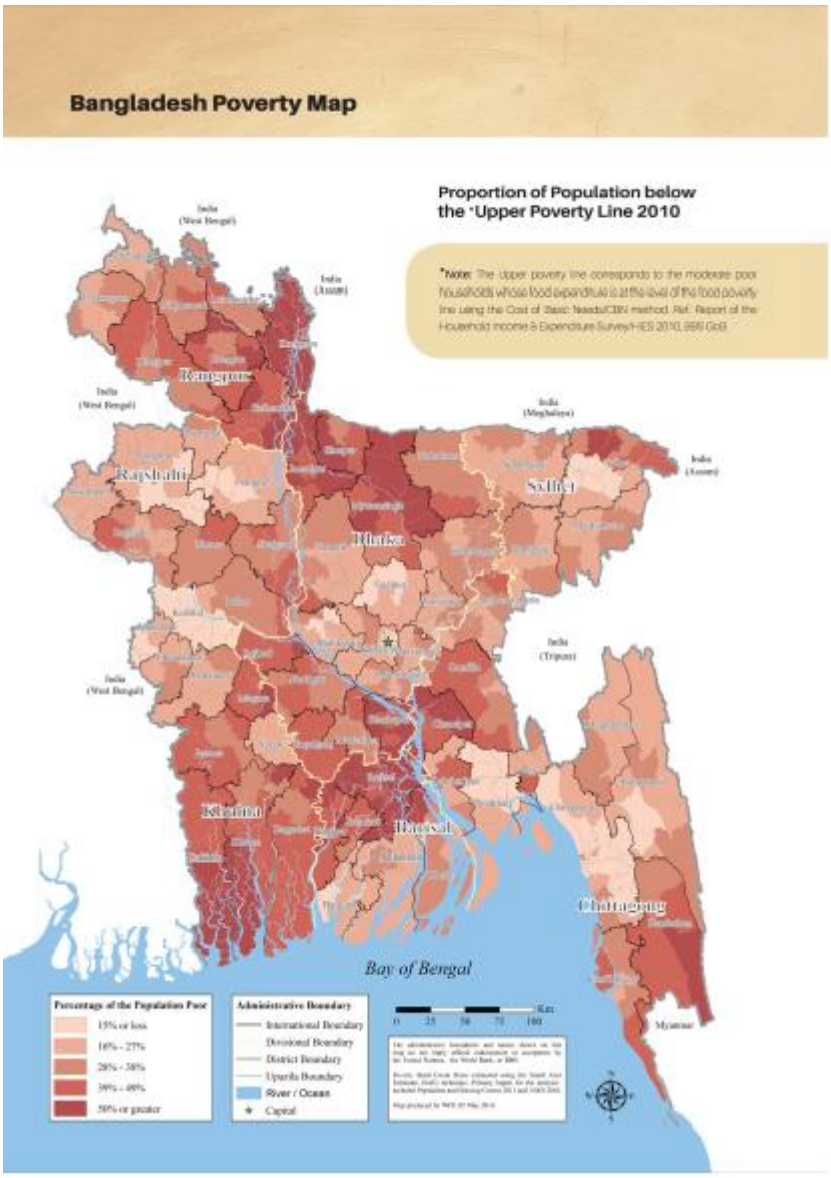


Figure 4.17: Poverty Map of Bangladesh (BBS/WFP/ World Bank-2010)

4.8.3 Gender and Women

Women do not work in the field very often. Sometimes poor women, widows, divorcees work as day labourer in the field as well as road maintenance workers of LGED. Frequently they do not go for shopping or marketing in the local bazaar. Women headed households also share with the neighbors to fulfill their shopping or marketing needs as maximum as possible to avoid teasing or harassment from the male members of the society. Women hawkers also sell some commodities in the village visiting door to door.

4.8.4 Conflict of Interest and Law and Order Situation

Local conflicts may occur between local residents who may feel that they have received unfair compensation and other local residents or conflict with staff of the Deputy Commissioner's Office. Conflict may occur between local residents and external workers because of any changes to local customs if external workers cannot understand local customs.

A number of consultations with local residents will be required to conduct in preparing the LARAP during implementation. Regulations in Bangladesh stipulate the need to conduct public consultations in land acquiring processes.

Local people should be employed for the construction works to the maximum extent possible, and any workers from other countries should be taught to respect local customs in order to facilitate good relationships with local people. The lodgings of the project workers should be equipped with sufficient living facilities to keep workers at the project site as much as possible.

The existing law and order situation is improved. Because people of the project area are getting compensation form the authority on regular basis. It will continue up to finish the compensation of affected person.

4.8.5 Historical, Cultural and Archaeological Sites

There are no Historical, Cultural and archeological sites within the proposed embankment cum road areas. Adinath Temple of Moheshkhali Upazilla located 10 km east of the project.

4.8.6 Seismic activity

In the project area the earthquake magnitude is 4-5 and in July 1999 the Moheshkhali Island and its adjoining sea were affected by around 5.2 magnitude earthquake. During the design of the project structure the historical information of earthquake should be taken care of.

4.9 Environmental Quality

4.9.1 Air Quality

There is no official secondary air quality data for the project area due to the non-availability of a regular air quality-monitoring program. However, the prevailing conditions are generally typical of rural Bangladesh, which implies generally good conditions, with the exception of

towns, industrial pockets and areas immediately adjacent to roads. These may experience increased pollution from vehicular sources and dust. The principal source of pollutants in the region is from vehicular traffic and some small industries.

4.9.2 Water Quality

(1) Surface Water

The observed parameters of the surface water are mainly pH, Dissolved Oxygen (DO), Total Dissolved Solids (TDS), Total Suspended Solids (TSS), Chemical oxygen demand (COD), Biochemical oxygen demand (BOD5), Electric Conductivity (EC), Chloride (Cl), Total Alkalinity and Total Solids (TS). The parameters are analyzed in the reputed environmental laboratory of BRTC, BUET, Dhaka.

Matamuhuri and Kuheli rivers chlorine result observed very high than the other river water. The saline water is captured adjacent to the river bank land areas for salt cultivation. Due to high Saline and TDS content the EC found very high in the Matamuhuri and Kuheli rivers.

Table 4.8: River Water Quality Analysis Report

Sl. No.	Parameters for Laboratory Analysis	Bangladesh Standard (Inland Surface Water)	River-1 (Matamuhuri)	River-2 (Uzantia)	River -3 (Kuheli)	River -4 (Masgona)
1	pH	6-9	7.45	7.37	7.48	7.33
2	Total Dissolved Solids	2100 mg/l	3979	299	4590	784
3	Total Suspended Solids	150 mg/l	179	186	71	66
4	Chemical oxygen demand (COD)	200 mg/l	30	7	33	21
5	Biochemical oxygen demand (BOD)	50 mg/l	2.4	1	2.4	3.2
6	Electric Conductivity	1200 micro mho/cm	6370	494	7000	1334
7	Chloride	600 mg/l	2500	250	2750	525
8	Total Alkalinity	-	56	51	53	37
9	Total Solids	-	4158	485	4661	850
Note: 1. Yellow color indicates the exceeding of standard limit						

(2) Ground Water

Table 4.9: Ground Water Quality of the Project area

Parameters	Cox's Bazaar	BSTI Standard
Ambient Temp. (^{0}C)	33	-
Water Temp. (^{0}C)	27.08	-
pH	7.19	6.4-7.4
EC. (μScm^{-1})	1646.86	-
TDS (mgL^{-1})	823.86	Max 500
% NaCl	3.01	-
DO (mgL^{-1})	2.27	Max 6
Acidity (mgL^{-1})	20.56	-
T. Alkalinity (mgL^{-1})	283.63	-
T. Hardness (mgL^{-1})	243.75	Max 500
Chloride (mgL^{-1})	404.63	Max 600
NO^{2-}-N (mgL^{-1})	0.09	Nil
NO^{3-} -N (mgL^{-1})	0.925	Max 4.5
O-PO_4^{3-} -P (mgL^{-1})	2.02	Max 6
SO_4^{2-} -S (mgL^{-1})	404.99	Max 400
Ni (mgL^{-1})	BDL	-
Zn (mgL^{-1})	BDL	Max 5
Cu (mgL^{-1})	BDL	Max 1
Co (mgL^{-1})	0.005	-
Cr (mgL^{-1})	BDL	Max 0.5
Cd (mgL^{-1})	BDL	0.005
Pb (mgL^{-1})	0.045	Max 0.05
As (mgL^{-1})	BDL	Max 0.05
Fe (mgL^{-1})	2.8	0.3-1.0
Mn (mgL^{-1})	0.52	Max 0.1

4.9.3 Soil Quality

Soil quality is the capacity of a specific kind of soil to function, within natural or managed ecosystem boundaries, to sustain plant and animal productivity, maintain or enhance water and air quality, and support human health and habitation.

Soil quality is said to be a measure of the condition of soil relative to the requirements of one or more biotic species and or to any human need or purpose.

Soil quality reflects how well a soil performs the functions of maintaining biodiversity and productivity, partitioning water and solute flow, filtering and buffering, nutrient cycling, and providing support for plants and other structures. Soil management has a major impact on soil quality. A soil sample data as a sample soil quality of the project area is tabulated in the table 4.10.

Table 4.10: Result of Chemical Characteristics of Top Soils

Location	Depth (cm)	pH	EC ds/m	OM (%)	Ex-K Me/100 gm soil	Ex-Na Me/100 gm soil	NH_4-N ppm	P ppm	S ppm	B ppm	Fe ppm	Pb ppm	Cd ppm
L-1	0-6	5.1	1.00	2.10	0.18	0.60	29	13	15	0.11	110	0.18	0.01
L-1 Village: Goraghata、 Union: Chata Maheshkhali、Thana: Maheshkhali、District: Cox's Bazar **Laboratory name: Department of Soil Science, University of Dhaka, Bangladesh, 30th August, 1998**													

4.9.4 Noise Level

High-intensity sound, such as that emitted by machines used for excavating earth and welding pipes, for long periods of time is disturbing and potentially damaging to nearby human populations and wildlife. When continued for long periods of time it can also permanently damage the hearing of workers engaged in the area. While 50 dB (decibels) creates severe discomfort, 85dB is usually considered as the critical level for ear damage. The Environmental Quality Standards for Bangladesh (DOE, 1991) have set noise guidelines for industrial sites in Bangladesh. According to this standard, noise level should not exceed 75dB in the daytime and 70dB at night. Hearing protection should be provided to workers where noise levels exceed 80 dBA. The prevailing noise conditions are generally typical of rural Bangladesh, which implies generally good conditions.

4.9.5 Sediment Quality

In the project area no sediment data were possible to test for this project due to limitation of study work. However the sediment quality standards are tabulated considering the USEPA sediment standards as a guiding reference for Bangladesh. The Muller scale is also present here for defining the sediment quality by classifying six classes (Source: publications of 2011 2nd International Conference on Environmental Science and Technology IPCBEE vol.6 (2011) © (2011) IACSIT Press, Singapore.)

Table 4.11: EPA Guidelines for Sediments (Mg/Kg dry weights)

Metal	Not polluted	Moderately polluted	Heavily polluted
Pb	<40	40-60	>60
Cd	….	…	>6
Cr	<25	25-75	>75
Cu	<25	25-50	>50
Zn	<90	90-200	>200

Table 4.12: MULLER's Classification for the Geo-accumulation Index

I_{geo} Value	Class	Sediment Quality
≤0	0	Unpolluted
0-1	1	From unpolluted to moderately polluted
1-2	2	Moderately polluted
2-3	3	From moderately to strongly polluted
3-4	4	Strongly polluted
4-5	5	From strongly to extremely polluted
>6	6	Extremely polluted
I_{geo}: Geo-accumulation Index = **$\log_2$[Cn/1.5Bn]** where, Cn: Concentration of element n and Bn: Geochemical Background Value		

Chapter 5 Identification and Analysis of Key Environmental Issues

5.1 Environmental Sensitivity Investigation

The proposed road project area is environmentally sensitive due to the geographical location. All the environmentally sensitive issues were investigated by a selected consultants group through carry out primary and secondary data analysis. The main hindrance of the proposed project sustainability is natural calamity like storm surges, cyclones, Tsunami etc. Design consultants should consider this sensitive issue in the design structure to make project environmentally sound and sustainable. The structure should be maintained adequate height to protect from storm surges, cyclones, Tsunami flooding. Adequate tree plantation will be required along the right of way of the embankment.

5.2 Environmental Assets

Environmental assets are the naturally occurring living and non-living components of the Earth, together constituting the bio-physical environment, which may provide benefits to humanity. The environmental assets are two types one is individual type and other is ecosystem approach. In the project area individual environmental assets / resources include Timber, Water, Soil and Fish. Ecosystem assets include Forests, Lakes and Agricultural areas. Both are benefitted in a symbiosis approach.

5.3 Environmental Hot Spots

No significant environmental hot spots existence in the project area. The project area is very close to the sea. Sea, itself an environmental hot spots for multiple resources diversity. The project authority will take appropriate protective measures to save these natural resources. Another important hot spot named Sonadia Island designated as a ecologically critical area by DoE. The area is far from the project site about 15 km downstream towards south. Neither of the hot spot area is affected by the project activities.

5.4 Likely Beneficial Impact

Many people are having business in the Cox's Bazaar. No industry or other major economic enterprises were set up in the project area. Due to the proposed 6.5 km embankment cum road development project connectivity between local and national areas will be improved. People will get benefit through set up new industry, increase in employment and business opportunities. By improving network connectivity, people easily contact with other areas,

exchange their views and customs, sharing experiences. Various utility services facility like electricity, road facility etc. enhance the local people livelihood and living standard.

5.5 Community Recommendations

The community has provided their views and comments during consultation process. Few recommendations are given below.

- Any structure which is maintained by local people shall be taken into consideration during and after the road construction of the project.
- Road crossing through hilly areas should consider Mitigation Measures like retaining wall etc.
- Matarbari is a siltation prone area. Study on siltation of the Kohelia River should be taken into consideration so that road construction over the Kohelia River does not create any damage to the adjacent areas
- Mangrove forest should be considered carefully so that no damage is done during and after the development
- For development work, people participation, awareness and motivation should be required. So the client should do work with very close contact with local representative (i.e. Chairman, member and other elite persons).
- For the land acquire for road development, take minimum land so that the affect will be less to the land owner.
- Proper compensation should be provided to the poor people.
- The soil condition is not good at that area. That's why proper design for the road and proper protection need for the road.
- In every rainy reason, flash water come down from the hills and washed the road and also enters the water in closed residences. As there is no drainage system around the road. So proper drainage network should be construction along the road
- Along the road if there any previous structure, which is very old. Proper protection work needs to be design for that.

5.6 Alternate Analysis

There are two way connections entering into the project area. One candidate is from Rajghat, Matarbari to Mohiraghona, Dhalghata 6.5 km embankment of BWDB located on the west bank of the Koheli River. Another candidate is existing embankment of BWDB located on the east of the Bay of Bengal. This site is existing access road from Matarbari to Dhalghata. The routes of access road are in the area from the national highway running between Chittagong and Cox's Bazar to the Power Plant site. Basically, existing road facilities will be utilized wherever possible. It is envisioned that the route segments to join the national highway in the north and the route from Maheskhali Island to the Power Plant site will involve new road and bridge construction. The candidate of 6.5 km embankment cum road is very close to the access road connection. Other candidate of existing embankment of BWDB located on the east of the Bay of Bengal which connecting to the access road will more complex due to zigzag pattern and congested local route. Proposed 6.5 km embankment site will more be economical due to the location. Earth filling and transportation of construction materials will be more economical than the other site. For other site extra facility will have to be required to create which will make it expensive. Proposed site social and environmental impact will be lower than the other site. For other site, more households will be directly affected by the interventions. Hence, considering all technical, social and environmental issues proposed site is more feasible than the other site. The proposed site shall also be more feasible in terms of economic factor.

Chapter 6 Environment and Social Impacts

6.1 Introduction

Environmental impacts assessment was carried out considering present environmental setting of the project area, and nature and extent of the proposed activities. Potential environmental impacts associated with the proposed project activities are classified as: (i) impacts during design and construction phase and ii) impacts during operation phase.

Some of the important impacts associated with the proposed project will be associated with land use (land acquisition), land stability (soil erosion), soil compaction and contamination, water availability, water quality of river/stream/canal, ground water contamination, waste and wastewater disposal, ambient air quality, ambient noise levels, vegetation, tree cutting (including social forestry tree), fauna (terrestrial and aquatic), drainage pattern, hydrology, climate change, socio economic, places of social/cultural importance (religious structures, community structure), construction material sourcing and occupational health and safety. Adequate mitigation measures are devised to mitigate/minimize all likely environmental impacts and the same have been presented along with the impacts.

During the field study, consultations were also held with people in the locality including those presently living in the project areas, NGOs and Government authorities like Forests Departments, RHD, and Fisheries. Outcome of these consultations were used in impact assessment and devising mitigation measures.

6.2 Impact on Water Resources

To assess the impacts of the proposed 6.5 km long embankment-cum-road on water resources, in particular on hydrologic and hydraulic parameters, two widely used mathematical models were used. In addition, statistical analyses of available tidal water levels at three surrounding stations were carried out.

Analysis of tidal water levels:

The Kohelia River itself is ungaged. So, there is no measured water level and discharge data of the river. However, there are a few surrounding rivers for which water level data is available. These data were collected from the Bangladesh Water Development Board (BWDB) and Water Resources Planning Organization. The details of the data collected are given in Table 6.1. The data was available since 1968.

Table 6.1: Period of available water level data of BWDB

Name of River	Name and ID of Station	Type of data
Kutubdia Channel	Lemsikhali (SW176)	Daily high and low tidal water levels
Moheskhali Channel	Saflapur (SW200)	Daily high and low tidal water levels
Bogkhali	Cox's Bazar (SW41)	Daily high and low tidal water levels

A frequency analysis of the high tidal water levels as well as the mean tidal water levels was carried out with these water level data using a number of probability distribution functions including normal, lognormal, log-Pearson and Gumbel distributions. Tables 6.2-6.4 show the results for Lemsikhali, Saflapur and Cox's Bazar, respectively. It is seen from the tables that the flood levels vary with the distributions considered, particularly at high return periods. A goodness-of-fit test was carried out using probability plot correlation coefficient to see which distribution fits the data the best. The Gumbel and log-Pearson type III fitted best to the annual maximum water level data at Lemsikhali and Saflapur, respectively. Figures 6.1 and 6.2 show the probability plots along with 90% confidence limits of the fitted Gumbel and Log Pearson Type III distributions to the annual maximum water levels at Lemsikhali and Saflapur, respectively. It is seen from the figures that the distributions fit to the respective data reasonably well.

Table 6.2: Frequency analysis of flood levels of the Kutubdia Channel at Lemsikhali

Probability distribution function	Water level (m PWD) corresponding to the return period of					Highest flood in m PWD (year)
	5 year	10 year	20 year	50 year	100 year	
Normal	3.99	4.25	4.48	4.73	4.90	5.46 (1971)
Log Normal	3.96	4.28	4.56	4.90	5.14	4.90 (1972)
Log Pearson Type III	3.97	4.27	4.52	4.82	5.02	4.20 (1997)
Gumbel	3.91	4.27	4.61	5.06	5.39	

Table 6.3: Frequency analysis of flood levels of the Moheskhali Channel at Saflapur

Probability distribution function	Water level (m PWD) corresponding to the return period of					Highest flood in m PWD (year)
	5 year	10 year	20 year	50 year	100 year	
Normal	3.95	4.14	4.30	4.48	4.60	4.36 (1985)
Log Normal	3.95	4.17	4.36	4.59	4.74	4.21 (1983)
Log Pearson Type III	3.95	4.16	4.33	4.53	4.66	4.20 (1987, 1988, 1989)
Gumbel	3.90	4.15	4.40	4.72	4.96	

Table 6.4: Frequency analysis of flood levels of the Bogkhali at Cox's Bazar

Probability distribution function	Water level (m PWD) corresponding to the return period of					Highest flood in m PWD (year)
	5 year	10 year	20 year	50 year	100 year	
Normal	3.67	3.80	3.90	4.02	4.10	3.93 (1987)
Log Normal	3.66	3.80	3.92	4.05	4.14	3.87 (1975)
Log Pearson Type III	3.67	3.79	3.90	4.02	4.10	3.79 (1989)
Gumbel	3.64	3.81	3.96	4.17	4.32	

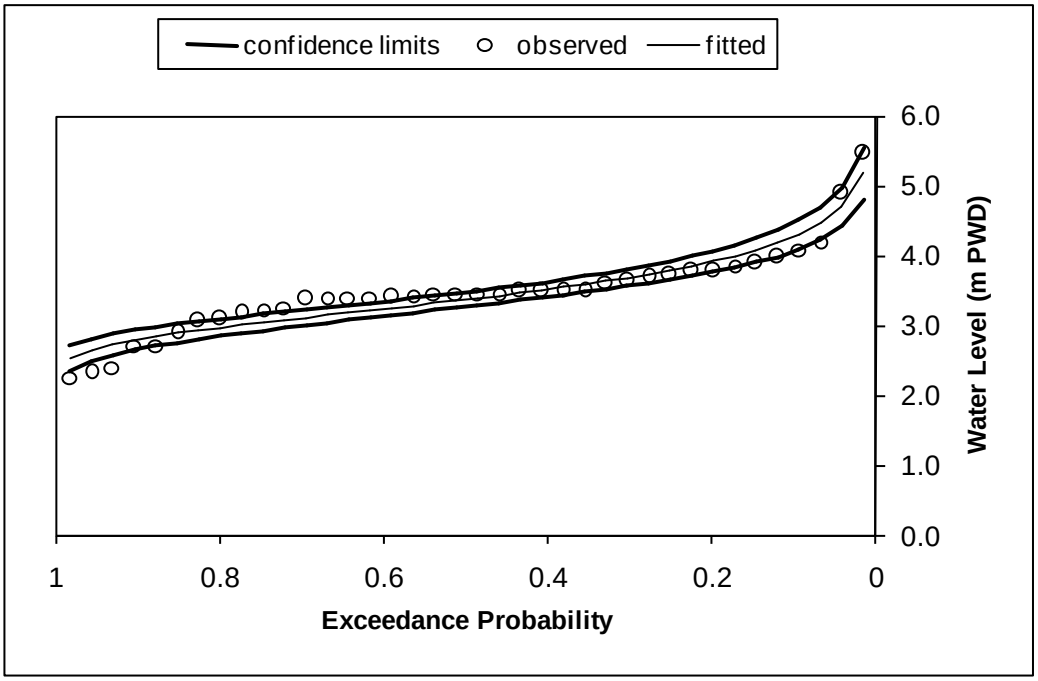


Figure 6.1: Probability plot along with 90% confidence limits of the fitted Gumbel distribution to the annual maximum water levels of the Kutubdia Channel at Lemsikhali

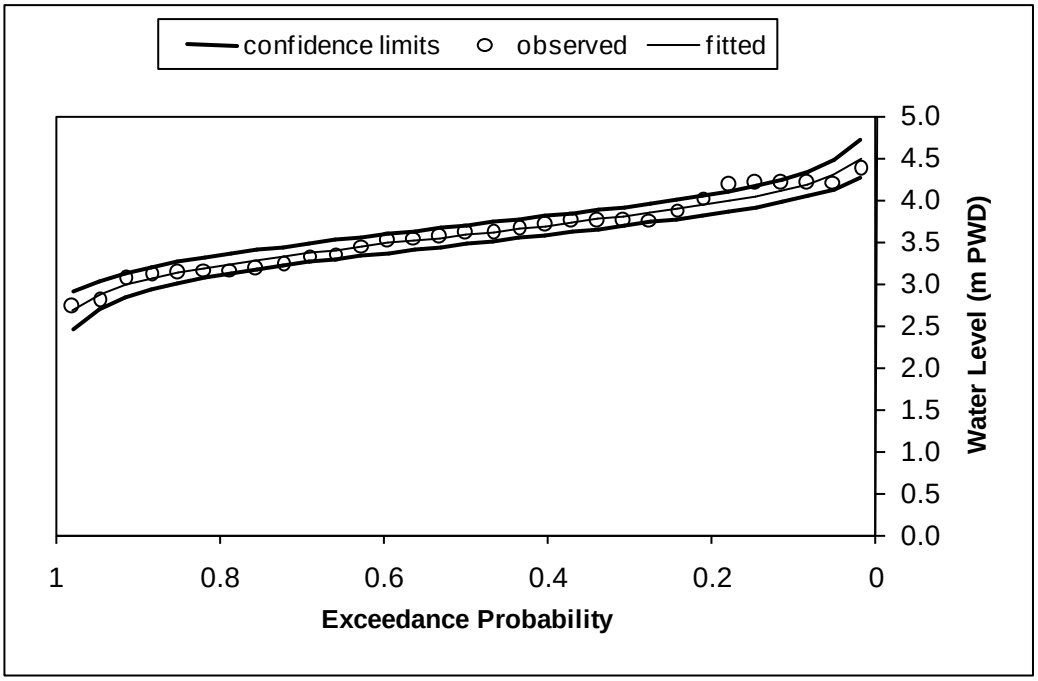


Figure 6.2: Probability plot along with 90% confidence limits of the fitted Log Pearson Type III distribution to the annual maximum water levels of the Moheskhali Channel at Saflapur

The frequency analysis for the annual maximum mean tidal water levels is given in Tables 6.5-6.7 and the goodness-of-fit plots in Figures 6.3-6.4.

Table 6.5: Frequency analysis of annual maximum mean tidal water levels of the Kutubdia Channel at Lemsikhali

Probability distribution function	Water level (m PWD) corresponding to the return period of					Highest flood in m PWD (year)
	5 year	10 year	20 year	50 year	100 year	
Normal	1.95	2.16	2.34	2.54	2.68	2.93 (1971)
Log Normal	1.92	2.22	2.49	2.85	3.11	2.68 (1972)
Log Pearson Type III	1.93	2.19	2.42	2.70	2.89	2.23 (2005)
Gumbel	1.89	2.18	2.45	2.80	3.07	

Table 6.6: Frequency analysis of annual maximum mean tidal water levels of the Moheskhali Channel at Saflapur

Probability distribution function	Water level (m PWD) corresponding to the return period of					Highest flood in m PWD (year)
	5 year	10 year	20 year	50 year	100 year	
Normal	2.07	2.29	2.46	2.66	2.79	2.92 (2009) 2.60 (2008) 2.31 (1976)
Log Normal	2.04	2.30	2.55	2.86	3.09	
Log Pearson Type III	2.04	2.28	2.49	2.73	2.90	
Gumbel	2.02	2.30	2.57	2.91	3.17	

Table 6.7: Frequency analysis of annual maximum mean tidal water levels of the Bogkhali River at Cox's Bazar

Probability distribution function	Water level (m PWD) corresponding to the return period of					Highest flood in m PWD (year)
	5 year	10 year	20 year	50 year	100 year	
Normal	2.41	2.53	2.62	2.73	2.81	2.92 (1988) 2.58 (1991) 2.54 (1971)
Log Normal	2.32	2.43	2.52	2.62	2.69	
Log Pearson Type III	2.32	2.43	2.54	2.66	2.75	
Gumbel	2.38	2.53	2.68	2.88	3.02	

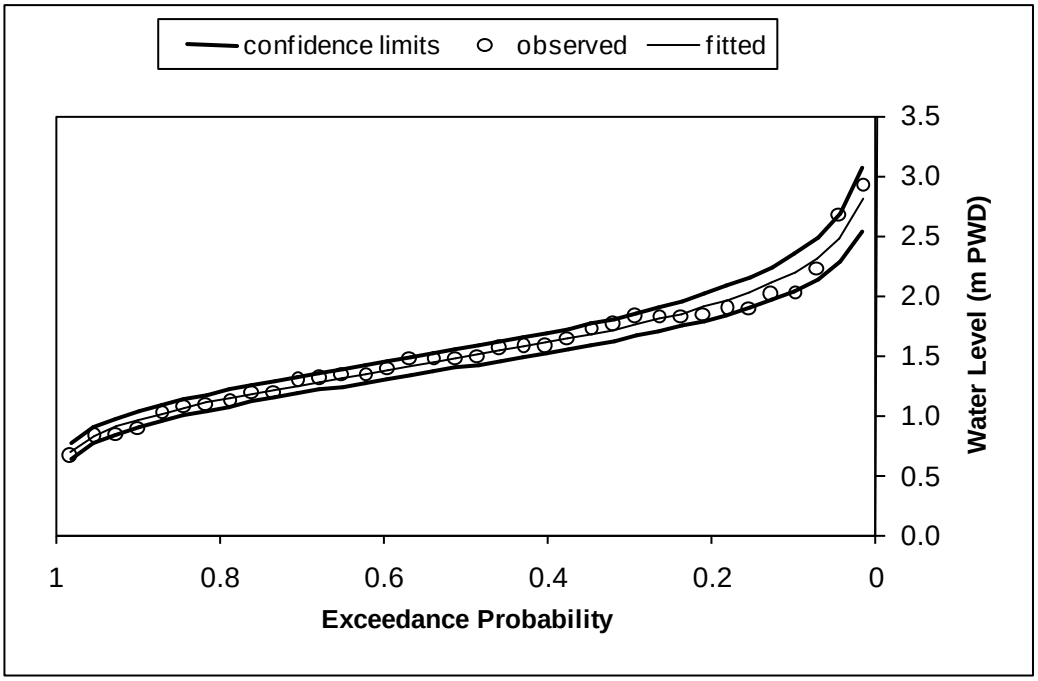


Figure 6.3: Probability plot along with 90% confidence limits of the fitted Log Normal distribution to annual maximum mean tidal water levels of the Kutubdia Channel at Lemsikhali

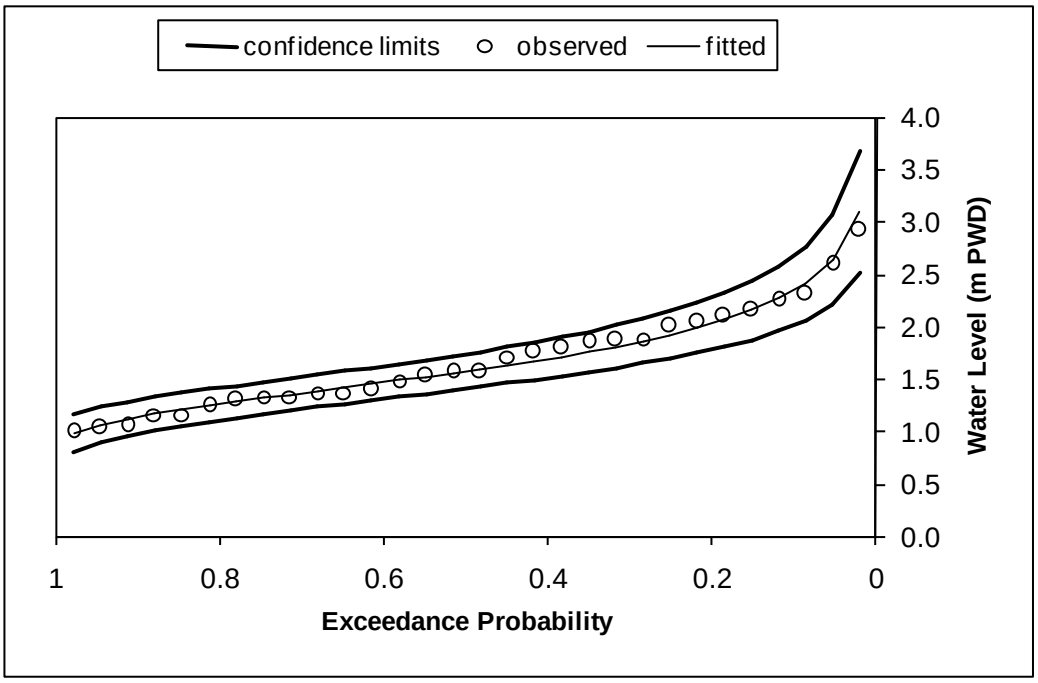


Figure 6.4: Probability plot along with 90% confidence limits of the fitted Log Pearson Type III distribution to annual maximum mean tidal water levels of the Moheskhali Channel at Saflapur

Given the locations of the three gage stations with respect to the Kohelia River at Matarbari, the 50-year flood level was estimated to be about 4.63 m PWD and the 50-year mean tidal water level about 2.74 m PWD. These estimated flood and tidal water levels would be used in mathematical models described below.

Hydraulic Analysis Using HEC-RAS Model

Now we discuss different hydraulic parameters that would relevant to evaluate the impact of the proposed embankment-cum-road. A widely used one-dimensional hydraulic model HEC-RAS, developed by the U.S. Army Corps of Engineers (2005), is used to derive a number of hydraulic parameters along the Kohelia River for existing (base) and proposed conditions.

The HEC-RAS system can be used for both steady flow water surface profile computation and unsteady flow simulation. The system can handle a full network of channels, a dendritic system, or a single river reach. The effects of various obstructions such as bridges, culverts, weirs, embankments and structures in the floodplain may be considered in the computations. For steady flow analysis, the solution of the one-dimensional energy equation by standard step method (Sturm, 2001) is used as the basic computational procedure. This is an iterative procedure using secant method of solution (Ortega and Poole, 1981). The flow in natural and man-made channels is estimated by the use of the one-dimensional Manning Equation. Energy losses are evaluated by friction and contraction/expansion (coefficient multiplied by the change in velocity head). Where the water surface profile is rapidly varied, the momentum equation is utilized. The HEC-RAS steady flow module has options to run either with upstream or downstream boundary conditions depending on the flow regime (U.S. Army Corps of Engineers, 2005). For sub-critical flow the downstream boundary condition in terms of any of (1) water surface elevations, (2) critical depth, (3) normal depth, and (4) rating curve is to be defined. For gradually varied unsteady flow simulation, the HEC-RAS solves the complete hydrodynamic mass conservation and momentum conservation equations (popularly known as the St. Venant Equations) with an implicit finite difference method generating a system of linearized algebraic equations. The solution algorithm uses the Preissmann type scheme (Cunge et al., 1980). The options for hydraulic calculations at cross-sections, bridges, culverts, roads, and other hydraulic structures that were developed for the steady flow component are also incorporated into the unsteady flow module.

In the present study for computation of hydraulic parameters, the HEC-RAS with option for a steady flow analysis was considered first. It was run as a single-reach model as there was no

major tributary/distributary of the Kohelia River in the modeled reach. For the present study, the third type of boundary condition, which is normal depth as mentioned above, was selected. This is calculated by the model itself using the Manning's equation. This needs the energy slope to be specified by the users. In absence of energy slope in the present analysis and given that there would be insignificant difference between the hydraulic gradient and energy gradient in the study area, the model was run with hydraulic gradient as the downstream boundary condition. Since the Kohelia River itself is ungaged, the hydraulic gradient was estimated based on our experiences of working with a number of rivers (for example, Bogkhali) in the region. Such gradient was estimated to be about 3.74 cm/km and was used in this study for estimation of hydraulic parameters along the Kohelia River. For the selected reach based on the information collected during the field visit on the bed materials and the flood plains, the Manning's roughness coefficient of 0.025 for the main river and 0.030 for the overbanks are considered reasonable and hence were used in the model. A 13-km river reach was modeled based on freely available bathymetry data and the information provided in JICA et al. (2013). Any additional cross section required in the model set-up was generated from the google earth image, field observations and our own professional judgments.

A brief description of each of these tools is given below in pre-construction, construction and post construction phase.

6.2.1 Pre-construction phase

Computation of hydraulic parameters at 'base' condition with HEC-RAS model

As mentioned earlier, there were no measured water level and discharge data for the Kohelia River. The data available were the water level data from three nearby gage stations from which 50-year flood level was estimated to be 4.63 m PWD at the downstream end of the river.

In a tidal river, when discharge is the maximum, tidal water level just crosses the mean tide level (Neill, 1973). The velocity is the maximum during the ebb tide. And when the ebb velocity attains the maximum value, tidal water level reaches the mean value (Walton, 2002). The extreme condition is expected to be during the spring tide. So, in order to calculate limiting (maximum) discharge and velocity, it is safe to consider mean tidal water level which is estimated to be about 2.74 m PWD. Therefore, the model was run with a hydraulic gradient of 3.74 cm/km to compute the limiting hydraulic parameters corresponding to the water level of 2.74 m PWD for the base condition. Figure 6.5 shows the reach of the river which was included in the model. The discharge corresponding to the above water level was found to be **1150 m^3/s**. The velocity of the river was found to vary between 0.43 m/s and 1.61 m/s

depending on the cross sectional flow area (Figure 6.6).

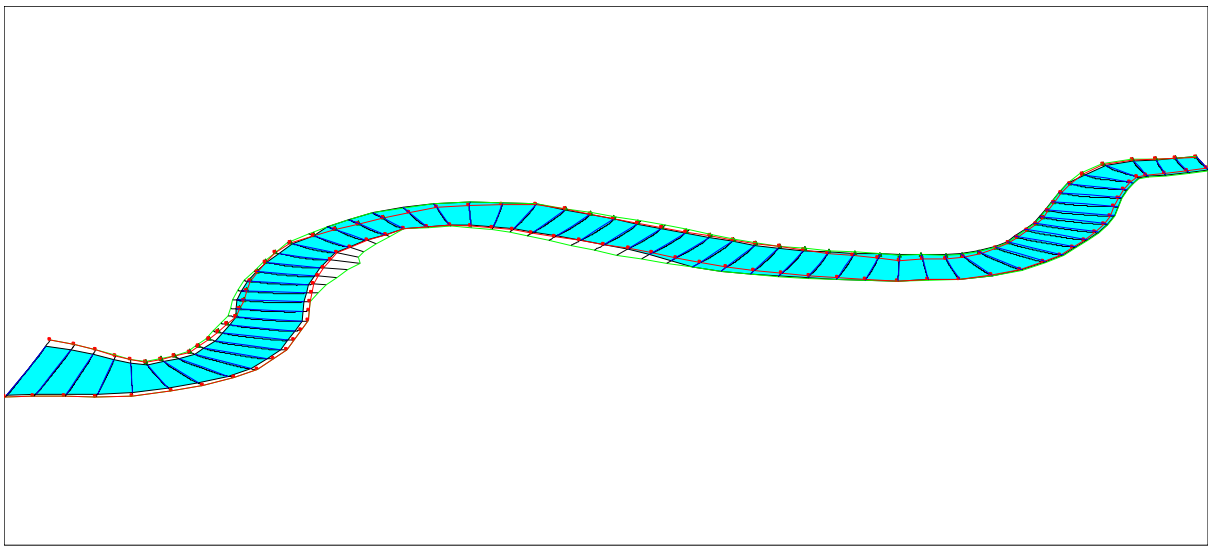


Figure 6.5: The 13-km reach of the Kohelia River included in the HEC-RAS model

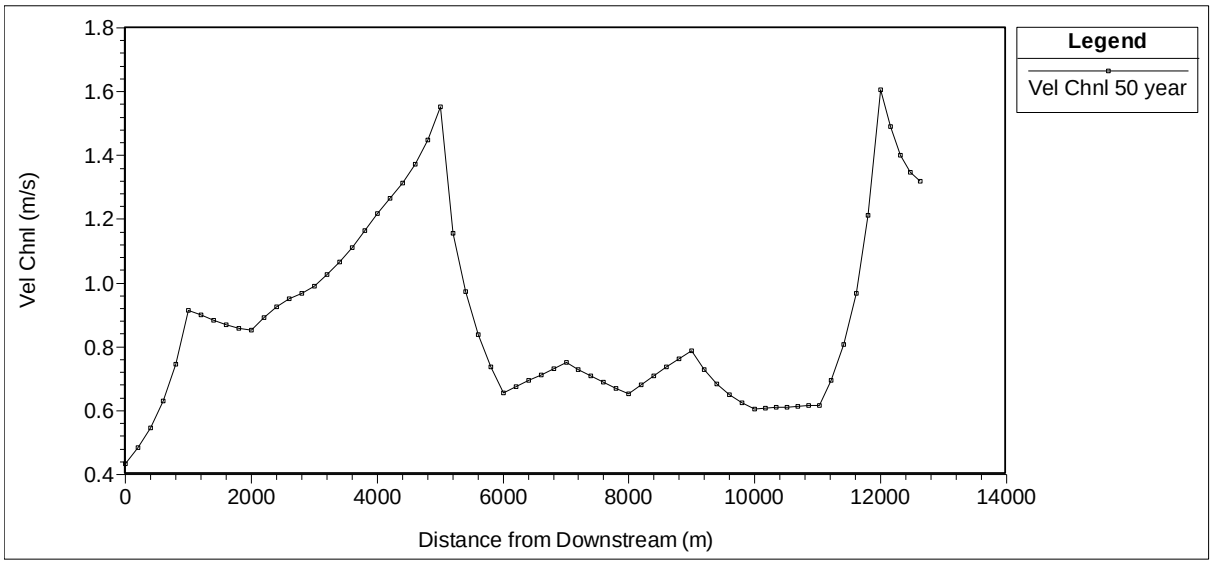


Figure 6.6: Simulated average channel velocity along the Kohelia River corresponding to a 50-year mean tidal condition

The model was then run under unsteady flow condition using the estimated water level from frequency analysis mentioned earlier as downstream boundary condition and estimated discharge from steady-state simulation as upstream boundary condition. The steady-state water velocity helped decide on the phase lag between the downstream and the upstream reaches.

The water surface profile corresponding to the maximum water level is shown in Figure 6.7. It is seen from the figure that the maximum water level under a 50-year return period tidal flood would be less than 5 m PWD. During the field visit to Matarbari area on September 10, 2015,

the accompanying project official informed that the existing crest level of the BWDB polder is at 5 m PWD. Thus, it appears that the polder is unlikely to be overtopped by a 50-year tidal flood. The velocity of flow at maximum flood level is shown in Figure 6.8. A comparison of this figure with the Figure 6.6 indicates that the velocity is lower at maximum flood level compared with the mean tidal water level, which is generally expected. Figure 6.9 shows the variation of tidal water level with time at the upstream of the river. The maximum tidal amplitude was found to be about 2.3 m which is consistent with the local people's observation. The local people during the field visit mentioned that the difference between the maximum and minimum tidal water levels at the Kohelia bridge is about 7-8 feet. This bridge is located at about 1 km downstream of the upper end of the model domain. Simulated unsteady flow in the mid-reach of the river is shown in Figure 6.10. The simulation results indicate that both flood and ebb tides ply in the river, but ebb tide dominates the flow pattern. Also, the steady and unsteady flow simulation results are consistent in that both simulations provide similar maximum discharges. So the HEC-RAS model can be used for assessment of post intervention (embankment-cum-road) situation.

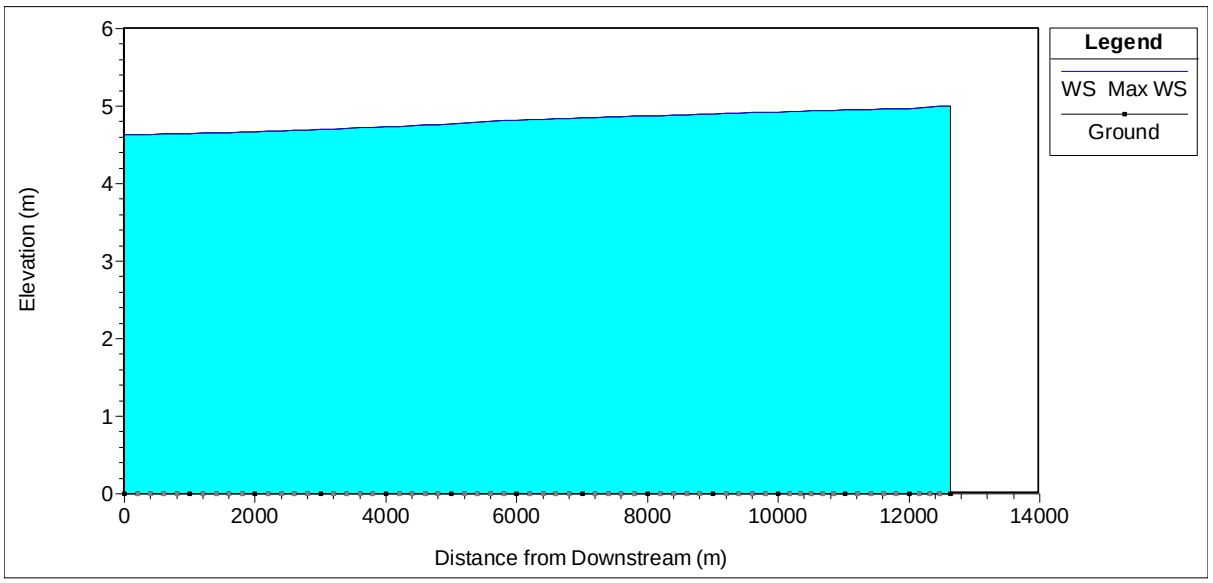


Figure 6.7: Water surface profile of the Kohelia River along its 13-km reach

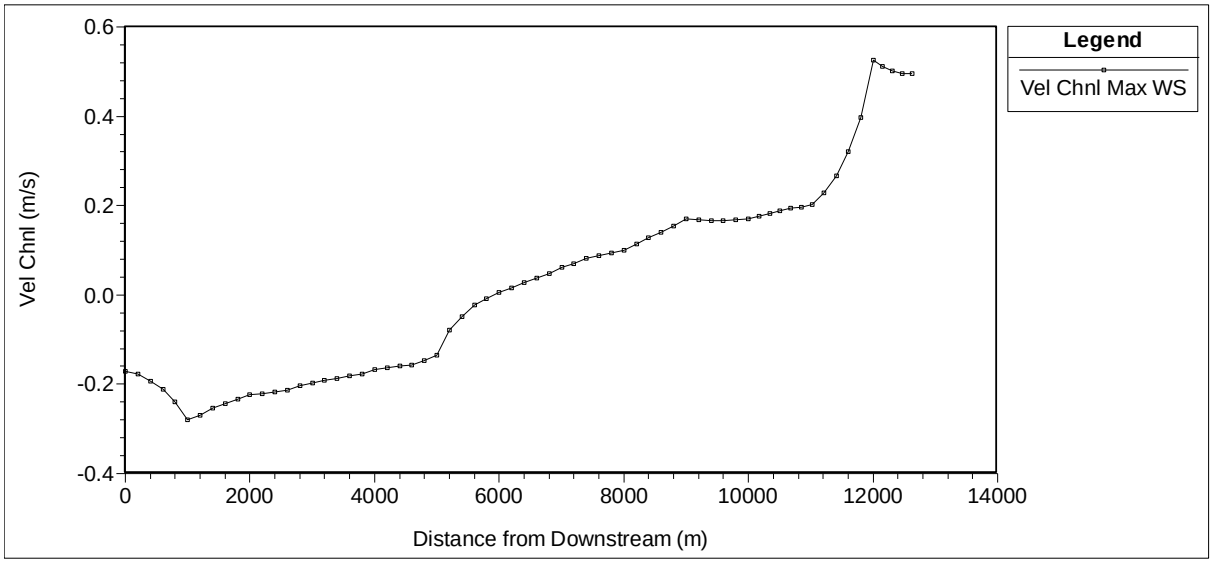


Figure 6.8: Velocity profile of the Kohelia River along its 13-km reach

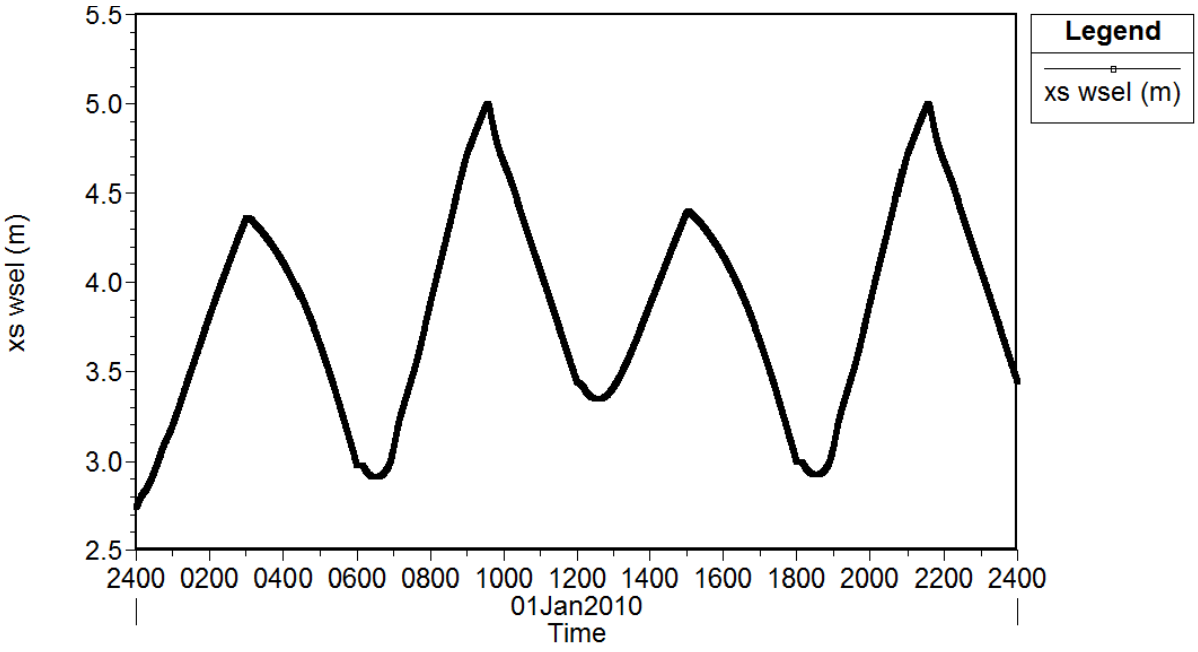


Figure 6.9: Simulated (unsteady) tidal water level at the upper end of the Kohelia River

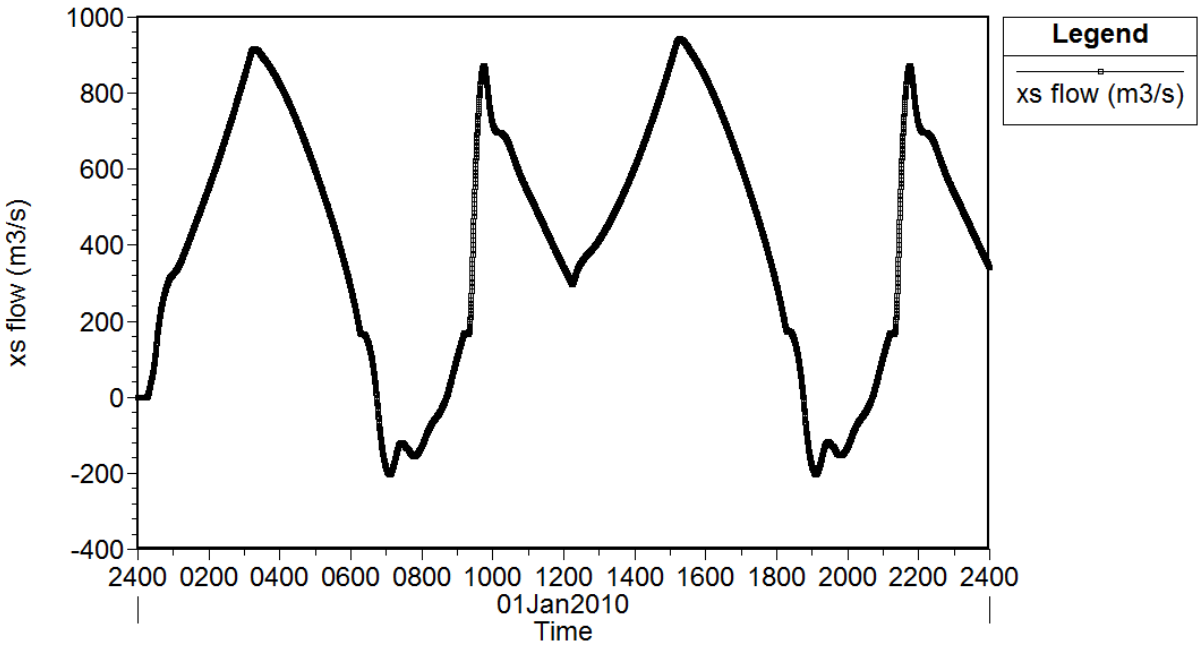


Figure 6.10: Simulated (unsteady) tidal flow at the middle reach of the Kohelia River

Computation of hydraulic parameters at 'base' condition with Delft 3D model

Another model, called Delft 3D, developed by the Delft Hydraulics and Delft University of Technology, was used to simulate the hydraulic parameters, particularly two dimensional velocity and discharge. The main purpose of the use of this model was to see the compatibility between the results of the two models (HEC-RAS and Delft 3D). The Delft 3D is an integrated modeling suite, which is capable to simulate the hydrodynamics and morpho-dynamics in coastal, riverine and estuarine environments. It is a widely used model to simulate several physical processes. Among others, it has a hydrodynamic module which solves the governing unsteady equations by finite difference technique. The equations are solved on a Cartesian rectangular, orthogonal curvilinear or spherical grid. When necessary, the vertical grid is defined following the sigma coordinate approach. In this study, one module of the Delft 3D modeling suite, i.e. the flow module, is used.

The study reach is selected considering the existing alignment of the proposed embankment-cum-road. Discharge is specified as the upstream boundary condition and water level as the downstream boundary condition of the model. The model domain with grids is shown in Figure 6.11. The model domain was confined to the Kohelia River and its floodplain between the existing polder/gher bund.

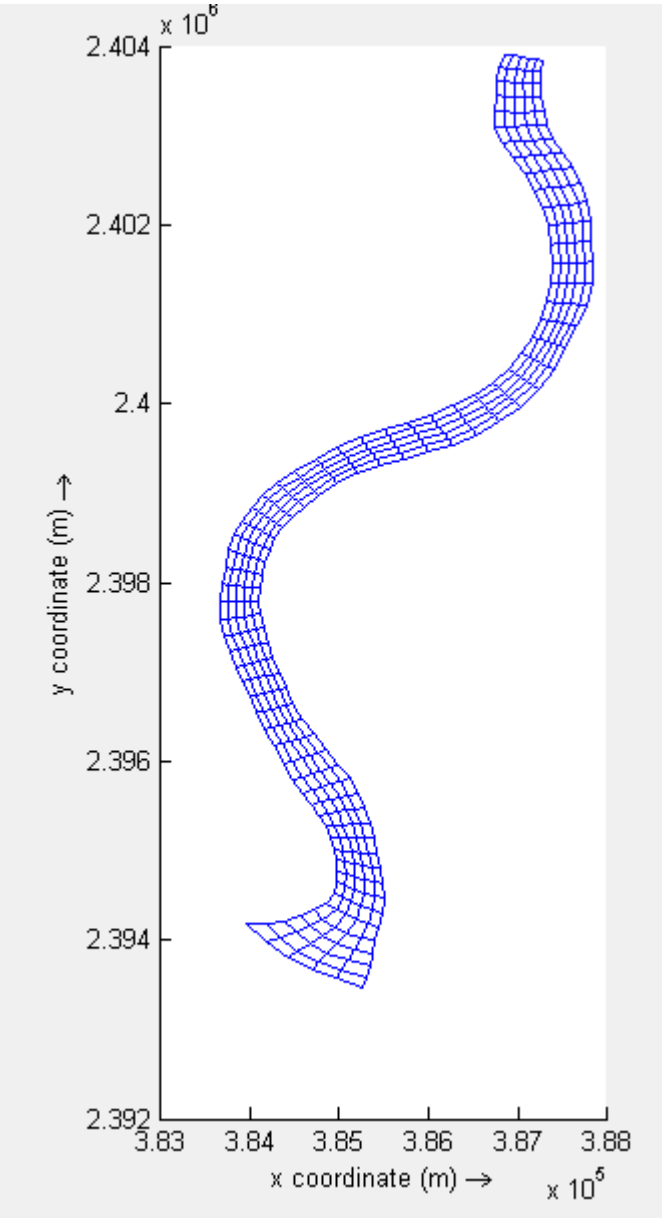


Figure 6.11: Discretized grids of the Kohelia River for the Delft 3D model setup

The velocity variation in a cross section is shown in Figure 6.12. The maximum velocity corresponding to a 50-year flood was found to be within 1.8 m/s. This is consistent with both the HEC-RAS results and the JICA et al. (2013) measured values. The velocity vector (Figure 6.13) shows that the velocities are higher, as expected, in the deeper grids of the cross section in the middle and lower in the shallower grids near the banks and over the floodplains. The simulated discharge at different points of the river (not shown) indicated that the lower part of the river is dominated by flood tides and the upper part by ebb tides.

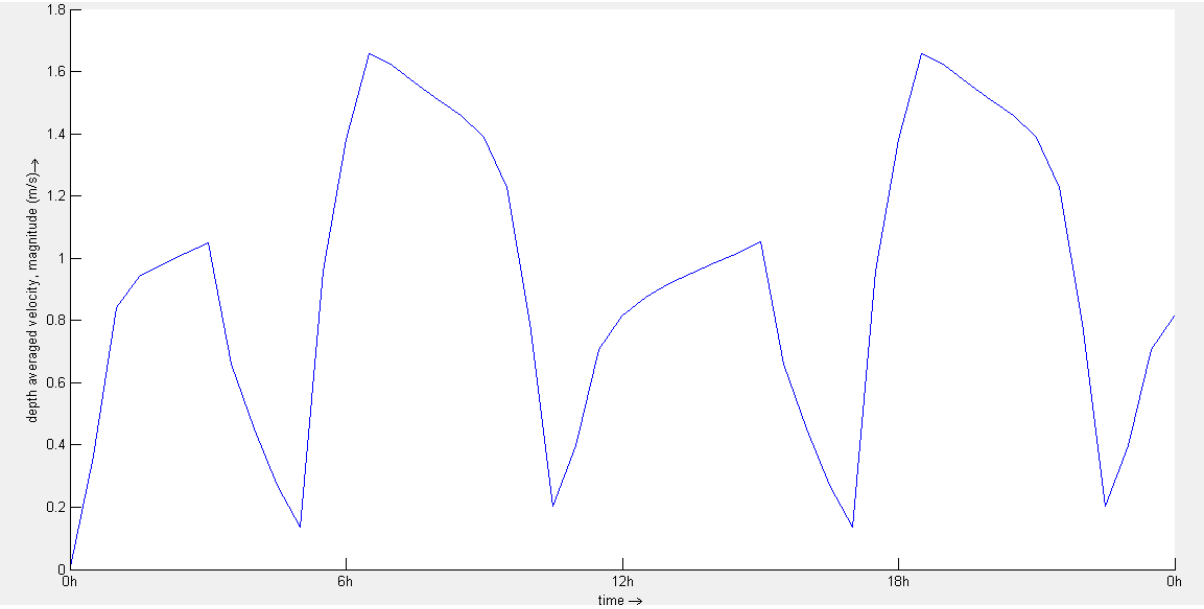


Figure 6.12: Depth averaged velocity from the Delft 3D model in a grid cell in the middle of the channel at a distance of about 5 km from the downstream

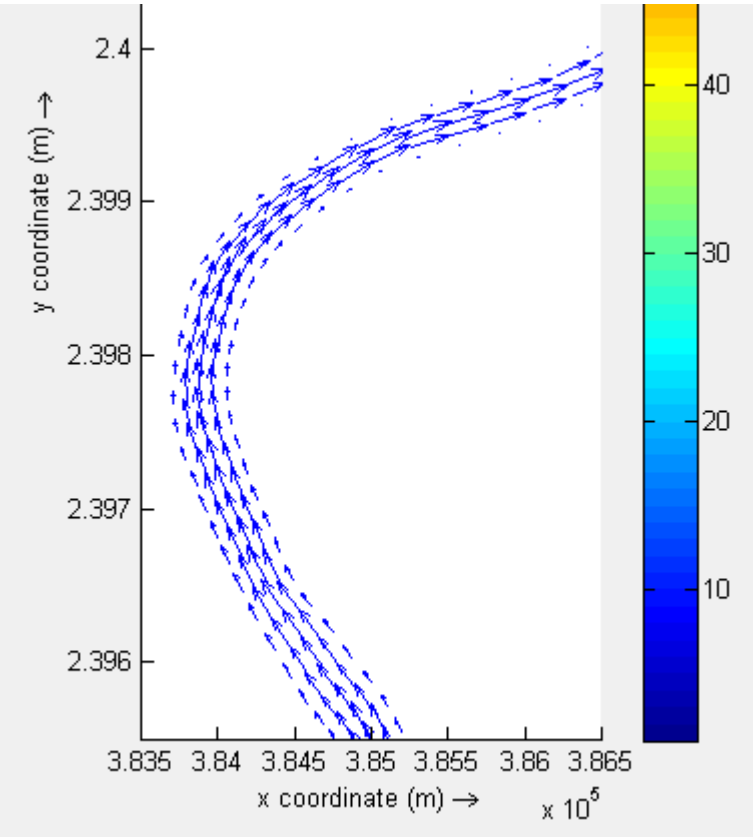


Figure 6.13: Depth averaged velocity from the Delft 3D model in part of the Kohelia River

6.2.2 Construction Phase

Computation of hydraulic parameters at 'proposed road' condition with HEC-RAS model

To assess the impact of the proposed road on flow conditions, the HEC-RAS model was rerun under the unsteady flow conditions. The top elevation, centerline alignment, top width and the riverside vertical slope of the proposed road are important parameters in assessing its impacts. Such information was gathered from the Executive Engineer's Office, Cox's Bazar, BWDB, Project Director's Office of the proposed embankment-cum-road, RHD and the CPGCBL Offices at Cox's Bazar and Dhaka. The top of the road was set at 10 m PWD.

Since the embankment-cum-road already exists and there would be only some realignment and raising of the top, it is generally expected that the effect of the proposed road on regional hydrologic and hydraulic conditions would be minimum. Indeed, the comparison of flood levels between the proposed and base conditions (Figure 6.14) indicated that there would not be any significant impact on flood level and hence on drainage through the Kohelia River. The situation is unlikely to aggravate further from its current state.

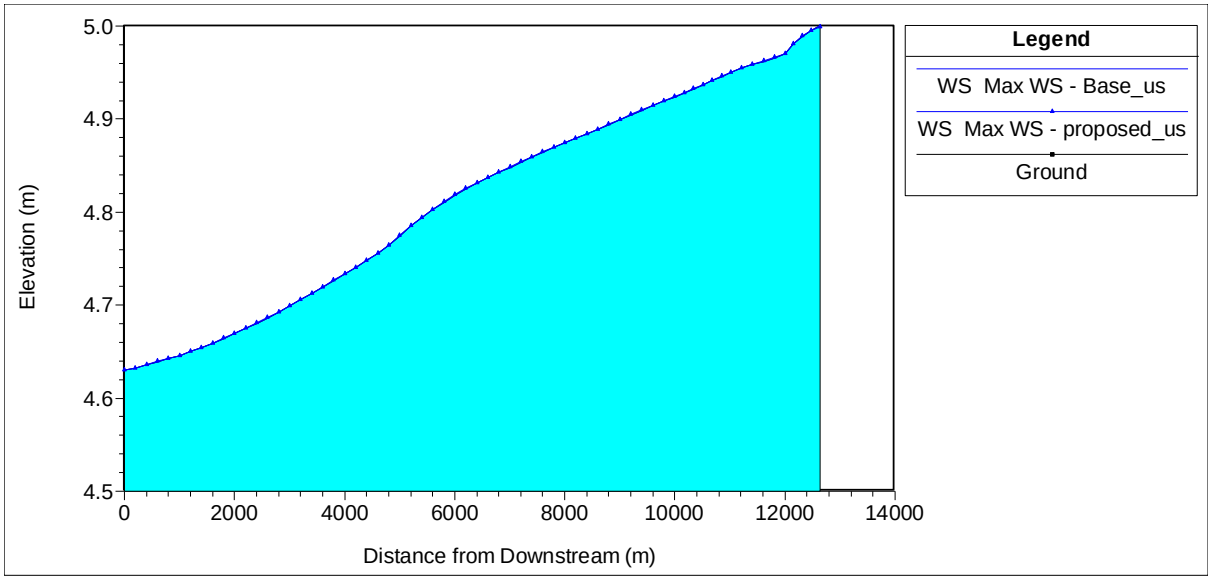


Figure 6.14: Comparison of the highest water level profiles between the base and proposed road conditions

A comparison of main channel velocities between the base and proposed road conditions (Figure 6.15) indicates that the flow velocities at the highest water surface which occurs during the flood time would essentially remain unchanged.

Comparisons of river discharges between the base and proposed road conditions at both upper end (see Figures 6.9 and 6.16) and middle reach (see Figures 6.10 and 6.17) indicate that there would not be any significant change in flow between the two conditions (base and proposed).

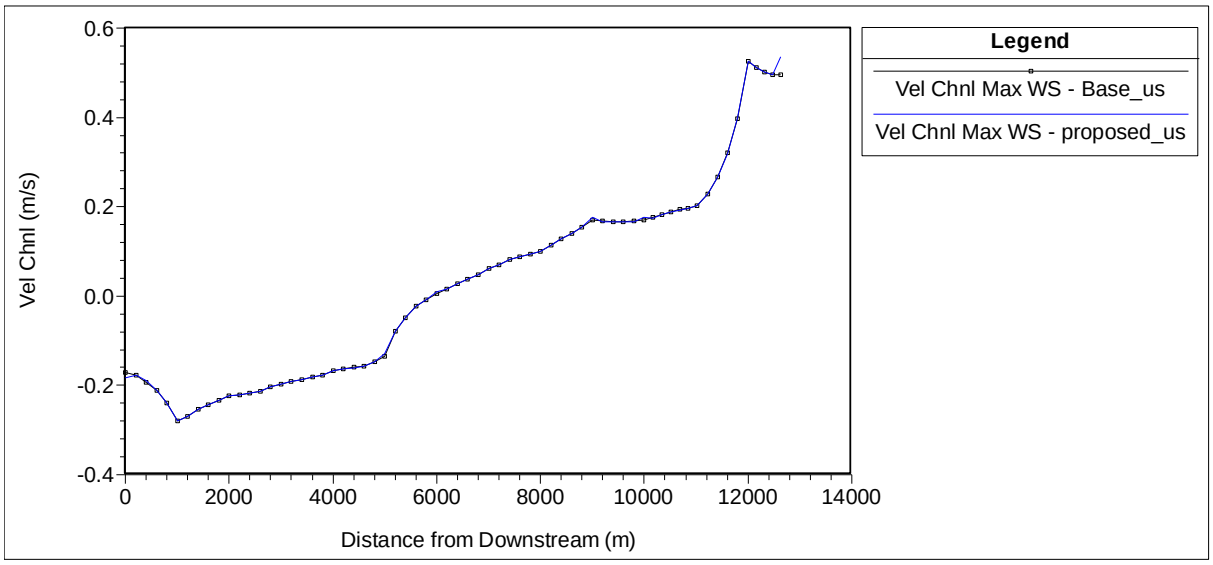


Figure 6.15: Comparison of flow velocities at maximum water surface between the base and proposed road conditions

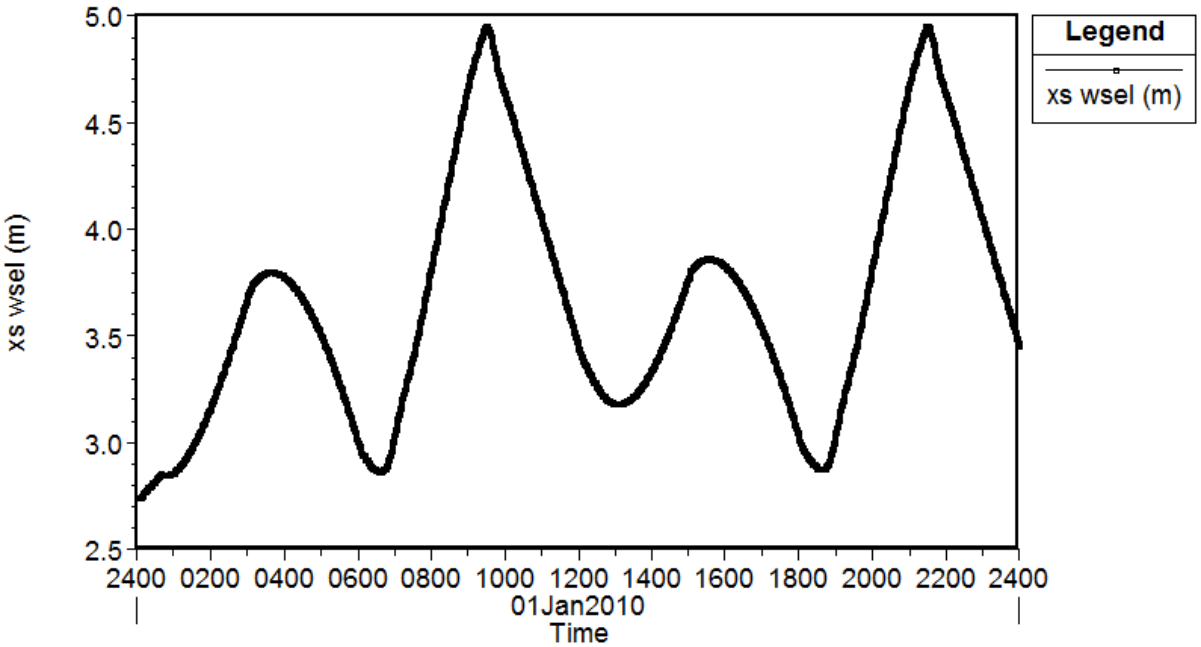


Figure 6.16: Simulated (unsteady) tidal water level at the upper end of the Kohelia River under the proposed road condition

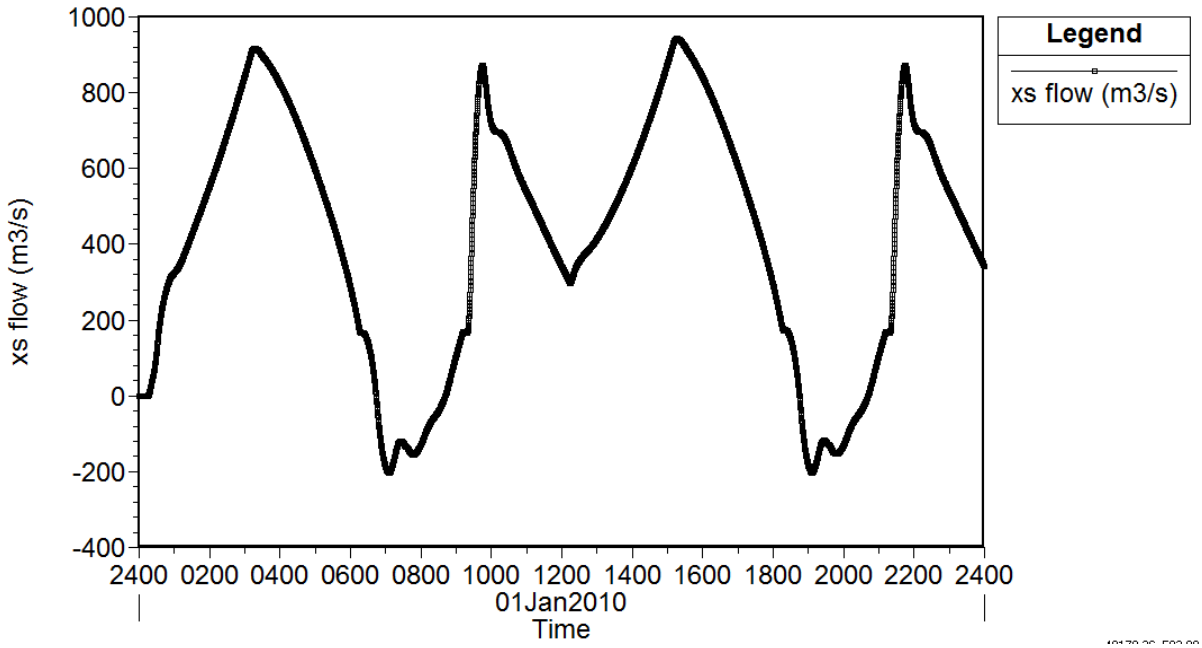


Figure 6.17: Simulated (unsteady) tidal flow at the middle reach of the Kohelia River under the proposed road condition

Based on the analyses carried out with the HEC-RAS model, it can be concluded that there would not be any significant impact of the proposed embankment-cum-road on flood and drainage in the concerned area. This is mainly due to the fact that the BWDB polder already exists and it will only be improved under the current proposal.

6.2.3 Post Construction phase

Prediction of changes in river morphology with Delft 3D model

The Delft 3D model can be used for morphological change prediction purpose. The Flow Module of the model with the sediment and morphology components enabled was used to predict morphological changes in the Kohelia River. As the embankment-cum-road is already in place and its alignment would be more or less the same under the proposed condition, the model was run a number of times with the grid and bathymetry setup earlier for base condition. The information on sediment characteristics was derived based on the data provided in JICA et al. (2013). Figure 6.18 shows the cumulative erosion/sedimentation scenarios for both base condition and three future time horizons (5, 10 and 20 years later). The overall results indicate that the morphological changes may be more in the lower reaches of the river than that in the upper reaches. These lower reaches may show both erosion and deposition in the future. The main channel between the downstream end and the middle reach may become deeper in future

due to bed erosion. Both sides of the deeper channel show a pattern of siltation due to low velocity in the short to medium terms (5-10 years). In the long term (10-20 years), the banks of the river show a tendency of erosion. It is to be noted that embankment erosion was observed during the field visit on September 10, 2015. Thus, erosion protection measures would be needed throughout the river. The existing protection work through bank revetment seen around the Kohelia bridge in South Rajghat may help guide the design and construction of the protection work of the proposed embankment-cum-road.

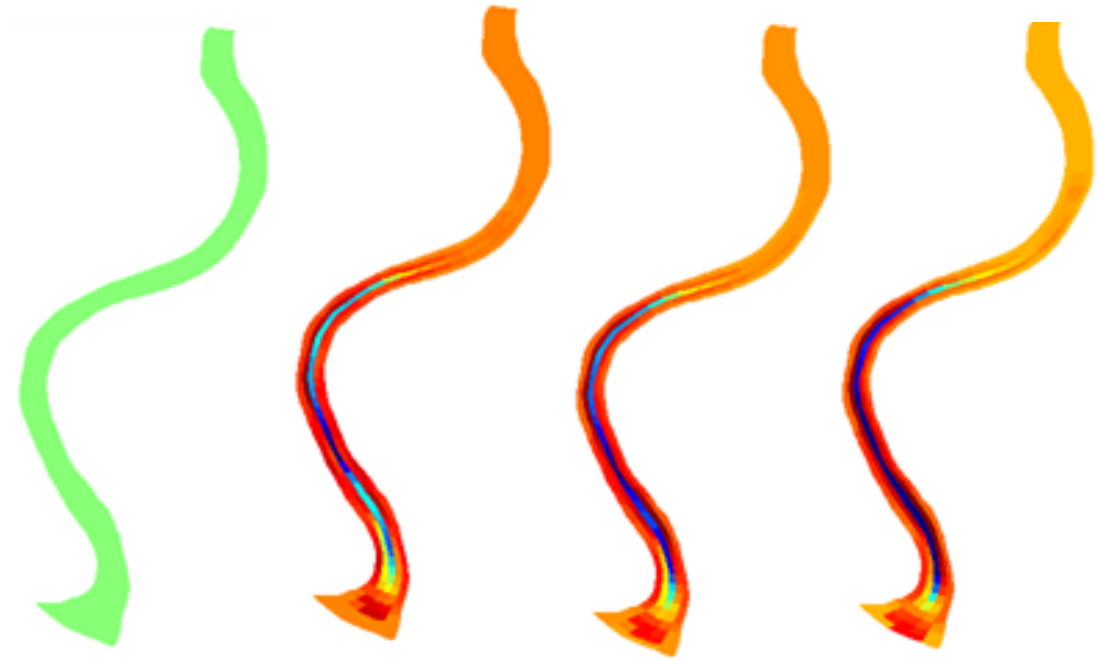


Figure 6.18: Simulated time series maps of erosion-sedimentation in the Kohelia River with the Delft 3D model (Note: The deep blue color indicates erosion, the deep red sedimentation and others indicate more or less no change).

Other potential impact associated with surface and ground water pollution during construction and operation phase.

Construction phase: There may be soil runoff from the exposed soil of the embankments and cut slopes, and water pollution of the downstream area of the surrounding river is predicted. Since the road construction area is mainly salt field or shrimp field, soil runoff and turbid water generation will not be significant. In addition, concrete wastewater and oil-containing wastewater are expected to have an effect, but only temporary. Anti-diffusion membranes will be installed around the construction site to prevent diffusion of turbidity, especially toward the mangrove forest. These measures will minimize the impact of contamination of sea water, river water and underground water.

Operation phase: Runoff of exposed soil surfaces into rivers is expected. Adequate measures

to prevent erosion will be treated.

6.3 Impact on Land Resources

6.3.1 Pre-Construction phase

The proposed road is existing BWDB embankment. Due to lack of proper maintenance few point of the embankment was breached. Earth filling would be required. This earth filling activity may be destroyed the quality of the soil as well as the structure of the soil. Filling materials quality must be tested before used as filling materials.

At the proposed site where the road will be constructed, about 12 households and 5-6 shops including tea stall will be directly affected by the project implementation who own, rent or use khas or private land within the proposed alignment site. A resettlement plan will be developed before implementation of the project.

6.3.2 Construction phase

Topography and Geology

The construction of the road may affect the topography and geology of the area around the proposed site. Cutting and filling will cause erosion of the slope, but the affect will not be significant because the road are exiting BWDB embankment, and the entire topography of project site is very flat. Some protect measures against slope sliding or erosion especially in rainy season will be considered.

Soil

Soil pollution will possibly be caused by leakages of oil and chemical materials at the construction site. Oil and chemical materials will be stored at an appropriate storage site to prevent any permeation into the ground. These measures will minimize the impact of any soil contamination.

Sediment

Sediment pollution may occur in the case construction wastewater flows into the river. Channels, ditches and temporary settling ponds will be dug and constructed around the construction area. Wastewater treatment facilities for workers, such as septic tanks and oil separators for oily run-off water, will be installed in the workers' camp and the construction area.

Oil and chemical materials will be stored in an appropriate storage site to prevent any permeation into the ground. These measures will minimize the impact of sediment contamination by river water.

6.3.3 Post Construction phase

Topography and Geology

Although erosion of slope is expected, the affects will be minimized by some protection work.

6.4 Impact on Agriculture Resources

6.4.1 Pre-Construction and Construction phase

No significant anticipated impact would be observed during Pre-Construction and Construction phase. Some trees along the village road in the protected forest area may be cut according to the procedure regulated by Forest Act (Act XVI of 1927), section 6.

6.4.2 Post Construction phase

Trees will be planted along the both sides of road slopes which can protect road soil erosion. The proposed can protect the agriculture resources from external flooding and provision of proper drainage channel can prevent the agriculture resources from internal flooding.

6.5 Impact on Fisheries

6.5.1 Pre-Construction and Construction phase

During construction period any oil and chemical materials may be released to the nearby river, ditches or pond from the construction site. This may be damaged the fisheries ecosystem of the respective water body. Oil and chemical materials will be stored in an appropriate storage site to prevent any release into the water body. These measures will minimize the impact of fisheries.

6.5.2 Post Construction phase

During operation runoff of exposed soil surfaces and drainage of waste water from drainage channel into rivers is expected which can lead to the any unexpected substances contamination to the water body and destroy fisheries ecosystem. Appropriate protection measure from waste water contamination to the rivers.

6.6 Impact on Ecosystem

6.6.1 Pre-Construction and Construction phase

Air Quality

Generation of dust is expected by land preparation, and generation of air pollutants (SOx and NOx, etc.) is anticipated from the operation of heavy machinery and trucks, but the impact will be limited only to the road construction area.

Watering the road, especially in the dry season, and using cover sheets on trucks for the transportation of soil will be undertaken to reduce dust generation. Periodic maintenance and management of all the construction machinery and vehicles will be conducted to reduce exhaust gas discharged from construction machinery and vehicles.

Waste

Waste generated from the construction work will include waste plastic, waste glass and waste oil. Furthermore, household waste discarded from the camping ground of the workers will include cans, bottles and garbage. If such waste is inadequately handled, sea water, river water and underground water may be contaminated, and sanitation problems may arise.

Segregating waste at collection, recycling and reusing waste will be promoted and non-recyclable waste will be disposed at appropriate sites according to related regulations. Hazardous waste will be treated under the related regulations. To reduce the amount of solid waste discharged from the workers during the construction work, efforts will be taken to employ local workers wherever possible, so that the amount of household waste at the workers camp will be minimized. These measures will be taken to ensure that water pollution or sanitary problems resulting from waste will not arise.

Noise and Vibration

The impact of noise caused by the operation of heavy machinery and trucks is predicted, but will be limited to the surrounding area. However, there is a residential area located near the road construction area and sufficient consideration must be given to minimizing any noise impact.

The operation of heavy machinery and trucks is predicted to create vibration, but this will be limited to the surrounding area. In the actual construction work, schedule management will be performed to maintain constant amounts of construction work and to ensure that low vibration equipment will be used as much as possible. Construction work will be performed during daytime, especially piling work.

Measures for reducing generation of noise, such as speed reduction of vehicles in residential areas, will be taken, whereby vehicle noise impact will be minimized. Thus, all efforts will be made to minimize the noise impact.

Odor

In case domestic waste from the workers' camp is not appropriately treated, the rotting waste may produce a foul odor. Before starting the construction work, workers will be instructed to classify and collect garbage and illegal waste disposal will be prohibited. Garbage will be disposed on a periodic basis to ensure that odor by putrefaction is not produced. These measures will be taken to minimize the generation of odor.

Ecosystem

A part of trees in the area will be cut down due to the road widening work, but it can be minimized and mitigated. The impact on flora and fauna will not be significant. Although mangrove forest is located along the west bank of Kohelia River

Regarding fauna, habitat fragmentation is considered. However road construction area is utilizing existing embankment. Therefore the impact on fauna will not be significant.

6.6.2 Post Construction phase

Air Quality

It is expected that air pollution will be caused from the exhaust gas generated from vehicles.

Noise and Vibration

The major noise and vibration source will be vehicles, but the increase of traffic amount will not be significant.

Ecosystem

The mangrove forest is located along the west bank of Kohelia River. The hydrological and morphological change is not significant. And the accessibility to the mangrove forest will be restricted. Therefore the impact on the mangrove forest will not be significant.

6.7 Impact of climate change

Since the proposed embankment-cum-road is located in the south-east coastal area, it is necessary to see the adequacy of the embankment-cum-road in a climate change context. Due to climate change, sea level is expected to rise and cyclonic storm is expected to intensify. The design of the embankment-cum-road should take these into consideration.

According to the fifth assessment report of the Intergovernmental Panel on Climate Change (IPCC, 2014), global mean sea level has risen by 19 cm (17-21 cm) over a period of 110 years (1901-2010). The rate of rise has been larger since the mid-19th century. For the period 2081-2100 relative to 1986-2005, the rise will likely be in the ranges of 26-55 cm for RCP2.6, and of 45-82 cm for RCP8.5 (IPCC, 2014). More importantly, such rise will not be uniform across regions. The increase in the Bangladesh coast can be 0-5 cm more than the global

average (Mondal et al., 2013). Thus, for a period of 95 years, the rise along the Bangladesh coast is expected to be within 87 cm, which gives a rise of 9.2 mm/year. Also, a number of studies have been conducted in Bangladesh with the measured tide gage data. The trends vary widely not only in magnitudes but also in directions (increasing or decreasing). The analyses of the three tidal gage data available at the Kutubdia Channel, Moheskhali Channel and Bogkhali River around the study area indicate that the rising trend in the area is relatively low compared to the trends in the south-western part of the country. The highest increasing trend is found to be about 8 mm/year at Cox's Bazar. Thus, the IPCC projection which is 9.2 mm/year can be taken as the upper limit of sea level rise for Bangladesh.

Sea level rise along with changes in other climatic parameters such as temperature are expected to increase cyclonic storm intensity. Storm surge height may increase due to the impacts of climate change. A maximum surge height of 6.0 m is recorded at the Cox's Bazar coast in the year of 1963 and a height of 7.6 m at the Chittagong coast in 1991. Due to a rise in temperature of 2 °C, a 7.6 m surge may increase to a 9.2 m surge in the Bangladesh coast (Ali, 1999). In the Bangladesh National Building Code, a surge height of 7.1 m has been suggested for the Maheshkhali-Kutubdia Islands corresponding to a 50-year return period and 8.6 m for a 100-year return period. It thus appears that a 10 m elevation of the proposed embankment-cum-road would be adequate to provide protection against storm surges even under a potential climate change scenario.

6.8 Socio Economic Impact

6.8.1 Pre-Construction and Construction phase

Land Acquisition

The proposed embankment cum road is property of BWDB. There will require an agreement between RHD & BWDB to use this land. Few households and shops are directly affected by the project at Rajghat point. A resettlement plan will be developed before construction start.

Disturbance to Water Usage, Water Rights, etc

The local economy may be affected by turbid water discharged from the construction site. Outflows of street dust and oil during rainy periods may also have certain effects. The turbid water discharged from the construction site and any oil spills may affect the water quality of the river and ground water, and adequate mitigation measures shall be taken. Water quality of well water, which is the main supply of drinking water, shall be monitored in order to monitor any adverse effects on ground water.

Disturbance to Existing Social Infrastructure and Services

As material, equipment and worker transportation may disturb existing road and water traffic including fishing boats.

In regard to vehicles, bus use will be promoted to reduce increasing the number of vehicles on the roads. The bus schedules shall be managed in consultation with related organizations.

Local Conflicts of Interest

Local conflicts may occur between local residents who may feel that they have received unfair compensation and other local residents or conflict with staff of the Deputy Commissioner's Office. Conflict may occur between local residents and external workers because of any changes to local customs if external workers cannot understand local customs.

A number of consultations with local residents will be conducted in preparing the RAP. Regulations in Bangladesh stipulate the need to conduct public consultations in land acquisition processes.

Local people should be employed for the construction works to the maximum extent possible, and any workers from other countries should be taught to respect local customs in order to facilitate good relationships with local people. The lodgings of the project workers should be equipped with sufficient living facilities to keep workers at the project site as much as possible.

Children's Rights

Children are often forced to work and cannot attend school, and this may occur in the case of the construction of the road. There will be children among those to be lose their livelihood means. Children from those households losing their land or jobs may suffer from adverse impact on their household economy such as drop-out of school. Labor contracts between the construction industry and children shall be prohibited. Regular patrols to check for child workers shall be conducted.

Infectious Diseases such as HIV/AIDS

A temporary influx of migrant labor during the construction period may increase the risk of sexual transmitted diseases, etc. Local people should be recruited for simple work as much as possible so to minimize the risk of infectious diseases being transmitted from external workers.

Pre-employment and periodic medical check-ups should be conducted for external workers (technical workers, etc.).

Work Environment (Including Work Safety)

A high risk rate of accidents is predicted for the construction work. Construction companies should establish work safety plans and submit them to RHD to obtain approval. Work safety plans should stipulate mitigation measures on soft aspects (safety training, etc.) and hard aspects (provide workers with appropriate protective equipment, etc.).

Others

Accidents

Land traffic accidents during construction work may occur. As prevention measures for land traffic accidents, observation of traffic regulations, and training and education on safe driving will be implemented. People in the surrounding villages shall be informed of the bus schedules.

Cross-Boundary Impact and Climate Change

CO2 will be produced by the construction work. Periodic maintenance and management of all construction machinery and vehicles will be conducted.

6.8.2 Post Construction phase

Disturbance to Water Usage, Water Rights, etc

Soil runoff may occur from the exposed soil of the embankments and cut slopes, resulting in water pollution of the downstream area of the surrounding rivers and possible alteration of water use. The road route is mainly located in flat area, so the soil runoff and turbid water generation will not be significant.

Disturbance to the Existing Social Infrastructure and Service

Traffic volume and traffic jams will increase in the road, community road and road around the power plant boundary. Mitigation measures to decrease traffic volume shall be conducted, such as the promotion of bus use.

Misdistribution of Benefits and Compensation

People who live in other areas may have limited access or be prevented from accessing the school and medical facility along the road, which may cause grievances. The road shall be open to all local people to the maximum extent possible in order to improve peoples' lives.

Local Conflicts of Interest

Local conflicts of interest may occur between employers and employees of salt farms, shrimp farms and the fishing industry, and between local administration bodies and local political leaders. There may be feelings of resentment and reconciliation, as people living around the road will benefit. However, conflicts among local residents may occur if such benefits were mis-distributed. The road shall be open to all local people to the maximum extent possible for the improvement of peoples' lives.

Gender

Residents will have better access to social services throughout the year if road is constructed along with the construction of the power plant, especially access during the rainy season.

Children's Rights

There is a possibility that children may be forced to work and not attend school. Labor contracts between the subcontractors and children shall be prohibited. Regular patrols to check for child workers shall be conducted. The road shall be built with sufficient height so that it can be used even in the rainy season, so that access to markets and social services shall be improved, including access by children.

Others

Accidents

The risk of traffic accident may be increased. Observation of traffic regulations, installation of traffic signs, and training and education on safe driving shall be conducted for land traffic vehicles.

Cross-Boundary Impact and Climate Change

CO2 will be emitted from the vehicles. The safety drive instruction will also contribute to reduce CO2 emission.

Chapter 7 Public Consultation and Disclosure

7.1 Introduction

Public consultation is one of the key components of the environmental assessment. The EA team conducted public consultations in several spots of the project road. The approach involved a mix of conventional as well as participatory rapid rural appraisal (PRA), focus group discussions (FGD) and one-to-one interviews. Accordingly, as first step, the literature and secondary data was reviewed. Local people from different socio economic backgrounds in the villages along the alignment, NGOs and concerned Govt. officials were consulted. Public consultations were held during the different site visits of EIA report preparation.

7.2 Objectives of Public Consultation and Disclosure Meeting

The public consultations were conducted with the following objectives: (i) to inform the public/local people about the construction of the project road, (ii) to identify the need and concern of the public, (iii) to assess the environmental impacts and (iv) to assess cultural patterns and behaviour of local communities.

7.3 Approach and Methodology of Public Consultation and Disclosure Meeting

Stakeholders from different backgrounds were consulted. Their concerns are summarized in the following three parts: (i) consultations with Government officials, (ii) consultation with local people and (iii) consultations with the NGOs. EA findings were also presented to stakeholders in a workshop and suggestions were integrated while finalizing this report. The signature sheet is attached in Annex A.

7.4 Public Consultation Meetings (PCMs)

A number of informal public consultations through Participatory Rapid Assessment and Focused Group Discussions were held along the priority roads. In all the places, respondents mostly welcomed the project. However, they did point out few issues of concern erosion, water quality, noise, air pollution and accident hazard along with loss of land and compensation issues. Photographs of consultation meetings are attached in Annex B.

In each of the consultation, participants were encouraged to share their observations, suggestions, and experiences on various environmental and safety issues and suitable mitigation and enhancement measures. Issues discussed are:

i. Awareness and extent of the project and development components;
ii. Benefits of the project for the economic and social upliftment of community;
iii. Labour availability in the project area or requirement of outside labour involvement;
iv. Local disturbances due to dust, noise generation during construction activities;
v. Necessity of tree-cutting and vegetation clearing at project sites;
vi. Water logging and drainage problem, if any;
vii. Drinking water problem;
viii. Forest and sensitive areas nearby the project site
ix. to ensure that the public was provided with opportunities to participate in the decision making process and to influence decisions that would affect them;
x. to identify the widest range of potential issues about the Project as early as possible and in some cases, have those resolved;
xi. to ensure that government departments were notified and consulted early in the process; and
xii. to ensure a board range of perspectives were considered in any decision

The following assurances have been given during consultation

i. Proposed 6.5 km embankment cum road project will ensure all utility facility to the local stakeholders for their livelihood improvements;
ii. Executive agency will give preference to engage qualified contractor to ensure quality of works as well as timely completion of work;
iii. Efforts will be made by government to facilitate all necessary utility services;
iv. Livelihood affected households (if any) will be given assistance in the mode of cash compensation or resettlement plan will be established;
v. Local people will be employed by the contractor during construction work;
vi. Adequate safety measures will be taken during construction work;
vii. Local people have appreciated the government and have ensured that they will cooperate with the executing agency during project implementation.

Concerns were also raised on possible land acquisition for the Project facilities. The participants were advised that a Resettlement Plan will be formulated and implemented to address compensation and other entitlements.

7.5 Public Disclosure Meetings (PDMs)

RHD/CPGCBL will extend and expand the consultation and disclosure process significantly during implementation of the investment program. They will appoint an experienced individual consultants or NGO to handle this key aspect of the programme. The NGO/consultants continuously (i) conducts a wide range of activities in relation to project in each area; and (ii) ensures the needs and concerns of stakeholders are registered and are addressed in project

design.

For this project, the NGO/consultant will develop, in close coordination with PMU and DSC, a public consultation and disclosure program which is likely to include the following:

(i) **Consultation during detailed design.** (a) Focus-group discussions with affected persons and other stakeholders (including women's groups, NGOs and CBOs) to hear their views and concerns, so that these can be addressed in project design where necessary; and (b) Structured consultation meetings with the institutional stakeholders (government bodies and NGOs) to discuss and approve key aspects of the project.

(ii) **Consultation during construction.** (a) Public meetings with affected communities to discuss and plan work programmes and allow issues to be raised and addressed once construction has started; and (b) Smaller-scale meetings to discuss and plan construction work with individual communities to reduce disturbance and other impacts, and provide a mechanism through which stakeholders can participate in project monitoring and evaluation; and

(iii) **Project disclosure.** (a) Public information campaigns (via newspaper, TV and radio) to explain the project to the wider native population and prepare them for disruption they may experience once the construction programme is underway; (b) Public disclosure meetings at key project stages to inform the public of progress and future plans, and to provide copies of summary documents in Bengali; and(c) Formal disclosure of completed project reports (EIAs) by making copies available at convenient locations, informing the public of their availability, and providing a mechanism through which comments can be made.

Chapter 8 Environmental Management Plan and Monitoring Plan

8.1 Introduction

The Environmental Management Plan (EMP) aims to ensure the compliance of all activities undertaken during the implementation and the operation of the proposed road with the environmental safeguard requirements of the Donor and Government of Bangladesh. Furthermore, it aims at integrating the environmental components of the project with existing initiatives and programs in these fields. The plan consists of mitigation, monitoring and institutional measures to be taken during implementation and operation to eliminate adverse environmental impacts, offset them, or reduce them to acceptable levels. The plan also includes the actions needed to implement these measures.

8.2 Environmental Management and Mitigation Measures

Table 8.1 summarizes the potential impacts, corresponding to mitigation measures related to the pre-construction (pertaining to project location and design), construction and operation of road interventions as well as responsible entity for implementation.which are to be controlled, the mitigation measures which are to be recommended, and indicated time frame for implementation and responsibility for ensuring the management plans are efficiently implemented. This EMP is outlining a preliminary; detail EMP should be prepared during detail design stage.

Potential impacts have been assessed according to magnitude (minor, moderate, major) and impact duration (Temporary or Permanent) and are presented in a manner that shows magnitude and duration of a particular impact. Level of duration and magnitude assumed without mitigation measures. This EMP will be further reviewed, updated during detail design stage and will be included in the bid documents. Environmental Management Plan

Environmental management is a sustainable way of planning, arranging, supervising, organizing, and developing the environment so that the preservation of natural resources can be maintained and impact can be prevented or mitigated.

Table 8.1 Environmental Management Plan

No	Potential Impact to be Managed	Sources of Potential Impact	Standard of Impact	Objectives	Mitigation Effort	Location	Period of Management	Management Institution	Cost
Pre-construction phase									
1	Land acquisition	1) Loss of commercial structures 2) Loss of trees, home gardens, and fruit	- Law of land acquisition and requisition of property ordinance 1982 - JICA guideline (2010)	-Consideration for persons losing their property	- Land acquisition should be conducted in compliance with the relevant laws and regulations, Resettlement and rehabilitation plan with livelihood restoration plan will be undertaken - The cost related to relocation will be given to relocated residents - Existing roads should be given maximum utilization - Repair and improvement of roads should be proposed at the minimum scale feasible	- South West site of Rajghat bridge	- During land acquisition process	- Office of the Deputy Commissioner - RHD	RHD
2	Disturbance to	- Poor	- Law of land	- Consideration	- Developing "livelihood	- At the site	- Prior to	- Office of the	RHD

No	Potential Impact to be Managed	Sources of Potential Impact	Standard of Impact	Objectives	Mitigation Effort	Location	Period of Management	Management Institution	Cost
	Poor People	households among those who are to be Resettled.	acquisition and requisition of property ordinance 1982 -JICA guideline (2010)	for burden on vulnerable groups	restoration program" including; * provide small scale trade facilities at new bridge sites, * provide employment opportunity during construction period and operation & maintenance period Developed access road will function as a vital access/supply route in time of disaster for communities along the road		start of construction	Deputy Commissioner - RHD	
3	Local Conflicts of Interest	- It can occur among residents, workers, government	- Affected peoples' emotions	Consideration to affected peoples' openions	- Developing an appropriate "land acquisition and resettlement action plan", including "livelihood restoration program". The	- At the site	- Prior to start of construction	- Office of the Deputy Commissioner - RHD	RHD

No	Potential Impact to be Managed	Sources of Potential Impact	Standard of Impact	Objectives	Mitigation Effort	Location	Period of Management	Management Institution	Cost
		officers, and local politicians			program will cover; provide small scale trade facilities along the road * provide employment opportunity during construction period and operation & maintenance period				
Construction phase									
1	Air Quality	1) Dust resulting from construction work 2) Exhaust gas from construction machinery and vehicles used for mobilization of equipment	- Ambient air quality standards of Bangladesh - IFC guideline values for ambient air quality (General/ 2007)	- Prevention of air pollution in the surrounding area	Dust prevention - Watering access road, especially in the dry season - Using cover sheets on trucks for the transportation of soil Gas emission prevention - Periodic maintenance and management of all the construction machinery and vehicles	- Construction area	- During construction phase	- Implementation: Contractor/ Environmental Consultant - Supervisor: RHD/ Supervision Consultant	Expense is included in contract cost by Contractor.

No	Potential Impact to be Managed	Sources of Potential Impact	Standard of Impact	Objectives	Mitigation Effort	Location	Period of Management	Management Institution	Cost
2	Water Quality	-River water from construction area -Waterway in salt/paddy field	- Waste water standards of Bangladesh	- Prevention of water pollution in the surrounding area	River water - Install silt protection curtain Waterway in salt/paddy fields - Cover the slope	1) River 2) Waterway in salt/paddy fields	-During construction phase	-Implementation: Contractor/ Environmental Consultant - Supervisor: RHD/ Supervision Consultant	Expense is included in contract cost by Contractor.
3	Waste	-Construction waste from construction work -Domestic waste from workers -Hazardous waste	- 3R Waste management rule	- Prevention of inappropriate waste disposal	Construction and Domestic waste - Conduct separate waste collection and promote recycling and reuse. - Appropriate disposal of non-recyclable waste according to rules Hazardous waste - Hazardous waste should be treated under the related regulation	- Construction area	- During construction phase	- Implementation: Contractor/ Environmental Consultant - Supervisor: RHD/ Supervision Consultant	Expense is included in contract cost by Contractor.
4	Noise and	1) Noise and	- Noise level	- Reduction of	Construction machinery	- Construction	- During	- Implementation:	Expense is

No	Potential Impact to be Managed	Sources of Potential Impact	Standard of Impact	Objectives	Mitigation Effort	Location	Period of Management	Management Institution	Cost
	Vibration	vibration caused by construction and workers machinery 2) Noise caused by vehicles used for mobilization of equipment	standards of Bangladesh - IFC guideline values for noise (General/ 2007)	noise levels from construction activities	- Optimizing construction schedule - Performing construction work during daytime, especially piling work. - Using low-noise/ low vibration equipment, as much as possible - Determine a traffic control plan including route-setting - Limit truck speed, especially around residential areas	area	construction phase	Contractor Environmental Consultant - Supervisor: RHD/ Supervision Consultant r/	included in contract cost by Contractor
5	Odor	- Domestic waste from workers	- Waste management rule	- Prevention of generating odors	- Taking appropriate measures for handling general waste. - Prohibit illegal waste disposal	- Construction area	- During construction phase	- Implementation: Contractor/ Environmental Consultant - Supervisor: RHD/ Supervision Consultant	Expense is included in contract cost by Contractor.

No	Potential Impact to be Managed	Sources of Potential Impact	Standard of Impact	Objectives	Mitigation Effort	Location	Period of Management	Management Institution	Cost
6	Soil	Leakages of oil and chemical materials from construction activity 2) Inappropriate disposal of waste 3) Exhaust gas and dust from vehicles	-Waste management rule -Ground water (Drinking water quality standards)	- Prevention of water and soil pollution in the surrounding area	-Leakages of oil and chemical materials - Storage of oil and chemical materials in an appropriate storage site and method to prevent permeation into the ground. Waste management - Prohibit illegal dumping Ground water - Groundwater monitoring	- Construction area	- During construction phase	- Implementation: Contractor/ Environmental Consultant - Supervisor: RHD/ Supervision Consultant	Expense is included in contract cost by Contractor.
7	Sediment	- Waste water or waste by the construction activities may contaminate river bottom sediment	- Wastewater standards of Bangladesh - Waste management rule	- Prevention of water pollution in the surrounding area	- Excavate channels, ditches and temporary settling pond around construction area	- Construction area	- During construction phase	- Implementation: Contractor/ Environmental Consultant - Supervisor: RHD/ Supervision Consultant	Expense is included in contract cost by Contractor.
8	Ecosystem	1) Mangrove forest	- Bangladesh wild life act,	- Protection of mangrove	- Silt protect curtain will be installed if necessary.	- Construction area	- During construction	- Implementation: Contractor/	Expense is included in

No	Potential Impact to be Managed	Sources of Potential Impact	Standard of Impact	Objectives	Mitigation Effort	Location	Period of Management	Management Institution	Cost
		2) Tidal flats	1974 (Preservation) (Amendment) - JICA guideline (2010) - World bank OP4.04		- Prohibit disturbance,		phase	Environmental Consultant - Supervisor: RHD/ Supervision Consultant	contract cost by Contractor.
9	Local Conflicts of Interest	- Conflict between local residents and workers	- Change in local customs	- Consideration to the attitudes of local residents to the project	- Employ local residents as much as possible - Promote communication between external workers and local people (e.g., join in local events)	- Villages near the road	- During construction phase	- Implementation: Contractor/ Environmental Consultant - Supervisor: RHD/ Supervision Consultant	Expense is included in contract cost by Contractor.
10	Children's Right	- Child labor	- Child labor	- Banning child labor	- Prohibit labor contracts between subcontractor and children - Patrolling periodically to check for any child labor	- Construction area	- During construction phase	- Implementation: Contractor/ Environmental Consultant - Supervisor: RHD/ Supervision	Expense is included in contract cost by Contractor.

No	Potential Impact to be Managed	Sources of Potential Impact	Standard of Impact	Objectives	Mitigation Effort	Location	Period of Management	Management Institution	Cost
								Consultant	
11	Infectious Diseases such as HIV/AIDS	- Temporary influx of migrant labor during construction may increase risk of infection	- Sanitation for local residents	- Consideration for sanitation for local residents	- Implementation of periodic medical check-ups by temporary medical team - Education and training for health care of workers	- Construction area	- During construction phase	- Implementation: Contractor/ Environmental Consultant - Supervisor: RHD/ Supervision Consultant	Expense is included in contract cost by Contractor.
12	Work Conditions (Including Work Safety)	1) Labor accidents 2) Diseases caused by air pollutants, water pollutants, and noise by construction work	- Handling heavy loads - Working at heights - Electric shocks - Ambient air quality standards - Noise level standards - Waste	- Prevention of labor accidents and health problems	Labor accidents - Prepare a manual for labor accident prevention including safety education and training - Provide workers with appropriate protective equipment such as helmets - Install fire extinguishers in fire handling places - Inspect and ensure that any lifting devices such as	- Construction area	During construction phase	- Implementation: Contractor/ Environmental Consultant - Supervisor: RHD/ Supervision Consultant	Expense is included in contract cost by Contractor. - Protective equipment: 5,000 Tk./ person

No	Potential Impact to be Managed	Sources of Potential Impact	Standard of Impact	Objectives	Mitigation Effort	Location	Period of Management	Management Institution	Cost
			management rule - IFC guideline value for ambient air quality (General/ 2007) - IFC guideline value for noise (General/ 2007)		cranes are appropriate for expected loads - Keep lifting devices well maintained and perform maintenance checks as appropriate during the period of construction. - Use equipment that protects against noise such as masks, ear plugs, etc.				
13	Accidents	- Traffic accidents	- Land traffic	- Traffic accidents	- Observation of traffic regulations, installation of traffic signs, and education on safe driving - Training safe operation of vehicles. - Optimization of vehicle schedule - Reducing the number of vehicles by using buses	- Roads near the construction area	- During construction phase	- Implementation: Contractor/ Environmental Consultant - Supervisor: RHD/ Supervision Consultant	Expense is included in contract cost by Contractor.

No	Potential Impact to be Managed	Sources of Potential Impact	Standard of Impact	Objectives	Mitigation Effort	Location	Period of Management	Management Institution	Cost
					- Consulting with related authorities on schedules - Informing vehicle schedules to the surrounding villages				
14	Cross-boundary impact and climate change	- CO_2 will be produced by construction work	- Amount of CO_2 emission	- Reduce CO_2 emission as much as possible	- Periodic maintenance and management of all the construction machinery and vehicles	- Construction area	- During construction phase	- Implementation: Contractor/ Environmental Consultant - Supervisor: RHD/ Supervision Consultant	Expense is included in contract cost by Contractor.
Operational Phase									
1	Air Quality	1) Exhaust gas from vehicles used for mobilization of equipment and workers 2) Dust from	- Ambient air quality standards of Bangladesh - IFC guideline values for ambient air	- Prevention of air pollution	Gas emissions from vehicles - Periodic maintenance and management of vehicles - Transplanting trees - Promotion of bus use for commute	- Along the road	- During the operation of the power plant	- RHD/ Environmental Consultant	RHD

No	Potential Impact to be Managed	Sources of Potential Impact	Standard of Impact	Objectives	Mitigation Effort	Location	Period of Management	Management Institution	Cost
		road	quality (General/ 2007)						
2	Water Quality	- Waterway in salt/ paddy fields	- Ambient water standards (Inland surface water)	- Prevention of water pollution	- Cover the slope	- Waterway in salt/ paddy fields	- During the operation of the power plant	- RHD/ Environmental Consultant	RHD
3	Noise and Vibration	- Noise caused by vehicles used for mobilization of equipment and workers	- Noise level standards - IFC guideline values for noise (General/2007)	- Prevention of noise and vibration impact	- Determine a traffic control plan including route-setting - Limit truck speed, especially around residential areas	- Along the road	- During the operation of power plant	- RHD/ Environmental Consultant	RHD
4	Local Conflicts of Interest	- Conflict between local residents	- Change in local customs	- Consideration of the attitudes of local residents to the project	- Establish a consultation section for any grievances	- Villages along the road	- During the operation of the power plant	- RHD/ Environmental Consultant	RHD
5	Gender	Improved road	- Living standards of gender	- Access to social services and market	- The road can be used even in the rainy season.	- Villages along the road	- During the operation of the power plant	- RHD/ Environmental Consultant	RHD
6	Children's	Child labor	Child labor	Banning child	Child labor	- Villages along	- During the	- RHD/ Environmental	RHD

No	Potential Impact to be Managed	Sources of Potential Impact	Standard of Impact	Objectives	Mitigation Effort	Location	Period of Management	Management Institution	Cost
	Rights			labor	- Prohibit labor contracts between subcontractor and children - Patrolling periodically to check for any child labor .	the road	operation of the power plant	Consultant	
7	Accidents	- Traffic accidents	- Land traffic	- Prevention of traffic accidents	- Observation of traffic regulations, installation of traffic signs, and education on safe driving - Reducing the number of vehicles by scheduling buses	- Villages along the road	- During the operation of the power plant	- RHD/ Environmental Consultant	RHD
8	Cross-boundary Impact and Climate Change	- Efficient road maintenance	- Amount of CO_2 emissions	- Reduce CO_2 emissions per road length	- Efficient maintenance - Promotion of efficient fuel driving	- Villages along the road	- During the operation of the power plant	- RHD/ Environmental Consultant	RHD

8.3 Enhancement and Contingency Plan

The implementation of an infrastructure project involves many complex and diverse risks. The identification and allocation of those risks is critical in structuring the financing facility for such a project. A contingency plan is a course of action designed to help an organization respond effectively to a significant future event or situation that may or may not happen. It can be used as an alternative action if expected results fail to materialize. Contingency planning is a component of disaster recovery and risk management.

The Contingency planning also serves as a tool for maintaining control over events or reduce the risk of loss of property. The Contingency planning process involves identification of projected needs that may arise as a result of an emergency and the resources that will be immediately available to meet those needs. One benefit of a realistic contingency plan is that it may encourage donors and others to provide the needed resources for enhancement of resource base of the agencies involved in plan implementation.

The project area is located in coastal areas. The frequency of the natural calamities is very common in the coastal areas. For smooth implementation of the project activity a contingency plan is required. Contingency plan is a management tool used to analyze the impact of potential crises so that adequate and appropriate arrangements are made in advance to respond in a timely, effective and appropriate way to the needs of affected populations. The contingency plan includes the management issues like Natural Calamities includes earthquake, cyclone Tsunami, Tidal Surge etc. It also includes accidental impact management during construction and operation & maintenance period. An emergency disaster response network should also be contained in the contingency plan.

The enhancement plan specifies procedures for handling unexpected and sudden situations. Its objective is to limit the consequences of emergencies and to that end, prevent fatalities and injuries, reduce damage to construction equipment, and accelerate the resumption of normal activity.

During the construction phase, the Contractor will establish an enhancement plan that will take into account: the formal commitment of the Construction Manager to the health safety of its employees; provide training on compliance with safety requirements of all workers; formation of a safety team ready to respond at any time; equipment of the construction site with safety products and devices (mini-pharmacy, fire extinguishers, etc.); signature of an emergency response contract with hospitals and local firefighting services; providing all workers with a health emergency telephone number; and carrying out periodic exercises/simulations to

implement the contingency plan to ensure appropriate management of emergency situations.

During the operational phase of the road, emergency management will be provided by regional or general hospitals in the project area, firefighters, police, etc. The concession holder will be responsible for the JCP in accordance with the laws in the countries concerned.

8.4 Compensation Plan

Compensation plan is a management tool used to payment in cash or kind for an asset to be acquired or affected by a project at replacement cost at current market value. At the proposed site where the road will be constructed, about 20-25 households and 15-20 shops including tea stall will be directly affected by the project implementation who own, rent or use khas or private land within the proposed alignment site. A resettlement/compensation plan including livelihood restoration plan (LRP) will be developed before implementation of the project. The LRP includes the income loss of the local inhabitants during construction period. Training should be provided to the local people as part of compensation plan. Losses of trees compensation have to be included in the plan by planting more trees.

8.5 Environmental Monitoring Plan

An Environmental Monitoring Plan will be prepared to provide guidelines for environmental management plan during the construction and operation phases of the Coal-fired Power Plant. The environmental components that will be monitored are those that will be positively or negatively affected, or expected to be affected, by construction activity. Environmental management is a sustainable way of planning, arranging, supervising, organizing, and developing the environment for the maintenance of the preservation of natural resources and the prevention or reduction of damage to the environment. The major environmental impact, monitoring method, responsible organization, and expense for each environmental item in the construction and operation phases for the road are listed in table below.

Table 8.52: Environmental Monitoring Plan

No	Significant Impact to be Monitored	Source of Significant Impact	Monitored Parameter	Purpose of the Monitoring	Monitoring Method			Responsible Organization	Cost
					Method of collecting and Analyzing Data	Location	Duration and Frequency		
Pre-Construction									
1	Land Acquisition	1)Loss of residential/ commercial structures 2)Loss of trees, home gardens, ponds, and fruit	-Percentage of acquired land, structures and trees	-Confirmation of compensation process	- Attendance of compensation payment -Record of compensation agreements	-Areas for compensation	-During land acquisition process	-Office of the Deputy Commissioner - RHD	RHD
2	Disturbance to Poor People	-Poor households among those who lose jobs	-People's opinion	- Confirmation of compensation process"	-Interviewing affected people	-Affected people	-Once a year	-Implementation: Contractor/ Environmental Consultant -Supervisor: RHD/ Supervision Consultant	RHD
Construction phase									
1	Air Quality	1)Dust resulting from construction work 2)Exhaust gas from	PM_{10}, $PM_{2.5}$ -Ambient air quality Standards of	-Evaluation of effect of the mitigation measure towards air	-Collecting samples and analyzing at the	3points -Along the road	-Quarterly	-Implementation: Contractor/ Environmental	Expense is included in contract cost

No	Significant Impact to be Monitored	Source of Significant Impact	Monitored Parameter	Purpose of the Monitoring	Monitoring Method			Responsible Organization	Cost
					Method of collecting and Analyzing Data	Location	Duration and Frequency		
		construction machinery and vehicles used for mobilization of equipment	Bangladesh -IFC guideline value for ambient air quality (General/2007)	pollution	lab.			Consultant -Supervisor: RHD/ Supervision Consultant	by Contractor.
2	Water Quality	1)Runoff water from construction area 2)River water, Khal, wetland etc.	**pH, BOD, SS, Oil, Coliforms, etc.** -Wastewater standards -Ambient water quality standards(inland Surface water)	-Evaluation of effect of the mitigation measure towards water pollution	-Collecting samples and analyzing at the Lab.	1)Runoff water -Water way in the salt/paddy field **2 point** -Groundwater Of existing wells: **1 point** 2)River water -Near the construction area:**3 point**	-Once every three month	-Implementation: Contractor/ Environmental Consultant -Supervisor: RHD/ Supervision Consultant	Expense is included in contract cost by Contractor.
3	Wastes	1)Construction waste from construction work 2)Domestic waste from	**Kind and quantity of waste, and the disposal**	Evaluation of effect of the mitigation measure for waste	-Record of kinds and quantity of waste, and the	-Contractor's office -disposal site	-Once a year	-Implementation: Contractor/ Environmental	Expense is included in contract cost

No	Significant Impact to be Monitored	Source of Significant Impact	Monitored Parameter	Purpose of the Monitoring	Monitoring Method			Responsible Organization	Cost
					Method of collecting and Analyzing Data	Location	Duration and Frequency		
		workers 3)Hazardous waste such as dry batteries, etc.	**method** -3R Waste management rule		disposal method			Consultant -Supervisor: RHD/ Supervision Consultant	by Contractor.
4	Noise and Vibration	1)Noise and vibration caused by construction machinery 2)Noise caused by Vehicles used for mobilization of equipment and workers	**Noise level** -Noise level standards -IFC guideline value for noise (General/2007)	-Evaluation of effect of the mitigation measure towards noise level	-Measurement using noise level meter	**3 points** -Along the road	-Once every three month	-Implementation: Contractor/ Environmental Consultant -Supervisor: RHD/ Supervision Consultant	Expense is included in contract cost by Contractor.
5	Ecosystem (Mangrove forest)	-Existence of mangrove forest	**Density** -JICA guideline (2010) -World bank OP4.04	-Evaluation of existence of mangrove forest	-Observation	Koheli River	- Once a year	-Implementation: Contractor/ Environmental Consultant -Supervisor: RHD/ Supervision Consultant	Expense is included in contract cost by Contractor.
	Ecosystem (Tidal flat)	-Potential impact due to the degradation of sedimentation and erosion	1)Topographic future 2)Sediment quality 3)Benthic animals	-Evaluation of effect of the mitigation measure towards water pollution -Confirming the	-Collecting samples at the site, analyzing at the lab	**5 points** -Sea area in front of construction area	- Once a year		

No	Significant Impact to be Monitored	Source of Significant Impact	Monitored Parameter	Purpose of the Monitoring	Monitoring Method			Responsible Organization	Cost
					Method of collecting and Analyzing Data	Location	Duration and Frequency		
				population and change in types of the marine organism					
6	Local Conflicts of Interest	-Conflict between local residents and workers	-Change in local custom	-Confirmation of the attitude of local residents to the project	-Interviewing residents	-Villages near the site	-Once a year	-Implementation: Contractor/ Environmental Consultant -Supervisor: RHD/ Supervision Consultant	Expense is included in contract cost by Contractor
7	Children's Right	-Subcontractor's recruitment	-Number of working child	-Evaluation of effect Of banning child labor	-Checking the labor contract between subcontractor and labors -Patrolling in construction area	-Contractor's office -Construction area	-Once a year	-Implementation: Contractor/ Environmental Consultant -Supervisor: RHD/ Supervision Consultant	Expense is included in contract cost by Contractor.
8	Infectious Diseases such as HIV/AIDS	-Temporary influx of Migrant labor during construction may	-Health of labors	-Evaluation of sanitation for labor	-Labor health records	-Related institutions	-Once a year	-Implementation: Contractor/ Environmental	Expense is included in contract cost

No	Significant Impact to be Monitored	Source of Significant Impact	Monitored Parameter	Purpose of the Monitoring	Monitoring Method			Responsible Organization	Cost
					Method of collecting and Analyzing Data	Location	Duration and Frequency		
		increase risk of infection						Consultant -Supervisor: RHD/ Supervision Consultant	by Contractor.
9	Work condition (including work safety)	-Labor accidents	**Record of accidents** -Handling heavy loads -Working at heights -Electric shock	-Evaluation of effect of the work safety plan	-Record of accidents	-Contractor's office	-Once a year	-Implementation: Contractor/ Environmental Consultant -Supervisor: RHD/ Supervision Consultant	Expense is included in contract cost by Contractor.
10	Accidents	-Traffic accidents	**Record of accidents** -Land traffic	-Evaluation of effect of traffic schedule	-Record of accidents	-Contractor's office	-Once a year	-Implementation: Contractor/ Environmental Consultant -Supervisor: RHD/ Supervision Consultant	Expense is included in contract cost by Contractor.
Operation Stage									
1	Air Quality	1)Exhaust gas from	**$SO_2$$NO_2$, PM_{10} and**	-Evaluation of effect	-Collecting	-Residential area	-Once every	-RHD/	RHD

No	Significant Impact to be Monitored	Source of Significant Impact	Monitored Parameter	Purpose of the Monitoring	Monitoring Method			Responsible Organization	Cost
					Method of collecting and Analyzing Data	Location	Duration and Frequency		
		Vehicles used for mobilization of equipment and workers for power plant 2) Dust from road surface	**$PM_{2.5}$** -Ambient air quality standards -IFC guideline values for ambient air quality (General/2007)	of the mitigation Measure towards air pollution	samples at the site, analyzing at the lab.	around the road	three month	Environmental Consultant	
2	Water Quality	-Surface runoff	**Water temperature, DO, SS, oil, BOD, COD, Heavy metals** -Ambient water quality standards(Inland surface water)	-Evaluation of effect of the mitigation Measure towards water pollution	-Collecting samples at the site, analyzing at the lab Continuous measurement using a sensor	-Salt/paddy field	-Once every three month	-RHD/ Environmental Consultant	RHD
3	Noise and vibration	-Noise caused by vehicles used for mobilization of equipment and workers	-Noise level standards -IFC guideline values for noise(General/2007)	-Evaluation of effect of the mitigation measure towards noise level	-Measurement using noise level meter	-Along the road	-Once every three month	-RHD/ Environmental Consultant	RHD
4	Ecosystem (Mangrove forest)	-Existence of mangrove forest	**Density** -JICA guideline (2010) -WorldbankOP4.04	-Evaluation of existence of mangrove forest	-Observation	Koheli River	- Once a year	-RHD/ Environmental Consultant	RHD

No	Significant Impact to be Monitored	Source of Significant Impact	Monitored Parameter	Purpose of the Monitoring	Monitoring Method			Responsible Organization	Cost
					Method of collecting and Analyzing Data	Location	Duration and Frequency		
	Ecosystem (Tidal flat)	-Potential impact due to the degradation of Sedimentation and erosion	1)Topographic future 2)Sediment quality 3)Benthic animals	-Evaluation of effect of the mitigation measure towards water pollution -Confirming the population and change in types of the marine organism	-Collecting samples at the site, analyzing at the lab	-Sea area in front of construction area	- Once a year		
5	Gender	Improved road	-Living standards of gender	-Evaluation of access to social services	-Same as those addressed in "Poor people"	-Same as those addressed in "Poor people"	-Once a year	-RHD/ Environmental Consultant	RHD
6	Work condition (including work safety)	-Labor accidents	**Record of accidents** -Handling heavy loads -Working at heights -Electrics hocks	-Evaluation of effect of the work safety plan	-Record of accidents	-Related institutions	-Once a year	-RHD/ Environmental Consultant	RHD
7	Accidents	-Traffic accidents	**Record of accidents** -Land traffic -Marine traffic	-Evaluation of effect of the work safety plan	-Record of accidents	-Related institutions	-Once a year	-RHD/ Environmental Consultant	RHD

8.6 Institutional Arrangement for Project Implementation

The main agencies involved in managing and implementing proposed 6.5 km embankment cum road are as follows:

- RHD/CPGCBL is the Executing Agency (EA) responsible for overall technical supervision and execution of the project, and the Implementing Agency (IA) responsible for the successful construction and subsequent operation of the project.
- RHD/CPGCBL will establish a Project Management Unit (PMU) to manage project implementation on its behalf. The PMU will be headed by a Project Director (PD), supported by RHD/CPGCBL technical and administrative staff and consultants in key fields. This will include Design Supervision Consultants (DSC) responsible for designing the infrastructure, managing the selection of Contractors, and supervising construction.
- RHD/CPGCBL will also establish a Project Implementation Unit (PIU) in which construction will take place, to be responsible for implementing the project. PIU will be headed by a RHD/CPGCBL Chief Engineer, supported by technical and administrative staff and consultants, with additional support from the PMU where necessary.
- Construction Contractors (CC) will be appointed by the PMU to build the infrastructure in the proposed development area. Each CC will be managed by the relevant PIU, and construction will be supervised by the DSC.

Environmental safeguards (environmental monitoring and further studies required to comply with national law and Donor policy) will be dealt with by the RHD/CPGCBL Environment Cell (EC) and by consultants appointed to assist the PMU.

Chapter 9 Cost Estimation for Environmental Mitigation Measures and Monitoring

9.1 Environmental Mitigation Measures and Monitoring Cost Estimation

Most of the mitigation measures require the contractors/project authority to adopt good site practice, which should be part of their normal procedures already, so there are unlikely to be major costs associated with compliance.

Mitigation that is the responsibility of CPGCBL/RHD and contractor's will be provided as part of their management of the project. The cost estimation for Environmental Mitigation Measures and Monitoring is given the following Table 9.1.

Table 9.1: Cost estimation for Environmental & Social Mitigation Measures and Monitoring

SI. No.	Potential impact to be monitored	Cost (Tk.)	
Pre-construction phase			
1	Land acquisition, Losses of land, livelihood and income source, Land clearing and losses of terrestrial flora and fauna		5000000.00
2	Resettlement Action Plan & Monitoring		2000000.00
	Sub-total		**7000000.00**
Construction phase			
1	Air quality	10000.00Tk x 3 point x 3 quarter =	90000.00
2	Water quality	8400.00Tk x 6 point x 3 quarter =	151200.00
3	Wastes		20000.00
4	Noise and vibration	21600.00Tk x 3 point x 3 quarter =	194400.00
5	Ecosystem (Flora and Fauna)		20000.00
	Fisheries ecosystem		30000.00
6	Work environment (Including Work Safety)		20000.00
7	Accidents		20000.00
	Sub-total		**545600.00**
Operation Stage			
1	Air quality	10000.00Tk x 1 point x 3 quarter =	30000.00
2	Water quality	8400.00Tk x 2 point x 3 quarter =	50400.00
3	Noise and Vibration	21600.00Tk x 1 point x 3 quarter =	64800.00
4	Work Environment (Including Work Safety)		50000.00
5	Accidents		50000.00
	Sub-total		**245200.00**
	Grand total		**7790800.00**

In Word: Tk. Seventy Seven Lac Ninety Thousand and Eight Hundred Only

Chapter 10 Conclusion and Recommendation

10.1 Conclusion

On the basis of the field reconnaissance, primary and secondary information collected from different authorities, it may be concluded that the project stands environmentally sound and sustainable when the recommended mitigation measure and environmental management processes are adopted properly.

The benefits of the project will be realized primarily at the level of the national economy. Benefits in the project area will be in significant except for some short terms employment and business opportunities during the construction phase. However, the needs of road to the power plant are obvious and for that the communication system of the area will be developed. Developed communication system will directly influence the growth of economy of the area.

The proposed project activities have no significant adverse environmental impact so far as a time bound execution program with application of advanced construction technology is ensured. The mitigation measures are well within such codes and practices of construction and operation of the proposed road.

10.2 Recommendation

Severe weather conditions would have an impact on the road construction activities. The construction activities may even have to be stopped during these storms. So it is recommended that commencing construction in early winter season may help to reap the benefit of full dry spell of the season. Further,

- A resettlement plan along with livelihood restoration plan will be developed for deprived poor households lived on the proposed 6.5 km embankment cum road at Rajghat point before start of the construction. CPGCBL/RHD will responsible for the resettlement plan along with livelihood restoration plan.
- To reduce hydrological impact adequate regulators and culverts should be provided to the road and proper management should also be established. Number of culverts and location should be determined from Feasibility Study/ Technical design of the proposed road project.
- In order to enhance the occupational health and worker safety during the construction period, construction equipment would have to be kept in good order. Adequate safety measures should be taken and safety related equipment including personal protective and safety equipments (PPE), firefighting equipment etc. must be provided in order to reduce the potential for accidents.
- Solid waste will be generated during the construction period from excavation and refuse from construction camps.
- The major issue is the need to minimize disturbance to the local population in the areas of road construction. Effort should be put in to arrive at a fair and equitable level of compensation for farmers, residents and other individuals affected by land taken (permanent and temporary) for the project. A positive policy of employing local people during the construction phase should be adopted.
- In the post construction phase, the environmental impact of the project will be some loss of land utility along the road alignments and any accidents. The farmer can be mitigated by adoption of a fair compensation policy and the latter by adequate maintenance and monitoring.

- The implementation of the proposed project will provide supply of clean burning fuel and thereby not only reduce Bangladesh's dependence on foreign energy resources but also help accruing a good number benefits in terms of health, agricultural, forestry, commercial and industrial development. To receive these benefits, certain environmental impacts of the project will have to be tolerated. However, the anticipated impacts are mostly of short duration and relatively minor in nature.
- In view of the above considerations and the fact that the executing agency (RHD) will maintain standard quality of implementation of the program with due consideration to other standing rules and regulations including but not limited to updated ECA 1995 and ECR 1997 the project may be recommended for implementation.
- Existing internal khals and cannals should be kept, renovated and regulated as far as the plan and design of the power plant and ancillary facilities permit.
- Required number of culverts with proper design should be providing along the road for maintaining drainage, tidal flow and runoff.
- It is to be ensured that Koheli River will not be further disturbed by the project activities.
- All conditions included in the MoU between BWDB and RHD should be properly followed.

Annex-A
Participants of the consultation meetings

Public Consultation

Project: 6 km long embankment cum road under Matarbari USC Coal fired Project
Target Group: local community people at Matrbari, Moheshkhali, Cox,s bazzar

Date : 10 September, 2015
Venue/ Location : Koheli Bridge, Rajghat

Sl	Name	Age	Occupation	Village	Signature
1	Md Kashem	25	Busines	S. Rajghat	
2	Ahmed Maji	50	Labour	"	
3	Md. Hasan	37	"	U. Rajak	
4	Md. Ali	60	Boat	S. Rajghat	
5	Badsha	50	Labour	T. Tanaira	
6	Md. Foyez	18	"	S. Rajghat	
7	Jojnal	50	"	Kalgon	
8	Abdur Roshit	30	Small Business	Rajghat	
9	Sahebuddin	35	Dry fish Business	"	
10	Shamsul Alam	35	B. Labour	"	
11	Md. Nazrul	20	D. Labour	"	
12	Sona Kual	28	"	S. Rajghat	
13	Abdul Munaf	25	Tailor	"	
14	Kashem Ali	35	D. Fish Business	"	
15	Md Afsar	26	D. Labour	"	

Annex-B
Photographs of consultation meetings

Public consultation meetings with local stakeholder in Matarbari Area

Consultants' team discussed with local people about the project

Consultant discussed with SDE of CPGCBL along with local people about the project

Hydrology advisor of BUET discussed with local people

Annex-C
Photographs of Project area

Shops near the proposed embankment cum road of the project area

Bazar near the proposed embankment cum road of the project area

Rajghat Bridge on Koheli River starting point of proposed embankment cum road

Local transport of the project area

Koheli river bank of proposed embankment cum road

Koheli River of the project area

Fish biodiversity of the project area

Fish businessmen of the project area