Vol. 1: Environmental and Social Impact Assessment Report for Proposed Kutubdia LNG Terminal Project

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Environment and Social Impact Assessment (ESIA) of the Proposed LNG Terminal Project, *Kutubdia Island, Cox's Bazar District, Bangladesh*

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CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF BOXES

LIST OF ANNEXES

ABBREVIATIONS

ADB	Asian Development Bank
ADIOS	Automated Data Inquiry for Oil Spills
ALARP	As Low as Reasonably Practicable
AP	Affected Persons
APHA	American Public Health Association
API	American Petroleum Institute
ARIPO	Acquisition and Requisition of Immovable Property Ordinance
BBS	Bangladesh Bureau of Statistics
BOG	Boil Off Gas
BOO	Built Own and Operate
CD	Chart Datum
CNG	Compressed Natural Gas
CO	Carbon Mono Oxide
CTMS	Custody Transfer Metering System
DFO	Divisional Fisheries Officer / Divisional Forest Officer
DMP	Disaster Management Plan
DO	Dissolved Oxygen
DOE	Department of Environment
DOF	Department of Fisheries
EC	Electrical Conductivity
ECA	Environment Conservation Act
ECC	Environment Clearance Certificate
ECR	Environment Conservation Rules
EGIG	European Gas pipeline Incident Data Group
EHS	Environment, Health and Safety
EIA	Environment Impact Assessment
ERL	Effects Range - Low
ERM	Effect Range - Median
ERM	Environment Resource Management
ERP	Emergency Response Plan
ESIA	Environment and Social Impact Assessment
ESMP	Environment and Social Management Plan
FEED	Front End Engineering and Design
FGD	Focussed Group Discussion
FSRU	Floating Storage and Regasification Unit
FSU	Floating Storage Unit

GIS	Geographic Information System
GoB	Government of Bangladesh
GRM	Grievance Redressal Mechanism
GTCL	Gas Transmission Company Limited
HD	High Duty
HH	Households
HME	Hazardous to Marine Environment
HSD	High Speed Diesel
IEE	Initial Environmental Examination
IFC	International Finance Corporation
IFV	Intermediate Fluid Vaporizers
IMO	International Maritime Organisation
IP	Indigenous People
IPP	Independent Power Producer
IR	Involuntary Resettlement
ITOPF	International Tanker Owners Pollution Federation Limited
JICA	Japan International Cooperation Agency
LBF	Land Based Facility
LD	Low Duty
LNG	Liquefied Natural Gas
LNGC	LNG Carrier
LOC	Level of Concern
LTD	Level Temperature Density
MARPOL	Marine Pollution
MLA	Marine Loading Arm
MLV	Main Line Valve
MMSCFD	Million Standard Cubic Feet Per Day
MMTPA	Million Tonnes Per Annum
MW	Mega Watt
NGO	Non-Governmental Organisation
NOAA	National Oceanographic and Atmospheric Administration
NOx	Oxides of Nitrogen
NTU	Nephelometric Turbidity Unit
OGP	International Association of Oil & Gas Producers
OOSA	Online Oil Spill Advisory System
ORF	Onshore Receiving Facility / Onshore Regasification Facility
OSHA	Occupational Safety and Health Administration
PLEM	Pipeline End Manifold

PM	Particulate Matter
PS	Performance Standards
RBLPL	Reliance Bangladesh LNG and Power Limited
RBLTL	Reliance Bangladesh LNG Terminal Limited
REA	Rapid Environmental Assessment
RLNG	Regasified LNG
RPL	Reliance Power Limited
SO_2	Sulphur di oxide
SOLAS	Safety of Life at Sea
SPS	Safeguard Policy Statement
SS	Suspended Solids
TDS	Total Dissolved Solids
TOC	Total Organic Carbon
TOR	Terms of Reference
UNDP	United Nation Development Programme
UNEP	United Nation Environmental Programme
UNO	Upazila Nirbahi Officer
UPS	Uninterruptible Power Supply
VCE	Vapour Cloud Explosion

A) Introduction

1. In Bangladesh, the demand for natural gas is rapidly rising due to its diversified use in industrial and electric power sector and fast depletion of existing reserves. As a result many of the gas fired power plants are experiencing gas shortages and running below their rated capacity.

2. Keeping this in view, Reliance Power Limited (hereinafter referred to as Reliance Power) through their subsidiary in Bangladesh, Reliance Bangladesh LNG Terminal Limited (RBLTL) plans to establish a LNG storage and re-gasification facility of up to 5.0 million tonnes per annum (MMTPA) capacity. Reliance Power has plans to establish another subsidiary in Bangladesh i.e. Reliance Bangladesh LNG and Power Limited (RBLPL) as an Independent Power Producer (IPP). Accordingly, RBLPL also proposes to develop a combined cycle natural gas (i.e RLNG) based power plant of capacity 750 MW in Bangladesh to meet the existing power shortage and demand-growth in future.

3. The LNG terminal is proposed with a Floating Storage and Regasification unit (FSRU) in the range of 3.5 – 5.0 MMTPA (about 750 MMSCFD peak send out load) with a storage capacity of 137,000 m^3 to 216,000 m^3 located offshore of the *Kutubdia* Island in *Cox's Bazar* region of Bangladesh (hereinafter referred to as the Project). Overall the Project will consist of:

   Marine component off *Kutubdia* Island covering

   i) Twin (double berth) jetty with topside (1.5 km to the west of *Kutubdia* Island) with 0.5 MW gas based power generation;
   ii) Floating Storage and Regasification Unit (FSRU) (of storage capacity of 137,000 m^3 to 216,000 m^3) to be moored starboard side of the jetty;
   iii) Re-gasification onboard FSRU of 750 MMSCFD peak capacity with ~10 MW onboard gas based power generation;
   iv) High pressure 30 inches (30") ~2.0 km subsea regasified LNG pipeline;

   Onshore component covering

   v) Subsurface/subsea gas spur pipeline of ~16 km length (30 inches diameter) connecting *Kutubdia* Island to custody transfer metering station (CTMS) through Valve Station no. 2 to be located at *Napura, Banskhali* from where the gas pipeline will be connected into the GTCL's national gas grid pipeline of *Moheshkhalli – Anwara* Section. The pipeline length of ~16 km also includes 2.7 km of subsea pipeline length passing through *Kutubdia* Channel. The CTMS at *Napura* will also have 0.5 MW (625 kVA) gas based power generating unit and pipeline pigging facility.

Note: It is to be noted that impacts worked out in draft ESIA of March 2017 have been revised due to change of Project design. The offshore pipeline on trestle, onshore regasification at land fall point, emissions from onshore gas based captive power plant of 20 MW and future onshore LNG storage tank are eliminated in this Final ESIA of October 2017. Also the land requirement for Land Based Facility at *Kutubdia* Island is no more required.

4. RBLTL has initiated an environmental and social impact assessment (ESIA) study to comply with the requirements of environmental impact assessment ("EIA") guidelines of the Government of Peoples' Republic of Bangladesh (Government of Bangladesh ("GoB")) to obtain necessary Environmental Clearance Certificate for the Project. RBLTL is also seeking finance from international lenders for setting up of the Project hence the ESIA conforms to the guidelines and requirements of the Asian Development Bank (ADB).

B) Policy, Legal & Administrative Framework

Environment

5. The Environment Conservation Act (ECA) 1995 and the Environment Conservation Rules (ECR), 1997 of the Department of Environment (DoE) under Ministry of Environment and Forest (MoEF), Govt of Bangladesh (GoB) which classifies the Project as Category Red and thus requiring an EIA to be conducted for obtaining the Environment al Clearance Certificate (ECC).

Land Acquisition

6. **LNG terminal and the re-gasification facility.** LNG terminal and regasification facility (onboad FSRU) being proposed offshore west of *Kutubdia* Island, it does not require land acquisition.

7. **Gas Spur Pipeline**: The high pressure 30 inches (30") gas pipeline includes ~2.0 km subsea section from FSRU to *Kutubdia* Island followed by ~16 km section from *Kutubdia* Island up to CTMS at *Napura* (including 2.7 km subsea pipeline passing through *Kutubdia* Channel). The onus of land acquisition for laying onshore section of spur pipeline is bestowed with Petrobangla[1], Government of Bangladesh. The pipeline will be buried and laid through horizontal directional drilling (HDD) methodology. For laying of the gas pipeline 26.361 acres of land will be acquired on permanent basis and 49.343 acres of land will be taken up as temporary land requisition during the construction period for movement of construction materials. The acquired land will be handed over to RBLTL by Petrobangla for 15 years for erection and subsequent operations and maintenance for supply of RLNG into the national gas grid. The width of the pipeline corridor for permanent land acquisition will be 8 m and additional ~15 m (as land requisition) along the pipeline will be required during construction period.

8. **Custody Transfer Metering Station (CTMS):** Petrobangla will also acquire 3.965 acres of land on permanent basis for setting up of CTMS and will hand over the land to RBLTL for 15 years. This will be a permanent land loss to the affected persons.
9. Upon completion of pipeline laying, Petrobangla will keep 30.326 acres as permanently acquired land and return requisition land parcels of 49.343 acres to

[1] GTCL, a subsidiary of Petrobangla, has the experience of implementing several gas transmission pipeline projects funded by ADB in compliance with its social safeguard policies (SPS, 2009). GTCL in compliance with ADB SPS, 2009 requirements, shall be advised to follow the guidelines as outlined in this RF.

respective land owners after restoration and reinstatement of the land parcels to the best achievable original conditions.

10. The requisition and acquisition of land for the Project will be taken up as per the Resettlement Framework developed to comply with the requirements of national law [i.e. "The Acquisition and Requisition of Immovable Property Ordinance (ARIPO), 1982" or acquisition of land and other assets through negotiated settlement based on consultations with affected persons (both title-holders and non-title holders] and of ADB's, Safeguard Policy Statement, 2009. The Resettlement Framework covers requirements to be followed to bridge the gaps between national law and ADB's safeguard policy statement.

International Safeguard Requirements

11. Asian Development Bank's (ADB's) Safeguard Policy Statement, 2009 - The Safeguard Policy Statement (SPS), 2009 governs the environmental and social safeguards of ADB's operations. It applies to all ADB-financed and/or ADB-administered projects and their components, regardless of the source of financing, including investment projects funded by a loan; and/or a grant; and/or other means, such as equity and/or guarantees.

12. This **Project** has been classified as category A as per the ADB SPS, 2009 for environmental components and category B for social components. Overall the Project is classified as category A, thus requiring an ESIA. The Project will conform to the ADB's Safeguard Policy Statement (SPS), 2009 in respect of environment and social sustainability to meet the safeguard principles and the requirements of disclosure and consultation.

13. **Applicable EHS Standards -** The IFC Environmental, Health, and Safety (EHS) General Guidelines (April 30, 2007) will be applicable for this Project. In addition to that, IFC's Sector specific EHS Guidelines for LNG Facilities (April 11, 2017), IFC General EHS Guidelines (April 2007), IFC EHS Guidelines for Offshore Oil and Gas Development (June 2015) will apply to the Project. The Project will conform to the requirements of the international maritime conventions, protocols and agreements as relevant including MARPOL.

14. Financing support for the Project will be sought from multi-lateral financial institutions, such as the ADB and the EPFIs. This support from the multi-lateral financial institutions/ export credit agencies requires adherence of international best practices and environmental and social safeguard requirements of the lenders. The major relevant guidelines and policies considered for this Project are as included in paragraph nos. 11 to 13.

C) Description of the Project

15. The marine facilities of the Project are planned to be set up in the Bay of Bengal, off *Kutubdia* Island. Approximately 2.0 km of subsea gas pipeline is planned to connect the FSRU with the onshore at *Kutubdia* Island from where it will be taken up to custody transfer gas metering system (CTMS) at *Napura, Banskhali* through onshore pipeline of ~ 16 km thus to transmit RLNG (gas) into GTCL's

national grid pipeline *Moheshkhalli – Anwara* Section. The total investment for the proposed LNG terminal and related infrastructure would be ~ US$ 200 million.

16. The *Kutubdia* Island is isolated from the main shore of Bangladesh with no direct road access. One has to cross the *Kutubdia* Channel to reach the island. At present state, the channel is approximately 4 km wide between *Boroghop* (*Kutubdia*) – *Magnama* Ferry Ghat. Aerial distance from the nearest town at Cox's Bazar is ~ 50 km and by road it is ~ 85 km including the channel crossing. The nearest national highway is *Chittagong*-Cox's Bazar National Highway (N-1).

17. The *Kutubdia* Channel is directly connected with the Bay of Bengal at both ends. The *Chittagong* Port is located on north of the *Kutubdia* Island and ~ 50 km from the Project site. An anchor point of the *Chittagong* Port is located in the *Kutubdia* offshore region along with an existing navigational channel, which is located ~ 3 km off the north western shore of the *Kutubdia* Island.

Resource Requirement

18. **Manpower**: During peak construction phase, the Project would deploy ~500 persons, mostly unskilled workers (~60%). Construction of Project is expected to be completed in ~12 months (working three shifts a day) from the date of obtaining of all Project related approvals. Construction manpower will be temporarily employed from within the local regions to the extent possible. The operation of the LNG terminal post-construction will require up to 35 full time employees onboard the FSRU for round the clock operations and 30 full time employees working three shifts daily at the CTMS.

19. **Water:** During construction phase, the Project would require domestic water of ~20 m^3/day for construction activities including water for drinking use after desired treatment for the workforce to be engaged offshore at FSRU (to be sourced through barges from the *Chittagong* Port). Approximately 10 m^3/day of water will be sourced from local sources at the construction camp at CTMS. No ground water will be extracted for the Project related construction purposes. During operation phase, the Project would require ~10 m^3/day of fresh water (to be sourced through barges from the *Chittagong* Port) to meet water requirement for personnel working on-board the FSRU. Approximately 2.0 m^3/day of fresh water will be procured from local market to meet the water requirement of personnel working at the CTMS.

20. **Land for Pipeline and CTMS:** Land for the spur pipeline construction and operation and for setting up of CTMS will be acquired by Petrobangla, Government of Bangladesh as per detail given paragraphs 6 to 8 above. The gas spur pipeline will be connected into the national grid of *Moheshkhali – Anwara* Section. The spur pipeline is expected to pass through *Dakhshin Dhurung*, *Uttar Dhurung, Chhanua* and *Puichhari* Union *Parishads* of *Kutubdia* and *Banshkhali Upazila* respectively.

21. **Power:** During pipeline laying, maximum 1 MW power would be sourced through diesel generators. During operation phase, power generation utilities would comprise of ~10 MW gas based power generation onboard FSRU through

gas engine (dual fuel fired), 0.5 MW based power generation at jetty through gas diesel generator and 0.5 MW based power generation at CTMS Napura through gas engine (dual fuel fired). At jetty and CTMS diesel generators will also be available as alternate power generation in emergency situation.

Pollution Sources and Characterisation

22. The Project will have following potential effects on the environment:
    a) **Air Emissions:** During construction phase of 12 months, air emissions (due to combustion of motor oil fuel related pollutants NOx CO, SO_2) will be from engines of 4 to 5 tugs and boats intermintently engaged for jetty construction and from diesel generators (maximum 1 MW at any point of time) along the pipeline route for pipeline laying. During operation phase, the routine air emission of fuel combustion related pollutants NOx and CO from onboard power generation at FSRU, engines of tugs and supporting vessels engaged for marine operations and onshore CTMS operations. There will be non routine emission due to vapourised gas combustion onboard FSRU during emergency flaring (when no cold venting will be resorted). Other potential non routine emission of pollutants SO_2 and NOx will be there from diesel generators to be operated in the event of emergency power requirement. The Project will optimize fuel use to minimize emission of green house gases i.e. CO_2 equivalent and gaseous pollutants from combustion of fuels (RLNG, diesel or motor oil). The power generating air emissions sources during operation phase include the following:
        i) Natural gas based engines (1 operating + 1 standby) onboard FSRU of ~10 MW (12,500 kVA) capacity (dual fuel based) with stack height of 35 m above mean sea level;
        ii) Gas engine with alternate diesel generator of 0.5 MW (625 kVA) (1 operating + 1 standby) at the jetty with stack height of 14 m above mean sea level;
        iii) 0.5 MW (625 kVA) captive power generation at CTMS natural gas based with alternate diesel as secondary fuel with stack height of 15 m above ground level
23. **Liquid Discharges:** Liquid discharges during construction and operation phases would include the following:
        i) During construction phase, sewage (black and grey water) of ~10 m^3/day will be generated during offshore jetty construction. All sewage generated will be treated and disinfected onboard and disposed offshore beyong 3 nautical miles (nm) complying with the MARPOL requirements.
        ii) During operation phase, the FSRU engaged will have valid certificates for marine pollution, thus complying with the requirements of MARPOL standards for the offshore operations. Any specific requirements by Department of Environment, Government of Bangladesh will be complied with for pollution related control measures. Bilge water of 1 to 5 m^3/day will be treated and temporily stored in holding tank onboard FSRU before disposed offshore beyond 3 nm through service boats. Any discharge with oil content is

prohibited unless all exceptions are met under Annex 1 of MARPOL. Only clean and segregated ballast water will be discharged into sea. Black water (sewage) (2 m^3/day) and grey water of (8 m^3/day) will be treated, disinfected onboard and temporarily stored in holding tank before it is will be disposed offshore beyond 3 nm through service boats.

iii) The FSRU would involve use of sea water for LNG vaporisation in the re-gasification process. The seawater intake and discharge points will take be alongside of the jetty. Cold water (of ~15,000m^3/hour) will be discharged offshore at a temperature of delta -7 ºC (i.e. less than the ambient receiving seawater temperature) at a location close to the FSRU that will allow maximum mixing of the thermal plume to ensure that the temperature remains within 3 ºC at the edge of the mixing zone. Apart from the cold water discharge, there will be discharge of ~3,000 m^3/hour auxiliary cooling seawater with temperature of delta +4 ºC (i.e. above the ambient temperature of the receiving seawater) at a location close to the FSRU. Both cold water and auxillary machine cooling water will discharged from the same port. The free chlorine concentration of the cooling seawater and cold seawater discharges will be maintained at levels less than the international norm of 0.2 ppm.

iv) At the onshore CTMS, a sewage treatment plant (STP) of capacity 2 m^3/day will be installed for treatment and disinfection before disposal for use in plantations at CTMS as per the requirements of DoE, Bangladesh.

b) **Solid Waste:** Solid wastes (i.e. garbage containing waste plastic, paper, rags, bottles, metal etc.) will be segregated, temporarily stored onboad FSRU and safely brought through service boats to the waste handling facilities available at the Chittagong Port / Cox's Bazar. Food waste will be comminuted onboard to 25 mm screen size, temporarily stored and disposed along with other waste at the Chittagong Port / Cox's Bazar as per MARPOL requirements. Plastic and non-incinerable solid waste generated at CTMS will be disposed of in nearby approved waste handling facility.

c) **Hazardous Wastes:** Both during construction and operation phases, the Project at FSRU and jetty would generate hazardous waste comprising of used oil; empty containers of paints, varnishes, thinners and lubricating oil; rags containing oil and grease, filter materials and packages containing hazardous wastes, waste oil generated from bilge and slop oil will be collected and disposed of at the nearby Chittagong Port. At the CTMS, hazardous waste include waste oil, rags containing oil, empty containers of paints, varnishes and thinners will temporarily stored on impervious surface before their disposal. All construction and operation phase hazardous wastes will be brought to on-shore dedicated area for recycling and/or final disposal at approved hazardous waste handling facilities near to the CTMS site.

d) **Marine Pollution (MARPOL) Compliant:** The FSRU related waste will be handled by a MARPOL compliant Ship-Board. Un-allowed solid and hazardous waste items as per MARPOL will be collected in separate bins and brought onshore for disposal.

e) Underwater Noise Emission:

The **underwater noise** sources of significance in the offshore region include the following activities:

- **Construction phase**: Piles driving for development of foundation of jetty. The sound pressure level (SPL) and sound exposure levels (SEL) expected during piles driving will be impulsive type that are likely to prevail for ~90 milliseconds with single strike per second in the shallow water of ~15 m depth. The underwater impulsive noise is expected to be SPL_{peak} of 225 decibel reference 1 micro pascal at 1 m (dB re 1µPa at 1m); SPL_{rms} of 210 dB ref 1µPa at 1m and SEL of 200 dB re 1µPa^{2}s.

  Note: It is to be noted that the Project design is under development stage, currently information on technique that would be used for pile driving is yet to be finalized. In absence of relevant information on pile driving and related underwater noise generation, the above mentioned input noise levels represents worst case levels.

24. **Operation Phase**: LNG cargo and support vessels movement in the jetty area is expected mainly during mooring of the LNG cargo to the jetty site. The underwater noise is expected to be mainly for 15% of time during ~24 hours of LNG cargo mooring and moving out of jetty. The underwater impulsive noise is expected to be SPL_{peak} of 203 dB re 1µPa at 1m; and SPL_{rms} of 185 dB ref 1µPa.

f) **Ambient Noise (in Air) Emissions:** The ambient noise sources of significance in the ambient air include the following activities:

- **Construction Phase**: The ambient noise levels generation of significance during construction phase will be mainly from construction activities for pipeline and CTMS. The expected construction related activities will have cumulative hourly equivalent noise level ($L_{eq\ hourly}$) of 95 dB(A) at source. While noise from construction of offshore jetty being located 1.5 km away will have negligible noise level received at human dwelling units at *Kutubdia* Island.
- **Operation phase**: The ambient noise emission sources from CTMS at *Napura* will be mainly from metering station. The expected $L_{eq\ hourly}$ at the fence line of the CTMS will be less than 70 dB(A). While the cumulative ambient noise levels of 95 dB(A) is expected from offshore sources (1.5 km away from shore) include LNG Carrier and FSRU installed pumps, compressors, generators, air coolers at liquefaction facilities, vaporizers used during regasification, and general loading /unloading operations of LNG carriers /vessels.

D) Description of Environment

25. A 10 km radial zone around the FSRU site has been considered as study area. Additionally, an area of 500 metres on both sides of the pipeline route and CTMS at Napura is also included within the study area.

Physical Environment

26. **Oceanographic Conditions:** The bathymetry indicates a steep sea floor with 10 m contour reaching within 1 km from the *Kutubdia* Island on the west and with water depth varying from 13 m to 15 m near the proposed jetty and FSRU location. Predominant wave direction is from south west. Maximum wave height recorded near the Project areas during 2005-2009 was found to be 2.25 m. Strong longshore currents occur in the monsoon season near *Kutubdia* Island. Direction of current is predominantly north during peak flood tide and south during ebb tide and NE monsoon.

27. **Physiography and Geology:** Major physiographic unit of *Kutubdia* Island is young coastal plain surrounded by active coastal plain which is present at the boundary of the *Kutubdia* Island. Geologically major portion of the study area dominantly consists of tidal deposits, i.e. inter tidal and supratidal deposits composed of silty clay with organic clay mix and little sand. The elevation of the island varies from mean sea level to 7.6 m (25 feet) above mean sea level. The northern part of the island is comparatively on higher elevation and the slope of the island is from north to south. An earthen embankment is present along the entire stretch of the island. The average height of this coastal wall is 6 m.

28. **Landuse:** The predominant land use of the onshore portion of the study area includes agricultural land (6.07%), salt pans (12.05%), and settlement (5.63%) and remaining sea front within 10 km radius from FSRU in the study area.

29. **Shoreline Erosion and Accretion:** About 9 km² area of *Kutubdia* was eroded whereas 0.35 km² of land accretion occurred on the *Kutubdia* Island in a period between 1972 and 2013[1]. Major erosion occurred on the southern part of the island. The western side of the island, i.e. towards the Bay of Bengal side was less prone to erosion compared to the southern section. The area near north-western side of the island, near the existing light house appears to have less erosion potential in comparison to the southern part of the *Kutubdia* Island.

30. **Drainage:** A natural drainage channel *Pilat Kata Khal* flows along the mid of the island and discharges into the *Kutubdia* Channel. This channel is influenced by tidal effects. Several minor channels are also connected with the *Pilat Kata Khal*. Also, several salt pans and some fresh water ponds are located within the study area.

31. **Marine Water Quality:** Marine water samples were collected from six locations in the Bay of Bengal and *Kutubdia* Channel for analysis of water quality. The pH values of the marine water samples were found to be neutral to slightly alkaline with salinity levels varying between 10.4 parts per thousand (ppt) and 17.7 ppt. Concentration of most of the heavy metals analysed were found to be below their corresponding detection limits.

[1] [1] Munshi Khaledur Rahman. 2015. Environmental and Social Vulnerabilities and Livelihoods of Fishing Communities of Kutubdia Island, Bangladesh by (A dissertation submitted to Kent State University).

32. **Inland Surface Water Quality**: Water samples were collected from *Pilat Kata Khal* for analysis of inland surface water quality. Water quality analysed for *Pilat Kata Khal* was found to be in compliance with the use of water for fisheries as per the ECR, 1997.

33. **Groundwater Quality:** Groundwater samples were collected from four locations within *Kutubdia* Island for analysis of water quality. The groundwater analysis reveal that almost all the parameters were within the standard values of the ECR, 97 (excepting TDS) and the ground water quality was satisfactory for potable uses within the *Kutubdia* Island.

34. **Soil Quality**: Soil samples were collected from two locations within *Kutubdia* Island for analysis of soil quality. Soil of the *Kutubdia* Island mainly formed from recent alluvial sediments. Primary analysis of soil samples collected from *Kutubdia* Island reveal that the soils are clay loam and acidic in nature. The soils were found to be non-saline to slightly saline. In general the soils were found to be of low nutrient content to very low nutrient content (except for potassium).

35. **Sediment Quality:** Marine sediment samples were collected from four locations in the Bay of Bengal and *Kutubdia* Channel for analysis of sediment quality. Sediment texture was found to be varying from sandy-loam to silty-loam in nature with neutral pH. Organic carbon contents of the sediment samples were found to be low. Heavy metal concentrations of the sediment samples were also found to be negligible.

36. **Meteorology:** Three distinct seasons *viz*. cool dry season (November-February), pre-monsoon hot season (March – May) and the rainy monsoon season (June – September) are recorded in *Kutubdia* Island. Average minimum temperature in *Kutubdia* region generally varied from 6.2°C to 13.4°C; while the maximum temperature of 39.5 °C is observed in May. The maximum annual rainfall recorded during the last decade (2000-2010), was about 3,171 mm with about 80% of the total rainfall occurring during the monsoon season. Wind direction generally prevails from south-southeast during June to September with maximum wind speed of 1.68m/s.

37. **Ambient Air Quality:** Ambient air quality was measured at six locations within the *Kutubdia* Island. The concentrations of PM_{10}, $PM_{2.5}$, SO_x, NO_x and CO were found to be in compliance with the national standards, presented under the ECR, 1997 (as amended).

38. **Ambient Noise Quality:** Ambient noise quality was monitored at six locations within the *Kutubdia* Island. Daytime and night time equivalent noise levels at residential and commercial areas were found to in compliance with the Noise Pollution (Control) Rules, 2006. The equivalent noise levels at the *Kutubdia Upazila* Health Complex were found to be exceeding the respective noise standards of **Silent Zone**.

39. **Natural Hazards:** The area surrounding *Kutubdia* Island is located in Earthquake Zone -II, where building design of moderate levels will be necessary. *Kutubdia*

Island is affected by cyclone and storm surge almost every year. *Kutubdia* Island is falling in a high risk area where surge heights are above 1 m. The southern part of the island (*Boroghop* and *Ali Akbar Deil* Unions) are most affected by inundation (3m to 4m), whereas the northern Unions are relatively at lesser risk, except for the coastal stretches. The Cox's Bazar coast falls within Tsunamigenic Zone-I, which is reportedly most vulnerable. RBLTL will ensure that the design of jetty construction is done after considering the natural hazards related safety factors. Cyclonic/Thunderstorms Hazards will be integral part of the Emergency Preparedness and Response Plan.

Ecological Environment

40. Terrestrial ecosystem: Total 87 terrestrial floral species were recorded from the terrestrial ecosystem of the study area which included 48 trees, 16 shrubs and 23 herbs and climbers. No protected floral species were recorded.

41. A total of 17 species of terrestrial herpetofauna are reported from the study area which included Green Frog (*Euphlyctis hexadactylus*) and Spotted Pond Turtle (*Geoclemys hamiltonii)* (Vulnerable as per IUCN Red List). A total of 91 Avifaunal species were observed in the study area. Black-headed Ibis (*Threskiornis melanocephalus*) is reported Vulnerable while Eurasian Curlew (*Numenius arquata*) is reported as Near Threatened as per IUCN Red List. A total of 11 species of mammals were reported within the study area. Large Indian Civet (*Viverra zibetha*) and Common otter (*Lutra lutra*) are listed as Near Threatened as per IUCN Red list.

42. **Aquatic Ecosystem:** Planktonic survey was conducted at six locations in the Bay of Bengal and *Kutubdia* Channel. Phytoplankton community was represented by 17 genera with *Nitzschia sp*. as the most dominant followed by *Navicula sp*. and *Synedra sp*. Zooplankton community was represented by 23 genera with *Crab Zoea* as the most dominant followed by *Copepod nauplii* and *Penaus sp*. Sediment samples collected reveal poor density of benthic communities. Among the benthic organisms higher concentration was recorded for Nematodes and Bivalves.

43. Fishery survey indicated that around 400 numbers of ponds were present in *Kutubdia* Island and among them 20 ponds were used for commercial aquaculture. Major inland fish species cultured were Pangas (*Pangasius pangasius*), Tilapia and Rui (*Labeo rohita*).

44. There were two different kinds of fishing activities on *Kutubdia* Island, (i) deep sea fishing; (ii) Estuarine and near shore fishing. It was revealed through consultation with fishermen that about 57 fish species were caught during deep sea fishing and about 32 species of fishes were caught from nearshore and channels of *Kutubdia*. Two species of fishes were threatened and these were Korat mach (*Anoxypristis cuspidate*; endangered as per *IUCN Red List*) and Koiputi (*Anodontostoma chacunda*) is now a rare locally.

45. During the consultation with local fishermen and Department of Fisheries, it was revealed that Hilsa migrate from deep sea towards *Gandamara* Point at *Bashkhali* where they breed and then the school begin its journey to enter into Meghna River system. The *Gandamara* Point is located at the 7 km North of the *Kutubdia* Island and no Project related activities are envisaged in this area.

46. Isolated Olive Ridley turtle nesting was reported by the villagers all along the west coast of *Kutubdia* Island (Olive Ridley's Turtle (*Lepidochelys olivacea) IUCN* listed Vulnerable 2016.3). However, sighting of Olive Ridley turtle nesting was not observed during survey. Consultations with local Biodiversity Experts working on turtle conservation in the *Moheshkhali* region as well as the community indicated that only sporadic nesting occurs in *Kutubdia* Island and it is not a critical habitat. It was also confirmed that nesting is reported mostly from the Southern most tip of the Island in *Ali Akbar Deil*.

47. Four marine Dolphin species were reported by the local fishermen (near day fishing zones (5 – 10 km) of Kutubdia Island and also further offshore areas. The dolphin species reported are not critically endangered, endemic, migratory, congregatory or restricted range species and thus the habitat is not expected to be a critical habitat for the reported dolphins.

48. There are no protected areas like National Park, Wildlife Sanctuary or Ecologically Critical Areas (ECAs) etc. within the study area.

Socioeconomic Environment

49. The Project footprint for the proposed onshore spur pipeline (of ~16 km) will pass through *Dakshin Dhurung* and *Uttar Dhurung* Unions in *Kutubdia Upazila* of Cox's Bazar District and *Chhanua* and *Puichhari* Union in *Banskhali Upazila* of Chittagong District. The CTMS will be located in *Banskhali Upazila* of Chittagong District.

50. Among these four unions *Puichhari* Union (38,224) has the highest population while the lowest populations were recorded in *Dakhshin Dhurung* Union (17,279). Average literacy rate of these 4 unions observed as 29.34% and highest and lowest literacy is recorded in *Puichhari* Union and *Chhanua*Union respectively. Employed population in *Kutubdia Upazila* and *Banskhali Upazila* are 70% and 72% of the total working age population respectively. Workforce participation rate recorded in the *Dakshin Dhurung, Uttar Dhurung, Chhanua* and *Puichhari* Unions are 78%, 79.51%, 76.35% and 77.27% respectively.

51. It has been observed during site visits that agriculture, salt cultivation and fishing are three major livelihood earing activities observed in *Kutubdia* Island. Community consultation also revealed that most of the community people are engaged in this activity and all other livelihood activity like small business, boat making and maintenance, salt and dry fish marketing are all directly and indirectly dependent on these three activities.

52. The main profession of the habitants (56% of the total population) of *Kutubdia Upazila* is agriculture. Agriculture has traditionally been the primary source of

income for the inhabitants of *Kutubdia Upazila*, but over the years due to frequent cyclonic events and sea water surge, the cultivable land on the island is increasingly being rendered infertile due to increased salinity. More and more agricultural lands are now being converted to salt fields.

53. Cox's Bazar is the only region in Bangladesh where salt harvesting is done. In *Kutubdia Upazila*, salt harvesting is one of the primary livelihood options of the island population and also practiced as a secondary seasonal source of income. It is mainly carried out at the central part of the island on both sides of the *Pilat Kata Khal*.

54. Fishing is also a key livelihood earner for the residents of *Kutubdia*. It was informed by the District Fisheries Officer (DFO), Cox's Bazar that number of registered fishermen with the Department of Fisheries as on June 30, 2016 is 7,116 in the *Kutubdia Upazila* (it was also understood that there may be additional 20% more fishermen in the island those who have not been registered due to various reasons). An estimated population of 8,500 fishermen is mostly living in 14 fishermen settlement in *Kutubdia*. Predominance of fishermen communities are more in *Uttar Dhurung, Ali Akbar Deil* and *Boroghop* Unions followed by *Dakshin Dhurung*. In *Lemshikhali* and *Kaiyarbil* Unions there is no fishermen settlement in particular and fishermen are scattered all over the union.

55. Focus Group Discussions (FGDs) and interviews with the key informants revealed that in *Kutubdia*, traditionally fishing was practiced by the minority fishing community – *jeles (Hindu community),* who had been residing in this island for almost four generations (~200 years). The Muslim population of the island adopted fishing as occupation in the last 20-25 years.

56. Types of fishing practiced by the fishermen in *Kutubdia* region can be classified into three category i.e. Deep-sea fishing, Daily fishing, Foot fishing. The hydrological conditions of the Bay of Bengal make it favorable for a variety of shrimps and fishes. Although fishes remain scattered in the Bay of Bengal in some places they get concentrated and constitute important fishing grounds. Four fishing grounds have been identified in the exclusive economic zones – *South Patches, South of South Patches, Middle Ground* and *Swatch of No Ground*. Discussions with the fishermen brought out the fact that in winter season income from fish sale is higher than in summer and monsoon. In monsoon the income majorly depends and varies on the Hilsa catch.

E) Potential Impacts and Mitigation Measures

57. The impacts have been identified based on the Project information provided by Reliance Power on the Project configuration (including recent revision in the Project design), stakeholder consultations with government officials and consultations with community members including fishermen community, reconnaissance visit and broad assessment of the high resolution satellite imagery. The potential environmental and social impacts have been assessed for the Project construction (including pre-construction) and operational phases.

Potential Impacts on Aesthetics and Visual Quality

58. The construction activity will be a short term activity of ~12 months from the date of all approvals obtained. The pipeline laying will be done through horizontal directional drilling (HDD) technique, thus no excavation in the beach area will be done due to pipeline laying. The bow shaped pipeline from FSRU will exit at *Kutubdia* Island ~100 m from shore from where it will again run as subsurface below 2 m from ground level. The depth of pipeline in the beach area will be maintained below 3 m from ground level. The sources of aesthetic and visual impacts can result from some excavation and earthwork of land along spur pipeline route; disposal of HDD cut material generated from pipeline laying; storage of construction materials at CTMS; storage and disposal of waste, physical presence of labour camps; etc. *Kutubdia* region has a typical rural setting with flat terrain (agricultural land and salt pans) with small villages with homestead plantation. The aesthetics and visual impact in the rural set up with scattered settlements (i.e. low number of receptors) is assessed to be **Minor**.

59. During the period of the construction, the Project will ensure that the entire CTMS site will be fenced with bamboo mat or tin sheet. All construction activities including material and waste stockpiling will be restricted between the boundaries of the CTMS site. All temporary structures, surplus materials and wastes will be completely removed from site and disposed at only designated areas.

60. During operation phase, the physical presence of the CTMS in the onshore region from *Banshkhali* region and the FSRU in offshore region will be visible from *Kutubdia* Island and surrounding area of 2 km to 3 km. The FSRU and CTMS will have bright illumination arrangements. The spur pipeline being buried and no structure is proposed in the *Kutubdia* Island, thus these will not be visible. The study area typically represents a rural setting with no industrial presence. The impact of aesthetics and visual quality is assessed to be **Minor**. To mitigate any visual impact, the Project will consider appropriate shading of lights to prevent scattering.

Potential Impact on Land Use

61. For laying of the gas pipeline 26.361 acres of land will be acquired on permanent basis and 49.343 acres of land for ~16 km pipeline will be required during the construction period for pipeline related construction activities. The width of the pipeline corridor acquired as permanent land will be 8 m and additional ~15 m along the pipeline will be required for pipeline construction. This requisition of land will be purely for the construction period and is expected to be for one year, after which the lands will be restored and reinstated to the best achievable original conditions and returned to the land owners. Once pipeline is laid, ~30 acres of land (including for 3.95 acres for CTMS) will be retained as permanently acquired land by Petrobangla. The ownership of land will remain with Petrobanlga, RBLTL will get the land for 15 years from Petrobangla. With the setting up of the Project, the land use from agricultural and salt pans of the government land/ private land will be permanently meant for industrial use. Although the pipeline will be subsurface, no structural development would be

permitted which may lead to loss of some value for land. Also refer to paragraph 87 on change of land use.

Potential Impact on Soil Quality

62. Any top soil specifically from agriculture field generated during construction activities at CTMS site and some part of spur pipeline route (as in most part the pipeline will be laid through HDD technique i.e. without any excavation) if not properly stripped and stored for future use, the entire volume of top soil will be permanently lost or fertility/soil characteristics will be changed. Soil contamination may happen only due to accidental spillage of fuel, lubricants and paints from storage areas and during the transfer of fuels and chemicals. Proper stripping of top soil, its conservation for future use in plantation or for reclaiming agricultural land along the pipeline shall be ensured. The drainage system at CTMS site will be designed with sedimentation tank and Oily-water Separator to prevent contaminants from entering soils. The potential impact on soil quality is assessed to be **Minor**.

63. During operation phase, contamination of soil may happen at CTMS site only due to accidental spillage of fuel, lubricants and chemicals from storage areas and during the transfer of fuels and chemicals. Sludge generated from the STP will be stored in pits and same will be periodically transferred for use as manure. Other industrial and hazardous wastes (including used/spent oil) will be stored in bins and sheds provided with impervious liners underneath the floor. Theses wastes will be sent for the disposal facility of the Chittagong Port. Improper handling and mixing with surface runoff water may lead to contamination of soil in nearby area. Contamination of soil may happen only during accidental cases or in case of improper management. The potential impact on soil quality is thus assessed to be **Minor**.

64. The Project will ensure proper spill control and management at CTMS site along with conduct of regular monitoring to detect any contamination on soil and ground water. It shall also be ensured that the waste from the Project is disposed only in designated storage and disposal area.

Potential Impact on Physiography & Drainage

65. Construction of the CTMS site will entail land grading and there will be no additional requirement of earthwork to be filled onsite. No considerable change in the existing local physiography is expected from the flat agricultural land for CTMS site. The pipeline laying will be done through HDD technique with limited excavations at some locations resulting in low and temporary impact on micro-drainage. In the beach area the depth of pipeline will be maintained below 3 m from ground level. The earth work (stacking of soil and drill cutting) involved along pipeline route due to excavation, if are not properly cleared, micro-drainage of the area may be disturbed. The impact on topography and drainage assessed to be **Moderate**.

66. The CTMS site will be designed with an adequate drainage system to prevent any impedance to local micro drainage. It will be ensured that the cross drainage structures along the pipeline route are properly maintained during the process

of pipeline laying and also that the sites are reclaimed immediately on completion of pipeline laying.

Potential Impact on Air Quality

67. During construction phase, there will be potential fugitive air emission from construction material handling, earth work, and emission from machinery and vehicles engaged for spur pipeline laying and CTMS site development. The fugitive particulate matter due to excavation will settle in areas surrounding pipeline corridor, however this activity will be limited as the pipeline laying will be done through HDD technique. The impact is assessed to be of **Minor** significance.

68. During the operation phase, the main source of air emissions from the Project will be from the ~10 MW of natural gas based power generation facility onboard FSRU, 0.5 MW gas based power generation at jetty, and 0.5 MW at CTMS. The emissions due to offshore and onshore power generation will primarily be NOx, and CO. There will be green house gases emission i.e. CO_2 equivalent from combustion of fuels (RLNG and motor oil).

69. Impacts were assessed due to the operation phase related NOx and CO pollutants emissions from offshore and onshore components of the Project. The resultant ambient air quality at the surrounding settlements is assessed to remain well within the applicable standards of DoE, Government Bangladesh and IFC's General EHS Guidelines. The impact magnitude is assessed to be **Minor**.

Potential Impact on Ambient Noise Generation Quality

70. **Construction phase** activities such as transportation of materials, operation of heavy equipment and construction machinery for HDD drilling are likely to cause increase in the ambient noise levels along pipeline route and in and around the CTMS site. The noise generated from the aforementioned activities may cause discomfort to inhabitants of the nearby villagers, requiring mitigation through noise barriers at the noise emission source. The potential impact on noise quality during construction stage is assessed to be **Minor**.

71. Ambient noise during **operation phase** will be primarily generated from operation onboard FSRU from power generation unit, pumps and compressors. The location of the FSRU is proposed to be located more than 1.5 km from any nearest settlement at *Kutubdia* Island, the likely impact of ambient noise on human receptors is likely to remain within the existing ambient noise conditions. The minor operations at CTMS site will result in ambient noise levels along the fence line within the applicable noise standards for day and night time. There will be no significant change in the resultant noise levels at each receptor due to the Project related activities, therefore, the impact magnitude is considered to be **negligibl**e.

Potential Impact on Surface Water Quality

72. Surface run offs from construction material storage area, construction waste storage areas, hazardous waste (waste oil, used oil etc.) and chemical storage areas may lead to addition of pollutants in the receiving natural drainage channels etc. The proposed ~16 km onshore pipeline related will involve its laying using HDD technique with limited involvlement of earth work due to excavation, however there will be some stacking of soil and drill cutting which if not control will escape through surface runoff into the nearby water receiving bodies. The surface run offs may contain high sediment load, oil residues, organic wastes, etc. This can cause adverse impact on water quality, which ultimately leads to impacts on aquatic ecology.

73. As subsea pipeline ~2 km from FSRU to *Kutubdia* Island and 2.7 km subsea pipeline in the *Kutubdia* Channel will be laid through HDD technique, the disturbance to seabed sediments will be minimal. The pile driving work in the seabed for construction of the jetty off *Kutubdia* Island will generate fine sediments and will also result in resuspension of sediments in water in localized area. This is expected to increase the turbidity of water and will have an adverse impact on surface water quality in the area surrounding the jetty. The turbid waters impact on aquatic ecology will temporily affect primary productivity. Any leakage and spillage of oil and lubricants from machineries and equipment will cause adverse impact on surface water quality.

74. During the pipeline laying, hydro-testing will be required. Hydro-testing water if directly discharged into the *Kutubdia* Channel or nearshore will affect the water quality. Hydro-testing water is generally characterized by high pH, turbidity, metals, oxygen scavengers (like ammonium or sodium bisulphite), and biocide residues which can adversely affect aquatic ecology as well as benthic ecosystem. The potential impact on surface water quality due to construction activities is assessed to be **Moderate**. RBLTL will ensure that the hydro-testing water is treated before discharge into sea/channel conforming to DoE standards.

75. The Project shall restrict earth work activities during monsoon season and shall also install proper storm water drainage system with adequate size double chambered sedimentation tank at the CTMS site.

76. Surface run off during the operation phase from lube oil storage, waste handling unit at CTMS may lead to the pollution of receiving water bodies. However, taking into account the provision of proper storage (provided with secondary containment), onsite drainage system with sedimentation tank, oil separators, etc., the pollution load is not expected to be significant. The grey water and black water from the FSRU, LNG carriers, etc. will be treated, disinfected, temporarily stored in holding tank before discharge into sea beyond 3 nm through service boats. The bilge water will be treated onboard to ensure oil content of less than 15 ppm before discharge into sea beyond 3 nm through service boats. Any discharge with oil content is prohibited unless all exceptions are met under Annex 1 of MARPOL. The ballast water discharge will be done into sea only after ensuring that it is clean and segregated. All waste oil

generated from bilge, slop and ballast water treatment will be collected and disposed of at the nearby Chittagong Port facility thus conforming to the requirement of MARPOL. No direct discharge of domestic /industrial waste water will be done into the sea near FSRU. The impact on surface water quality is assessed to be **Minor**.

77. The FSRU option would involve use of sea water for vaporisation in the re-gasification process and for engine cooling. The intake point will be located on the eastern side of the FSRU while the discharge point will be located on the western side of the FSRU in open sea. There will be cold water discharge (maximum of 15,000 m^3/ hour) at 7 degrees Celsius less than ambient temperature and machine cooling water (maximum 3000 m^3/hour) at 4 degree Celsius more than ambient will be discharged from engine room. Both cold water and machine cooling water will be discharged offshore to allow maximum mixing of the thermal plume to ensure that the temperature is well within 3 degrees Celsius of ambient temperature at the edge of the mixing zone as required under the International norms (IFC EHS Guidelines of LNG Facilities, April 2017). Separate simulations to consider worst case scenarios for cold water and machine cooling water discharge were done using Steady State three dimensional CORMIX Model. The results showed there will be temperature change of 0.25 ºC to 0.86 ºC within 100 m from maximum discharge of cold water. Similarly, the machine cooling water discharge will result in change in temperature of 0.10 ºC to 0.20 ºC within 100 m from maximum discharge of machine cooling water. Both discharge of cold water and machine cooling water will be done from the same port and will remain well within the permissible IFC standard of change of 3 ºC within 100 m of mixing zone from discharge location. The potential impact of cold water and machine cooling water will be **Minor**.

Potential Impact on Ground Water Quality

78. Potential spillage and seepage of chemical, lube oil, paints etc from storage area, waste handling area and generation of domestic waste/wastewater from construction labour camp area may adversely affect ground water quality in the area, if storage is not well managed. The existing groundwater quality analysis does not reveal any contamination or pollution of groundwater. The geographical extent of potential impact due to above activity is anticipated to be local and impact duration is expected to be short term. The sensitivity is high, as the water is unpolluted and provides services as drinking water, domestic uses for the region. The impact on ground water quality assessed to be **Moderate**. The mitigation measures to be followed by the Project include proper storage arrangements for chemicals, lube oil, paints etc with the provision of impervious surface and all material to be kept in covered shed provided with adequate bund arrangement to prevent escape of any spill.

Potential Impact on Terrestrial Habitat (Flora & Fauna)

79. During the construction phase, any vegetation removal along the pipeline route and CTMS site will cause loss of vegetation cover, habitat loss to the faunal species living within the Project area and habitat disturbances to the faunal species in the nearby areas. The pipeline route has been selected to avoid its

passage through mangrove plantation. The faunal species of concern amongst mammals are Indian Grey Mongoose, Large Indian Civet both listed 'Near Threatened as per IUCN Red List'. Among avifauna Red-breasted Parakeet (listed Near Threatened as per IUCN Red List) and among herpetofauna Spotted Pond Turtle (Vulnerable as per IUCN Red List) and Indian Black Turtle (Near Threatened as per IUCN Red List) are reported from the area. No floral species was identified to be under the threatened category. The impact of the vegetation clearance along pipeline route is assessed as **Minor**.

80. Operation phase impacts will be mitigated by plantation of saplings at the identified areas along the inland pipeline line route and at CTMS.

Potential Impact on Marine Fauna due to Underwater Noise Generation:

81. During **construction phase**, there will be potential impact on marine fauna due to **underwater noise** generation mainly during pile driving activities for jetty construction at ~1.5 km to the west of shore of *Kutubdia* Island. The sound energy generated from source of pile driving due to hammering of piles into seabed propagates compression and transverse waves along the length of the piles into seabed through marine water column. The transverse waves and some of the ambient noise propagate through seabed into the sea water. Transmission loss of sound energy takes place spherically when it propagates uniformly in all directions in deeper regions whereas in shallow water, it propagates cylindrically. The sea water depth in the areas of pile driving for raising foundation of the proposed jetty is ~15 m. The intermediate noise propagation model has been considered to assess impact of underwater noise levels on prevailing marine fauna due to pile driving for jetty construction at the shallow water depth (~15m). It is also important to note that absorption of sound energy increases with the increase of frequency of the sound waves. After referring to the baseline of prevailing fauna of offshore *Kutubdia* Island, the criterion considered as injury threshold (applicable to turtles and cetaceans) is peak sound pressure level (SPL_{peak}) of 224 decibel reference 1 micro pascal (dB re 1 µPa); sound exposure level (SEL) of 198 decibel reference 1 micro square pascal second (dB re 1 μPa^2 s); and threshold for behavioural changes the SEL of 183 dB re 1 μPa^2 s. The maximum underwater noise generation from pile driving at source will be SPL_{peak} of 225 dB re 1µPa at 1m; root mean square sound pressure level (SPL_{rms}) of 210 dB ref 1µPa at 1m and SEL of 200 dB re 1μPa^2s. The results of the modelling for intermediate noise propagation model showed that the criterion threshold for injury of 224 dB re 1 µPa will remain within 50 m from source of pile driving activities; the criterion injury threshold of SEL of 198 dB re 1 μPa^2 s will remain within 1 km from source and the criterion threshold for behavioural changes of SEL of 183 dB re 1 μPa^2 s will be remain within 6.5 km from the source. The pile driving activity is of very short duration (of a few days) and no sensitive habitats are located within the impact zone, and cetaceans generally prevail in 50 m and above water depth, the impact of underwater noise generation on marine fauna (turtles and cetaceans) from the pile driving activities is assessed as **Minor**. As mentioned in paragraph 22 (g) above, in absence of relevant information on pile driving and related underwater noise generation, the input of worst case noise levels were considered in the ESIA. Once the project design is finalized, RBLTL will

develop necessary revision in the action plan prior to start of construction activities for its implementation during pile driving activities in concurrence with prior discussion with ADB.

82. During **operation phase**, the underwater noise generation will be mainly from LNG cargo movement (particularly during arrival at and departure from the jetty). The expected underwater noise levels will be SPL_{peak} of 203 dB re 1µPa at 1m or SPL_{rms} of 185 dB ref 1µPa. With these source noise levels, the criterion SEL of 198 dB re 1 μPa^2.s (threshold of permanent injury to turtles) is expected to remain within 100 m from source, while criterion SEL of 183 dB re 1 μPa^2 s (threshold for behaviour changes in turtles or permanent threshold shift in cetaceans) is expected to remain within 2,000 m from source. The underwater noise due to LNG cargo movement in the area with no sensitive habitats within the impact zone, and cetaceans generally prevail in 50 m and above water depth, the impact of underwater noise generation from the LNG cargo and related vessels movement along the jetty location is assessed as **Minor**.

Potential Impact on Aquatic Habitat

83. There is likelihood of turtle and dolphin mortality/injury during the construction period due to boat and vessel movement in sea and channel area. Other impact on marine fauna will be there due to potential impingement of marine fauna during water intake for machine cooling and evaporator heat exchange. Turtle nest can be poached by the working labour force. Impact on aquatic habitat flora and fauna is assessed as **Moderate**.

84. A pre survey of turtle nesting habitats along pipeline route on beaches of *Kutubdia Island* and *Kutubdia* Channel will be conducted prior to start of construction works. Adequate safeguard will be built in the contract of the EPC Contractor to prevent any poaching of turtle eggs by the construction workforce as well as to prevent any disturbance to aquatic habitats from construction activities. To eliminate impingement of fish fauna, RBLTL will maintain water after the screen intake velocity of equal to or less than 0.15 m/sec (0.5 ft/sec).

85. During the operation phase, impacts may arise from spillage and leakage of fuel and lubricant, mortality caused due to movement of ships and vessels and from illumination in the offshore region of jetty and FSRU. The Project will have in place specific procedures and necessary preparedness to contain any accidental spill at source and also prevent their spread in the surrounding environment. The Project will also plan vessel movement and design the site illumination in a manner to limit impacts on aquatic habitats.

86. The Project will also support the Local Forest Department and Local NGOs in their initiatives to study and protect turtle nesting activities on the *Kutubdia* Island and also support government initiatives in terms of research and monitoring for dolphin studies in the region.

Potential Impact due to Land Acquisition

87. Land Loss: As described in paragraphs 6 to 8 and 20 above, the land requisition and acquisition for spur pipeline and valve station will be undertaken and

owned by Petrobangla. The land for spur pipeline erection and subsequent operation and maintenance will be handed over to RBLTL. The process of land requisition and acquisition will be done as per the Resettlement Framework complying with the requirements of national law and ADB's safeguard policy statement, 2009 and the ownership of land will lie with Petrobangla.

88. It is anticipated that during the construction phase the land owners will lose land due to land acquisition. Based on preliminary assessment using 1991 census records, it is expected that there will be 2,877 land owners (from 625 Daag numbers) for 49.334 acres of temporary land requisition and 30.326acres of permanent land acquisition. Based on initial estimation, the land owners for permanent land acquisition are expected to be 1,095 with likely 238 land parcels while for temporary land requisition the expected land owners will be 1782 with likely 387 land parcels. The land parcels taken as part of temporary land requisition will be returned back to the land owners upon completion construction period (of ~12 months) of pipeline laying. Compensation will be paid to the land losers as per the Resettlement Plan to be prepared as per requirement included in Resettlement Framework covering the requirements of national law and ADB's SPS, 2009. The ownership of permanently acquired land will remain with Petrobangla. Impact due to land loss is assessed to be of **Moderate** significance.

89. **Change in Landuse:** The establishment of the Project will result in permanent change in land use of the land involved (for laying of subsurface gas spur pipeline and setting up of CTMS at Valve 2) from sea beach, agricultural and salt pan to industrial. The pipeline laying will be done through HDD technique, thus no excavation in the beach area will be done due to pipeline laying. The bow shaped pipeline from FSRU will exit at *Kutubdia* Island ~100 m from shore from where it will again run as subsurface below 2 m from ground level. The depth of pipeline in the beach area will be maintained below 3 m from ground level. The land for the spur pipeline (~26 acres) will be available to the land owners after construction of the pipeline. The ownership of permanently acquired land will remain with Petrobangla. Thus, it is envisaged that the laying of the pipeline will not significantly impact in the change of land use along the pipeline route (~26 acres) as it will be subsurface and after construction the land will be restored to the best achievable original condition by growing grass and trees at designated areas. No woody shrubs will be planted to avoid their interference with the integrity of the pipeline. The requisition land will be restored and reinstated to the best achievable original conditions and returned to the land owners. Impact due to land use change is assessed to be **Minor.**

90. **Fragmentation of Land Holdings:** Parcels of land along the proposed gas spur pipeline route may get temporarily fragmented due to the linear acquisition associated with the route of the gas pipeline. There may be creation of orphan

lands [1]which may be rendered too small or unviable for cultivation both for agriculture or salt. Valuation of the land prices may decrease.

91. As a mitigation measure it should be carefully assessed during socio-economic survey and Petrobangla should try to avoid creation of such orphan land parcels. If creation of orphan land parcels could not be avoided, the land owners will be appropriately compensated (to be compensated if remaining land is no longer viable) as detailed out in Entitlement Matrix in the Resettlement Framework with special focus on vulnerable households.

Potential Livelihood Impacts

92. **Construction Phase:** The land parcels that will potentially go for land acquisition are agricultural lands and salt cultivation fields as assessed form satellite imagery and from the Reconnaissance Survey Report for the RLNG pipeline route. The impacts on different stakeholder groups are assessed as per paragraphs 91 to 95.

93. **Livelihood of Land Owners:** Owners and families deriving income from the land parcels involved in agricultural and salt pan activities for the pipeline and CTMS will be impacted due land loss, resulting in loss of their livelihood from the portion of the land to be acquired for the Project. Restriction on use of land in Project area may lead to impacting their livelihood and income. The impacts could also be long term and in some instances lead to change in occupational pattern (like cultivator to agricultural wage labour, contract worker etc.) if any sharecropping family or land depended workers is unable to find alternate land/ salt pan.Compensation will be paid as per the Resettlement Framework for the permanent loss of privately owned land (out of total ~30 acres) involved in the livelihood earning.

94. **Sharecroppers, Lessee Farmers & Land Depended Groups Salt Pan Workers**: Sharecroppers (if any) and salt harvesting workers cultivating along the onshore gas pipeline route and CTMS at *Napura* would have to discontinue their practice in the portion of land involved in agriculture and salt pan activities once the construction activities start. The impacts on crop productivity or livelihood losses for the land owner are expected during the construction period that is likely to last for a maximum of 12 months. Based on site visits on existing gas pipelines in the vicinity implemented by Petrobangla and discussions with the land owners along the pipelines recently constructed, it is confirmed that the private lands were available for continued use once the construction of the pipeline is completed and no permanent land losses are expected to the land owners due to the laying of the proposed gas pipelines. To ensure safety of the pipelines and for maintenance purposes, RBLTL will carry out consultations with the land owners informing them on restrictions to erect structures or plant large trees apart from allowing access to enable maintenance activities whenever required.

[1] Orphan land parcel is that land located outside of the normal compensation area but is made uneconomic by occupation or acquisition part of the plot. It is eligible for compensation. Compensation may be determined based on reviewing of the land parcel by Revenue Department or any Valuation Committee on cases to case basis if any land owner lodges a request.

95. The land owners will receive cash compensation, transition allowance and they will also be allowed to take away the crops, also the affected employees and wage earners will receive cash grants as defined in the Entitlement Matrix in the Resettlement Framework. Impact significance is assessed as **Moderate**.

Potential Impact on FishingActivities

96. Fishing is one of the primary livelihood options of the inhabitants of *Kutubdia* Island. As per the Fisheries Department records there are 168 registered fishermen in *Ali Fakir Deil* Village and 23 fishermen[1] in *Bindapara* Village in *Dakshin Dhurung* and *Kaiyarbil* Unions respectively. The fishermen practice deep-sea fishing, daily fishing, foot fishing/ shoreline fishing throughout the year as their livelihood means. The modelling of the cold water and machine cooling water discharge confirms that there is no appreciable decrease or increase in temperature in the worst-case scenarios within 100m of the mixing zone from the discharge location and therefore livelihood impacts on fishing communities are unlikely. Construction related impacts on livelihoods of fishing communities carrying out on-shore fishing and deep sea fishing activities along the ~2 km subsea pipeline is not expected as the pipeline will be laid through horizontal directional drilling underneath the seabed, without the need for (i) exclusion of fishing activities for the period of construction and operation; (ii) restriction of movement of fishing vessels, and (iii) access restrictions to the fishing grounds or traditional fishing routes. However, detailed livelihood impacts will be assessed including any restrictions on fishing and required measures to be developed in the Resettlement Plan. No impact on fishing activities are anticipated both during construction and operation phases.

97. **Spur Pipeline:** During construction phase ~2 km of subsea pipeline will be laid connecting FSRU/jetty to *Kutubdia* Island and further up to *Napura* through ~16 km onshore buried spur pipeline. The bow shaped pipeline laid through HDD technique from FSRU will exit at *Kutubdia* Island ~100 m from shore from where it will again run as subsurface below 2 m from ground level. The depth of pipeline in the beach area will be maintained below 3 m from ground level.There will be no impact on shoreline fishing for two nearby villages i.e. *Ali Fakir Deil* and *Bindapara* in terms of restriction on use of push nets and small setback nets (*choto behundi jal*). There is no fixed ground for shoreline fishing, the fishermen generaly shift north or south of the location depending on fish availability. As no onshore structure at *Kutubdia* Island or close to *Kutubdia* Channel are proposed, hence no potential impact on shoreline fishing activities are anticipated both during construction and operation phase of LNG terminal.

98. **Twin Berthing for FSRU and LNG Carrier:** The Floating Storage and Regasification Unit (FSRU) will be located in the Bay of Bengal, approximately 1.5 km from the north western shoreline off *Kutubdia* Island; it will have an exclusion zone of 500 m surrounding the FSRU/jetty for security and safety reasons. This will not directly impact fishing activities and the access routes for

[1] Ward wise list of registered fishermen as on 30th June, 2016, data received from District Fisheries Office

daily fishing or deep-sea fishing. The fishermen generally take a south-west route and north-west route sailing to the fishing grounds. There could be some minor disruption in existing fishing boat movements during the construction of the sub-sea pipeline laying but fishermen can continue fishing without access problems.

99. **Impacts related to livelihood during Operation Phase:** Positive impact on local enterprise and economy will improve from construction phase to operation phase in the immediate vicinity of the pipeline route and near CTMS that will see a spurt of entrepreneurial activity in the form of locals opening up food joints, tea stalls, spare-parts and repair outlets and general provisions.

Potential Impact on Community Health & Safety

100. Construction materials and heavy equipment used during the construction phase will be brought into the site through barges using the water ways. Though it will not cause any traffic congestions on roads and possible disruption to the community usage of roads – however, it will increase short term inconvenience to community due to air and noise pollution caused during construction phase pipeline laying.

101. Impacts, risks associated with access to waterways are comparatively lesser and the only identified impact is with respect to spillage and seepage in the sea due to lubeoil movement and handling and unloading/bunkering of fuel (diesel/marine gas oil). As there will be subsea pipeline thus eliminating earlier proposal of trestle for pipeline and onshore re-gasification, the potential risk to the fishing boats and the fishermen involved in shoreline fishing are eliminated. An exclusion zone of 500 m will be maintained surrounding FSRU/jetty, which will further eliminate potential safety risk to fishing boats. Potential societal risks will get attenuated due the proposal of subsea and subsurface (2 m below ground level) gas pipeline for its entire route. Adequate mitigation measures as outlined in the ESMP will be implemented to prevent and minimise impacts on community health and safety.

Potential Impact on Occupational Health & Safety

102. The health and safety risks during LNG terminal operations onboard FSRU include potential for respiratory diseases, burns, allergies and industrial accidents among the employees and the workers of other sub-contractors would be exposed to such risks. Impact on workers' health and safety is assessed to be **moderate**. Adequate mitigation measures as listed out in the ESMP will be implemented to prevent and minimise impacts occupational health and safety.

F) Analysis of Alternatives

Site Location Alternatives

103. Five locations on the west coast of Bangladesh were studied as potential locations for the LNG terminal *viz. Parki, Kutubdia, Matarbari, Maheshkhali / Sonadia* and Elephant Point. Among the five sites *Kutubdia* was selected as it was technically feasible; cost effective, least ecologically sensitive among the other sites.

Technology Alternatives

104. FSU/FRSU - The onshore regasification unit can protect the LNG facility from extreme weather conditions as the offshore facility would be more vulnerable to waves, currents and natural calamities (cyclones etc.). The operation cost of the offshore gasification would be higher due to high lease rate of FRSU. However, in case of FSRU, the onshore facilities will only comprise of RLNG pipeline and metering station (i.e. CTMS). This will require only ~26 acres of land for ~16 km subsurface pipeline and 3.95 acres for CTMS at *Napura* which would result in a significant reduction of societal risk and environmental and social footprint of onshore land. In view of this the FSRU option is preferred over the FSU option.

105. FSRU Berthing Options (Dual or Single Berthing) - Considering better operability in different climatic/oceanographic conditions, dual berthing option is preferred over the single berthing option and would support simultaneous LNG unloading and FSRU operations.

106. Offshore Pipeline - Submerged/ Pipeline on Trestle - Trestle mounted pipeline would be more vulnerable to oceanographic and climatic conditions compared to the subsea pipeline. Also the subsea pipeline is not expected to create significance disturbance to the benthic communities and do not create barrier to the movement of vessels as compared to the trestle mounted pipeline. So construction of subsea pipeline is considered to be more feasible option.

Pipeline Route Alternatives

107. Four pipeline alignment options from *Kutubdia* to CTMS at *Napura* were studied to identify the alignment with least environmental and social sensitivity. Channel and road crossing is more for Alignment A and Alignment B compared to the other alignments. Among the four alignments considered Alignment A and B will pass through mangrove vegetation and the other two alignments would not. The identified Alignment D with some modification to avoid mangroves, its route with minimal agricultural lands and will **not** result in physical displacement impacts along the entire length. The detailed surveys and design of the pipeline to be carried out prior to land take by Petrobangla.Minimum physical resettlement would take place for Alignment D. In view of this Alignment D is preferred over the other three routes.

G) Information Disclosure, Consultation and Participation

108. Series of consultations were held during the ESIA process with stakeholders to have an insight of the baseline situation of the site and regulatory and administrative setups in the *Kutubdia* LNG Terminal site. The first round of consultations were done from August to November 2016 and second from August 23 to 30, 2017. Documents with revised design were kept at offices of District Magistrate (Zila Parishad), Cox's Bazar and Sub Divisional Magistrate (Upazila Parishad), Kutubdia and Regional Office of Department of Environment, Cox's Bazar. Public Consultation was done on August 30, 2017 at Elham Community Centre, Kutubdia Island when 123 people (98 male + 25 female) including representation from ADB participated.This in turn helped in

developing an understanding of the perceptions of stakeholders with regards to the Project and also allowed for a means of recording their feedback. The stakeholder views expressed were incorporated in the ESIA and the planning and development of the Project. Further disclosure will be done as a part of the environmental clearance process, as well as a part for ADB's disclosure requirements.

H) Grievance Redressal Mechanism

109. A Grievance Redressal Mechanism (GRM) will be in place to handle and resolve the conflicts and aggrieved situations. It is understood that Reliance Power already has GRM in place. There will be a specific GRM that will be put in place by RBLTL for this Project. This Project specific GRM will be formulated in keeping with the process and procedure of the existing GRM and will be integrated into the same. The GRM will aim to provide a time bound and transparent mechanism for expressing and resolving social and environmental concerns linked to this Project. It is to be noted that the use of GRM by affected persons does not preclude access to the country's legal system or accessing the ADB's accountability mechanism.

I) Environment and Social Management Plan

110. Project specific Environment and Social Management Plans (ESMP) have been developed with an aim to avoid, reduce, mitigate, or compensate for adverse environmental and social impacts/risks and to propose enhancement measures. The ESMP covers:
- mitigation of potentially adverse impacts;
- monitoring of impacts and mitigation measures during Project implementation and operation;
- institutional capacity building and training;
- compliance to statutory requirements; and
- integration of the ESMP with Project planning, design, construction and operation.

Resettlement Framework

111. A Resettlement Framework has been prepared. The requisition and acquisition of land for the onshore gas spur pipeline and CTMS will be executed and owned by Petrobangla. RBLTL will be given the land for 15 years for erection of pipeline and subsequent RLNG transmission into GTCL's *Moheshkhali – Anwara* Section of national gas grid. The Resettlement Framework covers requirements to be followed by Petrobangla on compliance of national laws as well as ADB's Safeguard Policy Statement of 2009. Compensation arrangements for land acquisition, involuntary resettlement and livelihood restoration of the affected persons (APs) - title holders, non-titleholders, land users groups, encroachers are included in the Resettlement Framework.

Institutional Setting and Implementation Arrangements

112. The ESMP (mitigation plan) will be included in the construction contract and the contractor will be responsible for implementation of the measures associated

with design and construction. The Project Developer's staff, specifically the EHS Officer and Site Engineer, will monitor the implementation of these mitigation measures by the contractors at the site. These two officers will be responsible for the field level monitoring of the Project.

Environmental Monitoring

113. The environmental monitoring programme has been devised with the following objectives:
    - To evaluate the effectiveness of the proposed mitigation measures and the protection of the ambient environment as per prescribed/ applicable standards for the Project;
    - To identify the need for improvements in the management plans;
    - To verify compliance with statutory and community obligations; and
    - To allow comparison against baseline conditions and assess the changes in environmental quality in the Project area.

Reporting Mechanism for Environmental and Social Monitoring Program

114. A robust reporting system will provide the Project with the necessary feedback mechanisms to ensure quality and timely implementation of the works. The reporting system will ensure regular flows of information from the Project site to the Project headquarters and, as necessary, to regulatory authorities and funding agencies. The reporting system will provide a mechanism for ensuring that the measures proposed in the Project's ESMP are implemented. The quarterly reports of the management measures will form an integral part of the Quarterly Progress Reports that can be submitted to the lenders. Additional compliance reports to the Regional Office and Head Office of the Department of Environment (DoE) required as a part of environmental clearance process shall also be prepared and submitted based on the necessary monitoring and reporting formats.

J) Conclusion and Recommendations

115. This environmental and social impact assessment of the *Kutubdia* LNG Terminal ('the Project') has been prepared based on review of draft technical specifications of the Project (including recent revision of Project design) as provided by Reliance Power and through analysis of primary and secondary information of the site and surroundings as collated by ERM. Through this process, an assessment has been undertaken of the potential environmental and social risks and impacts that may be attributed by the development of the Project in its pre-construction, construction and operation phases.

116. The Project will have both positive and adverse impacts on social environment. The positive impacts will include temporary employment opportunity for the unskilled labourers during the construction period and business opportunities for the local people. Based on the present level of information available from the Project Developer it is anticipated that the Project is likely to have adverse social impacts pertaining to permanent land loss (of 3.95 acres for CTMS and 26.361 acres for subsurface pipeline), land fragmentation due to subsurface ~16 km

pipeline, potential physical displacement, loss of income (that may include agricultural labourers, sharecroppers, workers/labourers of salt pans), loss of productive land, potential temporary income loss during construction activities for the subsea pipeline erection. The impacts may be localised and some are permanent in nature that can be mitigated with appropriate measures.

117. The construction phase of the Project (of ~12 months from the date of obtaining of all approvals) will have an important role in the socio-economic development of the area, whereas the operation phase of the Project will play an important role by supplying gas in the region. A reliable and expanded gas supply will support future economic development of dependent sectors like industry and manufacturing enabling them to operate and compete.

118. During the operation phase of the Project, the two key impacts will be from the increase in ambient noise and air quality levels due to operation of plant equipment and auxiliary machinery.

119. Based on the analysis conducted in this environmental and social assessment, it is concluded that overall the Project will result in moderate positive socio-economic benefits and the potential negative environmental and social impacts that have been identified as mostly short-term and localised in nature, and can be minimized adequately through good design, appropriate application of mitigation measures and regular supervision of implementation.

1 INTRODUCTION

1. In Bangladesh, the demand for natural gas is rapidly rising due to its diversified use in industrial and electric power sector. On the contrary, the existing reserves are depleting. As a consequence, Bangladesh has been experiencing gas shortages, especially in respect of the gas fired power plants that has resulted in several of them running below the rated capacity and few remaining shut due to non-availability of gas.

2. Indications that indigenous gas resources are falling below sustainable economic operational levels and eventually may run out in the short- to medium-term have resulted in the need for supplementary feedstock in form of importing liquefied natural gas (LNG). Keeping this in view, Reliance Power Limited (hereinafter referred to as Reliance Power or RPL or the Client) through their subsidiary in Bangladesh, Reliance Bangladesh LNG Terminal Limited (RBLTL) plans to establish a offshore LNG storage and re-gasification facility of up to 5.0 million tonnes per annum (MMTPA) capacity with peak send out load of 750 million standard cubic feet per day (MMSCFD). There will be LNG storage of 137,000 m^3 to 216,000 m^3 in Floating Storage and Regasification Unit (FSRU) located offshore *Kutubdia* Island with connecting pipeline from *Kutubdia* Island to custody transfer metering station (CTMS) at *Napura* in *Cox's Bazar* region of Bangladesh (hereinafter referred to as the Project). Reliance Power Limited through their subsidiary in Bangladesh – Reliance Bangladesh LNG and Power Limited (RBLPL), has strategic plans to establish itself as an Independent Power Producer (IPP). Accordingly, RBLPL proposes to develop a combined cycle gas based power plant of capacity 750 MW (Natural Gas/RLNG based) in Bangladesh to meet the existing power shortage and the demand-growth in future years.

3. Presently at the Project planning stage, an environmental and social impact assessment (ESIA) study has been commissioned to comply with the requirements of environmental impact assessment ("EIA") guidelines of the Government of Bangladesh ("GoB") to obtain necessary Environmental Clearance Certificate for the Project. RBLTL is seeking finance from international lenders including Asian Development Bank (ADB) for setting up of the Project hence the ESIA needs to conform to the guidelines and requirements of the ADB.

4. ERM India Private Limited (*hereinafter referred as "ERM"*) has been engaged to conduct this ESIA study. At the first phase, an Initial Environmental Examination (IEE) was carried out as part of the ESIA process. The current deliverable presents the ESIA report developed by ERM based on revision in the Project design post submission of the draft ESIA by ERM in March 2017.

1.1 PROJECT BACKGROUND

5. The LNG terminal is proposed to be located offshore of *Kutubdia* Island in the *Cox's Bazar* District of Bangladesh (Refer to ***Figure 1.1***). The *Kutubdia* Island is isolated from main shore of Bangladesh. There is no direct road access to this island. The *Kutubdia* Channel has to be crossed to reach the island.

6. The proposed facility is being planned as offshore Floating Storage and Regasification (FSRU) unit off *Kutubdia* Island. The techno economic feasibility for this Project is currently being explored by Reliance Power. Overall the Project will consist of the following:

Marine component off *Kutubdia* Island covering

i) Twin (double berth) jetty with topside (1.5 km to the west of *Kutubdia* Island) with 0.5 MW gas based power generation;
ii) Floating Storage and Regasification Unit (FSRU) (of storage capacity of 137,000 m^3 to 216,000 m^3) to be moored starboard side of the jetty;
iii) Regasification onboard FSRU of 750 MMSCFD peak capacity with ~10 MW onboard gas based power generation;
iv) High pressure 30 inches (30") subsea ~2.0 km regasified LNG pipeline;

Onshore component covering

v) Subsurface/subsea gas spur pipeline of ~16 km length (30 inches diameter) connecting *Kutubdia* Island to custody transfer metering station (CTMS) through Valve Station no. 2 to be located at *Napura, Banskhali* from where the gas pipeline will be connected into the GTCL's national gas grid pipeline of *Moheshkhalli – Anwara* Section. The pipeline length of ~16 km also includes 2.7 km of subsea pipeline length passing through *Kutubdia* Channel. The CTMS at *Napura* will also have 0.5 MW (625 kVA) gas based power generating unit and pipeline pigging facility.

Note: Earlier, draft ESIA of March 2017 was developed by ERM based on Project design comprising of:

a) offshore jetty for LNG cargo unloading;
b) offshore floating storage unit (FSU) for storage of unloaded LNG;
c) 2.4 km long cryogenic pipeline on motorable trestle for LNG transfer from offshore to onshore;
d) onshore regasification facility at *Kutubdia* Island (spread over in ~34 acres);
e) utilities comprising of onshore gas based captive power generation of 20 MW and other services;
f) onshore LNG storage tank (for future storage;
g) 17-km long high pressure gas spur pipeline up to *Napura* to send out maximum 750 MMSCFD; and
h) custody transfer metering station at *Napura, Banskhali* for transfer of gas into GTCL' national grid.

This ESIA of October 2017 has been revised following change of the Project design - thus to cover

a) offshore jetty for LNG cargo unloading;
b) floating storage and regasification unit (FSRU) for offshore LNG storage and regasification;
c) high pressure subsea gas pipeline of ~2.0 km long for transfer of regassified LNG (RLNG) direct from offshore FSRU connecting to onshore

spur pipeline of ~16-km from *Kutubdia* Island up to *Napura* to send out maximum 750 MMSCFD;

d) custody transfer metering station (CTMS) at *Napura*, *Banskhali* for transfer of high pressure gas into GTCL' national grid pipeline

e) utilities comprising of ~10 MW gas based power generation onboard FSRU+ 0.5 MW gas based power generation at jetty + 0.5 MW gas based power generation at CTMS Napura. At each location alternate power source will be available to meet emergency situation.

With the change of the Project design, impacts due to offshore pipeline on trestle, onshore regasification at earlier proposed land fall point, emissions from onshore gas based captive power plant of 20 MW and future onshore LNG storage tank are eliminated in this ESIA. Also the land requirement for Land Based Facility at *Kutubdia* Island is no more required.

1.2 PROFILE OF THE PROJECT PROPONENT

7. Reliance Power Limited (Project proponent) is part of the Reliance Group. Reliance Power has been established to develop, construct and operate power projects both in India as well as internationally. The Company on its own and through its subsidiaries has a large portfolio of power generation capacity, both in operation as well as capacity under development.

8. The subsidiaries of Reliance Power Limitd i.e. RBLPL and RBLTL are operating in Bangladesh from September 2016[1] from their office premises at *Rupayan Karim* Tower at *Kakrail*, Dhaka. It is also planned that RBLTL will set up a site office near the Project site on *Kutubdia* Island before initiation of construction stage.

1.3 PROJECT RATIONALE

9. Bangladesh is heavily dependent on natural gas and the demand for natural gas is growing rapidly while existing reserves are depleting. The country faces severe gas shortages of around 500-650 MMSCFD that are forecasted to increase. Its recoverable gas reserves of 16.36 trillion cubic feet is set to be exhausted within the next decade if no new gas fields are discovered.

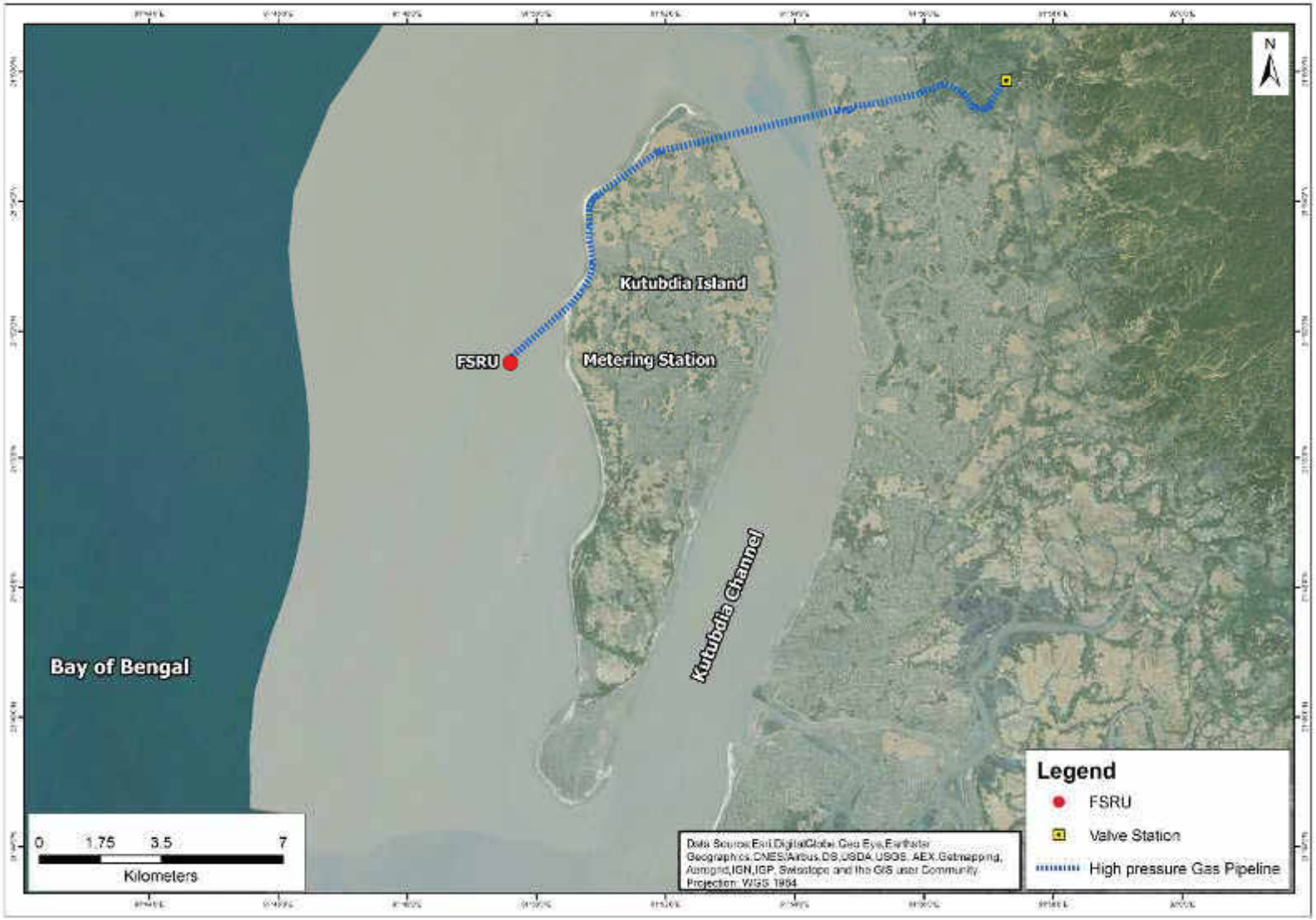
10. The World Bank estimates that most industrial facilities in Bangladesh are operating at half of their installed capacity due to a lack of reliable power and gas. Reliable long-term availability of natural gas is critical to the development of competitive industry in the country.

11. This gas deficit has especially affected gas-fired power plants. These plants are either running below their rated capacity or have been shut down due to non-availability of gas. To address this gas crisis, Government of Peoples' Republic of Bangladesh i.e. Government of Bangladesh (GoB) is initiating projects related to import of LNG. GOB is proposing to change the lease agreement model from Build, Own and Operate (BOO) for 22 years (as proposed earlier based on FSU)

[1] Reliance Bangladesh LNG and Power Limited (RBLPL) has been incorporated on Sep 21, 2016 under the Companies Act (Act XVIII) of 1994 in Bangladesh.

to Build, Own, Operate and Transfer (BOOT) for 15 years (as revised now). Thus the Lease Agreement would result in transfer of the Project with FSRU to GOB after 15 years. Keeping this in view; Reliance Power has planned to establish a LNG terminal of up to 5.0 MMTPA capacity off *Kutubdia* Island in the *Cox's Bazar* District of Bangladesh.

Figure 1.1 Location of Project Site (showing offshore LNG Terminal & Connecting Onshore Subsurface & Subsea Pipeline Route)



1.4 PURPOSE & SCOPE OF THE ESIA

1.4.1 Purpose of the ESIA

12. Reliance Power has approached the ADB for raising investment capital for the Project. As per the ADB's environmental and social screening criteria, the proposed Project falls under category A for environmental components and category B for social components. Overall the Project is classified as category A. The Project will conform to the ADB's Safeguard Policy Statement (SPS), 2009 in respect of environment and social sustainability to meet the safeguard principles and the requirements of disclosure and consultation under Category "A" and thus requires a comprehensive Environmental and Social Impact Assessment (ESIA) study.

13. Applicable regulatory regime in Bangladesh in this regard is principally driven through the Environment Conservation Act (ECA), 1995 (as amended in 2000, 2002 and 2010) and the Environmental Conservation Rules (ECR), 1997 and ensures that "*no industrial unit or project shall be established or undertaken without obtaining, in the manner prescribed by rules, an Environmental Clearance Certificate from the Director General*". Ensuring compliance with the provision of this Act and Rules is the responsibility of the Department of Environment (DoE). As per the *ECR 1997*, the proposed LNG terminal Project falls under the Red category due to:
    - *Item 65:* Exploration/extraction/distribution of mineral resources;
    - *Item 64:* Water, power and gas distribution line laying/relaying/ extension.

14. Hence, this ESIA study was carried out to meet the environmental and social safeguard requirements of the ADB as well as the relevant country's applicable laws. The applicable reference framework used for the study is as follows:
    - Applicable Bangladesh national, regional and local regulatory requirements.
    - ADB's Safeguard Policy Statement ("SPS") (2009);
    - ADB Social Protection Strategy (2001);
    - ADB's Public Communications Policy (2011);
    - IFC Performance Standards for Environmental and Social Sustainability (2012);
    - IFC General EHS Guidelines (2007); and
    - IFC EHS Guidelines for LNG Facilities (April 2017)
    - IFC EHS Guidelines for Offshore Oil and Gas Development (June 2015)
    - International Convention for the Prevention and Control of Polllution from Ships: MARPOL 73/78 as amended

15. The reference framework and its applicability with respect to the Project have been further described in ***Section 2*** of this Report.

1.4.2 Scope of the ESIA

16. The detailed scope of the ESIA study is outlined as following:
    - Screening of the Project based on applicable reference framework based on reconnaissance survey and desk based review of Project documents;
    - Scoping for the ESIA study;
    - Development of an integrated description of the Project components including its sub-components, which are under the purview of the Project Proponent (Reliance Power);
    - Development of a regulatory, policy and administrative framework relevant to the Project;
    - Monitoring, analysis and reporting of the environmental and social baseline data of the study area including consultation with local communities and other stakeholders;
    - Assessment of the environmental impacts of the Project in the study area based on professional judgement along with stakeholder consultation and feedback;
    - Assessment of social impacts on the local community as well as Project affected people and any other stakeholders, which have been identified during the social consultation process;
    - Risk assessment and consequence analysis of the Project;
    - Formulation of an Environment and Social Management Plan and associated/specific mitigation plans for identified impacts; and
    - Formulation of Stakeholder Consultation and Grievance Redress Mechanism for the Project.

1.5 APPROACH & METHODOLOGY

17. As the first step, project screening and scoping exercise was undertaken to identify the parameters needed to be considered for the study and to outline the activities for collecting data on each parameter. Data pertaining to all facets of the environment viz. physical, ecological and socioeconomic environment were collected from the study area (10 km around the marine facilities and 500 m around both sides of the onshore pipeline route) through both primary and secondary sources. The stepwise activities are detailed in the following subsections:

1.5.1 Discussions with Project Proponent

18. Discussions were held with Reliance Power, to understand the proposed Project, current status of agreements (i.e. implementation, land, water, power supply, etc.), project milestones, legal requirements and scope and collation of relevant project documents such as the Site and Configuration Selection Report, Reconnaissance Survey Report for LNG Terminal and Associated Pipeline, Onshore Facility Layout, etc.

1.5.2 Screening & Scoping Exercise

19. The screening and scoping exercise involved the following:
    - Desk based review of the relevant documents and available imagery of the Project site and its surroundings;
    - Reconnaissance survey of the site and surrounding areas and preliminary discussions with local people, local government officials and other stakeholders;
    - Meetings and discussions with Regional Office of Department of Environment (DOE) at *Cox's Bazar*, to understand sensitivities and regulatory requirements associated with the proposed Project;
    - The outcome of the screening was then used to identify the study area, key data to be collected and the categorization of the Project; and
    - A preliminary stakeholder mapping exercise was also undertaken to identify key stakeholders from the Government, relevant Governmental Agencies, Non-Governmental Organisations (NGOs) as well as the community at the local, regional and national level. This information was then used for consultation during different stages of the Project.

20. *Categorization*: Categorization of the Project was attempted based on the Project description, the screening assessment, reconnaissance survey, environmental and social sensitivities, limited consultation and the DOE categorization; ADB's categorisation criteria based on environment categorisation, involuntary resettlement (IR) impact categorisation checklist and indigenous peoples (IP) impact screening checklist; as well as with reference to the IFC's approach to categorization.

21. *Scoping*: The categorization with respect to ADB and IFC classifications was further used as a basis for defining scope for the impact assessment, planning and implementation of mitigation, monitoring and reporting mechanisms for the project to meet potential Lender's requirements as well as those of the GoB.

1.5.3 Baseline Data Collection

22. Baseline data collection involved the following:
    - Identification of the monitoring locations for air, water, soil, sediment, biomonitoring and noise as per sensitive receptors, key locations for the Project facilities and their surrounding areas;
    - The baseline data collection, monitoring and analysis for environmental parameters was completed during the period from October – November, 2016;
    - Socio-economic data collection and consultation was carried during August and November 2016 and subsequently discussions were held during May and August 2017 during process of identification of land parcels involved for the onshore components;
    - Secondary data was also collected from different government departments, local bodies and through literature surveys etc.; and

- All the data was compiled and compared with applicable standards where relevant, and is presented in ***Section 4*** of this report.

1.5.4 Stakeholder Consultation

23. The following activities were undertaken:
    - Extensive consultation was conducted with key stakeholders' including the local population, government departments/agencies, fishermen, and NGOs;
    - Stakeholder consultation was completed with the intent of collecting baseline information on the environmental and social conditions and sensitivities, developing a better understanding of the potential impacts, informing the public of the proposed Project and to gain an understanding of the perspectives/concerns of the stakeholders;
    - A summary of the stakeholder engagement process and the profile of the groups and their opinions forms a part of the Section on Information Disclosure, Consultation and Participation in this report (***Section 7***); and
    - Information gathered was used for formulating mitigation measures and environmental and social management plan.

1.5.5 Impact Assessment & Mitigation Measures

24. It involved the following:
    - Analysis of the baseline results and the impacts of the Project were assessed in accordance with the Bangladesh national guidelines for air, water and noise emissions; standards stipulated in the Environment Conservation Rules (ECR), 1997 and amendments thereof and with reference to the IFC's Performance Standards, ADB Safeguard Policy Statement and the IFC's Environmental, Health and Safety (EHS) Guidelines;
    - The impact assessment involved the prediction and evaluation of impacts from the Project in different phases, including site preparation, construction and operation phases of the Project and included consideration of mitigation measures towards the same;
    - Impact prediction covered residual impacts (impacts remaining after all possible mitigation has been incorporated) and took into account control measures that are part of the Project design. Additional measures aimed at further avoiding, minimizing and mitigating predicted impacts were suggested where necessary or appropriate;
    - Impact assessment has also covered potential for cumulative impacts if any due to presence of existing and planned future developments in the region.
    - Impact assessment also involved risk assessment covering hazard identification, consequence analysis and risk reduction measures and recommendations; and
    - Impacts have been further classified as insignificant, minor, moderate or major based on the criteria for rating of impacts.

1.5.6 Analysis of Alternatives

25. Analysis of alternative options was considered to minimise impacts of the Project while undertaking this ESIA study. The alternative options assessed in the study ranged from technology, transportation methods, site and operations, including the no project alternative. Alternatives are considered in terms of their potential environmental impacts, the feasibility of mitigating these impacts alternatives for mitigation measures for high residual impact/risk, if any etc.

1.5.7 Risk Assessment

26. A risk assessment study has been carried out to provide a systematic analysis of the major risks that may arise as a result of the operation of the proposed LNG terminal covering both offshore and onshore facilities. It involved rational evaluations of the identified risks based on their significance and provided an outline for appropriate preventive and risk mitigation measures. The output of the assessment contributed towards strengthening of emergency response planning in order to prevent damage to personnel, infrastructure and receptors in the immediate vicinity of the proposed facilities. An initial Risk Assessment with Emergnecy Response and Disaster Management Plan is presented in ***Annex 13***.

1.5.8 Management Plans & Grievance Redress Mechanism

27. It involved the following:
    - Environmental and Social Management Plan (ESMP) were developed for the mitigation measures suggested and included defined roles and responsibilities for implementation;
    - A grievance redress mechanism was developed to address any complaints and concerns from all stakeholders;
    - Based on the risk assessment, risk reduction measures and recommendations for a disaster management plan (DMP) were also developed; and
    - Institutional review and finalization of the EMP and grievance redress mechanism were completed in consultation with Reliance Power.

1.6 LIMITATIONS

28. ERM would like to highlight the following limitations to this ESIA document as stated below. A project configuration has been developed by Reliance Power and preliminary feasibility has been established around the same. Detailed feasibility with revised Project components (earlier from FSU to now FSRU) provided by Reliance Power as on mid August 2017 has been considered as input to this ESIA study. The present ESIA considers the revised Project information provided by Reliance Power along with the most likely projects components (as has been summarized in ***Sections 1 & 3*** of this report) are representative for the purpose of impact assessment.

29. The land requirement, ownership details and current status of land for onshore project components i.e. spur pipeline and custody transfer metering system are presently in the process of getting finalized. The Project related land requisition and acquisition will be done by Petrobangla. For the land requisition and acquisition by Petrobangla, a Resettlement Framework has been prepared for its implementation by Petrobangla thus complying with the national law and ADB's SPS 2009.

30. Discussions with Reliance Power indicated that technical designs would be further optimised in the final Feasibility Report and efforts made to the extent possible to reduce and minimise Involuntary Resettlement impacts.

Uses of this Report

31. The Client acknowledges that report provided by ERM in relation to the provision of Services is delivered to the Client solely for the Client's benefit. ERM, its officers, employees, contractors, and agents shall owe no duties, obligations or liabilities to any persons in connection with any use of or reliance on the Project information provided by Reliance Power. We make no warranties, express or implied, including without limitation, warranties as to merchantability or fitness for a particular purpose.

32. ERM is not engaged in social and environmental, health & safety consulting and reporting for the purposes of advertising, sales promotion, or endorsement of any client's interests, including raising investment capital or recommending investment decisions, or other publicity purposes. The client acknowledges that the report prepared by ERM are for exclusive use of the client and agrees that ERM's reports or correspondence will not be used or reproduced in full or in part for such promotional purposes, and may not be used or relied upon in any prospectus or offering circular. The client also agrees that none of its advertising, sales promotion, or other publicity matter containing any information obtained from these assessments or reports, either in parts or entirety, will make reference to ERM's trade name.

33. Nothing contained in this report shall be construed as a warranty or affirmation by ERM that the site and property described in the report are suitable collateral for any loan or that acquisition of such property by any lender through foreclosure proceedings or otherwise will not expose the lender to potential environmental or social liability.

1.7 INPUT INFORMATION/DATA SOURCES

34. Key relevant information sources have been summarized in ***Table 1.1***.

Table 1.1 Key Data Sources for the ESIA

Parameters	Information sources	Remarks
Project Background, Technical details on project components, pipeline route and CTMS location	▪ Site and Configuration Selection Report - Reliance Bangladesh LNG Import Terminal Feasibility Study , September 2016 ▪ Report on Reconnaissance Survey for LNG Terminal and spur pipeline up to *Napura*, Cox Bazar, Bangladesh, December 2016 ▪ Desktop Study for Site Screening in Chittagong and *Moheshkhali* Region, Bangladesh, March 2016	Reliance Power provided other information as available during the course of the study.
Study area features and sensitivities	▪ Ground physical survey ▪ Satellite imageries ▪ National web portal of Bangladesh: www.bangladesh.gov.bd	Details of the satellite data used is included in Baseline Section
Legal framework	▪ Department of Environment ▪ Board of Investment, Bangladesh ▪ IFC and ADB documents	Discussions with and weblinks of DOE, Govt. departments and Reliance Power
Landuse/ Land cover details	▪ Ground Physical Survey ▪ GIS based landuse analysis	Details of the satellite imagery used is included in the Baseline Section
Meteorology and climatic conditions	▪ Bangladesh Meteorological Department ▪ Kutubdia Observatory Surface Meteorological Data	
Geology, topography, soil, hydrology , drainage and met oceanic conditions	▪ RPL's Site and Configuration Selection Report ▪ RPL's Desktop Study for Site Screening in *Chittagong* and *Moheshkhali* Region ▪ Bangladesh Water Development Board ▪ Soil Research and Development Institute of Bangladesh ▪ Scientific Papers and Technical Journals ▪ Previous EIA / ESIA Studies conducted in the *Matarbari / Moheshkhali* region ▪ Web portal of National Encyclopedia of Bangladesh (Banglapedia)	In association with field observations
Natural hazards	▪ Bangladesh Meteorological Department ▪ *Upazila* Disaster Management Committee, *Kutubdia* ▪ Study Reports and Research Papers ▪ Web portal of National Encyclopedia of Bangladesh (Banglapedia)	Included in consultation with locals
Environmental baseline as air quality, water quality, soil and sediment quality, noise and traffic	▪ Primary data collection ▪ Applicable Standards from Department of Environment (DOE), Bangladesh	Monitoring was completed from October to November 2016
Ecological parameters	▪ Primary data collection, observations, surveys and local consultations ▪ Websites of birdlife international ▪ IUCN Data base ▪ Chittagong Coastal Forest Division ▪ Coastal Forest Department Office, *Kutubdia* ▪ Marinelife Alliance, *Cox's Bazar* ▪ Study Reports and Research Papers	Survey was carried out in month of Nov 2016. Endangered, critical status was checked from the website www.iucnredlist.org

Parameters	Information sources	Remarks
Socio-economic parameters	▪ Primary data collection surveys, extensive consultations, meetings and discussions held with stakeholders ▪ Bangladesh population and housing census for 2011 for Cox's Bazar District ▪ General Economics Division, Planning Commission, Government of Bangladesh ▪ Bangladesh Bureau of Statistics ▪ Department of Fisheries, Ministry of Fisheries and Livestock, Bangladesh ▪ Divisional Fisheries Office, *Cox's Bazar* ▪ Office of Dy. Commissioner, *Cox's Bazar* ▪ Land Revenue Department, *Cox's Bazar* ▪ Office of *Upazila Nirbahi* Officer (UNO), *Kutubdia* ▪ Fisheries Cell, *Kutubdia* ▪ Upazila Health Complex, *Kutubdia* ▪ Upazila Education Office, *Kutubdia* ▪ Agriculture Department, *Kutubdia* ▪ BSCIC Salt Office, *Cox's Bazar* ▪ Web portal of National Encyclopaedia of Bangladesh (Banglapedia)	Field surveys and consultations were carried out in the months of August and November 2016 and May and August 2017. Details provided in Annex 10 and included in section on baseline environmental and social conditions

Note: A detailed list of references is annexed at the end of the report as **Annex 1.**

1.8 STRUCTURE OF ESIA REPORT

35. The content of the ESIA has been largely structured based on the ADB's Safeguard Policy Statement (Outline of an Environmental Impact Assessment Report). The layout of the Report is as follows:

- ***Section 1*** : Introduction
- ***Section 2*** : Policy, Legal and Administrative Framework
- ***Section 3*** : Description of the Project
- ***Section 4*** : Description of the Environment
- ***Section 5*** : Impact Assessment and Mitigation Measures
- ***Section 6*** : Analysis of Alternatives
- ***Section 7*** : Information Disclosure, Consultation and Participation
- ***Section 8*** : Grievance Redress Mechanism
- ***Section 9*** : Environnent and Social Management Plan
- ***Section 10***: Conclusions and Recommendations
- ***Annexes 1 to 14***

2 POLICY, LEGAL & ADMINISTRATIVE FRAMEWORK

2.1 INTRODUCTION

36. The GoB has specified regulations, policies and guidelines to address environmental and social risks of any project and its associated components and to protect and conserve the environment from any adverse impacts. International Lenders' also have their own set of policies including to comply with the requirements of the ADB's Safeguard Policy and IFC's Performance Standards to which any project funded by them must operate.

37. This Section focuses on the administrative framework under the purview of which the Project will fall and the ESIA study will be governed, namely:
    - Bangladesh national and local, legal and institutional framework;
    - ADB Policies and framework;
    - IFC Performance Standards and EHS Guidelines.

2.2 ENVIRONMENT-RELATED POLICIES IN BANGLADESH

38. The GoB has developed a policy framework that requires environmental issues to be incorporated into economic development planning. The key tenets of the various applicable policies are detailed in the following subsections.

2.2.1 National Environmental Policy, 1992

39. The Bangladesh National Environmental Policy, approved in May 1992, sets out the basic framework for environmental action together with a set of broad sectoral action guidelines.

40. The Policy requires specific actions with respect to the industrial sector which are as follows:
    - To phase-in corrective measures in polluting industries;
    - To conduct Environmental Impact Assessments (EIAs) for all new public and private industrial developments;
    - To ban, or find environmentally sound alternatives for, the production of goods that cause environmental pollution; and
    - To minimize waste and ensure sustainable use of resources by industry.

41. The policy also states that EIAs should be conducted before projects are undertaken and the Department of Environment (DOE) is directed to review and approve all Environmental Impact Assessments.

2.2.2 *Other Relevant Policies*

42. Other relevant policies in Bangladesh and their key features and applicability to the subject Project are detailed in ***Table 2.1***.

Table 2.1 Policies relevant to the Environment

Policy	Key Features	Applicability
National Conservation Strategy, 1992	▪ All industries shall be subject to an EIA; ▪ Adoption of pollution prevention/control technologies shall be enforced; ▪ Hazardous or toxic materials/wastes shall not be imported as raw materials; ▪ Import of appropriate and environmentally-sound technology; ▪ Dependence on imported technology and machinery gradually be reduced in favour of sustainable local skills and resources.	Applicable as the Project is an industrial sector development
The National Forest Policy, 1994	▪ Afforestation of 20% project land ▪ Bio-diversity of the existing degraded forests ▪ Strengthening of the agricultural sector ▪ Control of Global warming, desertification ▪ Control of trade in wild birds and animals ▪ Prevention of illegal occupation of the forested land, tree felling and hunting of wild animals	Applicable when considering global warming and the protection of forests
National Land Transport Policy, 2004	▪ All new roads and major improvements will be subjected to an EIA ▪ Funding will be provided for mitigation measures ▪ The Government will publish environmental standards for new roads and new design standards addressing environmental issues	Not directly applicable, however, the standards may apply for the project approach road (that will be refurbished and strengthened)
The National Water Policy, 1999	▪ Protection, restoration and enhancement of water resources ▪ Protection of water quality, including strengthening regulations concerning agrochemicals and industrial effluent ▪ Sanitation and potable water ▪ Fish and fisheries ▪ Participation of local communities in all water sector development	Applicable for the preservation of water quality Applicable, the bay and the *Kutubdia* Channel may also be used for transport of construction materials and laying of subsea pipeline.
National Landuse Policy, 2001	▪ Deals with several land uses including: agriculture (crop production, fishery and livestock), housing, forestry, industrialization, railways and roads, tea and rubber ▪ Identifies land use constraints in all these sectors	Applicable as land use changes from sandy beach / agricultural to industrial

Policy	Key Features	Applicability
Draft Wetland Policy, 1998	▪ Establishment of principles for the sustainable use of wetland resources ▪ Maintenance of the existing level of biological diversity ▪ Maintenance of the functions and values of wetlands ▪ Promotion and recognition of the value of wetland functions in resource management and economic development	Not directly applicable, however may be applicable once the draft policy is finalised
National Fisheries Policy, 1998	▪ Preservation, management and exploitation of fisheries resources in inland open water ▪ Fish cultivation and management in inland closed water. ▪ Prawn and fish cultivation in coastal areas ▪ Preservation, management and exploitation of sea fishery resources	Applicable as fishing is the prime occupation of the community in *Kutubdia*.
National Agriculture Policy, 1999	▪ The Policy deals with the programs related to make the nation self-sufficient in food through increasing production of all crops, including cereals, and ensure a dependable food security system for all	Not applicable
The Energy Policy, 1996	▪ Provides for utilization of energy for sustainable economic growth, supply to different zones of the country, development of the indigenous energy source and environmentally sound sustainable energy development programmes ▪ Highlights the importance of EIA for any new energy development project	Not directly applicable
The Power Policy, 1995	▪ The Power Policy is an integral part of the Energy Policy and deals with policy statement on demand forecast, long term planning and project implementation, investment terms, fuels and technologies, load management, institutional issues, private sector participation, technology transfer and research programme, environmental policy and legal issues	Applicable as the interlinked project is a power plant. The project also includes offshore power generation ~10 MW onboard FSRU, 0.5 MW based power generation jetty and onshore power generation through gas engines of ~0.5 MW at CTMS.
Industrial Policy, 1999	▪ Deals with industrial development, direct foreign investments, investment by public and private sector, introduction of new appropriate technology, women's participation, infrastructure development and environmentally sound industrial development	Applicable as the Project is a private sector, industrial development

2.3 ENVIRONMENT & SOCIAL RELATED LEGISLATIONS IN BANGLADESH

43. The main acts and regulations guiding environmental protection and conservation in Bangladesh are outlined in the following subsections and ***Table 2.2***.

2.3.1 The Environment Conservation Act, 1995 (as amended in 2000, 2002 & 2010)

44. The provisions of the EC Act authorize the Director General of Department of Environment (DOE) to undertake any activity that is deemed fit and necessary to conserve and enhance the quality of environment and to control, prevent and mitigate pollution. The main highlights of the act are:
    - Declaration of Ecologically Critical Areas;
    - Obtaining Environmental Clearance Certificate;
    - Promulgation of standards for quality of air, water, noise, and soils for different areas and for different purposes;
    - Promulgation of acceptable limits for discharging and emitting waste; and
    - Formulation of environmental guidelines relating to control and mitigation of environmental pollution, conservation and improvement of environment.

2.3.2 Environment Conservation Rules (ECR), 1997 (as amended in 2002 & 2003)

45. The Environment Conservation Rules, 1997 are the first set of rules promulgated under the Environment Conservation Act, 1995. These Rules provide for, inter-alia, the following:
    - The National Environmental Quality Standards (EQS) for ambient air, surface water, groundwater, drinking water, industrial effluents, emissions, noise and vehicular exhaust;
    - Categorization of industries, development projects and other activities on the basis of actual (for existing industries/development projects/ activities) and anticipated (for proposed industries/development projects/activities) pollution load;
    - Procedure for obtaining Environmental Clearance Certificate;
    - Requirements for undertaking IEE and EIA as well as formulating EMP according to categories of industries/development projects/ activities; and
    - Procedure for damage-claim by persons affected / likely to be affected due to polluting activities or activities causing hindrance to normal civic life.

2.3.3 Acquisition & Requisition of Immovable Property Ordinance, 1982

46. The basic principles behind compensation of property in Bangladesh are founded in Articles 42 and 47 of the Constitution (1972). The current legislation for governing land acquisition in Bangladesh is the "Acquisition and Requisition of Immovable Property Ordinance (ARIPO), 1982 and amended in 1983, 1993 and 1994. Key features of the ordinance are as follows:
    - This Ordinance provides the Deputy Commissioner (DC) with the power to initiate the acquisition of any property in any locality within his district that is likely to be needed for a public purpose or in the public interest.

- It also defines the process to claim compensation.
- It describes the entire procedure of notice and intimations prior to acquisition of any property and process and timeframes for raising objections.
- It defines the role and authority of Deputy Commissioner in decision making, compensation issues and in case of dispute. Among the matters to be considered in determining compensation are the following:
  - The damage that may be sustained by the person interested, by reason of the taking of standing crops or trees which may be on the property at the time of taking possession thereof by the Deputy Commissioner,
  - The damage that may be sustained by reason of the acquisition injuriously affecting his other properties, movable or immovable, in any other matter, or his earnings; and
  - If in consequence of the acquisition of the property, the person interested is likely to be compelled to change his residence or place of business, the reasonable expenses, if any, incidental to such change will be paid in terms of compensation. The Ordinance explicitly states that the DC, when determining compensation, shall neither consider any disinclination of the person to part with the property, nor any increase in the value of the property to be acquired likely to accrue from the use of it after it has been acquired.
- The Ordinance also covers the case of temporary acquisition of property for a public purpose or in the public interest.

Property (Emergency) Acquisition Act, 1989

47. The Act was formulated to expedite the emergency acquisition of land to enable the Government to control inundation, flood and upsurge caused by natural calamity and to prevent river erosion. The 1989 Act complements the 1982 Ordinance in special circumstances. Normally, acquisition of land for development purposes would not come under the 1989 Act. Use of this Act to acquire land for development would require extremely compelling reasons.

2.3.4 Framework for Leasing of Government-owned (Khas) Agricultural Land

48. The rules for managing and leasing Government-owned (*khas*) land are notified through two Bangladesh Gazette notifications i.e. : (1) Notification: *Bhumo/Sha-8/Kha-jo-bo/46/84/261*, Bangladesh Gazette Extra Edition dated May 12, 1997, pp 1527-1536; and (2) Notification: *Shuno/ Sha-4/Kri-kha-jo--bo-1/98-264*, Bangladesh Gazette, September 15, 1998.

49. Under these regulations, the Government leases cultivable agricultural land in the rural areas to landless farming households. The allotments cannot be more than one acre, except in the southern districts where up to 1.5 acres of *char* land can be allotted. The regulation further defines structure and responsibilities for management and leasing of *Khas* Lands at the National, District, and *Thana* levels.

50. ***Table 2.2*** presents an outline of National legal instruments relevant to the proposed Project with respect to the environmental and social considerations.

2.4 ADMINISTRATIVE SETUP RELATED TO ENVIRONMENT IN BANGLADESH

51. The Ministry of Environment & Forest (MoEF) is the nodal agency in the administrative structure of the GOB, for overseeing all environmental matters relating to national environmental policy and regulatory issues in the country. The MoEF oversees the activities of the following technical/implementing agencies:
    - Department of Environment (DOE);
    - Forest Department (FD);
    - Bangladesh Forest Industries Development Corporation (BFIDC);
    - Bangladesh Forest Research Institute (BFRI); and
    - Bangladesh National Herbarium (BNH).

2.4.1 Other Related Government Organizations

52. Other organisations that would also govern social and environmental functions related to the proposed Project, include:
    - Forest Department;
    - Ministry of Land: Land reform and land acquisition directorate;
    - Ministry of Water Resources: Bangladesh Water Development Board; and
    - Local Government Engineering Department (LGED).

Table 2.2 National Legal Instruments relevant to the Project

Act / Rule / Law / Ordinance	Enforcement Agency – Ministry / Authority	Key Features	Applicability to the Project
The Environment Conservation Act, 1995 and subsequent amendments in 2000 and 2002	Department of Environment Ministry of Environment and Forests	▪ Define applicability of environmental clearance certificate ▪ Regulation of development activities from environmental perspective ▪ Framing applicable limits for emissions and effluents ▪ Framing of standards for air, water and noise quality ▪ Formulation of guidelines relating to control and mitigation of environmental pollution, conservation and improvement of environment ▪ Declaration of Ecologically critical areas	Applicable
Environmental Conservation Rules, 1997 and subsequent amendments in 2002 and 2003	Department of Environment Ministry of Environment and Forests	▪ Declaration of Ecologically critical areas ▪ Requirement of environmental clearance certificate for various categories of projects ▪ Requirement of IEE/EIA as per the category ▪ Renewal of the environmental clearance certificate within 30 days after the expiry ▪ Provides standards for quality of air, water and sound and acceptable limits for emissions/discharges from vehicles and other sources	Applicable Projects falls under Red Category and require environmental clearance
Environment Court Act, 2000 and subsequent amendments in 2002	Ministry of Environment and Forests and Judiciary	▪ Highest priority accorded to environment pollution ▪ Completion of environment related legal proceedings effectively	Applicable for completing environmental legal requirements effectively
The Vehicle Act, 1927; The Motor Vehicles Ordinance, 1983; and The Bengal Motor Vehicle Rules, 1940	Bangladesh Road Transport Authority	▪ Exhaust emissions ▪ Vehicular air and noise pollution ▪ Road/traffic safety ▪ Vehicle Licensing and Registration ▪ Fitness of Motor Vehicles ▪ Parking by-laws.	Applicable for proposed Project in relation to road transport
The Removal of Wrecks and Obstructions in inland Navigable Water Ways Rules 1973	Bangladesh Water Transport Authority	▪ Removal of wrecks and obstructions in inland navigable waterways	May be applicable if the *Kutubdia* Channel - a navigable waterway is used for transport of heavy equipment and raw material during the construction stage of the Project

Act / Rule / Law / Ordinance	Enforcement Agency – Ministry / Authority	Key Features	Applicability to the Project
Water Supply and Sanitation Act, 1996	Ministry of Local Government, Rural Development and Cooperatives	▪ Management and Control of water supply and sanitation in urban areas.	Not directly applicable, however, indirectly applicable when considering water usage management and sanitation facilities
The Ground Water Management Ordinance, 1985	Upazila Parishad	▪ Management of ground water resources ▪ Installation of tube-wells at any place after license from Upazila Parishad only	Proposed Project will use surface water source however, should groundwater also be required then licenses will need to be obtained prior to installation of any tube-wells.
The Forest Act, 1927 and subsequent amendments in 1982 and 1989	Ministry of Environment and Forests	▪ Categorization of forests as reserve, protected and village forests ▪ Permission is required for use of forest land for any non-forest purposes	Not directly applicable as proposed Project is not on forest land. However the immediate surroundings of the identified pipeline route include social forestry plantations (i.e. *Jhauban* – Casuarina plantations) that have been planted by the Forest Department to act as shelter belts. Consultations with the Range Office, *Kutubdia* reported that land for such shelter belts are under the possession of UNO *Kutubdia* and are made available to the Forest Department for such plantation through community participation. Felling of such trees (if required) will necessitate approval from local level DFO, *Chittagong* Coastal Forest Division and at the central level from Chief Conservator of Forests, *Dhaka* and may require NOC from the Forest Department.
The Private Forests Ordinance Act, 1959	Regional Forest Officer, Forest Department	▪ Conservation of private forests and for the afforestation on wastelands	Not applicable as the project area does not have any private forests.

Act / Rule / Law / Ordinance	Enforcement Agency – Ministry / Authority	Key Features	Applicability to the Project
Bangladesh Wild Life (Preservation) Act, 1974	Ministry of Environment and Forest; Bangladesh Wild Life Advisory Board	▪ Preservation of Wildlife Sanctuaries, Parks, and Reserves	Not applicable as the Project study area does not have any wildlife areas
National Biodiversity Strategy and Action Plan (2004)	Ministry of Environment and Forest Bangladesh Wild Life Advisory Board	▪ Conserve, and restore the biodiversity of the country ▪ Maintain and improve environmental stability for ecosystems ▪ Guarantee the safe passage and conservation of globally endangered migratory species, especially birds and mammals in the country	Applicable for conservation of bio-diversity
National Water Bodies Protection Act, 2000	Town development authority / Municipalities	▪ The characterization of water bodies as rivers, canals, tanks or flood plains identified in the master plans formulated under the laws establishing municipalities in division and district towns shall not be changed without approval of concerned ministry	Applicable due to the proximity to and use of surface water bodies
The Protection and Conservation of Fish Act 1950 subsequent amendments in 1982	Ministry of Fisheries and Livestock	▪ Protection and conservation of fish in Government owned water bodies	Applicable for the conservation of fish as the FSRU will be located and operational in the Bay of Bengal
The Embankment and Drainage Act 1952	Ministry of Water Resources	▪ An Act to consolidate the laws relating to embankment and drainage and to make better 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 and other damage by water	Applicable due to the site location and presence of an existing earthen coastal embankment within the study area.

Act / Rule / Law / Ordinance	Enforcement Agency – Ministry / Authority	Key Features	Applicability to the Project
Antiquities Act, 1968	Ministry of Cultural Affairs	▪ This legislation governs preservation of the national cultural heritage, protects and controls ancient monuments, regulates antiquities as well as the maintenance, conservation and restoration of protected sites and monuments, controls planning, exploration and excavation of archaeological sites	Not applicable as the study area does not have any likely cultural heritage or ancient monuments of national or international significance. However in case, any such evidence of archaeological findings arise, the Project will act in consonance to the Act
The Acquisition and Requisition of Immovable Property Ordinance 1982 and subsequent amendments in 1994, 1995 and 2004	Ministry of Land	▪ The act and guidelines relates to procedures for acquisition and requisition of land	Applicable
Administrative and Regulatory Guidelines and Instructions for Land Acquisition	Ministry of Land	▪ Regulation of land acquisition process by certain administrative instructions and procedural requirements	Applicable
Framework for Leasing of Government (*Khas*) Agricultural Land	Ministry of Land	▪ The rules for allotting and leasing Government-owned (*khas*) land to land less families	Not directly applicable but indirectly if a family becomes landless in the process of acquisition
The Building Construction Act 1952 and subsequent amendments	Ministry of Works	▪ This act provide for prevention of haphazard construction of building and excavation of tanks which are likely to interfere with the planning of certain areas in Bangladesh	Applicable
The Factories Act, 1965 Bangladesh Labour Law, 2006	Ministry of Labour	▪ This Act pertains to the occupational rights and safety of factory workers and the provision of a comfortable work environment and reasonable working conditions	Applicable
Ozone Depleting Substances (Control) Rules, 2004	Ministry of Environment and Forests	▪ Ban on the use of Ozone depleting substances ▪ Phasing out of Ozone depleting substances	Applicable
Noise Pollution (Control) Rules 2006	Ministry of Environment and Forests	▪ Prevention of Noise pollution ▪ Standards for noise levels	Applicable

Act / Rule / Law / Ordinance	Enforcement Agency – Ministry / Authority	Key Features	Applicability to the Project
Territorial Water and Maritime Zones Act- 1974 & Rules- 1977	Bangladesh Navy	▪ Preventing and controlling marine pollution and preserving the quality and ecological balance in the marine environment in the high seas adjacent to the territorial waters	Applicable as the Project has provision of transportation through marine and adjacent inland waterways within Bangladesh territory and may have pollution impact in the surrounding water ways.
Ports Act- 1908	Ministry of Shipping	▪ Prohibits the discharge of ballast, rubbish and oil into any port or adjacent areas; ▪ Prohibits the discharge of ballast, rubbish and oil into any port or adjacent areas	Applicable as the Project has likeliness of pollutants offshore discharge (oil, grease, oily water, bilge and ballast water, rubbish etc.), creation of fires, creation of obstacles for navigation and spread of infectious diseases in the surrounding environment or damage of shore/bank
Bangladesh Merchant Shipping Ordinance- 1983	Ministry of Shipping	▪ Regulates engagement of sea men for maritime activities	Applicable as the Project has provision of engagement of seaman during project activities.
Coast Guard Act-1994	Bangladesh Coast Guard	▪ Preventing and controlling marine pollution	Applicable as the Project has likeliness of pollution discharges and requires compliance to this act.

Source: Websites of DOE, Legislative and Parliamentary Affairs Division: Bangladesh Laws and Bangladesh Board of Investment: Business laws

2.4.2 *Department of Environment (DOE)*

53. The DOE has been placed under the MoEF as its technical wing and is statutorily responsible for the implementation of the *Environment Conservation Act, 1995.* The principal activities of the DOE are:
    - Defining EIA procedures and issuing environmental clearance certificates - the latter being the legal requirement before the proposed Project can be implemented;
    - Providing advice or taking direct action to prevent degradation of the environment;
    - Pollution control, including the monitoring of effluent sources and ensuring mitigation of environmental pollution;
    - Setting the Quality Standards for environmental parameters;
    - Declaring Ecologically Critical Areas (ECAs), where the ecosystem has been degraded to a critical state; and
    - Review and evaluation of Initial Environmental Examinations (IEEs) and EIAs prepared for projects in Bangladesh.

Environmental Clearance Process

54. The ECR 1997 has classified projects to be assessed by the DOE in four categories based on the severity of impacts on IECs:
    - Green: Nil;
    - Orange A: minor;
    - Orange B: medium; and
    - Red: severe.

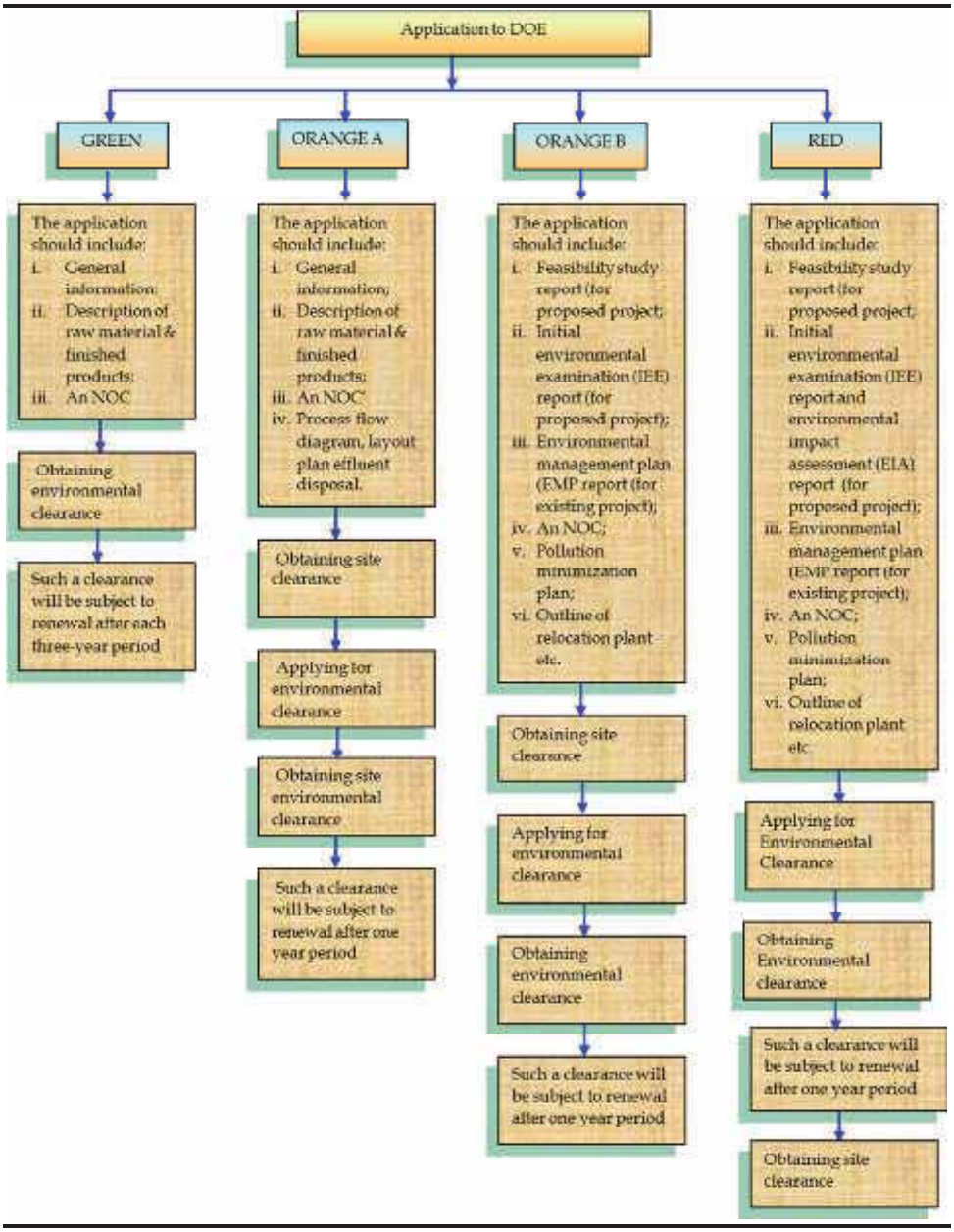
55. The applicability of environmental clearance and the process in Bangladesh is described in ***Figure 2.1***.

56. The EIA process consists of three stages, screening, IEE, and detailed EIA:
    - Projects categorized as Green and Orange-A requires no IEE or EIA for environmental clearance however, the proponent has to submit an application in a prescribed format along with specified documents;
    - Projects categorized as Orange-B require an IEE to be submitted to the DOE along with an application in a prescribed format and other specified documents; and
    - Red category projects require both IEE and EIA. An IEE is required for the location clearance and an EIA is required for the environmental clearance certificate.

57. As per the *ECR 1997*, the proposed Project falls under the *Red* category as it falls within the following:
    - Item 65: Exploration/extraction/distribution of mineral resources;
    - Item 64: Water, power and gas distribution line laying / relaying/ extension.

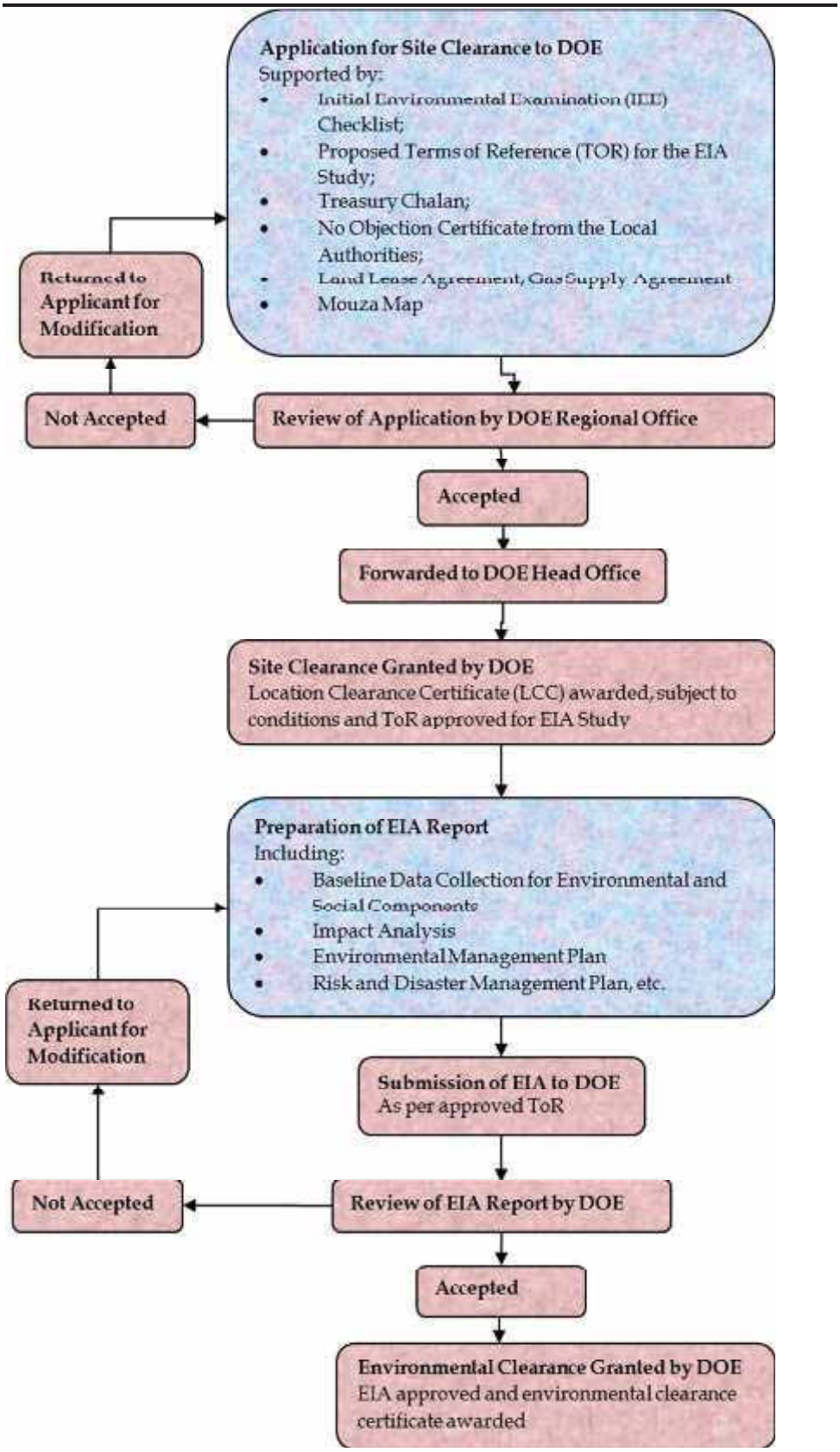
58. The process for obtaining an Environmental Clearance Certificate (ECC) for the proposed Project is outlined in ***Figure 2.2***

Figure 2.1 DOE Environmental Clearance Applicability and Procedure



Source: Adapted from DOE

Figure 2.2 Flow Chart of EIA Process Applicable to the Proposed Project



Source: Adapted from DOE

2.4.3 Status of Project Approval from DOE

59. The Department of Environment, GoB has approved terms of reference through their letter no. DOE/Clearances/5732/2017-172 dated March 16, 2017 for conduct of the EIA study for the proposed LNG Terminal Project of Reliance Power. The compliance status of the terms of reference is included in ***Table 2.3***.

60. The present ESIA Report, which has been prepared to comply with the requirement of DoE, GoB as described in their terms of reference for conduct of EIA and potential lenders to fulfil the safeguard requirements.

Table 2.3 Compliance to Terms of Reference (TOR) approved by Department of Environment (DOE) for EIA

S.N.	TOR Point	Compliance Status
I.	The project authority shall submit a comprehensive Environmental Impact Assessment (EIA) considering the overall activity of the said project in accordance with the TOR and time schedule submitted to the Department of Environment (DoE) and additional suggestions provided herein.	An Environmental and Social Impact Assessment (ESIA) Report has been prepared considering the overall activity of the said project in accordance with the approved TOR and will be submitted to DoE in due course of time for Environmental Clearance Certificate for the Project.
II	The EIA report should be prepared in accordance with following indicative outlines:	
1.	Executive summary	An Executive Summary has been included at the start of the ESIA Report
2.	Introduction: (Background, brief description, scope of study, methodology, limitation, EIA team, references)	The introduction and other referred sections are included in Section 1 of the ESIA Report on '*Introduction*' whereas the references are provided under ***Annex 1***.
3.	Legislative, regulation and policy consideration (covering the potential legal, administrative, planning and policy framework within which the EIA will be prepared)	The potential legal, administrative, planning and policy framework within which the ESIA will be prepared is presented as ***Section 2*** of the ESIA Report on *'Policy, Legal and Administrative Framework'*
4a.	Project activities: -A list of the main project activities to be undertaken during site clearing, construction as well as operation -Project Plan, Design, Standard, Specification, Quantification, etc.	The main project activities to be undertaken for this project along with other specified details are included in ***Section 3*** of the ESIA Report on '*Description of the Project*'.
4b.	Project schedule: The phase and timing for development of the Project	The Project Schedule is indicated in ***Figure 3.15*** of the ESIA Report.
4c.	Resources and utilities demand: Resources required to develop the project, such as soil and construction material and demand for utilities (water, electricity, sewerage, waste disposal and others), as well as infrastructure (road, drains, and others) to support the project.	Resource requirements and infrastructure to support the Project is discussed under ***Section 3.7*** of the ESIA Report.
4d.	Map and survey information -Location map, Cadastral map showing land plots (project and adjacent area), Topographical map, Geological map showing geological units, fault zone, and other natural features	The use of maps has been made to adequately represent the information in the ESIA Reports. Specific maps referred as presented as follows: *Location map - Figure 1.1, Cadastral map showing land plots – Figure 3.6, Bathymetric map – 3.13, Geological Map – Figure 4.9* and others.

S.N.	TOR Point	Compliance Status
5.	Baseline Environmental Condition should include, inter alia, following: (Identification and Quantification of Physical Situation that has been proposed to be changed) Physical Environment: Geology, Topology, Geomorphology, Land-use, Soils, Meteorology and Hydrology Biological Environment: Habitats, Aquatic life and fisheries, Terrestrial Habitats and Flora and Fauna Environment Quality: Air, Water, Noise, Vibration, Soil and Sediment Quality Relate baseline in both Quantitative and Qualitative term with the anticipated outcomes, achievement of goals, objectives and changes due to project interventions	The baseline environmental conditions and specified details have been included in Chapter 4 of the ESIA Report on *'Description of the Environment'* This ***Section 4 on Description of the Environment*** includes relevant information on Physical and Biological Environment and also on Environmental Quality. The baseline information has been utilised to conduct the necessary impact assessment due to project interventions which is presented ***Section 5*** of the ESIA on *'Impact Assessment and Mitigation Measures'*
6.	Socio-economic environment should include, inter alia, following: -Population: Demographic profile and ethnic composition -Settlement and housing -Traffic and transport -Public utilities: water supply, sanitation and solid waste -Economy and employment: employment structure and cultural issues in employment -Fisheries: fishing activities, fishing communities, commercial important species, fishing resources, commercial factors.	The socio-economic environment has been described in ***Section 4*** of the ESIA Report on *'Description of the Environment'* under ***Section 4.18***. In addition to the specified details, this section also includes information on economic activities including details of fishing activities and fishing communities.
7.	Identification, Prediction and Evaluation of Potential Impacts (identification, prediction and assessment of positive and negative impacts likely to result from the proposed project). In identification and analysis of potential impacts'-the 'Analysis' part shall include the analysis of relevant spatial and non-spatial data. The outcome of the analysis shall be presented with the scenarios, maps, graphics etc. for the cases of anticipated impacts on baseline. Description of the impacts of the project on air, water, land, hydrology, vegetation-man maid or natural, wildlife, socio-economic aspect shall be incorporated in detail. Appropriate models shall be used for prediction of potential impacts of the project on surface water and ambient air quality using updated data. Model prediction shall be compared with national water and air quality standards and specific sensitivity data of the organisms known to be present in the project area (likely impacted area) for impact assessment.	The identification, prediction and evaluation of potential impacts likely to result from the proposed project have been presented in details in ***Section 5*** of the ESIA on *'Impact Assessment and Mitigation Measures'*. The analysis presented in ***Section 5*** has made use of relevant spatial and non-spatial data and outcomes have been presented with maps, graphics, etc. where applicable. The impacts assessment has been presented for relevant components of physical, biological and socio-economic environment. Also appropriate models have been used for prediction of potential impacts of the project on surface water quality as well as ambient air quality and noise levels.

S.N.	TOR Point	Compliance Status
8.	Management Plan/Procedures: For each significant major impact, proposed mitigation measures will be set out for incorporation into project design or procedures, impacts, which are not mitigable, will be identified as residual impacts Both technical and financial plans shall be incorporated for proposed mitigation measures. An outline of the Environmental Management Plan shall be developed for the project. In Environmental Monitoring Plan, a detail technical and financial proposal shall be included for developing an in-house environmental monitoring system to be operated by the proponent's own resources (equipments and expertise).	The management plan for the project has been presented under ***Section 9*** of the ESIA Report on 'Environmental and Social Management Plan'. The Environmental and Social Management Plan (ESMP) for different project phases are presented in ***Table 9.1*** whereas the environmental and ecological monitoring programmes are presented under ***Tables 9.2 & 9.3***. The budget required for implementing the ESMP provisions is included in ***Table 9.4***.
9.	Consultation with Stakeholders/Public Consultation (ensures that consultation with interested parties and the general public will take place and their views taken into account in the planning and execution of the project). Beneficial impacts (summarize the benefits of the project to the Bangladesh nation, people and local community and the enhancement potentials).	The Stakeholder consultations conducted and details on the same have been included in ***Section 7*** of the ESIA Report on *'Consultations and Participation'*. The beneficial impacts of the project are included in ***Section 5*** of the ESIA on *'Impact Assessment and Mitigation Measures'* under ***Sections 5.3.19, 5.3.20, 5.3.21 & 5.3.22***
10.	Risk assessment, risk management, system of valuation of environmental and properties damage, damage compensation issues shall be addressed	Risk assessment for the proposed project has been presented as an annex to the ESIA document titled *'Risk Assessment and Disaster Management Plan for Proposed Kutubdia LNG Project, Cox's Bazar District, Bangladesh' (Annex 13)*
11.	Emergency Response Plan & disaster Impact Assessment.	The emergency preparedness and response plan is included under ***Section 5*** of ***Annex 13*** on Risk Assessment and Disaster Management Plan.
12.	Conclusion and Recommendations	It is presented in ***Section 10*** of the ESIA Report on *'Conclusions and Recommendations'*.
III	Without approval of EIA report by the Department of Environment, the project authority shall not be able to open L/C in favor of importable machineries.	Will be complied by Reliance Bangladesh LNG Terminals Limited.
IV	Without obtaining Environmental Clearance, the project authority shall not be able to start the physical activity of the project.	Will be complied by Reliance Bangladesh LNG Terminals Limited.
V.	The project authority shall submit the EIA report along with the filled-in application for Environmental Clearance in prescribed form, the feasibility study report, the applicable Environmental Clearance fee in a treasury chalan, the applicable VAT on clearance fee in a separate treasury chalan, the No Objection Certificate (NOC) from local authority, NOC from Forest Department (if it is required in case of cutting any forested plant, private or public) and NOC from other relevant agencies for operational activity etc. to the Cox's Bazar District Office of DOE in Cox's Bazar with a copy to the Head Office of DOE in Dhaka.	Will be complied by Reliance Bangladesh LNG Terminals Limited.

2.5 *INSTITUTIONAL ARRANGEMENTS RELATED TO LAND ACQUISITION IN BANGLADESH*

61. The administrative set up for land acquisition has two tiers under the Ministry of Land Administration. At the Division level, there is an Additional Commissioner dealing with land administration under the Commissioner. At the district level, there is an Additional Deputy Commissioner (ADC) in charge of land administration. Under him, there is at least one Land Acquisition Officer and several Assistant Land Acquisition Officers. The number of officers depends on the size of the District. Non-gazette officers in the land administration include *Kanungos* and surveyors.

62. The Deputy Commissioner allows 15 days to invite objections on the notice for land acquisition/requisition under Section 3. If no objection is raised within the specified period, the Deputy Commissioner makes a decision within 10 days of the expiry of the notice period. If objections are received by Deputy Commissioner, then the records of the objection raised along with the inquiry made by him submits to the Divisional Commissioner if property does not exceed 50 standard bighas, and submits to Government of Bangladesh if the property exceeds 50 standard bighas. The decision of the Government or Divisional Commissioner as the case may be, is final provided the decision by Divisional Commissioner is made within 15 days and the decision made by Government of Bangladesh is done within 90 days. The decision by the Government or Divisional commissioner shall be conclusive evidence that the property is needed for a public interest.

63. The Deputy Commissioner serves the notice of acquisition of the property under Section 6 requiring the all persons interested in the property to state the nature of their respective interests in the property and particulars of their claims to compensation for such interests not being earlier than fifteen days after the date of publication of the notice. After examining all the claims/ statements received from all interested parties shall make an award stating the compensation and any apportionment of the said compensation. Deputy Commissioner shall give notice of his award to the persons interested and send the estimate of the award of compensation to the requiring person within 7 days from the date of making award of compensation.

64. Section 10 makes the payment of the compensation before taking the possession of the property. If the persons entitled do not consent to receive it, or any dispute over the apportionment then the amount of the compensation is deposited in the Public Account of the Republic which is considered as deemed payment for the purpose of taking over possession.

65. Any person interested who has not accepted any award made by the Deputy Commissioner within 45 days of the service of the award, make an application to the arbitrator for revision of the award. Section 30 restricts the scope of the enquiry by the Arbitrator to a consideration of interests of the persons affected by the objection. Arbitrator shall be guided by the provisions of the sections 8, 9 or 20 provided that the compensation determined by the Arbitrator shall not exceed more than 10 per centum of the award of the Deputy Commissioner. An

appeal shall lie to the Arbitration Appellate Tribunal against the award of the Arbitrator and the decision of the Tribunal shall be final.

66. After the compensation for the property is paid or is deemed to be paid, Deputy Commissioner publishes a notice to that effect in official Gazette. The notice concludes the land acquisition procedure and vests the property absolutely in the government free from all encumbrances, and Deputy Collector takes the possession of the property.

2.6 PROJECT RELEVANT INTERNATIONAL TREATIES & CONVENTIONS

67. Bangladesh is party to a number of international environmental convention, treaties and agreements. The Project relevant international treaties and conventions signed, ratified and in the process of ratification by GoB are detailed in ***Table 2.4***.

Table 2.4 Project Relevant International Treaties & Conventions Signed/Ratified by GoB

SN	Environment related International convention and Treaties	Status
1	International Plant Protection Convention (Rome, 1951)	01.09.78 (ratified)
2	International Convention for the Prevention of Pollution of the Sea by Oil (London, 1954 (as amended on 11 April 1962 and 21 October 1969)	28.12.81 (entry into force)
3	Plant Protection Agreement for the South East Asia and Pacific Region (as amended) (Rome, 1956)	04.12.74 (accessed) (entry into force)
4	International Convention Relating to Intervention on the High Seas in Cases of Oil Pollution Casualties (Brussels, 1969)	04.02.82 (entry into force)
5	Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar, 1971) ("Ramsar Convention").	20.04.92 (ratified)
6	Convention Concerning the Protection of the World Cultural and natural Heritage (Paris, 1972)	03.08.83 (accepted) 03.11.83 (ratified)
7	Convention on International Trade in Endangered Species of Wild Fauna and flora (Washington, 1973) (CITES Convention)	18.02.82 (ratified)
8	United Nations Convention on the Law of the Sea (Montego Bay, 1982)	10.12.82 (ratified)
9	Vienna Convention for the Protection of the Ozone Layer (Vienna, 1985)	02.08.90 (accessed) 31.10.90 (entry into force)
10	Montreal Protocol on Substances that Deplete the Ozone Layer (Montreal 1987)	02.08.90; 31.10.90 (accessed) (entry into force)
11	London Amendment to the Montreal Protocol on substances that Deplete the Ozone Layer (London, 1990)	18.03.94 (accessed) 16.06.94 (entry into force)
12	Copenhagen Amendment to the Montreal protocol on Substances that Deplete the Ozone Layer, Copenhagen, 1992	27.11.2000 (accepted) 26.2.2001 (entry into force)
13	Montreal Amendment of the Montreal Protocol on Substances that Deplete the Ozone Layer, Montreal, 1997	27.7.2001 (accepted) 26.10.2001 (entry into force)
14	Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Disposal (Basel, 1989)	01.04.93 (accessed)
15	International Convention on Oil Pollution Preparedness, Response and Cooperation (London, 1990)	30.11.90 (signed) In the process of ratification
16	United Nations Framework Convention on Climate Change, (New York, 1992)	09.06.92 (signed) 15.04.94 (ratified)
17	Convention on Biological Diversity, (Rio De Janeiro, 1992)	05.06.92 (signed); 03.05.94 (ratified)

SN	Environment related International convention and Treaties	Status
18	International Convention to Combat Desertification, (Paris 1994)	14.10.94 (signed); 26.01.1996 (ratification); 26.12.1996 (entry into force)
19	Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques, (Geneva, 1976)	03.10.79 (accessed); (entry into force)
20	Agreement Relating to the Implementation of Part XI of the United Nations Convention on the Law of the Sea of 10 December 1982 (New York, 1994)	28.07.96 (signed)
21	Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and on their Destruction (Paris, 1993)	14.01.93 (signed)
22	Convention on persistent Organic Pollutants, Stockholm	23.5.2001 (signed); 12.03.2007 (ratified)
23	Kyoto protocol to the United Nations Framework Convention on Climate Change	21.8.2001 (accessed)

Source: DOE, Bangladesh

2.7 RELEVANT NATIONAL & MARITIME REGULATIONS / STANDARDS

2.7.1 *International Maritime Conventions, Protocols and Agreements applicable for LNG Transportation*

68. The International Maritime Organization (IMO) came into existence in 1958 but before that, several important international conventions had already been developed including the International Convention for the Safety of Life at Sea of 1948, the International Convention for the Prevention of Pollution of the Sea by Oil of 1954 and treaties dealing with load lines and the prevention of collisions at sea. However, IMO was made responsible for ensuring that the majority of these conventions were kept up to date. It was also given the task of developing new conventions as and when required. Bangladesh is signatory of the IMO and therefore, all activities relating to shipment of LNG shall have to be done strictly in compliance with the standards set by the IMO, particularly the conventions, protocols and agreements. The conventions / protocols relevant for the proposed project and agreed by GOB are highlighted in table below:

Table 2.5 International Maritime Conventions, Protocols and Agreements relevant to the Project

Issues	Conventions, Protocols and Agreements	Remarks
Maritime Safety	International Convention for the Safety of Life at Sea (SOLAS), 1960 and 1974 (and all other amendments which include IMSBC code to create an amendments to SOLAS chapter-VI and to make the code mandatory and adopted by maritime safety committee in 2008).	Applicable-as safety and pollution issues are addressed.
	International Convention on Load Lines (LL), 1966 (and all amendments)	Applicable-as limitation of draft and load issues are addressed for safety of the ship.
	Convention on the International Regulations for Preventing Collisions at Sea (COLREG), 1972 (and all amendments)	Applicable-as the convention provided guidelines for avoidance of collisions.
	International Convention for Safe Containers (CSC), 1972 (and all amendments)	Applicable-as it provided guidelines for high level safety of containers to avoid incidents.
	Convention on the International Maritime Satellite Organization (INMARSAT), 1976 (and all amendments)	Applicable- as it is related to guidance of maritime communication and safety at sea.
	International Convention on Maritime Search and Rescue (SAR), 1979	Applicable- as search and rescue plan (SARP) through cooperation with relevant government are addressed.
Marine pollution	International Convention for the Prevention of Pollution of the Sea by Oil (OILPOL), 1954 (including all amendments	Applicable-as the convention controls deliberate discharge of oil and oil mixture from the sea going vessels causing environmental impacts.
	Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (LDC), 1972 (including all amendments)	Applicable-as the convention represents international control and prevention of marine pollution due to dumping of wastes and other matter.
	International Convention for the Prevention of Pollution from Ships (MARPOL), Adoption: 1973 (Convention), 1978 (1978 Protocol), 1997 (Protocol - Annex VI); Entry into force: 2 October 1983 (Annexes I and II).	Applicable- 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.
	MARPOL, Annex I Regulations for the Prevention of Pollution by Oil (entered into force 2 October 1983)	Covers prevention of pollution by oil from operational measures as well as from accidental discharges; the 1992 amendments to Annex I made it mandatory for new oil tankers to have double hulls and brought in a phase-in schedule for existing tankers to fit double hulls, which was subsequently revised in 2001 and 2003

Issues	Conventions, Protocols and Agreements	Remarks
	MARPOL, Annex II Regulations for the Control of Pollution by Noxious Liquid Substances in Bulk (entered into force 2 October 1983)	Details the discharge criteria and measures for the control of pollution by noxious liquid substances carried in bulk; some 250 substances were evaluated and included in the list appended to the Convention; the discharge of their residues is allowed only to reception facilities until certain concentrations and conditions (which vary with the category of substances) are complied with. In any case, no discharge of residues containing noxious substances is permitted within 12 miles of the nearest land.
	MARPOL, Annex III Prevention of Pollution by Harmful Substances Carried by Sea in Packaged Form (entered into force 1 July 1992	Contains general requirements for the issuing of detailed standards on packing, marking, labelling, documentation, stowage, quantity limitations, exceptions and notifications. For the purpose of this Annex, "harmful substances" are those substances which are identified as marine pollutants in the International Maritime Dangerous Goods Code (IMDG Code) or which meet the criteria in the Appendix of Annex III.
	MARPOL, Annex IV Prevention of Pollution by Sewage from Ships (entered into force 27 September 2003)	Contains requirements to control pollution of the sea by sewage; the discharge of sewage into the sea is prohibited, except when the ship has in operation an approved sewage treatment plant or when the ship is discharging comminuted and disinfected sewage using an approved system at a distance of more than three nautical miles from the nearest land; sewage which is not comminuted or disinfected has to be discharged at a distance of more than 12 nautical miles from the nearest land.
Marine pollution	International Convention for the Prevention of Pollution of the Sea by Oil (OILPOL), 1954 (including all amendments	Applicable-as the convention controls deliberate discharge of oil and oil mixture from the sea going vessels causing environmental impacts.
	Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (LDC), 1972 (including all amendments)	Applicable-as the convention represents international control and prevention of marine pollution due to dumping of wastes and other matter.
	International Convention for the Prevention of Pollution from Ships (MARPOL), Adoption: 1973 (Convention), 1978 (1978 Protocol), 1997 (Protocol - Annex VI); Entry into force: 2 October 1983 (Annexes I and II).	Applicable- 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.
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Issues	Conventions, Protocols and Agreements	Remarks
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	MARPOL, Annex V Prevention of Pollution by Garbage from Ships (entered into force 1 January 2013)	Deals with different types of garbage and specifies the distances from land and the manner in which they may be disposed of; the most important feature of the Annex is the complete ban imposed on the disposal into the sea of all forms of plastics. Shippers need to consider whether or not the cargo and hence residues, including those contained in wash water are 'harmful to the marine environment' (HME). In essence the discharge of cargo residues contained in wash water is governed by the following criteria: No discharge of cargo residues should occur less than 12 nautical miles from the nearest land or the nearest shelf; No discharge of any cargo residues specified as HME. Wash water should be discharged to a suitable reception facility.

Issues	Conventions, Protocols and Agreements	Remarks
	MARPOL Annex VI Prevention of Air Pollution from Ships (entered into force 19 May 2005)	Sets limits on SOx and NOx emissions from ship exhausts and prohibits deliberate emissions of ozone depleting substances; designated emission control areas set more stringent standards for SOx, NOx and particulate matter. A chapter adopted in 2011 covers mandatory technical and operational energy efficiency measures aimed at reducing greenhouse gas emissions from ships.
	International Convention Relating to Intervention on the High Seas in Cases of Oil Pollution Casualties (INTERVENTION), 1969 (and all amendments)	Applicable- as this convention applied to casualties involving pollution by oil and other matter and impacts in the surrounding environment.
	International Convention on Oil Pollution Preparedness, Response and Cooperation (OPRC), 1990	Applicable- as the convention provides guidelines for combating incidents of marine pollution and ensure Ships to carry a shipboard oil pollution emergency plan, the contents of which are to be developed by IMO.
Liability and Compensation	International Convention on Civil Liability for Oil Pollution Damage (CLC), 1969 (and all amendments)	Applicable- as oil pollution related penalties are addressed
	International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage (FUND), 1971 (including all amendments and related protocol)	Applicable- as the convention and related protocol has provision for imposing greater compensation to be paid to victims of oil pollution incidents.

2.8 INTERNATIONAL SAFEGUARD REQUIREMENTS

69. Financing support for the Project will be sought from multi-lateral financial institutions, such as the IFC, the ADB, and the EPFIs as well as from the export credit agencies of the countries where major pieces of equipment for the Project will be sourced. This support from the multi-lateral financial institutions/ export credit agencies are also linked with the adherence of international best practices and environmental and social safeguard requirements of the lenders. The following subsections outline the key environmental and social requirements of the ADB and the IFC, applicable to the Project.

2.8.1 *ADB's Safeguard Policy Statement, 2009*

70. In July 2009, ADB's Board of Directors approved the new Safeguard Policy Statement (SPS) governing the environmental and social safeguards of ADB's operations. The SPS builds upon ADB's previous safeguard policies on the Environment, Involuntary Resettlement, and Indigenous Peoples, and brings them into one consolidated policy framework with enhanced consistency and coherence, and more comprehensively addresses environmental and social impacts and risks. The SPS also provides a platform for participation by affected people and other stakeholders in the project design and implementation.

71. The SPS applies to all ADB-financed and/or ADB-administered projects and their components, regardless of the source of financing, including investment projects funded by a loan; and/or a grant; and/or other means, such as equity and/or guarantees. ADB works with borrowers and clients to put into practice the requirements of SPS.

72. The objectives of ADB's safeguards are to:
    - avoid adverse impacts of projects on the environment and affected people, where possible;
    - minimize, mitigate, and/or compensate for adverse project impacts on the environment and affected people when avoidance is not possible;
    - assist borrowers and clients to strengthen their safeguard systems and develop the capacity to manage environmental and social risks.

73. ADB's SPS sets out the policy objectives, scope and triggers, and principles for three key safeguard areas:
    - Environmental safeguards;
    - Involuntary Resettlement safeguards; and
    - Indigenous Peoples safeguards.

74. To help borrowers and clients and their projects achieve the desired outcomes, ADB adopts a set of specific safeguard requirements that borrowers and clients are required to meet in addressing environmental and social impacts and risks. These safeguard requirements are as follows:
    - Safeguard Requirements 1: Environment (Appendix 1 of SPS);
    - Safeguard Requirements 2: Involuntary Resettlement (Appendix 2 of SPS);
    - Safeguard Requirements 3: Indigenous Peoples (Appendix 3 of SPS); and

- Safeguard Requirements 4: Special Requirements for Different Finance Modalities (Appendix 4 of SPS).

75. In addition, ADB does not finance activities on the prohibited investment activities list (Appendix 5 of SPS). Furthermore, ADB does not finance projects that do not comply with its safeguard policy statement, nor does it finance projects that do not comply with the host country's social and environmental laws and regulations, including those laws implementing host country obligations under international law.

Consultation and Disclosure requirements of ADB

76. ADB's *Safeguard Policy and Public Communications Policy (2011)* sets out disclosure requirements for various ADB activities, including safeguard requirement. Safeguard Requirements 2: Involuntary Resettlement (Appendix 2 of SPS); and Safeguard Requirements 3: Indigenous Peoples (Appendix 3 of SPS) sets out the need for meaningful consultation and information disclosure during project preparation and operation to the affected population and other stakeholders. Key requirements include:
    - Information Disclosure: The borrower/client will submit the following documents to ADB for disclosure on ADB's website as per the applicability with respect to the Project:
    - Draft EIA including draft EMP;
    - Final EIA/IEE;
    - Updated EIA/IEE and corrective action plan;
    - Environmental Monitoring Reports.
    - Resettlement Plan ("RP")
    - Indigenous Peoples Plan ("IPP")
    - Information disclosure to affected people or stakeholders: The borrower/client will provide relevant environmental information in a timely manner, in an accessible place and in a form and language(s) understandable to affected people and other stakeholders. For illiterate people, other suitable communication methods will be used.
    - Consultation and Participation: The borrower/client will carry out meaningful consultation with affected people and other concerned stakeholders, including civil society, and facilitate their informed participation.
    - Timing and Frequency for consultation and participation: Meaningful consultation begins early in the project preparation stage and is carried out on an on-going basis throughout the project cycle.

2.8.2 ADB Project Categorisation

77. The SPS, 2009 further outlines a classification system for the categorization of projects. The classification tentatively occurs at the project identification stage, during the initial screening of anticipated impacts. However, classification is an on-going process, and the classification can be changed at any time with the

concurrence of the Chief Compliance Officer (CCO), as more detailed information becomes available and a project proceeds.

Environment

78. A project's environment category is determined by the category of its most environmentally sensitive component, including direct, indirect, induced, and cumulative impacts. Each proposed project is scrutinized as to its type, location, scale, sensitivity and the magnitude of its potential environmental impacts. The level of detail and comprehensiveness of the EIA or IEE are commensurate with the significance of the potential impacts and risks.

79. A proposed project is assigned to one of the following categories depending on the significance of the potential environmental impacts and risks:
    - *Category A:* A proposed project is classified as category A if it is likely to have significant adverse environmental impacts that are irreversible, diverse, or unprecedented. These impacts may affect an area larger than the sites or facilities subject to physical works. An EIA, including an environmental management plan ("EMP"), is required;
    - *Category B:* A proposed project is classified as category B if its potential adverse environmental impacts are less adverse than those of category A projects. These impacts are site-specific, few if any of them are irreversible, and in most cases mitigation measures can be designed more readily than for category 'A' projects. An IEE, including an EMP, is required;
    - *Category C:* A proposed project is classified as category C if it is likely to have minimal or no adverse environmental impacts. An EIA or IEE is not required, although environmental implications need to be reviewed; and
    - *Category FI:* A proposed project is classified as category FI if it involves the investment of ADB funds to, or through, a financial intermediary.

Involuntary Resettlement

80. A project's involuntary resettlement category is determined by the category of its most sensitive component in terms of involuntary resettlement impacts. The involuntary resettlement impacts of an ADB-supported project are considered significant if 200 or more persons will experience major impacts, which are defined as (i) being physically displaced from housing, or (ii) losing 10% or more of their productive assets (income generating). The level of detail and comprehensiveness of the resettlement plan are commensurate with the significance of the potential impacts and risks. A project is assigned to one of the following categories depending on the significance of the probable involuntary resettlement impacts:
    - *Category A*: A proposed project is classified as category A if it is likely to have significant involuntary resettlement impacts. A resettlement plan, including assessment of social impacts, is required;
    - *Category B*: A proposed project is classified as category B if it includes involuntary resettlement impacts that are not deemed significant. A resettlement plan, including assessment of social impacts, is required;

- *Category C*: A proposed project is classified as category C if it has no involuntary resettlement impacts. No further action is required; and
- *Category FI*: A proposed project is classified as category FI if it involves the investment of ADB funds to, or through, a financial intermediary.

Indigenous Peoples

81. ADB also screen all projects to determine whether or not they have potential impacts on Indigenous Peoples[1]. For projects with impacts on Indigenous Peoples, an Indigenous Peoples Plan needs to be prepared. The degree of impacts is determined by evaluating (i) the magnitude of the impact on Indigenous Peoples' customary rights of use and access to land and natural resources; socio-economic status; cultural and communal integrity; health, education, livelihood systems, and social security status; or indigenous knowledge; and (ii) the vulnerability of the affected Indigenous Peoples.

82. Indigenous people's or ethnic minorities' issues are likely to be significant when it is established that groups in the project area have one or more of the following attributes: (i) self-identification or identification by others as a distinct cultural group; (ii) a display of a desire to preserve such cultural identity; (iii) a linguistic identity distinct from that of the dominant society; (iv) distinct social, economic, and political traditions and institutions; (v) an economic system oriented more toward a traditional system of production; and (vi) a unique tie with and attachment to traditional habitat and ancestral territory and its natural resources; such groups are found to exhibit historical, socioeconomic, political, or demographic vulnerability; project intervention will be (positively or negatively) affecting one of these areas: customary rights to (ancestral) land and natural resources; their socioeconomic status; their health, education, livelihood, and social security status; indigenous people's knowledge; the project involves new construction, rehabilitation or expansion of large-scale infrastructure; or such interventions as water supply, sanitation, education, health, nutrition, or social protection target indigenous people; the project is located within or nearby the habitat of indigenous people; and/or project impacts are potentially long term, or irreversible or permanent, affecting a substantial portion of the indigenous community or the community as a whole.

[1] As per the working definition of indigenous peoples by ADB, two significant characteristics of indigenous peoples would be:

- descent from population groups present in a given area, most often before modern states or territories were created and before modern borders were defined; and
- maintenance of cultural and social identities; and social, economic, cultural, and political institutions separate from mainstream or dominant societies and cultures. In some cases, over recent centuries, tribal groups or cultural minorities have migrated into areas to which they are not indigenous, but have established a presence and continue to maintain a definite and separate social and cultural identity and related social institutions. In such cases, the second identifying characteristic would carry greater weight.

Additional characteristics often ascribed to indigenous peoples include

- self-identification and identification by others as being part of a distinct indigenous cultural group, and the display of a desire to preserve that cultural identity;
- a linguistic identity different from that of the dominant society;
- social, cultural, economic, and political traditions and institutions distinct from the dominant culture;
- economic systems oriented more toward traditional systems of production than mainstream systems; and
- unique ties and attachments to traditional habitats and ancestral territories and natural resources in these habitats and territories.

(Source: Policy on Indigenous Peoples, ADB)

83. A project is assigned to one of the following categories depending on the significance of the probable impact on the indigenous peoples:

Table 2.6 Categories of Probable Impact on Indigenous Peoples

Category	Impact	Actions Required
Category-A	Expected to have significant impact	Both IPP and SIA are required
Category-B	Expected to have limited impact	Both IPP and SIA are Required. A specific action favourable to indigenous peoples/ethnic minority is required and addressed through a specific provision in RRP and in related plans such as a resettlement action plan, a gender action plan, or a general community participatory plan.
Category-C	Not expected to have any impact on ethnic minority	No specific action required.

2.8.3 IFC Performance Standards

84. The Performance Standards (PS) (January 2012) established by IFC stipulates that the Project shall meet certain requirements throughout the life cycle of an investment by IFC or other relevant financial institution such as other DFIs (e.g. DEG, FMO) or commercial banks, which are signatory to the *Equator Principles, 2006*. A brief description of the Performance standards is provided in ***Table 2.7.***

Table 2.7 IFC Performance Standards

Performance Standards	Specific Areas
Performance Standard 1:	Assessment and Management of Environmental and Social Risks and Impacts
Performance Standard 2	Labour and Working Conditions
Performance Standard 3	Resource Efficiency and Pollution Prevention
Performance Standard 4	Community Health, Safety and Security
Performance Standard 5	Land Acquisition and Involuntary Resettlement
Performance Standard 6	Biodiversity Conservation and Sustainable Management of Living Natural Resources
Performance Standard 7	Indigenous Peoples
Performance Standard 8	Cultural Heritage

IFC Performance Standards, January 2012

85. These PS and EHS guidelines provide ways and means to identify impacts and affected stakeholders and lay down processes for management and mitigation of adverse impacts.

2.9 COMPARISON OF SAFEGUARD PRINCIPLES

2.9.1 Gap Analysis –Environment Safeguard Framework

86. SPS 2009 has 11 environmental safeguard principles and ***Table 2.8*** presents a comparison of the environmental safeguard principles of ADB and the GoB. There are existing gaps between ADB and GoB requirements (e.g., setting up of grievance redress mechanism and public disclosure of environmental reports) but they can be readily addressed and complied with by the EAs.

2.9.2 Gap Analysis –Social Safeguard Framework

87. The Acquisition and Requisition of Immovable Property Ordinance, 1982 (ARIPO) regulations does not cover project-affected persons without titles or ownership records, like – informal settlers/squatters, tenants and leaseholders. ARIPO only covers the legal compensation for land, structures, crops and trees and has no provision for loss of income, livelihood restoration and transfer, reconstruction and vulnerability measures. The compensation paid does not constitute replacement cost of the property acquired.

Table 2.8 Comparison of Environment Safeguard Principles

ADB SPS 2009			GoB Framework	Measures to Bridge Gaps
Principles		Delivery Process		
1	Use of screening process to determine the appropriate environmental assessment	Uses sector-specific rapid environmental assessment checklist for screening and assigns categories based on potential impacts: ▪ A - EIA required (irreversible, diverse or unprecedented adverse environmental impacts) ▪ B - IEE required ▪ C - no environmental assessment required but a review of environmental implications ▪ FI - ESMS required	ECA 1995 and ECR 1997 set screening criteria to classify industries/projects based on potential environmental impacts as follows: ▪ Green (pollution-free), Orange-A ▪ Orange-B and Red (cause significant environmental impacts). These screening criteria are based on project or industry type and do not consider the scale and location. The category determines the level of environmental assessment.	▪ Both ADB and GOB screening and classification procedure be applied and more stringent classification be followed.
2	Conduct an environmental assessment	▪ EIA and IEE - Identify potential impacts on physical, biological, physical cultural resources, and socioeconomic aspects in the context of project's area of influence (i.e., primary project site and facilities, and associated facilities) ▪ ESMS for FIs	Industry/project category ▪ Green - no environmental assessment required ▪ Orange A - no IEE or EIA required but must provide process flow, lay-out showing effluent treatment plant, etc. ▪ Orange B - IEE required ▪ Red - both IEE and EIA are required	▪ Conduct an environmental assessment to identify potential direct, indirect, cumulative, and induced impacts and risks in the context of the project's area of influence.
3	Examine alternatives	▪ Analyze alternatives to the project's location, design, and technology ▪ Document rationale for selecting the particular project location, design, and technology ▪ Consider "no project" alternative	▪ Regulations (i.e., ECA 1995 and ECR 1997) do not require specifically the identification and analysis of alternatives	▪ Analysis of alternative will be conducted as a part of impact assessment study to reduce potential environmental and social impacts and document the rationale for selecting the particular alternative.
4	Prepare an environmental management plan (EMP)	▪ EMP to include monitoring, budget and implementation arrangements	▪ EMP and procedures included in the IEE and EIA (i.e., Orange-A, Orange-B, and Red category projects)	▪ As per the GOB and ADB requirement EMP with budgetary provision will be included with EIA report and project proponent will stress training and capacity development to ensure satisfactory implementation of the EMP.

ADB SPS 2009			GoB Framework	Measures to Bridge Gaps
Principles		Delivery Process		
5	Carry out meaningful consultation	▪ Starts early and continues during implementation ▪ Undertaken in an atmosphere free of intimidation ▪ Gender inclusive and responsive ▪ Tailored to the needs of vulnerable groups ▪ Allows for the incorporation of all relevant views of stakeholders ▪ Establish a grievance redress mechanism	▪ Public consultation and participation are not mandatory based on ECA 1995 and ECR 1997 ▪ Grievance redress mechanism is not mentioned in ECA 1995 and ECR 1997 ▪ EIA format required by DOE includes stakeholders consultation	▪ Gender inclusive and responsive consultation will be held with all level of stakeholder in deferent phases of the project and include relevant views of the stakeholder during implementation of the project. ▪ Specific consultation will be held with vulnerable groups for identification of their need and concern related to the project ▪ Appropriate grievance redress mechanism will be developed before initiation of project
6	Timely disclosure of draft environmental assessment (including the EMP)	▪ Draft EIA report posted on ADB website at least 120 days prior to Board consideration ▪ Draft EA/EARF prior to appraisal ▪ Final or updated EIA/IEE upon receipt ▪ Environmental monitoring report submitted by borrowers upon receipt	▪ No requirement for public disclosure of environmental reports but DOE posts the Minutes of the Meeting on the application for environmental clearance certificate to its website, http://www.doe-bd.org/minutes.php	▪ The 120 days prior disclosure requirement of ADB will be followed and feedback received will be considered.
7	Implement EMP and monitor effectiveness	▪ Prepare monitoring reports on the progress of EMP ▪ Retain qualified and experienced external experts or NGOs to verify monitoring information for Category A projects ▪ Prepare and implement corrective action plan if non-compliance is identified ▪ Requires submission of quarterly, semi-annual, and annual reports to ADB for review	▪ ECC is subject to annual renewal based on compliance of the conditions set by DOE	▪ Project proponent will monitor compliance to agreed EMP ▪ Post monitoring will be carried out to ensure all necessary permits and renewals are in place. ▪ For select Red category or Category A (per ADB) projects or where noncompliance is observed, field monitoring will be carried out through third party agencies. ▪ Results of monitoring will be reported to ADB and DOE on regular basis.

ADB SPS 2009			GoB Framework	Measures to Bridge Gaps
Principles		Delivery Process		
8	Avoid areas of critical habitats (use of precautionary approach to the use, development and management of renewable natural resources)	Provides guidance on critical habitats	▪ ECA 1995 and ECR 1997 identifies ecologically-critical areas and the rules to protect them	▪ Ecologically Critical Areas to be avoided for development of the project. ▪ Habitat and species specific management plans to be developed for ecologically critical areas and protected species if found in proximity to the project footprint.
9	Use pollution prevention and control technologies and practices consistent with international good practices	Refers to World Bank's Environmental Health, and Safety (EHS) General Guidelines 2007 ▪ If national regulations differ, more stringent will be followed ▪ If less stringent levels are appropriate in view of specific project circumstances, provide full and detailed justification	▪ Ambient and emission standards included in ECA 1995 and ECR 1997	▪ Where applicable to the type of project apply international standards with special reference to World Banks's Pollution, Prevention and Abatement Handbook. ▪ Alternative accepted standards and approaches may be allowed to best reflect national or local conditions, if they are justified and recommended in the EIA report.
10	Provide workers with safe and healthy working conditions	Refers to EHS General Guidelines 2007 (or any updates)	▪ Occupational health and safety standards included in the Factories Act 1965 and the Bangladesh Labour Law 2006.	▪ Both international and GOB standard will be followed for the project and more stringent one will be applied
11	Conserve physical cultural resources (PCR) and avoid destroying or damaging them	Use of field-based surveys and experts in the assessment ▪ Consult affected communities on PCR findings ▪ Use chance find procedures for guidance	▪ Preservation and protection of cultural resources are within the Antiquities Act 1968.	▪ Extensive field based survey by the sector expert and consultation with local people and concern government department will be carried out for finding PCR within the project area of influence

88. Gap analysis of the key components of the Government led land acquisition process against the international safeguard requirements of ADB SPS, 2009 is presented in ***Table 2.9***.

Table 2.9 IFC Performance Standards

Issues	ADB SPS, 2009	GoB, ARIPO	Measures to Bridge Gaps
Payment of compensation	Requires affected persons to be compensated prior to start of civil work	Land is handed over to the project proponent once payment of awards has been initiated	Physical and economic displacement will occur after full compensation at replacement cost or resettlement benefits have been paid
Valuation of land	Valuation of land at replacement cost	ARIPO determines the land price as the average market value during last 12 months of the land parcel from date of publication of the notice under section 3. Tax is deducted from the total land value and 50 percent premium is added	Provisions to be adopted for additional top up payments to ensure replacement costs
Valuation of structure	Structural cost at replacement cost of assets without taking into consideration the depreciation cost	As per law the structural cost is determined by deducting construction profit, overhead charge, value added tax (VAT) and depreciation, plus 50 percent premium is added	
Eligibility criteria	Non-title holders are eligible for compensation for loss of assets and income	Eligibility of non-title holders are not recognized for compensation under the law	All affected persons (APs) title holders and non-title holders to be compensated and provided with assistance
Relocation assistance	Affected households to be assisted in the relocation process	No provision for relocation assistance	Affected households (HHs) and businesses will receive relocation assistance in the form of additional lumpsum as well as support by the project proponent in identifying and negotiating as alternative place to stay.
Economic displacement	Improve or at least restore the livelihoods of all displaced persons	No compensation for loss of income	Affected households, especially vulnerable HHs are eligible to participate in livelihood improvement trainings along with seed grants as outlined in resettlement plan.

Issues	ADB SPS, 2009	GoB, ARIPO	Measures to Bridge Gaps
Consultation/ disclosure	Affected Persons (APs) must be consulted during project design and resettlement plan preparation; disclosure of the resettlement plan (RP) including documentation of the consultation in an accessible place and languages understandable by the APs and other stakeholders. All documents must be disclosed locally and on the ADB website.	ARIPO does not emphasize on consultation/ disclosure	Extensive consultations have been carried out during design and the ESIA stage; consultations with APs and other stakeholders must be done during the RP preparation and its implementations. RP along with the Entitlement Matrix (EM) must be disclosed locally and also on the website of ADB and project proponent.
Safeguarding needs of vulnerable groups	RP must have provisions for vulnerable groups	ARIPO does not have any especial provision or assistance for vulnerable groups	Special assistance measures for vulnerable groups

2.10 APPLICABLE EHS STANDARDS

89. The Project has to comply with Bangladesh environmental, health and safety laws and Lender Guidelines with special attention to comply with the Bangladesh (GOB Environmental Conservation Rule 1997) and the World Bank Group EHS requirements.

90. Therefore, the EHS standards as stipulated in ECR 1997 and amendments thereof as well as in the IFC EHS guidelines (General of 2007 and EHS Liquefied Natural Gas Facilities, April 2017 and IFC EHS Offshore Oil and Gas Development of June 2015) and International Convention for the Prevention of Pollution from Ships (MARPOL 73/78) for air quality, marine water, surface and ground water quality, ambient noise levels, emissions and effluent discharge will be applicable.

91. The ADB SPS policy Statement 2009 (SPS) also states, "During the design, construction, and operation of the project the borrower/client will apply pollution prevention and control technologies and practices consistent with international good practice, as reflected in internationally recognized standards such as the World Bank Group's Environment, Health and Safety Guidelines. These standards contain performance levels and measures that are normally acceptable and applicable to projects." For this purpose IFC EHS guidelines are recommended. The relevant environmental standards (national as well as international) applicable to this Project are indicated in ***Annex 2***.

92. It is evident from ***Annex 2*** that except noise level standards, the WB/IFC guidelines are more stringent than the local standards. The Project needs to comply with the Bangladesh environmental, health and safety laws and the World Bank Group Guidelines. Hence, it is mandatory for the Project to meet the stringent standards, as per applicability.

2.11 CATEGORISATION OF THE PROJECT

2.11.1 Project Classification as per DOE, Ministry of Environment and Forest, Bangladesh

93. Depending upon location, size and severity of pollution loads, projects/ activities have been classified in the ECR, 1997 into four categories: *Green*, *Orange A*, *Orange B* and *Red*, respectively, to nil, minor, medium and severe impacts on important environmental components (IECs). As defined in paragraph 57 of this ESIA, the proposed Project relates to "**Red Category"**

2.11.2 Project Classification as per ADB Safeguard Policy Statement

94. Categorization for the proposed Project was undertaken by using ADB's Rapid Environmental Assessment (REA), Involuntary Resettlement (IR) and Indigenous People (IP) Assessment checklists during the screening and scoping exercise. The findings of the assessment are presented in ***Table 2.10***.

Table 2.10 Project Categorisation as per ADB Safeguards

u	Criteria	Relevance	Remarks	Category
1	**Environmental Categorization**			
(a)	Irreversible	Environmental issues and impacts of the Project are anticipated during the construction and operation of the marine facilities (twin jetty, FSRU, subsea pipeline) and onshore facilities including RLNG spur pipeline and CTMS.	Irreversible impacts due to the Project include: ▪ Increase noise and vibration during the plant construction and operation ▪ Change in air quality due to air emissions from gas engines for power generation onboard FSRU and at the onshore gas metering station. ▪ Affected aquatic ecology and surface water quality during construction of twin jetty and laying of subsea pipeline ▪ Change in water quality due to discharge of ballast and bilge water ▪ Occupational health and safety; ▪ Community health and safety; ▪ Risks due to transport, storage and handling of highly flammable chemicals; ▪ Associated development in the area.	***Based on irreversible, diverse and unprecedented impacts, it should be categorized as 'A'.***
(b)	Diverse	Nature of activities	The nature of activities is diverse for the area, LNG terminal comprising of offshore FSRU and (onshore gas spur pipeline and CTMS). The onshore areas are largely rural in nature with an agrarian character.	
(c)	Unprecedented	Change in landuse	The establishment of the Project will result in permanently change land use of the land based facilities (CTMS) to be developed and areas for associated infrastructure (like gas pipeline, etc.) from agricultural and coastal uses to industrial character. The land required for construction (i.e. laying) of ~16 km long (30 inches diameter) high pressure gas spur pipeline (from *Kutubdia* Island to CTMS Valve Station no. 2 at *Napura, Banshkhali*) and CTMS will be ~50 acres. For operation and maintenance purposes out of ~50 acres, Petrobangla, Government of Bangladesh will acquire ~30 acres of land on permanent basis both for pipeline (~26 acres) and CTMS (~4.0 acres). The ownership of all the land required and acquired will lie with Petrobangla. With the setting up of the Project, the land use from agricultural and salt pan of the government land/ private land will be permanently converted into industrial land.	

u	Criteria	Relevance	Remarks	Category
2	**Involuntary Resettlement Categorization**			
(a)	Unprecedented	Land		***Based on current project design (FSRU with onshore subsurface pipeline and CTMS) magnitude related to large number of plots that will go for land requisition (49.343 acres) and permanent acquisition (of 30.326 acres) will involve the issues of resettlement and associated project affected households- the Project shall be categorized as 'B'.*** *The provisions of LA and IR impacts are to be addressed by Petrobanlgla as per detail given in "Resettlement Framework", a separate document prepared as per requirements of national laws and ADB's SPS.*
(b)	Adverse	Land Acquisition (LA)	Land requisition and acquisition will occur for the onshore pipeline and the CTMS at valve station 2 by Petrobangla (i.e. not in the scope of RBLTL) of the upcoming LNG Terminal. Involuntary resettlement impact is envisaged. The ownership of all the land required and acquired for pipeline will lie with Petrobangla. Once land is acquired, it will be handed over to RBLTL for 15 years for pipeline erection and subsequent operations and maintenance for supply of RLNG into the national gas grid. Th requisition of land (49.343 acres) will be purely for the construction period and is expected to be for one year, after which the lands will be restored and reinstated to the best achievable original conditions and returned to the land owners.	
(c)	Irreversible	Project Affected Households	Loss of unproductive private land	
3	**Indigenous People Categorization**			
(a)	Presence	Existence of Indigenous People (IP)	The census data (2011) of Bangladesh shows that in the entire *Kutubdia Upazila*, there are only 5 households of ethnic minority population. Currently that there is no population under this group within the area where the Project related land is being proposed.	***In case of no foreseen adverse impact, project shall be categorized as 'C'***
(b)	Impact	Impact on indigenous/ ethnic/ scheduled tribes	No adverse impact on the Ethnic Minority is foreseen	

3 DESCRIPTION OF PROJECT

3.1 PROJECT COMPONENTS & THEIR SETTING

95. Reliance Power Limited (RPL) intends to develop LNG storage and re-gasification facility (LNG terminal) of about 3.5 to 5.0 MMPTPA. As defined in ***Section 1.1***, the LNG terminal will include the following components:

Marine component off *Kutubdia* Island covering

i) Twin (double berth) jetty with topside (1.5 km to the west of *Kutubdia* Island) with 0.5 MW gas based power generation;

ii) Floating Storage and Regasification Unit (FSRU) (of storage capacity of 137,000 m^3 to 216,000 m^3) to be moored starboard side of the jetty;

iii) Regasification onboard FSRU of 750 MMSCFD peak capacity with 10 MW onboard gas based power generation;

iv) High pressure 30 inches (30") subsea ~2.0 km regasified LNG pipeline;

Onshore component covering

96. Subsurface/subsea gas spur pipeline of ~16 km length (30 inches diameter) connecting *Kutubdia* Island to custody transfer metering station (CTMS) through Valve Station no. 2 to be located at *Napura, Banskhali* from where the gas pipeline will be connected into the GTCL's national gas grid pipeline of *Moheshkhalli – Anwara* Section. The pipeline length of ~16 km also includes 2.7 km of subsea pipeline length passing through *Kutubdia* Channel. The CTMS at *Napura* will also have 0.5 MW (625 kVA) gas based power generating unit and pipeline pigging facility.

97. The regional setting map indicating the proposed location of the LNG terminal is presented as ***Figure 3.1***. A schematic representing the different project components is shown in ***Figure 3.2*** whereas a map showing the administrative (union) boundaries in *Kutubdia* Island is presented in ***Figure 3.3***. It is to be noted here that the *Kutubdia Upazila* entirely comprises of the *Kutubdia* Island. The salient features of the LNG terminal Project is provided in ***Table 3.1.***

Table 3.1 Salient Features of the LNG facility with FSRU/FSU Options

Parameter	Specifications
Cargo Storage Capacity onboard FSRU	137,000 m^3 –216,000m^3
Minimum Regasification Output	50 mmscfd
Nominal Regasification Output	500 mmscfd
Peak Regasification Output	750 mmscfd
Boil Off Rate	Max. 0.15% per day
Regasification Equipment Sparing	N+1
Major Maintenance Plan	15 years docking cycle
LNG Regasification System	Open loop for FSRU
Nominal Pressure of Send-Out Gas	70-100 bar g after Regasification
Boil Off Gas (BOG) Management	Efficient BOG management for at least 7 days of zero send-out. No venting allowed under normal operating conditions required.

Source: Reliance Power from their study titled "Reliance Bangladesh LNG Import Terminal Feasibility Study – Site and Configuration Selection Report, Advisian Worley Parsons Group, Singapore, July 2016"

Figure 3.1 Regional Setting Map of Proposed LNG Facility

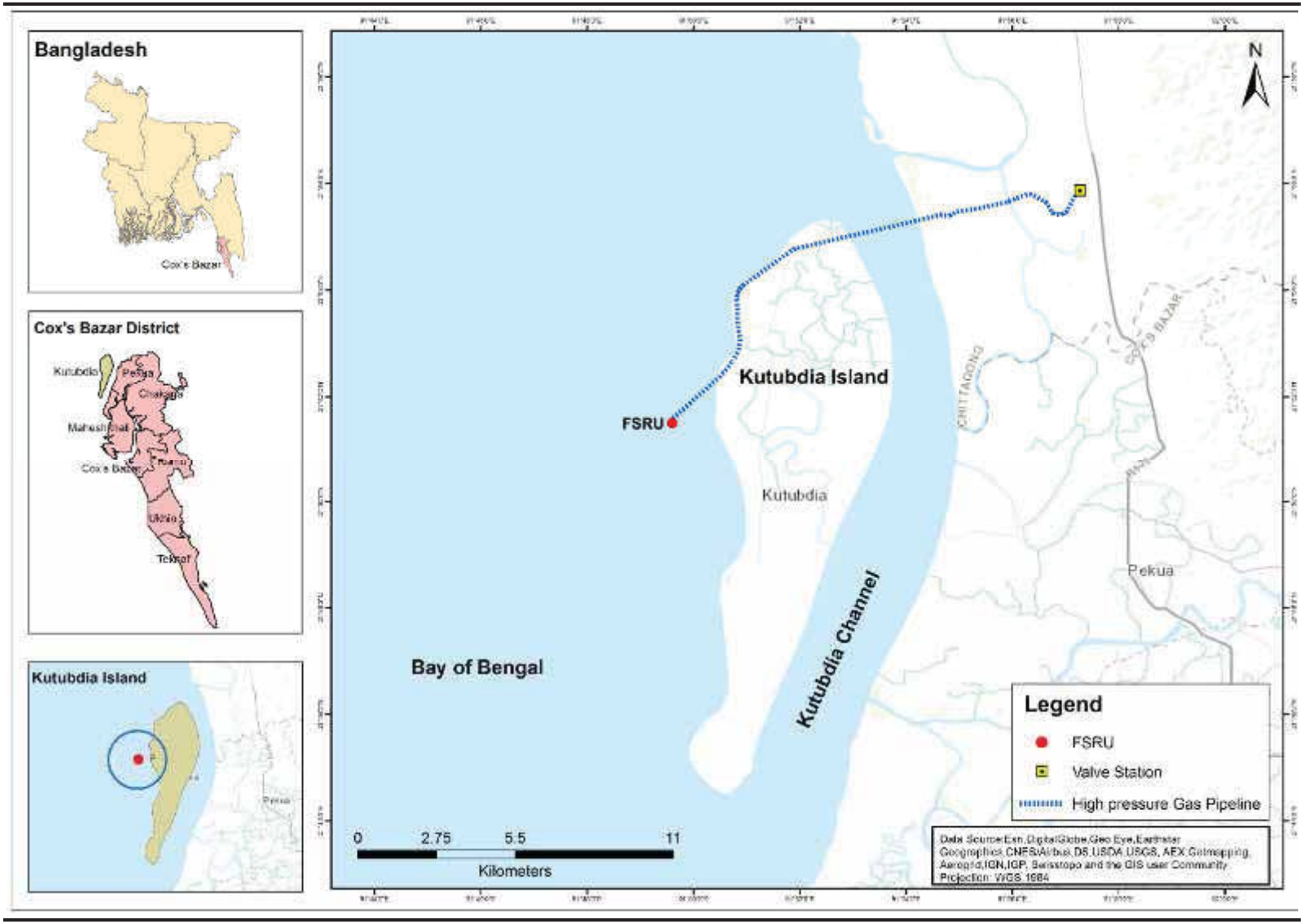
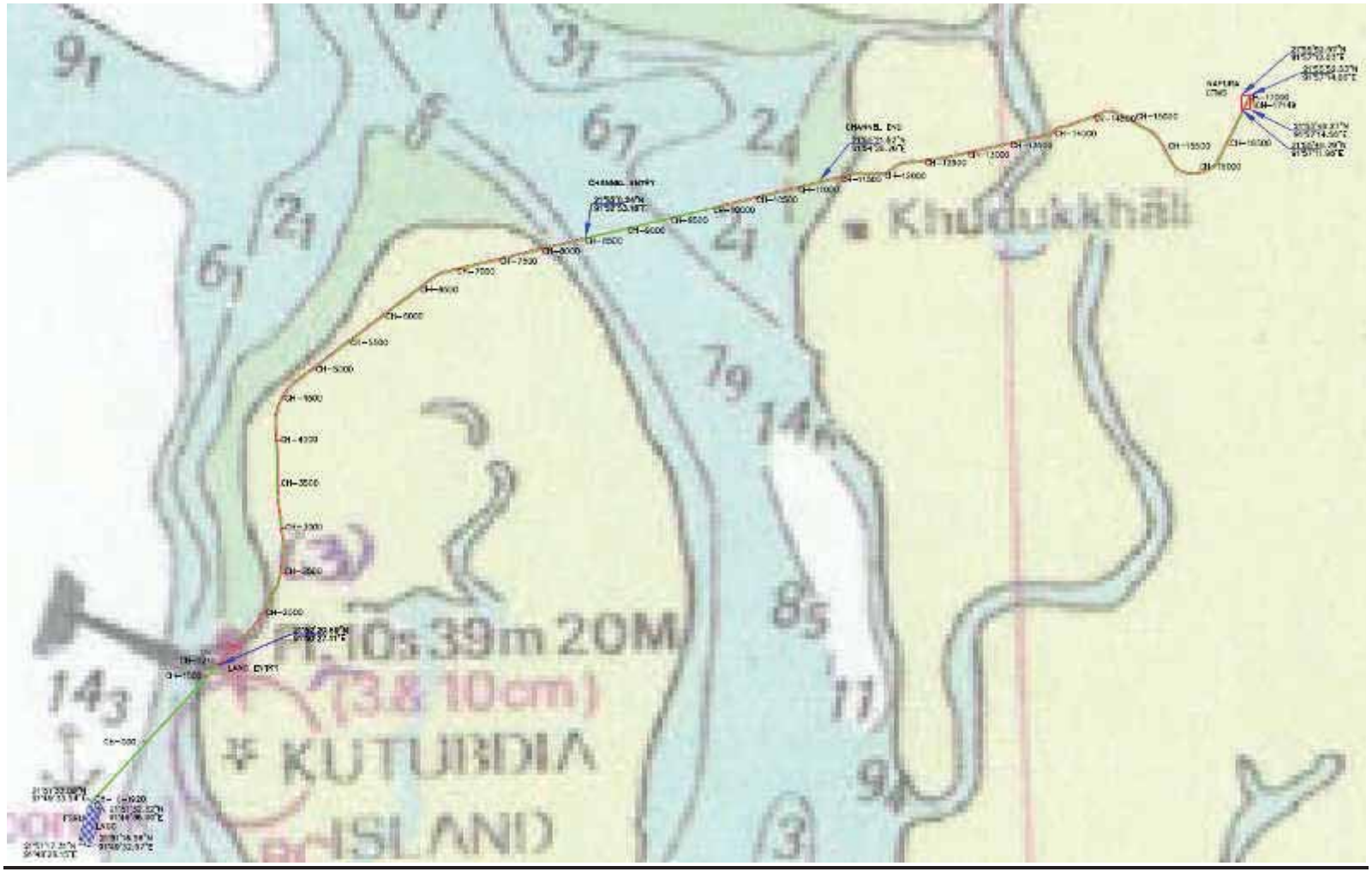
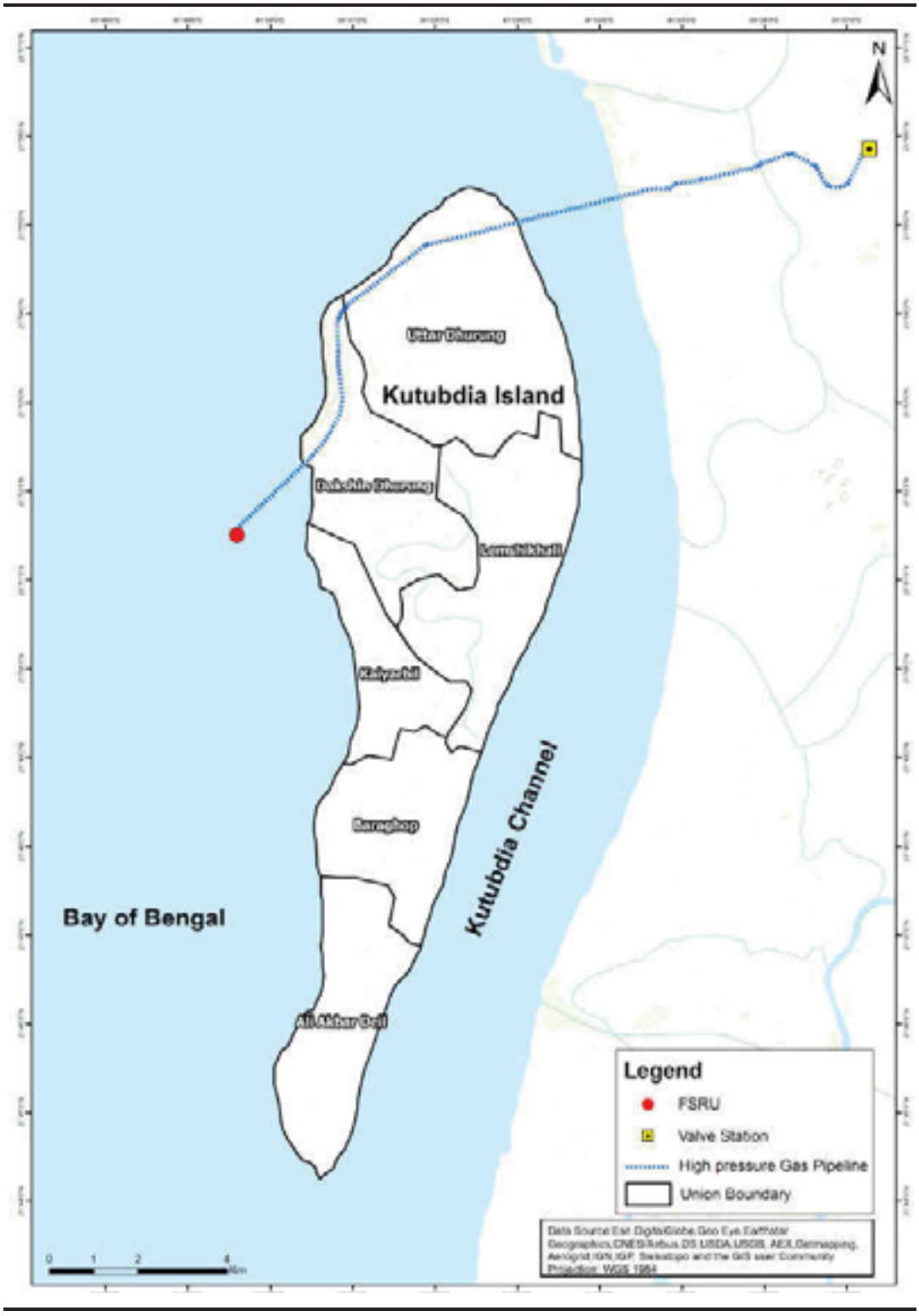


Figure 3.2 Kutubdia LNG Facility & Spur Pipeline Route



Source: Reliance Power

Figure 3.3 Administrative (Union) Boundaries in Kutubdia



98. The proposed LNG terminal Project will consist of (i) seafront based marine facilities (FSRU) and (ii) ~16 km gas spur pipeline and CTMS facilities. The locations of these facilities are as follows:

3.1.1 Seafront Based Facilities

a) Floating Storage & Regasification Unit (FSRU)

99. The Floating Storage Unit (FSRU) will be located in the Bay of Bengal, approximately 1.5 km from the north western shoreline off *Kutubdia* Island semi-permanently moored to the twin Jetty. The FSRU will be designed for a storage capacity of 137,000 m^3 to 216,000 m^3 of LNG Storage. The regasification facilities will be provided onboard the FSRU.

b) Jetty

100. Jetty with offshore steel/concrete structures and mooring facilities on either side is planned offshore near the FSRU. The proposed jetty configuration will comprise of two parallel berthing facilities to manage simultaneous berthing of both FSRU and LNG Carriers (LNGCs).

c) Subsea High Pressure Pipeline

101. High pressure (~90 bar g) RLNG subsea pipeline of diameter ~30" of ~2.0 km length from the FSRU.

3.1.2 Onshore Facilities

a) Subsurface and Subsea High Pressure Spur Pipeline (~16 km)

102. The spur RLNG pipeline of ~16 km onshore gas pipeline of ~30" will be operated at ~90 barg of pressure, connecting into the main gas grid of GTCL at Banshkhali. The ~16 km spur pipeline will be laid subsurface (2 m below ground level) and also includes 2.7 km of subsea pipeline length passing through *Kutubdia* Channel. The spur pipeline will route through *Dakshin Dhurung, Uttar Dhurung, Chhanua* and *Puichhari Union Parishads* of *Kutubdia* and *Banshkhali Upazila*s respectively. There will be land requisition of 49.343 acres for laying of the pipeline and 30.326 acres will be permanent land acquisition for operation and maintenance and CTMS operation. The land for the pipeline will be owned by Petrobangla and will be provided to RBLTL for 15 years.

b) Custody Transfer Metering Station (CTMS)

103. The site for CTMS is selected at *Napura, Banshkhali*. As per present planning considerations, Reliance Power is considering a potential site of 3.95 acres. However, the exact dimensions of the site will be confirmed after necessary review and scrutiny by the Land Revenue Department and the Deputy Commissioners Office at *Cox's Bazar*. The CTMS site will include the following:
    i) Control room;
    ii) RLNG metering station;
    iii) Utilities comprising power generation (gas engines) 0.5 MW, nitrogen generator and instrument air package unit, pipeline pigging facility; and
    iv) Administration office.

3.2 GENERAL FEATURES PREVAILING ALONG PIPELINE ROTUE

104. The eastern of the coastal embankment supports typical landuses such as agriculture, salt cultivation, etc. In addition certain groves of trees have been noticed along with presence of homestead land.

Figure 3.4 Project Site and Surroundings

Kutubdia Island – Western Side of the Beibandh

Eastern Side of the Beibandh

Beribandh – Coastal Embankment

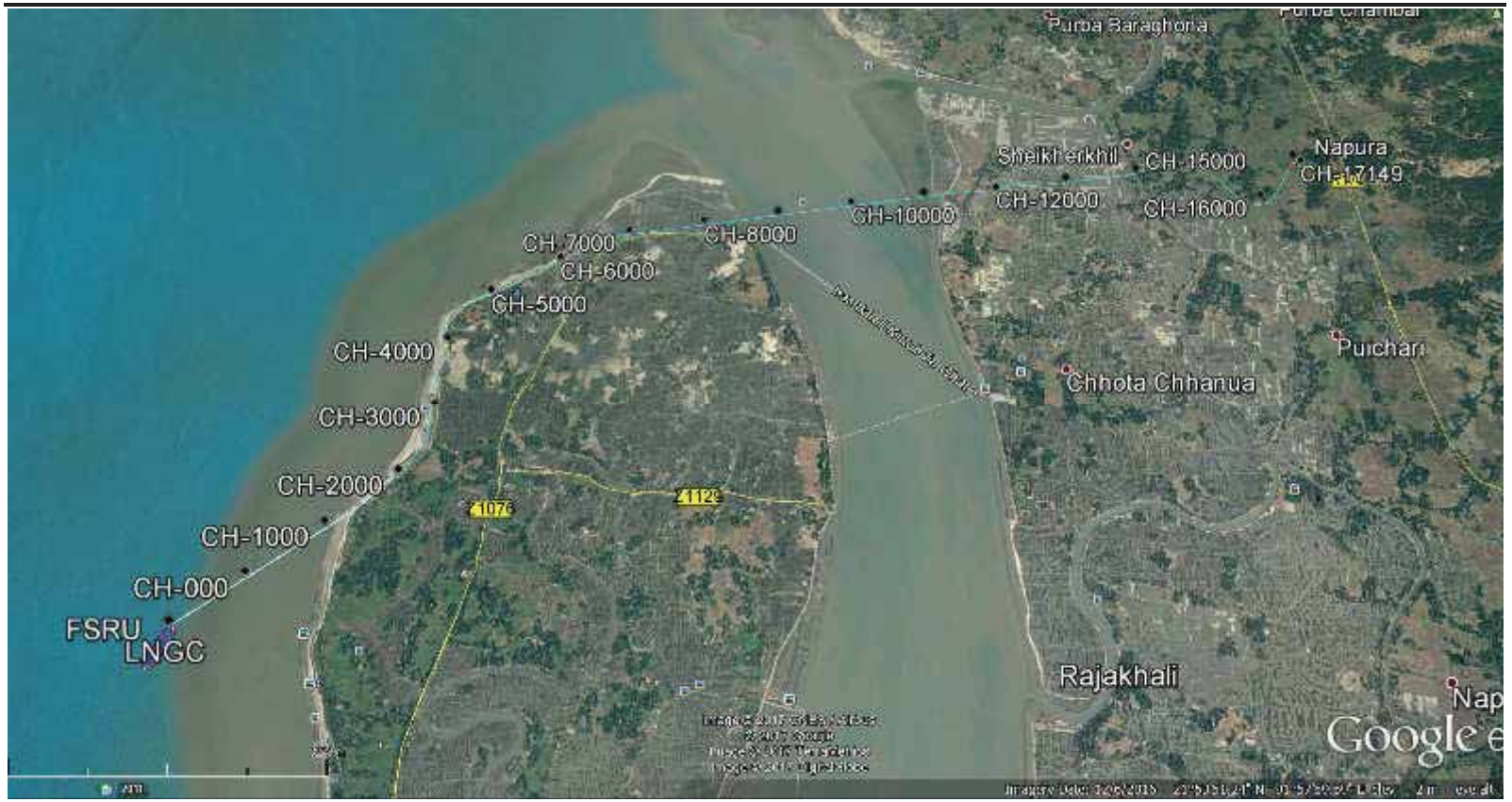
The Existing Lighthouse (North of Site)

Tree Groves and Homestead Land

Casuarina Plantation

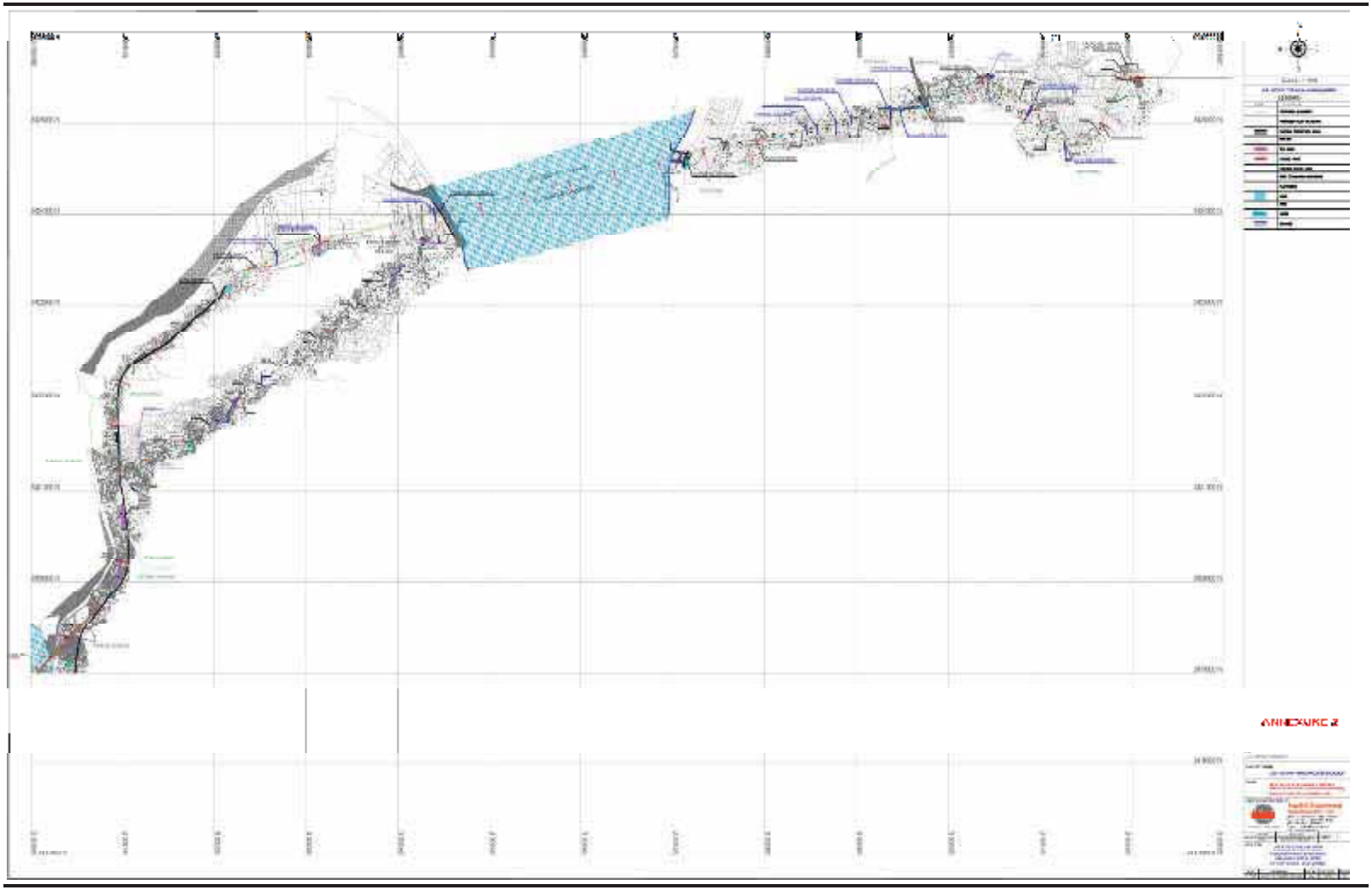
105. The location of the land fallsub-sea and onshore pipeline route point on Google Earth Imagery and Cadastral Mapstopographical survey map is presented in ***Figure 3.5*** and ***Figure 3.6*** respectively.

Figure 3.5 Proposed LNG Location and Spur Pipeline Route



Source: Google earth (as provided by Reliance Power)

Figure 3.6 ***Proposed Onshore Gas Spur Pipeline Route Superimposed on Cadastral Map***



Source: Reliance Power

3.2.1 Onshore Spur Pipeline

106. Indicative onshore spur pipeline (of ~16 km) from near shoreline of *Kutubdia* Island up to Napura to connect to national gas grid (*Moheshkhali Anwara* section) of GTCL at *Banskhali* with connectionof this pipeline at valve station 2 (at *Napura*). The gas spur pipeline will be laid by RBLTL on land to be provided by Petrobangla on lease to RBLTL.

Figure 3.7 Indicative Onshore Pipeline Route of Petrobangla /GTCL

3.3 CONNECTIVITY

107. The *Kutubdia* Island is isolated from main shore of Bangladesh. There is no direct road access to the island. One has to cross the *Kutubdia* Channel to reach the island. At present state, the *Kutubdia* Channel is ~4 km wide between *Boroghop* (*Kutubdia*) – *Magnama Ferry Ghat*.

108. Aerial distance from the nearest town at *Cox's Bazar* is ~ 50 km and by road ~85 km including the channel crossing. The nearest national highway is *Chittagong-Cox's Bazar* National Highway (N-1). Speed boat, trawler, ferry are the primary means of transport from the mainland to the island. For communicating by road the inhabitants of the island use the *Magnama Ghat* on the mainland and then use the regional roads (R-170 and R-172) to reach *Chokoria* on the national highway. However, buses are available at *Pekua* (~ 5 km from *Magnama Ghat*) from where one can travel to other locations of the country.

109. The *Kutubdia* Channel is directly connected with the Bay of Bengal at both ends. The *Chittagong* Port is located on north of the *Kutubdia* Island and ~50 km from the proposed jetty site. An anchor point of the *Chittagong* Port is located in the *Kutubdia* offshore region along with an existing navigational channel, which is located ~3 km from the sea front on the north western part of the island (Refer to ***Figure 3.10)***.

Figure 3.8 Existing Navigational Channel off Kutubdia

110. Imported plant and equipment can be transported to the site by this sea route through all seasons of the year. Most of the heavy equipment is expected to be unloaded at *Chittagong* Port, and same will be transported to the Project site at *Kutubdia* Island.

111. The accessibility map of the Project site is presented in Figure 3.9 whereas the navigational chart of this region showing the anchor point of the *Chittagong* port is presented in ***Figure 3.10.***

Figure 3.9 Accessibility Map of the Proposed Project site

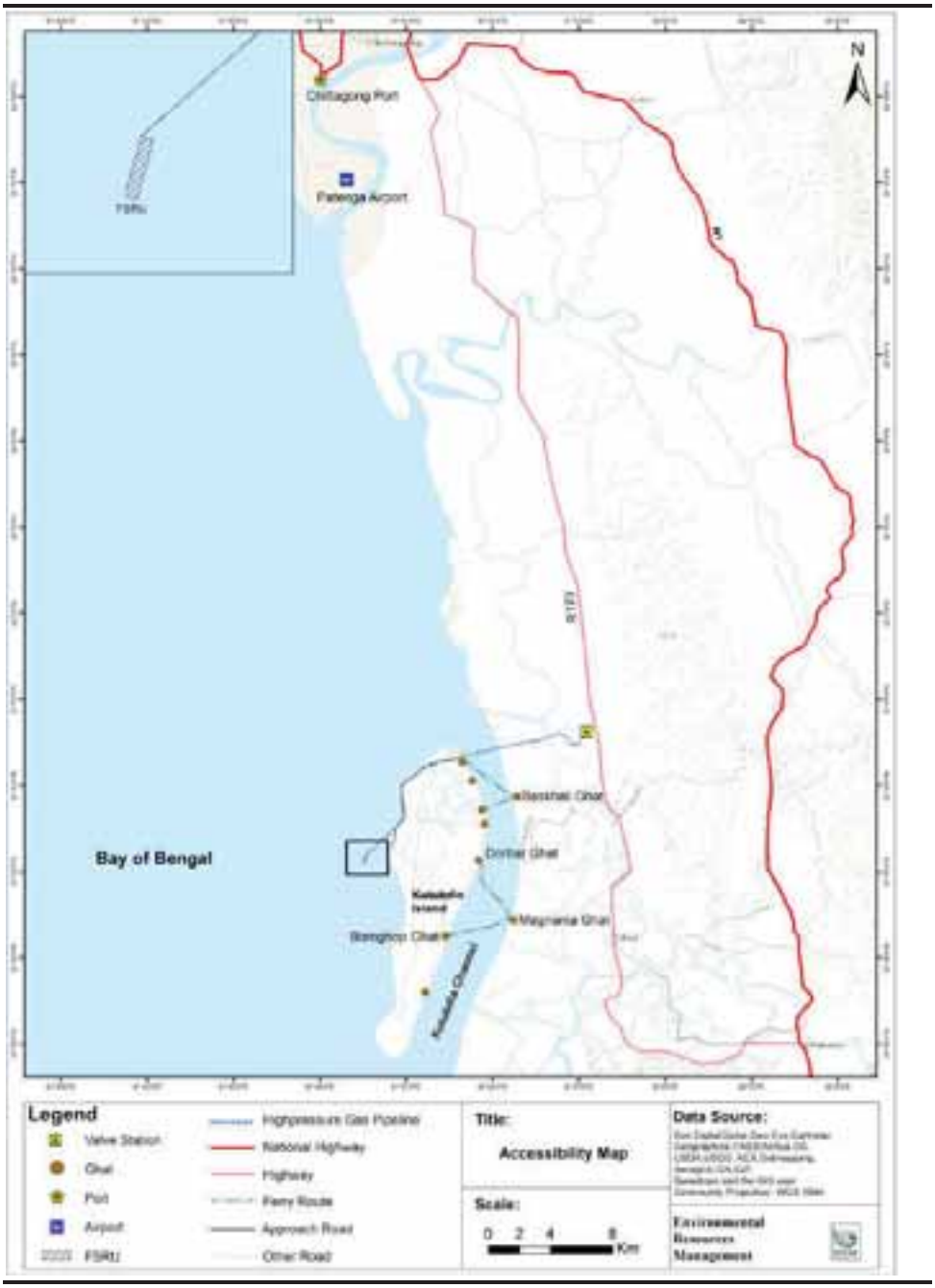
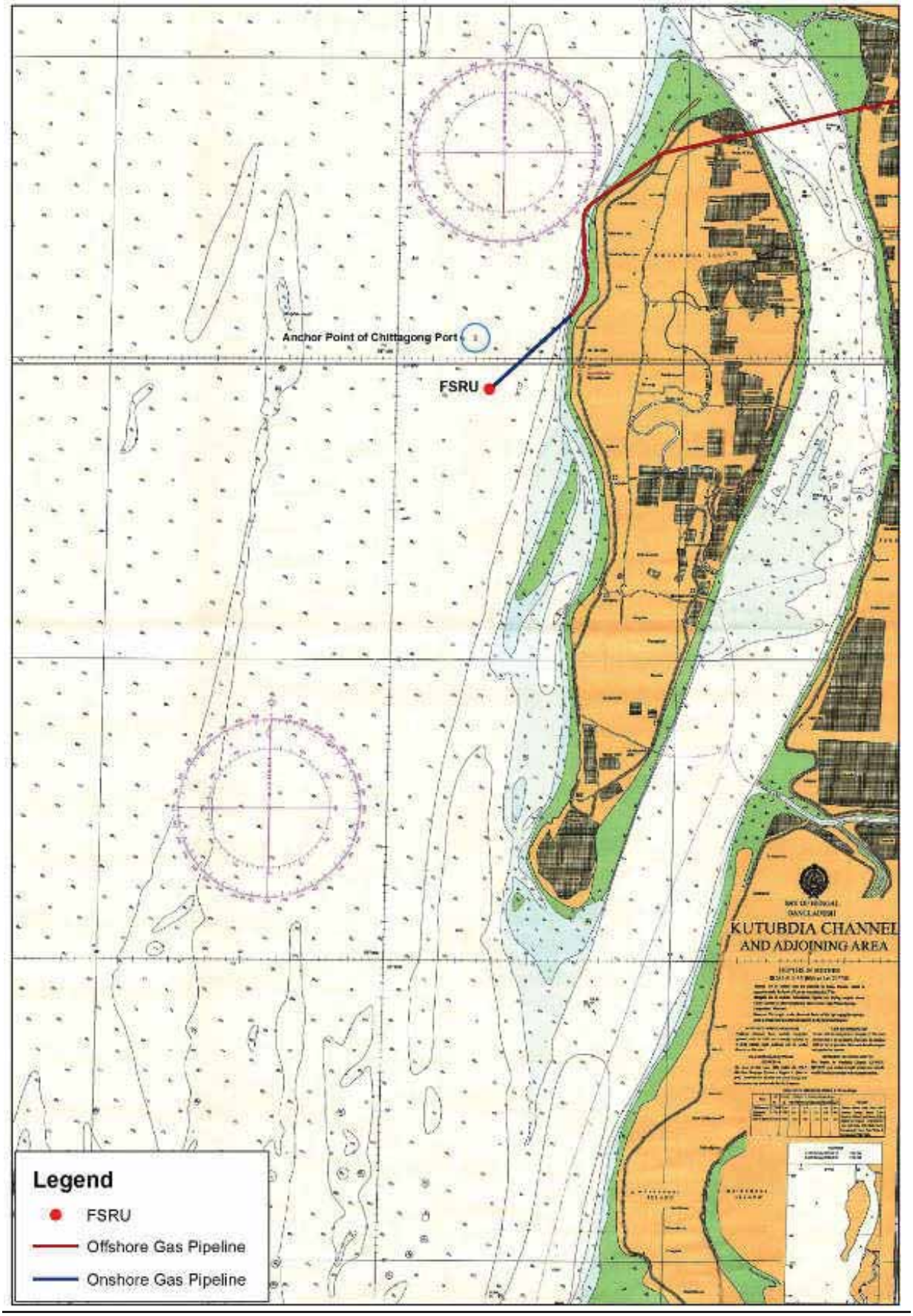


Figure 3.10 Navigational Chart – Kutubdia Channel and Adjoining Areas



3.4 PROPOSED PROJECT SCHEDULE FOR IMPLEMENTATION

112. The duration of the construction and commissioning of the Project has been preliminarily assumed as lasting ~12 months from the date of all approvals obtained for the Project. The whole development of the Project will involve the following main activities:

- Conceptualization stage;
- Pre-FEED and FEED studies;
- Construction and fabrication, inclusive of procurement of long lead items; and
- Deployment and commissioning of FSRU at the jetty.

113. The following construction activities will be developed separately:

- Jetty construction on piles with topside facility;
- Subsea and onshore high pressure pipeline; and
- Custody Transfer and Metering Station facilities.

3.5 TECHNOLOGY & PROCESS DESCRIPTION

114. The proposed FSRU technology based LNG terminal will include the following operations:

i) LNG Cargo Offloading;
ii) Storage of LNG onboard FSRU;
iii) Regasification of LNG onboard FSRU; and
iv) RLNG sendout through high pressure pipeline up to CTMS andn Napura. Point for its supply to national gas grid into *Anwara – Moheshkali* Section.

3.5.1 LNG Offloading

115. LNG will be brought by LNG carriers (LNGC) of sizes ranging from 125,000 m^3 to 263,000 m^3 capacity (the maximum being equivalent to Q-Flex LNG Carrier). LNG will be offloaded from the LNG Carrier via twin jetty (with topside facility) to the FSRU. The LNG offloading will be performed through Marine Loading Arms (MLAs) on both the LNG Carrier and FSRU sides of the jetty. The offloaded LNG will flow through 4 nos. (3 working+1 standby) of MLAs (each of 16" diameter and of arm length of up to 12 m) on the FSRU side of the jetty to the FSRU Storage Tanks with attached couplings. At an offloading rate of ~10,000 m^3/hour, LNG cargo will be transferred within 24 hours. Considering 5.0 MMTPA, there will be annual requirement of 51 LNG cargos of 216,000 m^3 or 77 cargos of 137,000 m^3. Thus with representative offloading of ~24 hours per day, there will be LNG cargo offloading at roughly 5 days per cycle.

3.5.2 LNG Storage

116. FSRU serves as LNG receiving, storage and regasification facility. The cryogenic LNG will be stored in membrane/moss type cargo storage tanks onboard the FSRU with total storage capacity varying from 137,000 m^3 to 216,000 m^3. Each

storage tank will be equipped with block valves on the filling lines which will allow isolating the tank in case of emergency. Moreover, in case of failure of the tank pressure control system, each tank is protected against overpressure by independent safety valves discharging directly to the atmosphere via a dedicated vent mast.

117. Tanks will be provided with one radar type level instrument to monitor the level and give high and low level alarms. In addition, an independent high level switch will be fitted to initiate the shut-down of the LNG carrier loading operation to protect the tank from overfilling in case all other preventive actions fail. Each tank will be also supplied with a Level Temperature Density (LTD) measurement instrument which allows measuring of liquid level, tank temperature profile and tank density profile. This instrument will be used to monitor tank stratification and as a backup for the radar level instrument. Tanks will be equipped with submerged electric LNG In-tank pumps used to lift LNG from storage tanks to the Re-gasification plant. The cooling of the electric motor and bearings and bearings lubrication is ensured by pumped LNG.

118. The start/stop of each LNG in-tank pump will be controlled by the operator who shall ensure that enough pumps are in operation to fulfil the FSRU send out flow rate. Each pump discharge will be equipped with:

- A minimum flow recirculation which ensures that the pumps never operate below their minimum flow. The minimum flow recirculation will also be used for pump start-up.
- A vent to tank. During pump start-up sequence the vent will be opened to allow venting the gas contained in the pump well. The vent opening will be controlled by a timer. After an adjustable time, the vent will close.

119. Tanks will be equipped with spray pumps. Each pump discharge will be equipped with a control valve which enables to control the pump electrical current. Moreover, a return line to tank with an additional control valve will be provided in order to control the spray nozzles inlet pressure. The LNG storage within FSRU will be maintained at the 0.1 barg. The LNG offloading will be done at the pump inlet pressure of 5 barg connecting MLAs of LNGC with MLAs of FSRU at the jetty. Displaced vapour is balanced from the FSRU back to the LNG Carrier.

3.5.3 LNG Regasification onboard FSRU

120. LNG (transferred from LNGC to FSRU and stored onboard FSRU) will be regasified through Shell and Tube vaporisers (STVs). The peak 750 MMSCFD gas send-out capacity targeted in this Project would be met by re-gasification skids with N+1 philosophy. As per the current information, FSRU will have vaporizer system with direct sea-water heater (open loop system) wherein LNG at ~ -155ºC passing through shell – tube type exchanger will be heated by sea water (at 20ºC to 30ºC offshore *Kutubdia* Island) flowing through the shell side in an open loop (discharged to sea and not recycled back) configuration. The

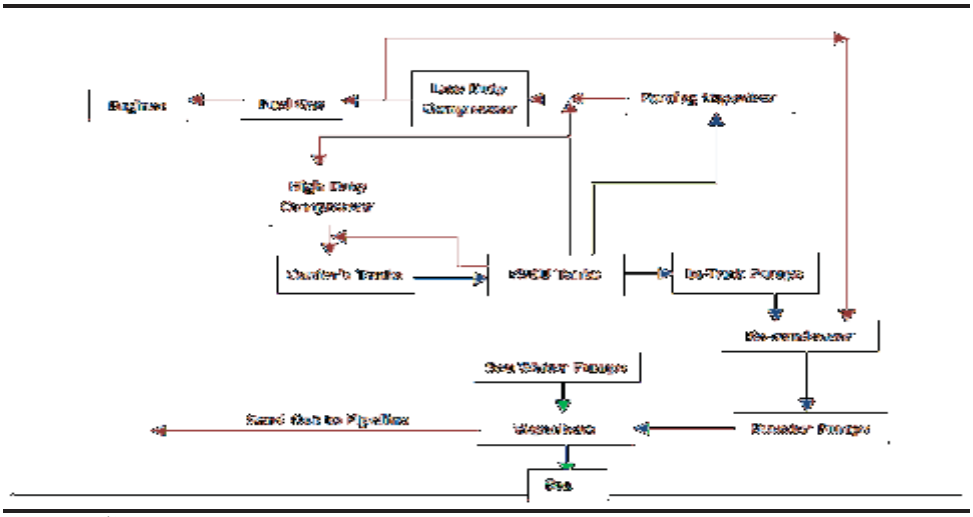
salient features of the FSRU are given in ***Table 3.2*** and flow diagram is as shown in ***Figure 3.12***.

Table 3.2 Salient Features of the FSRU

Parameter	Specification Required
LNG Storage Capacity	145,000 m^3 to 216,000 m^3
Regas Technology	Open loop
Spare Philosophy	Operating + Standby for all critical equipment
Flaring	Zero Flaring under Normal Conditions
Staff / Crew	Operation Phase ~ 35 persons on board FSRU

Source: Reliance Power

Figure 3.11 Typical Operational Activities of Regasification Plant



Source: Reliance Power

3.5.4 Seawater System

121. A seawater system will be provided to supply the required seawater to the LNG vaporizers for LNG vaporization. Seawater system is made up of:
   - Seawater intakes;
   - Seawater pumps;
   - Seawater filters installed upstream seawater pumps provided for protecting pumps;
   - Seawater filters provided for protecting LNG vaporizers; and
   - Cold seawater and equipment cooling seawater discharges.

122. The seawater intake will be through seawater filters and will be pumped by the seawater pumps to the LNG Vaporizers. Seawater filters will be provided on discharge header to protect LNG vaporizers. Seawater will then be routed overboard through gooseneck and, then, to the seawater discharge line.

123. It is expected that the cold water discharge of ~15,000m^3/hour will be done with ~-7 ºC delta (temperature of ~7 ºC lower than the receiving water) at peak send out.

124. Apart from the cold water discharge, there will be discharge of ~3,000m^3/hour auxiliary cooling seawater of delta +4ºC (temperature on higher than the receiving water).

3.5.5 Other Support Facilities

a) Twin Jetty

125. The Jetty proposed will consist of two parallel berthing facilities with offshore steel/concrete structures and mooring facilities on either side so as to manage simultaneous berthing of a FSRU and LNG carriers (LNGCs) for unloading LNG (adjacent / side-by-side) berthing and mooring on either side of jetty with fenders. The Jetty and associated facilities will be built to operate in a draft of more than 12 m. The design of Jetty and necessary facilities would be such that it puts no restriction for the movement of FSRU / LNG carrier ships (entry channel, turning circle, berthing / mooring pockets) to and from proposed jetty with required navigational aids.

b) Mooring Facilities

126. LNG Cargo will be moored at the Jetty on arrival and demoored after offloading the cargo. FSRU will be permanently moored on Jetty. Capability of disconnection and moving to a sheltered location under emergency conditions is part of the Project design of the facility.

c) Power Generation System

127. The FSRU will be provided with a main power generation system designed for power supply. The actual power requirement onboard FSRU is expected to be ~10 MW to be generated through gas engine (1 operating +1 standby) (dual fuel). Because of the necessity to handle the boil off gas (BOG) that naturally boils from cargo tanks, almost all FSRU are designed to use the vaporized LNG as fuel for power production and propulsion. The boil off gas is collected in the vapour header and compressed by the low duty (LD) compressors into the fuel gas main that feed the power plant. If the natural boil off is not sufficient, forced vaporizers will be used for vaporizing part of the cargo and feed the fuel gas main. The main power requirements onboard FSRU will be for:

- Regasification unit;
- Low duty and high duty compressors;
- Ballast pumps;
- Cargo pumps; and
- Accommodation load.

128. In addition to the main power production system, a generator will be provided to guarantee the availability of essential systems in case of failure of the main power generator system; such essential systems necessarily include:

- Navigational aids;
- Lighting;
- Communication systems;

- Fire and gas detection; and
- Firewater pumps.

129. Furthermore an uninterruptable power supply (UPS) system will be available on board to power vital systems such as navigation lights, communication, emergency lighting, etc.

130. Jetty will have gas engines of 0.5 MW. At the jetty, there will also be emergency diesel generator of 0.5 MW capacity.

131. At the land based CTMS facility, there will be 0.5 MW gas engine to meet the power requirement at the onshore. There will also be emergency diesel generator of 0.5 MW capacitygenerated.

d) Ballast System

132. FSRU will be provided with a ballast system sized on the basis of the following philosophy:

- The ballast tanks capacity shall be able to compensate the full unload of the stored LNG;
- The ballast pumps shall be able to discharge outboard the ballast water at a sufficient rate to compensate the LNG loading and keep the drought almost constant. Clean and segregated ballast water will be discharged into sea.

133. LNG carriers will have their own ballast water exchange plant or treatment system as per regulations in force.

e) Venting System

The venting system will aim to discharge any flammable vapour release to atmosphere at safe location, thus minimizing any potential risk to involved personnel.

f) Nitrogen System

A nitrogen system will be available for the following types of services:

- Purging of unloading arms: vapour and liquid unloading arms shall be purged after any loading;
- Intermittent services (tank barriers, sealing system between compressors and relevant motors, other seals, vent system purging);
- Continuous (essential) services (tank barriers, purging of the vent mast (first purge) and of unloading arms, continuous services).

The system will be made up of two redundant nitrogen generation packages - a buffer tank and a nitrogen distribution system.

g) Accommodation

134. In order to face operative conditions, the number of people on board the FSRU will be a maximum of ~35 (covering all shifts), inclusive of technical personnel

dedicated to typical terminal operations. Based on that, accommodations will include the following:

- Public spaces: officers' dining room, officers' lounge, crew mess, crew lounge, duty mess, hospital/dispensary, gymnasium;
- Service spaces: galley, officer and crew pantries, pantry at cargo control room, officer, FSRU and crew laundries, storage lockers, linen (clean, dirty) lockers, waste handling room;
- Sanitary spaces: public toilets, officer and crew changing rooms;
- Operational spaces: combined wheelhouse with chart and radio room, engine control room, cargo control room with related meeting room, conference room, main administration office, one office each for Captain, Engineer and Senior Officers, document store, central fire control station, fire equipment rooms; and
- Provisions stores: Dry provision (18°C), meat (-25 °C), fish (-25°C), vegetable (2°C), lobby (4°C), bonded store.

3.5.6 High Pressure Subsea & Subsurface Pipeline

135. The high pressure subsea pipeline of length ~2.0 km connecting into ~16 km onshore pipeline (including 2.7 km of pipeline passing through *Kutubdia* Channel) will be designed for LNG at delivery pressure of ~95 bar(g) [range 70 to 100 bar(g)]. It will be designed for operability of the plant design life (at least 25 years). The salient features of the proposed subsea pipeline are as covered in ***Table 3.3***.

Table 3.3 Salient Features of the High Pressure Subsea Pipeline

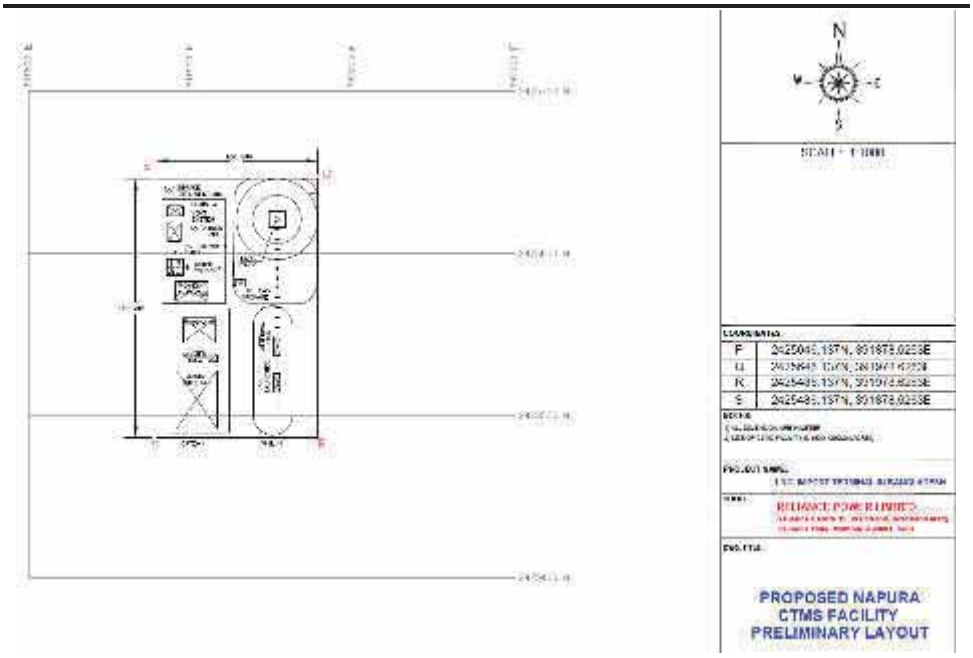
Parameter	Units	Value
Length	km	~2.0 + ~16
Diameter	Inch	30
Design pressure	bars (g)	150 bar(g)
Design temperature	°C	5

136. The CTMS would consist of:

- Gas receiving and metering facilities (up to 750 MMSCFD).
- Nitrogen facilities (Air Separation facilities)
- Power plant – gas engines of 0.5 MW and emergency power back up through diesel generators of equivalent capacity;
- Pig receiving facility
- Potable water system (2 m^3 /day)
- Administrative Building including control, chemical laboratory and security.

137. The proposed layout of the CTMS facility is shown in ***Figure 3.12.***

Figure 3.12 Preliminary Layout Plan of CTMS Facility at Napura



Source: Reliance Power

138. The onshore spur pipeline ~16 km of 30" high pressure (HP of 80 barg to 77 barg) from *Kutubdia* Island up to valve station 2 (at *Napura*) *Banskhali Upazila* will be laid by RBLTL on land owned by Petrobangla. The natural gas will flow up to *Napura* where record of the flowrate of gas will be determined through Custody Transfer Metering system (CTMS) before connect into the proposed national gas grid of GTCL (*Moheshkhali - Anwara* section) at *Banskhali*.

3.5.7 Waste Generation & Their Management

139. The FSRU engaged will have valid certificates for marine pollution, thus complying with the requirements of MARPOL standards for the offshore operations. Any specific requirements by Department of Environment, Government of Bangladesh will be complied with for pollution related control measures. During operation phase, bilge water of 1 to 5 m^3/day will be treated (to 15 ppm of oil content) and temporily stored in holding tank onboard FSRU before disposed offshore beyond 3 nm through service boats. Any discharge with oil content is prohibited unless all exceptions are met under Annex 1 of MARPOL. Only clean and segregated ballast water will be discharged into sea. Black water (sewage) (2 m^3/day) and gray water of (8 m^3/day) will be treated, disinfected onboard and temporarily stored in holding tank before it is will be disposed offshore beyond 3 nautical miles (nm) through service boats.

140. Various kinds of solid wastes that will be generated at the FSRU will be safely brought onshore and disposed in onshore waste facilities available with the *Chitagong* Port / *Cox's Bazar* Town. Food wastes generated on board the FSRU after removal of all plastic materials will be comminute or ground to a particle size capable of passing through a screen with openings of 25 mm and will be

brought to Chittagong Port along with other waste for disposal through service boats. Solid wastes from CTMS will be collected and either recycled or safely disposed in nearby approved waste handling facility.

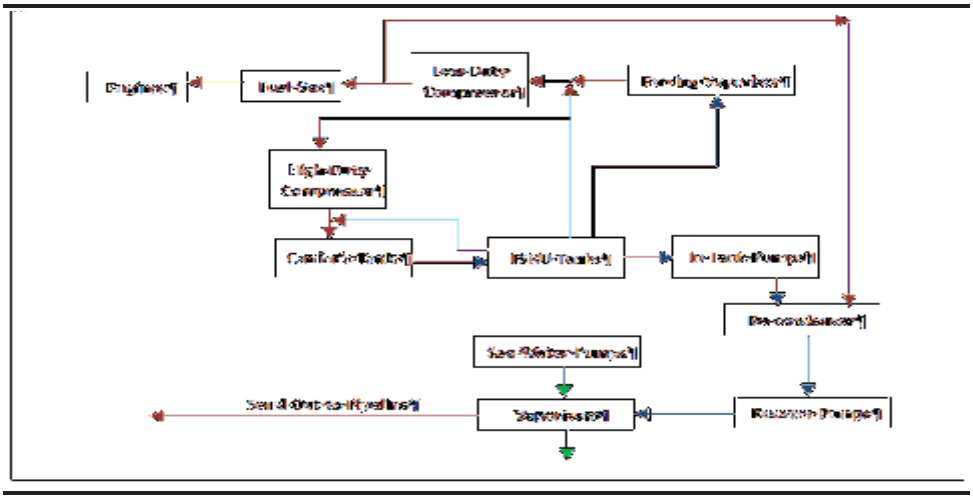
141. Some hazardous wastes are also expected to be generated at both the FSRU and CTMS facility. These include:
- Waste oil (collected from treatment of slop, bilge and ballast water)
- Oil sludge (from maintenance operation);
- Paints, varnishes and thinners;
- Rags and filter materials;
- Packages containing hazardous wastes (i.e. drums for oil and diesel);
- Solvents; and
- Pigging wastes.

142. All these wastes will be temporarily stored on the FSRU, where proper dedicated areas will be identified. Wastes will be further sent to an on-shore dedicated area for recycling and/or final disposal.

143. The FSRU related waste will be handled by a MARPOL compliant Ship-Board. Un-allowed items as per MARPOL will be collected in separate bins and brought onshore. All wastes will be disposed to an approved onshore disposal facility. Some ofthe other industrial process wastes likely to be generated from FSRU will include:
- Oil filters; and
- Waste non-contaminated by hydrocarbons.

144. Approximately 0.15% of boil off gases (BOG) (generated on board the FSRU) will be compressed and transferred back to LNGC/FSRU. Typical operational of the LNG terminal Project is presented through ***Figure 3.13***.

Figure 3.13 Typical Process Flow Diagram- Regasification Unit onboard FSRU



Source: Reliance Power

3.6 RESOURCE REQUIREMENTS

3.6.1 Manpower

Construction Phase

145. The construction phase of the project is expected to span over a period of 24 months from the date of obtaining all Project related approvals. Approximately 500 workers would be required during the peak construction period, most of whom (~ 60%) would be unskilled workers. The construction workers (as recruited by the construction contractors) will be employed from the local area to the extent possible, in order to benefit local people by giving them employment opportunities during the project construction phase. Labour camps (if any) that need to be setup during the constructed phase will be restricted within the boundaries of the identified Project site.

Operation Phase

146. The FSRU operations personnel will recruited by the FSRU. The operation of the facility post-construction will require up to 35 full time employees onboard the FSRU and 30 full time employees working at the onshore land based facility working during three shifts.

147. The expected manpower requirement during the construction and operation phases is presented in ***Table 3.4*** . The man power projected is tentative and may vary by ±20% from the stated figures.

Table 3.4 Manpower Requirement

Stage	Managerial Personnel	Skilled Personnel	Unskilled Personnel	Total Manpower
Construction	50	150	300	500
Operation				
FSRU & Jetty	6	15	14	35
CTMS	5	10	15	30

3.6.2 Freshwater

148. During construction phase, the Project would require domestic water of ~20 m^3/day (normal) to 40m^3/day (peak construction). Drinking water will be provided onsite after desired treatment. During operation phase, the Project would require ~10 m^3/day of domestic water (to be sourced through barges from the *Chittagong* Port) for personnel working on-board the FSRU and ~2.0 m^3/day for land based CTMS facility will be sourced from local market. No ground water will be extracted for project purposes.

3.6.3 Land

The land requisition for construction (i.e. laying) of ~16 km long (30 inches diameter) high pressure gas spur pipeline (from *Kutubdia* Island to CTMS Valve Station no. 2 at *Napura, Banshkhali)* and CTMS will be 49.343 acres. For operation

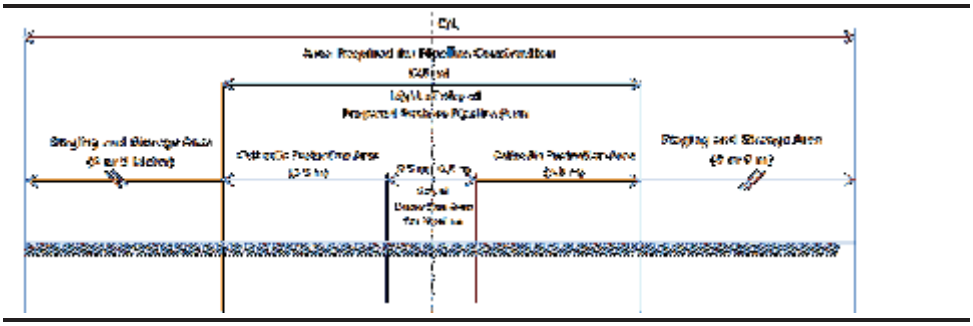
and maintenance purposes, Petrobangla, Government of Bangladesh will acquire 30.326 acres of land on permanent basis both for pipeline (26.361 acres) and CTMS (3.965 acres). The ownership of all the land required and acquired will lie with Petrobangla. Once land is acquired, it will be handed over to RBLTL on lease for 15 years for pipeline erection and subsequent operations and maintenance for supply of RLNG into the national gas grid. The width of the land to be acquired for laying of pipeline will be ~ 15m along the pipeline route while for operation and maintenance it will be 8 m width along the pipeline route. The indicative route of the land required and acquired for pipeline route is shown in ***Figure 3.6*** and summary description given in ***Table 3.5.*** The likely route of the spur pipeline is expected to pass through *Uttar Dhurung, Chhanua* and *Puichhari Union Parishads* of *Kutubdia* and *Banshkhali Upazila*s respectively. A typical cross section of the pipeline laying is present ted in ***Figure 3.14***.

Table 3.5 Summary of Land Requisition & Acquisition for Pipeline Route & CTMS

SN	Mouza Name	Land Requisition Acres		Permanent Land Acquisition Acres	Estimated number of Land Owners
		Left Side of Corridor (7.5 m wide)	Right Side of Corridor (7.5 m wide)		
A	**Pipeline Route**				
1	Dakshin Dhurung	4.051	3.995	4.317	487
2	Utar Dhurung	5.488	5.610	5.914	815
3	Char Dhurung	4.005	3.952	4.244	465
4	Kudukhanlli	5.563	5.559	5.941	378
5	Sakherkhil	5.570	5.549	5.945	545
B	**Custody Transfer Metering Station CTMS**				
6	Sakherkhil	0.000	0.000	3.965	187
		24.676	24.666		
Total		**49.341**		**30.326**	**2,877**

Note: Refer to Annex 8 for detailed chain-age wise description of land involved Daag/Khatia nos.

Figure 3.14 Typical Cross Section of the Onshore Gas Spur Pipeline



Source: Reliance Power

149. The ownership of the land parcels and other associated details is addressed in a separate document Resettlement Framework prepared in line with the national laws and ADB's SPS 2009.

3.6.4 Power Requirement

150. During pipeline laying, maximum 1 MW power would be sourced through diesel generators. Diesel would be utilized as fuel in diesel generators. The operation phase power requirement is described in paragraphs 126 to 130.

3.6.5 Earth Requirements

151. No additional soil requirement for the CTMS land related developed is anticipated, hence no soil storage is presently envisaged during construction stage. For the soil excavated for the pipeline route it will be stored temnporarily with proper bund arrangements to prevent any escape of the excavated soil.

152. There will also be no spoil storage area inside construction site. RBLTL will be evolving procedures for disposal of the same after discussing with local administration.

3.6.6 Equipment and Machineries

153. The equipment and machineries required for the construction stage are highlighted in the Table below.

Table 3.6 List of Equipment to be Used during Construction

Construction Activity	Equipment to be used
Onshore CTMS	Excavators, Dozers, Graders, Vibro Rollers, Back Hoe Loaders, Generators (Backhoe dredger, Rock hammer, Trenchers/ Excavators). Material Carrying Vehicles, Construction Equipment
Subsea high pressure gas pipeline laying	Pipe laying Crane, Barges, Dozers, Generators (Backhoe dredger, Rock hammer, Split hopper/Side dumping vessels, Survey Spread including ROV, Tugboats, Multipurpose shallow draft vessel and Diving support, Trenchers / Excavators).
Onshore Pipeline Laying	Pipe laying Crane, Dozers, Generators (Backhoe dredger, Rock hammer, Trenchers/Excavators).
FSRU Jetty Construction and LNGC Mooring Dolphins	Material Carrying Barges / Vehicles, Diesel Generators.

3.6.7 Construction Camps

154. A construction camp for the Project construction will be located within the site earmarked for CTMS facility. The peak manpower estimated for the Project during the construction phase is 500 workers of which 60%are unskilled workers. Most of the unskilled workers will be sourced from *Kutubdia* and surrounding regions and maybe a small percentage of the unskilled workers will be required to stay in the construction. The maximum extent of the managerial personnel is expected to be based out nearest urban centres at *Pekua*, *Chitagong*, *Cox Bazar*, etc. The skilled labourer estimated as 150 personnel during the peak construction period will be housed within the proposed construction camp. At any point of time during the construction stage, the camp is not expected to house more than 125 to 200 personnel.

155. The construction camp will be designed in conformance to the international standards with inbuilt safeguards especially in relation to workers accommodation, drinking water supply, sanitation facilities, garbage disposal systems, ventilation, natural and artificial lighting, cooking fuel and facilities, etc. In this case, the Guidance note by IFC and the EBRD on '*Workers' accommodation - processes and standards*'[1] will be referred to and the safeguards as recommended by IFC/EBRD will be duly considered while planning for the construction camp for this Project. Some of the key benchmarks in this regard are highlighted in the Box below.

156. These benchmarks as relevant and others as specified in the referred Guidance Note will be complied with while designing, construction and managing the construction camp under this Project.

Box 3.1 Benchmarks for Construction Camps

- The relevant national and local regulations have been identified and implemented.
- Living facilities are located to avoid flooding and other natural hazards.
- Living facilities are built with adequate materials, kept in good repair and kept clean and free from rubbish and other refuse.
- The camp site is adequately drained to avoid the accumulation of stagnant water.
- Adequate ventilation and/or air conditioning systems are provided.
- Both natural and artificial lighting are provided and maintained in living facilities. It is best practice that the window area represents not less than 5% to 10% of the floor area. Emergency lighting is provided.
- For worker accommodation a minimum ceiling height of 2.10 metres is provided.
- Rooms/dormitories are built with easily cleanable flooring material.
- In collective rooms, which are minimised, in order to provide workers with some privacy, only a reasonable number of workers are allowed to share the same room. Standards range from 2 to 8 workers.
- All doors and windows should be lockable, and provided with mosquito screens
- A separate bed for each worker is provided. There is a minimum space between beds of 1 metre
- Double deck bunks are not advisable for fire safety and hygiene reasons, and their use is minimised
- Facilities for the storage of personal belongings for workers are provided.
- Separate storage for workers boots and other PPEs need to be provided
- Access to an adequate and convenient supply of free potable water is always available to workers. Depending on climate, weather conditions and accommodation standards, 80 to 180 litres per person

[1] http://www.ebrd.com/downloads/about/sustainability/Workers_accomodation.pdf

per day are available.
- Rooms/dormitories are kept in good condition and are aired and cleaned at regular intervals.
- Drinking water meets national/local or WHO drinking water standards.
- All tanks used for the storage of drinking water are constructed and covered as to prevent water stored therein from becoming polluted or contaminated.
- Wastewater, sewage, food and any other waste materials are adequately discharged, in compliance with local or World Bank standards – whichever is more stringent – and without causing any significant impacts on camp residents, the biophysical environment or surrounding communities.
- Specific containers for rubbish collection are provided and emptied on a regular basis. Standards range from providing an adequate number of rubbish containers to providing leak proof, non-absorbent, rust and corrosion-resistant containers protected from insects and rodents. In addition it is best practice to locate rubbish containers 30 metres from each shelter on a wooden, metal, or concrete stand. Such containers must be emptied at regular intervals (to be determined based on temperatures and volumes generated) to avoid unpleasant odours associated with decaying organic materials.
- Pest extermination, vector control and disinfection are carried out throughout the living facilities in compliance with local requirements and/or good practice. Where warranted, pest and vector monitoring should be performed on a regular basis.
- Sanitary facilities are located within the same buildings and provided separately for men and women.
- Sanitary and toilet facilities are constructed of materials that are easily cleanable.
- Sanitary and toilet facilities are cleaned frequently and kept in working condition.
- Sanitary and toilet facilities are designed to provide workers with adequate privacy, including ceiling to floor partitions and lockable doors.
- Sanitary and toilet facilities are not shared between men and women, except in family accommodation
- An adequate number of toilets are provided to workers. Standards range from 1 unit to 15 persons to 1 unit per 6 persons. For urinals, usual standards are 1 unit to 15 persons.
- An adequate number of handwash facilities are provided to workers. Standards range from 1 unit to each 15 persons to 1 unit per 6 workers. Handwash facilities should consist of a tap and a basin, soap and hygienic means of drying hands.
- An adequate number of shower/bathroom facilities are provided to workers. Standards range from 1 unit to 15 persons to 1 unit per 6 persons.
- Canteen, cooking and laundry facilities are kept in a clean and sanitary

condition.

- If workers can cook their own meals, kitchen space is provided separate from sleeping areas.
- Adequate facilities for washing and drying clothes are provided. Standards range from providing sinks or tubs with hot and cold water, cleaning soap and drying lines to providing washing machines and dryers
- Wall surfaces adjacent to cooking areas are made of fire-resistant materials. Food preparation tables are also equipped with a smooth durable washable surface. Lastly, in order to enable easy cleaning, it is good practice that stoves are not sealed against a wall, benches and fixtures are not built into the floor, and all cupboards and other fixtures and all walls and ceilings have a smooth durable washable surface.

Source: Workers' accommodation - processes and standards, IFC and EBRD

3.7 POLLUTION SOURCES & CHARACTERIZATION

157. The project development might involve following potential effects on the environment:

- Air emissions;
- Water discharges;
- Waste generation; and
- Noise emissions.

3.7.1 Air Emissions

158. During construction phase of ~12 months, air emissions (due to combustion of motor oil fuel related pollutants NOx CO, SO_2) will be from engines of 4 to 5 tugs and boats intermintently engaged for jetty construction and from diesel generators (maximum 1 MW at any point of time) along the pipeline route for pipeline laying. During operation phase, the routine air emission of fuel combustion related pollutants NOx and CO from onboard power generation at FSRU, engines of tugs and supporting vessels engaged for marine operations and onshore CTMS operations. There will be non routine emission due to vapourised gas combustion onboard FSRU during emergency flaring (when no cold venting will be resorted). Other potential non routine emission of pollutants SO_2 and NOx will be there from diesel generators to be operated in the event of emergency power requirement. The Project will optimize fuel use to minimize emission of green house gases i.e. CO_2 equivalent and gaseous pollutants from combustion of fuels (RLNG, diesel or motor oil). The operation of FSRU and CTMS facility will involve the following emissions to atmosphere:

- Natural gas based engines (1 operating + 1 standby) onboard FSRU of ~10 MW (12,500 kVA) capacity (dual fuel based) with stack height of 35 m above mean sea level;
- Gas engine with alternate diesel generator of 0.5 MW (625 kVA) (1 operating + 1 standby) at the jetty with stack height of 14 m above mean sea level;

- 0.5 MW (625 kVA) captive power generation at CTMS natural gas based with alternate diesel as secondary fuel with stack height of 15 m above ground level

3.7.2 Liquid Discharges

159. During construction phase, sewage (black and grey water) of ~10 m^3/day will be generated during offshore jetty construction. All sewage generated will be treated and disinfected onboard and disposed offshore beyong 3 nautical miles (nm) complying with the MARPOL requirements.

160. During operation phase, the FSRU engaged will have valid certificates for marine pollution compliance, thus complying with the requirements of MARPOL standards for the offshore operations. Any specific requirements by Department of Environment, Government of Bangladesh will be complied with for pollution related control measures. Bilge water of 1 to 5 m^3/day will be treated (to 15 ppm of oil content) and temporily stored in holding tank onboard FSRU before disposed offshore beyond 3 nm through service boats. Only clean and segregated ballast water will be discharged into sea. Black water (sewage) (2 m^3/day) and grey water of (8 m^3/day) will be treated, disinfected onboard and temporarily stored in holding tank before it is will be disposed offshore beyond 3 nm through service boats.

161. A sewage treatment plant (STP) of capacity 2 m^3/day will be installed for treatment and disinfection before disposal for use in plantations at CTMS as per the requirements of DoE, Bangladesh. The treatment technology to be selected will be finalised subsequently during the detailed design stage. The STP is proposed to be located next to the north eastern boundary of the proposed site adjacent to the administrative building (Refer to ***Figure 3.12***).

162. There will be cold water and machine cooling water discharges as described in ***Section 3.5.4*** on Seawater System for re-gasification system onboard FSRU.

3.7.3 Waste Generation

Solid Waste and Disposal

163. During construction phase, the Project would generate domestic solid waste of ~75 kg/day. Of the domestic waste ~60% is expected to be biodegradable. Both biodegradable and non-biodegradable waste will be disposed of in separate bins at the nearby disposal site. Other waste during construction phase would be construction civil waste of ~30 tonnes which will be used in raising the ground levels within the CTMS facility.

164. During operation phase, solid wastes (i.e. garbage containing waste plastic, paper, rags, bottles, metal etc.) will be segregated, temporarily stored onboad FSRU and safely brought through service boats to the waste handling facilities available at the Chittagong Port / Cox's Bazar. Food wastes of ~10 kg/day to be generated on board the FSRU will be ground to a particle size capable of passing through a screen with openings of 25 mm and temporarily stored before

disposal along with other waste at the Chittagong Port / Cox's Bazar as per MARPOL requirements. While plastic and non-incinerable waste (~5 kg/day) will be collected and disposed of along with solid wastes (~15 kg/day) from CTMS facility to be disposed of at an approved waste handling facility.

165. The FSRU related waste will be handled by a MARPOL compliant Ship-Board. Un-allowed items as per MARPOL will be collected in separate bins and brought onshore for disposal.

Hazardous Wastes

166. Both during construction and operation phases, the Project at FSRU and jetty would generate hazardous waste comprising of used oil; empty containers of paints, varnishes, thinners and lubricating oil; rags containing oil and grease, filter materials and waste oil generated from bilge and slop oil will be collected and disposed of at the nearby Chittagong Port. Dedicated areas will be earmarked for temporary storage of hazardous wastes on impervious surface at the project site. All construction and operation phase hazardous wastes will be brought to on-shore dedicated area for recycling and/or final disposal at approved hazardous waste handling facilities near to the CTMS site.

3.7.4 Noise Emissions

167. The underwater noise sources of significance in the offshore region include the following activities:
    - Construction phase: Piles driving for development of foundation of jetty. The sound pressure level (SPL) and sound exposure levels (SEL) expected during piles driving will be impulsive type that are likely to prevail for ~90 milliseconds with single strike per second in the shallow water of ~15 m depth. The underwater impulsive noise is expected to be SPL_{peak} of 225 decibel reference 1 micro pascal at 1 m (dB re 1µPa at 1m); SPL_{rms} of 210 dB ref 1µPa at 1m and SEL of 200 dB re 1µPa^2s.

    Note: It is to be noted that the Project design is under development stage, currently information on technique that would be used for pile driving is yet to be finalized. In absence of relevant information on pile driving and related underwater noise generation, the above mentioned input noise levels represents worst case levels.

    - Operation Phase: LNG cargo and support vessels movement in the jetty area is expected mainly during mooring of the LNG cargo to the jetty site. The underwater noise is expected to be mainly for 15% of time during ~24 hours of LNG cargo mooring and moving out of jetty. The underwater impulsive noise is expected to be SPL_{peak} of 203 dB re 1µPa at 1m; and SPL_{rms} of 185 dB ref 1µPa.

168. The main noise emission in the ambient air sources from LNG Carrier and FSRU include pumps, compressors, generators and their drivers, compressor suction / discharge, recycle piping, air dryers, air coolers at liquefaction facilities, vaporizers used during regasification, and general loading /unloading

operations of LNG carriers /vessels. Sound pressure levels (at 1 m from the source) of each equipment have been considered to be within 75 and 95 dB(A).

169. The sound pressure levels from land based CTMS facility in normal operating conditions are expected to be within 80 and 90 dB(A) (at 1 m from the source) and less than 70 dB(A) at the fence line.

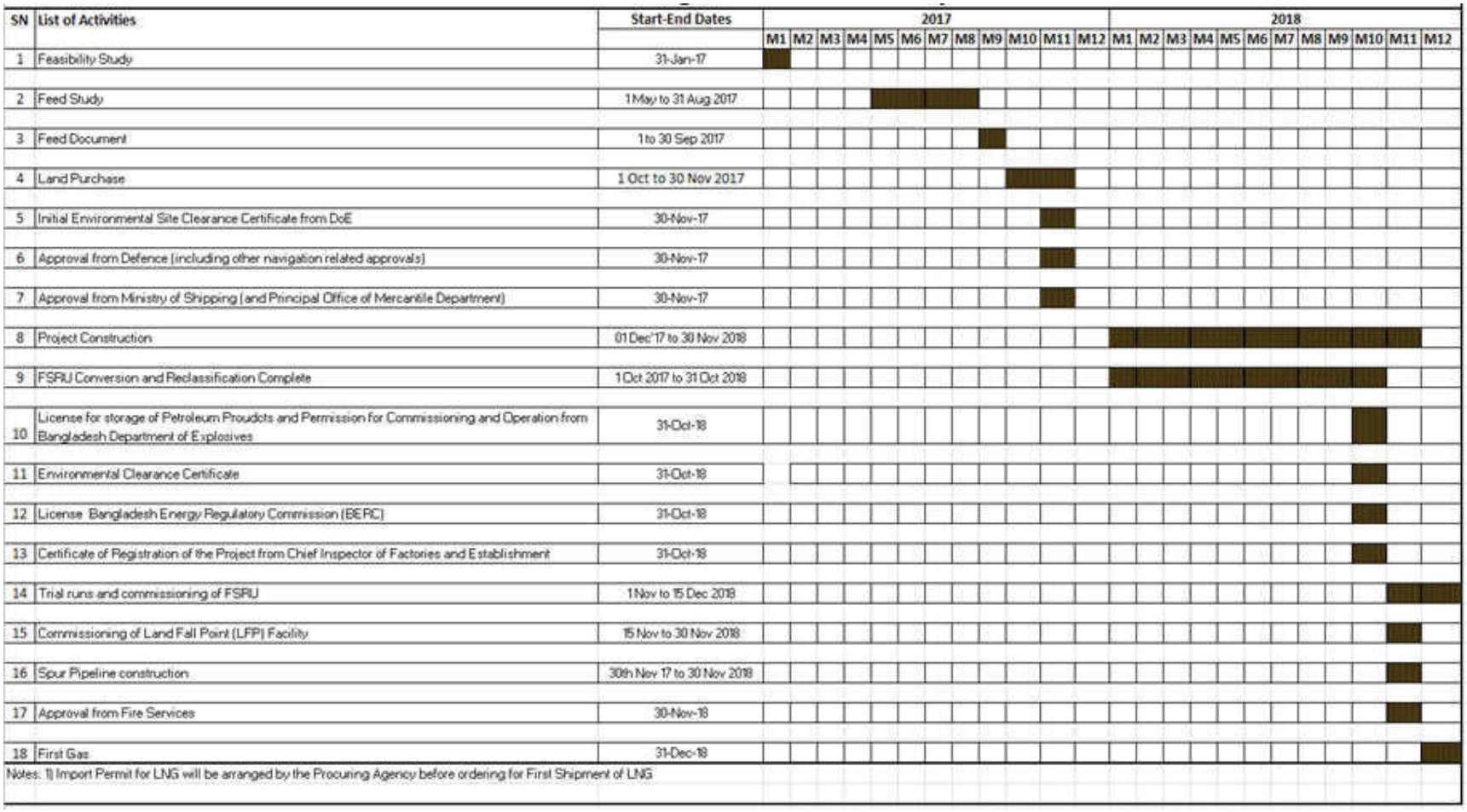
3.8 CAPITAL & RECURRING DREDGING

170. As reported by Reliance Power, no capital dredging is involved for the Project during the construction stage. Also no recurring dredging is involved during the operation phase of the Project.

3.9 PROJECT TIMELINE & PROJECT COST

171. As described in ***Section 3.4***, the construction phase of the Project is expected to continue for ~12 months from the date of receipt of Project related all approvals. The target dates for the key milestones are presented in Figure 3.15**.** Total investment for the proposed LNG facility and associated infrastructures would be approximately US$ 200 million.

Figure 3.15 Indicative Project Schedule of the proposed Kutubdia LNG Terminal, Bangladesh



SN	List of Activities	Start-End Dates	2017												2018											
			M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12
1	Feasibility Study	31-Jan-17																								
2	Feed Study	1 May to 31 Aug 2017																								
3	Feed Document	1 to 30 Sep 2017																								
4	Land Purchase	1 Oct to 30 Nov 2017																								
5	Initial Environmental Site Clearance Certificate from DoE	30-Nov-17																								
6	Approval from Defence (including other navigation related approvals)	30-Nov-17																								
7	Approval from Ministry of Shipping (and Principal Office of Mercantile Department)	30-Nov-17																								
8	Project Construction	01 Dec'17 to 30 Nov 2018																								
9	FSRU Conversion and Reclassification Complete	1 Oct 2017 to 31 Oct 2018																								
10	License for storage of Petroleum Proudcts and Permission for Commissioning and Operation from Bangladesh Department of Explosives	31-Oct-18																								
11	Environmental Clearance Certificate	31-Oct-18																								
12	License Bangladesh Energy Regulatory Commission (BERC)	31-Oct-18																								
13	Certificate of Registration of the Project from Chief Inspector of Factories and Establishment	31-Oct-18																								
14	Trial runs and commissioning of FSRU	1 Nov to 15 Dec 2018																								
15	Commissioning of Land Fall Point (LFP) Facility	15 Nov to 30 Nov 2018																								
16	Spur Pipeline construction	30th Nov 17 to 30 Nov 2018																								
17	Approval from Fire Services	30-Nov-18																								
18	First Gas	31-Dec-18																								

Notes: 1) Import Permit for LNG will be arranged by the Procuring Agency before ordering for First Shipment of LNG

Source: Reliance Power

4 DESCRIPTION OF THE ENVIRONMENT

4.1 INTRODUCTION

172. This section describes the existing environmental and social baseline of the study area around the FSRU location and along the pipeline corridor. This includes relevant components of physical, biological and socio-economic environment. The purposes of describing the environmental settings of the study area are:

- To understand the project needs and environmental characteristics of the area; and
- To assess the quality of the existing environment, as well as the environmental impacts of the future developments being studied.

173. The baseline environment for the ESIA was studied through primary surveys, information collected from secondary sources and discussions held with local stakeholders.

4.2 STUDY AREA

174. A 10 km radial zone around the FSRU site has been considered to ascertain presence of sensitivities/ sensitive receptors in this region. ***Figure 4.1*** shows the study area map of 10 km radius. Also an area of 500 metres on both sides of the associated spur pipeline corridor of Petrobangla from *Kutubdia* Island up to CTMS at *Napura* is also included within the study area.

175. The study area comprises of distinct zones i.e. offshore, intertidal and the onshore zones. The onshore zone/area is dominated by agricultural land, salt pans, settlements with homestead plantation and block plantation areas (coastal shelter belts). The offshore zone/area includes the Bay of Bengal which is located on the western periphery of the *Kutubdia* Island and the *Kutubdia* Channel.

176. For the socio-economic baseline, data collection extended beyond a 10 km study area (when required) for implications on fishing grounds and fishing practices as well as the impact on land and livelihoods from the proposed LNG terminal Project .

Figure 4.1 Study Area Map

4.3 METHODOLOGY

177. Environmental and social baseline data was collected through primary baseline surveys, information available through secondary literatures and discussion held with local stakeholders. Primary baseline data was collected during the post monsoon season (October-November, 2016) and preliminary discussions

held during May 2017 during identification of land parcels involved for the Project.

178. In the study considered, the primary environmental monitoring is conducted representative during any of the three dry seasons i.e. post-monsoon, winter or pre-monsoon are considered representative i.e. other than during monsoon. For the purpose of this ESIA, the baseline environment was monitored in course of the post monsoon season between October – November 2016 and was considered representative of the environmental quality in the proposed area of influence.

179. Further with a view to monitor and collate information for the other seasons monitoring framework is proposed to be followed as part of the ESMP implementation. The details are subsequently provided in ***Section 9*** of this report.

4.3.1 Primary Baseline Data Collection: Environment and Ecology

180. ERM deputed specialist teams and conducted site surveys and field studies related to environment and biodiversity components. ERM also engaged EQMS Consulting Limited (EQMS), Bangladesh for conducting primary environmental baseline data collection in respect of ambient air, surface and ground water, soil and sediment quality, noise levels and traffic. ***Table 4.1*** provides an outline of the typical baseline information which was collected and analyzed by ERM and EQMS for the current study.

181. In addition, studies related to certain specific components were also conducted by Mitra SK Laboratory - Due to very limited availability of high precision equipment (*NDIR-Non Dispersive Infrared Spectroscopy*) in Bangladesh for analysis of carbon monoxide (CO) in ambient air, ambient air samples were collected from study area and brought to India for analysis of CO. Mitra S.K Pvt. Ltd., a Kolkata based Indian laboratory was engaged by ERM to conduct the analyses of collected CO samples using Non Destructive Infrared (NDIR) Spectroscopy method.

182. Fishery Expert - Dr. Mohammad Mamun Chowdhury (Associate Professor, Department of Fisheries, University of Dhaka), a local fishery expert was engaged for conduct of site specific fishery study in *Kutubdia* Island region.

183. The detailed methodology for baseline data collection is presented in ***Table 4.1.*** A detailed sampling plan specifying equipments and procedures employed for primary sampling and analysis along with QA-QC requirements is presented as ***Annex 3***.

Table 4.1 Methodology for Baseline Data Collection-Environment & Ecology

S.N.	Items	Frequency	Sampling Details	Rationale for Collection of Data
1.1	Air quality Respirable Particulate Matter (PM_{10}, $PM_{2.5}$), Sulphur Dioxide (SO_2), Oxides of Nitrogen (NOx), Carbon Monoxide (CO)	6 weeks, once a week at each location during post monsoon season (October-November, 2016)	6 locations (Refer ***Figure 4.2***)	Primary air pollutants that are expected to be emitted from the Project activities include PM_{10}, $PM_{2.5}$, SO_2, NOx, CO. Monitoring of ambient air quality is important to establish the baseline levels of air pollutants in ambient air before the commencement of the Project. The baseline data collected would be later compared with the ambient air quality data to be collected during construction and operation phases of the Project to identify the contribution of the Project in releasing air pollutants in the local air environment. The rationale for selection of monitoring locations is as following: AQ1 (Lighthouse): The location is selected at the nearest settlement to the landfall point AQ2 (Dakshin Dhurung): Location crosswind to the landfall point near the approach road AQ3 (Lemshikhali): Location crosswind to the landfall point AQ4 (Kaiyarbil): Location cross wind to the landfall point AQ5 (Uttar Dhurung): Location upwind to the landfall point; also this settlement is in proximity to the pipeline crossing route AQ6 (Boroghop): Location downwind to the landfall point
1.2	Marine and Inland Surface water quality monitoring for physical, chemical, and biological parameters	Once during post monsoon season (November, 2016)	6 marine water samples from Bay of Bengal and *Kutubdia* Channel and one inland surface sample taken from *Kutubdia* Island in one season. (Refer ***Figure 4.2***). Surface and mid depth water samples were	Marine and inland water quality analysis was conducted to establish the baseline level of physicochemical factors of water. The baseline data collected would be later compared with the water quality data to be collected during the construction and operation phases of the Project components to identify the contribution of the Project in releasing pollutants to the marine water. Four locations for marine water samples collection in the Bay of Bengal near the Project components were selected to cover the entire stretch of footprints of marine facilities viz. FSRU, pipeline from FSRU to landfall point. One location was selected (SW1) in proximity to the landfall point. Another location was selected at a distance of 3,000 m west of the landfall point (SW2) at the sea near the proposed FSRU location. Two other locations (SW3 and SW4) were selected north west and south west of the landfall point and the offshore

S.N.	Items	Frequency	Sampling Details	Rationale for Collection of Data
			collected from the Bay of Bengal water near offshore Project components.	pipeline (subsea). Two locations were selected at *Kutubdia* Channel near the pipeline likely entry point (SW6) at the channel (near *Kutubdia* Island) and likely exit point (SW7) in *Banskhali Upazila*. One location was selected (SW5) at the major inland water channel within the island (*Pilat Kata khal*)
1.3	Ground water quality monitoring for physical, chemical, and biological parameters as per ECR 1997 including heavy metals	Once during post monsoon season (November, 2016)	4 samples taken in one season. (Refer ***Figure 4.2***)	Groundwater quality analysis was conducted to establish the baseline level of physicochemical factors of groundwater which could be compared with the water quality data to be collected during the construction and operation phases of the Project to identify the contribution of the Project in releasing pollutants to the groundwater. Groundwater in the area is collected mostly through tube wells. Samples were collected from shallow tube wells in *Dakshin Dhurung*, *Kaiyarbil*, *Lemshikhali* and *Boroghop* Unions of *Kutubdia* Island to understand the groundwater quality of the *Kutubdia* Island.
1.4	Meteorology	Data for one year (2015) was collected and analyzed	Secondary data from BMD for the Kutubdia Station was collected.	Meteorological data was collected from the Bangladesh Meteorological Station within the *Kutubdia* Island. The data is important to understand the pre-dominant meteorological conditions which affect in dispersal of air pollutants at the area.
1.5	Noise (At receptors such as settlements/ hospitals etc.) ambient noise levels	Once over 24 hours during post monsoon season (October, 2016)	At 6 locations, 24 hour measurements recorded at each location. (Refer ***Figure 4.2***)	Monitoring of ambient noise levels is important to establish the baseline levels on the island. These baseline noise levels may be compared with noise monitoring to be conducted during Project implementation phase to assess the impact of the Project activities on the baseline noise environment. Noise monitoring was conducted at 6 locations within *Kutubdia* Island to assess the baseline noise levels. The locations covered residential areas (Light House, *Ali Fakir Deil*; *Kata Para*, *Lemshikhali*; *Ismail Haji Para*, *Kaiyarbil*; *Uttar Masjid Para*, *Uttar Dhurung*); mixed (*Dakshin Dhurung* union complex, *Pachar Para*) and Silent Zone (*Kutubdia Upazila* Health Complex).

S.N.	Items	Frequency	Sampling Details	Rationale for Collection of Data
2.0	Soil and Sediment Quality for essential physio-chemical parameters	Once during post monsoon season (November, 2016)	2 soil samples from Kutubdia Island. 4 sediment samples, from Bay of Bengal and Kutubdia Channel (Refer ***Figure 4.2***)	Soil samples were collected from agricultural lands of *Ali Fakir Deil* and *Darbar* village to understand physical properties of the soil and baseline levels of nutrients. The baseline soil quality may be compared with the soil quality at the time of the Project implementation phase. Marine sediment samples were collected at four locations *viz.* two from the Bay of Bengal and two from Kutubdia Channel. The sediment samples collected from Bay of Bengal was meant to assess the baseline marine sediment quality status which may be compared with the future sediment quality levels to be assessed during construction and operation stages of the jetty and deployment of FSRU, erection of offshore pipeline (subsea) . Marine sediment samples were also collected from two locations on the *Kutubdia* Channel to assess likely impact of construction and operation of gas pipeline that is expected likely to pass through the stretch of *Kutubdia* Channel.
3.0	Traffic Survey ▪ Road Traffic ▪ Waterway Traffic	Once during post monsoon season (November, 2016)	Road traffic in the nearby road to the Project Site and Waterway traffic in the *Kutubdia* Channel for 24 hrs in a week day. (Refer ***Figure 4.2***)	Road traffic survey was conducted at the approach road to the site i.e. road connecting *Ali Fakir Deil* with *Uttar Dhurung* Road to assess the existing traffic density on this road. River traffic densities were surveyed at two major ferry ghats (*Boroghop Ferry Ghat* and *Darbarghat Ferry Ghat*) which are used for connecting *Kutubdia* Island with the main land.
4.0	Ecological Survey ▪ Terrestrial survey including vegetation and habitat mapping, ▪ Terrestrial wildlife surveys (avifauna, herpetofauna and mammal surveys) ▪ Aquatic survey including plankton, benthos and fish ▪ Fishery Survey ▪ Migratory birds	Once during post monsoon season (November, 2016)	One time survey of terrestrial and freshwater aquatic ecology including wildlife.	Baseline ecological surveys were conducted at the aquatic and terrestrial habitats in proximity to the *Kutubdia* Island. The surveys were conducted to identify the major habitats, pre-dominant flora and faunal community structure that may get impacted due to the implementation of the proposed Project.

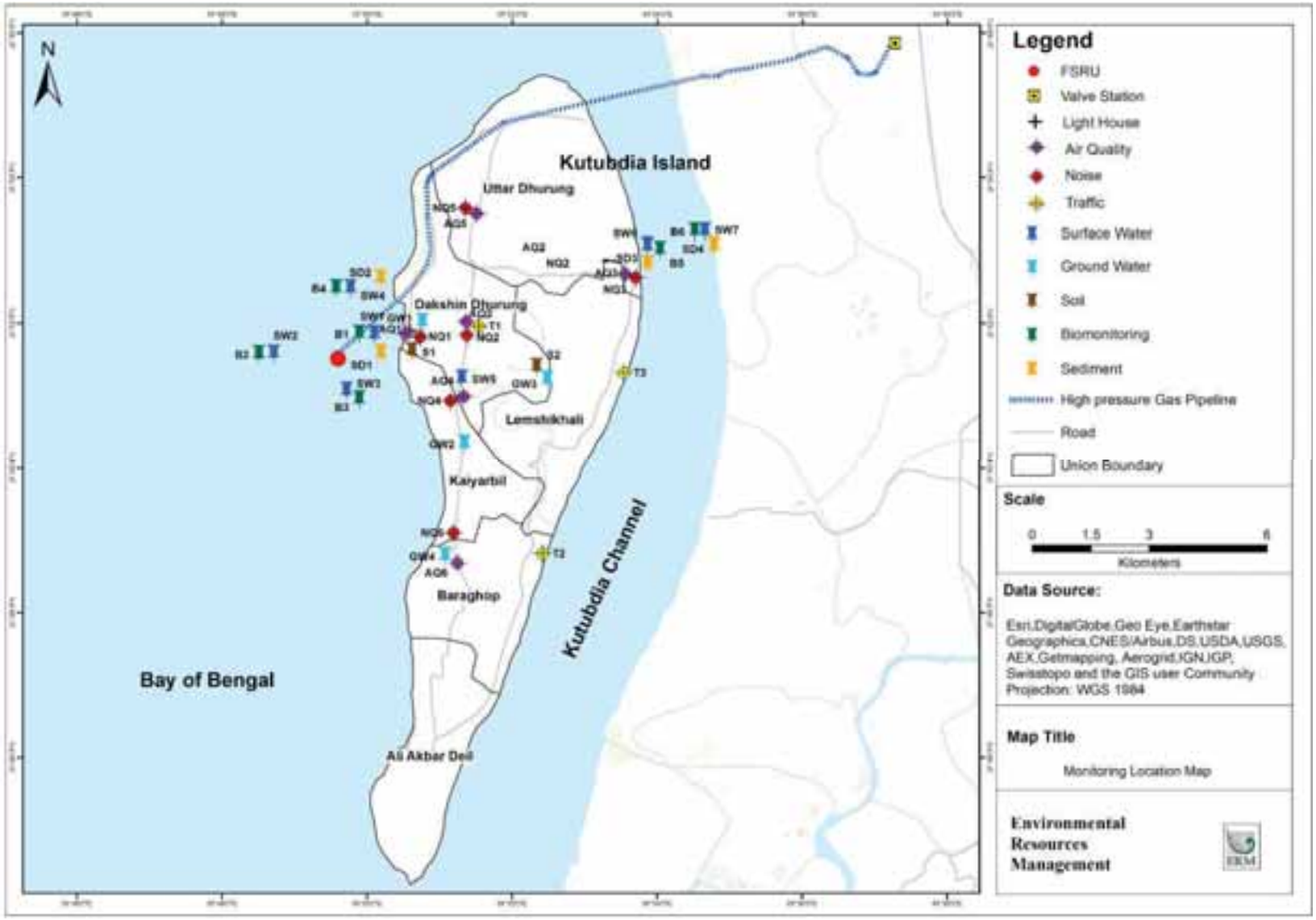
Note: Landfall point is the point on the Kutubdia Island where the subsea pipeline meets the onshore spur gas pipeline

4.3.2 Primary Baseline Data Collection: Socio-economic and Livelihood

184. To capture the socio-economic conditions prevailing within the Project area of influence, following initiatives/discussions were undertaken:

- Identification of stakeholders;
- Undertaking consultations, interviews and focussed group discussions;
- Discussions with Government Departments, Local Authorities, District Officials, etc., as required;
- Socio-economic survey, including sample household survey of land users and displaced/resettled families (if any) supplemented by community and village level consultations.
- Discussion with fishermen and salt pan cultivators;
- Discussion with UNO Office, *Kutubdia* and Land Revenue Department, *Cox's Bazar*

Figure 4.2 Monitoring Location Map



4.4 OCEANOGRAPHIC CONDITIONS

4.4.1 Bathymetry

185. *Kutubdia* Island is located in the south-eastern part of Bangladesh and separated from the main land by the *Kutubdia* Channel.

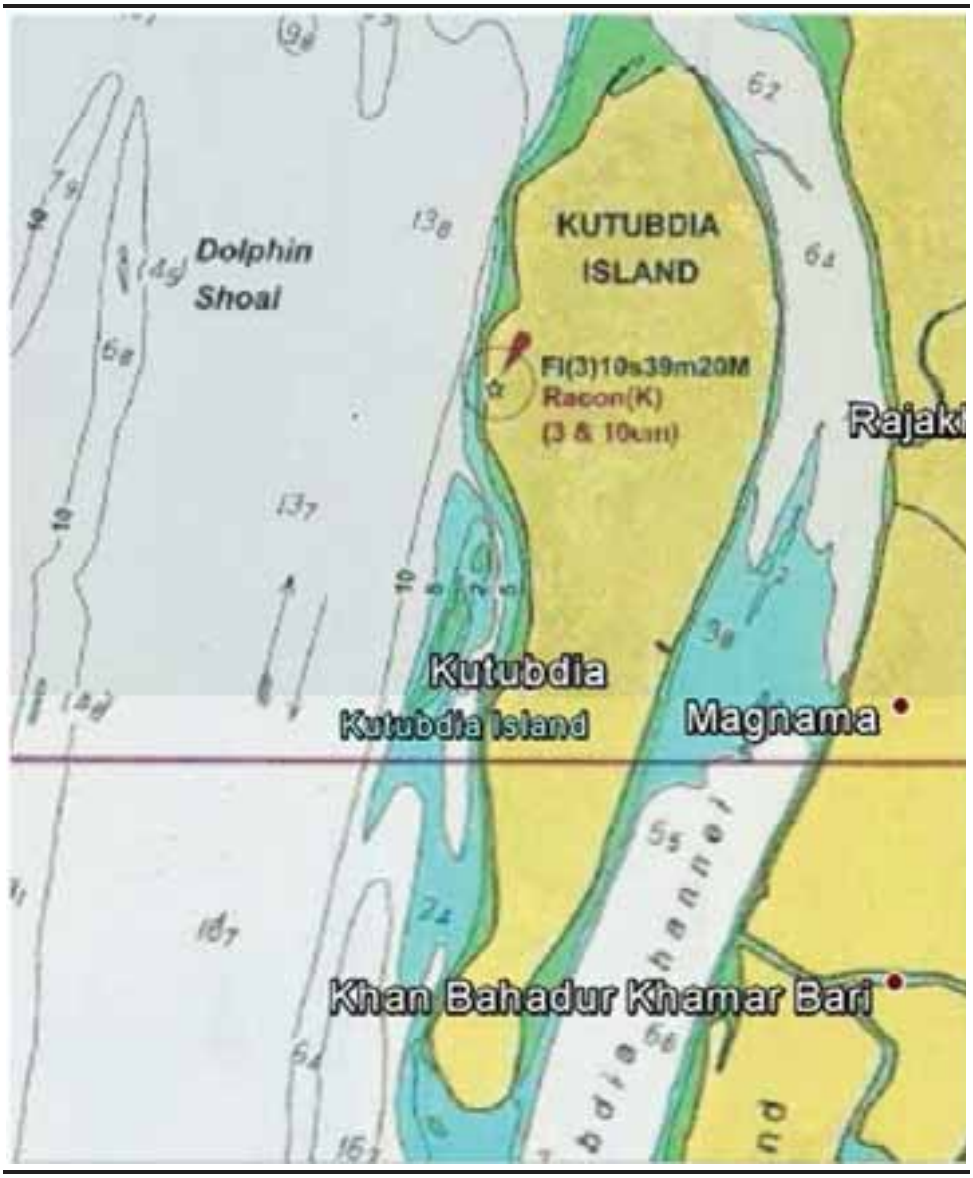
Bathymetry of the West Coast Region

186. The bathymetry map indicates a steep sea floor with 10 m contour reaching within 1 km from the *Kutubdia* Island on the west. An area with more than 13m water depth can be found less than 3km from shore (current project location). Access to this area by LNGCs would be possible without dredging. A Dolphin shoal is located at ~7 km from shore. This shallow patch is approximately trending N-S; extending for ~35 km, almost parallel to the coastline. The depths in this shoal are up to ~6.5 m. Another small shoal (depth 0.1-1 m) was also observed close to the west coast also extending north-south between *Kaiyarbil* and *Boroghop*. This shoal is about 6-7 km in length at a distance of 0.5-1 km from the shore.

Bathymetry of Kutubdia Channel

187. The depths are greater at the north ranging between 5.2m and 16.4 m, less at the central portion of the channel (between 2.2m and 4.4 m) and again greater at the south ranging between 5.2 m and 7.8 m. In general the depth is greater at the east near the landward side. Near the proposed offshore pipeline crossing area the water depth is 7.9 m at the west, reducing upto 6.1 m in the east and then again increasing to 9 m further east and decreasing to 2.5 m, near the shore. According to hydrographic map of *Kutubdia* to Elephant Point the depths in *Kutubdia* Channel are subject to rapid change and therefore vessels should exercise extreme caution while traversing in this channel.

Figure 4.3 *Navigational Chart Showing water Depth & Shoreline near Kutubdia Island and Kutubdia Channel*



Source: Reliance Power - Advisian WorleyParson Group. 2016. Reliance Bangladesh LNG Import Terminal Feasibility Study - Site and Configuration Selection Report

4.4.2 Tide

188. Tide data available near *Kutubdia* Island as mentioned on the Naval Hydrographic Chart No. 319 & 361 with reference to Chart Datum (CD) is given in ***Table 4.2.***

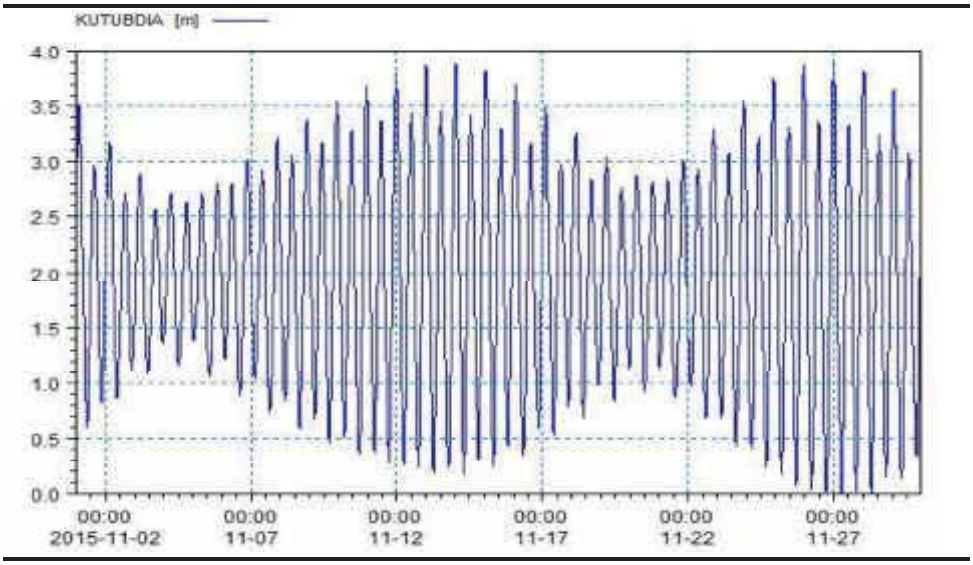
Table 4.2 *Tidal levels at Kutubdia island with respect to Chart Datum (in metres)*

Station Name	Coordinate		Tidal levels w.r.t CD (m)				
	Latitude	Longitude	MHWS	MHWN	MSL	MLWN	MLWS
Kutubdia Island	21^0 52″N	91^0 50″E	3.9	2.7	2.0	1.3	0.2

Source: Reliance Power

189. Strong tidal current occur near *Kutubdia* Island. Results of hydrodynamic modelling analysis carried out for the period 15 October 2015 to 30 November 2015 to cover the full spring and neap phase tidal cycle are shown in ***Figure 4.4.***

Figure 4.4 Predicted Tidal Levels at Kutubdia w.r.t. CD (in metres)



Source: Reliance Power:DHI, 2016: Desktop Study for Site Screening in Chittagong & Moheshkhali

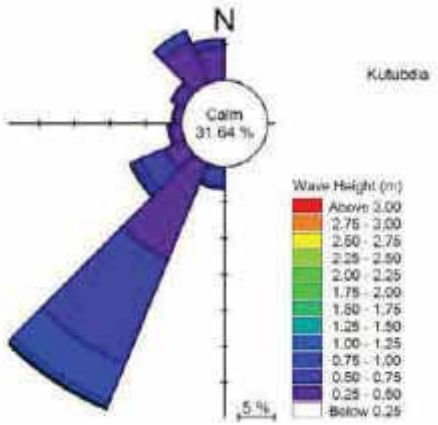
4.4.3 Waves

190. The area around *Kutubdia* Island is represented by benign wave conditions. Wave characteristics near *Kutubdia* Island from offshore wave data at 10 m water depth are represented below[1].

- Predominant wave direction is from southwest (***Figure 4.5***)
- Wave data for the period of 2005-2009 showed maximum wave height of 2.25 m and a maximum zero crossing periods of 14 seconds.
- The percentage occurrence of significant wave heights and peak wave periods near *Kutubdia* Island derived for 2011 showed maximum wave height of 2 m and occurrence of peak period greater than 18s (***Table 4.3***).

[1] Advisian WorleyParson Group, 2016. Reliance Bangladesh LNG Import Terminal Feasibility Study – Site and Configuration Selection Report

Figure 4.5 Annual Waverose of Significant Wave Heights & Mean Wave Direction: Kutubdia



Source: Reliance Power - Advisian WorleyParson Group, 2016 - Site and Configuration Selection Report

Table 4.3 Percentage Occurrence of Significant Wave Heights & Peak Wave Periods: Kutubdia

Peak wave Period seconds	Significant wave height Vs Peak wave period (%) during the Period of 2011 Significant (Resultant) wave height in metre													
	0-0.25	0.25-0.5	0.5-0.75	0.75-1.0	1.0-1.25	1.25-1.5	1.5-1.75	1.75-2.0	2.0-2.25	2.25-2.5	2.5-2.75	2.75-3.0	≥ 3.0	Total (%)
0-2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2-3	0.14	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.21
3-4	1.37	2.47	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.91
4-5	0.14	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.27
5-6	0.00	0.00	0.21	0.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.41
6-7	0.00	0.00	1.17	0.69	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.85
7-8	0.00	0.00	1.37	4.87	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.25
8-9	0.00	0.00	0.89	4.53	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.70
9-10	0.00	0.41	1.10	2.75	1.44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.70
10-11	0.00	1.72	0.41	0.34	0.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.81
11-12	0.96	4.53	1.51	0.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.62
12-13	0.75	6.86	3.71	1.65	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.97
13-14	0.48	7.82	7.62	5.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	21.21
14-15	0.41	4.32	4.26	4.39	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.52
15-16	0.21	1.10	2.54	2.13	0.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.18
16-17	0.07	1.03	2.68	2.68	0.48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.93
17-18	0.00	0.21	0.14	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.48
≥ 18.0	0.00	0.55	1.92	0.96	0.55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.98
Total%	4.53	31.23	29.58	31.23	3.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00

Source: Reliance Power: DHI, 2016 - Desktop Study for Site Screening in Chittagong & Moheshkhali

4.4.4 Current

191. Strong longshore currents occur in the monsoon season near *Kutubdia* Island. Direction of current is predominantly north during peak flood tide and south during ebb tide and NE monsoon.

Hydrodynamic Modelling

192. As part of the site screening study conducted by DHI for this project[1], hydrodynamic modelling analysis was carried out around the Project area for a period of over one month (15 October 2015 to 30 November 2015) to cover the

[1] Source: DHI, 2016 - Desktop Study for Site Screening in Chittagong and Moheshkhali Region

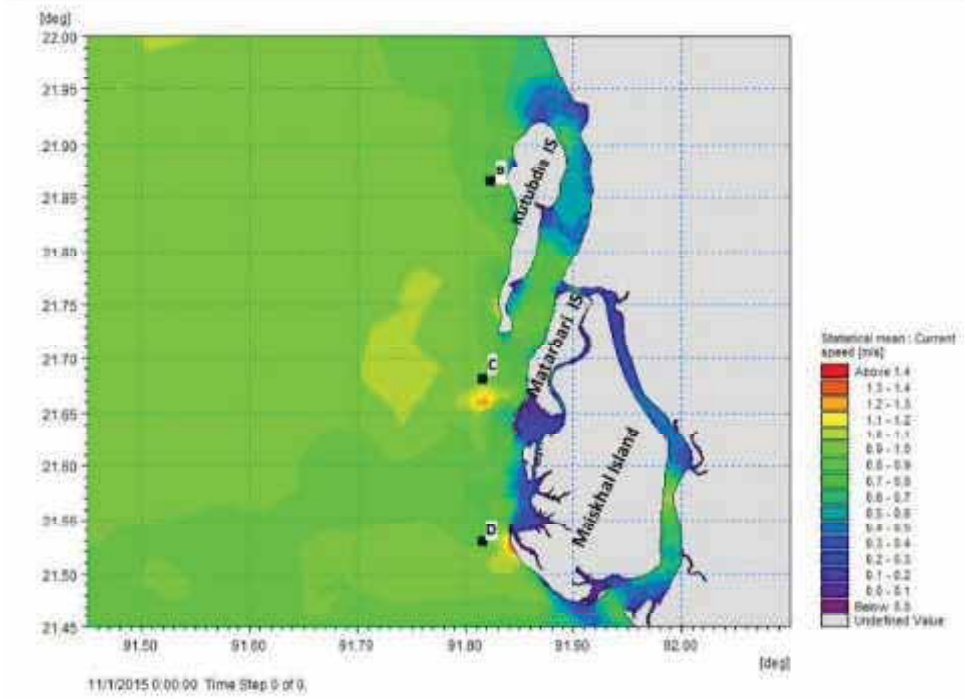
full spring and neap phase of tidal cycle. The hydrodynamic model was executed for periods representing north east monsoon.

193. The Hydrodynamic modelling was carried out using DHI's MIKE21 FM (Flexible Mesh) HD model. The model simulates 2D free-surface flows, solving the depth averaged Navier-Stokes equations and is applicable to the simulation of hydrodynamic processes in lakes, estuaries, bays, coastal areas and seas.

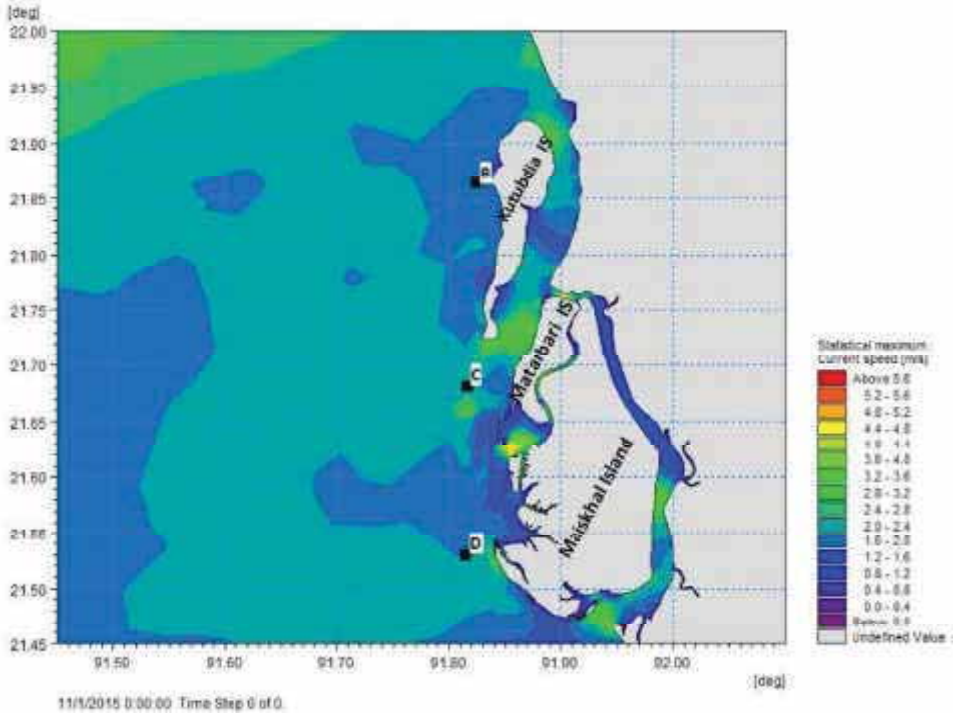
194. The model was executed for periods representing NE monsoon. The simulated depth averaged currents were analysed statistically to estimate mean currents speed and maximum current speeds as shown in ***Figure 4.6***. The normal operating current speeds were found to be less than 1.0 m/s near *Kutubdia* Island with the maximum current speed recorded as 2m/s.

195. Current direction is predominantly to North during peak flood tide and to South during ebb tide and NE monsoon. The snapshot of current pattern during peak flood tide and ebb tide is shown in ***Figure 4.7*** and the corresponding rose plot is shown in ***Figure 4.8***

Figure 4.6 Mean & Maximum Current Speeds near Kutubdia Island



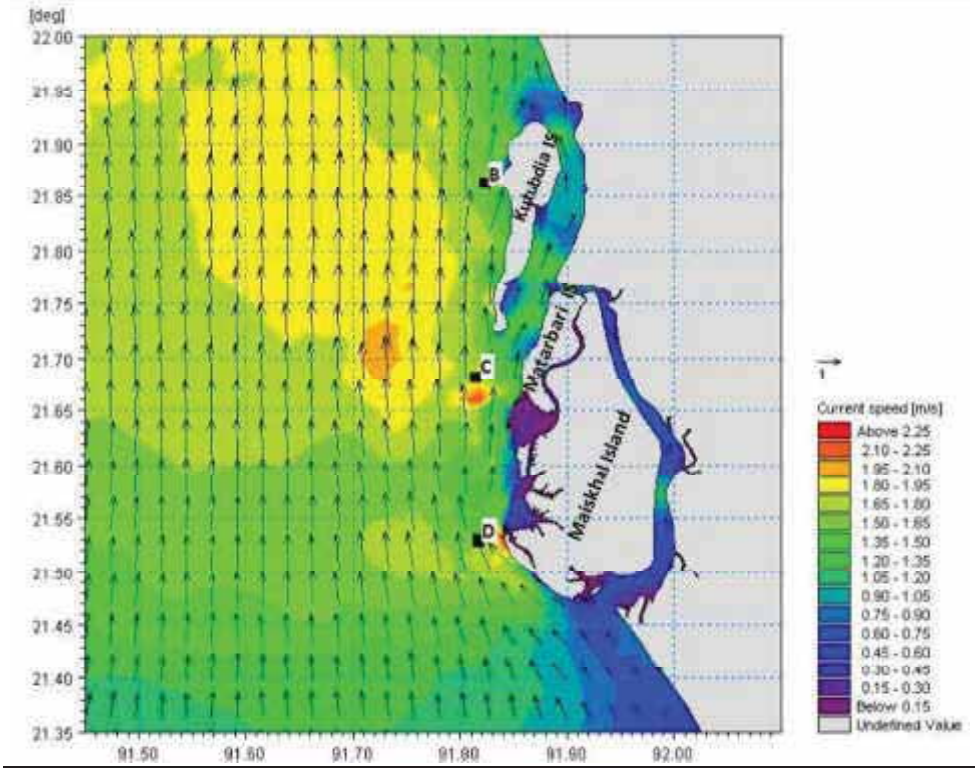
Mean Current Speed during NE Monsoon



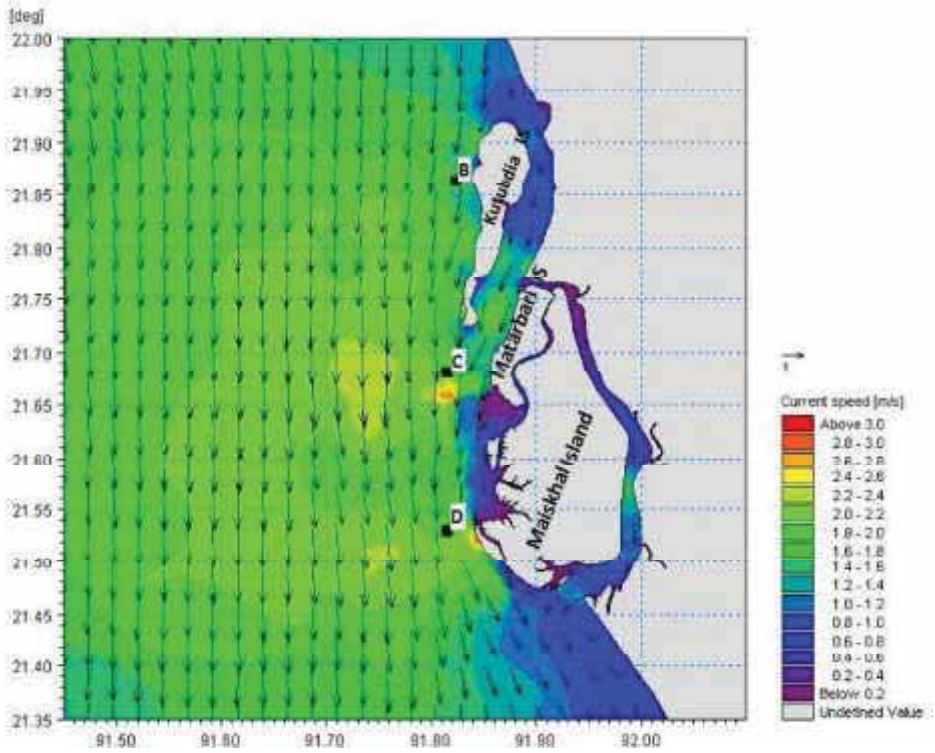
Maximum Current Speed during NE Monsoon

Source: Reliance Power: DHI, 2016 Desktop Study for Site Screening in Chittagong & Moheshkhali Region

Figure 4.7 Current Pattern near Kutubdia Island



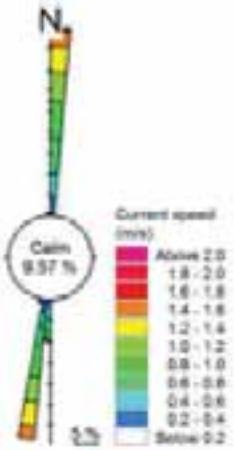
Current Pattern during Peak Flood Tide



Current Pattern during Ebb Tide and NE Monsoon

Source: Reliance Power: DHI, 2016 - Desktop Study for Site Screening in Chittagong & Moheshkhali Region

Figure 4.8 ***Roseplot of Current Pattern near Kutubdia Island***



Source: Reliance Power: DHI, 2016 - Desktop Study for Site Screening in Chittagong and Moheshkhali Region

196. Utilising the findings from the Hydrodynamic Model, the study on current pattern of the Bay of Bengal near the proposed project area reveals that the area experiences maximum current speed of approximately 2 m/s with an average current speed of 1 m/s. As also explained in ***Section 4.5.6*** the proposed Pproject area is not prone to erosion. The ocean environment near the proposed project area is found to be more stable as compared to other alternative sites (*Matarbari*, *Moheshkhali* etc.) that were considered and experiences less harsh wave and current.

197. Given the stable hydrodynamic nature around the proposed project areas as established through the hydrodynamic modelling exercise and the nature of marine components proposed under this project (i.e. FSRU as a floating unit moored to an island jetty and sub-sea pipeline), any significant alternation of hydro dynamic behaviour / flow regime is not really foreseen.

4.5 LAND ENVIRONMENT

4.5.1 Physiography

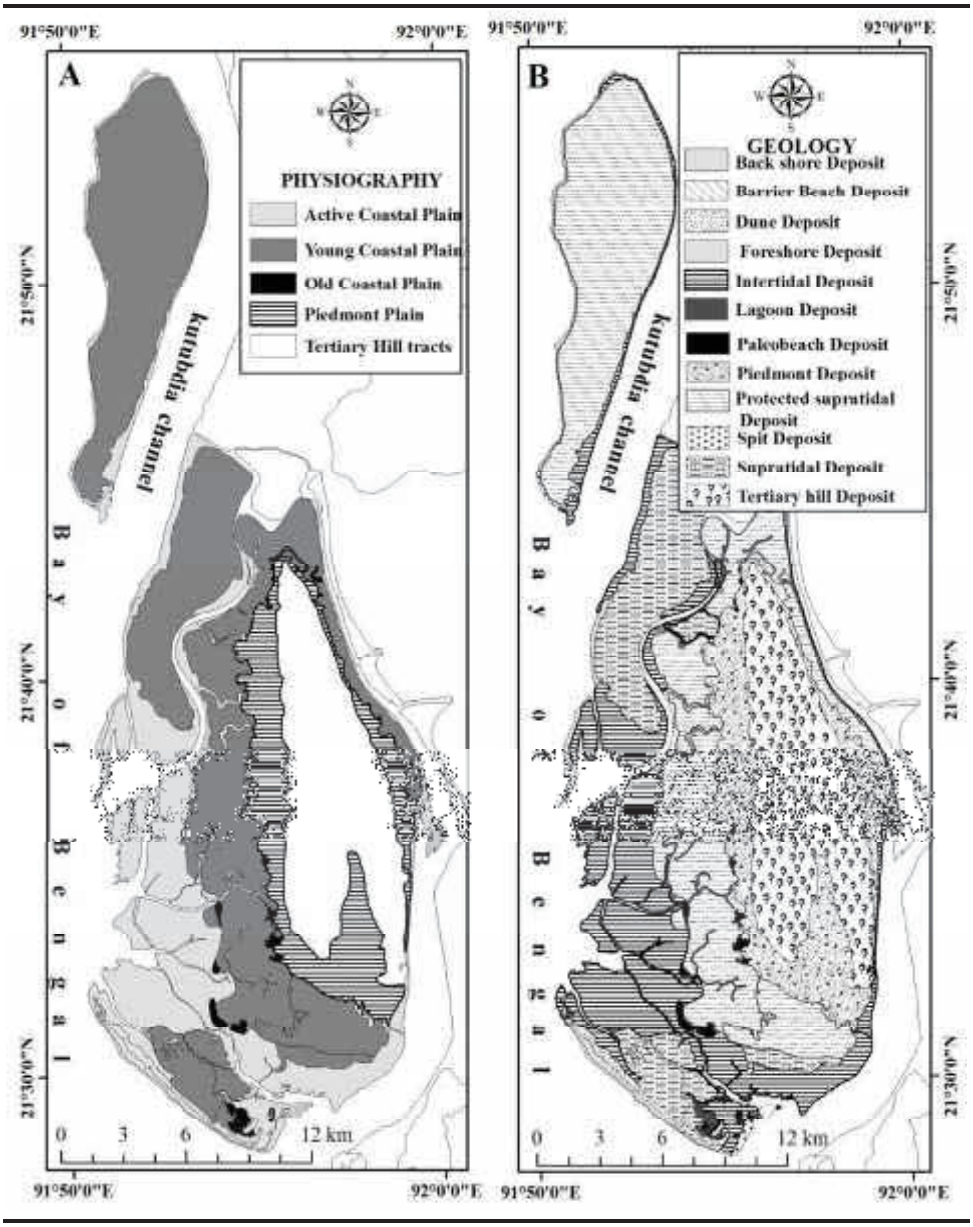
198. The *Kutubdia* Island falls under the physiographic unit '**Upper-Tidal Deposit of Bangladesh**'. According to *Majlis et al*. 2013[1] major physiographic unit of the Islands is **young coastal plain** having average elevation of ~6 meters and surrounded by active coastal plain which is present at the boundary of the *Kutubdia* Island. The study area faces strong longshore currents in the rainy season which eventually cause rapid erosion along the southern and western shorelines of the island. The physiography of *Kutubdia* Island is presented in ***Figure 4.9.***

4.5.2 Geology

199. Geologically this island is young and is dominantly consisting of unconsolidated sediments. According to *Majlis et al*. (2013), major portion of the study area dominantly consists of tidal deposits, i.e. inter tidal and supratidal deposits composed of silty clay with organic clay mix and little sand. The beaches and dunes are composed of loose, fine to medium sand with considerable quantity of heavy minerals. The geology map of *Kutubdia* Island is presented in ***Figure 4.9.***

[1] Majlis, A.B.K., M.A. Islam, M.H. Khasru and M.K. Ahsan. 2013. Protected to Open basin depositional system: an appraisal for the late quaternary evolution of the Moheshkhali Kutubdia coastal plain, Bangladesh. Bangladesh J. Geology 31-32: 16- 28.

Figure 4.9 Generalized Physiography and Geology Map



Source: Majlis, A.B.K., M.A. Islam, M.H. Khasru and M.K. Ahsan. 2013. Protected to open basin depositional system: an appraisal for the late quaternary evolution of the Moheshkhali Kutubdia coastal plain, Bangladesh. Bangladesh J. Geology 31-32: 16- 28.

4.5.3 Topography

200. The study area is part of an estuarine island in the south-eastern part of Bangladesh. The elevation of the island varies from mean sea level up to 7.6 m (25 feet) above sea level. The site selected is located along the north western part of the island and is principally flat. The northern part of the island is having comparatively higher elevation and the slope of the island is from north to south. An earthen embankment is present along the entire stretch of the island. The average height of this coastal wall is 6 m. Several stretches of this embankment have got badly damaged resulting from repeated cyclonic events in this region.

4.5.4 *Land use*

Land Use of Study Area

201. Land uses of the LNG terminal Project and its surrounding area have been studied using high resolution satellite imagery (of May 2015) and through subsequent ground truthing exercise conducted during the site reconnaissance surveys.

202. A major part of the 10 km radial study area (from FSRU location) falls in the Bay of Bengal, which covers ~62.78% of the study area. The predominant land use-land cover of the on-shore portion of the study area includes agricultural land (6.07%), salt pans (12.05%), and settlement (5.63%). Results of the land use-land cover analysis for the study area, as mentioned above, is presented in ***Table 4.4.***. Corresponding land use and land cover map of study area is presented in ***Figure 4.10.***

203. Landuses along onshore pipeline construction corridor of 23 m width has been studied and represented in ***Table 4.5*** and ***Figure 4.11***.

Table 4.4 Land Use / Land Cover in 10 Km Radial Study Area

S N.	Land Use Category	Area (sq. km)	Percentage
1	Agriculture	19.08	6.07
2	Block Vegetation	0.10	0.03
3	Channel	39.10	12.44
4	Coastal Sandy Area	2.43	0.77
5	Creek	0.50	0.16
6	Mudflat and Mangrove	0.19	0.06
7	Saltpan	37.88	12.05
8	Sea	197.33	62.78
9	Settlement	17.70	5.63
10	Waterbodies	0.01	0.002
	Total	314.12	100.00

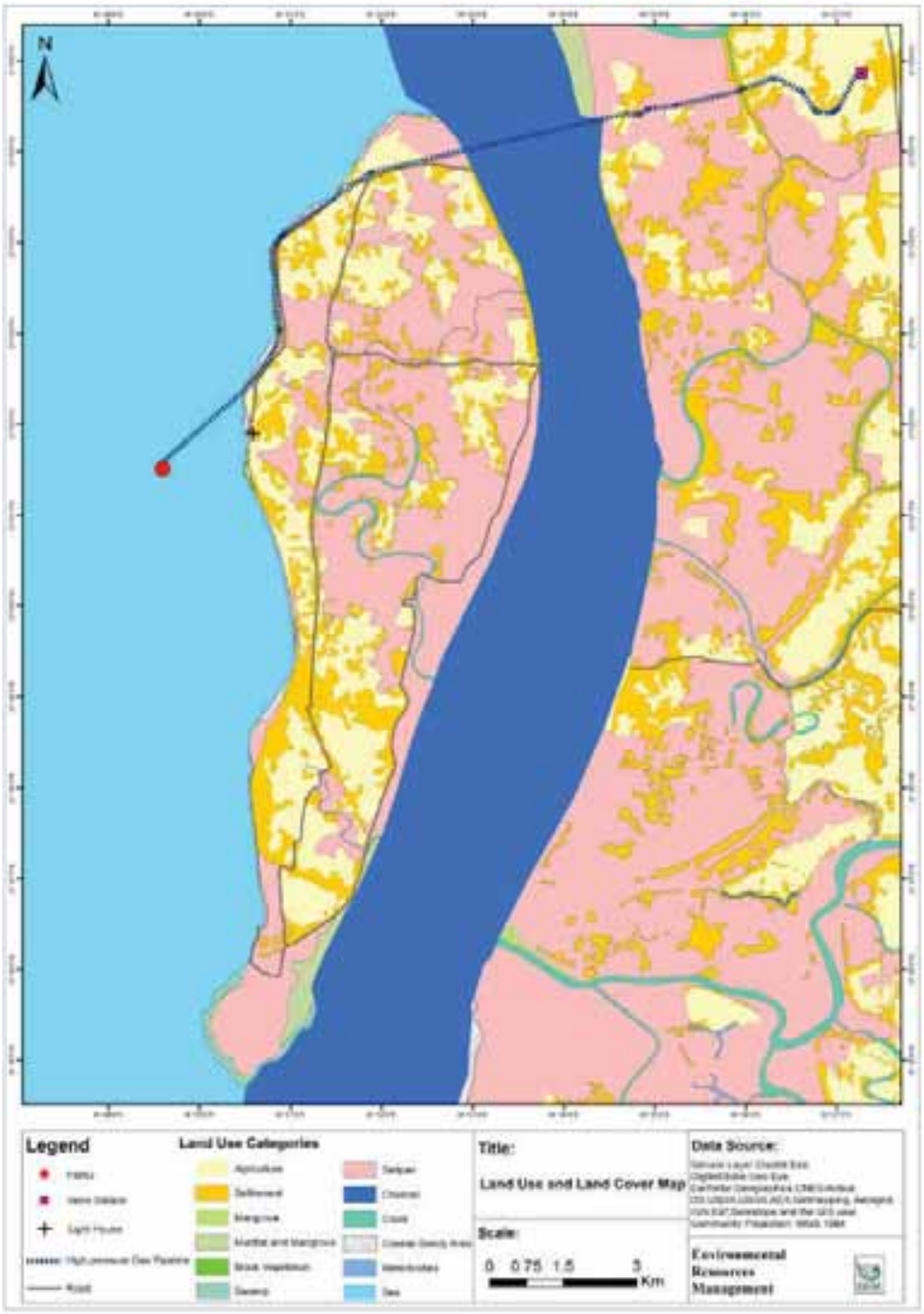
Source: GIS mapping and interpretation of satellite imagery and supplemented with findings from the ground truthing surveys conducted during the site reconnaissance study

Table 4.5 Land Use / Land Cover along High Pressure Onshore Pipeline Corridor

S. N.	Land Use Category	Area (sq. km)	Percentage
1	Agriculture	0.1420	36.0
2	Block Vegetation	0.0035	0.87
3	Channel	0.0632	16.03
4	Coastal Sandy Area	0.0743	18.83
5	Creek	0.0006	0.15
6	Road	0.0019	0.49
7	Saltpan	0.0997	25.27
8	Sea	0.0014	0.35
9	Settlement	0.0079	2.01
	Total	**0.3945**	**100.00**

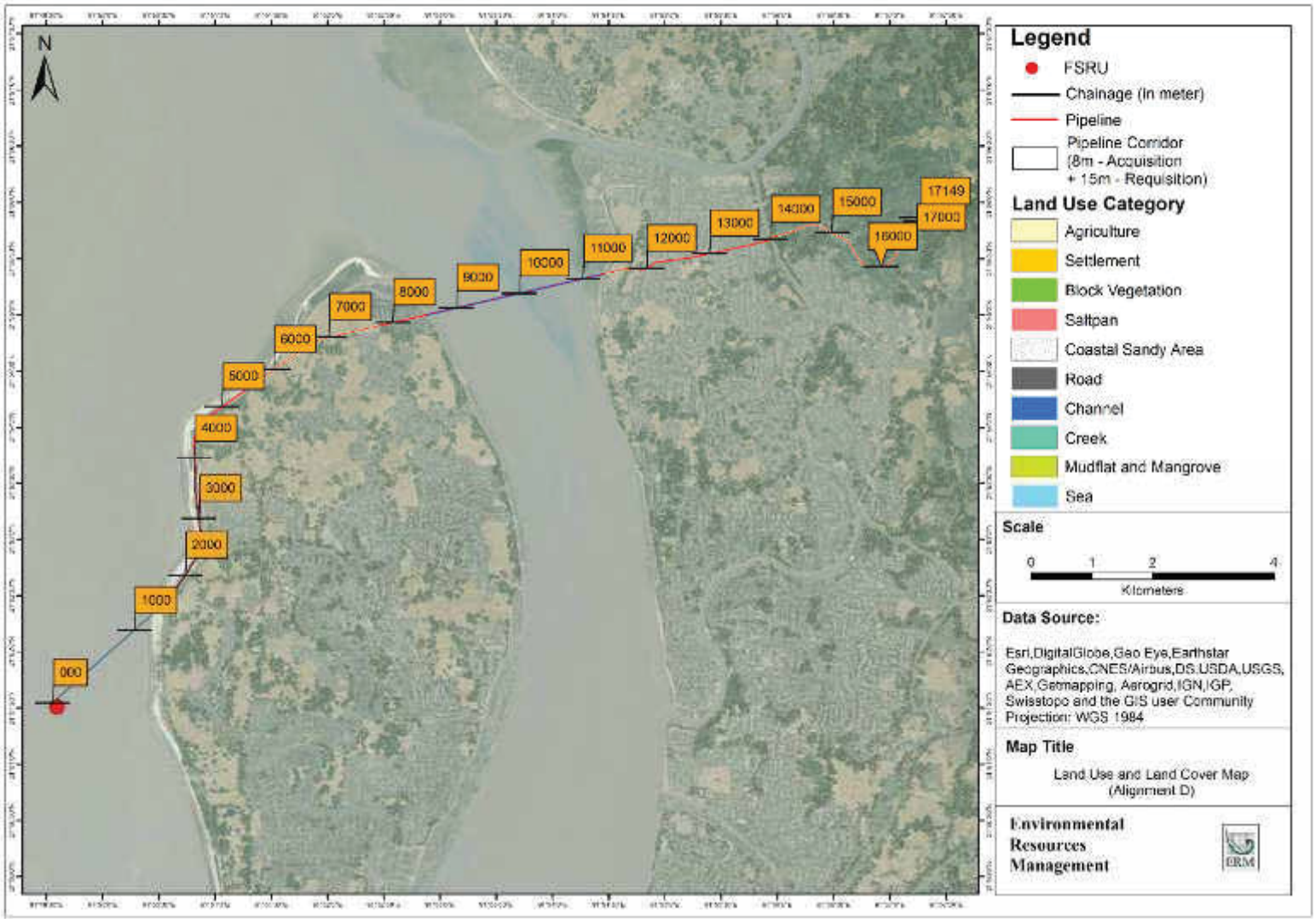
Source: GIS mapping and interpretation of satellite imagery

Figure 4.10 Land use / Land cover Map of the Study Area



Source: GIS mapping and interpretation of satellite imagery and supplemented with findings from the ground truthing surveys conducted during the site reconnaissance study

Figure 4.11 Land use / Land cover Map of Pipeline Corridor



Source: GIS mapping and interpretation of satellite imagery

4.5.5 Soil

204. Soil of the Project area mainly formed from recent alluvial sediments. The major types of soils reported from the study area include:

Tidal Flood Plains - Tidally flooded, very poorly drained, finely stratified - now silty to clayey alluvium. Occurring on tidal mud flats, they are tidally flooded on a regular basis and remain wet throughout the year. This type of soil is found in the southern and south eastern part of the *Kutubdia* Island.

Alluvium - Mostly moderately to strongly saline. These soils are grey coloured, silty clay loam to clayey non-saline soils occurring on high to medium highlands.

Medium Lowlands - Seasonally moderately or deeply flooded. Soils found in this type of land forms are grey coloured, moderately fine textured and strongly saline (often used for salt bed). This type of soils is mainly occurring in the middle part of the island and is currently used as salt pans.

Beach Sands Soils - Mainly grey in colour and sandy in texture. They are tidally flooded and strongly saline. This type of soil is mainly occurring in the western side of the island; i.e. on and around the sea beach.

Primary Monitoring Results

205. Soil samples were collected from two locations *Kutubdia* Island for analysis of physicochemical parameters. The two locations selected are agricultural lands of *Ali Fakir Deil* and agricultural land near *Darbar* Village.

206. Soil samples were collected using tools from a depth of 45 cm from the top soil surface. At each location, soil samples were collected from three spots and homogenized. The homogenized samples were collected following quartering technique and then packed in polythene plastic jars and sealed. The sealed samples were sent to the laboratory for analysis. Details of the sampling locations are presented in ***Table 4.6*** and the soil sampling locations are shown in ***Figure 4.2***.

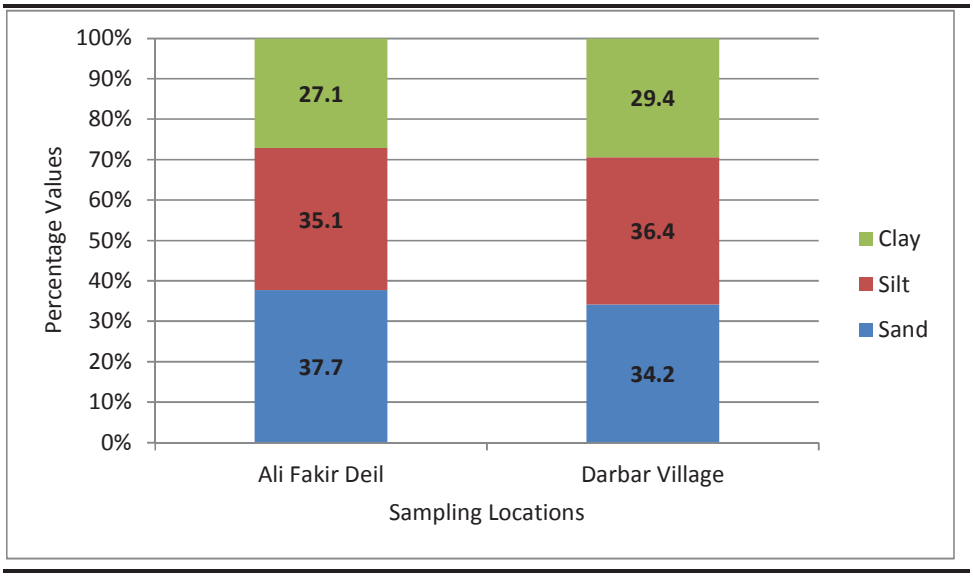
Table 4.6 Soil Sampling Locations

S N.	Sampling location	Code	Monitoring date	Geographic location
1	Agricultural land near embankment of Ali Fakir Deil village	S1	19.11.16	21°51'43.91"N 91°50'33.22"E
2	Agricultural land of Darbar village	S2	19.11.16	21°51'22.84"N 91°52'20.15"E

Texture & pH

207. Soil texture is an important soil characteristic that could influence water retention capacity, aeration, drainage, and susceptibility to erosion which drive crop production and management. Sand, silt and clay contents of the soil samples collected from *Ali Fakir Deil* and *Darbar* Village were found to be 37.7% & 34.2%, 35.1 & 36.4% and 27.1& 39.4% respectively (***Figure 4.12***). The soil samples collected from agricultural lands of *Ali Fakir Deil* and *Darbar* village were found to be clay loam in nature with pH values indicating *strongly acidic soils* (pH value between 4.6 and 5.5)[1].

Figure 4.12 Clay, Silt and Sand Contents of Soil Samples



Permeability

208. Soil permeability depends upon pore size distribution of the soil. Permeability values of the soil samples were found to be 0.8 and 0.9 cm/hour which is found to be *slow*[2].

Electrical Conductivity

209. Electrical conductivity (EC) indicates presence of soluble salts concentration in soil, and is commonly used as a measure of salinity. EC values of the soil samples were found to be *non saline* (0.89 dS/m for *Ali Fakir Deil* sample) and *slightly saline* (3.76 dS/m for *Darbar* Village sample)[3].

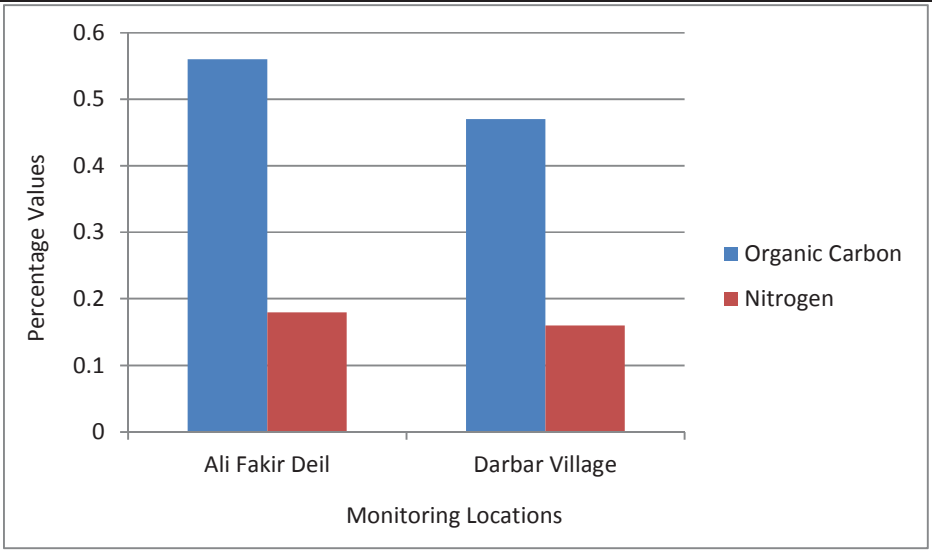
Nutrient Content

210. The nutrient content of the soil samples were compared with the recommended values of *Fertilizer Recommendation Guide 2005, Bangladesh Agricultural Research Council (BARC)*. Organic carbon contents of the soil samples (0.56% and 0.47%)

[1] Fertilizer Recommendation Guide 2005, Bangladesh Agricultural Research Council (BARC).
[2] Soil Crop Suitability Classification for Bangladesh. 1985. FAO/UNDP Agricultural Development Adviser Project (BGD/81/035), Agriculture & Forest Division, Ministry of Agriculture, Dhaka, Bangladesh.

were found to be *very low*. Nitrogen contents of the soils (0.18% & 0.16%) were found to be *low* and phosphorus (2.3 µg/g and 2.0 µg/g) content *very low*. Potassium content was found to be *medium* for the *Ali Fakir Deil* sample and *very high* for the *Darbar* Village sample. Calcium contents of both the samples were found to be *low*. Organic carbon and nitrogen contents of the soil samples are shown in ***Figure 4.13.***

Figure 4.13 Organic Carbon and Nitrogen Values of Soil Samples



211. The soil analysis results reveal the soil samples are clay loam and strongly acidic in nature. The soils were found to be non-saline to slightly saline. In general the soils were found to be of low nutrient content to very low nutrient content (except for potassium). Detailed soil analysis results are presented in ***Table 4.7.***

Table 4.7 Soil Analysis Results

S N.	Parameter	Unit	Soil Quality	
			S1	S2
1	Particle Size Distribution	g/cm³	2.06	1.96
2	Sand	%	37.7	34.2
3	Silt	%	35.1	36.4
4	Clay	%	27.1	29.4
5	Texture	-	Clay loam	Clay loam
6	Bulk density	g/cm³	1.36	1.34
7	pH	-	4.7	5.2
8	Salinity	-	Non saline	Slightly saline
9	SAR	m.e/100g soil	0.54	0.73
10	Electrical Conductivity	dS/m	0.89	3.76
11	Organic Carbon	%	0.56	0.47
12	Nitrogen	%	0.18	0.16
13	Phosphorous	µg/g	2.3	2.0
14	Potassium	m.e/100g soil	0.17	0.43
15	Sodium	m.e/100g soil	0.54	1.43
16	Magnesium	m.e/100g soil	1.26	1.19
17	Calcium	m.e/100g soil	2.69	2.72

S N.	Parameter	Unit	Soil Quality	
			S1	S2
18	Chloride	mg/g	1.32	6.72
19	Fluoride	ppm	210	239
20	Permeability	cm/hr	0.9	0.8
21	Porosity	%	34	32
22	Cation Exchange Capacity	m.e/100g soil	0.47	0.52
23	Infiltration rate	mm/hr	7.6	7.1

Source: Primary Monitoring, November 2016

4.5.6 Shoreline Erosion & Accretion

212. The island estuarine system is very dynamic. Sedimentation as well as erosion is a common feature in this region of Bangladesh. Within a span of three decades, this estuarine region has seen, some of its land forms being completely/majorly eroded whereas at some other locations new formations have come up. In view of this dynamic scenario, review of erosion /deposition trends of this estuary assumes a lot of importance, before locating any facility near the coastal areas.

213. A study conducted by M.K Rahman (2015)[1] reviewed long term erosion and accretion trends prevailing in *Kutubdia*. This study revealed that about 9 km² area was eroded whereas 0.35 km² of land accretion occurred on the *Kutubdia* Island in a period between 1972 and 2013. Major erosion occurred on the southern part of the island. The western side of the island, i.e. towards the Bay of Bengal side was less prone to erosion compared to the southern section. Photographs of erosion at the southern and northern section of *Kutubdia* Island are presented in ***Figure 4.14.***

214. The accretion occurred mostly along the eastern side of the island; i.e. towards the *Kutubdia* Channel. The LFP based facility has been proposed on the north-western side of the island, south of the existing light house and appears to comparatively have less erosion potential.

215. A map showing erosion and accretion trends as established by the above referred study in a period between 1972 and 2013 is presented in ***Figure 4.15***.

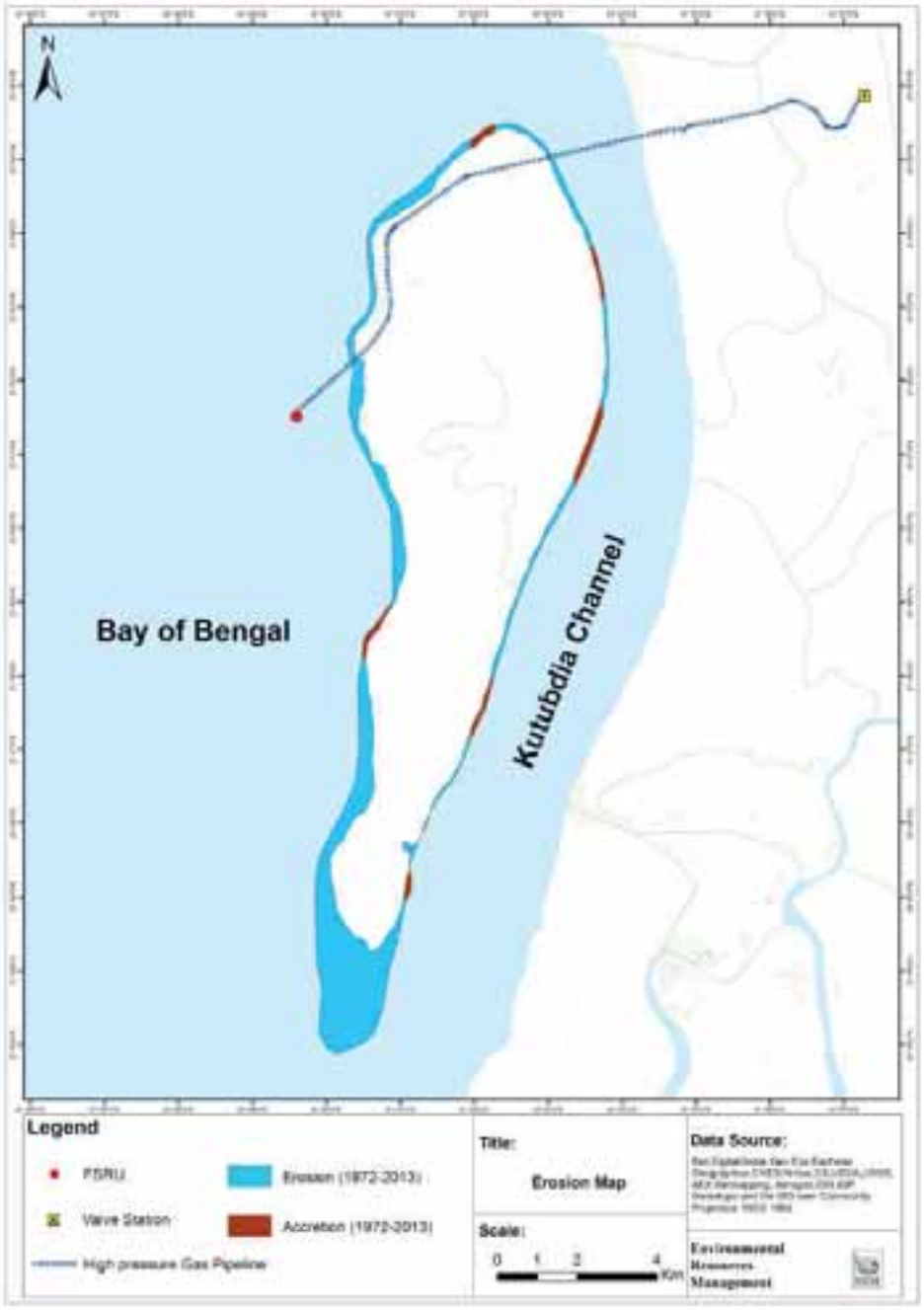
[1] Munshi Khaledur Rahman. 2015. Environmental and Social Vulnerabilities and Livelihoods of Fishing Communities of Kutubdia Island, Bangladesh by (A dissertation submitted to Kent State University).

Figure 4.14 Erosion at the Southern & Western Banks

Erosion at Southern Bank near Tabaleshwar

Erosion at Western Banks near Kaiyarbil

Figure 4.15 Erosion & Accretion Map of Kutubdia Island (1972-2013)



Source: Environmental and Social Vulnerabilities and Livelihoods of Fishing Communities of Kutubdia Island, Bangladesh by *Munshi Khaledur Rahman*, August 2015

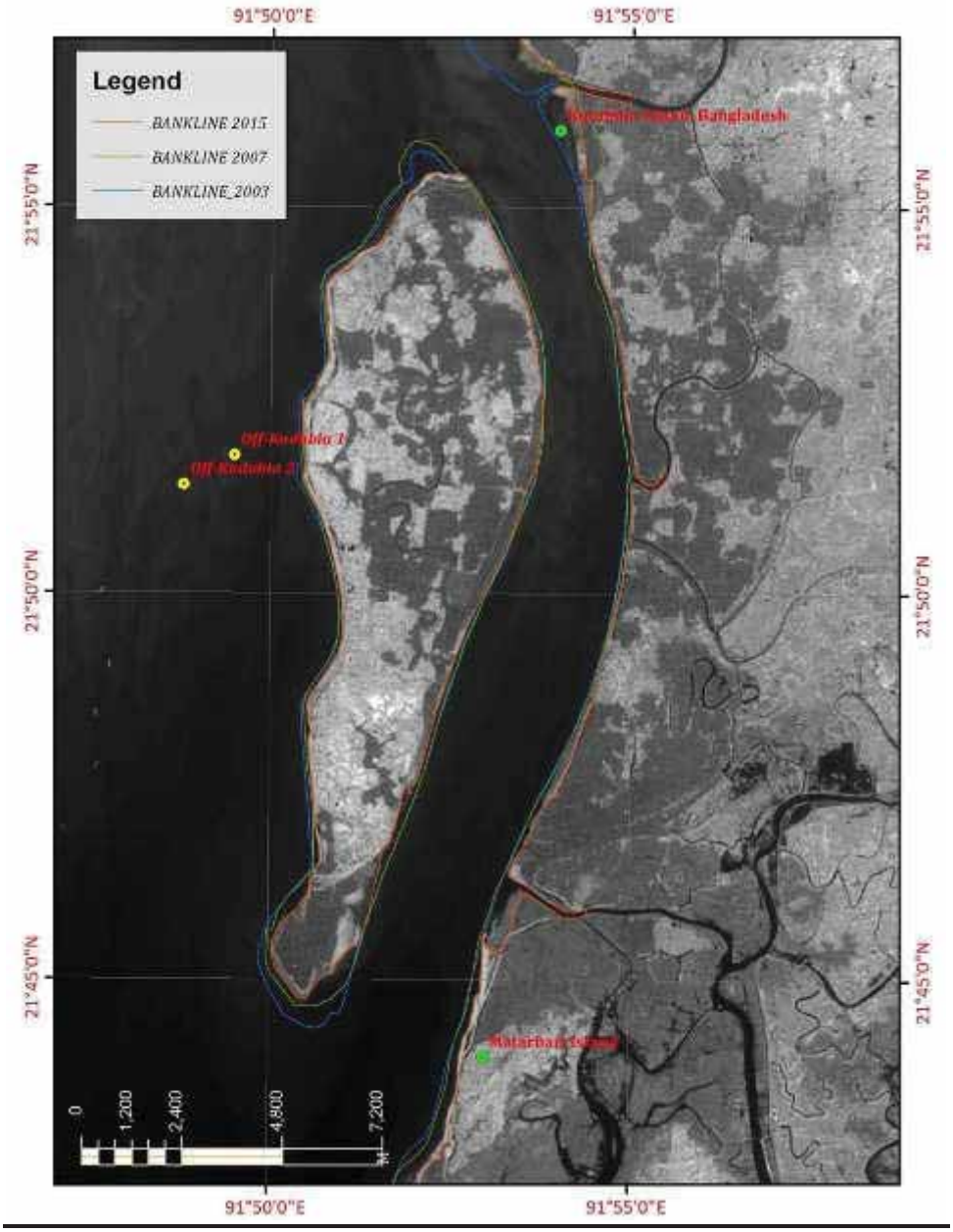
Shoreline Evolution

216. As part of the site screening study conducted by DHI for this project[1], shoreline erosion and accretion along with shoreline evolution off the *Kutubdia* Island was studied utilizing time series satellite data (2003, 2007, 2015). The examination of the high tide line at *Kutubdia* Island for the past 10 years (Figure 4.16) indicates

[1] Source: DHI, 2016 - Desktop Study for Site Screening in Chittagong and Moheshkhali Region for Reliance Power

that the southern part of this island is severely affected by coastal erosion. The area near *Ali Fakir Deil* is not affected significantly by shoreline erosion in the past 10 years.

Figure 4.16 Kutubdia Island 2015, 2007, 2003 Bankline with 2015 Satellite data



Source: Reliance Power DHI, 2016: Desktop Study for Site Screening in Chittagong & Moheshkhali Region

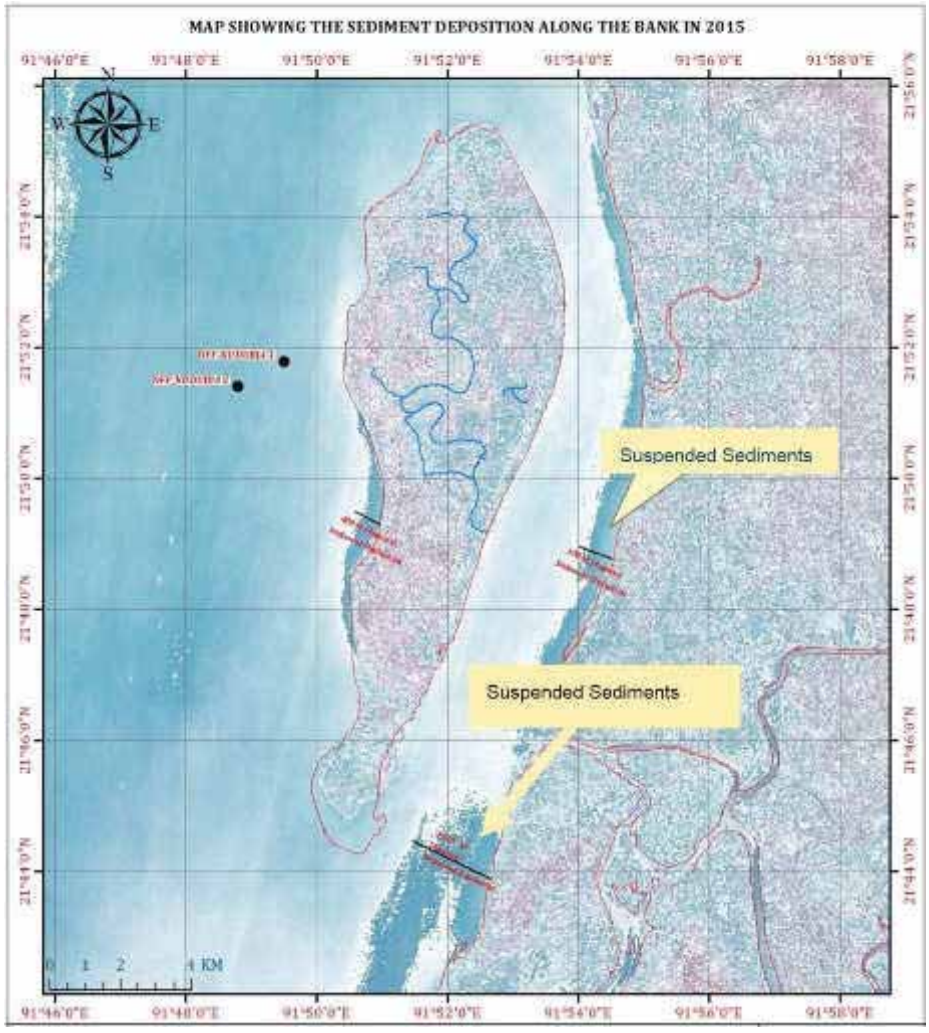
Sediment Transport

217. Suspended sediment concentrations offshore *Kutubdia* Island has also been studied as part of site screening studies conducted[1]. As part of this study, the Landsat ETM+ image analysis was performed to estimate the suspended sediment concentration using the empirical multivariate regression algorithm.

[1] Source: DHI, 2016 - Desktop Study for Site Screening in Chittagong and Moheshkhali Region

The spectral reflectance values corresponding to sediments and water content have been distinguished by the algorithm for estimating sediment concentration and their spatial distribution. The sediment deposition map is presented in Figure 4.17.

Figure 4.17 Suspended Sediment Concentration near Offshore Kutubdia Island



Source: Reliance Power: DHI, 2016: Desktop Study for Site Screening in Chittagong & Moheshkhali Region

218. It is revealed from the map that the high sediment deposition areas near *Kutubdia* Island are present mostly along the coast of the *Pekua Upazila* with high sediment deposition near *Magnama ghat* area. Greater sediment deposition was observed at *Matarbari* Island near the southern tip of the *Kutubdia* Island. The southern tip of *Kutubdia* Island is severely affected by erosion; the eroded sediment of *Kutubdia* Island has probably contributed to sediment deposition at *Matarbari* Island on the other bank of *Kutubdia* Channel.

219. Within *Kutubdia* Island major sediment deposition occurred at the western side of the island in *Kaiyarbil* and *Boroghop* Unions. However, significant level of sediment deposition has not been observed near *Ali Fakir Deil*.

220. Given the nature of construction activities planned under this Project close to the shoreline, any significant aggravation of erosion potential around the proposed site is not quite foreseen.

4.6 HYDROGRAPHY

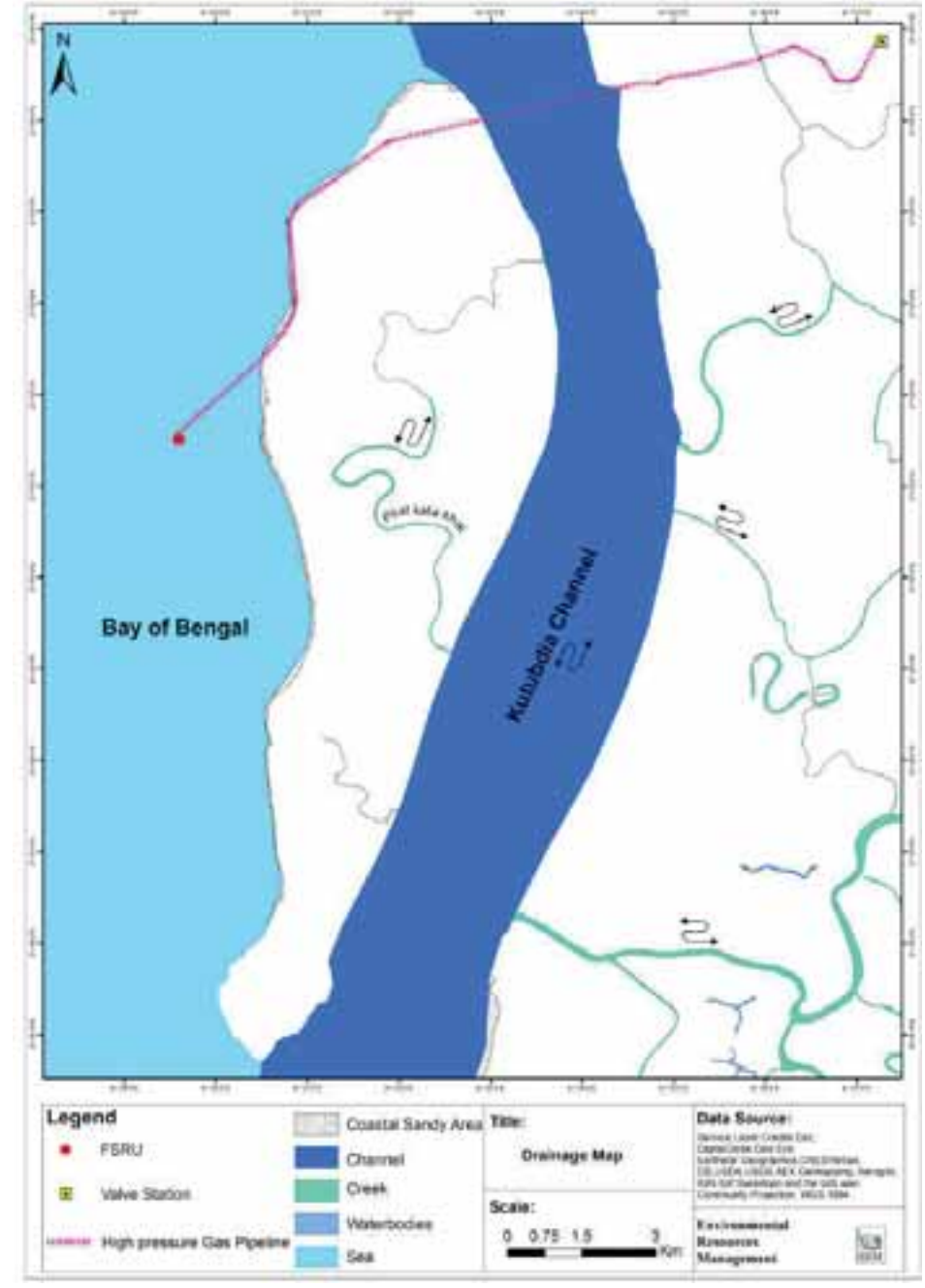
221. Hydrographic and bathymetric information available for this region from Reliance Power sponsored studies[1] indicated a steep sea floor with 10 m contour reaching within 1 km from the *Kutubdia* Island. A Dolphin shoal is located at about 7 km from shore. This shallow patch is approximately trending N-S; extending for about 35 km, almost parallel to the coastline. The depths in this shoal are up to ~6.5 m. Admiralty chart showing water depths in the offshore areas of *Kutubdia* Island is presented in ***Figure 3.10.***

4.7 HYDROLOGY & DRAINAGE PATTERN

222. A natural drainage channel the '*Pilat Kata Khal*' flows along the mid of the island and is connected with *Kutubdia* Channel. This channel is influenced by tidal effects. Inflow and outflow of water from the *Kutubdia* Channel into this *Pilat Kata Khal* is regulated by several sluice gated located at different locations. The flow of water in this *Kata Khal* is regulated to suit the requirements of salt cultivators. Several minor channels are also connected with the *Pilat Kata Khal*. Also, several salt pans (used for commercial salt production) and some fresh water ponds are located within the study area. The drainage map in the study area is presented in ***Figure 4.18***.

[1] DHI, 2016 - Desktop Study for Site Screening in Chittagong and Moheshkhali Region

Figure 4.18 Drainage Map of the Study Area



4.8 MARINE WATER QUALITY

223. Marine water quality is analyzed from six locations, which included four locations in the Bay of Bengal and two locations in the *Kutubdia* Channel. Samples were collected from the surface (0.3 m to 0.5 m below the surface) and mid depth for the Bay of Bengal samples while samples were only collected from the surface (0.3 m to 0.5 m below the surface) for *Kutubdia* Channel. All the samples were collected during mid tide.

224. The samples were analysed for parameters covering physical and chemical characteristics. Parameters such as temperature, pH, Total Dissolved Solids (TDS), electrical conductivity (EC), dissolved oxygen (DO) and salinity were measured onsite. Water samples were collected as grab water sample in a pre-washed 5-litre plastic jerry can for complete physio-chemical tests.

225. The samples were analysed as per standard procedure/method given in Standard Method for Examination of Water and Wastewater Edition 20, published by APHA.

226. Details of the sampling locations are presented in ***Table 4.8*** and the surface water sampling locations are shown in ***Figure 4.2.*** Photographs of marine water sampling are presented in ***Figure 4.19.***

Table 4.8 Marine Water Sampling Locations

SN	Sampling Location	Marine /Inland Surface Water	Code	Monitoring Date	Geographic Location
1	500 m west towards the sea from the proposed landfall point	Marine	SW1	16.11.2016	21°51'50.09"N 91°50'5.85"E
2	3000 m west towards the sea from the proposed landfall point	Marine	SW2	16.11.2016	21°51'33.90"N 91°48'42.55"E
3	1500 m South West towards the sea from the proposed landfall point	Marine	SW3	16.11.2016	21°51'3.26"N 91°49'42.81"E
4	1500 m North West towards the sea from the proposed landfall point	Marine	SW4	16.11.2016	21°52'28.49"N 91°49'46.05"E
5	300 m towards the *Kutubdia* Channel from right bank near to the *Dhurung ghat*	Marine	SW6	17.11.2016	21°53'3.25"N 91°53'51.61"E
6	300 m towards the *Kutubdia* Channel from left bank near to the *Chunura ghat*	Marine	SW7	17.11.2016	21°53'14.81"N 91°54'39.05"E

Figure 4.19 Photographs of Marine Water Sample Collection

Interpretation of Primary Monitoring Results

Temperature

227. There is very little temperature variation between the sites ranging between 27.3ºC and 20.0 ºC. Samples collected from sea surface and at mid depth also showed very little difference. Water temperature measurements at surface and mid depth of the monitoring locations are presented in ***Figure 4.20.***

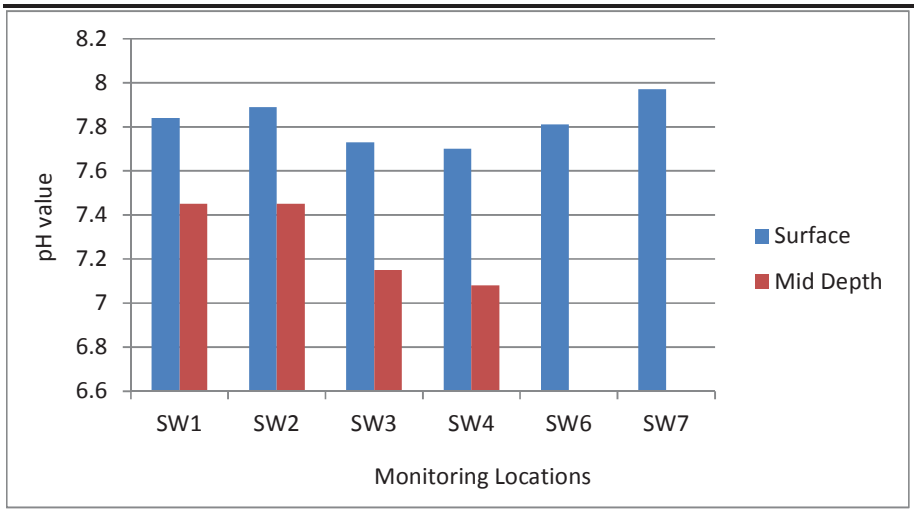
Figure 4.20 Water Temperature at Surface and Mid Depth for Monitored Locations

pH

228. pH values of the surface water samples varied between 7.73 and 7.97 and that of the mid depth water samples varied between 7.08 and 7.45. The mid depth water samples have lower pH compared to the surface water samples. The pH values at surface and mid depth water samples are presented in ***Figure 4.21***.

229. pH values were compared with marine water analyses conducted at *Kutubdia* Channel as part of *EIA for Construction of Matarbari 600X2 MW Coal Fired Power Plant and Associated Facilities (JICA, 2013)*. The JICA study found pH levels during October, 2012 at surface and mid depth as 8.11 and 7.94 respectively and during January, 2013 at surface and mid depth as 8.12 & 7.92 respectively. The JICA studies reveal slightly more alkaline pH than the current study.

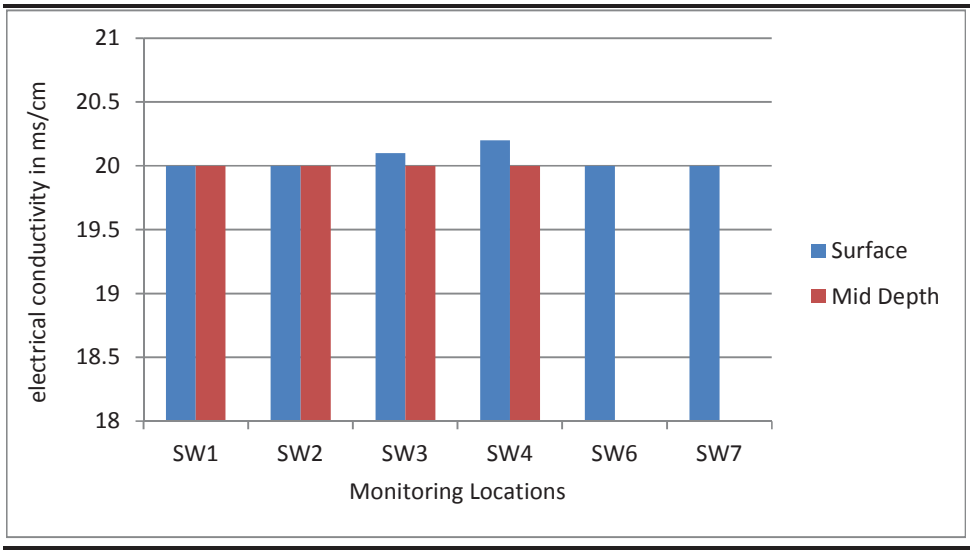
Figure 4.21 pH values at Surface & Mid Depth for Monitored Locations



Electrical Conductivity (EC)

230. EC values of the surface water samples varied between 20.0 and 20.2 ms/cm and that of the mid depth water was found to be 20 ms/cm. No variation was found between the EC values of surface and mid depth samples. The EC values at surface and mid depth water samples are presented in ***Figure 4.22***.

Figure 4.22 Electrical Conductivity Observed in Surface & mid Depth Marine Water Samples



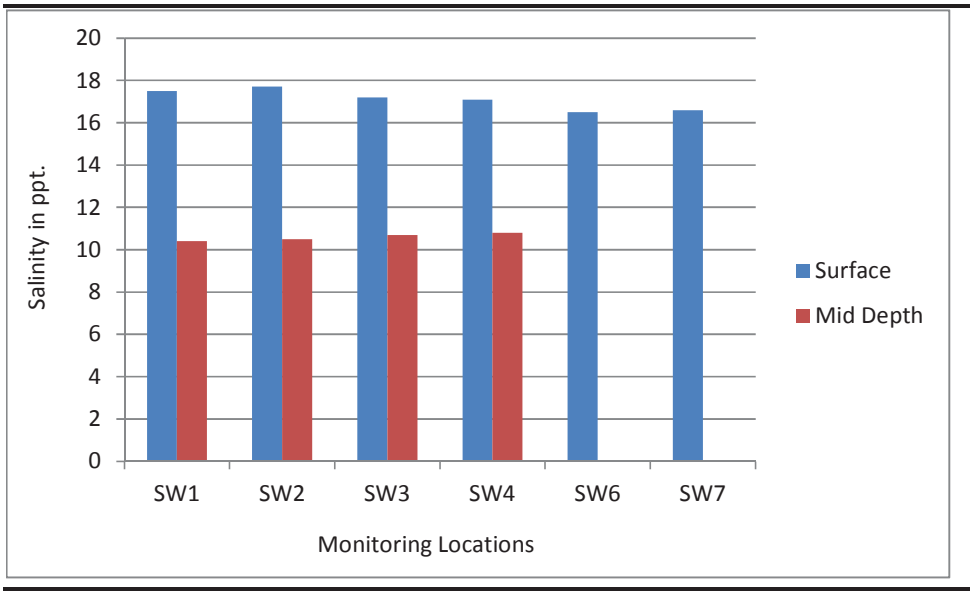
Salinity

231. An understanding of salinity of marine water plays an important role in understanding the hydrological cycle of water. Salinity can influence circulation and biological processes in the ocean. On average, the ocean has a salinity of 35 parts per thousand (ppt) which translates to 35 g of salt per 1000 g of water. Major components of this salt include sodium, chlorine, magnesium, calcium, potassium and sulphate, which comprise of a total of 99.4% of the salt in the ocean. The salinity values at surface and mid depth water samples are presented in ***Figure 4.23***.

232. Salinity values of the surface water samples varied between 16.5 ppt and 17.7 ppt and that of the mid depth water samples varied between 10.4 ppt and 10.8 ppt. The mid depth water samples have lower salinity compared to the surface water samples. Moreover, salinity levels at the samples collected from the surface of the *Kutubdia* Channel were also lower than the samples collected from the surface of the Bay of Bengal.

233. The salinity values were compared with marine water analyses conducted at *Kutubdia* Channel by JICA (2013). The JICA study found salinity levels during October, 2012 at surface and mid depth as 17.8 ppt and 18.4 ppt respectively and during January, 2013 at surface and mid depth as 35.3 ppt & 35.6 ppt respectively. The JICA study reveal slightly more salinity for the October values while the winter samples collected during January 2013 reveal significantly higher salinity values compared to the present study.

Figure 4.23 Salinity Observed in Surface & mid Depth Marine Water Samples

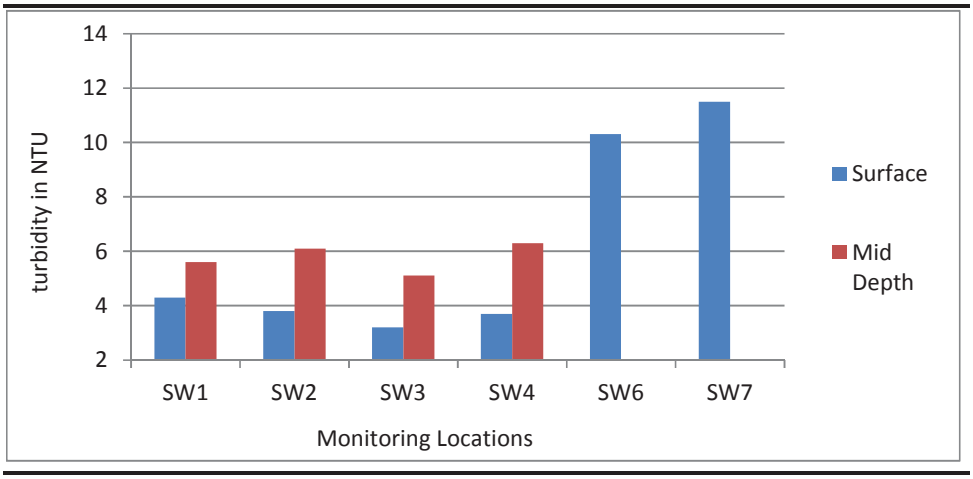


Turbidity

234. Turbidity refers to optical clearness of sea water and is affected by dissolved and suspended impurities in the sea water. Turbidity values at surface and mid depth at the monitoring locations are shown in ***Figure 4.24.***

235. Water samples collected from surface of the Bay of Bengal revealed turbidity values between 3.7 NTU and 4.3 NTU while the mid depth samples showed turbidity values between 5.6 NTU and 6.3 NTU. As the mid depth samples were closer to the sea floor, re-suspended solids from the sea floor could reach the mid depth more easily compared to the sea surface, which possibly had resulted in higher turbidity levels at the mid depth samples. Turbidity values for the samples collected from surface of *Kutubdia* Channel revealed much higher values (10.3 NTU to 11.5 NTU) compared to the Bay of Bengal samples which could possibly be attributed to shallow depth of the channel compared to the open sea.

Figure 4.24 Turbidity Observed in Surface & mid Depth Marine Water Samples



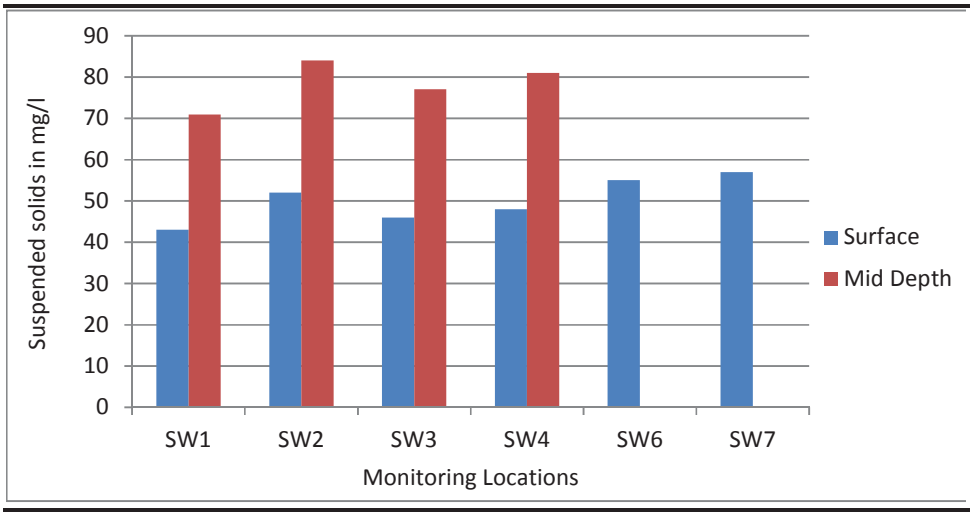
Suspended Solids (SS)

236. Suspended solids are the measure of particulate matter suspended in the sea water column. The total suspended solids are directly proportional to the turbidity, as higher numbers of suspended solids increase the turbidity of the sea water. Suspended solids concentrations at surface and mid depth at the monitoring locations are shown in ***Figure 4.25***.

237. Water samples collected from surface of the Bay of Bengal revealed suspended solids values between 43 mg/l and 52 mg/l while the mid depth samples showed suspended solids values between 71 mg/l and 81 mg/l. As explained earlier this could possibly be due to lesser depth of the mid depth samples from the sea floor. Suspended solids values for the samples collected from surface of *Kutubdia* Channel revealed values between 55 mg/l and 57 mg/l.

238. The suspended solids concentrations were compared with marine water analyses conducted at *Kutubdia* Channel by JICA (2013). The JICA study found average suspended solids levels during October, 2012 at surface and mid depth as 798 and 696 mg/l respectively and during January, 2013 at 49 & 80 mg/l respectively. The JICA studies reveal very high suspended solids for the October samples probably due to increased surface runoff to *Kutubdia* Channel due to heavy rains. However, the dry season samples (January, 2016) revealed suspended solids concentrations comparable to the current survey values.

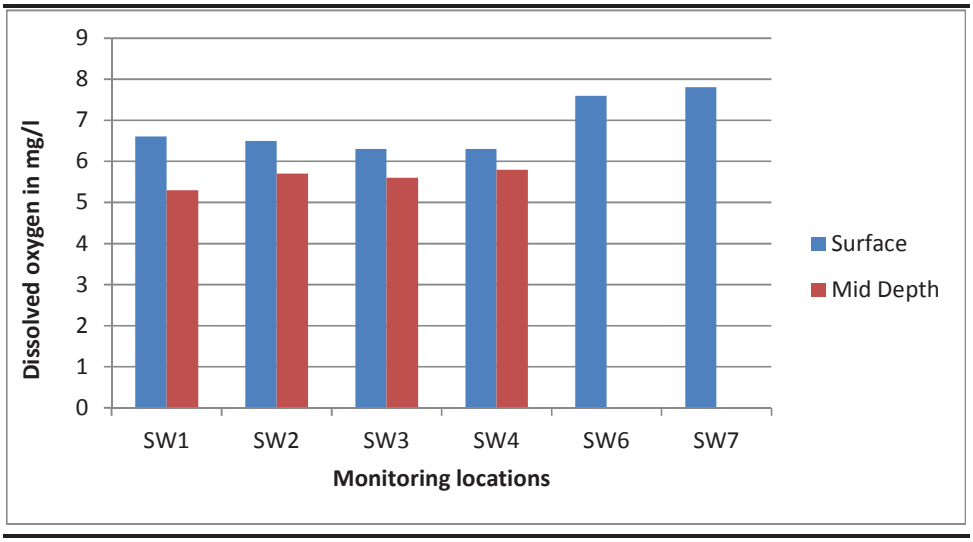
Figure 4.25 Suspended Solids Observed in Surface & mid Depth Marine Water Samples



Dissolved Oxygen (DO)

239. DO values of the surface water samples varied between 6.3 mg/l and 7.8 mg/l and that of the mid depth water was found to be 5.3 mg/l and 5.8 mg/l. Water samples collected from the surface reveal higher DO values compared to the mid depth samples due to dissolution of oxygen from the atmosphere at the sea surface. The DO values at surface and mid depth water samples are presented in ***Figure 4.26***.

Figure 4.26 DO Observed in Surface & mid Depth Marine Water Samples



Heavy Metals

240. Concentrations of cadmium and nickel at the surface and mid depth samples for all monitoring locations were found to be below detection limits. Concentration of lead was below detection limits for all surface and mid depth samples collected from the Bay of Bengal, while the samples collected from *Kutubdia* Channel revealed lead values of 0.01 mg/l. Almost all the samples revealed zinc and copper concentrations below detection limits. Chromium contents of the samples collected from the surface varied between 0.028 mg/l and 0.067 mg/l and mid depth samples varied between 0.034 mg/l and 0.075 mg/l. Concentrations of heavy metals at the marine water samples are shown in ***Table 4.9***

241. The heavy metals concentrations were compared with marine water analyses conducted at *Kutubdia* Channel by JICA (2013). The concentration of heavy metals lead, zinc, copper and cadmium were lower compared to the JICA study while chromium concentrations were slightly higher (refer ***Table 4.9).***

Table 4.9 Marine Water Analysis Results

SN	Parameter	Unit	SW1		SW2		SW3		SW4		SW6	SW7	JICA, 2013*	
			Sea surface (a)	Mid Depth (b)	Sea surface (a)	Mid Depth (b)	Sea surface (a)	Mid Depth (b)	Sea surface (a)	Mid Depth (b)			Sea surface (a)	Mid Depth (b)
1	Temperature	°C	28.6	28.4	27.9	27.3	29.1	28.1	28.1	27.3	28.7	29.0	18.2-30	18.2-29.3
2	pH		7.84	7.45	7.89	7.45	7.73	7.15	7.70	7.08	7.81	7.97	7.94-8.11	7.92-8.12
3	Electrical Conductivity	mS/cm	20	20	20	20	20.1	20	20.2	20	20	20	-	-
4	Dissolved Oxygen	mg/l	6.6	5.3	6.5	5.7	6.3	5.6	6.3	5.8	7.6	7.8	-	-
5	Turbidity	NTU	4.3	5.6	3.8	6.1	3.2	5.1	3.7	6.3	10.3	11.5	-	-
6	Salinity	ppt	17.5	10.4	17.7	10.5	17.2	10.7	17.1	10.8	16.5	16.6	17.8-35.3	18.7-35.6
7	TDS	ppt	10	10	10	10	9.8	10.2	10	10	10	10		
8	Suspended Solids	mg/l	43	71	52	84	46	77	48	81	55	57	49-798	80-696
9	Cadmium	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.001
10	Lead	mg/l	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	0.010	0.010	0.010-0.018
11	Chromium	mg/l	0.028	0.034	0.067	0.075	0.038	0.046	0.042	0.050	0.057	0.054	0.013-0.043	0.016-0.045
12	Zinc	mg/l	<0.1	0.16	<0.1	0.18	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.010-0.050	0.010-0.013
13	Copper	mg/l	<0.1	<0.1	<0.1	0.23	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.010	0.010-0.029
14	Nickel	mg/l	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	-	-

Source: Primary Monitoring, November 2016

*JICA, 2013. Environmental Impact Assessment of Construction of Matarbari 600X2 MW Coal Fired Power Plant and Associated Facilities

4.9 INLAND SURFACE WATER QUALITY

242. Inland surface water quality was monitored at one location in *Pilat Kata Khal* within *Kutubdia* Island. The water sample was collected from the surface during mid tide. Details of the sampling location are presented in ***Table 4.10*** and the surface water sampling location is shown in ***Figure 4.2***.

Table 4.10 Inland Surface Water Sampling Locations

SN	Sampling location	Marine/Inland Surface water	Code	Monitoring date	Geographic location
1	*Pilat Katakhal*	Inland surface water	SW5	17.11.2016	21°51'8.71"N 91°51'17.39"E

243. The analyzed results for inland surface water was compared to *Best Practice Based Classification of ECR, 1997* (refer to ***Annex 2***). pH of the water sample was found to be 7.73. Dissolved oxygen concentration was found to be 6.3 mg/l. BOD and COD concentrations were found to be 1.9 mg/l and 18.6 mg/l respectively. The EC and salinity values of the water sample were found to be 20 ms/cm and 15.1 ppt respectively. The water is primarily used for the fisheries and the analysis results are in compliance to the use of water for fisheries as per the ECR, 1997. As the EC values were high the water cannot be used for irrigation. Results of inland surface water analysis are presented in ***Table 4.11***.

Table 4.11 Inland Surface Water Analysis Results

S N.	Parameter	Unit	SW5
1	Temperature	°C	30.2
2	pH	-	7.73
3	Electrical Conductivity	mS/cm	20
4	Dissolved Oxygen	mg/l	6.3
5	BOD_5	mg/l	1.9
6	COD	mg/l	18.6
7	Turbidity	NTU	11.7
8	Salinity	Ppt	15.1
9	TDS	Ppt	10.0
10	Suspended Solids	mg/l	36.0
11	Nitrate	mg/l	0.13
12	Nitrite	mg/l	0.01
13	Manganese	mg/l	0.21
14	Phosphate	mg/l	1.12
15	Iron	mg/l	3.56
16	Oil and Grease	mg/l	2.9

Source: Primary Monitoring, November 2016

4.10 MARINE SEDIMENT QUALITY

244. Marine sediment samples were collected from four locations for analysis of physicochemical parameters. The samples were collected at two locations in the Bay of Bengal and two locations in *Kutubdia* Channel.

245. Sediment samples were collected using a sediment sampler. At each location, sediment samples were collected from three spots and homogenised. Care was taken to minimize the surface disturbance to the sediments. The homogenised samples were then packed in polythene plastic bags, sealed and sent to the laboratory for analysis. Details of the sampling locations are presented in ***Table 4.12*** and the sediment locations are shown in ***Figure 4.2***.

Table 4.12 Sediment Sampling Locations

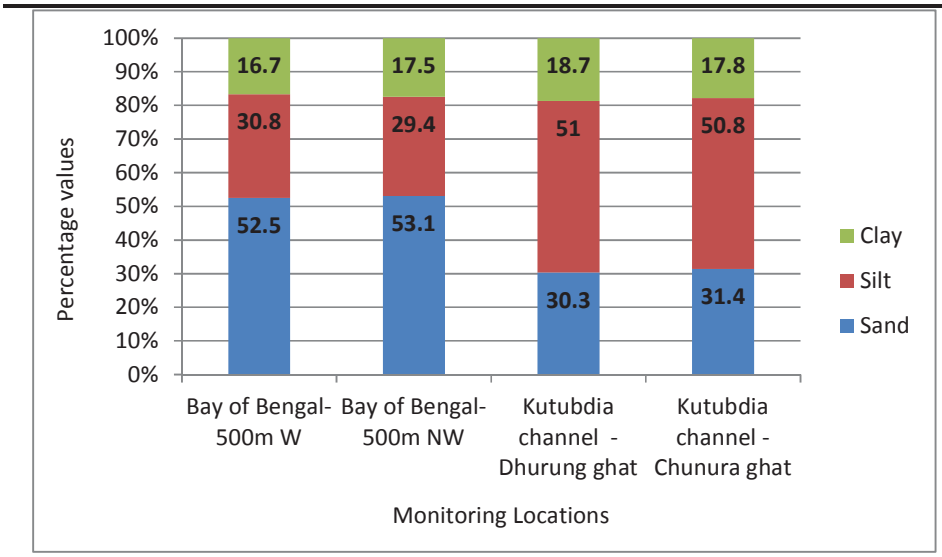
SN.	Sampling location	Code	Monitoring date	Geographic location
1	500 m west of the landfall point in the Bay of Bengal	SD1	18.11.2016	21°51'34.40"N 91°50'11.37"E
2	500 m North West of landfall point in the Bay of Bengal	SD2	18.11.2016	21°52'29.23"N 91°50'11.37"E
3	300 m towards the *Kutubdia* Channel from right bank near *Dhurung ghat*	SD3	17.11.2016	21°53'2.78"N 91°53'51.84"E
4	300 m towards the *Kutubdia* Channel from left bank near to the *Chunura ghat*	SD4	17.11.2016	21°53'15.55"N 91°54'38.65"E

Interpretation of Primary Monitoring Results

Texture

246. Analysis of sediment texture is important in understanding the hydrodynamic conditions of aquatic environment. The sand, silt and clay contents of the sediment samples are presented in ***Figure 4.27.*** Percentage contents of sand were higher in the samples collected from the Bay of Bengal compared to the *Kutubdia* Channel, while the silt percentages were higher in *Kutubdia* Channel samples compared to the Bay of Bengal samples. The Bay of Bengal sediment samples were found to be sandy loam in nature while those from *Kutubdia* Channel were found to be silty loam in nature.

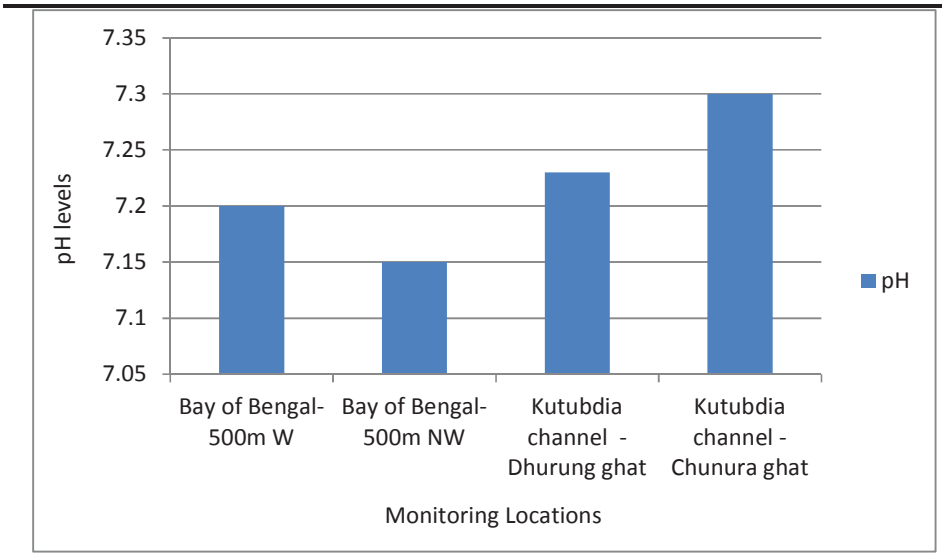
Figure 4.27 Sand, Silt & Clay Contents of Sediment Samples



pH

247. pH was measured in sediment samples to determine the reliability of the biological and chemical processes. Change in pH can have an effect on these processes with highly acidic pH (below 5.0) and alkaline pH (above 9.0) drastically affecting the efficiency of marine ecosystems. The pH values of the sediment samples are shown in ***Figure 4.28***. pH of the sediment samples were found to be neutral in nature varying between 7.15 and 7.30.

Figure 4.28 pH Values of Sediment Samples

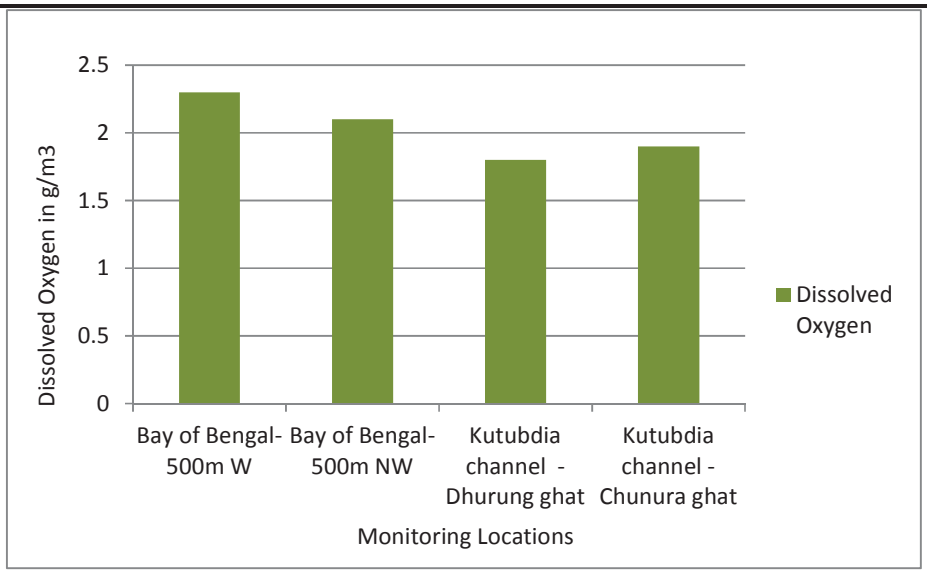


Dissolved Oxygen

248. Dissolved oxygen levels in marine sediment were measured by collecting a 1:10 extract (100 g sediment dissolved in 1000 mL bottle). Dissolved oxygen is an important indicator of biological potential of marine sediment and low dissolved oxygen levels is indicative of poor benthic life. The dissolved oxygen content of the sediment samples varied between 1.9 g/m^3 and 2.3 g/m^3 which

reveal low dissolved oxygen content. Dissolved oxygen content of sediment samples are shown in ***Figure 4.29.***

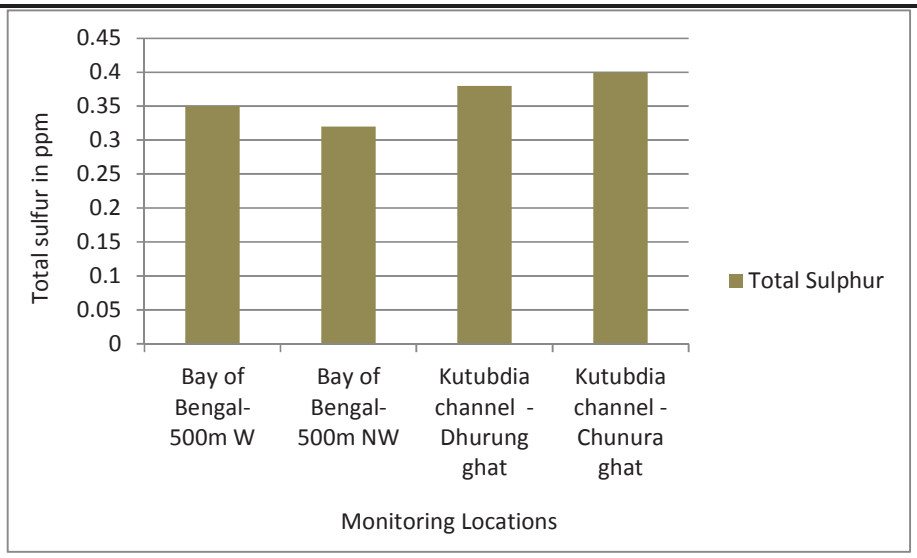
Figure 4.29 Dissolved Oxygen Levels in Sediment Samples



Total Sulphur

249. Sulphur content is the sediment samples is an important indicator of oil and gas pollution. Sulphur levels in sediment samples are presented in ***Figure 4.30.*** Sulphur contents of the samples varied between 0.35 ppm and 0.40 ppm which represents low sulphur content in the samples.

Figure 4.30 Sulphur Levels in Sediment Samples

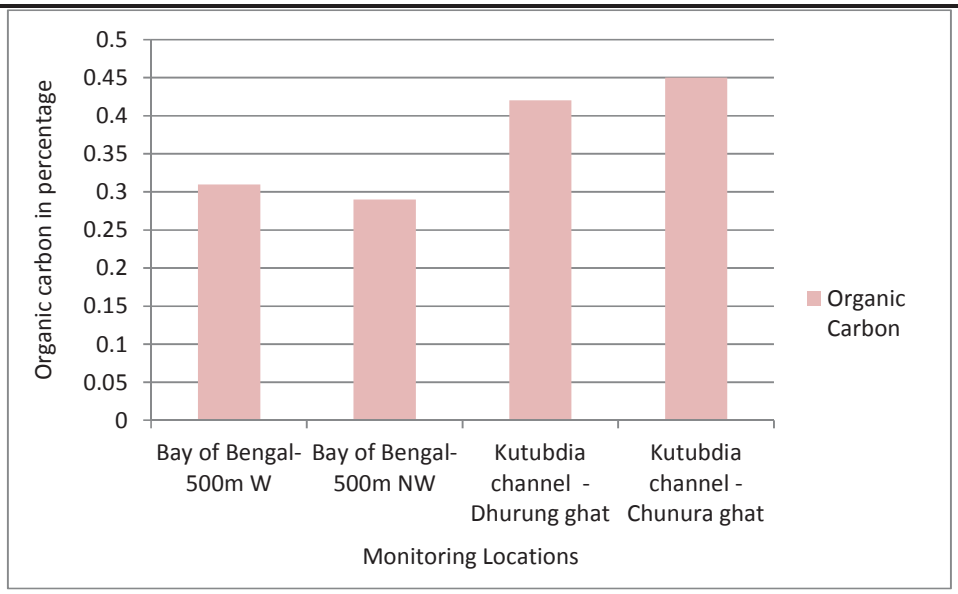


Organic Carbon

250. Organic carbon levels in sediments are an important indicator of productivity of biogeochemical cycles of the marine environment. One of the measures of overall productivity of the marine environment is to understand the biological pump that measures the fixing of atmospheric carbon dioxide into

photosynthetic organism and then transport it to the sediments as organic carbon. Organic carbon present in marine sediment due to natural conditions is normally around 0.5%. Organic carbon content of the sediment samples were found to be low varying between 0.31% and 0.45%. The organic carbon contents in the sediment samples are shown in ***Figure 4.31.***

Figure 4.31 Organic Carbon levels in Sediment Samples



Heavy Metals

251. Concentration of Cr in the sediment samples varied from 0.01 to 1.6 mg/kg and concentration of Pb varied from 8.52 to 13.07 mg/kg. Concentrations of Cd for all the samples were below 0.05 mg/kg.

252. The primary analysis results for heavy metals were comparable to the sediment analysis results conducted by JICA (2013)[1] in *Kutubdia* Channel near *Matarbari* Island (***Table 4.13)***. The concentrations of Cr, Cd and Pb were low compared to Dutch intervention values.

253. Effects Range-Low (ERL) and Effects Range-Median (ERMe) proposed by the NOAA (National Oceanic and Atmospheric Administration, U.S.) are accepted globally as the guidelines for concentration of heavy metal in sediment which affect benthic organisms. Concentration of heavy metals at the sediment samples were found to be low compared to the ERL. The sediment analysis results indicate that the sediments are not contaminated with heavy metals. Sediment analysis results are presented in ***Table 4.13***.

[1] JICA, 2013. Environmental Impact Assessment of Construction of Matarbari 600X2 MW Coal Fired Power Plant and Associated Facilities

Table 4.13 Sediment Analysis Results

SN	Parameter	Unit	Sediment Quality				JICA EIA, 2013*	Dutch Intervention Values 2013**	Guideline of NOAA	
			SD1	SD2	SD3	SD4			ERL	ERMe
1	Sand	%	52.5	53.1	30.3	31.4	-	-	-	-
2	Silt	%	30.8	29.4	51.0	50.8	-	-	-	-
3	Clay	%	16.7	17.5	18.7	17.8	-	-	-	-
4	Texture		Sandy loam	Sandy loam	Silt loam	Silt loam	-	-	-	-
5	Dissolved Oxygen	g/m^2	2.3	2.1	1.8	1.9	-	-	-	-
6	pH	-	7.20	7.15	7.23	7.30	-	-	-	-
7	Organic Carbon	%	0.31	0.29	0.42	0.45	-	-	-	-
8	Total Sulphur	ppm	0.35	0.32	0.38	0.40	-	-	-	-
9	Cadmium	mg/kg	<0.05	<0.05	<0.05	<0.05	0.032-0.05	13	1.2	9.6
10	Lead	mg/kg	8.52	10.21	12.25	13.07	3.39-11.6	530	46.7	218
11	Chromium	mg/kg	0.15	0.33	1.2	1.6	-	-	-	-
12	Zinc	mg/kg	21.1	30.9	21.8	27.0	20.2-63.7	720	410	410
13	Copper	mg/kg	9.98	11.83	8.78	7.10	3.75-23.8	190	34	270
14	Nickel	mg/kg	23.6	22.19	32.68	26.47	-	100	-	-

Source: Primary Monitoring, November 2016

*JICA, 2013. Environmental Impact Assessment of Construction of Matarbari 600X2 MW Coal Fired Power Plant and Associated Facilities

**Dutch Intervention Values (Soil Remediation Circular July 2013 Revision)

4.11 GROUND WATER RESOURCE & QUALITY

254. Groundwater is abundant in Bangladesh and the aquifers are highly productive. However, the ground water resource in the *Kutubdia* Island is limited, as the Island is surrounded by saline water on all sides. The ground water level in the central and southern part of the Island is shallow and also fresh. The ground water is mostly tapped through shallow tube wells and used for agriculture as well as domestic purpose. The ground water level in northern part of the island is comparatively deeper and mostly saline. This water is suitable for agriculture, and the drinking water is mostly sourced from the lower aquifer.

255. Groundwater samples were collected from shallow tube wells in *Dakshin Dhurung*, *Kaiyarbil*, *Lemshikhali* and *Boroghop* Unions of *Kutubdia* Island.

256. The samples were analysed for parameters covering physical, chemical and bacteriological characteristics. Parameters such as temperature, pH, Total Dissolved Solids (TDS), electrical conductivity (EC) and salinity were measured onsite. Water samples were collected as grab water sample in a pre-washed 5-

litre plastic jerry can and 250 ml sterilized clean PET bottle for complete physio-chemical and bacteriological tests respectively.

257. The samples were analysed as per standard procedure/method given in Standard Method for Examination of Water and Wastewater Edition 20, published by APHA.

258. Details of the sampling locations are presented in ***Table 4.14*** and the ground water sampling locations are shown in ***Figure 4.2*** and photographs of groundwater sample collection are shown in ***Figure 4.32.***

Table 4.14 Ground Water Sampling Locations

SN	Sampling Location	Depth (ft.)	Establishment	Code	Monitoring Date	Geographic Location
1	*Ali Fakir Deil* village, *Dakshin Dhurung* Union	200	2004	GW1	17.11.2016	21°52'0.20"N 91°50'45.50"E
2	*Baitul Sharif Madrasa* Complex, *Kaiyarbil* Union	800	2000	GW2	17.11.2016	21°50'16.80"N 91°51'17.80"E
3	*Darbar* village, *Lemshikhali* Union	680	2011	GW3	17.11.2016	21°51'12.29"N 91°52'28.64"E
4	*Uttar Mogdil* Village, *Boroghop* Union	900	2002	GW4	17.11.2016	21°48'46.30"N 91°51'12.10"E

Figure 4.32 Photographs of Ground Water Sample Collection


Discussion of Results

259. Summary of the results are as follows:

- pH of the groundwater samples were recorded in the range of 6.74 to 8.23 as against the ECR, 1997 standard of 6.5 to 8.5.
- Turbidity values of the groundwater samples ranged between 0.94 NTU and 2.1 NTU and are in compliance to the ECR. 1997 standard of 10 NTU.
- The level of total dissolved solids (TDS) recorded in the groundwater samples varied from 0.15 to 1.70 ppt. In almost all the samples, the TDS levels were found to be in exceedance to the acceptable limit of 1 ppt. (samples collected from *Ali Fakir Deil* Village, *Baitul Sharif Madrasa* Complex, *Darbar* Village).
- Chloride concentrations were recorded from 172 mg/l to 184 mg/l in the groundwater samples. Sample collected from all the locations showed chloride concentration in compliance to the ECR, 1997 limits.
- Fluoride levels in the groundwater samples were found to be in the range 0.33 to 0.45 mg/l. Fluoride concentrations for all the samples were found to be in compliance to the ECR, 1997 limit of 1.0 mg/l.
- Sodium and potassium contents of the samples varied from 104 mg/l to 114 mg/l and 1.22 mg/l to 1.56 mg/l. The results were found to be in compliance to the standard values of sodium (200 mg/l) and potassium (12 mg/l)
- Arsenic concentration of the samples were found to be varying from 0.0 to 0.2 mg/; which were in compliance to the standard limit of 0.05 mg/l
- Iron concentration of all the samples (0.78 to 0.91 mg/l) were found to be in compliance to the ECR, 1997 limit of 1.0 mg/l
- Concentration of heavy metals viz. cadmium, lead, mercury, chromium, nickel, manganese, zinc, copper etc. were found to be in compliance to the ECR, 1997 limits.
- Faecal and total coliforms were not detected from the collected samples

260. In summary the groundwater analysis reveal that almost all the parameters are within the standard values of ECR, 97 (excepting TDS) and it can be assumed that the ground water quality was satisfactory for drinking within the *Kutubdia* Island. Groundwater analysis results are presented in ***Table 4.15.***

Table 4.15 Ground Water Analysis Results

SN	Parameter	Unit	Ground Water Quality				Standards ECR, 97
			GW1	GW2	GW3	GW4	
1	Temperature	°C	27.3	27.3	27.1	28.3	-
2	pH	-	7.04	7.09	6.74	8.23	6.5-8.5
3	TDS	Ppt	1.70	1.57	1.38	0.15	1
4	EC	mS/cm	3.43	5.16	2.75	0.31	-
5	Salinity	Ppt	1.55	2.41	1.20	0.10	-
6	Colour	Hazen	13	11	9	12	15
7	Odour	-	Odorless	Odorless	Odorless	Odorless	Odorless
8	Turbidity	NTU	2.1	1.5	0.94	1.7	10
9	Total Hardness (as $CaCO_3$)	mg/l	219	227	196	205	-
10	Alkalinity (HCO_3)	mg/l	213	241	216	228	-
11	Chloride (Cl)	mg/l	172	182	181	184	150-600
12	Sulphate	mg/l	233	210	217	215	400
13	Nitrate	mg/l	2.2	1.7	1.8	1.3	10
14	Fluoride (F)	mg/l	0.33	0.45	0.44	0.38	1.0
15	Sodium (Na)	mg/l	104	114	107	110	200
16	Potassium (K)	mg/l	1.56	1.23	1.33	1.22	12
17	Arsenic (As)	mg/l	0.01	0.01	Nil	0.02	0.05
18	Cadmium (Cd)	mg/l	<0.001	<0.001	<0.001	<0.001	0.005
19	Chromium (Cr)	mg/l	<0.01	<0.01	<0.01	<0.01	0.05
20	Mercury (Hg)	mg/l	<0.001	<0.001	<0.001	<0.001	0.001
21	Lead (Pb)	mg/l	<0.01	<0.01	<0.01	<0.01	0.05
22	Iron (Fe)	mg/l	0.8	0.78	0.84	0.91	0.3-1.0
23	Nickel (Ni)	mg/l	<0.01	<0.01	<0.01	<0.01	0.1
24	Manganese(Mn)	mg/l	<0.01	<0.01	<0.01	<0.01	0.1
25	Copper (Cu)	mg/l	0.02	0.01	0.02	0.02	1
26	Zinc (Zn)	mg/l	0.7	0.6	1.2	0.9	5
27	Boron (B)	mg/l	0.1	0.23	0.15	0.08	1.0
28	Fecal Coliform	n/100ml	0	0	0	0	0
29	Total Coliform	n/100ml	0	0	0	0	0

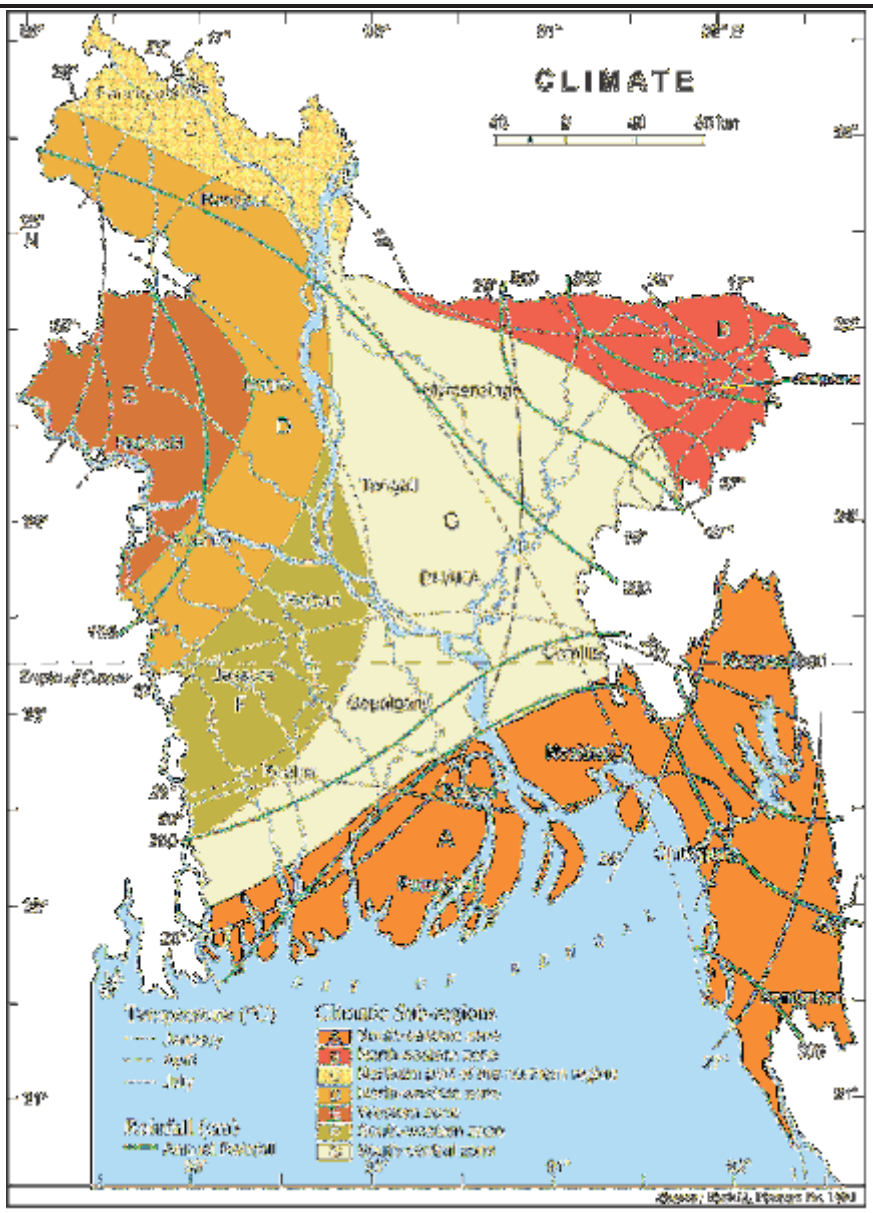
Source: Primary Monitoring, November 2016

4.12 METEOROLOGY

4.12.1 Climate

261. The *Kutubdia* Island falls under the South-eastern zone as per climatic sub-regions of Bangladesh (***Figure 4.33).*** From the climatic point of view, three distinct seasons can be recognised - the cool dry season from November through February, the pre-monsoon hot season from March through May, and the rainy monsoon season which lasts from June through September. The climatic data for the study area was obtained from the meteorological station located in *Kutubdia* and maintained by the Bangladesh Meteorological Department (BMD).

Figure 4.33 Climatic Sub-regions of Bangladesh



Source: Maps of Bangladesh
[https://mapofbangladesh.blogspot.in/2012/01/climate-climatic-sub-regions.html]

Temperature

262. The average minimum temperature in *Kutubdia* area is recorded during November to February and varies generally from 6.2°C to 13.4°C; while the maximum temperature of 39.5°C is observed in May. ***Table 4.16*** shows the yearly average maximum and minimum temperature at *Kutubdia* Station for the last 10 years (2000 – 2010).

Table 4.16 Climatic Data of the Kutubdia Station

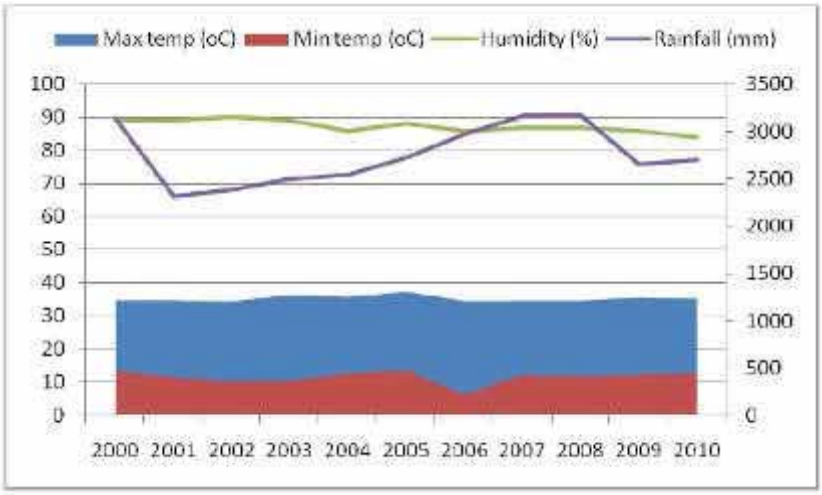
Year	Max Temp (°C)	Min Temp (°C)	Average Humidity (%)	Annual Rainfall (mm)	Average Wind Speed (m/s)
2000	34.8	13.2	89	3,138	1.4
2001	34.8	11.5	89	2,320	0.8
2002	34.5	10.2	90	2,389	0.9
2003	36.4	10.5	89	2,495	1.0
2004	35.8	12.5	86	2,541	1.2
2005	37.5	13.4	88	2,727	1.6
2006	34.6	6.2	86	2,967	1.5
2007	34.7	12.2	87	3,162	1.4
2008	34.7	11.7	87	3,171	1.3
2009	35.7	12.2	86	2,658	2.2
2010	35.3	12.7	84	2,702	2.1

Source: Bangladesh Meteorological Department, Kutubdia Station

Humidity

263. As seen from ***Table 4.16*** the average annual humidity in the region varied from 84% to 90% as depicted in the 10 years data (years 2001 to 2010) . In general, the relative humidity of the study area is lowest between January to April and from May there is a steady increase until November and then again the humidity starts dipping in December and this trend continues till March / April.

Figure 4.34 Graphical Representation - Temperature, Humidity & Rainfall at Kutubdia



Source: Bangladesh Meteorological Department, Kutubdia Station

Rainfall

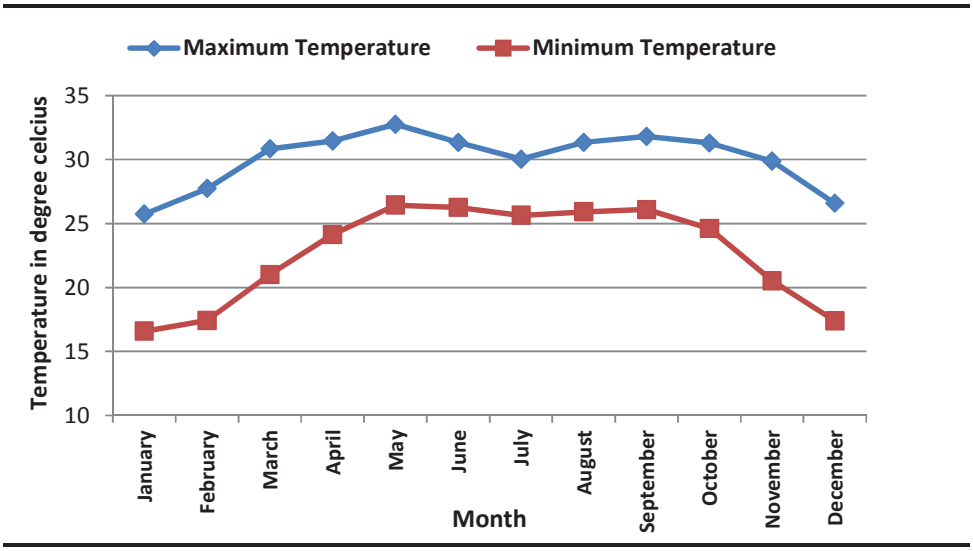
264. The maximum annual rainfall in this region, recorded during the last decade (2000-2010), is about 3,171 mm with about 80% of the total rainfall occurring during the monsoon period. The peak one day highest rainfall is 360 mm and has been recorded in June 2008. However, July is the highest rainfall recorded month in a year when the average monthly rainfall is 925.17 mm. Subsequently, the rainfall gradually decreases as dry spell in a month increases. An insignificant amount of rainfall has also been recorded in winter.

265. Monthly variation in meteorology was analyzed for the year 2015 from the data collected from the Meteorological Station at *Kutubdia* Island. The details are presented below.

Temperature

266. Monthly variation in maximum temperature fluctuated from 25.73^{0}C in January to 32.75 ^{0}C in May. Minimum temperature fluctuates from 16.59 ^{0}C in January and 26.44 ^{0}C in May. Monthly variation in maximum and minimum temperature levels are presented in ***Figure 4.35.***

Figure 4.35 ***Monthly Variation of Maximum and Minimum Temperature- Kutubdia (2015)***

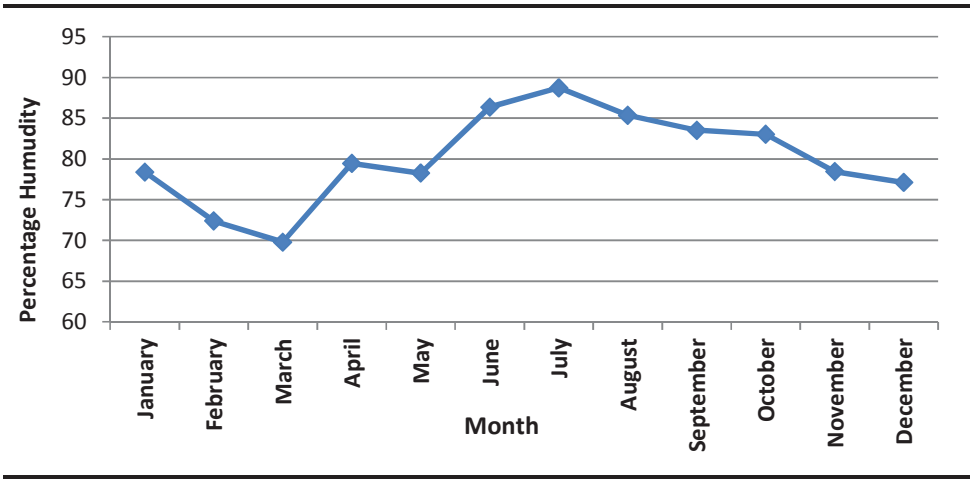


Source: Bangladesh Meteorological Department, Kutubdia Station

Humidity

267. Monthly average data of percentage humidity varied between 69.78% in March to 88.73% in July. ***Figure 4.36*** shows monthly variation in humidity.

Figure 4.36 ***Monthly Variations in Humidity Levels- Kutubdia (2015)***

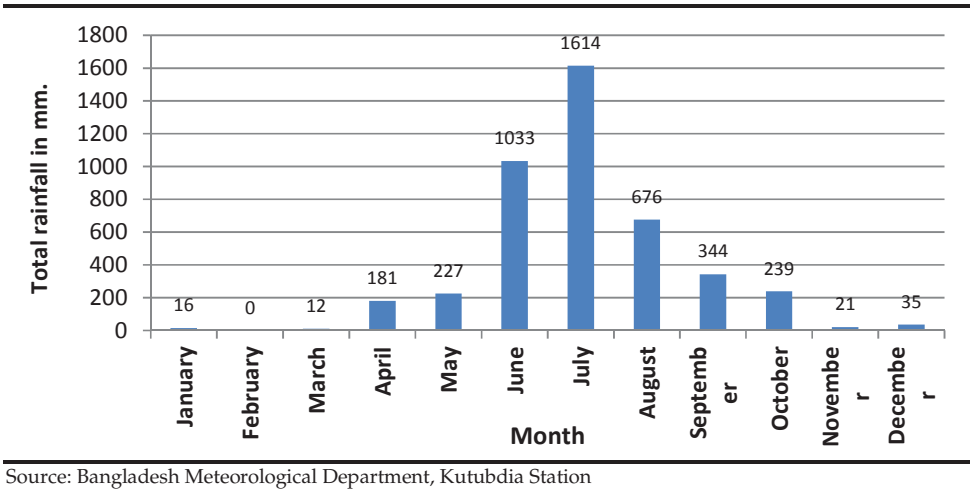


Source: Bangladesh Meteorological Department, Kutubdia Station

Rainfall

268. Rainfall primarily occurred from June to September (about 83% of the total rainfall) due to the influence of south-west monsoon. Moderate rainfall was also received during the months of April, May and October (181-239 mm.). November to March received very little rainfall. Monthly variation of total rainfall data is presented in ***Figure 4.37.***

Figure 4.37 *Monthly Total Rainfall- Kutubdia (2015)*

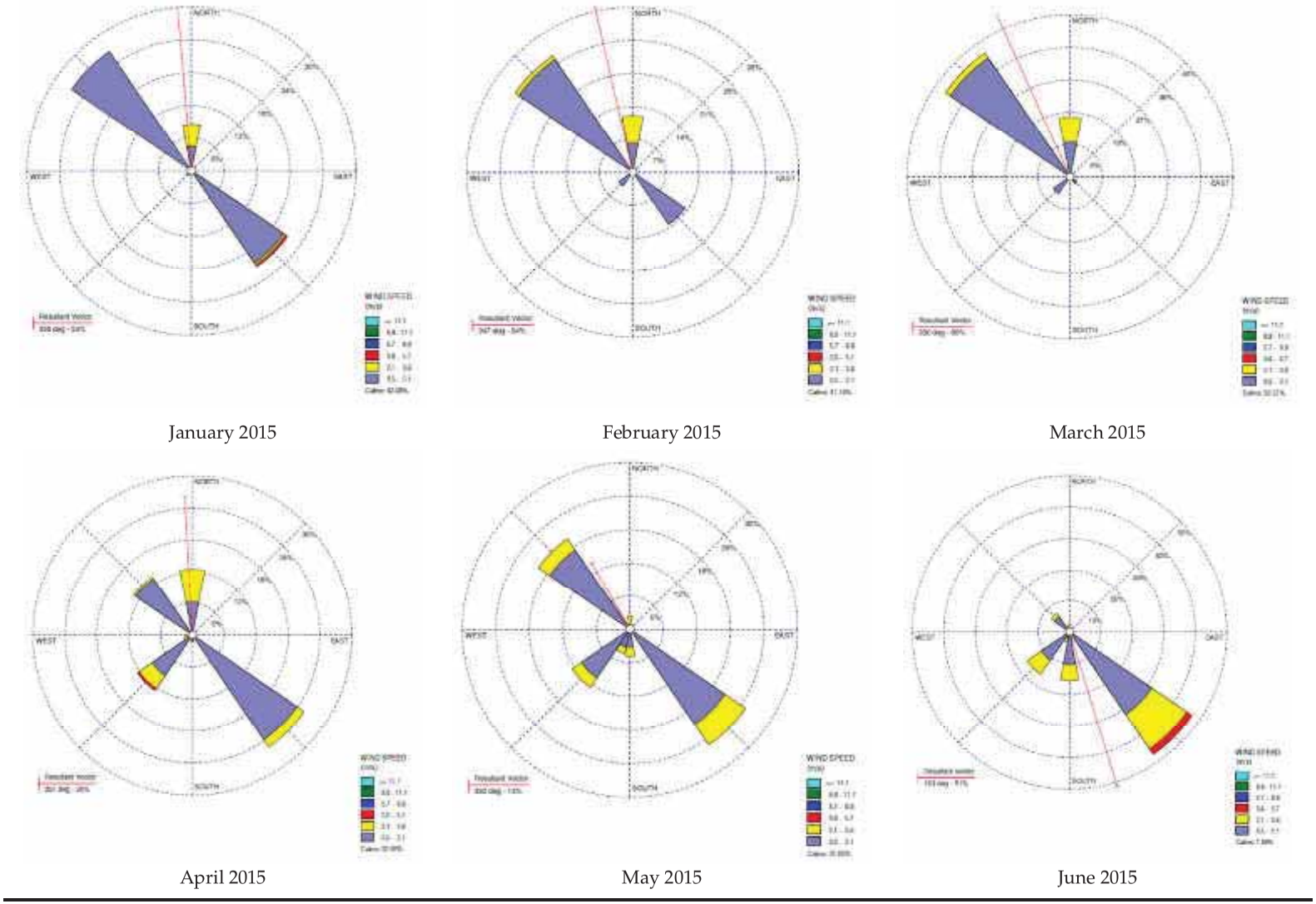


Source: Bangladesh Meteorological Department, Kutubdia Station

Wind Speed and Wind Direction

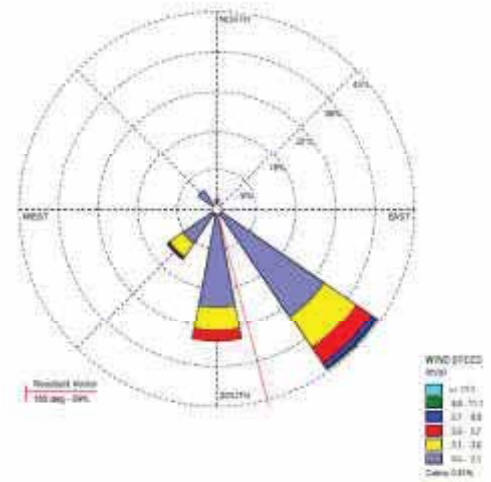
269. Wind direction was recorded from south-southeast during June-September. Average monthly wind speeds were also higher during June –September with the maximum wind speed of 1.68m/s recorded during the month of June. Wind direction was recorded from north-northwest for the rest of the months. Lowest wind speed was recorded during December (0.42 m/s). Monthly wind roses for 2015 are shown in ***Figure 4.38.***

Figure 4.38 Monthly Wind Rose – Kutubdia Station (2015)

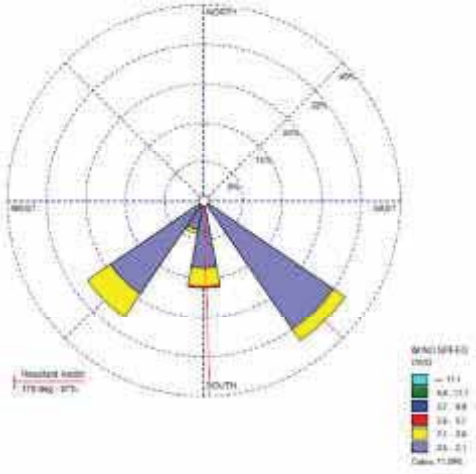


January 2015 | February 2015 | March 2015

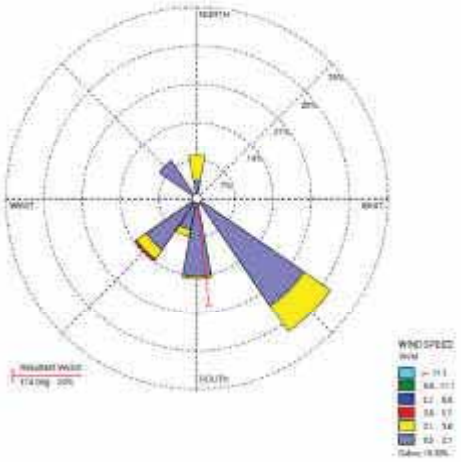
April 2015 | May 2015 | June 2015



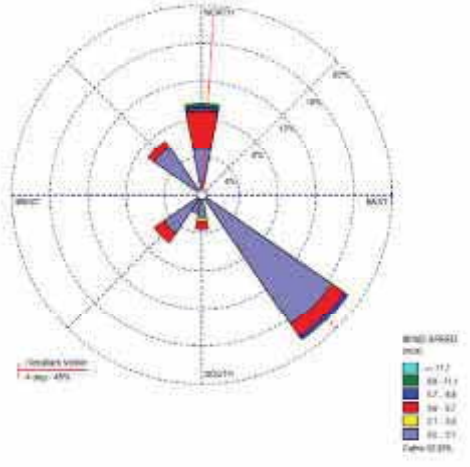
July 2015



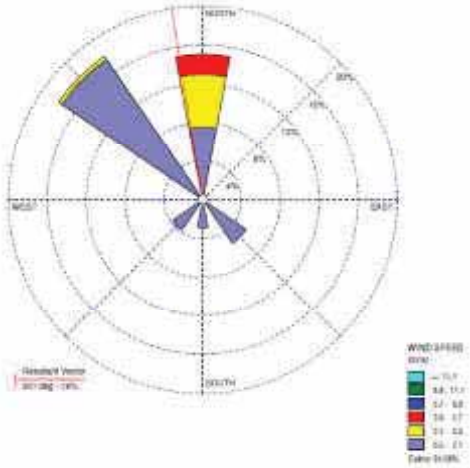
August 2015



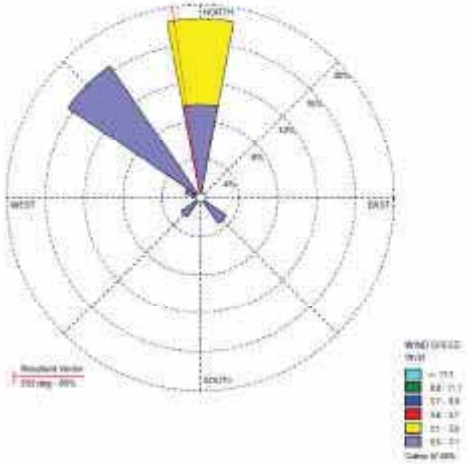
September 2015



October 2015



November 2015



December 2015

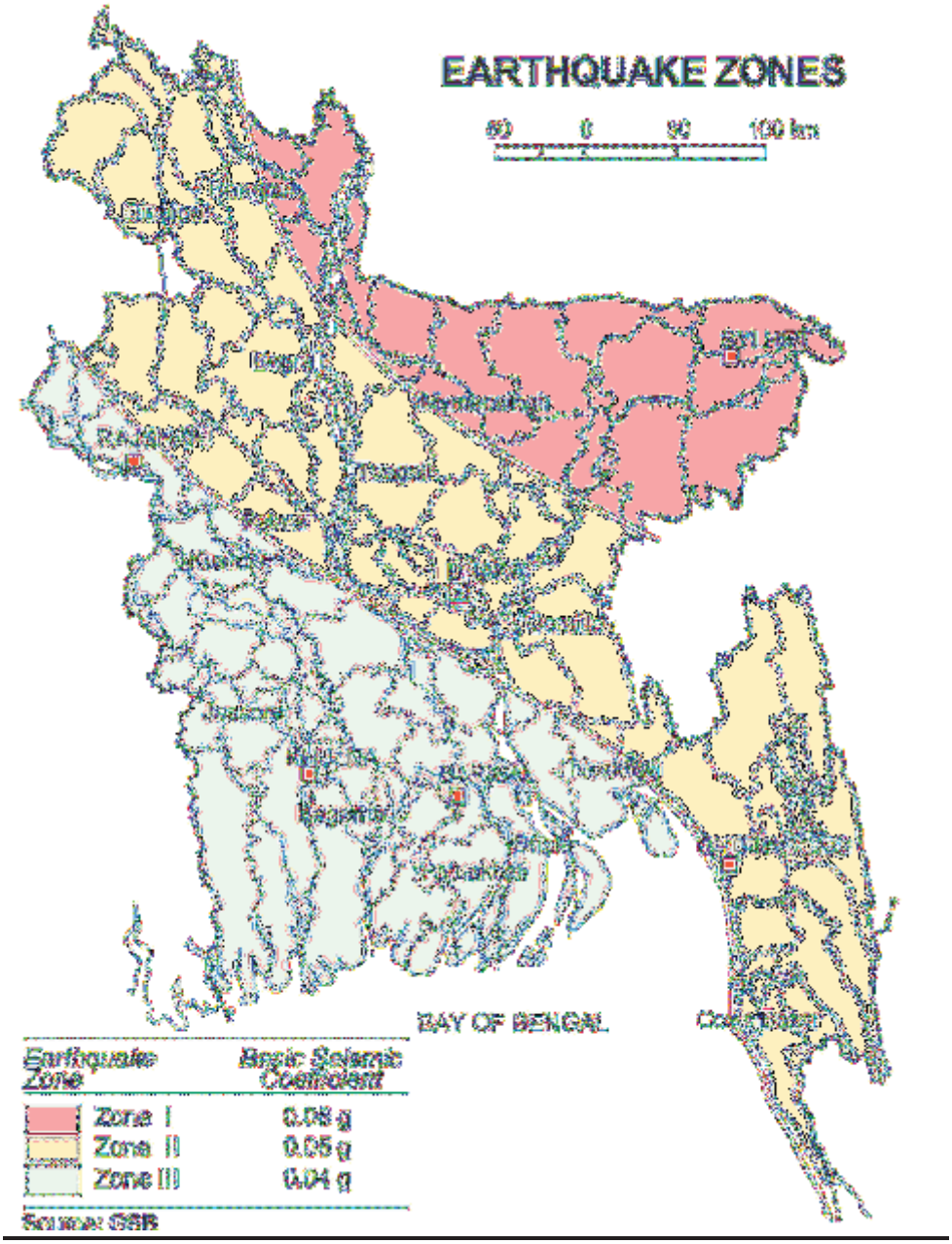
Source: Bangladesh Meteorological Department, Kutubdia Station

4.13 NATURAL HAZARDS

4.13.1 Earthquakes

270. As per the Seismic Zoning Map of Bangladesh, the country is divided into four seismic zones (***Figure 4.39***). The Project site is located in Zone -II, (same as *Chittagong*), where building design of moderate levels will be necessary.

Figure 4.39 Earthquake Zone Map of Bangladesh



Source: Geological Survey of Bangladesh
Maps of Bangladesh
[https://mapofbangladesh.blogspot.in/2011/10/bangladesh-seismicearthquake-zones.html]

4.13.2 Cyclones

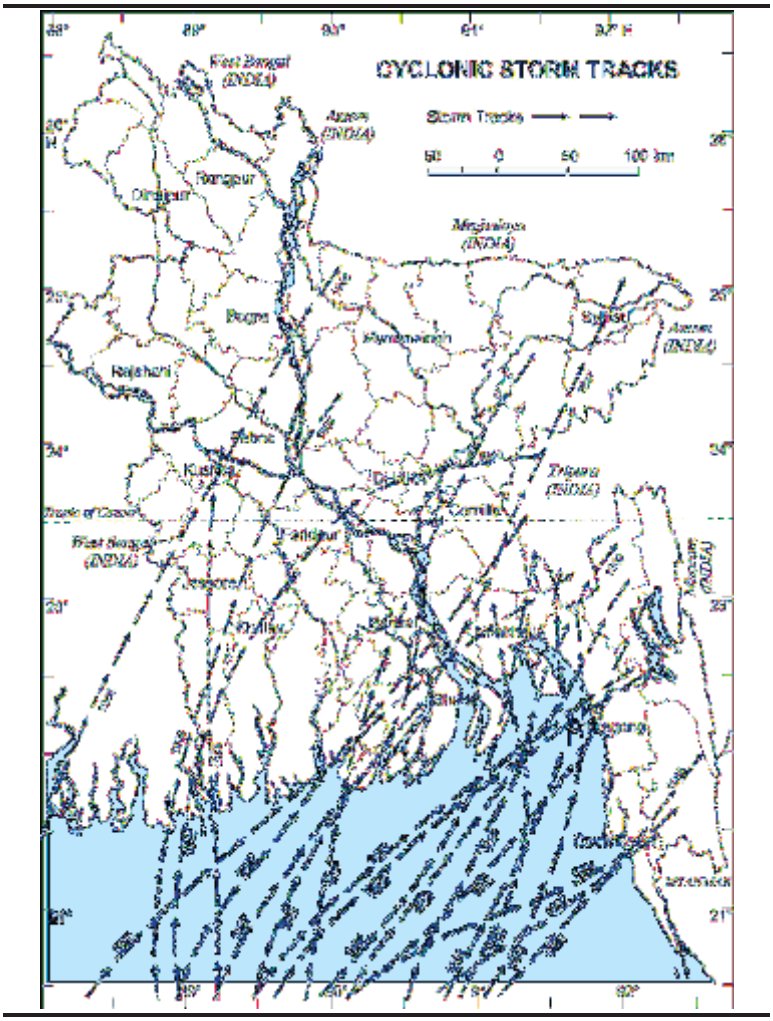
271. Bangladesh is one of the most cyclone prone areas on the earth. The South-western coastal zone (*Chittagong- Cox's Bazar*) is the most affected and is commonly considered as the most important cyclone prone zone of Bangladesh.

272. Devastating cyclones hit the coastal zones almost every year and are usually accompanied by high-speed winds, sometimes reaching 250 km/hr or more and with 3 m to 10m high waves, causing extensive damage to life, property and livestock. These cyclones usually occur in two seasons, April-May and October-November – i.e. before and after the monsoon season.

273. The *Kutubdia* Island is also adversely affected by cyclone almost every year. The worst ever cyclonic event was experienced on 29th April 1991, when a severe cyclonic storm accompanied with a core of hurricane winds hit the *Chittagong* region. Wind speeds reached up to 225 km/hr or more and with surge height of 6 m to 8 m. This great cyclone of 1991 caused extensive damage to life, property and livestock on this island.

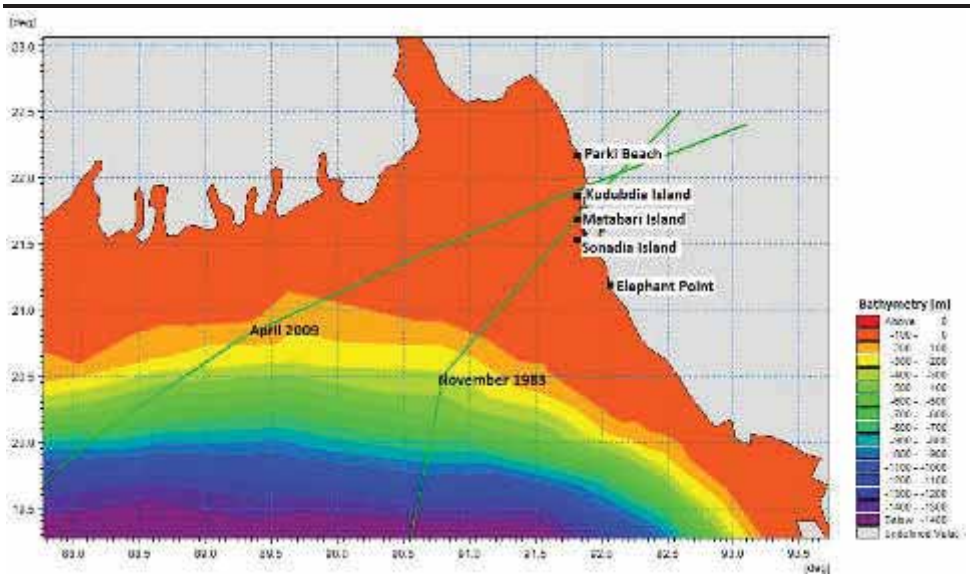
274. Key cyclonic storm tracks in Bangladesh has been mapped in ***Figure 4.40*** and severe cyclone track which have made an appearance very close to the proposed site at *Kutubdia* is provided in ***Figure 4.41***.

Figure 4.40 Cyclonic Storm Tracks in Bangladesh



Source: Banglapedia [http://en.banglapedia.org/index.php?title=Cyclone]

Figure 4.41 Severe Cyclonic Storm Track in the vicinity of Kutubdia



Source: Reliance Power: DHI, 2016 - Desktop Study for Site Screening in Chittagong & Moheshkhali Region

275. Key cyclonic storm tracks in Bangladesh have been mapped in ***Figure 4.40*** and list of major cyclones recorded in Chittagong-Cox's Bazar area in last 30 years is presented in ***Box 4.1***.

Box 4.1 30 years cyclone records of Chittagong-Cox Bazaar Area

- 24–25 May 1985: A severe cyclone hit *Chittagong*, *Cox's Bazar*, *Noakhali* and coastal islands (*Sandwip*, *Hatiya*, *& Urirchar*). Maximum wind speed at *Chittagong* was 154 km/h, at *Sandwip* was 140 km/h, at *Cox's Bazar* was 100 km/h. The storm surge reached a height of 3.0-4.6 m. Casualty: 11,069 people, 135,033 cattle. Damages: 94,379 houses and 74 km of road, and embankments destroyed.
- 29–30 April 1991: The diameter of the storm was close to 600 km. The maximum wind speed (observed at *Sandwip*) reached 225 km/h. At other places, the maximum wind speed was reported as follows: *Chittagong* 160 km/h, *Khepupara* (*Kalapara*) 180 km/h, *Kutubdia* 180 km/h, *Cox's Bazar* 185 km/h, and *Bhola* 178 km/h. The storm made landfall near the coast north of *Chittagong* port during the night of the 29th April. The maximum storm surge height reached about 5 to 8 m. Casualty: 150,000 people, 70,000 cattle. Damages: loss of property was estimated at about Tk 60 billion.
- 29 April-3 May 1994: A severe cyclonic storm hit the coastal islands near *Cox's Bazar*. Maximum wind speed reached 210 km/h. Casualty: 400 people, 8,000 cattle.
- 21–25 November 1995: A severe cyclonic storm hit the coastal islands near *Cox's Bazar*. The maximum wind speed was up to 210 km/h. Casualty: 650 people, 17,000 cattle.
- 16–19 May 1997: May 1997 Bangladesh cyclone hit the coastal islands and chars near *Chittagong*, *Cox's Bazar*, *Noakhali* and *Bhola* Districts. The maximum wind speed was 225 km/hour, and the storm surge reached 3.05 metres. Casualty: 126 people.
- 25–27 September 1997: A severe cyclonic storm hit coastal islands near *Chittagong*, *Cox's Bazar*, *Noakhali* and *Bhola*. It had wind speeds of up to 150 km/hour, and a storm surge of 1.83 to 3.05 metres.
- 16–20 May 1998: A severe cyclonic storm with wind speed of 150 km/hour struck coastal islands near *Chittagong*, *Cox's Bazar*, and *Noakhali*. The storm surge was from 1.83 to 2.44 metres.
- 14-15 May 2007: Cyclone Akash struck about 115 km south of *Chittagong* with wind speeds up to 120 km/hour. 14 people were killed and damages amounted to US$982 million.
- 15 November 2007: Cyclone Sidr with wind speeds up to 260 km/hour, made landfall on southern Bangladesh, causing over 3,500 deaths and severe damage.
- 16-17 May 2013: Cyclone Viyaru, formerly known as Cyclonic Storm Mahasen, hit near *Chittagong* with wind speeds up to 85 km/hour. 17 people died, and nearly 1.3 million were affected across the country. Losses to crops exceeded US$5.14 million.
- 29 July 2015: Cyclone Komen with wind speeds up to 75 km/hour, hit near *Chittagong*. About 510,000 houses in the country were damaged or destroyed, and many residents lost their source of income as 667,221 acres (270,000 ha) of crop fields were damaged. The floods killed 132 people, of which at least 39 were directly related to Komen.
- 21 May 2016: Cyclone Roanu made landfall near *Chittagong* killing 26 people in Bangladesh. It had wind speeds up to 100 km/hour. Around 40,000 homesteads and business houses were damaged. Food storage, seasonal crops were damaged. Livestock, including fish and shrimp firms were swept away.

Source: http://teacher.buet.ac.bd/akmsaifulislam/reports/SIDR_report.pdf; http://www.adpc.net/casita/case_studies/coastal%20hazard%20assessment/modelling%20cyclone%20hazard%20in%20bangladesh/background_information_on_the_storm_surge_modelling.pdf https://en.wikipedia.org/wiki/List_of_Bangladesh_tropical_cyclones

4.13.3 Storm Surge

276. Storm surges are partly caused by pressure differences within a cyclonic storm and partly by high winds acting directly on the water. Their periods range from a few minutes to a few days, depending on atmospheric forces in the weather system

277. *Kutubdia* is affected by cyclone and storm surge almost every year. The cyclone affected areas of Bangladesh with corresponding surge heights have been indicated in ***Figure 4.42.*** From this figure, it can be observed that the *Kutubdia* Island is falling in a high risk area (where surge heights are above 1 m)

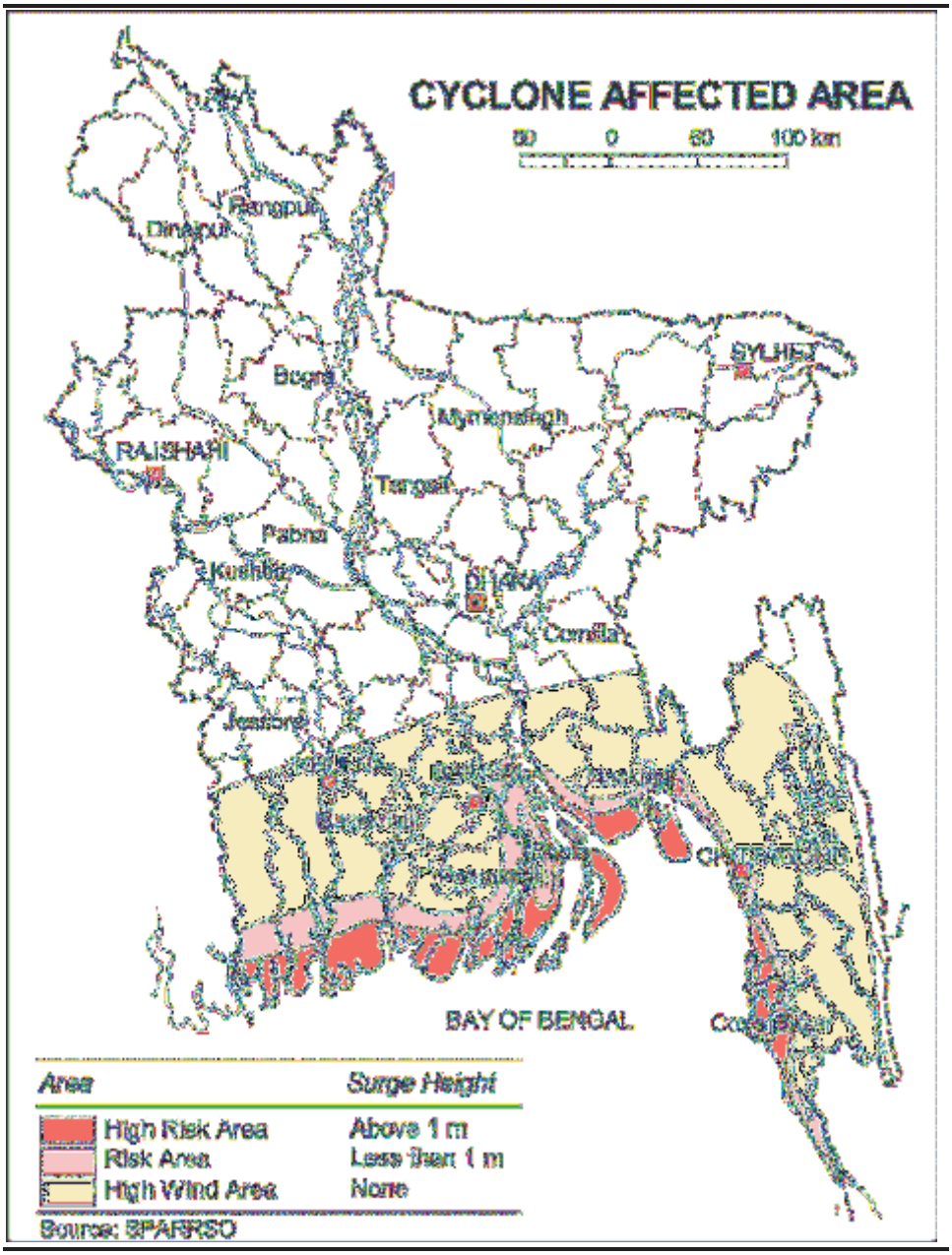
4.13.4 Inundation

278. There are six unions in the *Kutubdia Upazila*. After any cyclonic event and storm surge on the Island, the level of inundation is found to vary amongst different unions. This aspect has been specifically studied by Ahmed et al (2012)[1]. The study brought out the fact that the southern part of the island (*Boroghop* and *Ali Akbar Deil* Unions) are most affected by inundation (3m to 4m), whereas the northern Unions are relatively at lesser risk, except for the coastal stretches.

279. A map showing inundation levels in *Kutubdia* Island is presented in ***Figure 4.43.*** The map also shows the available cyclone shelters.

[1] Musfique Ahmed and Rifat Anwar, 2012. Risk Assessment of Storm Surge of Kutubdia Island Using GIS; IACSIT Coimbatore Conferences IPCSIT vol. 28 (2012) © (2012) IACSIT Press, Singapore

Figure 4.42 Cyclone Affected Area Map of Bangladesh



Source: Bangladesh Space Research and Remote Sensing Organisation (SPARRSO); Maps of Bangladesh [https://mapofbangladesh.blogspot.in/2011/10/cyclone-affected-area-bangladesh.html]

Figure 4.43 Inundation Map of **Kutubdia** *Island*

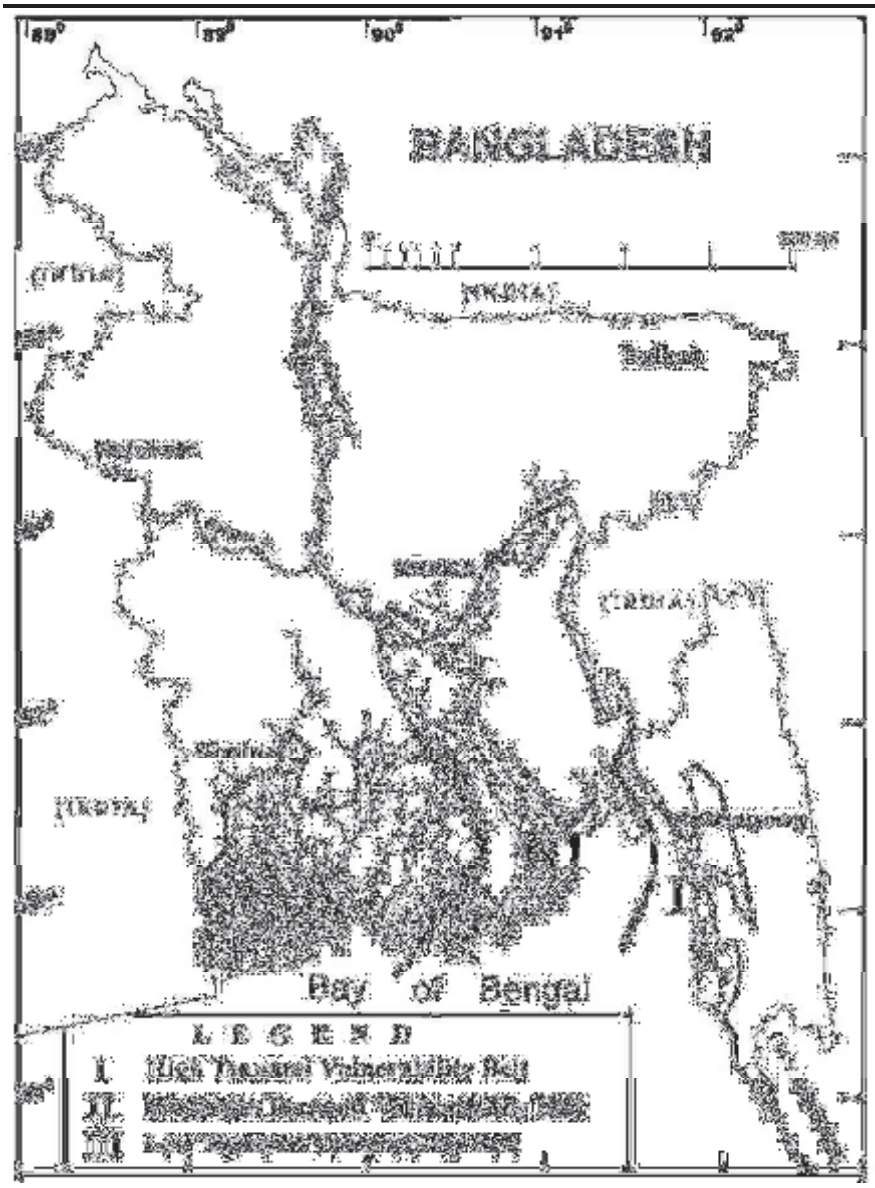
Source: Risk Assessment of Storm Surge of Kutubdia Island Using GIS; 2012 IACSIT Coimbatore Conferences IPCSIT vol. 28 (2012) © (2012) IACSIT Press, Singapore

4.13.5 Tsunami

280. Considering the state of tsunami vulnerability and potential seismic sources, the coastal belt is classified into three tsunami genic zones (Uddin, 2005[1]) as shown in ***Figure 4.44.*** The *Cox's Bazar* coast falls within Zone-I, which is reportedly most vulnerable.

[1] Uddin, A.M. K. 2005. Tsunami: A Status Paper reflecting Bangladesh coast's exposure and vulnerability, Program Development Office for Integrated Coastal Zone Management Plan (PDO-ICZMP)

Figure 4.44 Tsunami Vulnerability Map



[Source: Uddin, A.M. K. 2005. Tsunami: A Status Paper reflecting Bangladesh coast's exposure and vulnerability, Program Development Office for Integrated Coastal Zone Management Plan (PDO-ICZMP)]

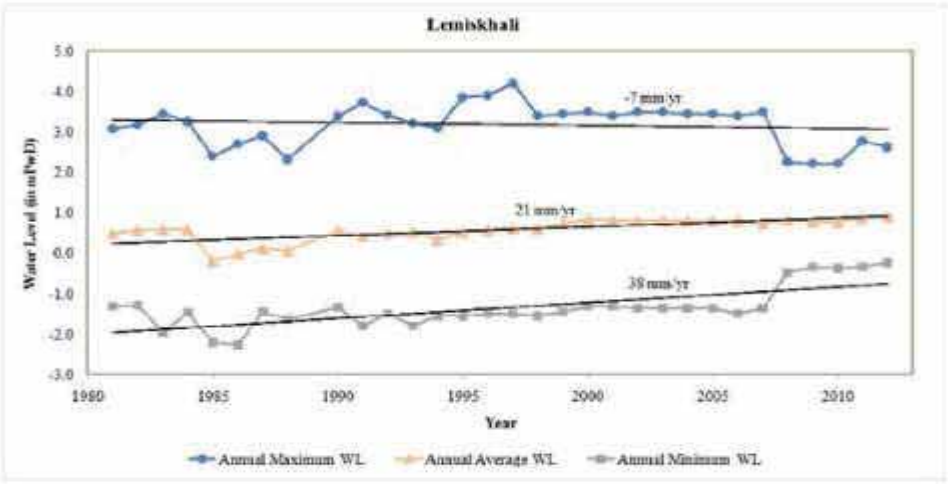
4.13.6 Climate Vulnerability

281. Coastal zone of Bangladesh is the vulnerable to climate change because of its location, flat topography, high population density, high levels of poverty, and reliance of many livelihoods on climate sensitive sectors particularly, agriculture, fisheries and water resources[1]. The average elevation of the southwest coastal zone ranges from 1 to 2 m. Low elevation; active delta and dynamic morphology of the Bangladesh coastal area play a significant part in its vulnerability to sea level change.

[1] Assessment of Sea Level Rise on Bangladesh Coast through Trend Analysis. 2016. Climate Change Cell Department of Environment Ministry of Environment and Forests

282. The "Climate Change Cell" of the Department of Environment (DoE), initiated a study titled "*Assessment of Sea Level Rise and Vulnerability in the Coastal Zone of Bangladesh through Trend Analysis*". The study revealed highest trend of sea level rise (SLR) in the *Chittagong* and *Cox's Bazar* region of Bangladesh coast compared to other two coastal sub-zone of the country (viz. *Ganga* and *Meghna* Subzones). Analysis of tidal water for 30 years (1981-2010) shows trends of water level in the *Chittagong* coastal plain areas is 11-21 mm/year. SLR at the *Lemshikhali* Substation (at the eastern bank of *Kutubdia* Island), closest to the proposed project site was found to be 21 mm/year based on trend analysis of 30 years data (1981-2012). SLR at the *Lemshikhali* substation is presented at the figure below.

Figure 4.45 Observed trend of Tidal Water Level at Lemshikhali over last 30 years



Source: Assessment of Sea Level Rise on Bangladesh Coast through Trend Analysis. 2016. Climate Change Cell Department of Environment Ministry of Environment and Forests

283. Sea level rise affects the coastal zone and its geometry in a number of ways including inundation, erosion and salt water intrusion into the water table etc. Climate Change vulnerability and climate resilient adaptation methods have been presented in the table below

Table 4.17 Climate Risk and Adaptation Strategy in Bangladesh

Sectors	Sector Impact & Vulnerability	Adaptation Options
Agriculture/ Food Security	Higher temperature, saline water intrusion, and changing monsoon rainfall patterns impacting crop production	Development and dissemination of climate-resilient crop varieties and cropping systems for water-logging and salinity-affected coastal areas
		Cultivation of vegetable crops in floating gardens and raised beds
	Prolonged drought may increase the need for inputs like irrigation and fertilizers	Research and dissemination of drought-tolerant crop varieties; better storage mechanisms, and crop diversification.
	Temperature increase would have severe impact on food production	Improve knowledge and agricultural extension services
		Sugar crops and other high value crops (HVC) improvement for adverse climate condition through biotechnology
		Agronomic manipulations such as shifting planting dates, using short duration crop cultivation

Sectors	Sector Impact & Vulnerability	Adaptation Options
Coastal Zones and Marine Ecosystems	Frequency and intensity of tropical cyclones and storm surge are increasing	Construction of Multi-purpose Cyclone Shelter Centers for people and of raised platforms
	Bay of Bengal more rough, making it difficult for fishermen and small craft to put to sea	Livelihood support and diversification to the coastal community
		Flood protection coastal defence structure
		Integrated project with promoting micro-finance in the vulnerable coastal areas; involvement of private sectors in the coastal areas through promoting micro-enterprise development
Water Resource Management	Too much water in wet season, too little water in dry season; untimely water and saline water are all experienced in the country	Modernization of existing irrigation schemes and demand management aimed at optimizing physical and economic efficiency in use of water resources and recycled water in water-stressed areas
	Frequency of intense rainfall in the country increasing, causing severe floods, water logging, landslides, and mud flows	Protection of groundwater resources and water catchment areas
	Sea Level Rise exacerbating drainage blockages & water logging; causes salt water intrusion	Rainwater harvesting, creation of water reservoir, low cost filter in salinity affected areas
	Shortages of fresh water for drinking becoming acute	Increasing surface water storage and restoring natural water courses
Health, Migration and Social Protection	Water, air, and vector-borne diseases and outbreaks of cholera, diarrhoea, and dengue increasing	Better irrigation water management to reduce mosquito breeding sites; improved diseases/vector surveillance and monitoring; education, training & awareness campaign on public health issues
	Children, women, elderly, and poor people suffering more from heat and cold waves	Improved housing and living condition in climate vulnerable zones
	People losing livelihood and getting displaced due to cyclone and storm surge, sea level rise, river erosion, etc. 'Climate migrants'	Livelihood protection in ecologically fragile areas and protection of vulnerable socio-economic groups
		Monitoring of internal and external migration and providing support for rehabilitation
		Improving the education and work skills of migrants and financing of resettlement costs and rehabilitation
Multi-sector		Mainstreaming climate change in national, sector and spatial development program
		Institutional strengthening and building of human resource capacity
		Improved capacity of Ministry of Environment and Forests (MOEF) to manage and coordinate investments in and knowledge on climate-resilient initiative

Source: Strategic Program for Climate Resilience: Bangladesh, 2010

284. Sea level rise near the proposed Project area by analysis of 30 years trend was found to be approximately 21 mm/year. Considering the Project life of 25 years (including construction period) a sea level rise of 0.5 m is expected in the area. However, as no land based facility is being planned near shore, significant impact to the proposed Project due to sea level rise is not anticipated.

4.14 AIR ENVIRONMENT

285. There are no air-polluting industries on the *Kutubdia* Island. A few brick kilns and a small diesel operated power plant of the Bangladesh Power Development Board is the prime source of air pollution on this island. The vehicles operating on the internal road are mostly battery operated rickshaw. Only a few fuel operated vehicles are found plying on the roads of the island. The only other source of air pollution in the study area includes domestic fuel combustion at the settlements.

4.14.1 *Methodology of Air Quality Monitoring*

286. Air monitoring was conducted at six locations within *Kutubdia* Island during post monsoon season (October-November), 2016. Parameters monitored were PM_{10}, $PM_{2.5}$, SO_2, NOx and CO. All the parameters were monitored for 24 hours for six weeks taking one sample each week. CO was monitored for 8 hours for a day at each monitoring location.

Selection of sampling locations

287. The baseline status of the ambient air quality has been established through a scientifically designed ambient air quality monitoring network. The ambient air quality monitoring locations ***(Figure 4.2)*** were based on the following aspects covered in field survey plan developed prior to the field work:
- Meteorological conditions of the area based on information of BMD observatory at *Kutubdia*; and
- Location of sensitive receptors such as major settlements;

288. The particulate and gaseous samples collected during the monitoring have been analysed as per the procedures specified in ***Table 4.18.*** Details of the monitoring locations are presented in Table 4.19 and the air monitoring locations are shown in ***Figure 4.2.*** Photographs of ambient air monitoring are presented in ***Figure 4.46***.

Table 4.18 Methodology for Analysis of Ambient Air Quality

SN	Parameter	Analysis Procedure
1.	PM_{10}	Gravimetric method
2.	$PM_{2.5}$	Gravimetric method
3.	SO_2	Colorimetric at 560nm using spectrophotometer (West-Gaeke) method
4.	NO_x	Colorimetric at 540nm using spectrophotometer (Jacob & Hochheiser) method
6.	CO	NDIR method

Table 4.19 Air Monitoring Locations

SN	Sampling location	Code	Monitoring date	Geographic location
1	Light House, Ali Fakir Deil	AQ1	02.10.16, 11.10.16, 16.10.16, 23.10.16, 29.10.16, 04.11.16	21°51'53.20"N 91°50'32.40"E
2	Pachar Para, Dakshin Dhurung	AQ2	04.10.16, 11.10.16, 16.10.16, 23.10.16, 29.10.16, 04.11.16	21°52'1.20"N 91°51'21.90"E

S N	Sampling location	Code	Monitoring date	Geographic location
3	Kata Para, Lemshikhali	AQ3	05.10.16, 12.10.16, 17.10.16, 25.10.16, 30.10.16, 05.11.16	21°52'40.70"N 91°53'33.20"E
4	Ismail Haji Para, Kaiyarbil	AQ4	07.10.16, 12.10.16, 17.10.16, 25.10.16, 30.10.16, 05.11.16	21°51'1.30"N 91°51'17.10"E
5	Uttar Musjit Para, Uttar Dhurung	AQ5	08.10.16, 14.10.16, 21.10.16, 27.10.16, 01.11.16, 06.11.16	21°53'30.00"N 91°51'30.20"E
6	Uttar Mogdil Para, Boroghop	AQ6	10.10.16, 14.10.16, 21.10.16, 27.10.16, 01.11.16, 06.11.16	21°48'40.90"N 91°51'14.70"E

Figure 4.46 Photographs of Ambient Air Quality Monitoring

AQ 1(Light House, Ali Fakir Deil)

AQ2 (Pachar Para, Dakshin Dhurung)

AQ3 (Kata Para, Lemshikhali)

AQ4 (Ismail Haji Para, Kaiyarbil)

AQ5 (Uttar Masjid Para, Uttar Dhurung)

AQ6 (Uttar Mogdil Para, Boroghop)

Particulate Matter ($PM_{2.5}$ & PM_{10})

289. The average and 98 percentile concentrations of $PM_{2.5}$ in *Kutubdia* Island varied from 21.55 to 43.67 µg/m³ and 26.09 to 47.58 µg/m³ respectively. The average and 98 percentile concentrations of PM_{10} in *Kutubdia* Island varied from 57.67 to 76.68 µg/m³ and 65.10 to 84.72 µg/m³ respectively. Station wise average PM concentration is presented in ***Figure 4.47***. The comparison of the results with the WHO guideline values for PM_{10} and $PM_{2.5}$, shows the average and 98 percentile values for PM_{10} and $PM_{2.5}$ were exceeding the guideline values.

Oxides of Nitrogen (NOx)

290. The average and 98 percentile concentrations of NOx in Kutubdia Island varied from 13.33 to 28.28 µg/m³ and 15.61 to 32.13 µg/m³ respectively. The NOx concentrations were not exceeding the NAAQS, for all the locations. Location wise average NOx concentrations are presented in ***Figure 4.48.*** The average and 98 percentile NOx concentrations were found to be in compliance to the WHO guideline values for NOx.

Sulphur Dioxide (SO_2)

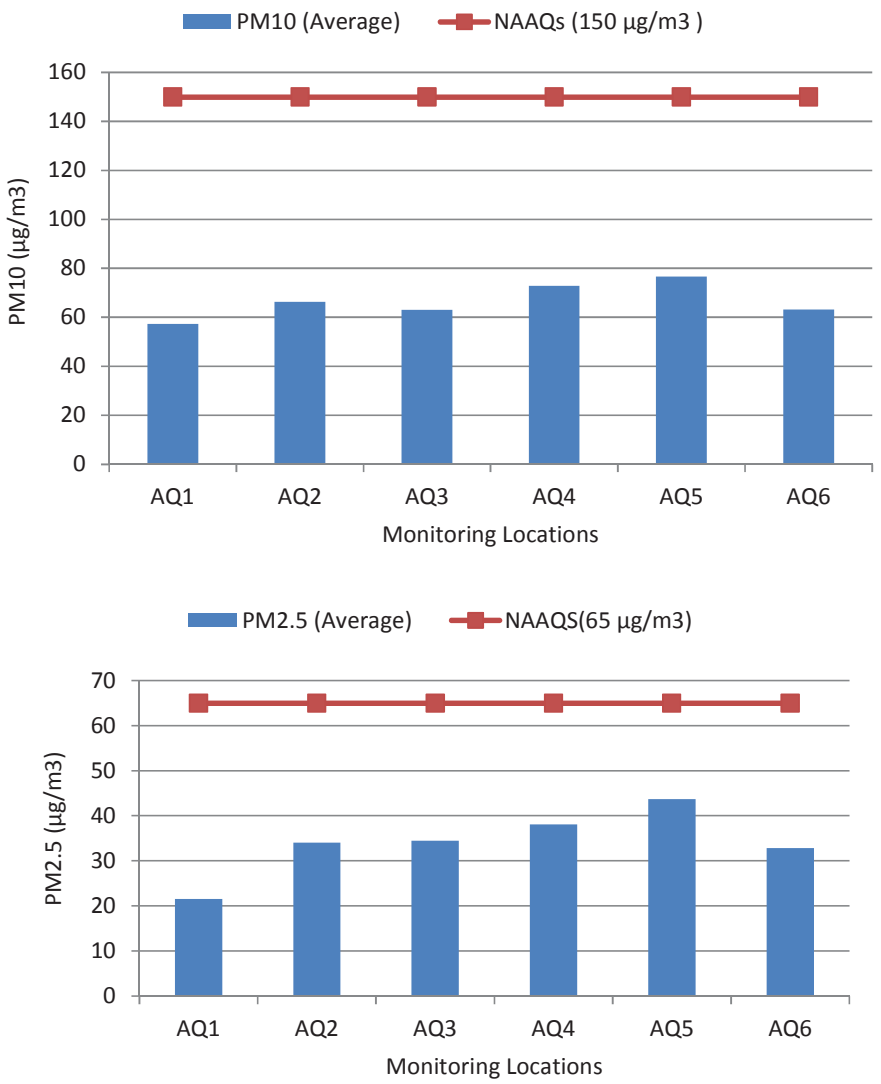
291. The average and 98 percentile concentrations of SO_2 at the monitoring locations varied from 3.64 to 5.12 µg/m³ and 4.19 to 5.71 µg/m³ respectively. The SO_2 concentrations were in compliance to the NAAQS for all the locations. The average and 98 percentile SO_2 concentrations were found to be in compliance to the WHO guideline values for SO_2. Station wise average SOx concentration is presented in ***Figure 4.49***.

Carbon Monoxide (CO)

292. Concentrations of CO at the sampling locations varied from 0.57 to 0.85 ppm which is lower that the Bangladesh National Standard of 10,000 µg/m³ or 8.73 ppm.

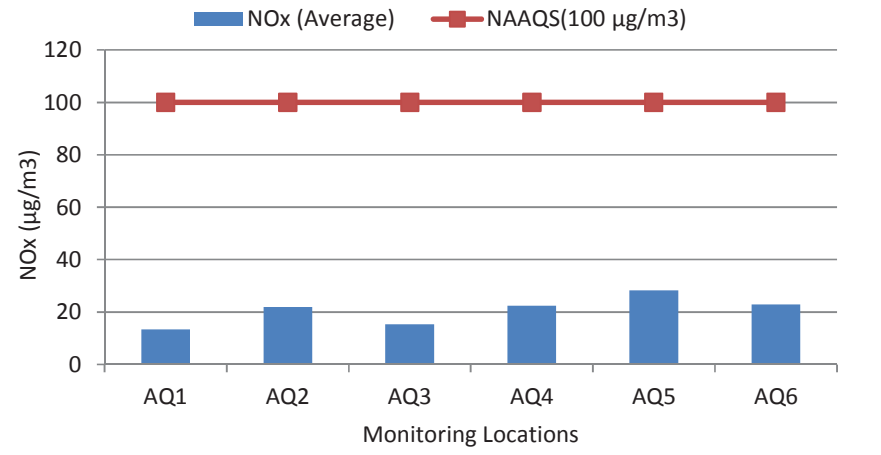
293. Summary of ambient air quality results are presented in ***Table 4.20.*** Detailed results are provided in **Annex 4**

Figure 4.47 Station wise Observed Concentrations of PM $_{2.5}$ & PM$_{10}$ in Kutubdia Island



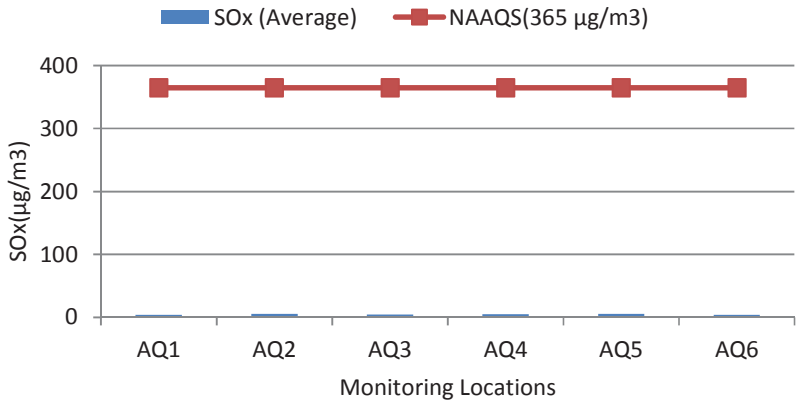
Source: Primary Monitoring, October- November 2016

Figure 4.48 Location wise Observed Concentrations of NOx in Kutubdia Island



Source: Primary Monitoring, October- November 2016

Figure 4.49 Location wise Observed Concentrations of SO_2 in Kutubdia Island



Source: Primary Monitoring, October- November 2016

Table 4.20 Summary of Ambient Air Quality Results-Kutubdia Island

Location	Value Description	Concentration (µg/m³)				CO (ppm)*
		PM_{10}	$PM_{2.5}$	SOx	NOx	
AQ 1(Light House, Ali Fakir Deil)	Maximum	65.62	26.41	4.2	15.72	0.63
	Minimum	52.19	18.67	3.02	10.42	
	Average	57.37	21.55	3.64	13.33	
	98 percentile	65.10	26.09	4.19	15.61	
AQ2 (Pachar Para, Dakshin Dhurung)	Maximum	76.31	39.42	5.97	24.76	0.57
	Minimum	60.12	30.55	4.9	18.25	
	Average	66.35	34.00	5.34	21.86	
	98 percentile	75.60	39.12	5.92	24.63	
AQ3 (Kata Para, Lemshikhali)	Maximum	70.54	39.66	4.53	18.41	0.68
	Minimum	57.34	28.35	3.26	12.53	
	Average	63.06	34.53	4.13	15.21	
	98 percentile	70.03	39.45	4.51	18.21	
AQ4 (Ismail Haji Para, Kaiyarbil)	Maximum	82.5	42.13	5.61	25.51	0.82
	Minimum	67.65	32.43	4.01	17.34	
	Average	72.77	38.07	4.83	22.41	
	98 percentile	81.67	42.01	5.57	25.49	
AQ5 (Uttar Masjid Para, Uttar Dhurung)	Maximum	85.43	47.71	5.75	32.34	0.85
	Minimum	70.45	39.54	4.67	23.56	
	Average	76.68	43.67	5.12	28.28	
	98 percentile	84.72	47.58	5.71	32.13	
AQ6 (Uttar Mogdil Para, Boroghop)	Maximum	68.34	35.76	4.24	26.32	0.67
	Minimum	56.74	28.43	3.11	18.54	
	Average	63.24	32.85	3.72	22.88	
	98 percentile	68.24	35.72	4.23	26.14	
National Standard**		**150**	**65**	**365**	**100**	**10,000 µg/m³ i.e. 9.0 ppm**
WHO Guidelines***		**50**	**15**	**80**	**100**	

Source: Primary Monitoring, October- November 2016;
* CO was analyzed once at the monitoring locations;
**The Bangladesh National Ambient Air Quality Standards have been taken from the Environmental Conservation Rules, 1997 which was amended on 19th July 2005 vide S.R.O. No. 220-Law/2005. ***WHO Ambient Air Quality Guideline Values (2005 and 2000), which are also being referred in the World Bank and IFC's General EHS Guidelines (2007)

4.15 NOISE ENVIRONMENT

294. There is no major noise generating industrial activities within the Island. The major source of noise is the vehicular movement on the internal roads and river traffic (motor boats, speed boats and trawlers) around the *ghats* in addition to anthropogenic sources of noise (human activities) on the island.

295. Noise monitoring was conducted at six locations within *Kutubdia* Island during post monsoon season (October), 2015. The purpose of ambient noise level measurement was to determine sound pressure levels at the monitoring locations. These locations are chosen in such a way that a representative data could be recorded all over the study area. The sound pressure level in decibel is recorded on A-weighted scale using equivalent continuous sound pressure levels (Leq) measuring instrument.

296. Details of the monitoring locations are presented in ***Table 4.21*** and the noise monitoring locations are shown in ***Figure 4.2***. Photographs of noise monitoring are presented in ***Figure 4.50***.

Table 4.21 Noise Monitoring Locations

SN	Sampling location	Category of Area/Receptor	Code	Monitoring Date	Geographic Location
1	Light House, Ali Fakir Deil	Residential	NL1	02.10.2016 to 03.10.2016	21°51'54.80"N 91°50'35.80"E
2	Dakshin Dhurung union complex, Pachar Para	Mixed	NL2	03.10.2016 to 04.10.2016	21°51'59.10"N 91°51'22.20"E
3	Nurul Hasan House, Kata Para, Lemshikhali	Residential	NL3	05.10.16 to 06.10.2016	21°52'39.80"N 91°53'35.90"E
4	Kamal Hossain House, Ismail Haji Para, Kaiyarbil	Residential	NL4	07.10.2016 to 08.10.2016	21°50'59.51"N 91°51'14.72"E
5	Saju Mia House, Uttar Masjid Para, Uttar Dhurung	Residential	NL5	08.10.2016 to 09.10.2016	21°53'31.80"N 91°51'28.80"E
6	Kutubdia Upazila Health Complex	Silent Zone	NL6	09.10.2016 to 10.10.2016	21°49'6.20"N 91°51'11.30"E

Source: Primary Monitoring, October 2016

Figure 4.50 Photographs of Noise Monitoring

NL1 (Light house, Ali Fakir Deil)

NL2 (Dakshin Dhurung Union Complex, Pachar Para)

	
NL3 (Nurul Hasan House, Kata Para, Lemshikhali)	NL4 (Kamal Hossain House, Ismail Haji Para, Kaiyarbil)
	
NL5 (Saju Mia House, Uttar Masjid Para, Uttar Dhurung)	NL6 (Kutubdia Upazila Health Complex)

297. Noise level monitoring was carried out for 24 hours during the monitoring period with 1-min equivalent sound pressure levels. At all the locations, measurement was taken at 1-min intervals over a 24 hour period. Further to that the equivalent noise levels have been converted to hourly equivalent noise levels. Finally, the measurements were done by dividing the 24 hours into two parts, i.e. daytime, which is considered from 0600 to 2100 hours and night from 2100 to 0600 hours. At each location, day time Leq has been computed from the hourly sound pressure level values measured between 0600 to 2100 hours and night time Leq has been computed from the hourly sound pressure level values measured between 2100 to 0600 hours.

Interpretation of Noise monitoring results

298. Four noise monitoring locations viz. *Ali Fakir Deil*, *Lemshikhali*, *Kaiyarbil* and *Uttar Dhurung* are located in residential areas. Day time equivalent noise levels at these locations were found to be varying from 46.4 dB(A) to 54.4 dB(A). Noise levels were found to be complying with the day time noise standards for residential area [55 dB(A)]. Night time equivalent noise levels at the stations were found to be varying from 43.2 dB(A) to 45.1 dB(A). Night time noise levels at all the stations were found to be conforming to night time noise standards for residential areas (45 dB(A)) for all locations except *Kaiyarbil* which has indicate a slight exceedance.

299. Day time and night time equivalent noise levels at *Dakshin Dhurung* Union Complex was found to be 58.9 dB(A) and 45.8 dB(A) respectively. The noise levels were found to be in compliance to the daytime and night time noise standards (60 dB(A) and 50 dB(A) respectively) for mixed areas.

300. Day time and night time equivalent noise levels at the *Kutubdia Upazila* Health Complex were found to be 54.6 dB(A) and 44.7 dB(A) respectively. Both the day time and night time noise levels were found to be exceeding the day time and night time noise standards [50 dB(A) and 40 dB(A) respectively] for silent zone.

301. Equivalent noise levels at the sampling locations are presented in ***Table 4.22.*** Hourly noise levels observed at the sampling stations are presented in **Annex 5.**

Table 4.22 Equivalent Noise Levels at Kutubdia Island

S N.	Locations	Category of Area/Receptor	Leq_{day} dB(A)	Leq_{night} dB(A)	Bangladesh Noise Standards	
					Day [dB(A)]	Night [dB(A)]
1	NL1	Residential	47.8	44.0	55	45
2	NL2	Mixed	58.9	45.8	60	50
3	NL3	Residential	49.6	45.0	55	45
4	NL4	Residential	54.4	45.1	55	45
5	NL5	Residential	46.4	43.2	55	45
6	NL6	Silent Zone	54.6	44.7	50	40

Source: Primary Monitoring, October 2016

4.16 ROAD & RIVER TRAFFIC

302. *Uttar Dhurung* Road is the main road connecting the northern portion of the island and is also the access road to the site. Road connecting *Ali Fakir Deil* with the *Uttar Dhurung* Road is selected for the road traffic survey to understand the traffic load and emissions from the road way traffic. *Kutubdia* Channel is the important waterway for the proposed Project site. Vessel traffic survey was also conducted at two locations viz. near *Boroghop Ferry Ghat* and *Darbar Ghat* in *Kutubdia* Channel (Refer ***Figure 4.2*** for survey location maps).

Road Traffic

303. The traffic survey was conducted continuously for 24 hours, one time during the study period at one location at the approach road to the proposed Project. The traffic survey was conducted for both way movement of vehicles and categorized as medium vehicle (tractor/power tiller), light vehicle (private car, auto rickshaw, CNG, motor cycle) and non-motorized vehicle (rickshaw, cycle etc.).

304. Total no. of vehicles plying the road in 24 hours are 194 including 109 motorized vehicle and 85 non-motorized vehicle. Maximum traffic volume of 19 vehicles in an hour was recorded between 8-9 AM and during 2-3 AM no traffic was recorded. Frequency of light vehicle, small vehicle and non-motorized vehicles plying the road were 1.55%, 54.64% and 43.81% respectively.

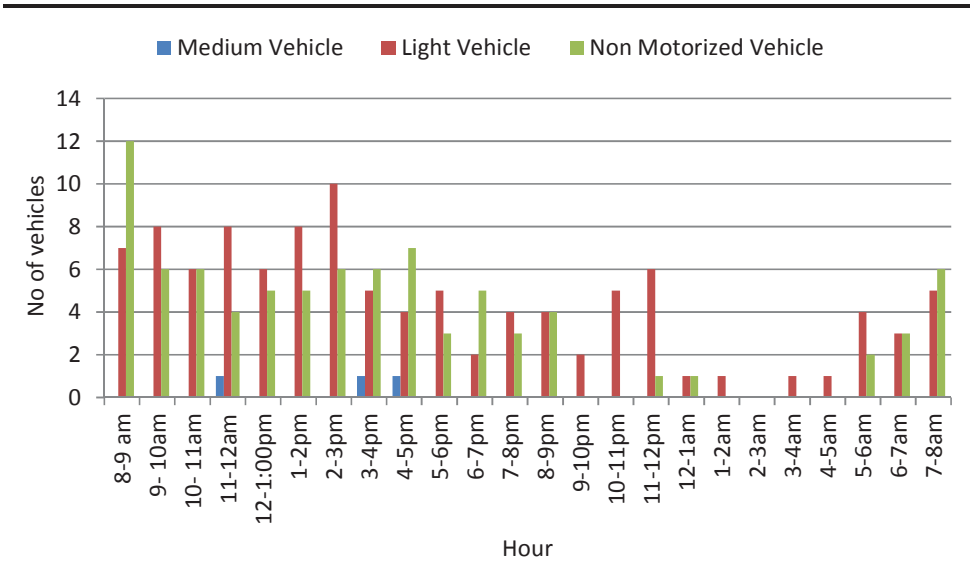
305. A summary of traffic survey results is presented in ***Table 4.23*** and hourly movement of vehicles is presented in ***Figure 4.51***.

Table 4.23 Status of Road Traffic

S N.	Vehicle Type	Numbers/Time
1	Total traffic volume (Nos)/24 hr	194
2	Average traffic volume/hr	8
3	Max Traffic volume (Nos)/hr	19
4	Min traffic volume (Nos)/hr	0
5	Minimum traffic flow hours	8-9 AM
6	Maximum traffic flow hours	2-3 AM

Source: Primary Monitoring, October 2016

Figure 4.51 Hourly Traffic Load



Source: Primary Monitoring, October 2016

306. Movement of man, material and machinery to the site is expected during the construction and operation stages of the project. This is likely to result in an increase in traffic movement on the island. It is understood that plant and equipment can be transported to the site by sea route through all seasons of the year. Most of the heavy equipment is expected to be unloaded at *Chittagong* Port, and same will be transported to the Project site at *Kutubdia* Island via the sea route. So the incremental road traffic volume on the island will principally be resulting from movement of passenger vehicles carrying construction and operation personnel to/from site.

River Traffic

307. The river traffic survey was conducted continuously for 24 hours, one time during the study period at two locations in *Kutubdia* Channel viz. *Boroghop Ferry Ghat* and *Darbar Ghat*. The river traffic survey was done for both way movement of vessels and categorized as fishing boat (motorized), trawler (goods carrying),

Danish boat (passenger carrying), passenger service boat (large), speed boat, fishing boat (non-motorized).

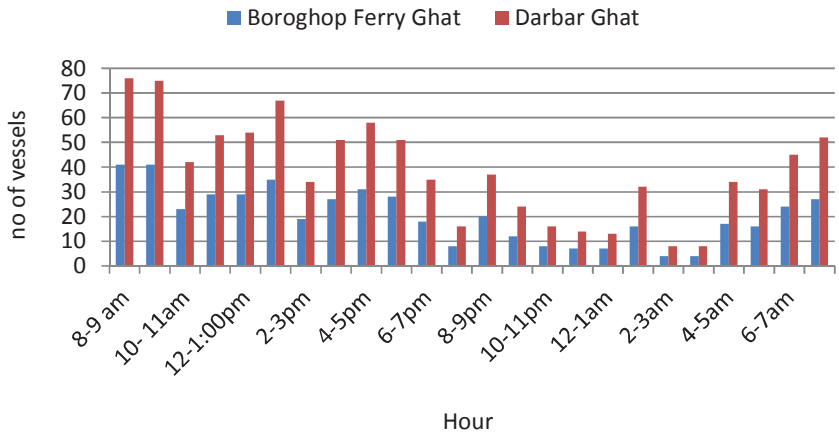
308. Total number of vessels recorded in *Boroghop Ferry Ghat* was 394 compared to 380 nos. in *Darbar Ghat*. At *Boroghop Ferry Ghat* maximum vessel count of 35 nos. in an hour was recorded during 8-9 AM and minimum vessel count of 3 nos. was recorded during 2-3 AM. At *Darbar Ghat* maximum vessel count of 52 nos. in an hour was recorded during 1-2 PM and minimum vessel count of 3 nos. was recorded during 3-4 AM and 4-5 AM. Summary of vessel survey results is presented in ***Table 4.24*** and hourly movement of vessels is presented in ***Figure 4.52***.

Table 4.24 Status of Vessel Traffic in Kutubdia Channel

S N.	Vehicle Type	Boroghop Ferry Ghat	Darbar Ghat
1	Total Vessel count (Nos) in 24 hours	394	380
2	Average Vessel count/Hr	16	16
3	Max Vessel count (Nos)/Hr	35	52
4	Min Vessel count (Nos)/Hr	3	3
5	Minimum Vessel Movement Hours	2-3 AM	3-4 AM, 4-5 AM
6	Maximum Vessel Movement Hours	8-9 AM	1-2 PM

Source: Primary Monitoring, October 2016

Figure 4.52 Hourly Movement of Vessels



Source: Primary Monitoring, October 2016

309. During the construction phase of the Project, the sea traffic will comprise of barges and other vessels which will be used for shipment of plant and machinery to the site. It will also comprise of tugs used for supplying water as well as for bunkering purpose.
310. During the operation phase LNG Carriers (LNGCs) will bring in the LNG and offload it to the FSRU through marine loading arms. It is understood that one LNGC is expect to arrive at the FSRU every week for offloading of LNG. In addition the operation phase will also comprise of movements of tugs for supplying water as well as for bunkering.

4.17 ECOLOGY

4.17.1 Introduction

311. ERM team comprising of two (02) ecologist conducted six (06) day survey of the *Kutubdia* Island from 14th to 20th November 2016. The survey was conducted with following objectives;
   - Delineation of Study area based on project footprint.
   - Identification of various habitats available within the *Kutubdia* Island;
   - Enumeration of terrestrial and aquatic floral and faunal species within *Kutubdia* Island;
   - Identification of floral and faunal species of conservational significance;
   - Prediction of likely impacts due to projects activities;
   - Suggesting mitigation measures and preparation of Biodiversity Management Plan for species of conservational significance.

4.17.2 Climatic Conditions

312. The climatic condition during the ecological survey was clear and sunny. The temperature ranged from minimum of 19°C to maximum of 31°C. No incremental weather such as rainfall and thunderstorms were experienced during the survey period.

4.17.3 Study area

313. The study area for ecological survey includes an area within 10 km from the proposed FSRU location. 500 m buffer area on either side of the proposed pipeline route is also considered as study area for the ecology and biodiversity survey. The study area for ecological survey is presented in ***Figure 4.1.***

314. As discussed in *Section 4.5.4: Land Use* major part of the study area (62.78%) falls in the Bay of Bengal. Predominant land use-land cover of the on-shore portion of the study area includes agricultural land (6.07%), salt pans (12.05%), and settlement (5.63%).

315. Land use of the pipeline corridor includes agricultural land (34.25%); saltpan (29.27%), channel crossing (16.55%), sandy area (9.48%), block vegetation (7.46%).

316. The total land area of the *Kutubdia* Island has been divided in 2 km x 2 km grids for the biodiversity study. Among the 25 grids generated biodiversity study was conducted at 16 grids. Special consideration was undertaken to select the grids in proximity to the land based facility and likely pipeline corridor. The grids selected for study of flora is presented in ***Figure 4.57.*** The study area has been divided 2 km x 2 km grid. List of plants; habitat affinity of the floral species is provided.

4.17.4 Classification of Study Area-Bio-ecological Zone of Bangladesh

317. IUCN has classified Bangladesh into 25 Bio-ecological Zones in the context of physiographic and biological diversity. The *Kutubdia* Island falls under the bio-ecological zone of '**offshore islands (8b)**' Details on this bioecological zone is presented in ***Box 4.2*** and ***Figure 4.53.***

Box 4.2 Offshore Islands (8b)

Location	:	21°35'-22°45' N and 90°15'-92°05' E
Relevant Adm HQ	:	Cox's Bazar, Bhola, Patuakhali, Noakhali
Physiography	:	Young Meghna estuarine floodplain; Chittagong coastal plain
Soil	:	Calcareous alluvium (saline); Acid sulphate soils; Brown hill soils
Rainfall	:	2290-2790 mm
Temperature	:	Minimum 12° C & Maximum 34° C,
Flooding depth	:	Medium Highland
Land use	:	Fallow-Fallow-T.aman (5b); Rabi-Aus-T.aman (2b); Planted Mangrove forest (15b)

Floral diversity:

Trees:

Narikel (*Cocos nucifera*), Supari (*Areca catechu*), Rendi koroi/Rain tree (*Samanea saman*), Bhadi (*Lannea coromandelica*)

Aquatic plants

Topapana (*Pistia strateotes*), Kolmi (*Ipomoea aquatica*), Jhanji (*Utricularia exoleata*)

Faunal diversity:

Mammals

Bengal fox (*Vulpes bengalensis*), Fishing cat (*Prionailurus viverrinus*), Common palm civet (*Paradoxurus hermaphroditus*), Ganges river dolphin (*Platanista gangetica*), Greater bandicoot rat (*Bandicota indica*)

Birds

Indian skimmer (*Rynchops albicollis*), Purple heron (*Ardea purpurea*), Painted stork (*Mycteria leucocephala*), Eurasian thick-knee (*Burhinus oedicnemus*)

Reptiles

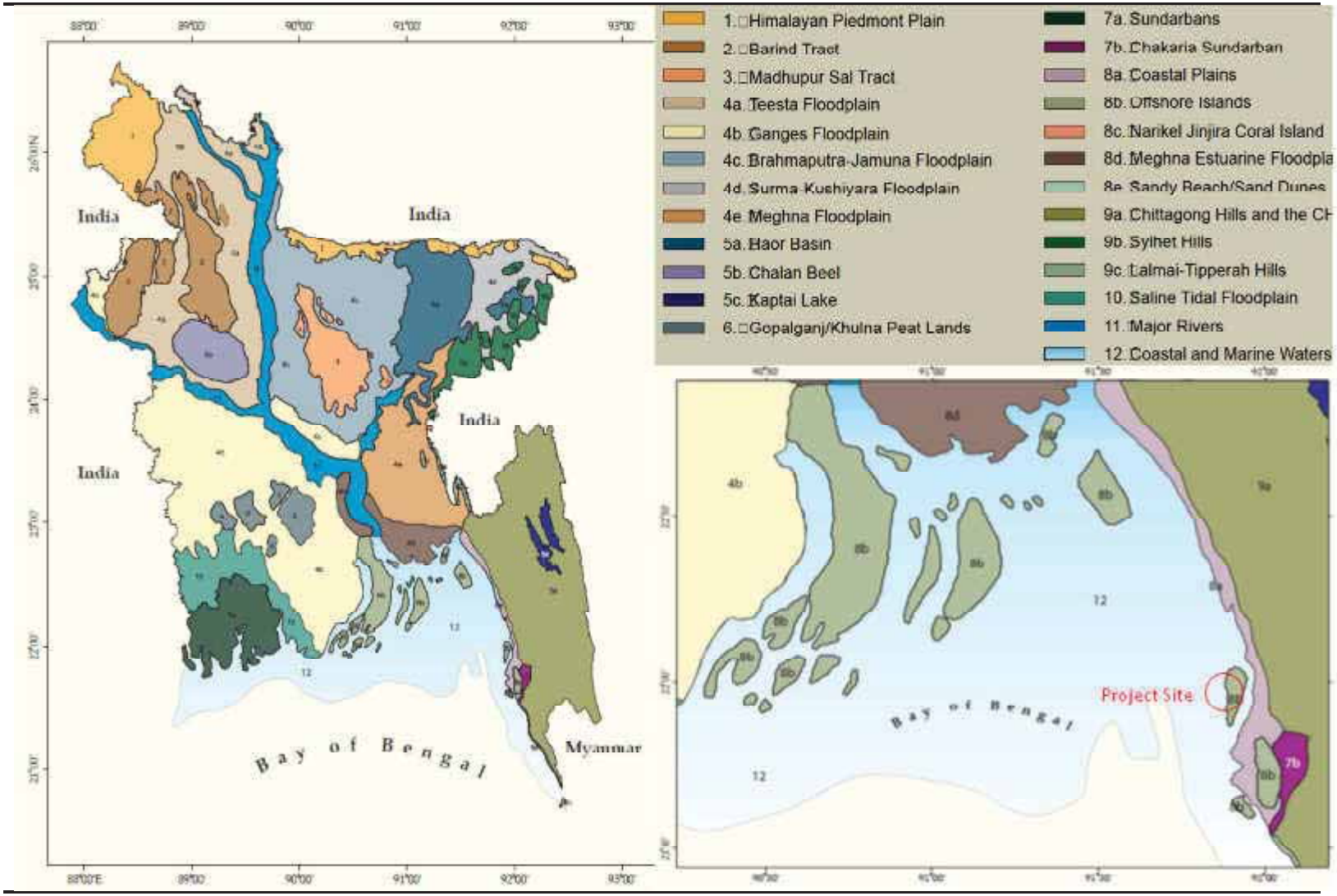
River terrapin (*Batagur baska*), Glossy marsh snake (*Gerardia prevostianus*)

Amphibians

Boulenger's frog (*Rana alticola*), Common toad (*Bufo melanostictus*)

Source: Nishat A. Haq, S.M. Imamul, Barua Shuvashish, P. Reza Ali, A.H.M., Khan, Moniruzzaman, A.S. (eds) 2002. Bio-ecological Zones of Bangladesh. IUCN Bangladesh Country office, Dhaka, Bangladesh. xii+131pp.Source: Bioecological Zones of Bangladesh, IUCN, 2002

Figure 4.53 Bio-ecological Zones of Bangladesh



Source: Nishat A. Haq, S.M. Imamul, Barua Shuvashish, P. Reza Ali, A.H.M., Khan, Moniruzzaman, A.S. (eds) 2002. Bio-ecological Zones of Bangladesh. IUCN Bangladesh Country office, Dhaka, Bangladesh. xii+131pp.Source: Bioecological Zones of Bangladesh, IUCN, 2002

4.17.5 Ecosystems within the Study Area

318. Available ecosystems within the study area are indicated below;

1. Terrestrial Ecosystem;
2. Coastal Ecosystem and
3. Aquatic Ecosystem
4. Marine Ecosystem

Vegetation in Terrestrial Ecosystem

319. Terrestrial ecosystem covers about 23% of the study area, which primarily includes agricultural lands, homestead plantation and strip plantation etc.

Agricultural lands

320. Agricultural land covers about 5% of the study area. Mono- cropping agricultural pattern of paddy is pre dominant in the area. *Rabi* crops cultivated are chilli, onion, vegetable, ladies finger, long yard bean, tomato, watermelon etc. Tree species observed near agricultural lands are *Mangifera indica, Samanea saman, Azadirachta indica, Cocos nucifera, Eucalyptus* sp., *Acacia auriculiformis, Phoenix sylvestris, Bambusa* sp., *Areca catechu, Borassus flabellifer* etc. It is envisaged that agricultural land would be falling within the land based facility and also within the proposed pipeline stretch (including both acquisition and requisition area).

Homestead Plantation

321. Homestead plantation was observed on marginal and fallow lands by the local villagers e.g. homestead, roads, embankment, canal banks and fallow agriculture land. Species observed are *Samanea saman, Acacia auriculiformis, Acacia manjiam, Azadirachta indica, Eucalyptus* sp., *Pongamia pinnata, Acacia nilotica, Ziziphus mauritiana, Leucaena leucocephala, Switenia mahogani, Tectona grandis, Casia siamea, Gmelina arborea, Casuarina equisetifolia, Phoenix sylvestris, Bambusa* sp., *Cocos nucifera, Mangifera indica, Tamarindus indica, Areca catechu, Borassus flabellifer, Artocarpus heterophyllus* etc. It is envisaged that some of the homestead plantation area would be falling in the area within the proposed pipeline stretch (including both acquisition and requisition area).

Strip Plantation

322. Afforestation program on participatory basis are being implemented along the roads, link road and embankment by the Forest Department under social forestry scheme to meet the demand of wood resources. Major species planted are *Samanea saman, Acacia auriculiformis, Swietenia mahogani, Tectona grandis, Artocarpus heterophyllus* etc.

Figure 4.54 Terrestrial Ecosystems in the Study Area

Homestead Plantation

Agricultural Land

Source: ERM Ecological Survey during14th to 20th November 2016

Vegetation in Coastal Ecosystem

323. Coastal ecosystems in the study area comprise of *Casuarina* plantation area, sandy beach areas and muddy areas

***Casuarina* Plantation**

324. *Casuarina* (Jhau) plantation is undertaken by the forest department at about 26.5 ha at the western coast of the *Kutubdia* Island as a shelter belt. Union wise *Casuarina* plantation is presented below

- *Dakshin Dhurung*- 2.0 ha.
- *Kaiyarbil*- 2.5 ha.
- *Uttar Dhurung*-15.0 ha
- *Ali Akbar Deil*- 4.0 ha.
- *Boroghop*- 10.0 ha.

325. A few *Casuarina* plantation is present along the shore.

Sandy Beaches

326. Sand beaches in the western coast of *Kutubdia* are mostly devoid of major floral species. Beach Morning Glory (*Ipomoea pes-caprae)* is the predominant natural vegetation at these sandy beaches. Some beach agriculture in small patches undertaken was also observed.

Figure 4.55 Coastal Ecosystems in the Study Area

Casuarina Plantation in Kaiyarbil

Sandy Beach area near Ali Fakir Deil

Ipomea pres-carpe vegetation on Sandy beach

Beach Vegetation in Western Coast Kutubdia

Source: ERM Ecological Survey during14th to 20th November 2016

Riparian vegetation

327. The unions are enriched with open water fisheries which are available in the rivers, canals and floodplain. Riparian vegetation are present along the sides of ponds, canals etc. Main type of plant species observed is *Syzygium cumini, Samanea saman, Cocos nucifera* etc.

Mangrove Plantation

328. Kutubdia Upazila is also an important place for mangrove plantation. Artificial mangrove plantation covered in about 30.0 ha[1]. Mangrove plantation in the island was undertaken by the Chittagong Coastal Forest Division. Mangrove plantation is present at the eastern coast near Kutubdia Channel and also at the south eastern end of the Kutubdia Island. Species most widely used for plantation area Avicennia officinalis, Avicennia marina. It was reported by the forest department that they have tried planting species like Sonneratia apetala (Keowra) and Excoecaria agallocha (Geowa), however the same could not be sustained. No mangrove plantation is available along the proposed pipeline stretch.

Salt Pans

329. Salt pans contribute to about 8.28% of the total study area for FSU and about 29% of the study area of the pipeline corridor. Salt pans are mostly devoid of any floral species.

[1&2] Land Use Zoning Report: Kutubdia Upazila, District Cox's Bazar, 2011

Figure 4.56 Inland Aquatic Ecosystems in the Study Area

Mangrove Plantations near Lemshikhali Union

Salt Pan area in Uttar Dhurung

Source: ERM Ecological Survey during14th to 20th November 2016

4.17.6 Terrestrial Ecosystem

Methodology for Survey of Terrestrial Floral species

330. The total land area of the Kutubdia Island is been divided in 2kmx 2 km grids for the biodiversity study. Among the 25 grids generated biodiversity study was conducted at 16 grids. Special consideration was undertaken to select the grids in proximity to the pipeline corridor. The grids selected for study of flora is presented in ***Figure 4.57***.

331. At each grid floral survey was conducted at the predominant land use classes. Land use classes selected for floral survey includes

- Agricultural lands
- Homestead Plantation
- Salt pans
- Riparian Vegetation
- *Casuarina* Plantation
- Mangrove Plantation

Figure 4.57 Area Selected for Terrestrial Floral Survey

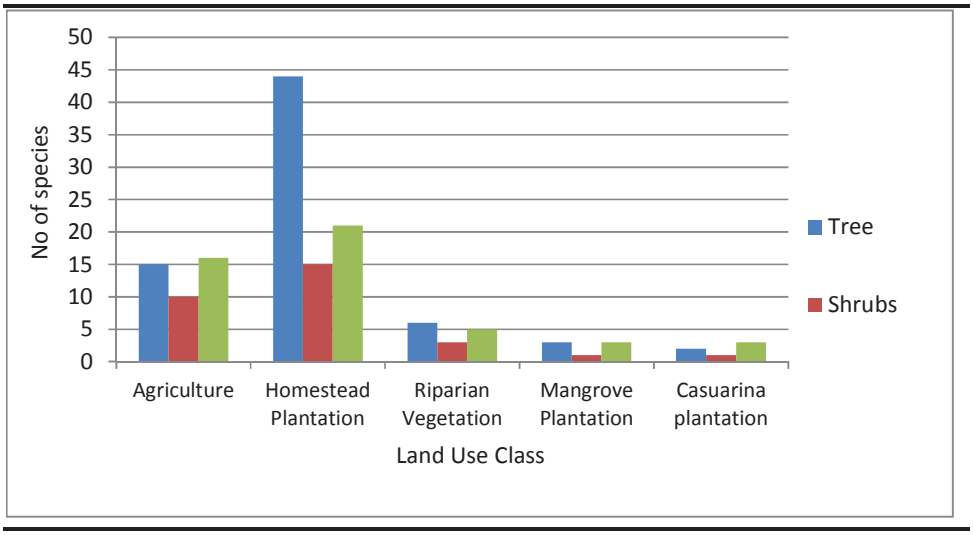
Terrestrial Floral Analysis

332. Total 87 terrestrial floral species were recorded from the study area which included 48 trees, 16 shrubs and 23 herbs and climbers. Detailed list of flora (including terrestrial and aquatic) is presented in **Annex 6.**

333. Among the land use classes maximum number of species were recoded from homestead plantation (80 species), followed by agricultural lands (41 species), riparian vegetation (14 species), mangrove plantation (7 species) and casuarina

plantation (6 species). Number of species in each land use classes is presented in ***Figure 4.58.***

Figure 4.58 Terrestrial Floral Species in Different Land Use Classes in Kutubdia



334. Summary of terrestrial floral analysis is presented in ***Table 4.25*** and grid wise record of floral species is presented in **Annex 7.**

Table 4.25 Terrestrial Floral Analysis -Summary

SN	Land Use Types	Habitat Type	Trees	Shrubs	Herbs & Climbers
1	Agricultural	Modified	*Acacia auriculiformis, Acacia mangium Acacia nilotica , Albizia lebbeck , Alstonia scholaris , Areca catechu, Artocarpus heterophyllus, Bambusa vulgaris, Borassus flabellifer, Cocos nucifera, Dalbergia sissoo , Mangifera indica, Phoenix sylvestris, Samanea saman, Tamarindus indica ,*	*Calotropis gigantea, Calotropis procera, Carica papaya, Carissa carandas,Clerodendrum inerme , Rosa centifolia, Suaeda maritima, Vitex negundo, Rosa centifolia, Woodfordia fruticosa*	*Alternanthera sessilis, Alternanthera philoxeroides, Amaranthus spinosus, Bacopa monnieri , Celosia argentea, Centella asiatica, Colocasia esculenta , Cucurbita maxima , Cynodon dactylon, Cyperus rotandus, Eclipta prostrata, Mimosa pudica, Musa paradisiaca , Ocimum tenuiflorum , Phragmites karka*
2	Homestead plantation	Modified	*Acacia auriculiformis, Acacia mangium Acacia nilotica , Albizia lebbeck , Alstonia scholaris , Areca catechu, Artocarpus heterophyllus, Bambusa vulgaris Bombax ceiba, Borassus flabellifer, Calophyllum inophyllum, Casuarina equisetifolia , Citrus aurantifolia, Citrus limon , Cocos nucifera, Dalbergia sissoo , Delonix regia, Dillenia indica , Eucalyptus camaldulensis, Ficus benghalensis, Ficus religiosa, Gmelina arborea, Lepisanthes rubiginosa, Leucaena leucocephala, Magnolia champaca, Mangifera indica, Melia azedarach, Mimusops elengi, Phoenix sylvestris, Pithecellobium dulce, Pongamia pinnata, Saraca asoca, Cassia siamea , Samanea saman, Spondias pinnata, Sterculia foetida, Swietenia mahagoni, Syzygium cumini, Tamarindus indica , Terminalia arjuna, Terminalia catappa , Thespesia populnea , Ziziphus mauritiana*	*Bougainvillea spectabilis, Calotropis gigantea, Calotropis procera, Carica papaya, Carissa carandas Clerodendrum inerme , Gardenia jesminoides, Hibiscus rosa-sinensis, Lantana camara, Lawsonia inermis , Pandanus foetidus, Ricinus communis, Rosa centifolia, Vitex negundo, Woodfordia fruticosa*	*Alternanthera sessilis, Alternanthera philoxeroides, Amaranthus spinosus, Bacopa monnieri , Boerhavia repens, Celosia argentea, Centella asiatica, Colocasia esculenta , Cucurbita maxima , Cynodon dactylon Cyperus compressus , Cyperus rotandus, Eclipta prostrata , Enhydra fluctuans, Mimosa pudica, Musa paradisiaca , ,Ocimum basilicum , Ocimum tenuiflorum , Phragmites karka , Phyllanthus niruri, Alternanthera sessilis*
3	Riparian vegetation	Modified	*Samanea saman, Acacia auriculiformis, Alstonia scholaris, Syzygium cumini, Cocos nucifera, Dalbergia sissoo*	*Lantana camara, Ricinus communis, Suaeda maritima*	*Alternanthera sessilis, Alternanthera philoxeroides, Porteresia coarctata, Saccharum spontaneum , Sesuvium portulacastrum*
4	Mangrove Plantation	Modified	*Avicennia alba, Avicennia officinalis Sonneratia apetala*	*Suaeda maritima*	*Porteresia coarctata, Saccharum spontaneum, Sesuvium portulacastrum*
5	*Casuarina* plantation	Modified	*Casuarina equisetifolia, Acacia auriculiformis*	*Calotropis procera*	*Ipomea pes-carpae, Celosia argentea, Cynodon dactylon,*

Source: ERM Ecological Survey during14th to 20th November 2016

Herpetofauna

335. A total of 17 species of herpetofauna are reported from the study area. Green Frog (*Euphlyctis hexadactylus*) is reported endangered as per IUCN Red List v2017.1. Spotted Pond Turtle (*Geoclemys hamiltonii)* is reported Vulnerable as per IUCN Red List v2017.1. A list of herpetofaunal species is provided in ***Table 4.26.***

Table 4.26 Herpetofaunal Species in the Study Area

S N	Scientific Name	English Name	Local Name	Conservational Status		
				IUCN BD	IUCN Global	WLPA 2012
1	*Duttaphrynus melanostictus*	Southeast Asian toad	Kono bang	LC	LC	-
2	*Euphlyctis hexadactylus*	Green Frog	Kotkoti bang	LC	LC	Schedule I
3	*Fejervarya limnocharis*	Cricket frog		LC	LC	Schedule II
4	*Hoplobatrachus tigerinus*	Bull frog	Kola bang,	LC	LC	Schedule I
5	*Sylvirana leptoglossa*	Cope's Assam Frog	Koper Ashami Bang	LC	LC	Schedule II
6	*Rana temporalis*	Bronzed Frog	Gaso Bang	-	-	-
7	*Calotes versicolor*	Garden Lizard	Roktochusha	LC	Not Evaluated	Schedule II
8	*Mabuya mabuya*	Skink	Achil	-	-	-
9	*Gekko gecko*	Tokay Gecko	Tokkhak	LC	Not Evaluated	Schedule II
10	*Hemidactylus brookii*	House lizard	Guti Tiktiki	LC	Not Evaluated	Schedule II
11	*Hemidactylus frenatus*	House lizard	Pati Tiktiki	LC	LC	Schedule II
12	*Melanochelys trijuga*	Indian Black Turtle	Kalo Kossop	NT	NT	Schedule I
13	*Geoclemys hamiltonii*	Spotted Pond Turtle	Kalo Kasim	EN	VU	Schedule I
14	*Pangshura tentoria*	Median Roofed Turtle	Majhari Kaitta	NT	LC	Schedule I
15	*Xenochrophis piscator*	Checkered keel back	Dhora sap	LC	Not Evaluated	Schedule I
16	*Naja kaouthia*	Monocled Cobra	Jati Sap	NT	LC	Schedule II
17	*Enhydris sieboldi*	Siebold's Smooth Water Snake	Sibolder Joloj Shap	Not Assessed	LC	Schedule I

Source: ERM Ecological Survey during14th to 20th November 2016

Avifaunal Species

336. A total of 91 species of Avifaunal species were observed in the study area. Black-headed Ibis (*Threskiornis melanocephalus*) is reported Vulnerable while Eurasian Curlew (*Numenius arquata*) is reported as Near Threatened as per IUCN Red List 2017.1. In addition to these 91 species one species Spoon-billed sandpiper (*Calidris pygmaea*) IUCN Red list Critically Endangered 2017.1 is reported to be present in *Matarbari* and *Sonadia* Islands. As the *Kutubdia* Island present similar habitat values and is close

by there is a likelihood of its presence and need further assessment during the month of January-February. A list of species is provided in ***Table 4.27*** and Photographic representation is provided in ***Figure 4.59.***

Figure 4.59 Avifaunal species in the Study Area

Brown headed Gull | Common Hoopoe

Black Drongo | Pacific Golden Plover

Common Sandpiper | Little Stint

	
Eurasian Curlew	Whimbrel
	
Terek Sandpiper	White Wagtail
	
Common Kingfisher	Lesser Sand Plover

Source: ERM Ecological Survey during14th to 20th November 2016

Table 4.27 Avifaunal Species in the Study Area

SN.	Scientific Name	English Name	Local Name	Migratory Status	Conservational Status		
					IUCN BD	IUCN Global	WLPA 2012
1	*Threskiornis melanocephalus*	Black-headed Ibis	Kalamatha Kastechora	M	VU	NT	I
2	*Chroicocephalus brunnicephalus*	Brown headed Gull	Heugliner Gangchil	M	LC	LC	I
3	*Sterna sumatrana*	Black-naped Tern	Kalaghar Panchil	M	-	LC	I
4	*Larus ichthyaetus*	Great Black-headed Gull	Palasi Gangchil	M	LC	LC	I
5	*Larus brunnicephalus*	Brown-headed Gull	Khoiramatha Gangchil	M	LC	LC	I
6	*Charadrius mongolus*	Little Sand Plover	Choto Dhuljiria	M	LC	LC	I
7	*Charadrius leschenaultii*	Greater Sand Plover	Boro Dhuljiria	M	LC	LC	I
8	*Charadrius alexandrinus*	Kentish Plover	Kentish Jiria	M	LC	LC	I
9	*Pluvialis fulva*	Pacific Golden Plover	Proshanto Shonajiria	M	LC	LC	I
10	*Calidris temminckii*	Timminck's Stint	Timinker Chaha	M	LC	LC	I
11	*Calidris alba*	Sanderlin	Sanderlin	M	LC	LC	I
12	*Arenaria interpres*	Ruddy Turnstone	Lal Nuribatan	M	LC	LC	I
13	*Actitis hypoleucos*	Common Sandpiper	Pati Batan	M	LC	LC	II
14	*Tringa glareola*	Wood Sandpiper	Bon Batan	M	LC	LC	II
15	*Numenius phaeopus*	Whimbrel	Choto Gulinda	M	LC	LC	I
16	*Numenius arquata*	Eurasian Curlew	Eureshio Gulinda	M	NT	NT	I
17	*Gallinago stenura*	Pin-tailed Snipe	Lenja Chega	M	LC	LC	I
18	*Todiramplus chloris*	Collared Kingfisher	Dholaghar Machranga	M	LC	LC	I
19	*Tadorna ferruginea*	Ruddy Shelduck	Khoira Chokachoki	M	LC	LC	I
20	*Pandion haliaetus*	Osprey	Machmural	M	LC	LC	I
21	*Nycticorax nycticorax*	Black-crowned Night Heron	Kalamatha Nishibok	R	LC	LC	I
22	*Sterna albifrons*	Little Tern	Choto Panchil	R	LC	LC	I
23	*Ardea cinerea*	Grey Heron	Dhupni Bok	R	LC	LC	I
24	*Ardeola bacchus*	Chinese Pond Heron	China Kanibok	R	LC	LC	I
25	*Ardeola grayii*	Indian Pond Heron	Deshi Kanibok	R	LC	LC	I
26	*Bubulcus ibis*	Cattle Egret	Go Boga	R	LC	LC	II
27	*Casmerodias albus*	Great Egret	Boro Boga	R	LC	LC	II
28	*Egretta intermedia*	Intermediate Egret	Majhla Boga	R	LC	LC	I
29	*Egretta garzetta*	Little Egret	Choto Boga	R	LC	LC	II
30	*Phalacrocorax niger*	Little Cormorant	Choto Pankouri	R	LC	LC	II
31	*Caprimulgus macrurus*	Large-tailed Nightjar	Lenja Ratchora	R	LC	LC	I
32	*Athene brama*	Spotted Owlet	Khuruley Pencha	R	LC	LC	I
33	*Ketupa zeylonensis*	Broun Fish Owl	Khoira mechupacha	R	LC	LC	I

SN.	Scientific Name	English Name	Local Name	Migratory Status	Conservational Status		
					IUCN BD	IUCN Global	WLPA 2012
34	*Cypsiurus balasiensis*	Asian Palm Swift	Asio Talbatashi	R	LC	LC	I
35	*Psittacula krameri*	Rose-ringed Parakeet	Shobuj Tia	R	LC	LC	II
36	*Psittacula alexandri*	Red-breasted Parakeet	Modna Tia	R	LC	NT	II
37	*Merops philippinus*	Blue-tailed Bee-eater	Neel-lej Shuichora	R	LC	LC	I
38	*Merops leschenaulti*	Chestnut-headed Bee-eater	Khoiramatha Shuichora	R	LC	LC	I
39	*Dinopium benghalense*	Lesser goldenback	Bangla kaththokra	R	LC	LC	I
40	*Upupa epops*	Eurasian Hoopoe	Pati Hoodhood	R	LC	LC	I
41	*Ceryle rudis*	Pied Kingfisher	Pakra Machranga	R	LC	LC	II
42	*Halcyon smyrnensis*	White-throated Kingfisher	Dholagoloa Machranga	R	LC	LC	II
43	*Alcedo atthis*	Common Kingfisher	Pati Machranga	R	LC	LC	II
44	*Rhipidura albicollis*	White-throated Fantail	Dholagola Chatighurani	R	LC	LC	I
45	*Dicrurus aeneus*	Bronzed Drongo	Fingey	R	LC	LC	I
46	*Dicrurus paradiseus*	Greater Racket-tailed Drongo	Boro Recket-Fingey	R	LC	LC	I
47	*Hypothymis azurea*	Black-naped Monarch	Kalaghar Rajon	R	LC	LC	I
48	*Aegithina tiphia*	Common Iora	Fatik Jal	R	LC	LC	II
49	*Ficedula albicilla*	Taiga Flycatcher	Taiga Chutki	R	LC	LC	I
50	*Prinia inornata*	Plain Prinia	Nirol Prina	R	LC	LC	II
51	*Zosterops palpebrosus*	Oriental White-eye	Udoi Dholachokh	R	LC	LC	I
52	*Pellorneum ruficeps*	Puff-throated Babler	Golafola Satarey	R	LC	LC	I
53	*Anthus rufulus*	Paddyfield Pipit	Dhani Tulika	R	LC	LC	II
54	*Lonchura striata*	White-rumped Munia	Dholakomor Munia	R	LC	LC	I
55	*Lonchura punctulata*	Scaly-breasted Munia	Tila Munia	R	LC	LC	I
56	*Lonchura malacca*	Tricoloured Munia	Kalamatha Munia	R	LC	LC	I
57	*Lonchura malabarica*	Indian Silverbill	Deshi Chandithot	R	LC	LC	I
58	*Ploceus philippinus*	Baya Weaver	Deshi Babui/Baoi	R	LC	LC	I
59	*Arachnothera magna*	Streaked Spiderhunter	Dahi Makarmar	R	LC	LC	I
60	*Aethopyga siparaja*	Crimson Sunbird	Shidure Moutushi	R	LC	LC	I
61	*Cinnyris asiaticus*	Purple Sunbird	Beguni Moutushi	R	LC	LC	I
62	*Leptocoma zeylonica*	Purple-rumped Sunbird	Begunikomor Moutushi	R	LC	LC	I
63	*Chalcoparia singalensis*	Ruby-cheeked Sunbird	Chunimukhi Moutushi	R	LC	LC	I
64	*Dicaeum trigonostigma*	Orange-bellied Flowerpecker	Komlapet Fuljhur	R	LC	LC	I
65	*Dicaeum erythrorhynchos*	Pale-billed Flowerpecker	Metethot Fuljhuri	R	LC	LC	I
66	*Dicaeum cruentatum*	Scarlet-backet Flowerpecker	Lalpith Fuljhuri	R	LC	LC	I
67	*Dendrocitta vagabunda*	Rufous Treepie	KhoiraHarichacha	R	LC	LC	II
68	*Artamus fuscus*	Ashy Woodswallow	Metey Bonababil	R	LC	LC	II
69	*Oriolus xanthornus*	Black-hooded Oriole	Holdey Pakhi	R	LC	LC	II

SN.	Scientific Name	English Name	Local Name	Migratory Status	Conservational Status		
					IUCN BD	IUCN Global	WLPA 2012
70	*Corvus macrorhynchos*	Jungle Crow	Dar Kak	R	-	LC	-
71	*Corvus splendens*	House Crow	Pati Kak	R	LC	LC	-
72	*Pycnonotus cafer*	Red-vented Bulbul	Bangla Bulbul	R	LC	LC	I
73	*Treron phoenicopterus*	Yellow-footed Green Pigeon	Holdepa Horial	R	LC	LC	I
74	*Streptopelia chinensis*	Spotted Dove	Tila Ghughu	R	LC	LC	I
75	*Streptopelia decaocto*	Eurasian Collared Dove	Raj Ghughu	R	LC	LC	I
76	*Treron bicintus*	Orange-breasted Green Pigeon	Horikol	R	LC	LC	I
77	*Columba livia*	Common Pigeon	Jalali Kabutor	R	LC	LC	I
78	*Orthotomus sutorius*	Common Tailorbird	Pati Tuntuni	R	LC	LC	-
79	*Copsychus saularis*	Oriental Magpie-Robin	Udoi Doel	R	LC	LC	II
80	*Acridotheres fuscus*	Jungle Myna	Jhuti Sahlik	R	LC	LC	II
81	*Acridotheres tristis*	Common Myna	Bhat Shalik	R	LC	LC	II
82	*Acridotheres cinereus*	Pale-bellied Myna	Dholatola Shalik	R	-	LC	I
83	*Sturnus malabaricus*	Chestnut-tailed Starling	Khoiralej Kathshalik	R	LC	LC	II
84	*Sturnus contra*	Pied Myna	Pakra Shalik	R	LC	LC	II
85	*Dicrurus macrocercus*	Black Drongo	Kala Fingey	R	LC	LC	II
86	*Passer domesticus*	House Sparrow	Pati Chorui	R	LC	LC	II
87	*Threskiornis melanocephalus*	Black-headed Ibis	Kalamatha Kastechora	M	VU	NT	I
88	*Calidris minuta*	Little Stint	Chhoto Chaha	M	LC	LC	I
89	*Xenus cinereus*	Terek Sandpiper	Terek Batash	M	LC	LC	I
90	*Motacilla alba*	White Wagtail	-	M	LC	LC	I
91	*Charadrius mongolus*	Lesser Sand Plover	Chhoto Dhuljiria	M	LC	LC	I

Source: ERM Ecological Survey during14th to 20th November 2016

Mammalian Species

337. A total 11 species of mammalian species were enumerated within the study area. The species were identified based on community consultation and direct sightings. Large Indian Civet (*Viverra zibetha*) and Common otter (*Lutra lutra*) are listed as Near Threatened as per IUCN Redlist 2016.3.

Table 4.28 Mammalian Species within Study Area

SN	Species Name	English Name	Local Name	BD IUCN Status	Global IUCN Status	WLPA 2012
1	*Pipistrellus coromandra*	Indian Pipistrelle	Chamchika	LC	LC	I
2	*Rousettus leschenaultia*	Leschenault's Rousette	Kola Badur	LC	LC	I
3	*Pteropus giganteus*	Indian Flying Fox	Baro badur	LC	LC	I
4	*Callosciurus pygerythrus*	Hoary-bellied Himalayan Squirrel	Kathbirali	LC	LC	I
5	*Rattus rattus*	House rat	Indur	LC	LC	III
6	*Bandicota indica*	Indian Mole rat	Indur	LC	LC	III
7	*Suncus murinus*	House shrew	Chika	LC	LC	-
8	*Viverra zibetha*	Large Indian Civet	Baghdas	NT	NT	I
9	*Lutra lutra*	Common otter	Ud biral	CR	NT	I
10	*Felis chaus*	Wild cat	Bon biral	NT	LC	I
11	*Herpestes edwardsii*	Indian grey mongoose	Bejji	LC	LC	I

Source: ERM Ecological Survey during14th to 20th November 2016

4.17.7 Aquatic Ecosystem

Marine Plankton Survey-Methodology

338. Survey of marine planktonic organisms was conducted at six locations, four locations at the Bay of Bengal and two locations at *Kutubdia* Channel. Locations for planktonic survey coincided with the marine water collection locations. Planktonic sample collection was conducted only from the surface (0.3 to 0.5 m from the surface) of the Bay of Bengal and *Kutubdia* Channel.

339. About 500 mL of water was collected from each station and preserved with Lugol's Iodine for phytoplanktonic analysis. About 50 L water was filtered through plankton net and preserved with buffered formalin for zooplanktonic sample collection. Details of the planktonic survey locations are shown in ***Table 4.29*** and shown in a map in ***Figure 4.2*** and photographic representation of collection of plankton samples are shown in ***Figure 4.60.***

Table 4.29 Plankton Survey Locations

SN.	Sampling location	Code	Monitoring Date	Geographic location
1	500 m west towards the sea from the landfall point	B1	16.11.2016	21°51'50.09"N 91°50'5.85"E
2	3000 m west towards the sea from the landfall point	B2	16.11.2016	21°51'33.90"N 91°48'42.55"E
3	1500 m South West towards the sea from the landfall point	B3	16.11.2016	21°51'3.26"N 91°49'42.81"E
4	1500 m North West towards the sea from the landfall point	B4	16.11.2016	21°52'28.49"N 91°49'46.05"E

SN.	Sampling location	Code	Monitoring Date	Geographic location
5	300 m towards the Kutubdia channel from right bank near to the Dhurung ghat	B5	17.11.2016	21°53'3.25"N 91°53'51.61"E
6	300 m towards the Kutubdia channel from left bank near to the Chunura ghat	B6	17.11.2016	21°53'14.81"N 91°54'39.05"E

Source: ERM Ecological Survey during14th to 20th November 2016

Figure 4.60 Photographic representation of Plankton Sample Collection

Source: ERM Ecological Survey during14th to 20th November 2016

Phytoplankton Analysis

340. Total phytoplanktonic density was much higher at the samples collected from *Kutubdia* Channel (5,642 & 7,040 individuals/L) compared to the Bay of Bengal samples (586-1,652 individuals/L). Phytoplankton community was represented by 17 genera. Among the phyoplanktonic genera *Nitzschia* sp. was the most dominant followed by *Navicula* sp. and *Synedra* sp. Phytoplankton community compositions at the monitored location are presented in ***Table 4.30.***

Table 4.30 Phytoplankton Community Composition at the Monitored Locations

SN	Phytoplankton Taxa/species	Number (individuals/L)					
		B1	B2	B3	B4	B5	B6
1	*Acanthes sp.*	32	40	7	25	94	74
2	*Amphipora sp.*	11	9	29	8	38	4
3	*Amphora sp.*	40	33	86	36	112	1,82
4	*Ceratium sp.*	29	-	25	17	309	1,04
5	*Chaetoceros sp.*	82	-	16	11	211	2,78
6	*Coscinodiscus sp.*	-	5	9	27	1,34	1,56
7	*Cyclotella sp.*	78	90	83	103	3,86	4,60
8	*Melosira sp.*	60	77	13	45	2,45	1,02

SN	Phytoplankton Taxa/species	Number (individuals/L)					
		B1	B2	B3	B4	B5	B6
9	*Navicula sp.*	234	220	10	273	1,219	1,782
10	*Nitzschia sp.*	892	72	155	405	1,510	2,751
11	*Pleurosigma sp.*	12	19	32	44	98	41
12	*Rhizosolenia sp.*	-	2	13	-	43	24
13	*Skeletonema sp.*	70	182	72	204	564	321
14	*Synedra sp.*	103	-	25	-	412	5,67
15	*Thalassionema sp.*	-	2	9	14	187	24
16	*Thalassiosira sp.*	-	-	2	23	52	1,70
17	*Triceratium sp.*	9	4	-	-	28	-
	Total	**1652**	**755**	**586**	**1235**	**5,642**	**7,040**

Source: ERM Ecological Survey during14th to 20th November 2016

Zooplankton analysis

341. Similar to that of phytoplankton samples, total zooplankton densities were much higher at the samples collected from *Kutubdia* Channel (4,513 & 2,930 individuals/L) compared to the Bay of Bengal samples (716-1,502 individuals/L). Zooplankton community was represented by 23 genera. Among the zooplanktonic genera Crab Zoea was most dominant followed by Copepod nauplii and *Penaus* sp. Zooplankton community compositions at the monitored locations are presented in ***Table 4.31***.

Table 4.31 Zooplankton Community Composition at the Monitored Locations

SN	Zooplankton Taxa/ species	Number (individuals/L)					
		B1	B2	B3	B4	B5	B6
1	*Heliosoma sp.*	-	-	-	2	13	8
2	*Diphyes sp.*	2	6	1	3	22	14
3	*Lensia sp.*	18	11	-	-	32	21
4	*Cresis sp.*	5	7	5	8	25	16
5	*Notobranchaea*	11	10	-	3	37	24
6	*Haloptilus sp.*	10	-	-	-	12	8
7	*Centropages sp.*	11	9	-	-	26	17
8	*Euchaeta sp.*	2	5	4	11	27	14
9	*Calocalanus*	27	35	38	52	132	86
10	*Acetes indicus*	78	66	70	12	142	92
11	*Calanopia sp.*	92	106	89	21	119	77
12	*Calanus sp.*	135	108	71	99	410	267
13	*Evadues sp.*	101	139	29	128	288	187
14	*Lucifer sp.*	57	15	21	14	341	222
15	*Penaeus sp.*	118	34	6	31	484	315
16	*Microsetella sp.*	48	110	73	101	228	148
17	*Oithona sp.*	20	15	31	34	176	114
18	*Sagitta sp.*	152	124	13	114	319	207
19	Polycheate larvae	28	37	18	24	352	229
20	Crab zoea	174	215	101	128	446	290
21	Barnacle nauplius	145	130	18	110	311	202
22	Bivalve larvae	78	70	23	64	144	94
23	Copepod nauplii	190	206	105	82	427	278
	Total	**1,502**	**1,458**	**716**	**1,041**	**4,513**	**2,930**

Source: ERM Ecological Survey during14th to 20th November 2016

342. The plankton recorded from the study area is common in occurrence with respect to the aquatic ecosystems in Bangladesh and forms the primary producers and primary consumers in the aquatic ecosystem food chain.

Analyses of Marine Benthic Communities

343. Marine sediment samples collected for analyses of physicochemical characteristics were also analyzed for the benthic communities. Details of the sediment survey locations are shown in ***Table 4.12*** and shown in a map in ***Figure 4.2.*** Composition of benthic communities at the monitored location is presented in ***Table 4.32.***

344. Sediment samples collected from the Bay of Bengal revealed poor benthic community composition represented by only1 to 2 individuals/m^2. Sediment samples collected from the *Kutubdia* Channel revealed comparatively higher concentration of benthic organisms varying from 15 to 25 individuals/m^2. However, the density of benthic organisms were observed poor in the *Kutubdia* Channel. Low density of benthic organisms could be due to low levels of organic carbon (0.31 to 0.45%) in the sediment. Among the organisms higher concentration was recorded form Nematodes and Bivalves.

345. JICA(2013)[1] study conducted in *Kutubdia* Channel also represented low concentration of benthic organisms varying from 3 to 18 individuals/m^2. The composition of benthic organisms found in the JICA study involving Crustaceans, Polychaetes, Bivalves and Gastropods are comparable to the current study.

Table 4.32 Composition of Benthic Communities at Monitored Locations

S N	Benthos Group/ species	Number (individuals/m^2)			
		SD1	SD2	SD3	SD4
1	Gastropoda				
2	*Mactra sp.*	-	-	5	9
3	Polychete	-	-	3	1
4	*Duplex sp.*	1	-	2	1
5	*Nematode sp.*	-	1	3	11
6	*Lumbrineris sp.*	-	1	2	-
7	Bivalvia	-	-	-	11
8	Crustacea	-	-	-	2
	Total	**1**	**2**	**15**	**35**

Source: ERM Ecological Survey during14th to 20th November 2016

Vegetation in Aquatic Ecosystem

346. Aquatic vegetation from the village ponds in the study area includes species of Eichhornia crassipes, Hydrilla verticillata, Hygrophila auriculata, Hygroryza aristata, Lemna perpusilla, Nymphaea nouchali, Ipoemea aquatica, Pistia stratiotes, Spirodela polyrhiza and Centrostachys aquatic.

[1] JICA, 2013. Environmental Impact Assessment of Construction of Matarbari 600X2 MW Coal Fired Power Plant and Associated Facilities

Aquatic Faunal Species-Inland Fishes

347. Fishery survey was undertaken during November 2016. Survey indicated that around 400 numbers of ponds were present in *Kutubdia* and among them 20 ponds were used for commercial aquaculture. Major fish species cultured were Pangas (*Pangasius pangasius*), Tilapia and Rui (*Labeo rohita*). As most of the marine fishes caught were not available sold in local fish market of *Kutubdia*, people of *Kutubdia* depend on these freshwater fishes for consumption. The yearly production of these freshwater fishes is approximately 30 tons. Tilapia was the highly priced among the freshwater cultured fishes. Common fish species in inland are Rui (*Labeo rohita*), Catla (*Catla catla*), Mrigal (*Cirrhina mrigala*) and exotic fishes Tilapia (*Tilapia nilotica*), Grass Carp (*Ctenopharyngodon idella*), Silver Carp (*Hypopthalmichthys militia)*, Big Head (*Hypopthalmicthys nobilis)Anabas testudineus* (Koi), *Clarias batrachus* (Magur), *Hetropneustes fossilis* (Sing), *Channa punctatus* (Taki), *Mystus tengra* (Tengra), *Glossogobius giuris* (Baila), *Gadusia chapra* (Chapila), *Chanda ranga* (Chanda), *Colisa* sp. (Kholisha), *Chana striatus* (Shoal), *Salmostoma phulo* (Chela), *Amblypharyngodon mola* (Mola) and small indigenous fish like *P. sarana* (raj punti), *Mastacembalus spp.* (Baim), *M. gulio* (Gulsha), *Nadus nandus* (Raina), *Ailia coila* (Bashpata), *Xenentodon cancila* (Kakila) etc.

Marine Fauna (inclusive of Kutubdia Channel)

348. A five day survey was undertaken by two local fishery experts to *Kutubdia* Island. The information presented is the outcome of their survey.

Fisheries Resources of Kutubdia

349. There were two different kinds of fishing activities on *Kutubdia* Island, (i) deep sea fishing; the fishermen who went to deep sea with mechanized larger boats and stayed 5 to 10 days or even more depending on the distance fishermen cross for a single trip with a group of 7 to 14 or more and (ii) Estuarine and near shore fishing; the fishermen who fish near shore and went on a daily basis and used smaller boats or non-mechanized boats that usually carry 1 to 10 fishermen on board. The fishermen who fish near shore mostly fish all the year round. But the fishermen who fish at deep sea mainly considered October to March as peak fishing season whereas; April to mid-September as a lean fishing season.

350. Deep Sea Fishing

351. Fishermen of *Kutubdia* usually catch fishes all the year. A total of 57 fish species were enumerated based on fisherman consultation in two seasons mentioned by them as summer and rainy season (April –September) and winter season (October-March) which have been listed in the ***Table 4.33***. Two price categories could be identified as more than 400 tk/kg and less than 400 tk/kg.

352. Out of 57 fish species, 24 species were of highly priced and others were low priced. All the fishes had commercial values but Indian Salmon fish was the highest priced fish followed by Triple tailed fish, Silver pomfret, Lady fish and Spotted sickle fish. As per anecdotal information a 30 kg Indian Salmon fish used to sell to the agents of Pharmaceuticals Company for 2-3 lac BDT whereas

20-30 kg Triple tailed fish used to sell at 40,000 to 60,000 BDT. Price of Silver pomfret, Lady fish and Spotted sickle fish varied according to the demand and seasonality. The list of deep sea fishes are given in ***Table 4.33***

i) Near shore and Channel Fishing

353. A total 32 species of fishes were found in Nearshore and Channel of Kutubdia. List of Nearshore and Channel fishes with their seasonal availability and values are given in ***Table 4.34.***

Figure 4.61 Fishery Resources in Study Area

Fishes caught from Kutubdia channel | Fishes caught offshore of Kutubdia

Mechanized fishing boats in Kutubdia | Fishing Net (Matiya & Undara jal)

Open auction in the boat before landing | Fish Market in Kutubdia

Source: Fishery Survey Report on Kutubdia, EQMS, Dec 2016

Table 4.33 List of Deep Sea Fishes Caught by Fishermen of Kutubdia

SN	Local Name	English Name	Scientific Name	Fishing Season	IUCN Consⁿ Status	Value
1.	Aila	Black banded trevally	*Seriolina nigrofasciata*	October-March	Least Concern	Low
2.	Bata	Gold-spot mullet	*Liza parsia*	October-March	Not Assessed	Low
3.	Koral bata	Flathead grey mullet	*Mugil cephalus*	October-March	Least Concern	Low
4.	Chowkha	Big-eye ilish	*Ilish filligera*	October-March	Not Assessed	High
5.	Pan mach	Spotted sickle fish	*Drepane punctata*	April-September	Least Concern	High
6.	Pan mach	Spotted sickle fish	*Drepane longimanna*	April-September	Least Concern	High
7.	Poysha mach	Deep pugnose pony fish	*Scutor ruconius*	October-March	Not Assessed	Low
8.	Futki chapa	Talang quenfish	*Scomberoides commersonianus*	April-September	Not Assessed	Low
9.	Faissa/dati faissa	Long jaw thryssa	*Thryssa setirostris*	October-March	Not Assessed	Low
10.	Sada datina	Silver grunter	*Pomadasys hasta*	April-September	Least Concern	High
11.	Ram chowkkhya	Elongati ilish	*Ilisha elongate*	October-March	Not Assessed	High
12.	Chowkkhya faissa	Jewelled shad	*Ilisha megaloptera*	October-March	Not Assessed	High
13.	Kata gogut	Catfish	*Arius nenga*	October-March	Not Assessed	High
14.	Hatir kan	Spade fish	*Ephippus orbis*	April-September	Not Assessed	High
15.	Toli	Tolishad	*Hilsa toli*	October-March	Not Assessed	High
16.	Ilish	Hilsa shad	*Tenualosa ilisha*	October-March	Least Concern	High
17.	Kamila	Indian Pike conger	*Congresox talabonoides*	October-March	Not Assessed	High
18.	Ram kata	Catfish	*Arius maculates*	October-March	Not Assessed	High
19.	Kaua mach	Hard tail scad	*Megalaspis cordyla*	October-March	Least Concern	High
20.	Khoilla	Grey mullet	*Mugil corsula*	October-March	Least Concern	Low
21.	Gang koi	Triple tailed fish	*Lobotes surinamensis*	October-March	Least Concern	High
22.	Koral	Giant seaperch	*Lates calcarifer*	October-March	Not Assessed	Low
23.	Korati chela	Tenpounders	*Elops machnate*	April-September	Not Assessed	Low
24.	Kuichcha	White spotted moray	*Gymnothorax punctatus*	April-September	Not Assessed	Low
25.	Laukka	Indian salmon	*Polynemus indicus*	October-March	Not Assessed	High
26.	Olua	Neglected grenadier anchovy	*Coilia neglecta*	October-March	Least Concern	Low
27.	Mur baila	Flathead fish	*Platycephalus indicus*	October-March	Data Deficient	Low
28.	Mouri	Shrimp scad	*Alepes djeddaba*	October-March	Not Assessed	High

SN	Local Name	English Name	Scientific Name	Fishing Season	IUCN Consⁿ Status	Value
29.	Pekhom mouri	Indian thread fin	*Alectis indicus*	April-September	Not Assessed	High
30.	Malabar mouri	Malabar cavalla	*Carangoides malabaricus*	April-September	Least Concern	High
31.	Chowkhkha	Yellow strie scad	*Selaroides leptoplepis*	October-March	Not Assessed	Low
32.	Samudrik pangas	Fatty catfish	*Pangasisus pangasius*	October-March	Not Assessed	Low
33.	Hail chanda	Black pomfret	*Parastromateus niger*	April-September	Not Assessed	High
34.	Tobolchi	Ox-eyed scad	*Selar boops*	April-September	Least Concern	High
35.	Takia	Fringe scale sardine	*Sardinella fimbriata*	April-September	Not Assessed	Low
36.	Ram gojar/shol	Cobia	*Rachycentron canadus*	October-March	Not Assessed	Low
37.	Nilambori	Short fin scad	*Decapterus macrosoma*	October-March	Least Concern	Low
38.	Sada datina	Silver grunter	*Pomadasys hasta*	April-September	Least Concern	High
39.	Taila faisa	Hair fin anchovy	*Setipinna taty*	October-March	Not Assessed	Low
40.	Tailla	Fourfinger threadfin	*Eleutheronema tetradactylum*	October-March	Not Assessed	Low
41.	Roissa	Paradise threadfin	*Polynemus paradiseus*	October-March	Not Assessed	High
42.	Tek chanda	Jacks	*Atropus atropus*	April-September	Not Assessed	Low
43.	Tengra	Bagrid catfish	*Mystus gulio*	October-March	Least Concern	Low
44.	Thuitta	Red cornet fish	*Fistularia villosa*	April-September	Least Concern	Low
45.	Hichchiri	White sardine	*Escualosa thoracata*	October-March	Not Assessed	Low
46.	Rupali Chanda	Silver pomfret	*Pampus argentius*	April-September	Not Assessed	High
47.	Undora	Lady fish	*Sillago domina*	October-March	Not Assessed	Low
48.	Lal poa	Silver jew	*Johnius argentius*	October-March	Not Assessed	Low
49.	Churi	Ribbon fish	*Trichiurus savala*	October-March	Not Assessed	Low
50.	Cheowa	Torpedo trevally	*Taenoides anguillaris*	October-March	Not Assessed	Low
51.	Loitta	Bombay duck	*Harpodon nehereus*	October-March	Not Assessed	Low
52.	Maitya	Jack and pompanos	*Cybium guttatum*	April-September	Data Deficient	High
53.	Pata mach	Sole	*Cynoglossus mactostomus*	October-March	Not Assessed	Low
54.	Bom maitya	Tuna	*Euthynnus affinis*	April-September	Least Concern	Low
55.	Bata	Bata	*Mugil cephalus*	October-March	Least Concern	Low
56.	Potka	Potka	*Chelonodon patoca*	October-March	Least Concern	Low
57.	Chiring	Gobi	*Apocryptes bato*	October-March	Not Assessed	Low

Source: Fishery Survey Report on Kurubdia, EQMS, Dec 2016
Notes: High=>400 tk/kg, Low =<400 tk/kg

Table 4.34 List of Nearshore and Channel fishes in Kutubdia

SN	Local Name	English Name	Scientific Name	Seasonal Availability	Commercial Value (High/ Low)	Source of Data
1.	Poysha mach	Deep pugnose pony fish	*Scutor ruconius*	October-March	Low	Boat survey
2.	Faissa/dati faissa	Long jaw thryssa	*Thryssa setirostris*	October-March	Low	Boat survey
3.	Chowkkhya faissa	Jewelled shad	*Ilisha megaloptera*	October-March	High	Boat survey
4.	Roissa	Paradise threadfin	*Polunemus paradiseus*	October-March	High	Boat survey / FGD
5.	Toli	Tolishad	*Hilsa toil*	October-March	High	FGD
6.	Ilish	Hilsa shad	*Tenualosa ilisha*	October-March	High	FGD
7.	Kamila	Indian Pike conger	*Congresox talabonoides*	October-March	High	Boat survey
8.	Ram kata	Catfish	*Arius maculates*	October-March	High	FGD
9.	Kaua mach	Hard tail scad	*Megalaspis cordyla*	October-March	High	FGD
10.	Khoilla	Grey mullet	*Mugil corsula*	October-March	Low	FGD
11.	Korati chela	Tenpounders	*Elops machnate*	April-September	Low	Boat survey
12.	Kuichcha	White spotted moray	*Gymnothorax punctatus*	April-September	Low	Boat survey
13.	Olua	Neglected grenadier anchovy	*Coilia neglecta*	October-March	Low	Boat survey
14.	Chowkhkha	Yellow stripe scad	*Selaroides leptoplepis*	October-March	Low	FGD
15.	Tobolchi	Ox-eyed scad	*Selar boops*	April-September	High	FGD
16.	Takia	Fringe scale sardine	*Sardinella fimbriata*	April-September	Low	Boat survey
17.	Taila faisa	Hair fin anchovy	*Setipinna taty*	October-March	Low	Boat survey
18.	Tailla	Fourfinger threadfin	*Eleutheronema tetradactylum*	October-March	Low	Boat survey
19.	Roissa	Paradise threadfin	*Polunemus paradiseus*	October-March	High	Boat survey
20.	Tengra	Bagrid catfish	*Mystus gulio*	October-March	Low	Boat survey
21.	Hichchiri	White sardine	*Escualosa thoracata*	October-March	Low	Boat survey
22.	Undora	Lady fish	*Sillago domina*	October-March	Low	FGD
23.	Lal poa	Silver jew	*Johnius argentius*	October-March	Low	FGD
24.	Churi	Ribbon fish	*Trichiurus savala*	October-March	Low	Boat survey
25.	Cheowa	Torpedo trevally	*Taenoides anguillaris*	October-March	Low	FGD

SN	Local Name	English Name	Scientific Name	Seasonal Availability	Commercial Value (High/ Low)	Source of Data
26.	Loitta	Bombay duck	*Harpodon nehereus*	October-March	Low	Boat survey
27.	Bata	Bata	*Mugil cephalus*	October-March	Low	Boat survey
28.	Potka	Potka	*Chelonodon patoca*	October-March	Low	Boat survey
29.	Chiring	Gobi	*Apocryptes bato*	October-March	Low	Boat survey
30.	Sada chingri	White shrimp	*Penaeus indicus*	All the year	High	Boat survey
31.	Horina chingri	Brown shrimp	*Metapenaeus monoceros*	All the year	High	Boat survey
32.	Chali chingri	Yellow shrimp	*Metapenaeus brevicornis*	All the year	High	Boat survey

Source: Fishery Survey Report on Kurubdia, EQMS, Dec 2016
Notes: High=>400 tk/kg, Low =<400 tk/kg

354. Hilsa (*Tenualosa ilisha*) fishing becomes intense during the months of May to October and in November and December. All types of mechanized boats usually engaged in nearshore to deep sea Hilsa fishing. Unfortunately this year Hilsa was drastically reduced in the month of November and the fishermen informed that it was due to the synchronization failure of ban on Hilsa fishing and Hilsa breeding time. Local fishermen informed that, once some fishermen made pen in salt production area of *Kutubdia* to encircle a school of Hilsa fish and tried to nurse/rear them but this type of activities were not found during the survey.

355. *Threatened fish species:* Based on the fishery survey and focus group discussion (FGD), it was found that only two species of fishes were threatened and these were Korat mach (*Anoxypristis cuspidata* is listed as Endangered as per *IUCN Red List v 2017.1.*) and Koiputi (*Anodontostoma chacunda*) is now a rare locally.

356. *Fishing* Boats*:* Mainly two types of boats were used by the fishermen *i.e.* Mechanized and Non-mechanized. The characteristics of these boats with CPUE are presented in ***Table 4.35.*** The CPUE were always variable as mentioned in the table.

Table 4.35 Boats in Use by Fishermen of Kutubdia

SN.	Types of boat	Sub-category (SC)	Engine power (hp) and freeze chamber	Number of fishermen in operation	Fishing area Offshore / Nearshore / Channel	CPUE Kg/Haul
1.	Mechanized	SC-1	18-22	5-7	Nearshore and Channel	5-50
		SC-2	45-65 with two freeze chamber	7-10	Offshore	20-200
		SC-3	70-110 with three freeze chamber	9-14	Offshore	50-300
2	Non-mechanized			Channel	0.5-10	1-2

357. *Fishing Gear:* Different types of gears are being used by the fishermen of *Kutubdia*, which are listed in the table below. Most fishermen used Ilish jal, Maitya jal and Undara jal for deep sea fishing while Behundi jal for nearshore fishing. Details on the gears are listed on ***Table 4.36***

Table 4.36 Types of Gears in Use for Fish Catch in Kutubdia Region

SN	Local Name	Common Name	Price, BDT	Major types of fishes caught
1.	Ilish jal	Gillnet for Hilsa	3-4 lacs	Hilsa
2.	Maitya jal	Large Mesh Drift Gill net	1-1.5 lacs	Indian salmon, Surma, Gang koi and other deep sea fishes
3.	Behundi jal	Set bag net for jewfish	0.6-0.8 lac	Deep sea fishes
4.	Undara jal	Set bag net for jewfish	1.5-2 lacs	Lady fish (Undara) and other deep sea fishes
5.	Behundi jal	Estuarine set bag net	0.2-0.4 lac	Shrimp, Crabs, Hicchir

Fish Market Survey

358. Only one very small sized fish market was observed at *Boroghop* area of *Kutubdia*. Only few species of fishes were sold in that market. Of them Pangas (*Pangasius pangasius*), Tilapia and Rui (*Labeo rohita*) are mentionable. The sellers used to sell fish whenever the Paikers delivers the fishes to the market. Two types of Pikers were found within the fish marketing system of *Kutubdia*. One type of Paikers had their own mechanized boats and competed in the open auction whenever any mechanized boat arrived at shore and bought the fishes and then sailed for *Chittagong or Cox's Bazar* landing center. Second type of Paikers usually participated in the open auction in the smaller sized boats and bought the fishes and brought them to the fish market.

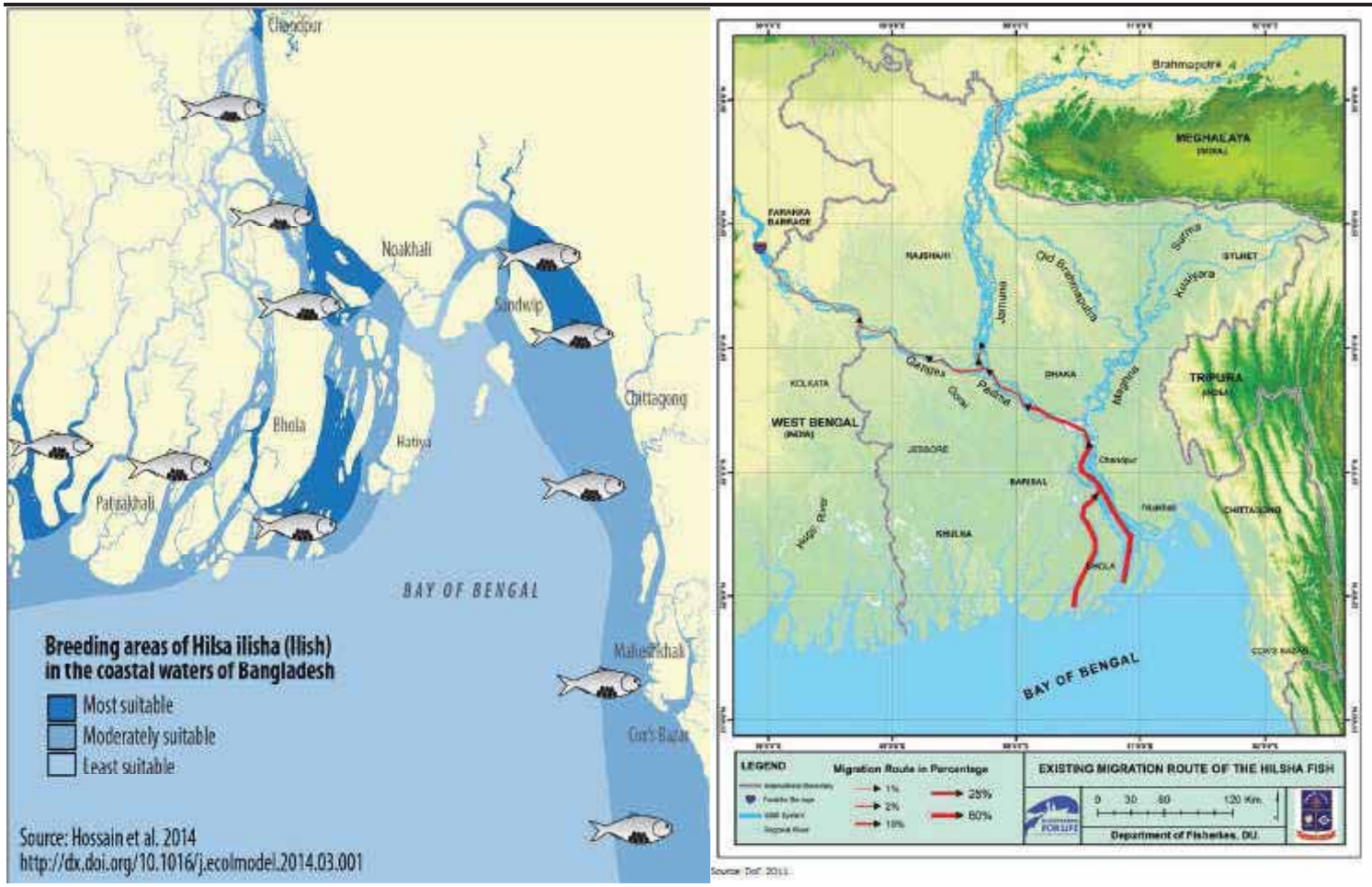
359. Nearshore areas of *Kutubdia* were fishing grounds of Loitta, Churi, Olua Kamila and Ramkata. Other fishes listed in ***Table 4.33*** were mostly caught in offshore areas (Deep Sea) of *Kutubdia* and local people informed that those deep sea areas were also their breeding grounds. Also, according to local people, *Kutubdia* Channel seemed to be both breeding and fishing ground of Icha, Hicchir, Chiring and Chewa.

Migratory Route of Hilsa

360. During the local consultation with fisherman and fishery department it was known that before 2000s, Hilsa were found in the *Kutubdia* Channel but now-a-days due to the presence of high anthropogenic activities and local fishing Hilsa population changed the route of migration. During the consultation with local fishermen and Department of Fisheries, it was revealed that Hilsa migrate from deep sea towards Gandamara Point at Bashkhali where they breed and then the school begin its journey to enter into Meghna River system. The Gandamara Point is located at the 7 km North of the Kutubdia Island and no Project related activities are envisaged in this area.

361. The breeding areas of Hilsa fish and identified Hilsa migration routes in Meghna and Padma River system are given in ***Figure 4.62.*** The project site and study area fall in moderately suitable habitat for Hilsa breeding.

Figure 4.62 Hilsa Breeding Map in Bangladesh and Major Hilsa migration routes in Meghna and Padma River System



Source: DoF (2008). Fisheries Statistical Yearbook of Bangladesh 2006-07. Bangladesh: Department of Fisheries, MoFL.
IUCN Publication: Migration, Spawning Patterns and Conservation of Hilsa Shad (*Tenualosa ilisha*) in Bangladesh and India by Dewan Ali Ahsan, M Niamul Naser, Utpal Bhaumik,Sugata Hazra and Subhra Bikash Bhattacharya http://cmsdata.iucn.org/downloads/iucn_hilsa_study.pdf

Marine Herpetofauna

362. The marine herpetofauna reported during community consultation and stakeholder consultations such as Forest Range officer of *Chittagong* Coastal Forest Division and Marine Life Alliance, a NGO working for Turtle Conservation in the *Cox's Bazar* area. The predominant reptile known for using Western coast of *Kutubdia* Islands for egg nesting is Olive Ridley's Turtle (*Lepidochelys olivacea) IUCN* listed Vulnerable 2017.1 and locally listed as Vulnerable. Primary survey was also conducted during the coastline Survey from *Bargop Bazar* area to *Miyarkata* Village in north of *Kutubdia* Island. No direct evidences of Olive ridley nesting sites can be identified during the survey due to non nesting season. Nesting in the Island is reported from (December to February/March) however, possible Olive ridley turtle nesting sites along with the turtle number annually was consulted with the local villagers. Visual identification of species was assisted with the help of field guides. The photographic representation is presentation in ***Figure 4.63*** and ***Figure 4.64***

Figure 4.63 Community Consultation during Coastline Survey for Turtle Nesting Site

Source: ERM Ecological Survey during14th to 20th November 2016

Figure 4.64 Stakeholder Consultation for Turtle Nesting Site

With Range Officer, Kutubdia Range Officer

With Marine life Alliance NGO working on Turtle Conservation

Source: ERM Ecological Survey during14th to 20th November 2016

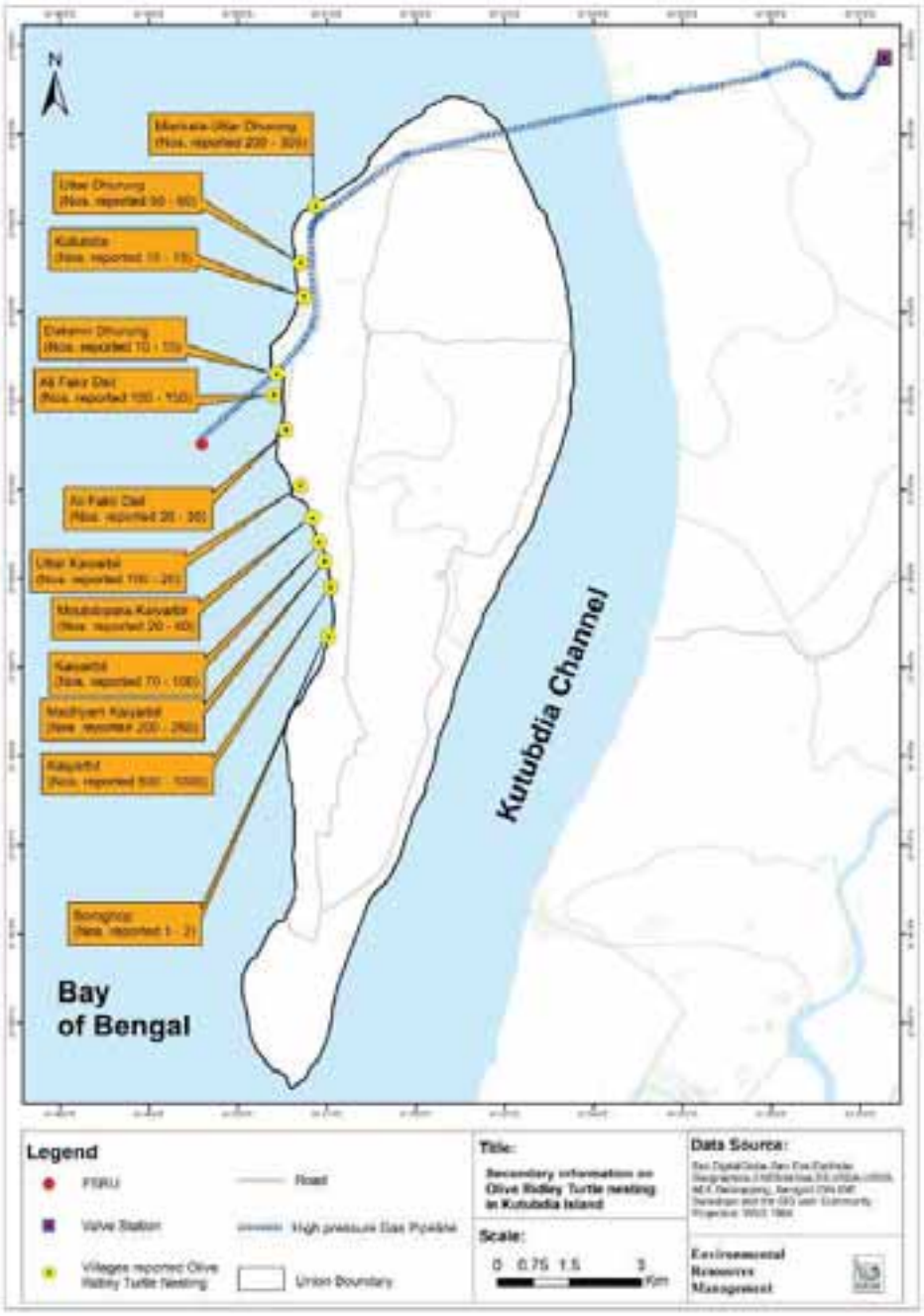
363. Isolated Olive turtle nesting is reported all along the west coast of *Kutubdia* Island. Consultations with local Biodiversity Experts working on turtle conservation in the *Moheshkhali* region as well as the community indicated that only sporadic nesting occurs in *Kutubdia* Island and it is not a critical habitat. It was also confirmed that nesting is reported mostly from the Southernmost tip of the Island in *Ali Akbar Deil*. These nesting are very sporadic and cannot be identified as mass nesting sites such as in notified ecologically critical areas such as *Sonadia* Islands in the southern part of *Moheshkali* Island. As indicated above the nesting season is from December to February/March, it is suggested to survey the coastline in the vicinity of the Project area prior to start of construction activity so as to avoid any impact of the Project activity. Mitigation measures suggested will be followed in case of sighting of any turtle nesting sites.

364. In addition to Olive Ridley Turtles, Green Sea Turtle (*Chelonia mydas*) IUCN listed Endangered v. 2017.1 and Hawksbill Turtle (*Eretmochelys imbricate*) IUCN listed Critically Endangered v 2017.1 also nest in the west coast of entire *Cox's Bazar* District and their nesting is reported(1)(2) in close by sandy beaches of *Sonadia* Island and *Matarbari* Island. There is a strong likelihood of these species nesting in *Kutubdia* Island and there is a requirement to undertake a primary survey to confirm their presence prior to start of construction activities. Map showing the nesting sites based on community consultation is given in ***Figure 4.65.***

(1) Hossain,MA; Miah,MI; Hasan,KR; Bornali,JJ; Shahjahan, M (2013) Present status of conservation and management of sea turtle in Cox's Bazar district of Bangladesh. Bang. J. Anim. Sci. 42 (2): 131- 138

(2) Rashid-S.M.A.-M.Z.-Islam.-2006.-Status-and-conservation-of-marine-turtles-in-Bangladesh.-In-Marine-turtles-of-the-Indian-subcontinent-Pp.-200-216

Figure 4.65 Olive Ridley Turtle Nesting Reported in Community Consultation during the Coastline Survey



Source: ERM Ecological Survey during14th to 20th November 2016; Note: It is to be noted that the figure denotes the number and presence of Olive Ridley Turtles as reported by villagers of Kutubdia Island during the coastline surveys. However, no authentic survey findings or veritable literature (research papers, forest department reports etc.) is available to confirm the presence and numbers as has been reported during the aforementioned consultation with villagers.

Marine Mammals

365. Four marine Dolphin species were reported by the local fishermen (near day fishing zones (5 – 10 km) of Kutubdia Island and also further offshore areas. The dolphin species reported are not critically endangered, endemic, migratory, congregatory or restricted range species and thus the habitat is not expected to

be a critical habitat for the reported dolphins. The species list is given in ***Table 4.37.***

Table 4.37 Marine Mammal Species Reported within the Study Area

S N.	Common Name	Scientific Name	Local Name	IUCN BD	IUCN Global	WLPA 2012
1.	Indo-pacific Humpback Dolphin	*Sousa chinensis*	Golapi Dolphin	Least Concern	Near Threatened	Sch-I
2.	Indo-Pacific Bottlenose Dolphin	*Tursiops aduncus*	Botolnaak Samudrik Shishu	Least Concern	Data Deficient	Sch-I
3.	Irrawaddy Dolphin	*Orcaella brevirostris*	Iraboti	Near Threatened	Vulnerable	Sch-I
4.	Indo-Pacific Finless Porpoise	*Neophocaena phocaenoides*	Paknahin Choto Shishu	Near Threatened	Vulnerable	Sch-I

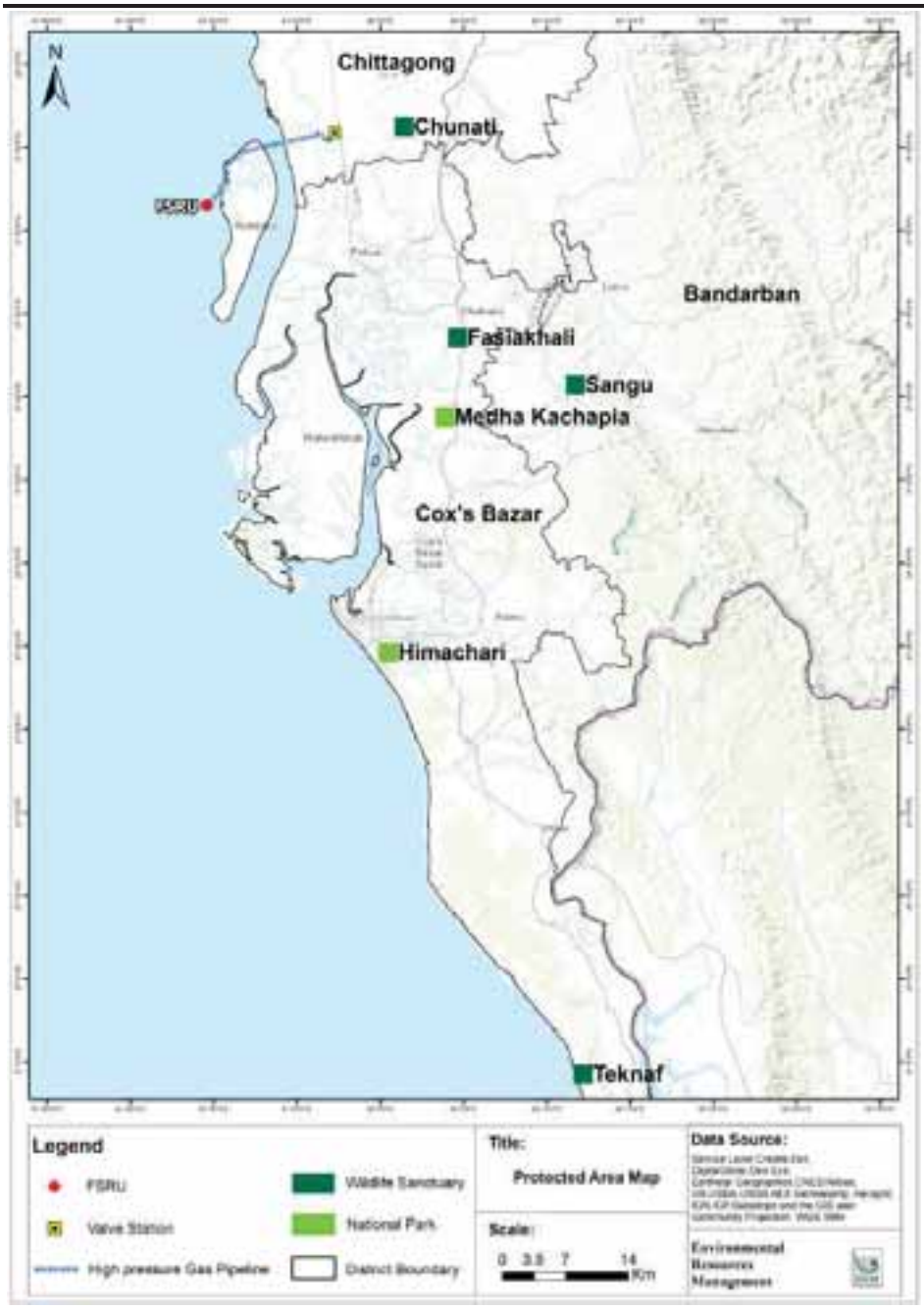
Source: ERM Ecological Survey during14th to 20th November 2016

4.17.8 Protected Area

366. There are no protected areas like National Park, Wildlife Sanctuary, etc. within the study area of 10 km radius from FSRU location. The nearest protected area is **Chunati Wildlife Sanctuary**, which is approximately 23 km from the FSRU.

367. The protected areas in the south-eastern part of Bangladesh (*Chittagong – Cox's Bazar* region) are presented in ***Figure 4.66***.

Figure 4.66 Protected Areas of the Region in Bangladesh



Source Fifth National Report to the Convention on Biological Diversity (Biodiversity National Assessment 2015), DoE, Nov 2015

4.17.9 Ecologically Critical Areas (ECAs)

368. Based on significance and ecological sensitivity, Department of Environment (DoE) has declared a number of areas as Ecologically Critical Areas (ECAs) There is no ECAs within the study area. The nearest ECA is at *Sonadia* about 36 km far from the proposed project site. The ECAs in the south-eastern part of Bangladesh are presented in ***Figure 4.67***

4.17.10 Other Sensitivities

369. Mangrove vegetation has been recorded from the south-eastern part of the *Kutubdia* Island, especially around the *Boroghop Ghat*. This patch of mangrove vegetation has been artificially established by the Forest Department. The species of mangrove primarily planted includes *Keora* (*Sonneratia apetala*) and *Byne* (*Avicennia sp*.).

370. The nearest coral reef to the Project site is at the St. Martin's Island approximately 148 km South of *Kutubdia*. The region around St. Martin's Island is rich in biodiversity and has coral reefs and sea grass bed or seaweed bed. It's also declared as an Ecologically Critical Area by the Department of Environment.

371. *Sonadia* Island situated at the southern tip of *Moheshkali* Island is known site for mass turtle nesting and wintering ground for Critically Endangered Spoonbilled Sandpiper.

372. No seagrass habitat is reported to be within 10 km area of the Project site.

4.17.11 Critical Habitat Assessment

373. IFC Guidance Notes (GN57) for PS-6 defines that internationally and/or nationally recognized areas of high biodiversity value will likely qualify as Critical Habitat (CH), which includes Protected Areas, Important Bird Areas (IBA). The study area is not located in proximity to any protected areas and IBAs.

Critical Habitat Triggers

374. Critical habitat is defined under IFC PS6. Critical habitats are areas with: high biodiversity value, including;

(i) habitat of significant importance to Critically Endangered and/or Endangered species;
(ii) habitat of significant importance to endemic and/or restricted range species;
(iii) habitat supporting globally significant concentrations of migratory species and/or congregatory species;
(iv) highly threatened and/or unique ecosystems; and/or
(v) areas associated with key evolutionary processes "

375. Assessment for Critical Habitat is undertaken as a screening process against the criteria defined within the IFC PS 6 Guidance Note. Criterion relevant for triggering the CHA as per IFC PS-6 is presented in ***Annex 12 (Section 4)***. As per the Criteria the candidate Critical Habitat species are;

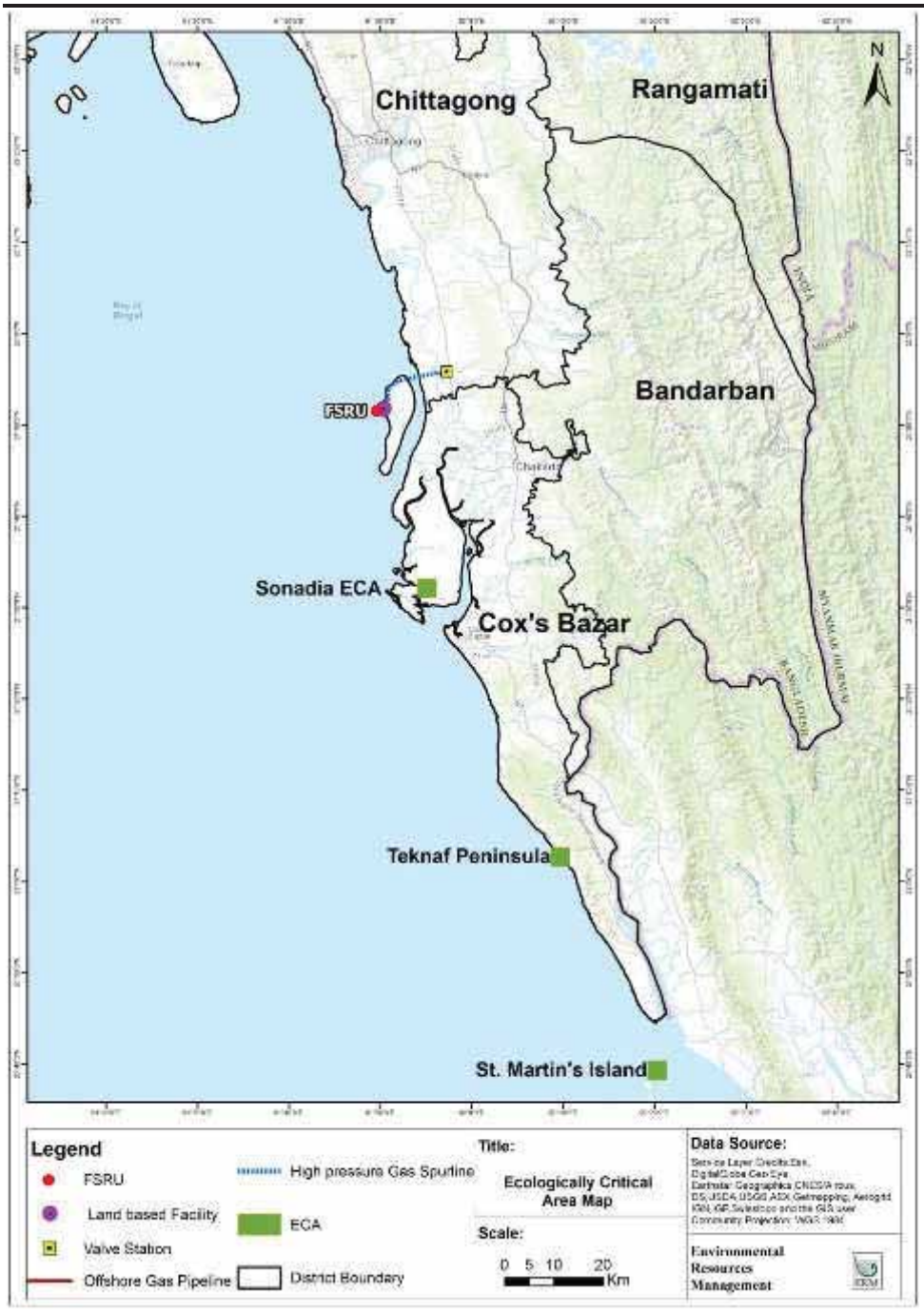
- Knifetooth Sawfish- Korat Machh (*Anoxypristis cuspidata*), IUCN Endangered species (Criteria 1 Tier 2c and e)
- Olive Ridley Turtle (*Lepidochelys olivacea*), Migratory and Congregatory Species (Criteria 3 Tier 2b and e)

- 25 migratory avifaunal species recorded during this survey and other surveys conducted by ERM in the area (Criteria 3 Tier 2b).

376. The screening process of candidate Critical Habitat species is presented in ***Annex 12 (Section 4)***. The screening process indicates that no species is likely to trigger criterion for Critical Habitat.

377. Regarding Hilsa, it needs to be noted that it is not a threatened species and the reported migratory pathway is not designated as an ecologically sensitive / protected area. Hence it is not expected to trigger any critical habitats as per IFC PS. During the consultation with local fishermen and Department of Fisheries, it was revealed that Hilsa migrate from deep sea towards Gandamara Point at Bashkhali where they breed and then the school begin its journey to enter into Meghna River system. The Gandamara Point is located at the 7 km North of the Kutubdia Island and no Project related activities are envisaged in this area.

Figure 4.67 Ecologically Critical Area of Bangladesh



Source: Fifth National Report to the Convention on Biological Diversity (Biodiversity National Assessment 2015), DoE, Nov 2015

4.18 SOCIO-ECONOMIC PROFILE

378. The Project site is located in *Dakshin Dhurung* and *Kaiyarbil* Union *Parishads* of *Kutubdia Upazila* (Sub-district) in the *Cox's Bazar* District and an associated proposed onshore gas pipeline from land based facility – the Project site to GTCL terminal at Napura-Valve station No.2 at *Puichhari* Union of *Banshkahli Upazila* in *Chittagong* District has also been proposed. Based on the assessment of the Project, its surroundings and its environmental & social influence, a 10 km radius for the study area around the FSRU and additionally 500 meter buffer on either side along the proposed pipeline route is considered as the study area. The study area for Landfall Point Facility falls entirely within *Kutubdia Upazila* while study area for the pipeline falls in *Kutubdia Upazila* as well as *Chhanua* and *Puichhari* Unions in *Banshkhali Upazila*. ***Table 4.38*** indicates the location of Poject activity across Unions, Upazila and Districts. The socio-economic features of the *Kutubdia Upazila* and *Chhanua* and *Puichhari* Union of *Banshkhali Upazila* in *Chitagong* District are discussed in this section.

Table 4.38 Study Area

Project Activity	Location		
	Union Parishad	Upazila	District
Landfall Point Facility	Dakshin Dhurung	Kutubdia Upazila	Cox's Bazar District
	Kaiyarbil	Kutubdia Upazila	Cox's Bazar District
Onshore Proposed RLNG Pipeline	Uttar Dhurung	Kutubdia Upazila	Cox's Bazar District
	Chhanua	Banshkhali Upazila	Chittagong District
	Puichhari		

4.18.1 *Administrative Structure*

Cox's Bazar District:

379. The *Cox's Bazar* District is bounded by the *Chittagong* District on the North, the Bay of Bengal on the South and West and the *Bandarban* District on the East. This district also shares an international boundary with Myanmar on the East. The total area of the district is 2,491.85 sq. km. *Cox's Bazar* District; it was formerly a sub-division of *Chittagong* District. It was constituted as a sub-division in 1,854 and comprised of *Cox's Bazar Sadar*, *Chakoria*, *Moheskhali* and *Teknaf Thanas*. Subsequently three new *Thanas* were added under this subdivision namely *Ukhia, Kutubdia* and *Ramu*. Under the decentralization scheme these *Thanas* were transformed into *Upazilas* and the *Cox's Bazar* subdivision was promoted to a district in 1984. Presently, this district consists of 8 *Upazilas*, 71 Unions, 182 *Mauzas*, 989 villages, 4 *Paurashavas*, 39 wards and 164 *Mahallas*. The *Upazilas* are *Chakoria, Cox's Bazar Sadar, Teknaf, Kutubdia, Moheshkhali, Pekua, Ramu* and *Ukhia*.

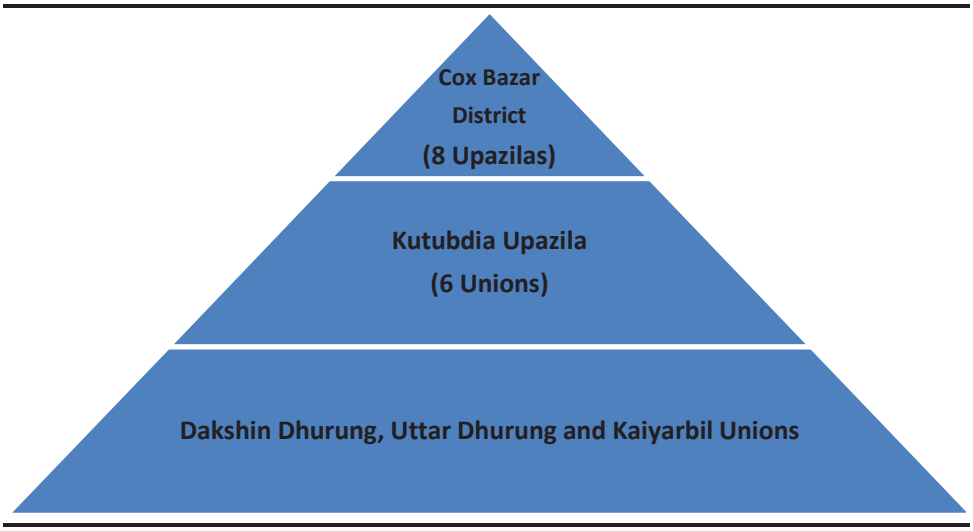
380. *Kutubdia Upazila*: The *Kutubdia Upazila* is located between.21°43´ and 21°56´ north latitudes and between 91°50´ and 91°54´ east longitudes and occupies an area of 215.79 sq. km. This *Upazila* is an island of the Bay of Bengal and is further divided into 6 Unions, 9 *Mouzas* and 55 villages.

381. *Dakshin Dhurung Union*: The *Dakshin Dhurung* Union is located between.21°43´ and 21°56´ north latitudes and between 91°50´ and 91°54´ east longitudes and occupies an area of 6.01 sq. km.

382. *Kaiyarbil Union*: The *Kaiyarbil* Union is located between. 21°51'and 21°48'north latitudes and between 91°50' ´ and 91°51' east longitudes and occupies an area of 3.6 sq. km.

383. *Uttar Dhurung Union*: The *Uttar Dhurung* Union is located between.21°53´ and 21°55´ north latitudes and between 91°50´ and 91°53´ east longitudes and occupies an area of 11.49 sq. km.

Figure 4.68 Administrative Set up of the Study Area



Source: Population and Housing Census of Cox's Bazar District, 2011

Chittagong District

384. Chittagong is bounded on the north by Feni and Khagrachhari District and Tripura state of India, east by Khagrachhari, Rangamati and Bandarban District, on the south by Cox's Bazar District and on the west by the Bay of Bengal and Noakhali District. The total area of the Chittagong District is 5,282.92 sq. km of which 1700 sq. km including coastal area is under forest. It lies between 21°54' and 22°59' north latitude and between 91°17' and 92°13' east longitude. The district consists of 14 Upazilas, 11 metropolitan thanas, 194 unions, 890 populated mauzas and 1,288 villages. It has one city corporation comprising of 41 wards and 237 mahallas. It has also 10 paurashavas having 90 wards and 199 mahallas. The upazilas are Anowara, Banshkhali, Boalkhali, Chandanaish, Fatikchhari, Hathazari, Lohagara, Mirsharai, Patiya, Rangunia, Raozan, Sandwip, Satkania and Sitakunda. The metropolitan thanas are Bakalia, Bayejid Bostami, Chandgaon, Bandar (Chittagong Port), Double Mooring, Halishahar, Khulshi, Kotwali, Pahartali, Panchlaish and Patenga.

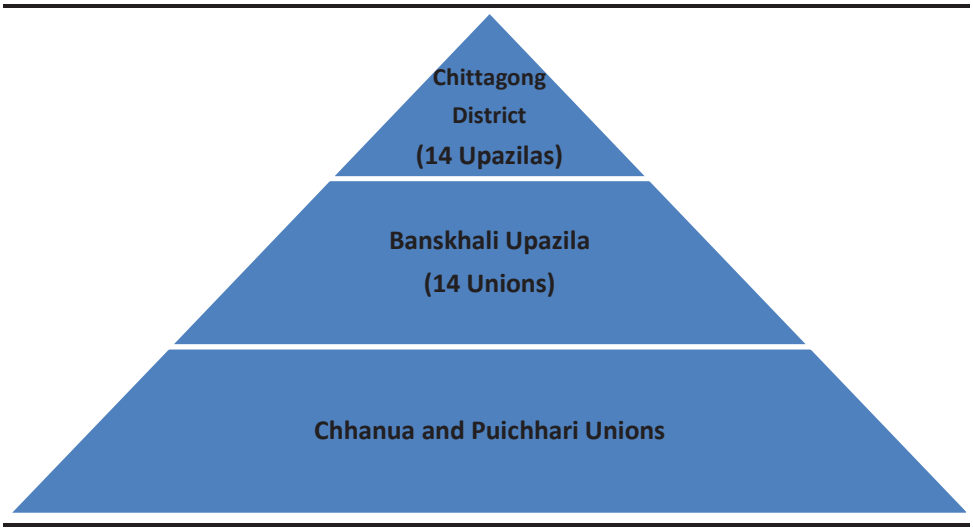
385. ***Banskahli Upazila:*** The *upazila* occupies an area of 376.90 sq. km. including 85.80 sq. km. forest area. It is located in between 21°53' and 22°11' north latitudes and in between 91°51' and 92°03' east longitudes. The upazila is bounded on the north by Sangu River and *Anowara Upazila*, on the east by *Satkania* and *Lohagara*

Upazilas, on the south by *Pekua* and *Chakaria Upazilas* of *Cox's Bazar* District and on the west by the Bay of Bengal. The upazila consists of 1 paurashava, 9 wards, and 38 mahallas, 14 unions, 70 populated mauzas and 81 villages.

386. *Chhanua Union:* The *Chhanua* Union is located between21°55´ and 21°56´ north latitudes and between 91°54´ and 91°55´ east longitudes and occupies an area of 20.19 sq. km.

387. *Puichhari Union*: The *Puichhari* Union is located between 21°54´ and 21°56´ north latitudes and between 91°55´ and 91°58´ east longitudes and occupies an area of 43.75 sq. km.

Figure 4.69 Administrative Set up of the Study Area



Source: Population and Housing Census of Chittagong District, 2011

4.18.2 Demography of Project Area

388. As per the Census of Bangladesh (2011), the total population of *Cox's Bazar* District and *Chittagong* District is 2,289,990 (comprising of 415,954 households) and 7,616,352 (comprising of 1,532,014 households) respectively. The average annual increase in population since 2001 has been estimated at 2.55% in *Cox's Bazar* District and 1.40% in *Chittagong* District. The ***Table 4.39*** provides an overview on the population trends of *Cox's Bazar* and *Chittagong* Districts over a period of 10 years from 2001 to 2011.

Table 4.39 Population Trends of the Districts

Index	Cox's Bazar District		Chittagong District	
	2011	2001	2011	2001
Total Households	415,954	296,109	1,532,014	1,240,537
Total Population	2,289,990	1,773,709	7,616,352	6,612,140
Change in Population	516,281	354,449	1004212	1,316,013
Average Annual Increase	51,628	35,445	100421	131601
Annual Rate of Growth over a Period of 10 years (percent)	2.55	2.25	1.40	2.24
Average Household (HH) size	5.45	5.99	4.92	5.35

Source: Population and Housing Census 2011, Bangladesh Bureau of Statistics (BBS), 2011

389. The population of *Kutubdia Upazila* and *Banskhali Upazila* is 125,279 and 431,162 as per the 2011 census and constitutes approximately 5.47% and 5.66% of the total population of *Cox's Bazar* and *Chittagong* District. The population density of *Kutubdia* and *Banshkhali Upazilas* is 581 persons and 1,144 persons per square kilometre respectively, which is lower than the average population density of *Cox's Bazar* District (919) and Chittagong District (1442). Gender ratio of *Kutubdia Upazila* has increased from 91 to 95 over the last decade while gender ratio of Banskhali upazila has decreased from 111 to 97. The ***Table 4.40*** accounts for the key demographic indicators of *Kutubdia* and *Banskhali Upazilas*.

Table 4.40 Population Trends of Kutubdia Upazila

Upazila	Index	2011	2001	Percent of District (2011 Census)
Kutubdia	Total Households	22,587	18,368	6.99
	Total Population	125,279	107,221	5.47
	Population Density	581	494	-
	Sex Ratio[1]	105	91	-
	Change in Population	18,058	12,166	-
	Average Annual Increase	1806	1217	-
	Annual rate of Growth over 10 years (%)	1.54	1,21	-
	Average Household Size	5.54	5.83	-
Banskhali	Total Households	84,216	71,229	5.49
	Total Population	4,31,162	3,91,320	5.66
	Population Density	1144	1038	-
	Sex Ratio	97	111	-
	Change in Population	39842	70981	-
	Average Annual Increase	3984	7098	-
	Annual rate of Growth over 10 years (%)	0.96	2.02	-
	Average Household Size	5.11	5.45	-

Source: Population and Housing Census 2011, Bangladesh Bureau of Statistics (BBS), 2011

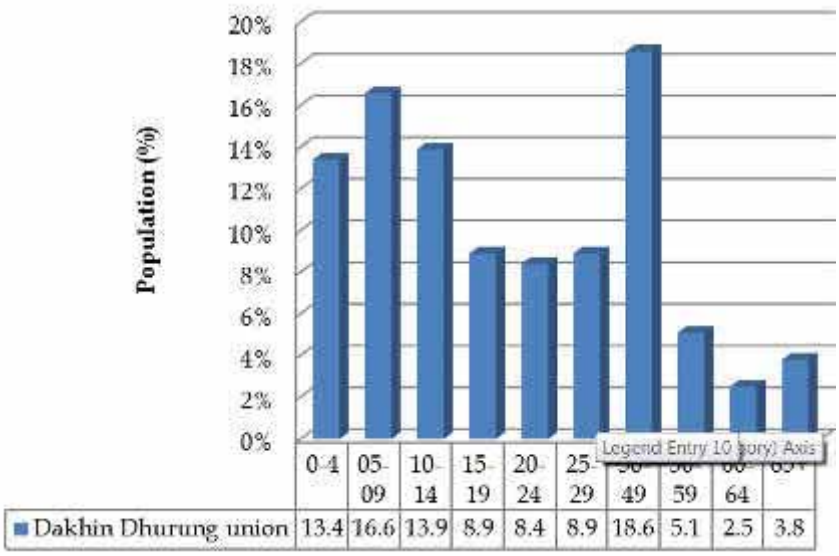
Dakshin Dhurung Union

390. Census of Bangladesh (2011) shows that *Dakshin Dhurung* Union has 17,279 population residing in 2942 household and constitutes approximately 13.79 percent of the total population of *Kutubdia*. The population density of *Dakshin Dhurung* Union is 2,873 persons per square kilometre, which is higher than the average population density of *Kutubdia Upazila* (581) and *Cox's Bazar* District (919). Gender ratio of this Union is 105 which is similar to the *Upazila*.

391. The census of Bangladesh divides the population age groups into ten (10) categories. These being, those below the age of 4, between 5 and 9, 10 to 14, 15 to 19, 20 to 24, 25 to 29, 30 to 49, 50 to 59, 60 to 64 and those above the age of 64 respectively. ***Figure 4.70*** highlights the age-wise distribution of population in *Dakshin Dhurung* Union whereas ***Figure 4.71*** presents a comparative trend in the age-wise population distribution in *Dakshin Dhurung* Union with that of the overall *upazila* and district.

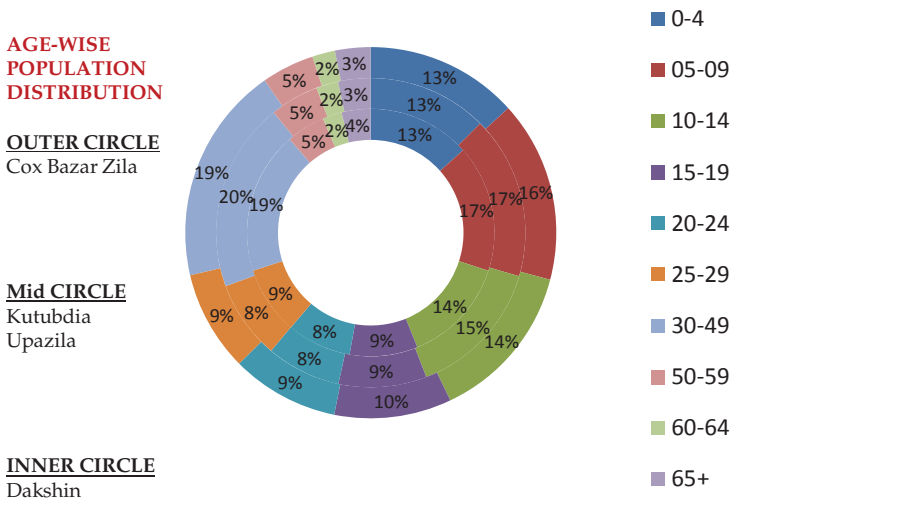
[1] Sex ratio per hundred male

Figure 4.70 Age-Wise Distribution of Population in Dakshin Dhurung Union



Source: Population and Housing Census 2011, Bangladesh Bureau of Statistics (BBS), 2011

Figure 4.71 Comparison of Age-wise Population Distribution of Dakhsin Dhurung Union with Kutubdia Upazila and Cox's Bazar District



Source: Population and Housing Census 2011, Bangladesh Bureau of Statistics (BBS), 2011

392. It can be observed from the above figure that a large percentage of the population (19%) in *Dakshin Dhurung* Union falls within the age group of 30 to 49 years followed by population within the age group of 05 to 09 years (17%) and 10-14 years (14%) respectively. The trend is quite similar for the *Kutubdia Upazila* and *Cox's Bazar* District where the largest percentage of the population falls within the age group of 30 to 49 years.

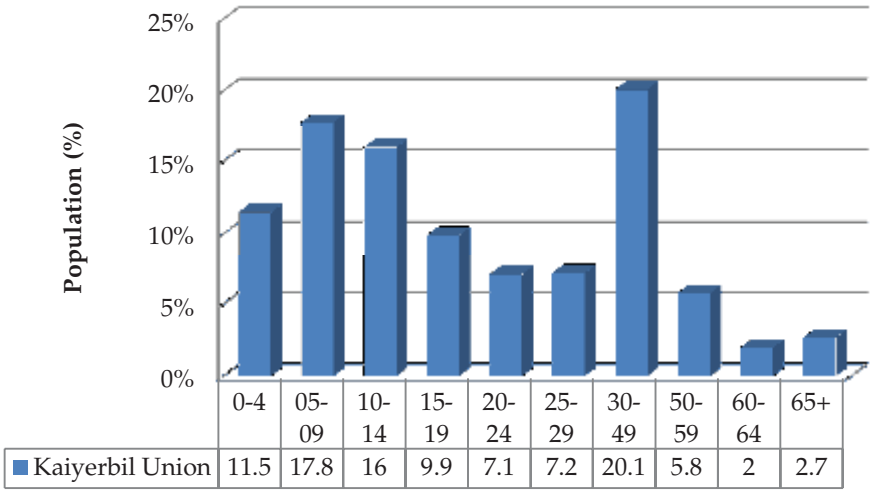
393. Thus 50% of the population in *Dakshin Dhurung* Union falls within an economically active age group (15-59 years), while rest 50% of the population is understood to be dependent. Similar trends are visible in *Kutubdia* and *Cox's*

Bazar District where 52% of the population falls within the economically active age group.

Kaiyarbil Union

394. As per Census of Bangladesh (2011), Kaiyarbil union has a population of 12,945 residing in 2,423 households and constitutes approximately 12.07 percent of the total population of Kutubdia Island. The population density of *Kaiyarbil* Union is 3,595 persons per square kilometre, which is higher than the average population density of *Kutubdia Upazila* (581) and *Cox's Bazar* District (919). Gender ratio of this Union is 98 which is lower than that of the *Kutubdia Upazila*. ***Figure 4.72*** highlights the age-wise distribution of population in Kaiyarbil Union whereas ***Figure 4.73*** presents a comparative trend in the age-wise population distribution in *Kaiyarbil* Union with that of the overall *upazila* and district.

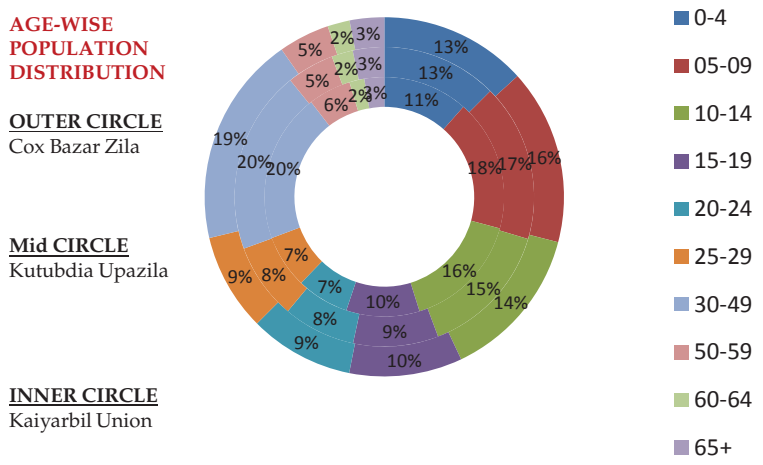
Figure 4.72 Age-Wise Distribution of Population in Kaiyarbil Union



	0-4	05-09	10-14	15-19	20-24	25-29	30-49	50-59	60-64	65+
Kaiyerbil Union	11.5	17.8	16	9.9	7.1	7.2	20.1	5.8	2	2.7

Source: Population and Housing Census 2011, Bangladesh Bureau of Statistics (BBS), 2011

Figure 4.73 Comparison of Age-wise Population Distribution of Kaiyarbil Union with Kutubdia Upazila and Cox's Bazar District



Source: Population and Housing Census 2011, Bangladesh Bureau of Statistics (BBS), 2011

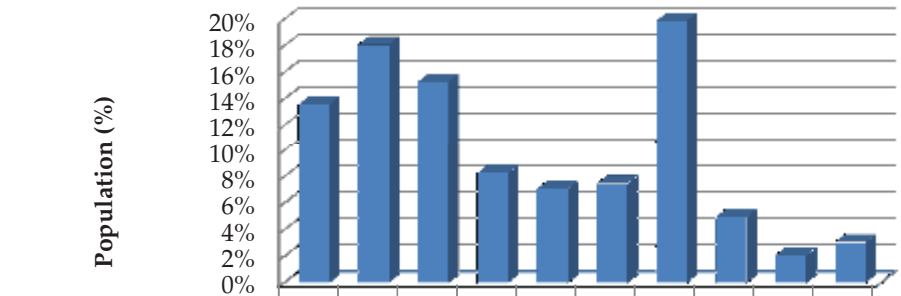
395. It can be observed from the above figure that a large percentage of the population (19%) in *Kaiyarbil* Union falls within the age group of 30 to 49 years followed by population within the age group of 05 to 09 years (17%) and 10-14 years (14%) respectively. The trend is quite similar for the *Kutubdia Upazila* and *Cox's Bazar* District where the largest percentage of the population falls within the age group of 30 to 49 years.

396. Thus 50% of the population in *Kaiyarbil* Union falls within an economically active age group (15-59 years), while rest 50% of the population is understood to be dependent. Similar trends are visible in *Kutubdia Upazila* and *Cox's Bazar* District where 52% of the population falls within the economically active age group.

Uttar Dhurung Union

397. Census of Bangladesh (2011) shows that *Uttar Dhurung* Union has 28,035 population residing in 4,889 household and constitutes ~28.09% of the total population of *Kutubdia*. The population density of *Uttar Dhurung* Union is 2,431 persons per square kilometre, which is higher than the average population density of *Kutubdia Upazila* (581) and *Cox's Bazar* District (919). Gender ratio of this Union is 96 which is lower than that of the Upazila. ***Figure 4.74*** highlights the age-wise distribution of population in Uttar Dhurung Union whereas ***Figure 4.75*** presents a comparative trend in the age-wise population distribution in *Uttar Dhurung* Union with that of the overall *upazila* and district.

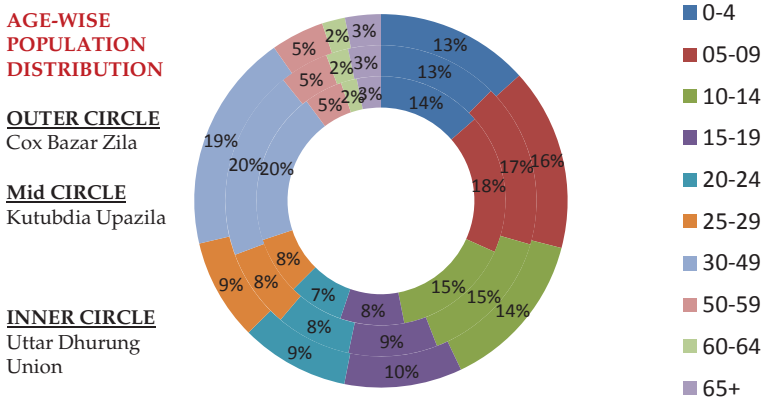
Figure 4.74 Age-Wise Distribution of Population in Uttar Dhurung Union



	0-4	05-09	10-14	15-19	20-24	25-29	30-49	50-59	60-64	65+
Uttar Dhurung union	13.6	18.1	15.3	8.3	7.1	7.5	19.9	5	2.1	3.1

Source: Population and Housing Census 2011, Bangladesh Bureau of Statistics (BBS), 2011

Figure 4.75 Comparison of Age-wise Population Distribution of Uttar Dhurung union with Kutubdia Upazila and Cox's Bazar District



Source: Population and Housing Census 2011, Bangladesh Bureau of Statistics (BBS), 2011

398. It can be observed from the above figure that a large percentage of the population (20 percent in *Uttar Dhurung* Union) falls within the age group of 30 to 49 years followed by population within the age group of 05 to 09 years (17%) and 10-14 years (14%) respectively. The trend is quite similar for the *Kutubdia Upazila* and *Cox's Bazar* District where the largest percentage of the population falls within the age group of 30 to 49 years.

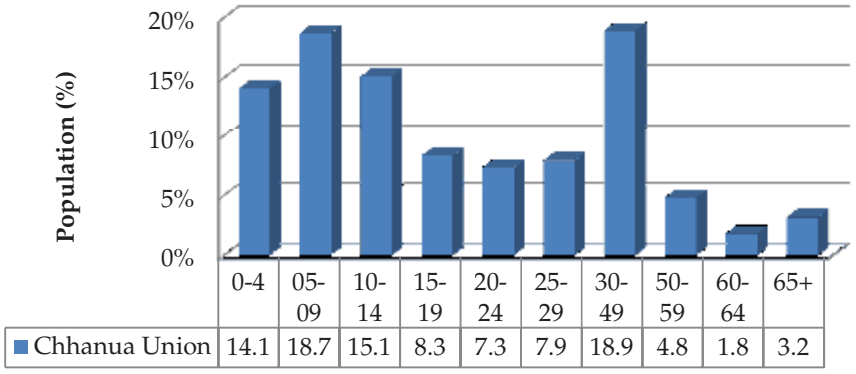
399. Thus 48% of the population in *Uttar Dhurung* Union falls within an economically active age group (15-59 years), while rest 50% of the population is understood to be dependent. Similar trends are visible in *Kutubdia Upazila* and *Cox's Bazar* District where 52% of the population falls within the economically active age group.

400. Overall it is noticed that 25-30 percent of the population falls in the age bracket of 15 to 30 years, which can be considered as the potential population which looks for livelihood diversification. It is also important to note that around 18 percent of the total population constitute infants and elderly population, whose sensitivity to health needs to be considered during impact assessment study.

Chhanua Union

401. Census of Bangladesh (2011) shows that *Chhanua* Union has a population of 28,748 residing in 5586 households, and constitutes approximately 6.66percent of the total population of *Banshkhali Upazila*. The population density of *Chhanua* Union is 1,424 persons per square kilometre, which is higher than the average population density of *Banshkhali Upazila* (1,144) but lower than the *Chittagong* District (1442). Gender ratio of this Union is 97 which are lower than the *Upazila*. ***Figure 4.76*** highlights the age-wise distribution of population in *Chhanua* Union whereas ***Figure 4.77*** presents a comparative trend in the age-wise population distribution in *Chhanua* Union with that of the overall upazila and district.

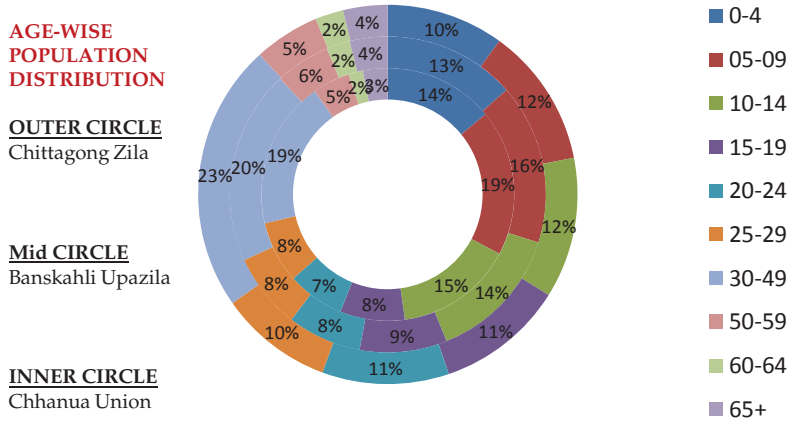
Figure 4.76 Age-Wise Distribution of Population in Chhanua Union



	0-4	05-09	10-14	15-19	20-24	25-29	30-49	50-59	60-64	65+
Chhanua Union	14.1	18.7	15.1	8.3	7.3	7.9	18.9	4.8	1.8	3.2

Source: Population and Housing Census 2011, Bangladesh Bureau of Statistics (BBS), 2011

Figure 4.77 Comparison of Age-wise Population Distribution in Chhanua Union with Banskhali Upazila and Chittagong District

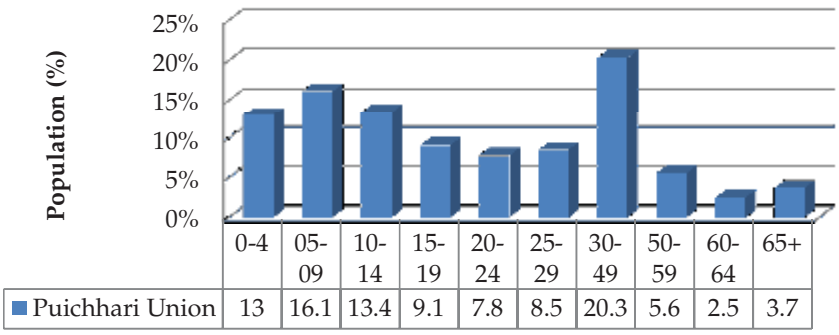


Source: Population and Housing Census 2011, Bangladesh Bureau of Statistics (BBS), 2011

Puichhari Union

402. *Puichhari* Union has a population of 34,224 residing in 6,849 households and constitutes 7.93% of the total population of *Banshkhali Upazila*. The population density of this union is 782 persons per square kilometre, which is lower than the average population density of *Banshkhali Upazila* (1,144) and the *Chittagong* District (1442). Gender ratio of this Union is 103 which are higher than the *upazila*. ***Figure 4.78*** highlights the age-wise distribution of population in *Puichhari* Union whereas ***Figure 4.79*** presents a comparative trend in the age-wise population distribution in *Puichhari* Union with that of the overall *upazila* and district.

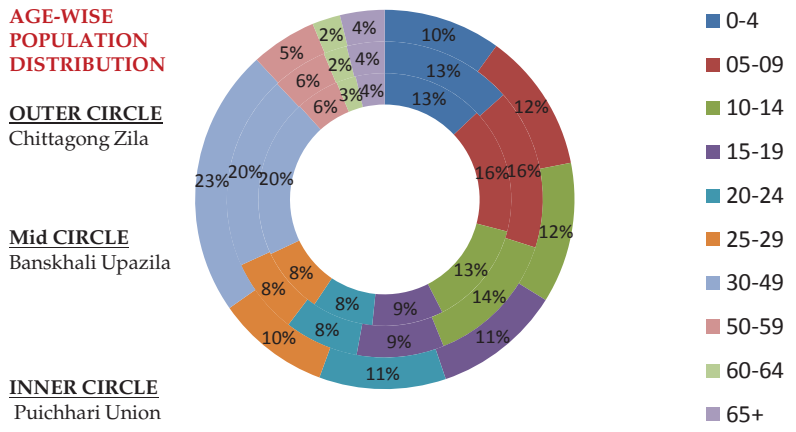
Figure 4.78 Age-Wise Distribution of Population in Puichhari Union



	0-4	05-09	10-14	15-19	20-24	25-29	30-49	50-59	60-64	65+
Puichhari Union	13	16.1	13.4	9.1	7.8	8.5	20.3	5.6	2.5	3.7

Source: Population and Housing Census 2011, Bangladesh Bureau of Statistics (BBS), 2011

Figure 4.79 Comparison of Age-wise Population Distribution in Puichhari with Banskhali Upazila and Chittagong District



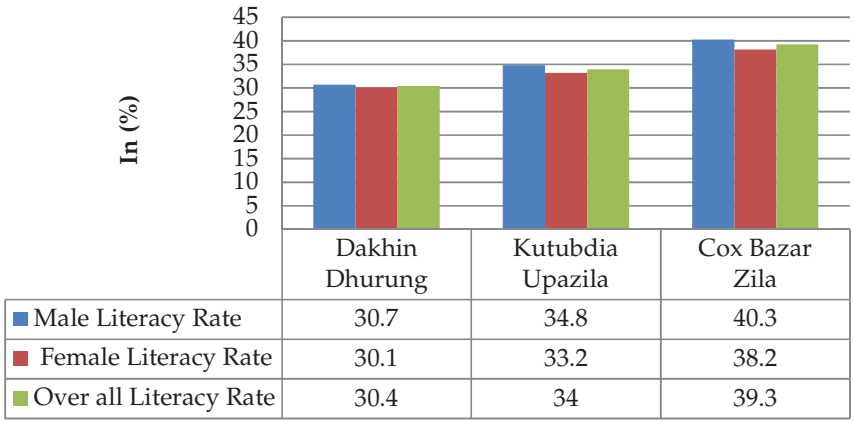
Source: Population and Housing Census 2011, Bangladesh Bureau of Statistics (BBS), 2011

4.18.3 *Literacy Profile*

Dakshin Dhurung

403. Population Census of Bangladesh, 2011 shows that literacy rate in *Dakshin Dhurung* Union has been indicated at 30.4%, which is lower than the national literacy rate of 56.75%. The overall literacy rate for the *Kutubdia* and *Cox's Bazar* District stands at 34% and 39.3% respectively. Male and female literacy rate is 30.4% and 31.1% respectively. The graphical representation of literacy indicators are shown in ***Figure 4.80***

Figure 4.80 Literacy Profile of Dakshin Dhurung Union



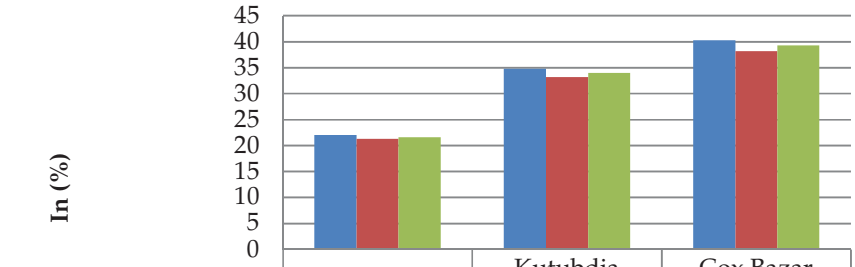
	Dakhin Dhurung	Kutubdia Upazila	Cox Bazar Zila
Male Literacy Rate	30.7	34.8	40.3
Female Literacy Rate	30.1	33.2	38.2
Over all Literacy Rate	30.4	34	39.3

Source: Population and Housing Census 2011, Bangladesh Bureau of Statistics (BBS), 2011

Kaiyarbil Union

404. As per Population and Housing Census, 2011 literacy rate in *Kaiyarbil* Union is 21.6%, which is lower than the literacy rate for the *Kutubdia Upazila* and *Cox's Bazar* District which stands at 34% and 39.3% respectively. Male and female literacy rate is 21.3% and 21.6% respectively. The graphical representation of literacy indicators are shown in ***Figure 4.81.***

Figure 4.81 Literacy Profile of Kaiyarbil Union



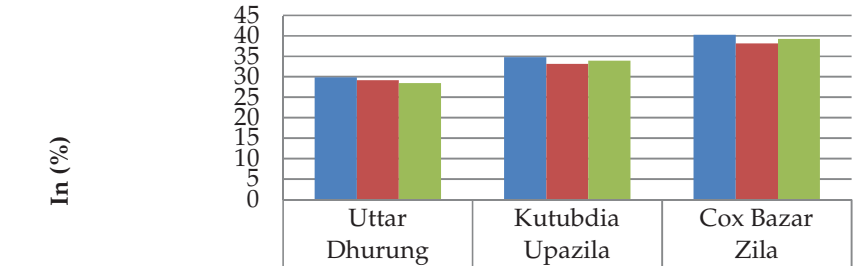
	Kaiyarbil	Kutubdia Upazila	Cox Bazar Zila
Male Literacy Rate	22	34.8	40.3
Female Literacy Rate	21.3	33.2	38.2
Over all Literacy Rate	21.6	34	39.3

Source: Population and Housing Census 2011, Bangladesh Bureau of Statistics (BBS), 2011

Uttar Dhurung

405. Population and Housing Census data shows that Literacy Rate of *Uttar Dhurung* Union is 30.4% which is lower than the literacy rate of *Kutubdia Upazila* and *Cox's Bazar* District which stands at 34% and 39.3% respectively. Male and female literacy rate is 29.9% and 29.2% respectively. The graphical representation of literacy indicators are shown in ***Figure 4.82***.

Figure 4.82 Literacy Profile of Uttar Dhurung Union



	Uttar Dhurung	Kutubdia Upazila	Cox Bazar Zila
Male Literacy Rate	29.9	34.8	40.3
Female Literacy Rate	29.2	33.2	38.2
Over all Literacy Rate	28.5	34	39.3

Source: Population and Housing Census 2011, Bangladesh Bureau of Statistics (BBS), 2011

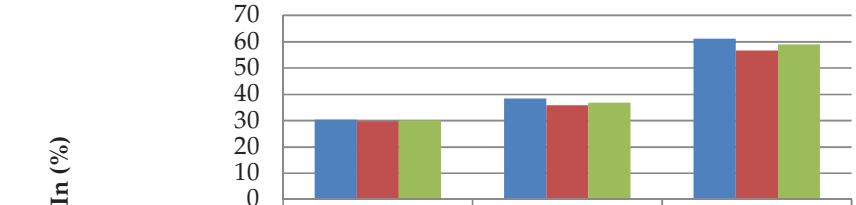
406. With respect to individual literacy trends amongst males and females, it can be observed that literacy amongst women is higher than their male counterparts.

The difference registered was higher in *Cox's Bazar* District (2.1%) than in the union and *upazila*.

Chhanua Union

407. Population Census of Bangladesh shows that the literacy rate in *Chhanua* Union is 30.1%, which is lower than the national literacy rate of 56.75%. The overall literacy rate for the *Banshkahli Upazila* and *Chittagong* District stands at 36.9% and 58.9% respectively. Male and female literacy rate is 30.4% and 29.8% respectively. The graphical representation of literacy indicators are shown in ***Figure 4.83.***

Figure 4.83 Literacy Profile of Chhanua Union



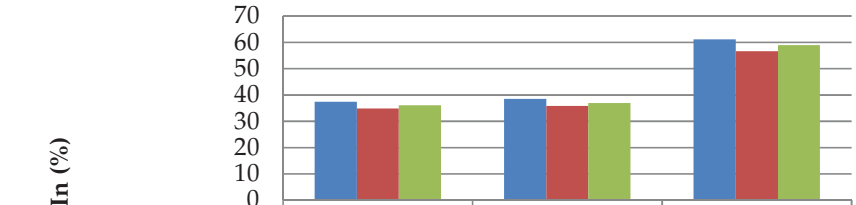
	Chhanua Union	Banshkahli Upazila	Chittagong Zila
Male Literacy Rate	30.4	38.5	61.1
Female Literacy Rate	29.8	35.9	56.7
Over all Literacy Rate	30.1	36.9	58.9

Source: Population and Housing Census 2011, Bangladesh Bureau of Statistics (BBS), 2011

Puichhari Union

408. As per Census, 2011 *Puichhari* Union has a literacy rate of 36.1%, which is lower than the national literacy rate of 56.75%. The overall literacy rate for the *Banshkahli Upazila* and *Cox's Bazar* District stands at 36.9% and 58.9% respectively. Male and female literacy rate is 34.8% and 36.1% respectively. The graphical representation of literacy indicators are shown in ***Figure 4.84.***

Figure 4.84 Literacy Profile of Puichhari Union



	Puichhari Union	Banshkahli Upazila	Chittagong Zila
Male Literacy Rate	37.4	38.5	61.1
Female Literacy Rate	34.8	35.9	56.7
Over all Literacy Rate	36.1	36.9	58.9

Source: Population and Housing Census 2011, Bangladesh Bureau of Statistics (BBS), 2011

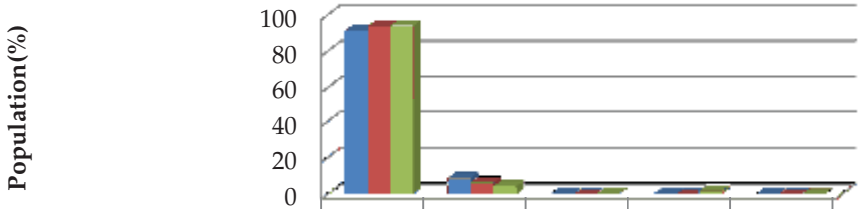
409. With respect to individual literacy trends amongst males and females, it can be observed that literacy amongst women is lower than their male counterparts. The difference registered was higher in *Chittagong* District (4.4%) than in the union and *upazila*.

4.18.4 Religion and Ethnic Composition

Dakshin Dhurung Union

410. Resident of *Dakshin Dhurung* Union mostly comprises of people following Islam. Census of Bangladesh shows that only 8.80% of the population in *Dakshin Dhurung* Union is following other faith, while 91.11% comprises of Muslim population.

Figure 4.85 Religious Composition of Dakshin Dhurung Union



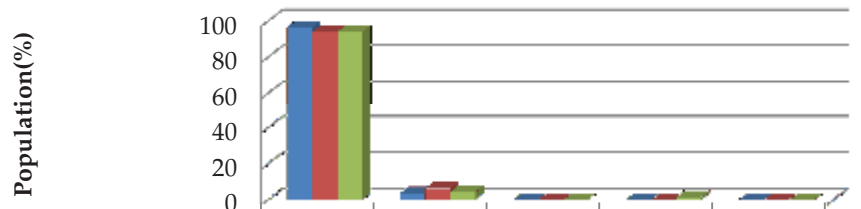
	Muslim	Hindu	Cristian	Buddhist	Other
Dakhin Dhurung Union	91.11	8.80	0	0	0
Kutubdia Upzila	93.65	6.31	0.002	0.004	0.038
Cox Bazar District	93.97	4.26	0.07	1.65	0.05

Source: Population and Housing Census 2011, Bangladesh Bureau of Statistics (BBS), 2011

Kaiyarbil Union

411. Resident of *Kaiyarbil* Union mostly comprises of people following Islam. ***Figure 4.86*** shows that only 3.66% of the population in *Kaiyarbil* Union is following Hindu religion, while 96.34 %comprises of Muslim population.

Figure 4.86 Religious Composition of Dakshin Dhurung



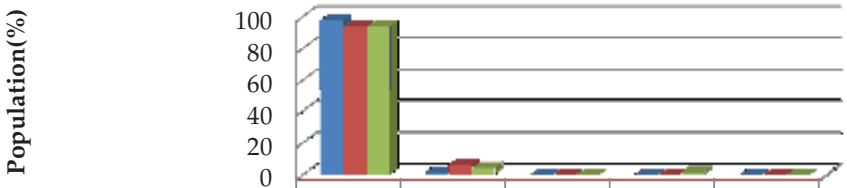
	Muslim	Hindu	Cristian	Buddhist	Other
Kaiyarbil Union	96.34	3.66	0	0	0
Kutubdia Upzila	93.65	6.31	0.002	0.004	0.038
Cox Bazar District	93.97	4.26	0.07	1.65	0.05

Source: Population and Housing Census 2011, Bangladesh Bureau of Statistics (BBS), 2011

Uttar Dhurung Union

412. Resident of *Uttar Dhurung* Union mostly comprises of people following Islam. Census of Bangladesh, 2011 depicted that only 2.5% of the population in Uttar Dhurung Union is following other faith, while 97.54% comprises of Muslim population.

Figure 4.87 Religious Composition of Uttar Dhurung



	Muslim	Hindu	Christian	Buddhist	Other
Uttar Dhurung Union	97.54	1.51	0.004	0	0.007
Kutubdia Upzila	93.65	6.31	0.002	0.004	0.038
Cox Bazar District	93.97	4.26	0.07	1.65	0.05

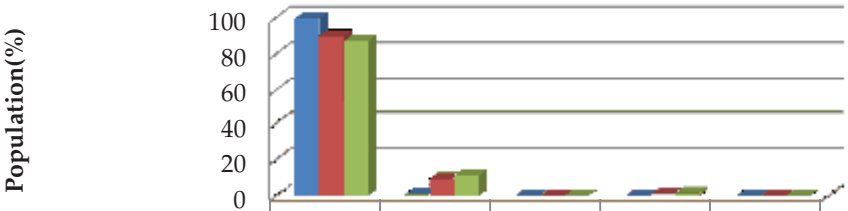
Source: Population and Housing Census 2011, Bangladesh Bureau of Statistics (BBS), 2011

413. The population belonging to other ethnic minorities is quite negligible. *Kutubdia* has only 0.015% ethnic minority population. There are only 5 ethnic households in the entire *upazila* with total population of 19.

Chhanua Union

414. Resident of *Chhanua* Union mostly comprises of people following Islam. It can been seen from the below figure that only 1% of the population in *Chhanua* Union is following other faith, while 99.30% comprises of Muslim population.

Figure 4.88 Religious Composition of Chhanua Union



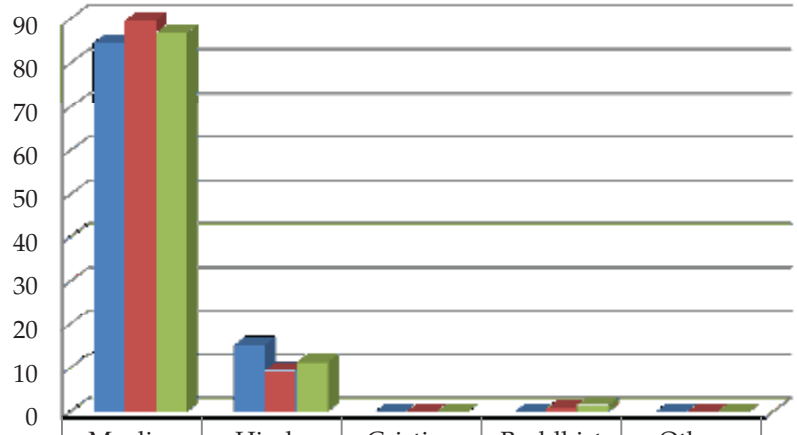
	Muslim	Hindu	Christian	Buddhist	Other
Chhanua Union	99.30	0.70	0	0.003	0
Upzila	89.69	9.43	0.041	0.811	0.021
CHittagong District	86.90	11.31	0.10	1.59	0.10

Source: Population and Housing Census 2011, Bangladesh Bureau of Statistics (BBS), 2011

Puichhari Union

415. Resident of *Puichhari* Union mostly comprises of people following Islam. It can be observed from the figure mention below that only 15% of the population in *Puichhari* Union is following other faith, while 84.62% comprises of Muslim population.

Figure 4.89 Religious Composition of Puichhari Union



	Muslim	Hindu	Cristian	Buddhist	Other
Puichhari Union	84.62	15.28	0	0.10	0
Upzila	89.69	9.43	0.041	0.811	0.021
CHittagong District	86.90	11.31	0.10	1.59	0.10

Source: Population and Housing Census 2011, Bangladesh Bureau of Statistics (BBS), 2011

416. As per population and housing census, 2011 there is no ethnic minorities' population residing in the two above referred unions.

4.18.5 Vulnerability

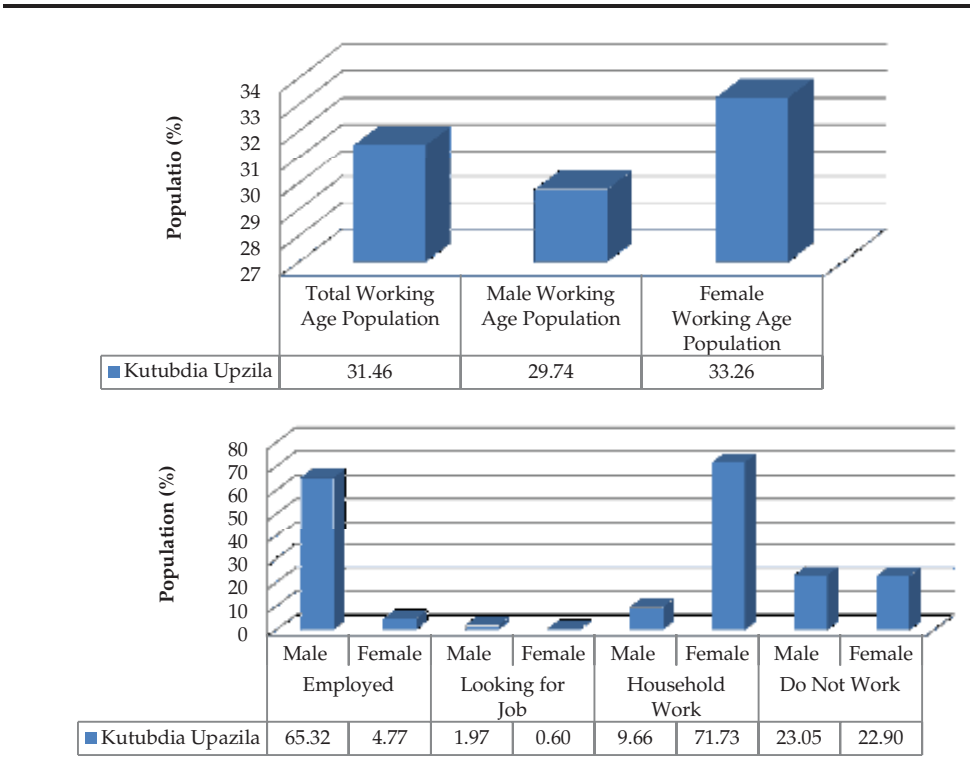
417. In addition to the infant and elderly age group, widows/separated population and disabled/differently abled population are considered as vulnerable population. The disabled or differently abled population constitutes 2% of the total population.

4.18.6 Local Economy and Employment

Kutubdia Upazila

418. As per the Population and Housing Census of *Cox Bazar* District, 2011 employed population in *Kutubdia Upazila* is only 70% of the working age population (15-65 years), however female working population is quite low (only 4.77%) in this *upazila*. Female population is mainly engaged in household work. Hence, the employment situation of female population looks quite grim in study area.

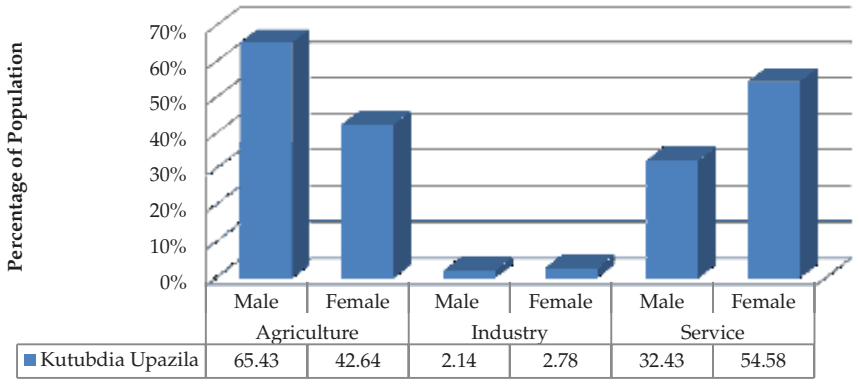
Figure 4.90 Employment Status of Kutubdia Upazila



Source: Population and Housing Census 2011, Bangladesh Bureau of Statistics (BBS), 2011

419. It can be observed from population census data that the main source of livelihood for a majority of the population is agriculture and related activities. Other than that salt production, fishing and dry fish production also plays a vital role in case of livelihood generation in this *upazila*.

Figure 4.91 Sector Wise Employment of Kutubdia Upazila



Source: Population and Housing Census 2011, Bangladesh Bureau of Statistics (BBS), 2011

Dakshin Dhurung Union

420. The workforce participation rate in the *Dakshin Dhurung* Union is 78% as per the population and housing Census data of *Cox Bazar* District. Community consultation reveals that majority of inhabitants in *Dakshin Dhurung* Union are

involved in fishing and salt pan activity. Cultivators comprise the second most important work category of the total workforce.

Kaiyarbil Union

421. Population Census of *Cox Bazar* District, 2011 shows that workforce participation rate in the *Kaiyarbil* Union is 78.25%. Community consultation reveals that majority of inhabitants in *Kaiyarbil* Union are involved in agricultural activity. Fishing comprises the second most important work category of the total workforce.

Uttar Dhurung Union

422. As per Bangladesh Census, 2011 the workforce participation rate in *Uttar Dhurung* Union is 79.51%. Community consultation reveals that majority of inhabitants in this union are employed as fisherman and salt pan workers and cultivators are very low in number.

Banshkhali Upazila

423. Census data of *Cox's Bazar* District shows that the employed population in *Banskhali Upazila* is 72% of the working age population, however female working population is quite low (only 5.2%) in this *upazila*. Female population is mainly engaged in household work.

Chhanua Union

424. It can be observed from population census data that the workforce participation rate in the *Chhanua* Union is 76.35%. Community consultation reveals that majority of inhabitants are involved in fishing and salt pan activity. Cultivators comprise the second most important work category of the total workforce.

Puichhari Union

425. The workforce participation rate in the *Puichhari* Union is 77.27%. Community consultation reveals that agriculture is main economic activity in this union and majority of inhabitants are involved in agricultural practices. Few people are also involved in other activities like fishing and small business.

4.18.7 Major Livelihood Activities of Kutubdia Island

426. It has been observed during site visits that agriculture, salt cultivation and fishing are three major livelihood earing activities observed in *Kutubdia* Island. Community consultation also revealed that most of the community people are engaged in these activities and all other livelihood activity like small business, boat making and maintenance, salt and dry fish marketing all are directly and

indirectly dependent on these activities. Therefore the present study is also considering agriculture, salt cultivation and fishing as its point of focus for studying livelihood dependence for the population of the *Kutubdia* Island.

Agriculture

427. The main profession of the habitants of *Kutubdia Upazila* is agriculture; 56% of the total population is dependent on agriculture. People of *Ali Akbar Deil, Boroghop, Kaiyarbil, Dakshin Dhurung* and *Uttar Dhurung* are mostly involved in agriculture and cultivation of seasonal vegetables. The following table gives an insight to total arable land available in the six Union *Parishads* of the *Kutubdia Upazila*.

Table 4.41 Union Based Total Arable Land and its Use

Name of Union	Total Arable Land (Acres)	Utilization of Land in Acres		
		Single Crop	Double Crop	Triple Crop
Uttar Dhurung	2,890	124	2,025	741
Dakshin Dhurung	2,297	172	1,309	815
Lemshikhali	1,828	148	963	716
Kaiyarbil	1,530	172	741	617
Boroghop	2,321	124	840	1,358
Ali Akbar Deil	2,630	124	1,729	778
Total	13,496	864	7,607	5,025

Source: Disaster Management Plan for Kutubdia Upazila

428. Agriculture had been the primary source of income for the inhabitants of the island *upazila*, but frequent cyclonic events and sea water surge has made the cultivable land of *Kutubdia* infertile due to salinity. More agricultural land was converted to salt fields. Cultivation is mostly done for selling and self-consumption.

Box 4.3 Agriculture in Kutubdia Upazila

- 5,465 hectares of land is under cultivation in *Kutubdia Upazila*
- Some of the regions on the *upazila* are triple cropped – *Rabi, Karif I (Aaush)* and *Karif II (Amon)* crops are grown
- Farmers are being given identity cards – *Krishi Upakaran Sahayata* Card
- There are 13,740 farmers in *Kutubdia*

Source: Upazila Agriculture Office, Kutubdia Upazila

Salt Cultivation

429. Salt production is quite an ancient industry in the coastal zones of Bangladesh, especially in *Chittagong* and *Cox's Bazar* areas. Salt is produced seasonally from December to mid-May and the preparation starts from October-November. Traditionally salt was produced by evaporating water by boiling the seawater. From 2000-2001 salt was produced in a different way known popularly as polythene process, in which salt production per acre is much higher than old

method. In traditional method, per acre production of salt was 17.25 m ton, while in the new method per acre production of salt has been 21 m ton and furthermore, production per acre and the quality of salt is very standard. Moreover the market price of this salt produced in this new method has doubled and cultivators earn good profit.

430. Hundreds of person from the different *upazilas* of *Cox's Bazar* District are involved into salt harvesting including *Kutubdia Upazila*. *Cox's Bazar* is the only region in Bangladesh where salt harvesting is done. In *Kutubdia Upazila*, salt harvesting is one of the primary livelihood options of the island population and also done as a secondary seasonal source of income. It is mainly done at the central part of the island on both sides of the *Filate Kata Khal*. Due to frequent cyclonic events and sea water surge, more and more agricultural lands are becoming infertile and getting converted for salt harvesting. ***Table 4.42*** provides union wise land under salt cultivation in *Kutubdia Upazila* and number of salt cultivators.

Table 4.42 Union Parishad wise Area under Salt Cultivation & Salt Cultivators 2015-16

Name of Union	Land Area (Acres)	Number of Cultivators
Uttar Dhurung	1770	1180
Dakshin Dhurung	475	340
Kaiyarbil	820	550
Lemshikhali	2525	1700
Boroghop	450	300
Ali Akbar Deil	960	530
Total	7000	4600

Source: Bangladesh Small & Cottage Industries Corporation (BSCIC) Office, Cox's Bazar

Box 4.4 Salt Cultivation in Kutubdia Upazila

- In *Kutubdia Upazila* 7,000 acres of land is under salt cultivation
- There are 4,600 salt cultivators in the whole *upazila*
- The number of salt cultivators is not the same every year; it increases by 10% if the yield is good in the current year
- In *Kutubdia* all the salt cultivators are from the island itself

Source: Bangladesh Small & Cottage Industries Corporation (BSCIC) Office, Cox's Bazar

Fishing

431. In Bangladesh the Fisheries sector plays a significant role in providing income opportunities, earning foreign exchange, alleviating protein shortage and socio-economic development of the population. The fisheries sector contributes 4.43% to the national GDP [1]and 22.21% to the total agricultural GDP as per Department

[1] Haq N. Bangladesh Tackels Poverty and Hunger with Fish Farming

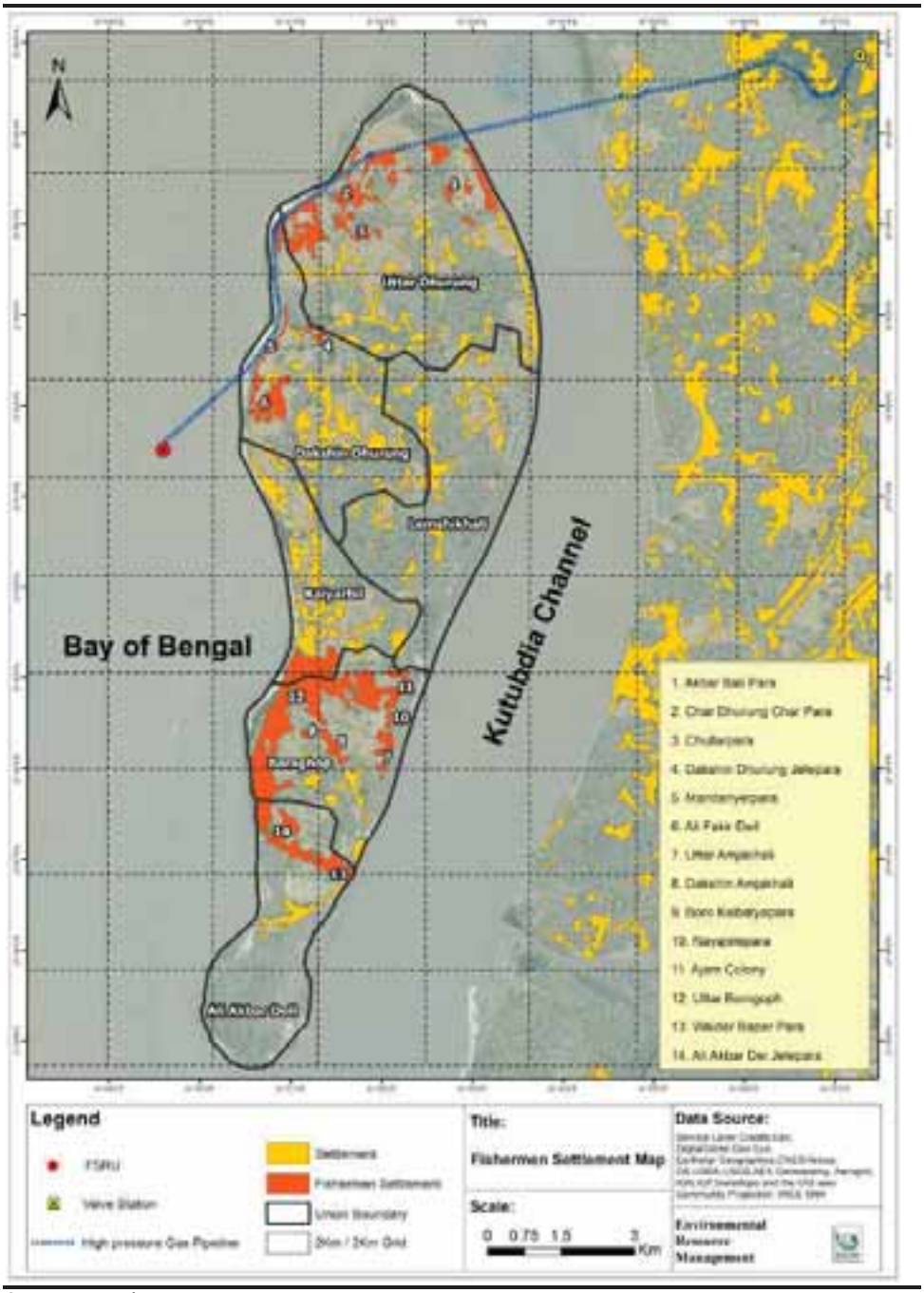
of Fisheries (DoF), 2011. Fisheries are the second largest export sector in Bangladesh. An estimated 1.4 million people are engaged fulltime and approximately 12 million people as part time in the fisheries sector[1]. Majority of these people are concentrated in the coastal areas of Bangladesh.

432. *Kutubdia Upazila*, an island in itself, is house to several such fishermen whose primary livelihood is fishing. One of the key stakeholders of this project is the fishermen community of *Kutubdia* Island and especially those who are residing adjacent to the Project footprint area.

433. As an approach towards the Fishermen Study, inorder to avoid randomness, the island was delineated interposing a uniform grid (2 km x 2 km), following which the fishermen settlements were mapped based on the information obtained from the District Fisheries Office, *Cox's Bazar* and key informant interview with elderly fishermen (***Figure 4.92***). Focus Group Discussions (FGDs) and key informant interviews were conducted with the fishermen from these identified fishermen settlements across all the six Union *Parishads* of *Kutubdia Upazila*.

[1] Ahmed, Halim and Sultana 2012

Figure 4.92 Fishermen Settlements



Source: Key Informant Interviews

Fishermen in Kutubdia Upazila

434. It was informed by the District Fisheries Officer (DFO), District Fisheries Department, *Cox's Bazar* that number of registered fishermen with the department as on 30th June, 2016 is 7,116 in *Kutubdia Upazila* (***Table 4.43***). According to DFO there may be additional 20% more fishermen in the island upazila those who have not been registered due to various reasons. Therefore it can be estimated that there are approximately 8,500 fishermen in *Kutubdia Upazila*. Following ***Table 4.43*** provides the ward wise number of registered fishermen in the respective six Union *Parishads*.

Table 4.43 List of Registered Fishermen in Kutubdia Upazila as on 30th June, 2016

Union	Ward 1	Ward 2	Ward 3	Ward 4	Ward 5	Ward 6	Ward 7	Ward 8	Ward 9	Total
Boroghop	148	76	93	466	199	142	345	24	51	1,588
Dakshin Dhurung	192	168	118	122	76	24	53	186	190	1,120
Uttar Dhurung	406	134	472	165	209	79	194	101	138	1,912
Kaiyarbil	23	40	20	24	82	14	90	59	65	391
Ali Akbar Deil	214	188	255	82	146	459	250	207	00	1,739
Lemshikhali	14	39	44	29	70	79	56	52	63	410
TOTAL										**7,116**

Source: District Fisheries Office, Cox's Bazar

435. As indicated in ***Table 4.43***, the predominance of fishermen communities are more in Uttar Dhurung, Ali Akbar Deil and Boroghop Unions followed by Dakshin Dhurung. This has been reflected in the fishermen settlement map. In Lemshikhali and Kaiyarbil Unions there is no fishermen settlement in particular and fishermen are scattered all over the union.

436. The highlighted cells in ***Table 4.43*** indicate the ward 2 and ward 1 under the *Dakshin Dhurung* and *Kaiyarbil* Union *Parishads* respectively, which are adjacent to the project foot print. There are 191 registered fishermen (as on 30th June, 2016) residing near the project area; approximately around 230 fishermen[1] is expected to reside in this region in these two wards.

Fishing Communities & Fishing as Occupation

437. Focus Group Discussions (FGDs) and interview of the key informant revealed that in *Kutubdia*, traditionally fishing was practiced by the minority fishing community – *jeles (Hindu community)*, who had been residing in this island for all most four generations, 200 years approximately. Fishing was predominantly their occupation. The Muslim population of the island adopted fishing as occupation in the last 20-25 years. The Muslim population of the island was traditionally into agriculture, livestock rearing and practiced fishing in small scale (aquaculture). Repeated cyclonic serge had reduced agricultural activity in the island over the years and people opted for alternate occupations. The Muslim population learnt the art of deep sea fishing and fishing in sea using different types of nets from the *jeles* (minority fishermen community).

Table 4.44 Minority (Hindu) Fishing Settlements in Kutubdia

Union Parishad	Name of Settlement	No. of Fishermen (Approx.)
Dakshin Dhurung	Dakshin Dhurung Jelepara	300
Boroghop	Boro Kaibatyapara	450
Ali Akbar Deil	Ali Akbar Deil Jelepara	300

Source: Key Informant Interview held on 15th Nov. 2016 at Boroghop with an elderly fishermen referred by District Fisheries Officer

Type of Fishing

438. Types of fishing practiced by the fishermen in *Kutubdia* can be classified into:
   - Deep-sea fishing

[1] There may be additional 20 percent more fishermen in the island upazila those who have not been registered due to various reasons as per DFO.

- Daily fishing
- Foot fishing/ Shore line fishing

439. Discussions with the fishermen during FGDs across all the Unions revealed that, all the fishermen practice all types of fishing; they cannot be classified into any one category.

Deep-Sea Fishing

440. From the onset of monsoon till spring (July/August to March/ April), for a period of 9-10 months – fishermen go for deep-sea fishing. Trawlers are used for deep-sea fishing and they usually goes upto India boarder in the west and southwest for fishing (ranging from 70 to 300 km). The fishermen fish for 12 to 15 days in each trip; in a month's time they can complete two trips. The deep-sea fishing is based on the lunar calendar and the cycle revolves round the new moon cycle and full moon cycle. Fish catch is usually more during the full moon *('Purnima')* and new moon *('Amavashya')*. In each fishing trawler about 25 – 32/35 fishermen goes for fishing in deep sea. For deep sea fishing, boats with engine capacity of around 50-70 HP are used. The most common fish net used are *Behundi* (marine setback net) and Hilsa net.

Daily Fishing

441. Daily fishing can be categorized into two types as mentioned by the fishermen during the focus group discussions:

(i) Daily fishing in sea for about 24-30 hours, where 7-8 fishermen goes together for fishing on sea. Fishing is usually done 25-50 km from the west coastline.
(ii) Daily fishing with ice – where the fishing boats fish for 4-5 days with 8-12 fishermen on sea. Fishing is usually done 50-75 km from the west coastline.

442. For daily fishing boats with engine capacity less than 30 HP and non-motorised boats are used and most common fish net is *Behundi* (marine setback net).

Foot Fishing / Shoreline Fishing

443. Use of any type of motorized and non-motorized boat is not required for this type of fishing. Foot fishing can be done standing on the coast line or at the bank of the water body or at less depth water near the coast line. Fishermen of *Kutubdia* use push net and shrimp net to catch shrimps and shrimp fry during their lean fishing periods.

Shoreline Fishing

444. It was reported during the focus group discussions that nearshore foot fishing is done, especially by the elderly fishermen and young boys using push net and shrimp net both in *Kutubdia* Channel and along the shore line. It was also observed during the site visits and reported by the fishermen during FGDs that

the fishermen have fixed *Behundi* jal (Estuarine set bag net) near the western coastline and it is usually fixed upto 1.5 km where depth of sea is less.

Figure 4.93 Shoreline Fishing using Pushnet and Estuarine Setbag Net

Katha Fishing

445. *Katha* fishing is done by piling of tree branches, bushes or water hyacinth set on the river or beel bottom. Fish are usually attracted into the *katha* by the shelter provided and by the increased food supply. During the dry season, fish can become densely amassed in a *katha* and thus becomes easier to catch once they have taken refuge there. To harvest a katha zone, blocking nets is set around the *katha*, the branches are removed and blocking net is closed up. Final harvest may be with a beach seine or castnet inside the blocking net. However, this type of fishing is not in practice in *Kutubdia Upazila*; *Kutubdia* Channel is mostly used for navigation purpose.

Fishing Ground

446. The hydrological conditions of the Bay of Bengal make it favourable for a variety of shrimps and fishes. Although fishes remain scattered in the Bay of Bengal in some places they get concentrated and constitute important fishing grounds. Four fishing grounds have been identified in the exclusive economic zones – South Patches, South of South Patches, Middle Ground, Swatch of no Ground.

447. South patches located at 91.30'E to 92.10' E and 20.55'S to 21.52'S, having a total area of 3,662 sq km, with its depth ranging from 10m to 100m, however 90% of the total area is less than 40 m deep. Nearest distance of the ground from *Chittagong* and *Cox's Bazar* are 40 km and 10 km respectively.

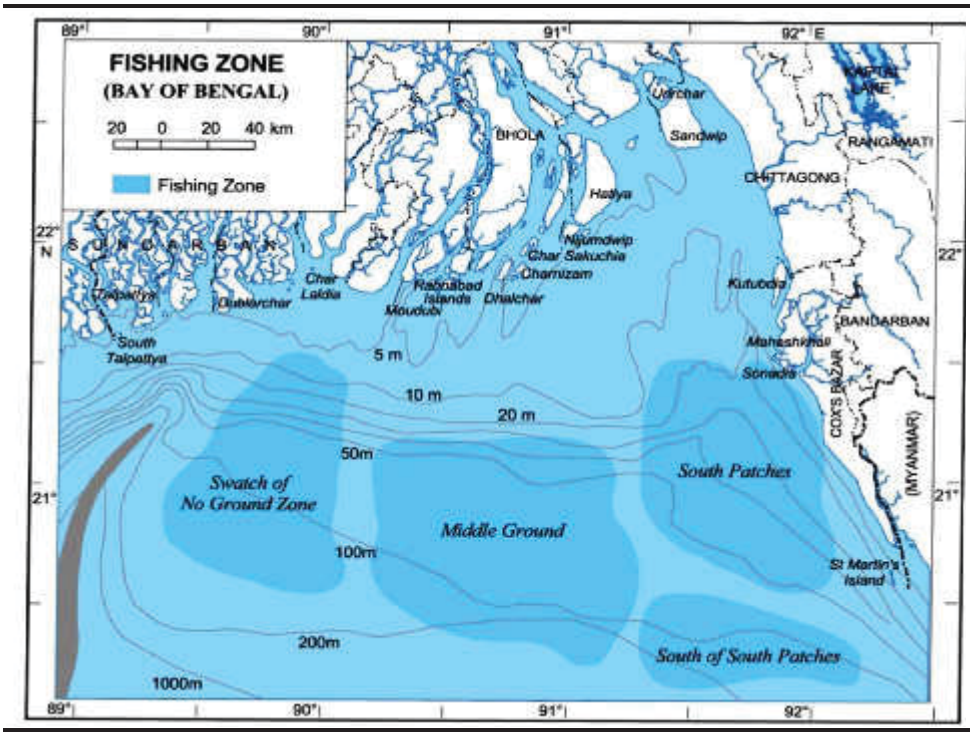
448. South of south patches located at 91°30'E to 92°20'E and 20°15'S to 20°50'S, having a total area of 2538 sq. km, with depth ranging from 10m to 100m. Depth of 75% of the area is more than 40 m deep. This area is about 5 km from *Teknaf*.

449. Middle ground located at 90°20'E and 91°30'E and 20°25'S to 21°20'S, having a total area of about 4,600 sq. km., with 70% of the total area is more than 40m deep. The nearest distance from the *Cox's Bazar* is about 65 km.

450. Swatch of no Ground 1located at 89°35'E to 90°10'E and 20°55'S to 21°55'S, having a total area of about 3,800 sq. km., with 70% of the total area is more than 40m deep. The overall depth ranges between 10 m to 100 m. The region is about 30 km away from Dublarchar and 40 km from *Sonarchar*.

451. The following figure shows the fishing zones as identified in the Bay of Bengal.

Figure 4.94 Fishing Zones in Bay of Bengal



Source: Department of Fisheries, Cox's Bazar

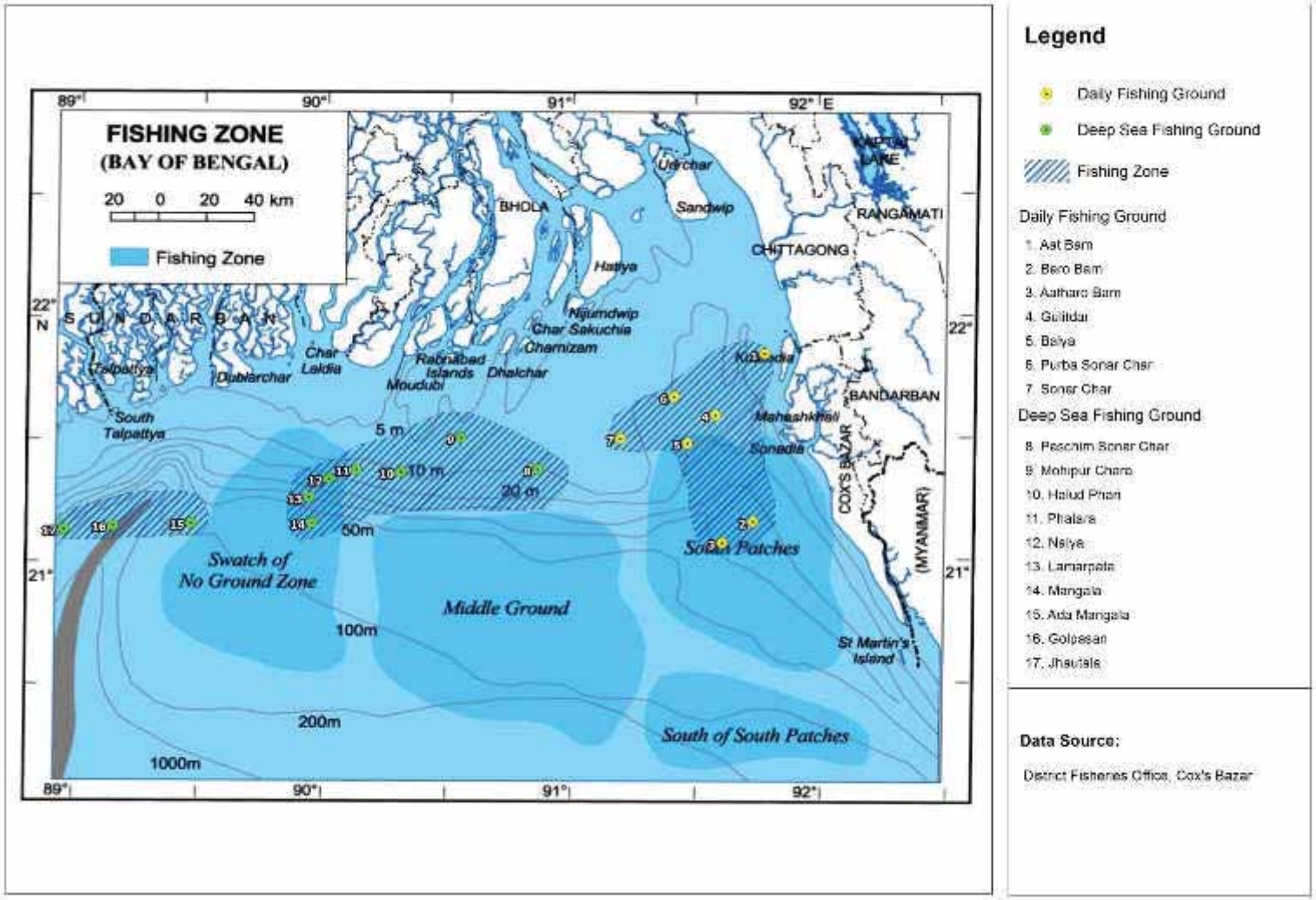
[1] Announced on October 27, 2014, the Swatch of No Ground (SoNG-MPA) is Bangladesh's first marine protected area. It is located in the Bay of Bengal at the head of a submarine canyon. It spans approximately 672 square miles (1,738 square kilometers) and is more than 900 kilometers in depth in some locations. The area is a key breeding and spawing ground for dolphins, whales, sharks and turtles. The marine protected area was established for the long-term protection of cetanceans that inhabit waters offshore of Bangladesh. - *http://www.mpatlas.org/mpa/sites/60009462/*

452. All these fishing grounds are potential reserves for various species of fish and shrimps. The fishermen mapped the fishing grounds on Bay of Bengal where they usually go for daily fishing and deep-sea fishing using motorized boats and trawlers, during the focus group discussions. ***Figure 4.95*** points out the fishing grounds and fishing zones as pointed out by the fishermen. Nearest daily fishing ground no. 1 on map 4.95 is 20 km from FSRU location.

Box 4.5 Mapping of Fishing Grounds

Fishermen from three settlements of Dakshin Dhurung Union Parishad – *Dakshin Dhurung Jelepara, Madanyerpara and Ali Fakir Deil* were present for the FGD held at the Union Office. The group contributed some important information related to fishing practices, fish catch, fishing grounds and also participated in mapping of fishing grounds.

Figure 4.95 Fishing Zones as Demarcated by Fishermen



Source: District Fisheries Office, Cox's Bazar and FGDs with fishermen community

Fish Catch

453. In 2014 the estimated total fish catch in the country of Bangladesh was about 35.5 lakh Metric Ton [1]in which Marine Fisheries contributed 5.95 lakh Metric Ton of the total fish production of the country. It has been reported that over the last five years the 'capture fishery production' is decreasing at an average rate of 2.2 percent[2]. The FRSS data reveals that in 2012-13 marine capture fish production was 5.88 lakh Metric Ton which is 17.3 percent of share and in 2013 - 14 it reduced to 16.8 percent of the share. This has been further confirmed by the participating fishermen during the discussions. They were of the opinion that overall fish availability and fish catch has reduced in the recent years due to environmental changes. Discussions revealed that fish catch on sea varies with seasonality. A specific study on the 'Environmental and Social Vulnerabilities and Livelihoods of Fishing Communities of *Kutubdia* Island Bangladesh' [3] indicates that - the health of fisheries along the coast of Bangladesh has always been sensitive to changes in marine environment in Bay of Bengal. Sea surface temperatures have increased, slow sea level rise, cyclonic activities and increase in magnitude of both cyclones and storm surges have affected the coastal communities, especially those who are heavily dependent on fisheries for their livelihood are particularly vulnerable to these changes. A survey conducted during the study shows that 40 percent of the fishermen respondents said *Hilsa* fish (Tenualosailisha) catch has reduced followed by Shrimp (Metapenaeusmonoceros), Loitta (Harpadonnehereus), *Bhetki* (Latescalcarifer), etc. Overfishing has been cited as the prime reason for decrease in fish catch. However due to use of sophisticated fishing nets, climatic shift and catching fish fry are considered as the major causes behind fewer fish catch in Bay of Bengal.

Deep-sea Fishing

454. Fishermen venturing for deep-sea fishing sails as far as 300 km in winter and monsoon season for fishing, while in summer they try to fish closer to the coast (150 km approx.) due to frequent cyclonic whether conditions.

Table 4.45 Fish Catch Based on Seasonality

Season	Fish Catch Per Trip	
	kg	Metric Ton
Winter	10,000 – 12,000	10 – 12
Summer	4,000 – 6,000	4 – 6
Monsoon	10,000 – 12,000	10 – 12
Hilsa (during monsoon)	8,000	8

Source: Focus Group Discussion with Fishing community

[1] Source: FRSS, 2013-14
[2] Source: FRSS, 2013-14

[3] Environmental and Social Vulnerabilities and Livelihoods of Fishing Communities of Kutubdia Island, Bangladesh, Dissertation Paper to Kent State University by Munshi Khaedur RahmanN

455. As reported by the fishermen during the Fish Survey report the fishermen catch nearly 60-61 varieties of fish during deep-sea fishing out of which about 33 types of fishes are of low value and the rest are of high value

Daily Fishing

456. Small motorized boats and non-motorized boats are used for daily fishing; fish catch also depends on the availability of refrigerating arrangements in the boats. The small motorized boats usually have facilities of preserving fish catch with ice for 4-5 days. It was reported during the discussions with the fishermen that fish catch by small motorized boats with ices preservation varies between 30-40 kgs. While those fishermen who do daily fishing using non-motorized boats makes three trips a day; they sail out during the high tide – and in each trip they catch fish upto 15 kgs.

457. As reported by the fishermen during the Fish Survey report the fishermen catch nearly 30-31 varieties of fish during daily fishing in sea and Kutubdia Channel out of which about 20 types of fishes are of low value and the rest are of high value.

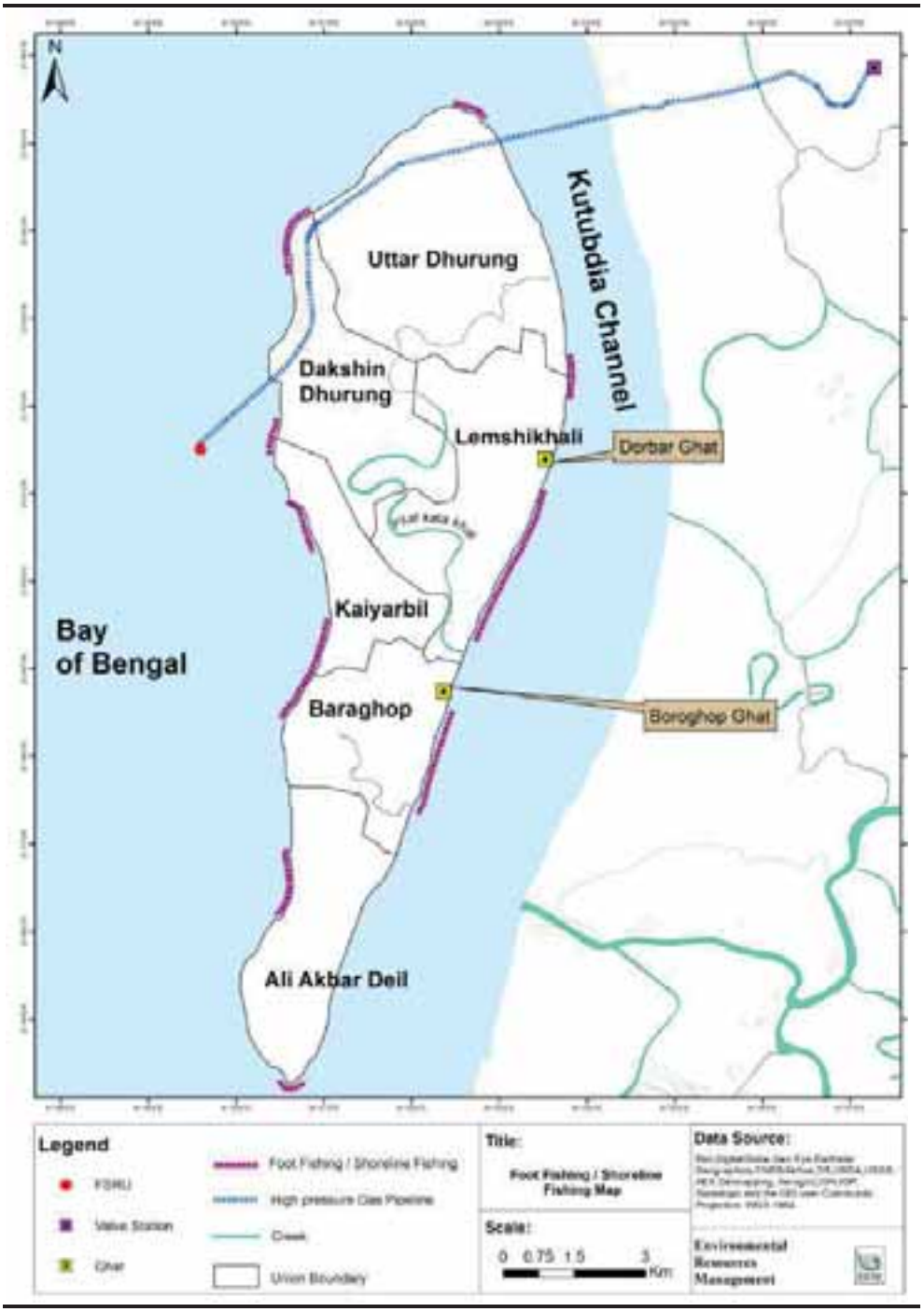
Figure 4.96 Boats Returning with its Catch after Daily Fishing

Foot Fishing

458. It is reported by key informant that foot fishing is mainly done using two types of fishing nets – push net and choto (small) Behundi jal. Push net is used to catch small shrimps during low tide; quantity of fish catch is very less and it is not meant for sell. This shrimp catch is for own family consumption. Choto Behundi jal is set along the shoreline to catch different kinds of small fish. The nets are set two time a day at the starting of high tide; fish catch is around 20-30 kgs.

459. The areas typically used for foot fishing / shoreline fishing is presented in ***Figure 4.97***

Figure 4.97 Areas Typically used for Foot Fishing / Shoreline Fishing

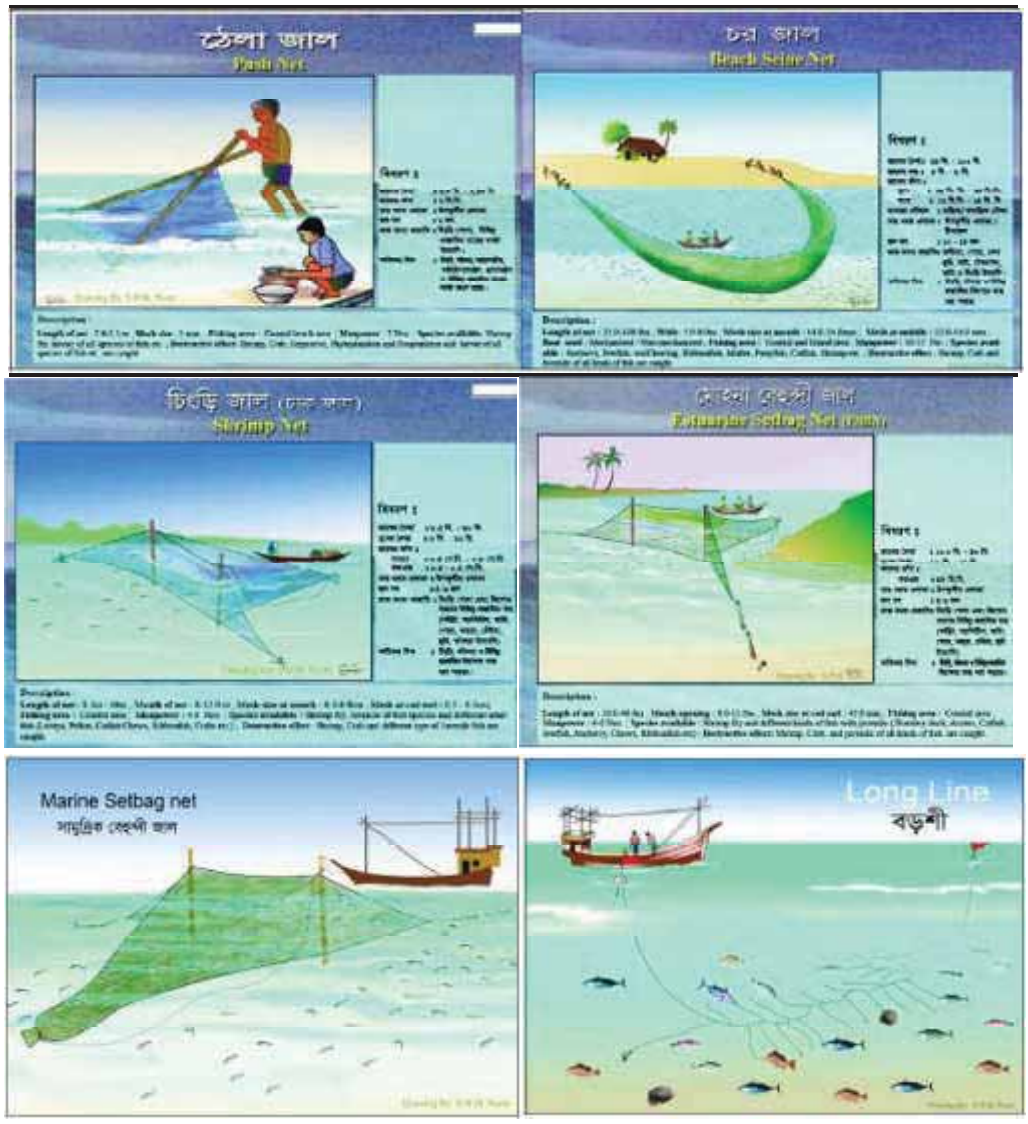


Use of Nets

460. Fishing gears used by the fishermen of Bangladesh are depicted in the following figures that have been sourced from the Department of Fisheries. Interviews with the local fishermen revealed that they use push nets, and shrimp nets in Kutubdia Channel for catching shrimps and Grillnet for Hilsa (Ilish jal), Large Mesh Drift Gillnet (Maitya jal), different types of Setbag nets (Behundi jal, Undara jal, Choto Behundi jal) for different types of fish catch. Fishermen have also mentioned about using *'Chai jal'* for catching crabs in

Kutubdia Channel and *'Banrshi jal'* (Long Line) for catching fish like Macarel in deep sea. The different fishing nets are shown in ***Figure 4.98.***

Figure 4.98 Fishing Nets



Source: Department of Fisheries, Bangladesh

Figure 4.99 Use of Fishing Gears

Consultation with fishermen at Ali Fakir Deil village regarding use of nets

Income from Fishing

461. Discussions with the fishermen during FGDs divulged that in winter season income from fish sell is higher than in summer and monsoon. In monsoon the income majorly depends and varies on Hilsa catch (***Table 4.46***).

Table 4.46 Fish-sell Income

Season	Income from Fish –sell (Tk) per trip
Deep-sea Fishing	
Winter	7-8 lakhs
Summer	2.0-2.5 lakhs
Monsoon	4-5 lakhs (depending on Hilsa catch)
Daily Fishing	
In all seasons (using motorized boats)	40,000 – 60,000
Daily fishing with non-motorized boats	500 – 600
Foot Fishing	
Foot fishing using *choto* Behundi jal	1000 - 1500

462. It was reported by the fishermen that the expenditure cost for undertaking one trip for deep-sea fishing is about 2.0 – 2.5 lakh Tk (Taka) in winter and 1.5 – 2.0 lakh Tk in summer and monsoon. This expenditure is incurred by owner of the trawlers. The owners of the trawlers for contractual fishing are either from Kutubdia island or they are from adjacent Upazilas, and district – Moheshkhali, Chittagong, etc. The boat owners do not go for deepsea fishing but hires all the first boat man (*majhi*), second boat man, Engine Driver, Master/Supervisor (*Gararíya*) along with the fishermen. The entire deep sea fishing trips is financed by the boat owners.

463. The yearly income of a fisherman varies between 1.30 – 1.50 lakh Tk that includes all types of fishing. Contractual fishing involves people in different capacities and different role – first boat man (*majhi*), second boat man, Engine Driver, Master/Supervisor (*Gararíya*) along with the fishermen.

Table 4.47 Income from Contractual Fishing

Person	Income per Year (Tk)
First Boatman	3-4 lakh
Second Boatman	1.5 – 2.0 lakh
Engine Driver	1.0 – 1.5
Master/Supervisor	1.0 – 1.5
Fisherman	80,000 – 90,000

Fish Selling Market

464. In *Kutubdia* there is no fish landing point; fish catch is usually sold on high-sea. As there is no electricity supply in the island preserving fish catch without ice or refrigeration is a major problem faced by the fishermen, and hence they sell their catch on sea. Trawlers and big boats come daily from Chittagong port region to purchase fish. There are three markets on high-sea where the fishermen sell their catch – *near Chittagong, near Cox's Bazar, Banskhali Bangla Bazar.* Apart from this

there is another market on mainland *Chuarphari* near Pekua Bazar where fish catch from daily fishing is also sold by the fishermen.

Fishing Route

465. Fishing routes as followed by the fishermen when they venture into sea generally depends on the location of the settlement, where the fishermen reside and where the boats and trawlers are anchored. The routes followed by the fishing trawlers and boats from the respective unions are as follows:

466. Daksin Dhurung Union: Fishermen sail from the shoreline west of the union and sail west or south-west into deep sea for fishing. Same route if followed for daily fishing also.

467. Uttar Dhurung: The fishermen residing towards the western side of the union usually follow the same route - they start sailing from the western shoreline and they sail west or south-west to Bay of Bengal. During monsoon the fishermen of Uttar Dhurung sail through Kutubdia Channel to reach Bay of Bengal.

468. Boroghop: The union is located at south-east part of the Island Upazila. The fishermen from this union usually sail south through Kutubdia Channel and reach Bay of Bengal; in winter they use the western coastline for sailing into the sea for fishing.

469. Ali Akbar Deil: The union is at the southern part of the island and the fishermen use the eastern side, i.e. they sail through Kutubdia Channel to Bay of Bengal. The union has faced server erosions on south and south-western parts.

Anchorage

470. There are several anchorage points along the west coast, northern coastal line and on the north-eastern side of the island in Kutubdia Channel. There are several anchorage points along the eastern side near Boroghop. It was reported by the fishermen that during summer and monsoon the fishermen anchor their boats in Kutubdia Channel to avoid destruction from the frequent tropical cyclonic surges. It was observed during the side visits that there are several anchorage points along the west coastline of Dakshin Dhurung and Uttar Dhurung Union where boats and fishing nets are repaired.

471. ***Figure 4.100*** demarcates the fishing routes whereas ***Figure 4.101***marks the anchors points.

Figure 4.100 Fishing Routes as Used by the Kutubdia Fishermen

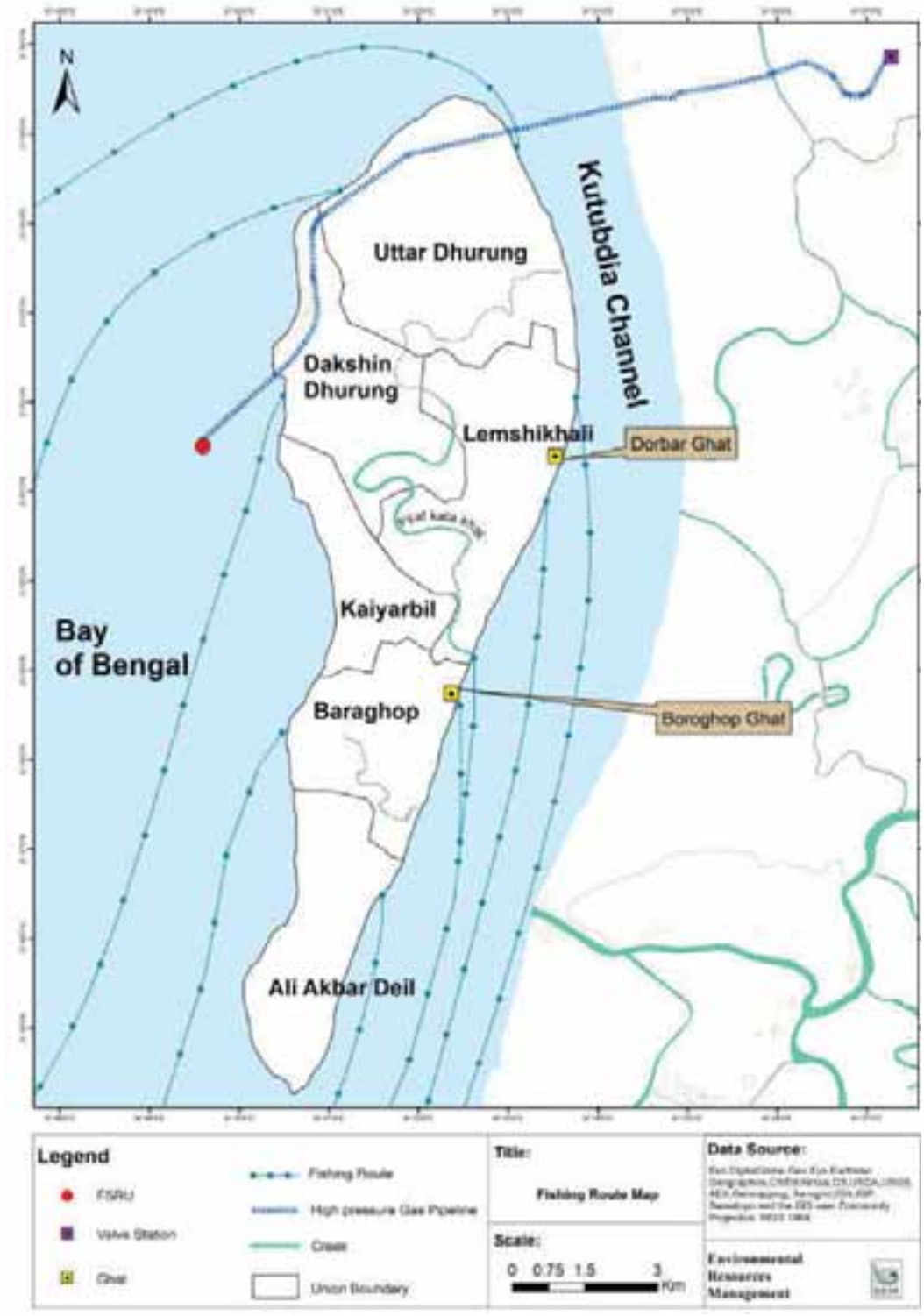


Figure 4.101 Anchorage Points as Used by the Kutubdia Fishermen

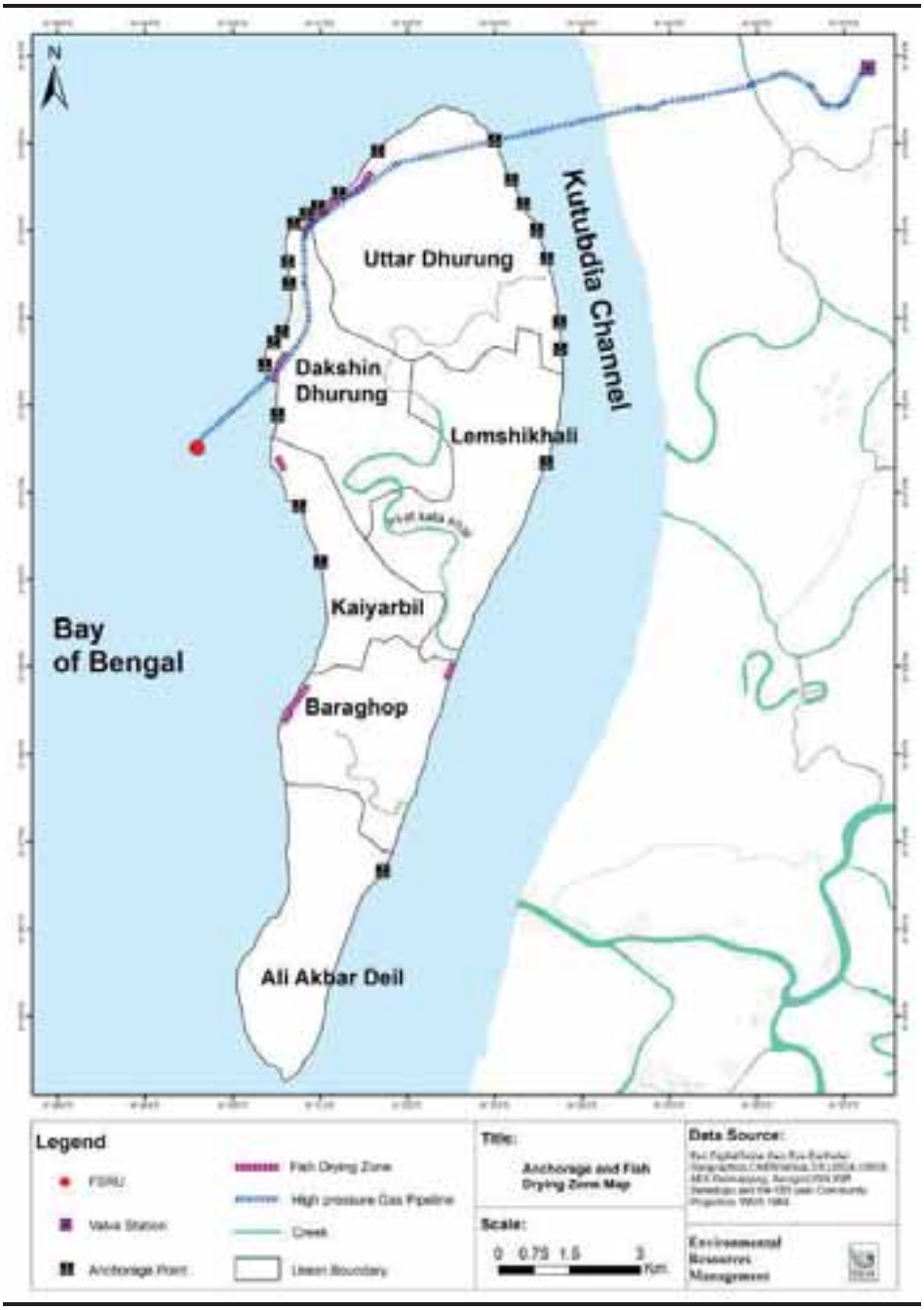


Figure 4.102 Anchorage Points in Kutubdia

Anchorage - Boroghop | Anchorage - Lemshikhali

Aquaculture

472. Aquaculture (shrimp cultivation) is also practiced in Kutubdia Island. During site visit it was observed in Uttar Dhurung and Dakshin Dhurung Union. Few families are involved in this activity as their secondary source of livelihood. Community Consultation revealed that 7 to 8 families from a group and take lease 20 to 22 gonda low laying land near the extended sea shore for Tk 10000 per season for 7 to 8 months and fill that land with saline water channelized from sea. They also invest 20000 to 25000 Tk for purchasing 80000-100000 shrimplets (seeds), among which 20000 to 25000 shrimplets die. Remaining seeds grow to the size of 100-120 gram in 3 to 4 month time. They sell that to mobile assembler, who is known as mahajan at 500 to 600 Tk/kg. For one season income of the group is 7 lakhs to 8 lakhs Tk.

Figure 4.103 Aquaculture Practices in Kutubdia

Shrimp Cultivation in Uttar Dhurung | Consultation with groups involved in Shrimp Cultivation

Fish Drying

473. Dried fish, typically known as '*sutki*' in Bangladesh, is an important component of the daily diet in Bangladesh and it has good domestic market. It was observed during site visit that many people all around Kutubdia Island are involved in fish drying activity. Fish drying generally starts in October and ends in March.

Dry fish processor purchase fresh fish from the fishermen - major species of fish used for drying are *Loittya, Poa, Parse, Phasa, Taposi, Chhuri, Boiragi, Fatra, Rupchanda, Pama.* Fish drying is done under sun. There are two techniques of sun drying i.e. Horizontal drying, Vertical drying.

474. **Horizontal drying:** The main bulk of the catch consists of small fish which are dried on horizontal wooden racks raised about one meter above the ground. The fish are placed on mats and turned occasionally to prevent sticking to the mat
475. **Vertical Drying:** Big fishes like *Loittya, Chhuri, Bol* and Indian salmon are typically dried hanging from vertical wooden racks. Some small stingrays are sliced into longitudinal strips which remain attached to the tail base, and the whole ray is hung by the tail from a vertical rack to dry.

476. A typical fish drying yard (locally named as *Shutki Mahal*) consists of a fenced area with a small house at one end which is used as store room. Dimension of yards varies widely. The fencing is made of bamboo poles and it is use both for demarcation line and vertical drying racks. Certain fish species dry much faster when hung *vertically* than when dried on horizontal racks. Bombay duck has high water content. It takes 12 days to dry on a horizontal rack, but only 6 days on a vertical rack. About 75-90 percent of a drying yard is covered by fish drying in a horizontal position. Typically the fish are dried on mats which are either placed to horizontal racks or directly on the ground.

477. The processors having their own drying houses (*Sutki Mahal*) earn 100,000 Tk to 200,000 Tk per *season* and laborers earn 3000 Tk. per month. About, 5-6 laborers work in each *Sutki Mahal*. Local processors sell their dried fish to mobile assembler, who known as mahajan.

Figure 4.104 Fish Drying in Kutubdia

Fish Drying Yard
(Locally named as *Shutki Mahal*)

Fish Drying Bed Preparation


Horizontal Drying

Vertical Drying

4.18.8 Housing and Sanitation

478. As per the census data, majority (95percent) of the population with in study area lives in kuchcha structures. The material used for construction of houses includes mud, bamboo, GI sheets, of which the most commonly used material is GI sheets.

479. With respect to ownership pattern, majority of the houses are self-owned in comparison to houses being rented out or under rent-free occupation.

480. As per the census information, the sanitation facilities with in study area comprises mostly of sanitary hardware with dry disposal mechanism. The facility was observed to be prevalent in more than 50percent of the households.

481. A smaller fraction (29.2percent) of the households was observed to be using sanitation facilities with water sealed latrines. Pit latrines with dry disposal without any sanitary hardware were observed only in 16.7percent of the households. Open defecation or absence of any form of sanitation facilities was observed in 4.6percent of the households.

4.18.9 Water and Power Supply

482. Most of the households are dependent on tube-well for drinking water supply. 95.2percent of households source their drinking water from tube-well and only 0.7percent depends on tap-water supply.

483. Only 8.6percent of the households in Kutubdia Island have electricity connection and almost 13.5percent household in Chhanua and Puichhari union has electricity connection.

4.18.10 Education Facility

484. As per district statistics, 2011, there are 32 government primary school, 24 registered primary school, 1 Government secondary school, 8 non- government secondary school, 1 non-government college is present in Kutubdia Upazila. In addition 7 madrasah, 4 kawmi madrasah and 14 ebtedayee madrasah also present in this Upazila.

485. Consultation with Upazila Education Department during social reconnaissance visit indicated that there are several educational institutions within the island Upazila – apart from general education madrasa education system is also followed. Although the education department has tried to align itself with the Millennium Development Goal (MDG) of 100 percent enrolment, which they have succeeded, however on the contrary the dropout rate is also high. Most of the boys drop out to earn from drying fish. The ***Table 4.48*** describes availability of educational institutional in Kutubdia Upazila.

Table 4.48 Educational Infrastructure Available in Kutubdia Island

SN	Educational Infrastructure	Number
1.	Govt. Primary School	59
2.	Private KG School	41
3.	Learning Centres for Dropouts	118
4.	Nimnya Madhyamik (Upper Primary level)	1
5.	High School (Secondary level)	8
6.	College (10+2 level)	2
7.	Primary level Madrasa schools	11
8.	Madhyamik level Madrasa (Secondary level)	7
9.	Higher Secondary level Madrasa	1
10.	Degree level Madrasa	1
11.	Vocational College	1

Source: Upazila Education Office

486. At least one primary school and madrasa is present with in the union boundary

4.18.11 Health Facility

487. The health facilities of the Kutubdia Upazila include:

- Upazila Health Complex – 1 No.
- Union Health Centre – 6 Nos. and
- Private Clinic- 1 No.

4.18.12 Financial Institutions

488. The Kutubdia Upazila has 4 Nationalised Banks

4.18.13 Cultural Heritage

489. Birth of Saint Hazrat Abdul Malek Shah makes the Kutubdia Island famous. There are certain cultural and religious sites - Ek Hatia Fakirer Masjid, Kalarma Masjid, Maharaja Kazir Masjid, Tomb of Qutb Auliya in Kutubdia. These places are of local cultural importance but are not having any regional / national importance or archaeological significance. The island is also famous for its Lighthouse that was built during the British period in 1896 and much later eroded by the sea.

490. A private graveyard has been identified during the site visit west of the present lighthouse on the sand beach portion. The graveyard along with portion on the

western part of Dakshin Dhurung union was subject to sea erosion due to cyclonic serge; part of the graveyard was reclaimed later and was demarcated by wooden poles by the villagers, where they often visit to seek blessings from their late forefathers.

Figure 4.105 Cultural Heritage Sites on Kutubdia Island

Ek Hatia Mosque – Located on the Way to the Site

Tomb of Kutub Aulia (Ali Akbar Deil)

Kalarma Mosque (Uttar Dhurung)

Graveyard located north of the proposed site