

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT

250kWp Standalone AC-DC Coupled Solar
Photovoltaic Based Mini Grid Power Plant

by

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Table of Contents

1	INTRODUCTION.....	1
1.1	Background.....	1
1.2	Purpose of the Study	3
1.3	Scope of the Work	4
1.4	Extent of the Study.....	5
1.5	ESIA Content	5
1.6	Approach and Methodology.....	6
1.6.1	Approach.....	6
1.6.2	Methodology	6
2	POLICY, LEGAL, AND ADMINISTRATIVE FRAMEWORK	11
2.1	General.....	11
2.2	Bangladesh Environmental Conservation Act (ECA) 1995, as amended in 2010.....	11
2.3	Bangladesh Environmental Conservation Rules, 1997	12
2.4	Renewable Energy Policy of Bangladesh, 2008	13
2.5	Guidelines for the Implementation of Solar Power Development Program, 2013	13
2.6	Remote Area Power Supply Systems (RAPSS) Guideline of 2007.....	13
2.7	Bangladesh Labor Law, 2006	14
2.8	Compliance under the National Laws	14
2.9	Policy Guidance	16
2.10	International Legal Obligations	18
2.11	Environmental Protected Areas of Bangladesh.....	19
2.12	The Japan International Cooperation Agency Requirements.....	22
2.13	World Bank's Guidelines on Environmental and Social Safeguards Policies	22
2.14	ADB Guidelines on Environmental and Social Safeguards.....	23
2.15	Environmental Clearance.....	24
3	DESCRIPTION OF THE PROPOSED PROJECT.....	26
3.1	Project Location	26
3.2	Land Classification of the Project Area	32
3.3	Project Description.....	32
3.4	Rationale of the Project.....	35
3.5	Positive and Negative Impacts of Replacing Conventional Electricity Supply System with Solar Mini-Grid System.....	37
3.6	Land Filling Activities	39
3.7	Site Clearance (SC) from Department of Environment for another Company	40
4	TECHNOLOGICAL ASPECTS	41
4.1	Proposed Process and Technology.....	41
4.2	Adequacy of Solar Irradiation.....	43
4.3	Opposite Reflection of Solar Panel.....	44

4.4	Plant Capacity Selection	44
4.5	Adequacy of Generator Size	46
5	DESCRIPTION OF THE PHYSICAL ENVIRONMENT	47
5.1	General.....	47
5.2	Physical Environment	47
5.2.1	Climate	47
5.2.2	Ambient Air Quality	54
5.2.3	Noise Level	55
5.2.4	Physiography.....	56
5.2.5	Topography	57
5.2.6	Geology.....	60
5.2.7	Geomorphology	62
5.2.8	Water Resources	64
5.2.9	Soil Quality	72
5.2.10	Agro-ecological Zones within the Project Area.....	74
5.2.11	Seismicity.....	76
5.3	Climate Change and Natural Disaster	78
5.3.1	Climate Change and Other Environmental Threats	80
6	DESCRIPTION OF THE ECOLOGICAL ENVIRONMENT	81
6.1	Eco-system Diversity	81
6.1.1	Rocky Habitat	82
6.1.2	Sand Dunes and Beach.....	82
6.1.3	Lagoons and Wetlands	83
6.1.4	Mangrove Habitat	84
6.1.5	Mudflats	84
6.1.6	Other Inter-tidal Habitats	85
6.1.7	Marine Habitats.....	86
6.2	Flora.....	88
6.2.1	Terrestrial Vegetation	88
6.2.2	Trees.....	88
6.2.3	Palm Trees	88
6.2.4	Moraceae.....	89
6.2.5	Mangrove Species	89
6.2.6	Shrubs and Herbs	90
6.3	Fauna.....	92
6.3.1	Echinoderms (Sea Stars, Sea Urchins, Sea Cucumbers).....	92
6.3.2	Cnidaria (Jellyfishes, Corals, Sea Anemons).....	93
6.3.3	Mollusks.....	93
6.3.4	Crustaceans (Lobsters, Crabs, Shrimps)	94

6.3.5	Horseshoe Crabs	95
6.3.6	Fishes	95
6.3.7	Reptiles and Amphibians	96
6.3.8	Olive Ridley Turtle	98
6.3.9	Birds.....	98
6.3.10	Mammals.....	99
6.4	Some Species of Conservation Significance.....	100
6.4.1	Olive Ridley Turtle <i>Lepidochelys olivacea</i> (Endangered).....	100
6.4.2	Hawksbill Turtle <i>Eretmochelys imbricate</i> (Critically Endangered).....	101
6.4.3	Green Turtle <i>Chelonia mydas</i> (Endangered).....	101
6.4.4	Loggerhead Turtle <i>Caretta caretta</i> (Endangered).....	102
6.4.5	Leatherback Turtle <i>Dermochelys coriacea</i> (Critically Endangered).....	102
6.4.6	Irrawaddy Dolphin <i>Orcaella brevirostris</i> (Vulnerable)	102
6.4.7	Finless Porpoise <i>Neophocaena phocaenoides</i> (Vulnerable).....	102
6.5	Bird Migration	102
6.6	Protected Areas and Red Book Species	106
7	DESCRIPTION OF THE SOCIOECONOMIC CONDITIONS	109
7.1	Administrative Structure	110
7.2	Demographic Information.....	110
7.3	Government Offices Present in the Island	111
7.4	Environmental Groups and Committee.....	111
7.5	Associations	112
7.6	Community Infrastructure.....	112
7.7	Land use.....	112
7.8	Transports and Communications	114
7.9	Agriculture	114
7.10	Livestock and Crop Ownership.....	114
7.11	Poverty	115
7.12	Education	115
7.13	Health Services and Sanitation Facilities.....	115
7.14	Water and Sewarge	116
7.15	Fishing.....	116
7.16	Coastal and Marine Activities.....	116
7.17	Current Electricity Consumption Condition	116
7.18	Livelihoods	117
7.19	Material Style of Life.....	121
7.20	Status of Women.....	122
7.21	Tourism	122
7.22	Recreational Activities.....	123

7.23	Archaeological and Cultural Heritage.....	123
7.24	Environmental and Social Hotspot	123
8	ANALYSIS OF PROJECT ALTERNATIVES	126
8.1	General.....	126
8.2	Project Objectives	126
8.3	Proposed Project Summary	127
8.4	Alternatives Eliminated from Further Consideration.....	127
8.4.1	Other Energy (Wind) Alternative.....	127
8.4.2	Alternative Site	128
8.5	Alternatives Selected for Analysis.....	129
8.5.1	Alternative A: No Project Alternative.....	130
8.5.2	Alternative B: Reduced Project Alternative.....	133
8.5.3	Alternative C: Build-Out of Existing Land Use Alternative.....	137
8.5.4	Alternative D: No Utility Scale Solar Development Distributed Commercial and Industrial Rooftop Solar Only Alternative.....	141
8.5.5	Comparison of Alternatives	145
8.5.6	Environmentally Superior Alternative	146
9	PUBLIC CONSULTATION AND DISCLOSURE.....	147
9.1	General.....	147
9.2	Objectives	147
9.3	Consultation with Various Stakeholders.....	147
10	ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES	151
10.1	General.....	151
10.2	Methodology of the Leopold Matrix.....	152
10.3	Environmental and Social Impact Assessment Using Leopold Matrix.....	153
10.4	Corridor of Impact (CoI).....	159
10.5	Pre-construction Phase.....	159
10.5.1	Land Use / Land-filling.....	159
10.5.2	Flood Hazards	160
10.6	Construction Phase.....	160
10.6.1	Visual Amenity	160
10.6.2	Water Resources	161
10.6.3	Noise	161
10.6.4	Air Quality	162
10.6.5	Soil	163
10.6.6	Terrestrial Ecology.....	163
10.6.7	Waste Generation.....	164
10.6.8	Employment Opportunities	165
10.6.9	Health and Safety	165
10.6.10	Traffic	166

10.6.11	Archaeology and Cultural Resources.....	166
10.7	Operational Phase	166
10.7.1	Visual Amenity	167
10.7.2	Water Resources	167
10.7.3	Noise	168
10.7.4	Air Quality	168
10.7.5	Soil	169
10.7.6	Terrestrial Ecology.....	169
10.7.7	Waste Generation.....	170
10.7.8	Employment Opportunities	170
10.7.9	Health and Safety	171
10.7.10	Traffic	172
10.8	Decommissioning Phase	173
10.8.1	Visual Amenity	173
10.8.2	Noise	173
10.8.3	Air Quality	173
10.8.4	Soil	174
10.8.5	Terrestrial Ecology.....	174
10.8.6	Waste Generation.....	174
10.8.7	Employment Opportunities	175
10.8.8	Health and Safety	176
10.8.9	Traffic	176
11	ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN	177
11.1	General.....	177
11.2	Objectives	177
11.3	Environmental and Social Management Plan (ESMP)	177
11.4	Environmental Monitoring Plan.....	195
11.4.1	General.....	195
11.4.2	Objectives	195
11.5	Inhouse Monitoring System	200
11.6	Environmental Budget	200
12	ENVIRONMENTAL AND SOCIAL BENEFIT	202
12.1	Introduction.....	202
12.2	Energy and Climate Concern	202
12.3	Energy and Livelihood Concern	203
12.4	Energy and Economy Concern	203
13	CONCLUSION.....	205
13.1	Conclusion	205
13.2	Recommendations.....	205

APPENDIXES	207
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List of Figures

Figure 1.1: Route Map of Environmental and Social Impact Assessment.....	7
Figure 1.2: Location of Sample Collections	9
Figure 2.1: Environmental Protected Areas of Bangladesh	21
Figure 2.2: Government of Bangladesh Environmental Assessment Process.....	25
Figure 3.1: Proposed Project Location (North View).....	26
Figure 3.2: Proposed Project Location (South View)	27
Figure 3.3: Proposed Project Location (Total Land Area: 2.40 acre or 240 decimle)	27
Figure 3.4: Project Location	28
Figure 3.5: Map of St. Martin's Island	29
Figure 3.6: Landscape diversity in St. Martin's Island.....	29
Figure 3.7: Zoning of St. Martin's Island	31
Figure 3.8: Accessible Route to Project Site	32
Figure 3.9: Single Line Diagram of the Plant.....	34
Figure 3.10: Layout of the Plant.....	34
Figure 3.11: Sample Structures Resembling the type of the Would be Made Structure.....	40
Figure 3.12: Solar Mini-grid Process Flow Diagram	41
Figure 3.13: Single Line Diagram of the Plant	42
Figure 3.14: Layout of the Plant	43
Figure 3.15: Plant capacity selection	45
Figure 3.16: Estimated Daily Load Profile.....	46
Figure 5.1: Climatic Zones of Bangladesh.....	49
Figure 5.2: Average Monthly Maximum and Minimum Temperature.....	50
Figure 5.3: Average Monthly Total Rainfall	50
Figure 5.4: Average Monthly Relative Humidity.....	51
Figure 5.5: Average Monthly Maximum Wind Speed.....	51
Figure 5.6: Average Monthly Sunshine Hours.....	52
Figure 5.7: Average Monthly Cloud Coverage.....	52
Figure 5.8: Average Monthly Solar Radiation at St. Martins Island.....	53
Figure 5.9: Air Quality Monitoring at Project Site	54
Figure 5.10: Noise Level Monitoring in the Project Area	55
Figure 5.11: Physiographic Sub Regions of Banglades	58
Figure 5.12: Topographic Elevation of the Project Area	59
Figure 5.13: Geology of Bangladesh.....	61
Figure 5.14: Surface Water Sampling from the Project Location.....	66
Figure 5.15: Water Sampling from the Project Location.....	70
Figure 5.16: Arsenic Concentrations in Groundwater.....	71
Figure 5.17: General Soil Categories of Bangladesh.....	73
Figure 5.18: Agro-ecological Zones of Bangladesh	75
Figure 5.19: Seismic Zones within Bangladesh.....	77
Figure 6.1: Generalized Zonation of East Coast Benthic Communities.....	85
Figure 6.2: Generalized Zonation of West Coast Benthic Communities	85
Figure 6.3: Bio-ecological Zones of Bangladesh	87
Figure 6.4: Species of Conservation Significance in the Island.....	101
Figure 6.5: Environmental Protected Areas of Bangladesh	108
Figure 7.1: Land Use Map of the Project Area	113
Figure 7.2: Percentage of Load Consumption Pie Chart	117
Figure 7.3: Seasonal calendar for key livelihoods activities on St. Martin's Island	118
Figure 7.4: Resource activity Map of St. Martin's Island.....	119

Figure 7.5: Habitats under threat due to land use changes on St. Martin's Island	120
Figure 7.6: Seasonal calendars (fish species)	121
Figure 7.7: House types on St. Martin's Island.....	122
Figure 7.8: Cultural and Sensitive Structures within 1 km Radius of the Project Location (Google Earth Map).....	125
Figure 9.1: Photos of Focus Group Discussions (FGD)	148
Figure 12.1: Trends of World Solar Energy Growth	204

List of Tables

Table 3.1: Project Key Information	33
Table 3.2: Monthly Average Solar Insolation Incident at 24Degree Tilted Angle	43
Table 3.3: Plant Capacity Determination	45
Table 5.1: Test Results of Ambient Air Quality Analysis	54
Table 5.2: Noise Level at Different Locations of Project Area.....	56
Table 5.3: Results for Surface Water Field Sample.....	66
Table 5.4: Results for Groundwater Field Sample.....	70
Table 5.5: Seismic Zonation of Bangladesh.....	76
Table 6.1: List of Plants in the Project Area.....	104
Table 7.1: Estimated Yearly Load Consumption.....	117
Table 8.1: Summary of Development Alternatives	129
Table 8.2: Comparison of Alternatives.....	145
Table 9.1: Details of FGDs	148
Table 9.2: Summary of the FGDs.....	148
Table 10.1: Matrix of Magnitude of the Impact Factors on Environmental Components	155
Table 10.2 Matrix of Significance of the Impacts of Factors on Environmental Components	156
Table 10.3: Matrix of Probability of the Impact of Factors on Environmental Components	157
Table 10.4: Matrix of Duration of the Impact of Factors on Environmental Components	158
Table 11.1: Environmental and Social Management Plan (ESMP) of Solar Mini-grid Power Plant Project	178
Table 11.2: Environmental Monitoring Plan.....	196
Table 11.3: Environmental Budget for Solar Mini-grid Power Plant Project	200

List of Appendix

Appendix A: Air Quality Monitoring Methodology	207
Appendix B: Air Quality Test Result.....	211
Appendix C: Noise Level Test Result.....	213
Appendix D: Test Result of Surface Water	215
Appendix E: Test Result of Groundwater	217
Appendix F: Important Sensitive Locations in the PIA	219
Appendix G: Details of FGDs with Attendance List.....	229
Appendix H: List of Marine Algae found in the St. Island (Molony et al., 2006)	235
Appendix I: List of Birds Species	238
Appendix J: Term of Reference (TOR) for Approval on Environemtal Impact Assesment (ESIA) Report Preparation.....	241
Appendix K: Permission Letter for Environmental Study from the Ministry of Environment and Forest	247
Appendix L: No Objection Certificate (NOC) from Local Authority	248
Appendix M: Site Clearance Certicate from DoE Coxsbazar	250
Appendix N: Permission from Director General of Department of Environemnt for Site Clearance Certificate	252
Appendix O: Responses on DoE Comments for IEE Report for Further Improvement.....	254

ABBREVIATIONS

ADB	Asian Development Bank
AEZs	Agro-ecological Zones
BBS	Bangladesh Bureau of Statistics
CITES	Convention on International Trade in Endangered Species
CoI	Corridor of Impact
DoD	Depth of Discharge
DoE	Department of Environment
DPHE	Department of Public Health Engineering
ECA	Ecologically critical area
ECC	Environmental Clearance Certificate
ECR	Environmental Conservation Rule
EIA	Environmental Impact Assessment
ESIA	Environmental and Social Impact Assessment
EMP	Environmental Management Plan
EQS	Environmental Quality Standards
FGD	Focus Group Discussion
GHGs	Greenhouse Gases
GIS	Geographical Information System
GPS	Global Positioning System
IEE	Initial Environmental Examination
IP	Indigenous People
IPCC	Inter-government Panel on Climate Change
IUCN	International Union for Conservation of Nature
IDCOL	Infrastructure Development Company Limited
JICA	Japan International Cooperation Agency
MFF	Multitranches financing facility
MSDS	Material Safety Data Sheet
NAPA	National Adaptation Programme on Action
NOC	No Objection Certificate
OSHA	Occupational Safety and Health Administration
PSMP	Power Sector Master Plan
PV	Photovoltaic
RAPSS	Remote Area Power Supply Systems
SLM	Sound Level Meter
SPM	Suspended particulate matter
SRDI	Soil Resource Development Institute
SREDA	Sustainable and Renewable Energy Development Agency
TDS	Total Dissolved Solids
TMP	Traffic Management Plan
ToR	Terms of References
UNDP	United Nations Development Program

EXECUTIVE SUMMARY

INTRODUCTION

According to the Global Status Report, it indicates that renewable energy provided an estimated 19% of global energy consumption in 2012 compared to 16.7 % in 2010. More than hundred countries now have renewable energy policy of one kind or the other. Keeping pace with the global trend, Bangladesh has also attached due importance to development of renewable energy. National plans - Five Year Plan, Power System Master Plan and policy documents including National Energy Policy, Industrial Policy 2010 underscored renewable energy. Development of renewable energy has been identified as one of the programmes of Bangladesh Climate Change Strategy and Action Plan. Renewable energy options are also included in the Bangladesh National Building Code. A dedicated policy, Renewable Energy Policy of Bangladesh, has been in force since 2009, which Blue Marine is having 5% power from renewable energy sources by 2015 and 10% by 2020. The government has established Sustainable and Renewable Energy Development Authority (SREDA) to promote renewable energy and energy efficiency. To strengthen international cooperation, Bangladesh became one of the initial members of the International Renewable Energy Agency (IRENA), the only inter-governmental agency working exclusively on renewable energy. Those endeavours manifest Bangladesh's commitment towards development of renewable energy.

St. Martin is a miniature island in the north-eastern part of the Bay of Bengal, which is distinct from the Cox's Bazar-Teknaf peninsula, Bangladesh. Currently there are around 6000 people amidst the majority number of people's primary livelihood sources are fishing, tourism, and agriculture. However, it has become a great tourist's attraction spot in Bangladesh due to its unique landscape. Consequently, its natural environment and ecosystem, especially unique biodiversity is annihilated frequently by-virtue-of indiscriminate human activities. This problem is triggering due to lack of education and awareness. Contrary, application of environmental ethics can minimize further damages as-well-as rehabilitate the island anew. Lately, the government and some NGOs have already taken and implemented several steps to protect the island but not fruitful still due to some drawbacks. Hence it is an island located in the deep sea. Any kind of infrastructural development is hard to establish there, especially power generation. Presently people are using generators for power source. But this is not continuous power. The generator operation continues 4-5 hours per day during night time.

Blue Marine Energy Limited proposed a project of a 250 kWp of solar mini-grid power plant. The proposed system will include 250 kWp solar mini-grids along with a 100 kVA diesel backup generator to meet the energy demand of the area. Once completed, the Project is expected to go into commercial operation in December 2016 and supply electricity to the adjacent 850 households, 70 Hotels/guest house/cottage/resort, 13 restaurant, 158 different types of shops, 1 madrasa, 6 mosque, 1 ten bed hospital, coastguard office & camp, Naval base, Weather office in the St. Martin Island.

METHODOLOGY

The study is based on both primary and secondary data and information. The primary data includes data collected from field observations and secondary data includes review of the Bangladesh statistical and relevant information from Government Departments. Discussions were held with stakeholders including community representatives and a wide range of Char areas.

POLICY, LEGAL, AND ADMINISTRATIVE FRAMEWORK

Legislative bases for Environmental and Social Impact Assessment (ESIA) in Bangladesh are the Environmental Conservation Act 1995 (ECA'95, as amended in 2010) and the Environmental Conservation Rules 1997 (ECR'97). Department of Environment (DoE), under the Ministry of Environment and Forests (MoEF) is the regulatory body responsible for enforcing the ECA'95 and ECR'97. It is the responsibility of the proponent to conduct an Environmental Assessment (EA) of development proposal and the responsibility to review ESIA's for the purpose of issuing Environmental Clearance Certificate (ECC) from the DOE.

DESCRIPTION OF THE PROPOSED PROJECT

The Project is located at Saint Martin's Island which is located on the southern-most tip of Bangladesh, roughly between 20°34'-20°39' N and 92°18'-92°21' E and 17 kilometers off Taknaf, the most southern main land of Bangladesh.. The Global Positioning System (GPS) coordinate of the project site is 20°37.788'N and 92°19.354'E. The specific location of this project is at Konapara village of ward no. 6 in this island (Figure 3.2). The project site is located in the island where the Bay of Bengal is 2.5 Km far to the north, 5 km to the south, ~1 Km to the east and 1 Km to the west. The site is on an open land currently not in used for agriculture or other commercial purposes, and is adjacent to some rural settlements.

The proposed Project involves setting up of a 250 kWp of solar minigrid power plant project at this island by Blue Marine Energy Limited. The proposed system will include 250 kWp solar mini-grids along with a diesel backup generator to meet the energy demand of the area. Once completed, the Project is expected to go into commercial operation in December 2016 and supply electricity to the adjacent 850 households, 70 Hotels/guest house/cottage/resort, 13 restaurant, 158 different types of shops, 1 madrasa, 6 mosque, 1 ten bed hospital, coastguard office & camp, Naval base, Weather office in the Saint Martin Island.

DESCRIPTION OF THE BASELINE ENVIRONMENT

Although less than half of Bangladesh lies within the tropics, the presence of the Himalaya mountain range has created a tropical macroclimate across most of the east Bengal land mass. Bangladesh can be divided into seven climatic zones (Rashid 1991). According to the classification, the project area is located in the South-western region climatic zone.

The highest average recorded temperature in this weather station was 32.2°C in May. The lowest average recorded temperature was found in the month of January which was 14.9°C. Statistical data of 1977 to 2012 shows that Teknaf stations experience almost 1100mm rainfall during monsoon. In the month of November to February of winter season the rainfall

occurred in the region of Teknaf weather station was 3 mm to 70 mm. The statistical data of humidity from 1977 to 2012 indicates that humidity in the above two stated areas maximized in June to October in the year which is ranges from 75% to 82%. On the other hand, humidity falls 65.7% to 76.1% in February, March and April during the winter season in the Teknaf station area. The statistical wind speed data from 1977 to 2013 shows that average wind speed remained maximum with 3.4m/s in March. The minimum wind speed was 1.4m/s in the month of December in the area of Teknaf weather station. The statistical sunshine data from 1977 to 2013 shows that average sunshine remained maximum with 9.0 hours in both January and February. The minimum sunshine was 3.00 hours in the month of July in the area of Teknaf weather station. The statistical cloud coverage data from 1977 to 2013 shows that average cloud coverage remained maximum from 6 octas to 5 octas during June to September. The minimum cloud coverage was less than 1.0 octas in the month of January in the area of Teknaf weather station.

According to Bangladesh National Ambient Air Quality Standards from the Environmental Conservation Rules, 1997 which was amended on 19th July 2005 vide S.R.O. No. 220-Law/2005; any of the measures parameter of the local ambient air does not exceed Bangladesh standard. The results show that time weighted average value of the sound monitored at inside and outside of the project area did not exceed the standard fixed for the respective areas. But at night time, one noise measurement showed slightly higher value due to natural events of some dogs was barking continuously.

The project lies in St. Martin's Island is a dumb-bell- shaped sedimentary Continental Island located on the eastern flank of an anticline, which like Chittagong may be part of the Arakan Yoma- Naga folded system (Warrick et. al., 1993).. The project area falls in the St. Martin's Island physiographic unit. The topography of the specific project location is 10.85– 35 m a.m.s.l. The main shoreline features are sandy beaches and dunes, where the main sediments are alluvial sands. The beaches and dunes of the southern part of the Island have a higher carbonate content compared to the northern Uttar Para beaches. Most carbonates comprise mollusc shell fragments. The sandy beach in the north and north-east stretches 300-400m into the sea. The western beach is sandy but the sub-tidal area consists of a bed of boulders.

The project area is surrounded by the sea water. Fresh water sources are limited in island. People use the water from the natural water bodies for washing, bathing and irrigation purposes.

The concentration levels of COD and BOD parameters for SW-2 were found higher set by the DoE, GoB, it indicates that there may be connection with sea. Since it is coral stony island that's why COD level may be higher.

From secondary report it is to be noted that water transparency measured in December fluctuated from 0.62 m near St. Martin's Bazar, where the water is heavily affected by human pressure, to 3.9 m at Galachipa (Hossain et al., 2006). This low light penetration is the consequence of many factors like COD, BOD, and TDS etc.

On 6th April 2016, groundwater sample was collected by environmental team from more than one tube well near the project area. The Department of Public Health Engineering (DPHE)

analyzed the sample. The result (see Appendix D) of the groundwater sample and the GoB standards for drinking water (ECR, 1997) are shown in Table 5.4. All the parameters concentration levels are within the acceptable limit of Bangladesh drinking water quality standard set by DoE.

Scattered throughout the area are small clumps of coral colonies, many still in growth position. A large shallow lagoon is located in the middle of Uttar Para. The lagoon has been largely converted into agricultural fields, and is connected to the sea at high tide by a narrow tidal channel on the west coast. The remaining flooded part of the lagoon has an area of about 0.4 km² with a depth of 1 m or less. The soil of the area is falls in Calcareous Saline of Bangladesh general soil classification.

As per the seismic zone map, project area falls in the zone II of medium seismic intensity.

The species of conservation significance of the island are Olive Ridley Turtle *Lepidochelys olivacea* (Endangered), Hawksbill Turtle *Eretmochelys imbricata* (Critically Endangered), Green Turtle *Chelonia mydas* (Endangered), Loggerhead Turtle *Caretta caretta* (Endangered), Leatherback Turtle *Dermochelys coriacea* (Critically endangered), Irrawaddy Dolphin *Orcaella brevirostris* (Vulnerable), Finless Porpoise *Neophocaena phocaenoides* (Vulnerable) etc.

St. Martin itself is an environmentally protected area. But the project activity may not be anticipated directly. Other potential factor like tourism may increase, it can destroy St. Martin ecosystem. But proper implementation of laws, regulation & guideline, proposed management plan can reduce the anticipated impact.

There are currently 1,200 households and approximately 8,000 people living on St. Martin's Island according to data obtained from the Union Parishad office. The voter registry showed that there were 1,342 males and 1,379 females registered. Households are found in clusters and are scattered in the North and South of the Island.

Historically, the first people to settle on St. Martin's Island apparently came from what is now Myanmar with 13 families arriving some 200 years ago. Those who currently identify themselves as islanders are descendents of these original families. Over the years, other people from mainland Bangladesh, and particularly from around the Noakhali area, have settled on the island as well. Most of these people are originally fishers and fish processors by trade, with seaweed collection for trade with Myanmar constituting an important seasonal activity in the past, although this has declined in importance in recent years.

From the 1940s onwards it is reported that land was gradually converted to paddy cultivation, and from the 1960s onwards this involved converting the main lagoon to cultivation. All the land of the Island is privately- owned, with the exception of 18.7 hectares at Cheradia which was purchased by Ministry of Environment and Forest, and some small areas on which public buildings have been constructed. Lands at the project area are open space not used as agriculture.

ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

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

During pre-construction phase, the impacts associated with the land use and flood hazards. The project developer has bought the land from the owner with a good value. There is no conflict in land use. Therefore, there are no anticipated impacts of land use of the Project. Since the area is subject to potential risk of local flood hazards during the rainy season. It should be considered in the design stage.

During construction phases, the major impact associated with environmental quality like air, noise, water, soil quality might be degraded due to improper management of the generated waste. Dust generated from construction machineries and gaseous emissions from vehicular transport as well machineries may deteriorate the air quality of the local area. Noise quality can be deteriorated due to the operation of various machineries and equipment. Various grease and oily substances may be released from the construction machineries may deteriorate the natural water of the project site. Soil quality may be deteriorated due to the leaching of various oily substances to the soil. All the impacts will be very much localized in nature. The project contractor is to take responsibility of minimizing environmental impact on the surroundings during construction phases by following the project's environmental management plan (EMP). Other social impacts associated with the visual amenity, health safety of the labors, cultural resources, employment opportunity etc. such type of impacts will be localized in nature and not anticipate to the project. The contractor should follow the rules and guidelines related to the environmental and social mentioned in the EMP.

Photo Voltaic power plants do not release greenhouse gases or any toxic pollutants during their operation. The solar power do not exhibit any significant noise from operations, the inverters and transformers may produce noise, but this is not anticipated to the environment. In addition, there is some residential dwellings beside the project area. The residential dwellings are sensitive receptors within the project site. Every phase of the construction and operation must be followed the project's environmental management plan (EMP). Soil impacts during operation phase are limited to accidental spillage of lubricant, fuel and other chemicals that may potentially cause soil degradation. Another most significant source of soil pollution is the damage of battery and PV panels in case of major accidents. These contain chemicals and may be harmful for soil quality. The surface water bodies may get flooded and polluted due to uncontrolled release of contaminated storm-water/runoff from plant area. The pollutants associated with the plant activities include, hydrocarbons, heavy, corrosive products and suspended solids including insoluble heavy metals as colloidal materials from plant chemicals such as batteries etc. Groundwater may get polluted due to contaminated runoff chemical materials. Additionally, the project may lead to faster development of the surrounding of the project area. This will exert stress on the availability of groundwater in the project area. Other impact issue like ecology, waste generation will not be significant for the

project. Some social impact are associated with health safety, employment, visual amenity etc.

To minimize/mitigate the impacts the developer should follow the Environmental Management Plan (EMP) properly.

ENVIRONMENTAL MANAGEMENT AND MONITORING PLAN

Environmental Management Plan has been developed for addressing all adverse impacts pertaining to the implementation of the project. The plan presented in tabular form includes impacts, their sources of occurrence, their mitigation measures, actors responsible for implementation of mitigation measures and their responsibilities.

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

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

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

CONCLUSION AND RECOMMENDATION

According to the above analysis, we can conclude that,if the recommended mitigation measures and environmental management processes are adopted properly, the project will beenvironmentally sound and sustainable.

Primarily the national economy will be benefitted by the project. Benefits in the project area will be in significant except for some short terms employment and business opportunities during the construction phase. However, the needs of the solar photovoltaic power plant are obvious and for that the livelihood of the area will be developed. Developed livelihood will directly influence the growth of economy of the area.

Adequate provisions have been made for the environmental mitigation and monitoring ofpredicted impacts, along with their associated costs. Adverse impacts if noticed during implementation will be mitigated using appropriate design and management measures. Thepotential cumulative and residual impacts of the project classify as not a highly sensitive or complex.

1 INTRODUCTION

1.1 Background

According to the National Development of the Bangladesh government, for the purpose of reducing the traditional dependency on oil, gas used for power generation, increase of utilization of alternative clean renewable energy like solar energy, wind energy, bio-energy, hydropower, geothermal and ocean energy is set out as one of the key policies in the energy field to ensure energy security. The use of renewable energy has risen considerably in recent times, both in developed and in developing countries. According to the Global Status Report, it indicates that renewable energy provided an estimated 19% of global energy consumption in 2012 compared to 16.7 % in 2010. More than hundred countries now have renewable energy policy of one kind or the other. Keeping pace with the global trend, Bangladesh has also attached due importance to development of renewable energy. National plans - Five Year Plan, Power System Master Plan and policy documents including National Energy Policy, Industrial Policy 2010 underscored renewable energy. Development of renewable energy has been identified as one of the programmes of Bangladesh Climate Change Strategy and Action Plan. Renewable energy options are also included in the Bangladesh National Building Code. A dedicated policy, Renewable Energy Policy of Bangladesh, has been in force since 2009, which Blue Marine ions having 5% power from renewable energy sources by 2015 and 10% by 2020. The government has established Sustainable and Renewable Energy Development Authority (SREDA) to promote renewable energy and energy efficiency. To strengthen international cooperation, Bangladesh became one of the initial members of the International Renewable Energy Agency (IRENA), the only inter-governmental agency working exclusively on renewable energy. Those endeavours manifest Bangladesh's commitment towards development of renewable energy.

Increasing economic growth and social development within Bangladesh is placing a growing demand on energy supply. Coupled with the rapid advancement in economic and social development, is the growing awareness of environmental impact, climate change and the need for sustainable development. Whilst Bangladesh relies heavily on gas to meet its energy needs, the country is well endowed with renewable energy resources that offer sustainable alternatives to fossil fuels. Renewable energy harnesses naturally occurring non-depletable sources of energy, such as solar, wind, biomass, hydro, tidal, wave, and ocean current, to produce electricity, gaseous and liquid fuels, heat or a combination of these energy types. The successful use of renewable energy technology in Bangladesh still requires extensive investigation, however, Concentrating Solar Power (CSP) and Photovoltaic (PV) technologies have been demonstrated to be economically and environmentally viable and capable of being employed on a large scale.

Bangladesh is a densely populated country with 160 million people. Population is increasing but the generation of electricity is not increasing as expected. The per capita generation is 348 kWh (Power Division, Government of the People's Republic of Bangladesh; Accessed on 19-08-2015). The Sixth Five Year Plan contains information on demand-supply gap for electricity, source of electricity supply, use of different types of energy, electricity generation

program and strategy for power generation. The plan document shows a clear gap between demand and supply and only about 68% have access to electricity. The policy of the Government of Bangladesh has been to ensure extension and stabilization of the power sector through both public and private sector undertakings toward not only meeting the existing power deficiency of the country but also ensuring continuous power in view of the projected future demand.

According to PSMP study the electricity demand would be 34,000MW by the year 2030. The government fully recognizes the fact that public sector investment alone is not sufficient to achieve its target and has aimed at mobilizing resources from the private sector investments. The Government is strongly committed to attract private investment for installing new renewable energy capacity on a build-own-operate (BOO) basis in order to achieve overall economic development targets of the country and avoid looming power shortages. Development of Renewable Energy is one of the important strategies adopted as part of Fuel Diversification Program. In line with the Renewable Energy policy 2009, the Government is committed to facilitate both public and private sector investment in Renewable Energy projects to substitute indigenous non-renewable energy supplies and scale up contributions of existing Renewable Energy based electricity productions. Under the existing generation scenario of Bangladesh, Renewable Energy has a very small share to the total generation. The share of Renewable Energy exceeds more than 1% till now. The present Government is placing priority on developing Renewable Energy resources to improve energy security and to establish a sustainable energy regime alongside of conventional energy sources. Government has already launched "*500 MW Solar Power Mission*" to promote the use of Renewable Energy to meet the increasing demand of electricity.

Bangladesh receives an average daily solar radiation in the range of 4-5 kWh/m². Encouraged by the availability of solar radiation, Power Division has initiated a programme to generate 500 MW of solar-based electricity. Under this programme, projects for electrification of rural health centres, educational institutions, E-centres at union levels, religious establishments and remote railway stations are required to be implemented by authorities concerned. Private sector is expected to implement commercial projects like Solar Irrigation, Solar Mini Grid, Solar Park and Solar Rooftop applications. The government is gradually meeting part of the lighting and cooling load of public offices by installing solar panels. The national capacity of solar power development currently exceeds 150 MW. Most of the capacity addition is from Solar Home Systems (SHS) implemented by Infrastructure Development Company Limited (IDCOL), a government-owned financial institution. Until recently, more than 3 million SHSs have been installed with aggregated capacity of about 135 MW. The international community recognizes Bangladesh's SHSs as the fastest growing solar power dissemination programme in the world.

St. Martin is a miniature island in the north-eastern part of the Bay of Bengal, which is distinct from the Cox's Bazar-Teknaf peninsula, Bangladesh. Currently there are around 6000 people amidst the majority number of people's primary livelihood sources are fishing, tourism, and agriculture. However, it has become a great tourist's attraction spot in

Bangladesh due to its unique landscape. Consequently, its natural environment and ecosystem, especially unique biodiversity is annihilated frequently by-virtue-of indiscriminate human activities. This problem is triggering due to lack of education and awareness. Contrary, application of environmental ethics can minimize further damages as-well-as rehabilitate the island anew. Lately, the government and some NGOs have already taken and implemented several steps to protect the island but not fruitful still due to some drawbacks. Hence it is an island located in the deep sea. Any kind of infrastructural development is hard to establish there, especially power generation. Presently people are using generators for power source. But this is not continuous power. The generator operation continues 4-5 hours per day during night time. Therefore, Blue Marine Energy Limited has showed high interest for power generation through introducing renewable energy, by constructing a Solar Mini Grid Power Plant at Saint Martin, Cox'sbazar has been implemented under this government national policy. This implementation program can lead enormous development of socio-economic condition of local people as well as national economy through ecotourism, appropriate zoning system for sustainable development, spreading education amid mass people can resolve the dispute, population control and resettle. Moreover, involving community people in the management program and initiating cottage industry as substitute of income Sources can reduce pressure on island natural resources depletion.

Blue Marine Energy Limited proposed a project of a 250 kWp of solar mini-grid power plant. The proposed system will include 250 kWp solar mini-grids along with a 100 kVA diesel backup generator to meet the energy demand of the area. Once completed, the Project is expected to go into commercial operation in December 2016 and supply electricity to the adjacent 850 households, 70 Hotels/guest house/cottage/resort, 13 restaurant, 158 different types of shops, 1 madrasa, 6 mosque, 1 ten bed hospital, coastguard office & camp, Naval base, Weather office in the St. Martin Island.

1.2 Purpose of the Study

Environmental Conservation Rules (ECA), 1997 should be properly implemented for sustainable management of St.Martin's Island- a declared 'Ecologically Critical Area' (ECA's) of Bangladesh. The key concern that needs immediate attention is the over-exploitation of natural resources. It is therefore essential that, prior to any future development activities, Environmental and Social Impact Assessments (ESIA) should be obligatory, including tourism development. This study investigates renewable energy-based rural electrification in Bangladesh, with a specific focus on the mini grid experiences. Specific references are made to solar PV technologies implemented under publicly supported programme. The study is also providing an examination and assessment of the environmental impacts of the project. The main purpose of this ESIA are to evaluate the impact of project location from the environmental point of view along with possible measures to be included in an Environmental Management Plan (EMP) to minimize the potential impacts resulting from project activities during the implementation and operation phase of the project.

This ESIA is a part of the process of compliance with the guidelines and legal requirement of Government of Bangladesh, JICA Guidelines for Loan Aid (Japan Bank for International

Cooperation Guidelines for Confirmation of Environmental and Social Considerations, April 2010) and World Bank OP 4.01 (Environmental Assessment) guidelines in relation to 250 kWp of solar minigrid power plant. Blue Marine Energy Limited as an implementing agency of 250 kWp of solar minigrid power plant project at this island along with the 'No Objection certificate (NOC)' from by Ministry of Environment and Forest of Bangladesh illustrates environmental issues in connection with the planning, design and implementation of this project. The ESIA provides a road map to the environmental measures needed to prevent and/or mitigate negative environmental effects associated with the development project. The ESIA also provides a detailed description of the direct and indirect environmental effects associated with the proposed project during key periods of work. In order to mitigate the potential impacts, appropriate measures have also been proposed in the Environmental Management Plan (EMP). Extensive public consultations undertaken as part of the ESIA work have been considered for identifying the mitigation measures.

1.3 Scope of the Work

IEE and ESIA are required in Bangladesh for solar mini grid projects as a precondition of obtaining required Site Clearance and Environmental Clearance Certificate permits. However, Blue Marine Energy Limited has already received a No Objection Certificate (NOC) from the Ministry of Environment and Forest dated 6 March 2016 (annexure J), to carry out the project activities along with the environmental and social assessment of the proposed 250 kWp of solar minigrid project. The scope of the required IEE and ESIA takes general environmental, social and public health issues into consideration to the extent that they are related to sources of potential environmental impacts (e.g. noise, air monitoring, surface & ground water). Public consultations are required as part of the IEE and ESIA review and approval process.

This ESIA report has been prepared keeping in view the Term of Reference (ToR) as provided by the Client. The scope of the present ESIA report describes the following most important features:

- A review of the environmental legislative, regulatory and policy guidelines and considerations relating to the implementation of the project;
- A general description of the project and existing physical, biological and socio-economic conditions;
- Consultation with the locals/stakeholder involving concerned people in order to identify and act on any undocumented or perceived environmental issues;
- Identification and assessment of the potential impacts on the natural and human environment in the project area, from the construction of the AC mini-grid power plant;
- Identification of mitigation measures and monitoring actions in the form of an Environmental Management Plan (EMP); and
- Recommendations and conclusions in order to operate the project works in an environmentally safe and sound manner.

1.4 Extent of the Study

This ESIA is carried out based on proposed development. The influence of impact has been defined as 1 Km on each side from the project location. However, the study area has been extended up to 1 Km area on each side of the project and in the whole Saint Martin Island. Geographical Information System (GIS) techniques have also been used based on recent satellite imageries of the project area for above purposes. Assessment is carried out on the following environment components: terrestrial and aquatic ecology, soil, water, air, noise, and socio economic aspects. The impacts on ecologically sensitive areas (e.g. wildlife sanctuaries, biosphere reserve, and protected places) within 1 Km of the project areas have also been assessed.

1.5 ESIA Content

The report fulfills the requirements of ESIA under ECR, 1997 and has been prepared in accordance with the TOR. This ESIA report is also consistent with the Government of Bangladesh guidelines, JICA Guidelines for Loan Aid (Japan Bank for International Cooperation Guidelines for Confirmation of Environmental and Social Considerations, April 2010) and World Bank OP 4.01 (Environmental Assessment) guidelines. The report contains eleven chapters and the chapter details are discussed below:

- Chapter 1 describes the introduction containing background, purpose of the ESIA study, scope of the study, and approach methodology of ESIA study.
- Chapter 2 is on policy, legal and administrative framework describing the relevant policy and legal frameworks for the ESIA process.
- Chapter 3 contains detailed project description including the all the aspects of the proposed project.
- Chapter 4 describes the technological aspects
- Chapter 5 describes environmental and social baseline condition with details on physical environment, land resources, agricultural resources, fisheries, ecosystem, socio-economic condition and social characteristics of the area.
- Chapter 6 describes analysis of the project alternatives
- Chapter 7 describes public consultation discussion with local stakeholders with their ideas, views about the project through knowledge sharing
- Chapter 8 presents the impacts of project during pre-construction; construction and post-construction phase and describes mitigations measures for minimizing the effect of the negative impacts and enhancement measures for increasing the benefits of the positive impacts.
- Chapter 9 describes the environmental management plan (EMP) and monitoring plan along with the costing of the mitigation measures and monitoring plan.
- Chapter 10 includes the environmental and social benefits.
- Chapter 11 concluding the ESIA report along with the recommendations.

1.6 Approach and Methodology

1.6.1 Approach

The study has been conducted in accordance with Environment Conservation Rules, 1997, Government of Bangladesh (GoB) EIA Guidelines, 1997, JICA Guidelines for Loan Aid (Japan Bank for International Cooperation Guidelines for Confirmation of Environmental and Social Considerations, April 2010) and World Bank OP 4.01 (Environmental Assessment) guidelines. The route map of this ESIA preparation is given in Figure 1.1. The study is based on both primary and secondary data and information. The primary data includes data collected from field observations and secondary data includes review of the Bangladesh statistical and relevant information from Government Departments. Discussions were held with stakeholders including community representatives and important locations of Saint Martin. The main purpose of this approach was to obtain a fair impression on the people's perceptions of the project and its environmental impacts.

1.6.2 Methodology

The following methodology was adopted for carrying out the ESIA of the proposed project:

(i) Orientation

Meetings and discussions were held among the members of the ESIA Team. This activity was aimed at achieving a common ground of understanding of various issues of the study.

(ii) Data Collection Planning

Subsequent to the concept clarification and understanding obtained in the preceding step, a detailed data acquisition plan was developed for the internal use of the ESIA Team. The plan included identification of specific data requirements and their sources; determined time schedules and responsibilities for their collection; and indicated the logistics and other supporting needs for the execution of the data acquisition plan.

(iii) Data Collection

In this step, primary and secondary data were collected through field observations, environmental monitoring in the field, concerned departments and published materials to establish baseline profile for physical, biological and socioeconomic environmental conditions. A map in Figure 1.2 is showing the data collection spots of several environmental features in the project area. Following activities were performed for data collection:

- Site Reconnaissance
- Analysis of Maps and Plans
- Literature Review
- Desk Research
- Field Observations and Studies
- Public Consultations
- Laboratory Analysis

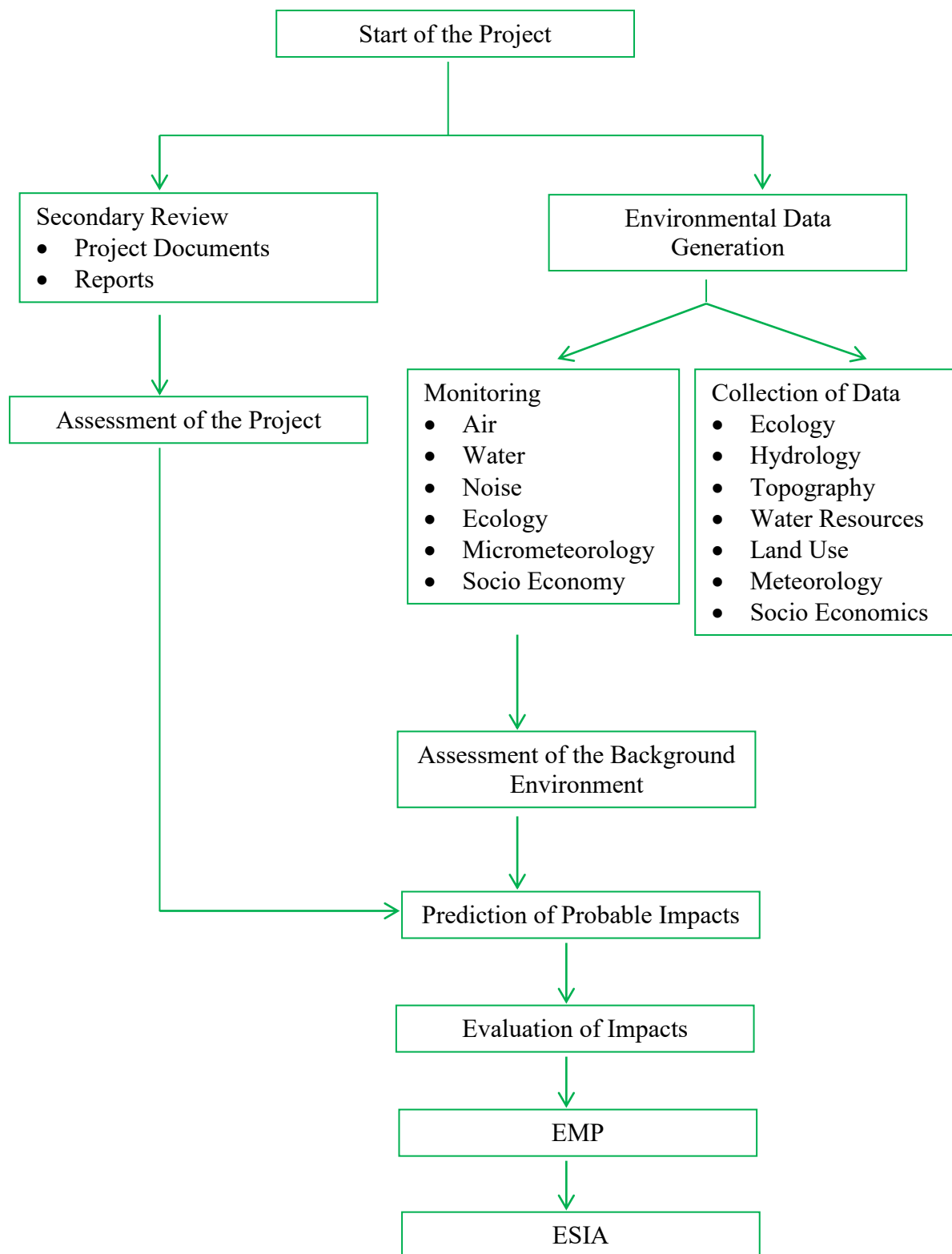


Figure 1.1: Route Map of Environmental and Social Impact Assessment

Physical Environment

Information was collected on the existing physical environment, particularly as related to geology, topography, soils, hydrology and drainage, water quality, air quality and noise. The primary sample collection map for the environmental issues has been given Figure 1.2.

Geology, Topography, Soils

Data related to geology, topography and soil was collected to establish the baseline of the project area and further to find out the impacts of the Project during the construction and operational phases.

Hydrology and Drainage

Data related to hydrology and drainage was collected to identify the elements of the flooding and water logging that are likely to have impacts on the project and the possible impacts that the project could have on the regime. Field assessments included a determination and verification of all the existing inflows into the drain, assessment of drainage issues, interviews with local community members.

Air Quality

Ambient air quality measurements are essential to provide a description of the existing conditions, to provide a baseline against which changes can be measured and to assist in the determination of potential impacts of the proposed construction on air quality conditions. Air quality measurements were observed two locations both Bazar and Project site during day and night time. To monitor ambient air quality, carbon monoxide (CO), sulphur dioxide (SO₂), nitrogen oxide (NO), nitrogen dioxide (NO₂), particulate matter (PM₁₀), particulate matter (PM_{2.5}), and suspended particulate matter (SPM) have been included for ambient air quality monitoring. A methodology for analyzing the air quality sample is described in Appendix A with test result.

Noise

The noise monitoring was performed by a trained specialist, using a calibrated Sound Level Meter set to A-weighting, fast response and statistical analysis settings. The Sound Level Meter (SLM) was mounted on a tripod at a height of approximately 1.5m, facing in the direction of the apparent predominant noise source. The SLM was programmed to record statistical noise levels for 15 minutes at each location and was calibrated before and after the survey; no significant drift was detected. Noise quality measurements were observed various locations of the Project site during day and night time.

Ground /Drinking Water Quality

Sampling and analysis of ground/drinking water has been carried for the following parameters: pH, Chloride (Cl⁻), Total Dissolved Solids (TDS), Iron (Fe), Arsenic (As), Salinity and Alkalinity.

Surface Water Quality

Sampling and analysis of surface water quality has been carried out for the following parameters: pH, Salinity, Total Dissolved Solids (TDS), Dissolved Oxygen (DO), Chemical Oxygen Demand (COD) and Biochemical Oxygen Demand (BOD₅).

Biological Environment

The status of the flora and fauna of the project area were determined by an ecological survey, review of literature relevant to the area, and an assessment of terrestrial environment.



Figure 1.2: Location of Sample Collections

Flora

The vegetative communities were identified and classified into community types. Identification was carried out of dominant tree species, assessment of stage of growth (mature or sapling) and assessment of canopy cover.

Fauna

Information on fauna was gathered from existing literature on reported species as well as observations in the field.

Socio-Cultural Environment

The Consultants utilized a combination of desk research, field investigations, census data, structured interviews, maps, reports to generate the data required for description of the existing social environment and assessment of the potential impacts due to the construction of the project. Data was collected on the following aspects given below:

- Land use
- Transportation and access Roads
- Demographics
- Livelihoods
- Education
- Health
- Community facilities
- Recreational activities
- Archaeological and cultural heritage

(iv) Public Consultation

Public consultation is an important component of the ESIA preparation activities. Local knowledge about the ecosystem and problems associated with the project activities were carefully recorded and used in impact assessment and developing mitigation plan. Formal public consultation, in tandem with opportunistic informal ones involving local villagers, and people whose livelihood depends on these project areas, were executed. Detailed description of public consultation has been presented at Chapter 7.

2 POLICY, LEGAL, AND ADMINISTRATIVE FRAMEWORK

2.1 General

An ESIA is an effective planning and decision-making tool for the project proponent. It allows for the identification and management of environmental impacts/issues that may occur through the establishment and operation of such a facility. Furthermore, an ESIA allows for resolution of the issue(s) reported on in the Scoping and ESIA Reports as well as dialogue with affected parties.

According to the national environmental legislation of Bangladesh all development projects are governed by some legal and institutional requirements. As such, assessment of relevant legal provisions, policies, strategies and institutional issues are very important for any project proponent or developer before execution of a program or plan. The proponent has to be well aware of these requirements and comply with the provisions as applicable and necessary. Before initiating any development project, it is hence required to obtain environmental clearance from DOE. Department of Environment (DoE), under the Ministry of Environment and Forests (MoEF) is the regulatory body responsible for enforcing the environmental laws and regulations like ECA '95 (amended in 2010) and ECR '97.

The need to comply with the requirements of the ESIA Regulations ensures that decision makers are provided the opportunity to consider the potential environmental and social impacts of a project early in the project development process, and assess if environmental impacts can be avoided, minimized or mitigated to acceptable levels. Comprehensive, independent environmental studies are required to be undertaken in accordance with the ESIA Regulations to provide the competent authority with sufficient information in order for an informed decision to be made. The following activities have been carried out under the ESIA study:

- Identification of national legal obligations in relation to the interventions which will be required to review under the ESIA study of the proposed project;
- Exploration of the national legislative provisions and policy guidelines on environmental sectors;
- Identification of the international legal obligations and relevant provisions of multilateral environmental agreements related to the renewable energy project;
- Exploration of national and international legal provisions on energy sector; and
- Identification of the standard guidelines at regional and international level related to the renewable energy.

2.2 Bangladesh Environmental Conservation Act (ECA) 1995, as amended in 2010

The Environmental Conservation Act (ECA) of 1995 is the main legislative framework document relating to environmental protection in Bangladesh. This umbrella Act includes laws for conservation of the environment, improvement of environmental standards, and control and mitigation of environmental pollution. This Act established the DOE, and

empowers its Director General to take measures as he considers necessary which includes conducting inquiries, preventing probable accidents, advising the Government, coordinating with other authorities or agencies, and collecting & publishing information about environmental pollution. According to this act (Section 12), no industrial unit or project shall be established or undertaken without obtaining, in a manner prescribed by the accompanying Rules, an Environmental Clearance Certificate (ECC) from the Director General of the DOE.

The Act was amended in 2010 on collection and recycling of used/non-functional batteries for conservation of environment, improving environmental standard and control and prevention of environmental pollution. According to this amendment, no recycling of battery will be permitted without environmental clearance of DOE. This also restricted the improper disposal of used batteries or any parts of used battery in open place, water bodies, waste bins, etc. All used batteries must be sent to the DOE approved battery recycling industry at earliest convenience. No financial transaction was allowed for used/non-functional batteries.

2.3 Bangladesh Environmental Conservation Rules, 1997

The Environment Conservation Rules, 1997 were issued by the Government of Bangladesh in exercise of the power conferred under the Environment Conservation Act (Section 20), 1995. Under these Rules, the following aspects, among others, are covered:

- Declaration of ecologically critical areas;
- Classification of industries and projects into four categories;
- Procedures for issuing the Environmental Clearance Certificate;

The Rule 3 defines the factors to be considered in declaring an area 'ecologically critical area' (ECA) as per Section 5 of ECA'95. It empowers the Government to declare an area 'ECA', if it is satisfied that the ecosystem of the area has reached or is threatened to reach a critical state or condition due to environmental degradation. The Government is also empowered to specify which of the operations or processes shall be carried out or shall not be initiated in the ecologically critical area. Under this mandate, MOEF has declared Sundarbans, Cox's Bazar-Tekhnaf Sea Shore, Saint Martin Island, Sonadia Island, Hakaluki Haor, TanguarHaor, Marzat Baor and Gulshan-Baridhara Lake as ecologically critical areas and prohibited certain activities in those areas.

ECR'97 (Rule 7) classifies industrial units and projects into four categories depending on environmental impact and location for the purpose of issuance of ECC. These categories are:

- Green
- Orange A
- Orange B, and
- Red

All existing industrial units and projects and proposed industrial units and projects, that are considered to be low polluting are categorized under "Green" and shall be granted Environmental Clearance. For proposed industrial units and projects falling in the Orange- A, Orange-B and Red Categories, firstly a site clearance certificate and thereafter an

environmental clearance certificate will be issued. A detailed description of those four categories of industries has been given in Schedule-1 of ECR'97.

Apart from general requirement, for every Orange-B and Red category proposed industrial / plant unit or project; the application must be accompanied with feasibility report on Initial Environmental Examination (IEE), Environmental Impact Assessment (EIA) based on approved ToR by DOE, Environmental Management Plan (EMP) along with lay-out plan (showing location of ETP), time schedule of ETP, etc. Although there is no categorization for renewable energy project, DoE has categorized the mini-grid project considering the potential adverse environmental impacts.

2.4 Renewable Energy Policy of Bangladesh, 2008

The renewable energy policy of Bangladesh has been approved on December 18, 2008 with the target of developing renewable energy resources. This Policy laid out the target of meeting 5% of total power demand from renewable energy sources by 2015 and 10% by 2020. The policy provides an overall guidance of

- institutional arrangements
- resource, technology and program development
- investment and fiscal incentives
- regulatory policy

The policy promotes appropriate, efficient and environment friendly use of renewable energy. It also suggest that for large biomass electricity projects (i.e., greater than 1 MW) the project developer must demonstrate that the biomass is being sustainably harvested and that no adverse social impact will result from that development. It also restricted the larger scale production and use of bio-fuels which may jeopardize the existing crops.

2.5 Guidelines for the Implementation of Solar Power Development Program, 2013

It is clearly mentioned in the section 3.8 of guidelines for the implementation of Solar Power Development Program (2013) that according to the Renewable Energy Policy, to establish a solar mini grid projects with a capacity up to 5 MW, entrepreneur will be exempted to get a waiver certificate. Mini grid projects with a capacity up to 250 MW will not be required any waiver certificate/license, but entrepreneur will have to inform the Commission by sending a letter. For implementation and operation of solar mini grid projects, license for a period of minimum 20 years may be issued with a condition to renew every year.

2.6 Remote Area Power Supply Systems (RAPSS) Guideline of 2007

The Remote Area Power Supply Systems (RAPSS) guideline of 2007 allows for private sector participation in development, operation, and maintenance of electricity generation system and distribution networks in remote rural areas including isolated islands to supplement GoB efforts at achieving universal access by 2020. However, there has not been much progress in implementing the RAPSS schemes. GoB is in the process to establish the Sustainable and Renewable Energy Development Agency (SREDA) as an autonomous body to lead its efforts in promoting renewable energy and energy efficiency in the country.

2.7 Bangladesh Labor Law, 2006

This Act pertains to the occupational rights and safety of factory workers and the provision of a comfortable work environment and reasonable working conditions. In the chapter VI of this law safety precaution regarding explosive or inflammable dust/ gas, protection of eyes, protection against fire, works with cranes and other lifting machinery, lifting of excessive weights are described. And in the Chapter VIII provision safety measure like as appliances of first aid, maintenance of safety record book, rooms for children, housing facilities, medical care, group insurance, etc. are illustrated.

2.8 Compliance under the National Laws

Wildlife (protection and safety) Act 2012

The Wildlife (protection and safety) Act 2012, passed in Parliament on 8th July, 2012. Under this act, the hunting, trapping, killing of wildlife are strictly prohibited. After the establishment of this Act, a board will be formed with the concerned members recommended by the Government. There are certain provisions kept in this Act, e.g. entrance, management, rules and regulation of the protected area etc. If any person without license performs any kind of trade, he will be jailed for at least a year. The details of the Act shall be further discussed in the ESIA report.

The Forest Act, 1927 and Amendment Act 2000

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

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

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

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

The Penal Code, 1860

The Penal Code of 1860 has some valid provisions related to pollution management, environment protection and protection of health and safety. Some of these are: Section 277:

Falling Water or Public Spring or Reservoir; Section 278: Making Atmosphere Noxious to Health; Section 284: Negligent Conduct with Respect to Poisonous Substance; Section 285: Negligent Conduct with Respect to Fire or Combustible Matter; and Section 286: Negligent Conduct with Respect to Explosive Substance. (Chapter XIV of offences affective Public health, safety, convenience, decency and morals).

The Acquisition and Requisition of Immovable Property Ordinance (1982)

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

The Ordinance has well-defined procedures regarding payment of compensation for an acquired piece of land. If, for example, the land is used for rice growing, then an amount equivalent to approximately 1.5 times the market value of a given variety of rice (e.g., paddy) that is currently being (or could be) produced annually is fixed as a yearly lease value. In case of outright purchase (carried out on a 99-year lease), the compensation-value of acquired land varies widely according to the locality, soil fertility, and access to transportation and related infrastructure factors. The current compensation and resettlement provisions are however inadequate both in terms of timing of payments and quantum. The procedures involved are cumbersome and time consuming and often causes hindrance to the smooth execution of the project. Legal provisions covering adequate compensation to the project affected persons, particularly disadvantaged groups such as women and squatters and such other vulnerable groups are yet to be framed.

The Protection and Conservation of Fish Rules, 1985

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

The Embankment and Drainage Act, 1952

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

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

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

The Water Resources Planning Act, 1992

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

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

2.9 Policy Guidance

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

National Environment Policy

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

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

National Environment Management Plan 1995

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

NEMAP has the following broad objectives:

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

The National Forest Policy (1994)

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

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

The National Water Policy (1999)

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

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

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

- Food security, social protection and health

- Comprehensive disaster management
- Infrastructure
- Research and Knowledge management
- Mitigation and low carbon development
- Capacity building and Institutional strengthening

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

2.10 International Legal Obligations

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

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

Rio Declaration

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

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

Convention on Biological Diversity (1992)

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

The Contracting Parties of the Convention have committed to:

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

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

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

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

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

2.11 Environmental Protected Areas of Bangladesh

Many wildlife species are in stress in Bangladesh, many more are endangered/ threatened and a large number already faced extinction. The status of faunal species in Bangladesh has been published by IUCN (2000). According to the IUCN findings this country has lost 10% of its mammalian fauna, 3% avifauna and 4% reptiles over the last 100 years. More than 50 species are presently critically endangered in Bangladesh of which 23 species are already declared as endangered in the Red Data Book of IUCN. In addition, 83 species are commercially threatened and are included in the appendices of Convention on International Trade in Endangered Species (CITES).

All the native species of flora and fauna of St. Martin's Island are under significant anthropogenic impact. Thus all the species of marine algae are treated as nationally threatened species. Similarly the echinoderms, cnidaria, molluscs and crustaceans have become of national conservation concern due to overexploitation.

All of the marine turtle species occurring on and around the Island are globally threatened with extinction.

Although the Island does not host significant numbers of threatened bird species, the numbers of wintering migrant water birds have declined considerably, and this is thought to be a direct result of increasing human use of the shoreline.

The species of conservation significance of the island are Olive Ridley Turtle *Lepidochelys olivacea* (Endangered), Hawksbill Turtle *Eretmochelys imbricata* (Critically Endangered), Green Turtle *Chelonia mydas* (Endangered), Loggerhead Turtle *Caretta caretta* (Endangered), Leatherback Turtle *Dermochelys coriacea* (Critically endangered), Irrawaddy Dolphin *Orcaella brevirostris* (Vulnerable), Finless Porpoise *Neophocaena phocaenoides* (Vulnerable) etc.

St. Martin itself is an environmentally protected area. But the project activity may not be anticipated directly. Other potential factor like tourism may increase, it can destroy St. Martin ecosystem. But proper implementation of laws, regulation & guideline, proposed management plan can reduce the anticipated impact.

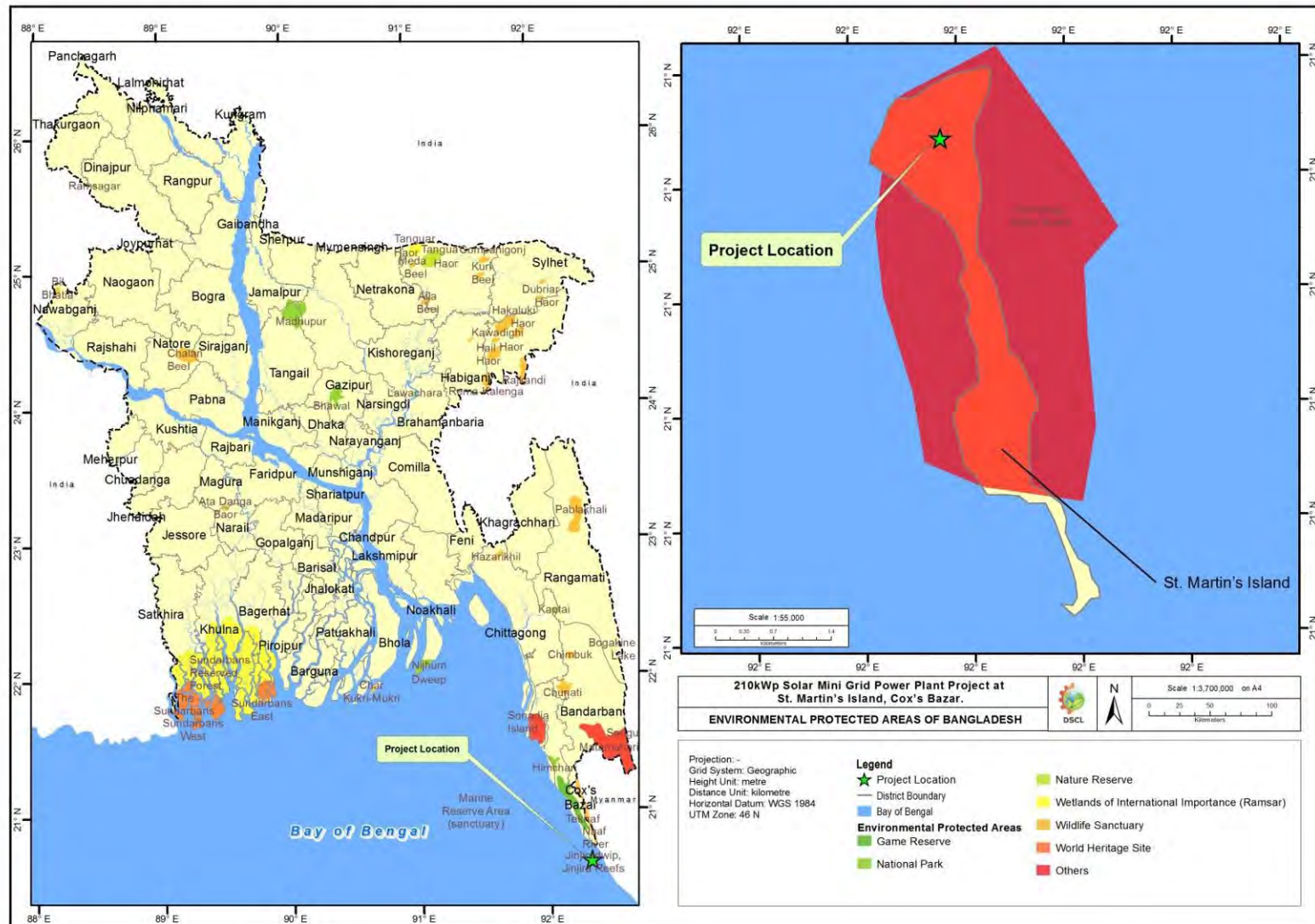


Figure 2.1: Environmental Protected Areas of Bangladesh

2.12 The Japan International Cooperation Agency Requirements

“JICA Guidelines for Loan Aid (Japan Bank for International Cooperation Guidelines for Confirmation of Environmental and Social Considerations, April 2010)” provide four categories of projects as per its environmental classification system. The Projects classified under this system are screened for the anticipated environmental impacts and are set under relevant categories. JICA has classified Projects in the following four categories:

1. *Category A:* A proposed project is classified as Category A if it is likely to have significant adverse impact on the environment. Borrowers and related parties must submit Environmental Impact Assessment (EIA) reports. For projects that will result in large-scale involuntary resettlement, basic resettlement plans must be submitted. EIA and other reports need to be submitted through the borrower before the JICA environmental reviews.
2. *Category B:* A proposed project is classified as Category B if its potential adverse environmental impact is less adverse than that of Category A projects.
3. *Category C:* A proposed project is classified as Category C if it is likely to have minimal or no adverse environmental impact.
4. *Category FI:* A proposed project is classified as Category FI if it satisfies all of the following:
 - JICA’s funding of the project is provided to a financial intermediary etc.;
 - the selection and assessment of the actual sub-projects is substantially undertaken by such an institution only after JICA’s approval of the funding and therefore the subprojects cannot be specified prior to JICA’s approval of funding (or assessment of the project); and
 - those sub-projects are expected to have potential impact on the environment.

The solar mini grid project, as per the above categorization, falls under Category B for the purpose of environmental investigations. Final ESIA report approved by DoE needs to be submitted to JICA and JICA discloses the results of environmental reviews on its website after concluding agreement documents for category B projects.

2.13 World Bank’s Guidelines on Environmental and Social Safeguards Policies

There are two types of safeguards requirement of the World Bank-environmental and social. Under these two safeguards there are a number of operational policies. Among them, the following operational policies could have relevance with the proposed Project:

OP 4.01 Environmental Assessment

The Bank requires environmental assessment (EA) of projects proposed to ensure that they are environmentally sustainable, and thus to improve decision making. EA is a process whose extent and type of analysis depend on the nature, scale, and potential environmental impact of the proposed project. EA evaluates a project's potential environmental impacts in its area of influence; examines project alternatives; identifies ways of improving project selection, sitting, planning, design, and implementation by preventing, minimizing, mitigating, or

compensating for adverse environmental impacts and enhancing positive impacts; and includes the process of mitigating and managing adverse environmental impacts throughout project implementation. EA takes into account the natural environment (air, water and land); human health and safety; social aspects (involuntary resettlement, indigenous peoples and physical cultural resources); and trans-boundary and global environmental aspects. The borrower is responsible for carrying out the EA and the Bank advises the borrower on the Bank's EA requirements.

The Bank classifies the proposed project into three major categories, depending on the type, location, sensitivity, and scale of the project and the nature and magnitude of its potential environmental impacts.

Category A: The proposed project is likely to have significant adverse environmental impacts that are sensitive, diverse, or unprecedented. These impacts may affect an area broader than the sites or facilities subject to physical works.

Category B: The proposed project's potential adverse environmental impacts on human population or environmentally important areas-including wetlands, forests, grasslands, or other natural habitats 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 Category A projects.

Category C: The proposed project is likely to have minimal or no adverse environmental impacts.

OP 4.04 on Natural Habitats

The conservation of natural habitats, like other measures that protect and enhance the environment, is essential for long-term sustainable development. The Bank therefore supports the protection, maintenance, and rehabilitation of natural habitats and their functions in its economic and sector work, project financing, and policy dialogue. The Bank supports, and expects borrowers to apply, a precautionary approach to natural resource management to ensure opportunities for environmentally sustainable development. The Bank promotes and supports natural habitat conservation and improved land use by financing projects designed to integrate into national and regional development the conservation of natural habitats and the maintenance of ecological functions. Furthermore, the Bank promotes the rehabilitation of degraded natural habitats.

2.14 ADB Guidelines on Environmental and Social Safeguards

Asian Development Bank (ADB) has three safeguard policies that seek to avoid, minimize or mitigate adverse environmental impacts and social costs to third parties, or vulnerable groups as a result of development projects. New lending modalities and financing instruments, such as the multitranches financing facility (MFF), have increased the complexity of applying safeguard policies and ensuring compliance. The new modalities and the likelihood of continued innovation, as well as changing client circumstances, suggest a need to enhance the relevance and effectiveness of ADB's safeguards, which has been reflected in an update of

the Safeguard Policy by 2009, announced through the Safeguard Policy Statement 2009 (SPS 2009).

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; and
- help borrowers/clients to strengthen their safeguard systems and develop the capacity to manage environmental and social risks.

Since the ADB Safeguard Policy Statement had been approved it supersedes the Involuntary Resettlement Policy (1995), the Policy on Indigenous Peoples (1998), the Environment Policy (2002), and the second sentence of para 73, and paras 77–85 and 92 of the Public Communications Policy (2005).

2.15 Environmental Clearance

Formal EIA guidelines in Bangladesh are set out in “Rules and Regulations under the 1995 Environmental Protection Acts” as published in the official Gazette on August 27, 1997. Any proponent planning an industrial project is currently required under Paragraph 12 of the Environmental Protection Acts, 1995 to obtain “environmental clearance letter:” from the Department of Environment.

Steps to be followed for obtaining the Environmental Clearance Certificate for this rail link are shown in Figure 2.1 as the solar power plant is yet not categorized by the DoE so they have circulated an amendment to prepare a full ESIA prior to implementation of such project for approval.

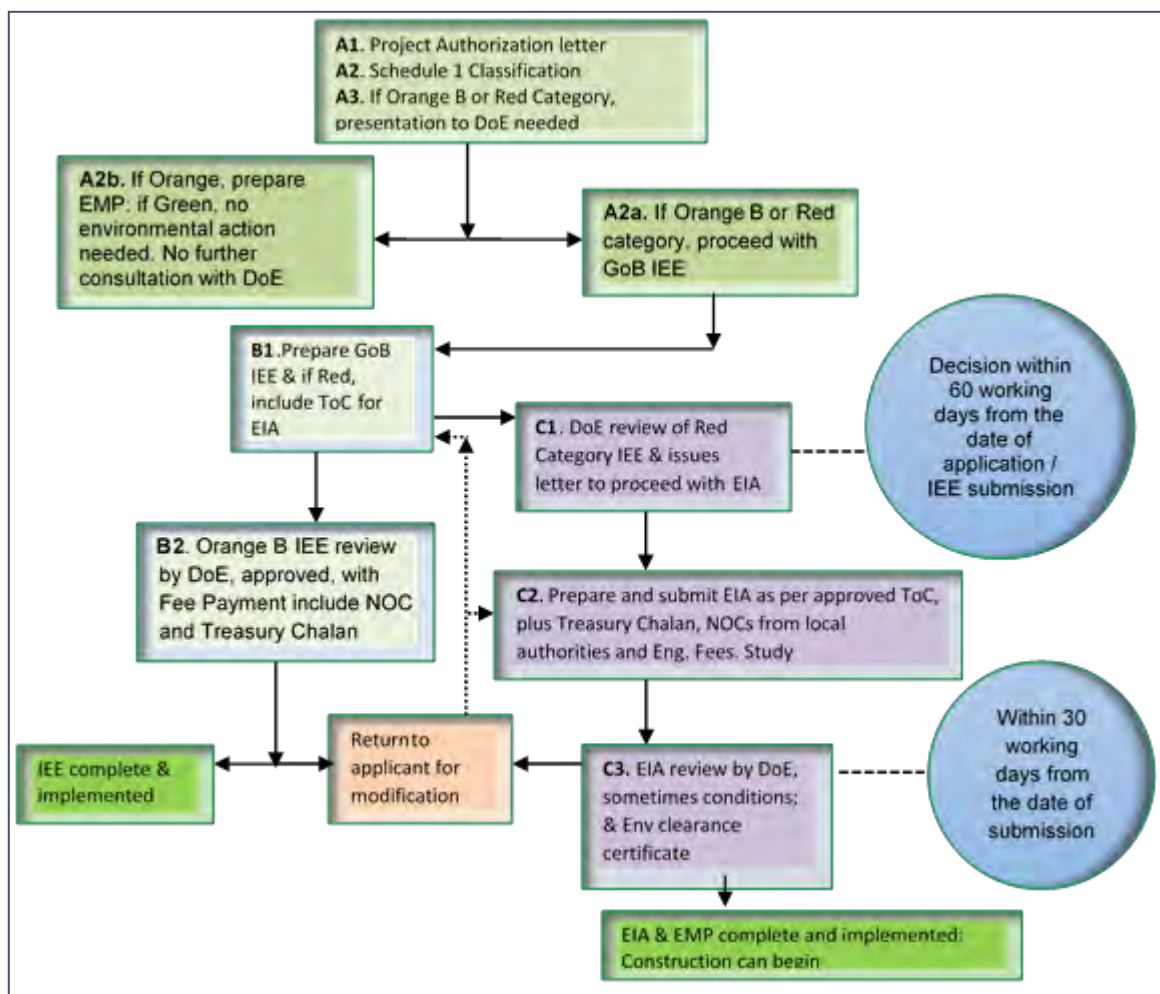


Figure 2.2: Government of Bangladesh Environmental Assessment Process

The first to obtain environmental clearance is for the project proponent to complete & submit an application form which may be obtained from the appropriate DoE regional offices as per the category. The application is accompanied by other supporting documents (i.e. project profile, lay-out plan, NOC from local authority, Government fees etc.) reviewed by the divisional and district offices of DoE who has the authority to request supporting documents as applicable. The divisional office has the power to take decision on Green and Amber-A & B category projects and the Red category projects are forwarded to head office for approval. The proposed project will receive an environmental site clearance at the beginning and the environmental clearance subject to the implementation of the project activities and all mitigation measures suggested in the ESIA report or in the application.

3 DESCRIPTION OF THE PROPOSED PROJECT

3.1 Project Location

The Project is located at Saint Martin's Island which is located on the southern-most tip of Bangladesh, roughly between 20°34'-20°39' N and 92°18'-92°21' E and 17 kilometers off Taknaf, the most southern main land of Bangladesh.. The Global Positioning System (GPS) coordinate of the project site is 20°37.788'N and 92°19.354'E. The specific location of this project is at Konapara village of ward no. 6 in this island (Figure 3.2). The project site is located in the island where the Bay of Bengal is 2.5 Km far to the north, 5 km to the south, ~1 Km to the east and 1 Km to the west. The site is on an open land currently not in used for agriculture or other commercial purposes (Figure 3.1), and is adjacent to some rural settlements. This is a legally designated protected area or environmentally sensitive location because of having rich biodiversity and particularly having coral in this island. This island is also known as coral island. It is a stock of marine, land and extraterrestrial resources. With the beach length of 14 kilometers it is the most attractive spot for tourist in Bangladesh. There are three categorized zone of this Environmental Critical Area and the project is located in the *Managed Resource Zone*. This island is the only place of blue sea and corals in Bangladesh. Some of the key environmental and social features that characterize the site and its surrounding include:



Figure 3.1: Proposed Project Location (North View)



Figure 3.2: Proposed Project Location (South View)



Figure 3.3: Proposed Project Location (Total Land Area: 2.40 acre or 240 decimle)

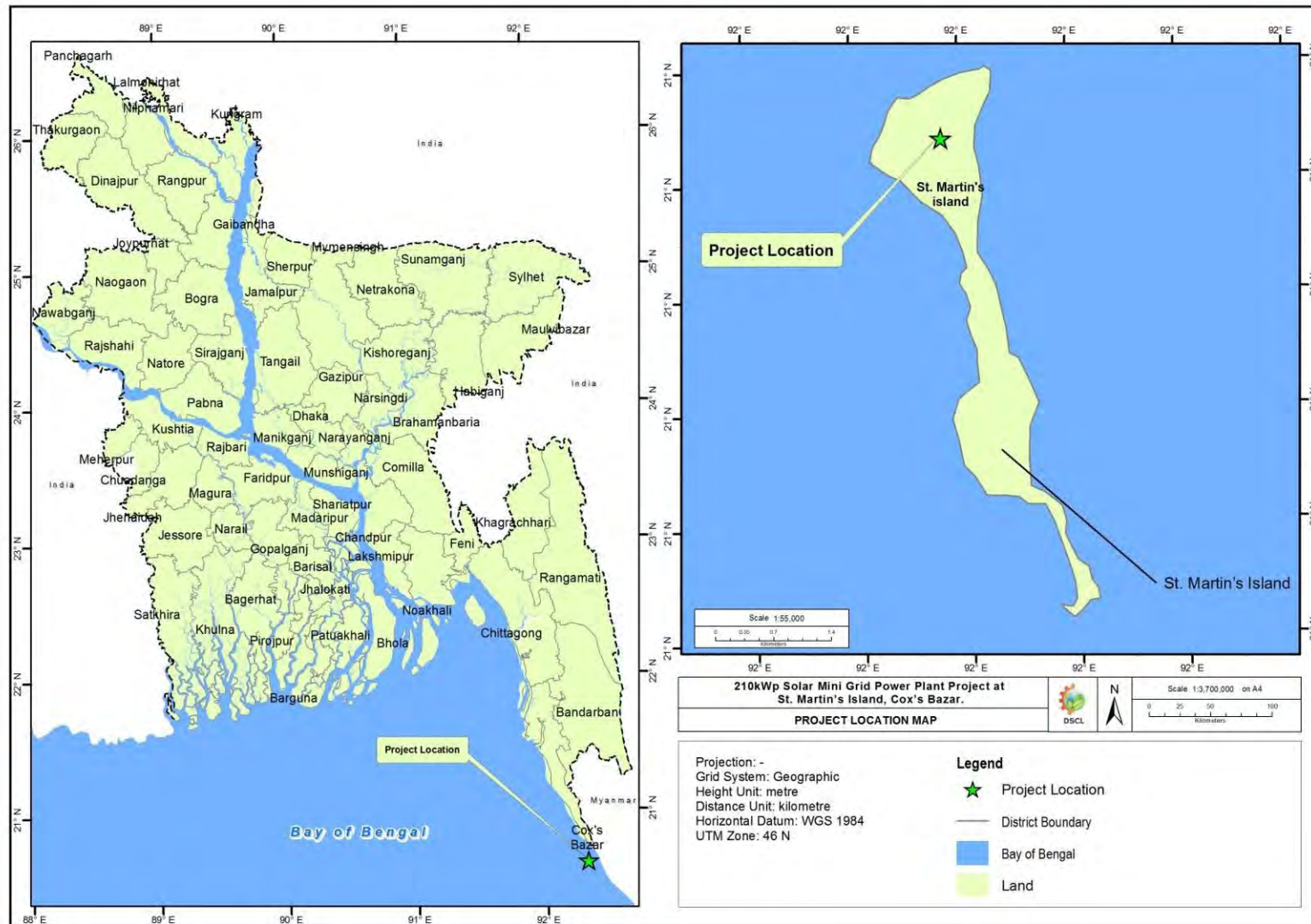


Figure 3.4: Project Location

St. Martin's Island is located in the Bay of Bengal, about 9 km south of the tip of the Teknaf Peninsula, the southernmost point of mainland Bangladesh, and 8 km west of the coast of Myanmar at the mouth of the Naf River. It is a small island with an area of about 8 km² and is 16 km long and 500 m wide in some areas while it is very narrow in the Golachipa area. The local name of the island is Narikel Jinjira, meaning "Coconut Island" and was named St. Martin's Island during British occupation. The first settlers were Arabian sailors who settled on the island 250 years ago. It is the only known place where corals are found in Bangladesh.



Figure 3.5: Map of St. Martin's Island

Besides the main island, the territory of St. Martin's Island includes three small uninhabited coral islands, the principle of which is called Cheradia which is occasionally attached to the mainland at low tide. The island is divided into three sections known as Uttarpara, Golachipa and Dakshinpara.



Figure 3.6: Landscape diversity in St. Martin's Island

St. Martin's Island is one of the most popular tourist destinations in Bangladesh. The island annually attracts thousands of tourists because of its beautiful land and seascapes and clear sea water. St. Martin's Island has an important ecological value as one of the few remaining nesting places in the region for several species of globally threatened marine turtles, as well as being a wintering site for migratory birds. Due to its favourable and unique environmental conditions, it is the only place in Bangladesh where coral colonies are found.

The Island is flat and just only about 3m high from the sea level. The island is very much resourceful with enormous biological diversity such as existing fauna and flora like; Coral, Mollusk, Fish, Amphibian, Turtle, Snail, Bird and Mammals. Besides above coconut tree is the important cash crop. According to National Biodiversity Strategy and Action Plan for Bangladesh, Ministry of environment and Forest, 2004, St. Martin Island declared as an ecologically critical area and plan to build an ecotourism park. Government permission or No Objection certificate (NOC) is required, if any private establishment can build or establish at this island.

Coastal and Wetland Biodiversity Management Project (CWBMP) has developed proposal for zoning of St. Martin's Island. The term "zoning" means dividing the Island (Ecologically Critical Area) into logical units for management and conservation purposes, with the aim of defining and limiting uses and acceptable development in each zone. The three zones are described in below (Figure 3.5):

1. *Managed Resource Zone:* This zone covers the northern part of the Island (ECA) south to Golachipa and represents almost 25% of the total area of the ECA. It will function as a multiple-use zone where sustainable development is encouraged to ensure a sustainable flow of natural products and services for the local community without impinging upon the overall objective of the ECA.
2. *Sustainable Use Zone:* This zone covers the middle part of St. Martin's Island and represents 25% of the total area of the Island. It starts from the southern border of the managed resource zone and continues southward to end approximately 400 m north of the lagoon of Dakhinpara. This zone will form a buffer for the sensitive core zone in the southern part of the Island and will also serve the community by providing a sustainable flow of natural services and products through environmentally friendly projects such as organic farming, handicrafts production and ecotourism. It also provides opportunities for public enjoyment through recreation and environmental tourism within strict environmental regulations and carrying capacity. The western beach will be protected as a nesting area for marine turtles.
3. *Restricted Access Zone:* This zone covers the southern part of the Island, known as Cheradia, and represents almost 50% of the total area of the Island. This zone possesses the ecological critical features for which the ECA was declared - coral-algal communities and coral associated biodiversity -and thus deserve strict protection. Within this zone are also patches of mangrove and other natural vegetation including seaweeds. The sandy beaches are important nesting grounds for marine turtles, and the zone also contains

spawning and nursery grounds for marine fishes and shrimps. A range of crabs, mollusks and echinoderms such as sea stars and sea anemones also occur here. There is little development in this area yet but change threatens these fragile ecosystems. Hence it is expected to form a “Strict Nature Reserve” or category I protected area under IUCN’s classification, dedicated for conservation and scientific research. The management strategy for this zone is to protect biodiversity and associated habitats, natural features and ecological processes in pristine conditions.



Figure 3.7: Zoning of St. Martin's Island

Because of its geographical position, ensuring grid electricity services on the island in the near future seems to be not only challenging but also impossible to reach. Currently, the electricity demand of the area is met by solar home systems, diesel generators, and kerosene lamps.

Travel to the project location people has to go to Teknaf upazilla of Cox's Bazar district which is the southernmost main land point of Bangladesh on the very southern tip, sandwiched up against Myanmar. From Teknaf sea cruise to St Martin's Island is the best and the safest way to travel and reach St Martin's comfortably in two or fewer hours. The cruise journey is a pleasant one people see the spectacular views of Teknaf's hill on one side and

Mayanmar on the other side while it cruises along the Naf River. After reaching the St. Martins Island; non-motorized three wheeler is the only mode of transport to go to the specific project site.



Figure 3.8: Accessible Route to Project Site

3.2 Land Classification of the Project Area

The proposed project land is classified as "Khila" land which means no cultivation is done on this land. So, it can be treated as barren land.

3.3 Project Description

The proposed Project involves setting up of a 250 kWp of solar minigrid power plant project at this island by Blue Marine Energy Limited. The proposed system will include 250 kWp solar mini-grids along with a diesel backup generator to meet the energy demand of the area. Once completed, the Project is expected to go into commercial operation in December 2016 and supply electricity to the adjacent 850 households, 70 Hotels/guest house/cottage/resort, 13 restaurant, 158 different types of shops, 1 madrasha, 6 mosque, 1 ten bed hospital, coastguard office & camp, Naval base, Weather office in the Saint Martin Island.

Expansion of rural electrification is the key to the development of rural areas of the country. The Government of Bangladesh has a vision of ensuring access to affordable and reliable electricity for all by 2021. However, supply of electricity at subsidized prices with depleting fossil fuel is becoming an ongoing challenge for the government. Only 62% of the population (including renewable energy) has access to electricity most of which are living in urban areas. Given the dispersed nature of rural settlements, grid expansion into those areas is difficult and expensive. Therefore, ensuring electricity through stand-alone renewable energy based options is being explored.

The proposed area, St. Martin, is an elongated and separate from land ward island located in Deeper part Bay of Bengal. The area of the Island itself is about 5.9 km and with the rocky platforms extending into the sea the total area of the island is about 12km² and there is no

closest grid network because it is an island located in the Bay of Bengal. Expansion of grid in this location will be quite impossible due to geographic location in the near future.

The proposed Project involves setting up of a 250 kWp solar AC mini-grid power plant by Blue Marine Energy Limited at St. Martin Island in Teknaf upazila of Cox's bazar district. The proposed system will include 144 kWp on-grid solar PV panels, 18 kWp off-grid solar panels (dedicated for charging batteries), 288 batteries of 1540 Ah (at 2 V) along with a 100 kVA diesel backup generator to meet the energy demand of the area.

The following table presents key Project information:

Table 3.1: Project Key Information

Particulars	Description
Project company	Blue Marine Energy Limited
Registered address	Lal bhaban (1st floor), 18 Rajuk avenue, Matijheel, Dhaka-1000, Bangladesh
Head office address	Same as registered address
Plant type and capacity	Photovoltaic power generation plant; 250kW _p
Location	St. Martin island
Project land area	2.40 acre
Major equipment and accessories	PV modules; on-grid & off-grid inverters; battery; transmission cable; transmission pole;
Estimated no. Of customers	1500 customers; local households and shops
Distribution network length	5km
Villages to be electrified	All of St. Martin Island
Tentative commercial operation date	June 2017

A typical single line diagram of plant along with the process mentioned above is provided below Figure 3.9 and the layout plan is shown in Figure 3.10.

3.4 Rationale of the Project

Bangladesh is predominantly a rural country with approximately 80 percent of the total population living in villages. Bangladesh's economic and social development is inherently linked to growth in the rural sector. In order to contribute to Bangladesh's overall development, the rural sector must have access to modern forms of energy such as electricity. Despite efforts by the governments in Bangladesh to improve electricity access and services during the last five decades, household electrification levels and electricity availability continues to lag behind the global average. While the global average electrification rate in 2011 was 81.9 percent, the average electrification rate for Bangladesh stood at 62 percent. About 40 percent populations in Bangladesh were living without electricity in 2015.

In Bangladesh, 32% of total population is connected to grid electricity. But still, most households meet their daily needs with biomass fuel. The country's electricity distribution board is failing to cope with the exponential growth in demand for power in the capital and all over the country. The possibilities of using solar power are already being tested and will mostly increase. Therefore, ensuring electricity through stand-alone renewable energy based options is being explored.

According to the survey findings of Blue Marin Energy Limited and IDCOL, it has been identified that local stakeholders, political leaders and businessmen might have significant interest on the Project to improve their livelihood. The project location is very much resourceful with enormous biological diversity such as existing fauna and flora like; Coral, Mollusk, Fish, Amphibian, Turtle, Snail, Bird and Mammals. Besides above coconut tree is the important cash crop. This island is the only place of blue sea and corals in Bangladesh. The project area comprises of various income generating people who have capabilities and willingness to pay premium price for electricity connection. The range of profession includes business, farmer, service etc.

IDCOL survey team visited the project site on March 2016. Notably, during the site visit, the local farmers expressed their willingness to avail electricity from the Project for improve their livelihood generation activity.

Irrigation is only required during January-April, during which time excess electricity from the Project may be considered to serve the irrigation pumps in the area for existing agricultural practices, which is currently running on diesel pump. Farming mainly occurs in the north of the Island (Uttar Para) with the main crops being chilli and watermelon. An indigenous small bulb onion variety is also cultivated and small amount of maize is inter cropped with chilli. A small amount of transplanted Aman rice is cultivated in the rainy season.

The Island has been a tourist destination for many years, but with recent developments in tourism infrastructure it has become one of Bangladesh's most popular tourist destinations. If, Blue Marin Energy Limited can successfully forward to implement a 250 kWp of solar minigrid project at this island. Tourism activity will be enhanced more rather than before. This can lead the economy of the island people. But keep in mind; if anthropogenic activities

occur more than natural resource depletion is concern. Careful management should ensure with proper implementation of regulation, rules and laws.

In view of the above, the proposed Project Blue Marineages supplying reliable and grid quality electricity to the households and local shops in villages. Electricity would be supplied at an affordable, reasonable and competitive price to encourage income generating activities more than before and enhance standard of living of the local people. Electricity will be mainly used for lighting, operating TV, DC ceiling and table fans, refrigerator, use of mobile phone chargers, etc.

Generating electricity through solar power is rather pollution-free during operation and compared with the current conventional way of producing electricity, the clean energy produced from renewable energy resources is expected to reduce consumption of alternative gas/coal/liquid fuels for electricity generation in Bangladesh, and will thus help in reducing greenhouse gas emissions, as well as air pollutant emissions. From field observations it is found that every day there are approximately 55 different capacities generators have been used to generate electricity in the island. Almost 5 liter diesel burned for every generator in everyday (Only at night time- some 7pm to 12 & some 7 pm to 6am), it means approximately 275 liter have been burned every day/night, which may expose 737 kg of Green House Gas emission (GHG) per day & 110 tons of GHG emissions in 5 months (calculating the tourist attraction time) and also create huge vibration and noise at the bazar area. This noise and vibration may destroy the coral island in future.

The cost of electricity from the present diesel based generator is much higher than the solarmini grid electricity cost. This happens due to high capacity-related costs and operating costs of the system. In case of intermittent off-grid load of Saint Martin, and considering transportation cost the electricity price can be BDT 35 to BDT 50 per unit. Additionally, since the load is not regular thus the per unit electricity price by diesel generator may be higher than the above mentioned price. However, the electricity will be sold at BDT 30 per unit to the consumer from the mini grid.

Whereas, basic electricity supply provision through a mini grid requires less capital, less subsidy volume and moderate monthly bills for consumers. Such a business can be organized by local entrepreneurs, private investors or local community organisations.

A 2011 IEA report said: "A portfolio of renewable energy technologies is becoming cost-competitive in an increasingly broad range of circumstances, in some cases providing investment opportunities without the need for specific economic support," and added that "cost reductions in critical technologies, such as wind and solar, are set to continue."

Renewable energy is also the most economic solution for new grid-connected capacity in areas with good resources. As the cost of renewable power falls, the scope of economically viable applications increases. Renewable technologies are now often the most economic solution for new generating capacity. Where "oil-fired generation is the predominant power generation source (e.g. on islands, off-grid and in some countries) a lower-cost renewable solution almost always exists today". A series of studies by the US National Renewable Energy Laboratory modeled the "grid in the Western US under a number of different

scenarios where intermittent renewables accounted for 33 percent of the total power." In the models, inefficiencies in cycling the fossil fuel plants to compensate for the variation in solar and wind energy resulted in an additional cost of "between \$0.47 and \$1.28 to each Megawatt hour generated"; however, the savings in the cost of the fuels saved "adds up to \$7 billion, meaning the added costs are, at most, two percent of the savings."

The Project will produce clean energy which will contribute to lowering electricity generation costs compared to the current costs associated with other fuels and thus leads to a substantial decrease in the Government of Bangladesh's fiscal deficit. Realizing the potential of this sector, IDCOL explored the opportunity of combining their relevant expertise to promote and develop the alternative/renewable energy production through Solar Power Plant Project.

3.5 Positive and Negative Impacts of Replacing Conventional Electricity Supply System with Solar Mini-Grid System

Human civilization has tremendously been advanced by the versatile uses of electricity and demand for electricity is integrated with all aspects of development. Bangladesh is progressing through a phase of development and as the country continues to industrialize, the importance of power generation and electricity supply becomes a key Government priority. Improving access to modern energy services in rural areas in developing countries like Bangladesh remains a major development priority.

There is no other way for accelerating development in a sustainable manner except to increase the power generation by fuel diversification. Development of Renewable Energy is one of the important strategies adopted as part of Fuel Diversification Program. Renewable energy is important for country like Bangladesh to meet the energy needs of a growing population as well as to sustain economic growth keeping the Environment in balance.

As of *International Energy Agency (IEA)*, a Mini-Grid is a set of electricity generators and, possibly, energy storage systems interconnected to a distribution network that supplies the entire electricity demand of a localized group of customers. In solar mini-grid, only the electricity is generated using solar system. It is a centralized solution which acts like a small power plant, utilizing a locally established electricity distribution network and saving the hassle of installing and maintaining hundreds of small consumer systems. Another unique and very interesting feature of solar mini grid is that it is a modular solution by means of which the capacity of the system can be elevated as per the requirement. This makes it a very efficient and convenient solution for municipalities, governments and other social organizations who want to transform the lives of people in remote communities.

38% of our population lives in the rural off-grid areas and rural electrification has always been a key concern of Govt. Solar Mini-Grids can be a viable option to ensure their electricity access in an efficient manner. Solar Mini-Grid can also reduce the high capital expenditure for grid extension to remote areas with low density of electricity consuming population. It can truly develop the rural economy and change livelihood of the poor people.

Solar Home System (SHS) is a successful business model in Bangladesh and has achieved worldwide recognition. However with the passage of time and evolution of technology, cutting edge smart and innovative solutions are available now. Solar Mini-Grid is the most

efficient alternative of individual solar home system for a large community of people in the remote off-grid areas. In this model the end user pay monthly tariff similar as conventional electricity tariff. Here upfront cost at the clients end is very low. From the view of sponsors, It is a very reliable, independent, cost-effective solution with low operation and maintenance costs.

Other benefits of Solar Mini-Grid are:

- **Turnkey solution:** Solar mini-grid is a comprehensive turnkey solution
- **Price volatility:** Independent of national tariff fluctuation.
- **Scalable:** can be designed for a wide range of power requirements
- **Centralized:** convenient control and maintenance
- **Fast deployment:** ready to work within hours or days
- **Long Tenure:** designed to work for at least 20 years
- **O&M cost:** Low operational and maintenance costs
- **Completely safe:** built in accordance with strict international safety standards
- **Pollution Free:** Solar powered energy ensures pollution free generation.
- **Future grid expansion:** For future national grid connection, infrastructure of the local mini-grid can be utilized

State owned Financial Intermediary, IDCOL had its first initiation with the financing a 100 kWp solar micro-grid project in *Sandwip* island. Gradually the demand for this centralized solution increased and IDCOL structured a program for mini-grid projects, with a vision of implementing 50 Solar Mini-Grid projects of capacity ranges from 100~200 kW by the year 2017. With the experience of the pilot project in Sandwip few solar Mini Grid projects are been approved by IDCOL. Among them 3 projects (GHEL: 100 kWp at Kutubdia, Souro Bangla: 141 kWpm at Narsingdi and Hydron: 141 kwp at Bagha, Rajshahi) are up and running and 2 other projects (Solar Electro: 177 kWp at Monpura, Bhola and AVA development: 148.5 kWp at Godagari, Rajshahi) are in the implementation stage.

Under IDCOL Mini Grid program, in operational model, the Sponsor designs the project and submits the same to IDCOL (Financial Institution) for approval. Once the project gets approved, it assigns the EPC contractor to source the equipment's and install the project. EPC contractor also plays a key role in designing the project. EPC contractor remains responsible to ensure technical performance of the project, alongside warranty of the equipment's. Sponsor has the responsibility to manage the ground level operation by ensuring delivery of energy to the consumers and collecting the monthly tariff. The consumers pay the monthly tariff in exchange of electricity generated from the mini grid plant. The following figure depicts the said model:

Govt. in its "500 MW solar Program" has set the target to generate 25 MW of electricity from solar mini grid. 30 remote areas for implementations have already been identified for this purpose. Most of these projects are in planning stage. In some areas there is no chance of grid

expansion in next 15-20 years. Solar mini grid can be proven as most efficient model for rural electrification

Many of the villages specially in the remote areas are currently suffers from low income levels, poor healthcare and inadequate education, with no access to electricity from the national grid and not expected to be enabled in the short term. Solar mini grid ensures self-sufficiency and uninterrupted source of Grid quality electricity. This in turns help boosting education of a community. Children are able to use good quality light to do their homework after dark, literacy rates improve and local economies are also boosted by new businesses and extended working hours. Also this green technology is replacing the kerosene fired lighting system, reducing indoor air pollution and bestow healthy environment. It relieves the consumers from price volatility in the extreme remote areas due to transportation and fuel unavailability. Ensuring access to TV, Radio, mobile and internet communication for the remote people can increase access to information and infotainment. Apart from this socio-economic impact, solar Mini-Grid reduces pressure on national electricity grid too.

Our country is predominantly a rural country with approximately 70 percent of the total population living in villages. Thus, our economic and social development is inherently linked to growth in the rural sector. In order to contribute to overall development, the rural sector must have better access to electricity and renewable energy in the form of mini-grid is the perfect way out to achieve that.

Negative impacts: The potential environmental impact associated with solar power is land use and habitat loss at the project site. However, there are other negative impacts associated with solar panels construction but these are not considerable risks in plant site.

Depending on their location, larger utility-scale solar facilities can raise concerns about land degradation and habitat loss. Total land area requirements vary depending on the technology, the topography of the site, and the intensity of the solar resource. Unlike other renewable energies, there is less opportunity for solar projects to share land with agricultural uses.

In case of St. Martins Island, the proposed land is presently barren and not using for any productive purpose. The surrounding land from the proposed site is also not using for agricultural purpose. So the negative impact from this project is very minimal or negligible.

3.6 Land Filling Activities

Environmental team visited the project site in April 2016 to physically verify the suitability of project location for implementation. The Island is almost flat with an average height of 2.5m above mean sea level (MSL), rising to a maximum of 6.5m high cliffs along the eastern coast of Dakhin Para. The site is on an open land currently not in used for agriculture or other commercial purposes.

Land form consists of flat low-lying sand deposits. The site is approximately 3 feet depth from the nearby existing road height and thus elevated RCC needs to be built to place the solar panel as land filling is not possible due to environmental restrictions from Government authorities.

So, it can be concluded saying that, land filling will not be required for this project. And the type of structure will not create any types of obstacles to the water flow. The figures below show the type of structure will be constructed without land filling and without creating obstacles to the water flow.



Figure 3.11: Sample Structures Resembling the type of the Would be Made Structure

3.7 Site Clearance (SC) from Department of Environment for another Company

The PM Solar Energy Pvt. Ltd. has already obtained the Site Clearance Certificate (SCC) from the Department of Environment (DoE). The name of the Managing Director of PM Solar Energy Ltd is Md. Shariful Islam Patwary from Motlab Thana, Chandpur District and Chairman Md. Al Mamun. They applied to DOE on 12 Feb 2014 and DOE requested to ministry for site Clearance on 17/09/2015.

The Blue Marine Energy has tried their best to collect a copy of this SCC but was failed to manage that anyway. However, we are informed by DoE Dhaka Office that they have issued such SCC to the above mentioned company.

In addition, the PM Solar Energy Pvt. Ltd. issued a letter to IDCOL regarding their project activities on 12th Feb 2014. Though they formally approached to IDCOL but later they did not precede further to implement this project anymore with IDCOL.

On the other hand, we also collected information from St. Martin Island regarding the project. The local people and other responsible agencies assured us that nobody bought any land in St. Martin yet for that Solar Project. Moreover, that company approached some local people in Saint Martin and took some money from them by offering some share of the project. After that incident, in the last two years they do not have any contact with them and no activity is done.

In a nutshell, it can be said that this project is no longer active and it is almost in dormant condition.

The site clearance from DoE for Blue Marine Energy Limited is attached in Appendix K of the report.

4 TECHNOLOGICAL ASPECTS

4.1 Proposed Process and Technology

Proposed technology for the solar mini grid is shown in Figure 4-1:

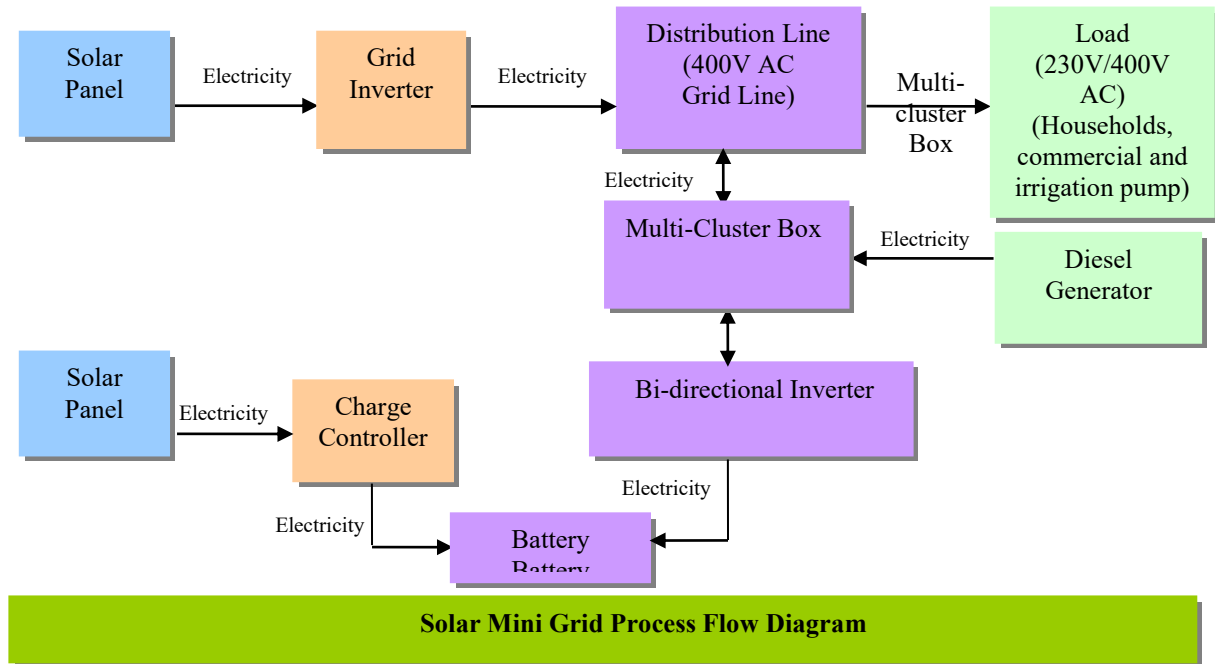


Figure 3.12: Solar Mini-grid Process Flow Diagram

The plant is considered to be composed of the following components:

(i) Solar PV modules and grid connected inverters:

PV modules with a total capacity of 250kWp will be installed to supply electricity to the grid while 5 grid connected inverters will be installed to convert DC output from solar panels to grid quality AC electricity. PV modules are the main sources of power generation during daytime. PV modules of 144kWp capacity will be connected to five grid inverters (“Sunny Tri-power”), which will supply AC power at 400V through 3-phase distribution line. However, electricity will be supplied to the customers at 230V using single phase distribution line. Remaining 18kWp PV modules (off-grid) will be used to charge the batteries.

(ii) Battery bank and bi-directional inverters:

Battery banks will be comprised of 288 units of 2V low maintenance lead acid type batteries, each of 1540Ah capacity. Energy stored in the battery banks will be converted to AC electricity using bi-directional inverters (Sunny Island inverters) to be supplied to the grid. Excess power from on grid PV modules will also be stored in the battery bank using bi-directional inverters. Sunny Island inverters will be automatically synchronized with the generator through a multi-cluster box.

(iii) Multi-cluster box and the charge controllers

Multi-cluster box is an interface for all the connectors and control. It is completely wired and fitted at the factory to make all the connections easier.

Charging of the batteries with the electricity from off-grid PV modules will be monitored using charge controllers. Charge controllers to be installed in the proposed Project will be equipped with a MPPT (Maximum Power Point Tracking) system to maximize the energy yield by 15% to 30% than that of conventional charge controllers.

(iv) Diesel generator

A backup diesel generator will be connected to the mini-grid system to supply electricity in case of electricity shortage from PV modules and the batteries. This scenario might happen during the peak time or during rainy and foggy days. Using the multi-cluster box, the generator can also be used to charge the batteries in case of consecutive foggy and rainy days to avoid any damage to the batteries due to insufficient charge for a longer period of time. The consumption of the diesel generator is optimized automatically by programmable Sunny Remote Control (SRC) supplying electricity to the loads and charging the batteries with the surplus. The diesel generator will also run in parallel with the battery bank to supply electricity to high load demand if necessary.

The stand by Generator won't run more than 50 hr yearly, which will suppress the diesel and kerosine burning in rural field. The highly sophisticated and low noise generating Japan made diesel generator will be used for this project. The sound pressure level of this generator is 63 dBA at no load and this noise is noticeable up to 7 m to the all direction from the source without any barrier or canopy.

A typical single line diagram of plant along with the process mentioned above is provided below Figure 4.2.

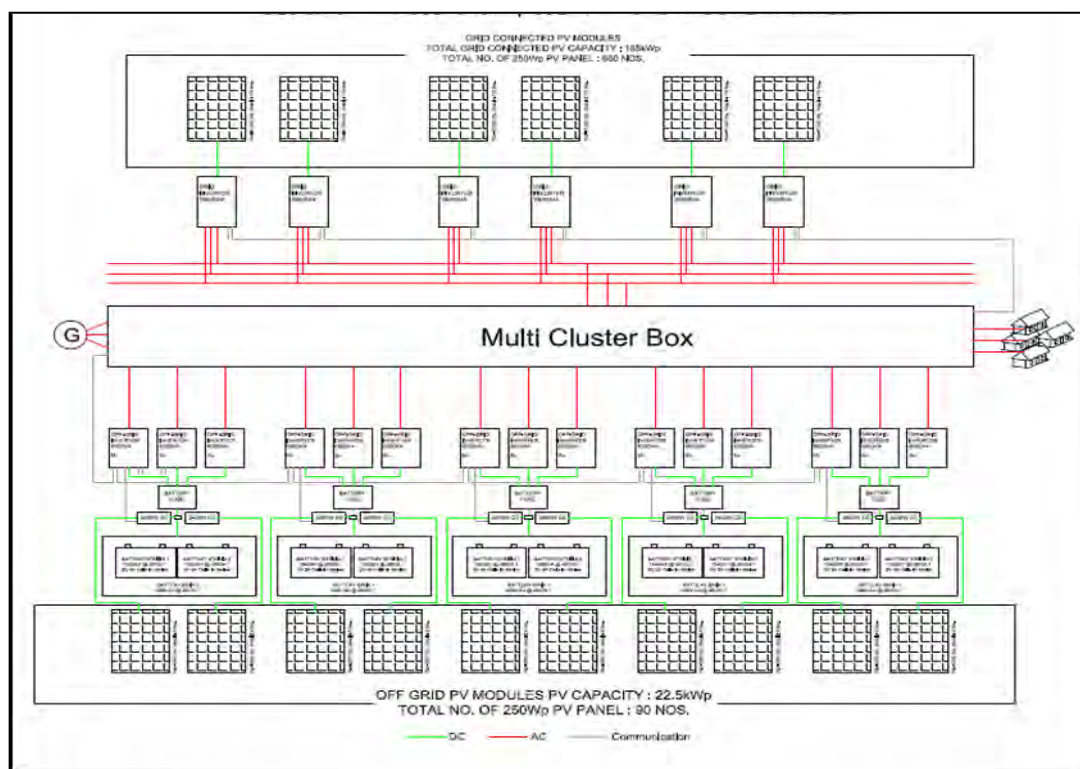


Figure 3.13: Single Line Diagram of the Plant

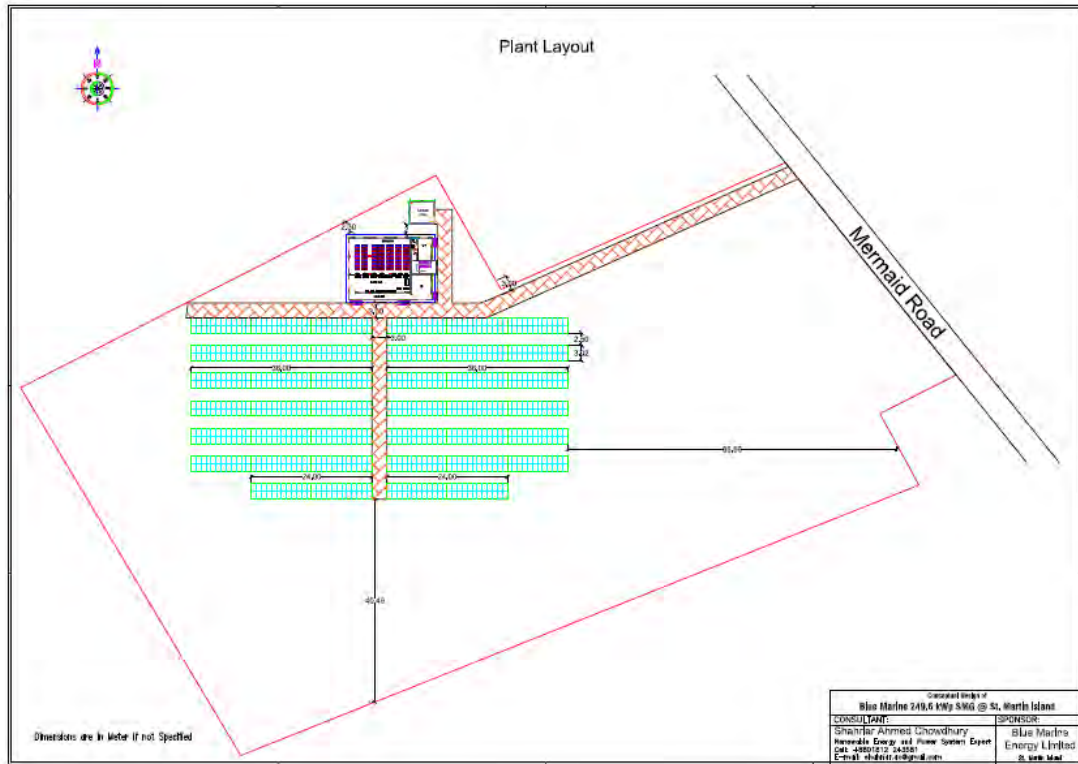


Figure 3.14: Layout of the Plant

4.2 Adequacy of Solar Irradiation

The proposed location of the Project is at St. Martin Island, Teknaf. The latitude of the proposed location is 20°34'-20°39' N and 92°18'-92°21' E. The solar irradiance profile¹ of the project location is as follows in Table 4.1.

Table 3.2: Monthly Average Solar Insolation Incident at 24Degree Tilted Angle

Month	Average irradiation(kWh/m ² /day)
January	5.27
February	5.76
March	5.96
April	5.73
May	5.14
June	4.25
July	3.95
August	4.01
September	4.04
October	4.8
November	5.19
December	5.33

The optimum tilt angle for solar panels in Bangladesh is considered to be 23.7±1 degrees at any place in Bangladesh². Average solar insolation in Bangladesh is considered to be

¹Source: Surface meteorology and Solar Energy website of NASA. Website: <https://eosweb.larc.nasa.gov/cgi-bin/sse/grid.cgi?email=ekarim@idcol.org>.

4.5kWh/m²/day. In the project site, the average insolation is 4.9525kWh/m²/day which is greater than the average of the country by 10%. Insolation data of the project site suggests that the project location is suitable for solar mini grid project as the solar irradiance profile is steady all through the year and the plant is expected to yield high energy output.

4.3 Opposite Reflection of Solar Panel

The Solar Panel will have anti-reflection coating. This coating will protect reflection over the lifetime. The panel will be fitted at 15° angle with land (South facing). In the facing side there is no such infrastructure which might be disturbed such reflection. However, if any infrastructure exists, it will not be glaring due to its facing and angle. As a result it won't make any trouble to any other things.

4.4 Plant Capacity Selection

Plant capacity selection is based on the conducted load survey and optimization parameters. Optimization parameters for selecting plant capacity are chosen carefully to ensure satisfactory plant performance. The optimization parameters used by the sponsor are (a) consumption of diesel fuel over the year as percentage of the total consumption, (b) unused solar energy as percentage of total solar generation and (c) ratio between capacities of grid-tied inverters and bi-directional inverters. The trade-off analysis of these three parameters is discussed below:

(a) Energy supplied by DG

Diesel generator will be used as backup to meet the supply and demand gap throughout the year. The diesel generator will run in cases e.g. lack in stored energy in battery backup, rainy and foggy days. However, under sizing the plant capacity will result in excessive usage of the diesel generator. Purposes of installing a Solar PV based mini grid project will be hampered if diesel generator is used most of the time. Hence, minimization of usage of diesel generator is an important optimization parameter. The parameter will be defined as follows:

$$\text{Percentage of energy supplied by DG} = \frac{\text{Annual consumption of energy from diesel generator} \times 100\%}{\text{Total annual consumption of energy from the plant}}$$

(b) Unused solar energy

Increasing the plant capacity will certainly decrease the percentage of diesel consumption annually. However, it can lead to the wastage of excessive solar energy during peak solar irradiation. Minimizing the excessive unusable energy will restrain the sponsor from overdesigning the system. There is a trade-off between minimization of unused solar energy and diesel consumption. The parameter of unused solar energy is defined as follows:

$$\text{Percentage of unused solar energy} = \frac{\text{Annual unused solar energy from the plant} \times 100\%}{\text{Total generation from solar PV modules}}$$

(c) Ratio between capacities of grid-tied inverters and bi-directional inverters

The proposed design of the mini grid is AC-DC coupled system. To ensure safety of the plant, extreme situations need to be analyzed and kept into design consideration. Bi-directional inverters to be used in the plant are of 6kW capacity and take maximum of

²Source: Optimum Tilt Angle for the south facing solar devices installing in Bangladesh, M M Rahman, Indian Journal of Radio and Space Physics, Volume: 30, December 2001, pp 292-293.

11.5kWp AC input power. If the loads are disconnected in any case, the bi-directional inverters should be capable of handling the AC input power from the grid-tied inverters before necessary measures are taken. Hence, the ratio of grid-tied inverters and bi-directional inverters is an important parameter. Since the bi-directional inverters can take up to twice its power, the ratio of grid tied inverter and bi-directional inverter capacity should not cross the value of 2. The parameter can be defined as:

$$\text{Ratio} = \frac{\text{Capacity of a grid tied inverters} \times \text{No of grid tied inverters}}{\text{Rated Capacity of bi-directional inverter} \times \text{No of bidirectional inverters}}$$

(d) Simulation Results:

Performance of the plant and optimization parameters was analyzed based on selection of different capacities. The simulation results and graphical representation is shown below:

Table 3.3: Plant Capacity Determination

Plant Capacity (kWp)	Ratio between grid-tied and bi-directional inverter capacities	Energy supplied by DG(% of total consumption)	Unused solar energy (% of total solar generation)
104	1.04	24%	5%
133	1.38	11.83%	13%
250	1.73	5.11%	23%
195	1.67	0%	33%
224	1.94	0%	41%

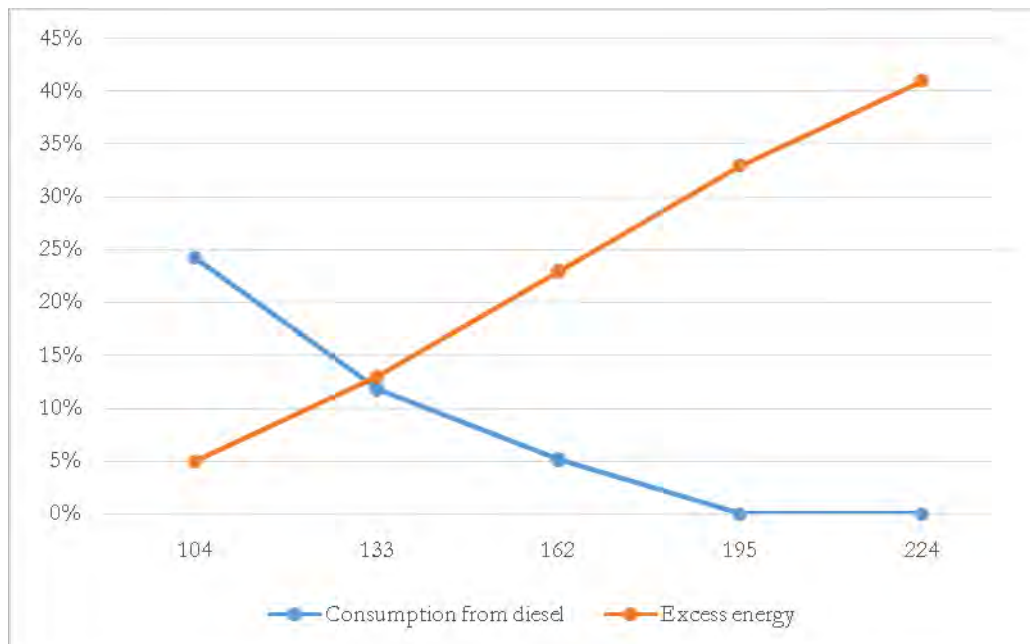


Figure 3.15: Plant capacity selection

According to the simulation results, a plant capacity of 250 kWp was found most suitable. Hence, the plant capacity of 250 kWp was selected for the solar mini grid project.

4.5 Adequacy of Generator Size

Diesel Generator will play a pivotal role in operating solar mini-grid when the generation of electricity from solar plant is insufficient to meet the demand. In that case, the diesel generator should be able to supply necessary electricity as per the electricity demand. While undersized generators will be overloaded if the demand is higher than the rated capacity of the generator, using oversized generators will be inefficient as it will result in higher diesel consumption.

In view of the above, BMEL selected a generator of 100kVA prime capacity. The justification for selecting 100kVA generator is explained in the following. The estimated daily load profile of the Project is shown below Figure 4.4.

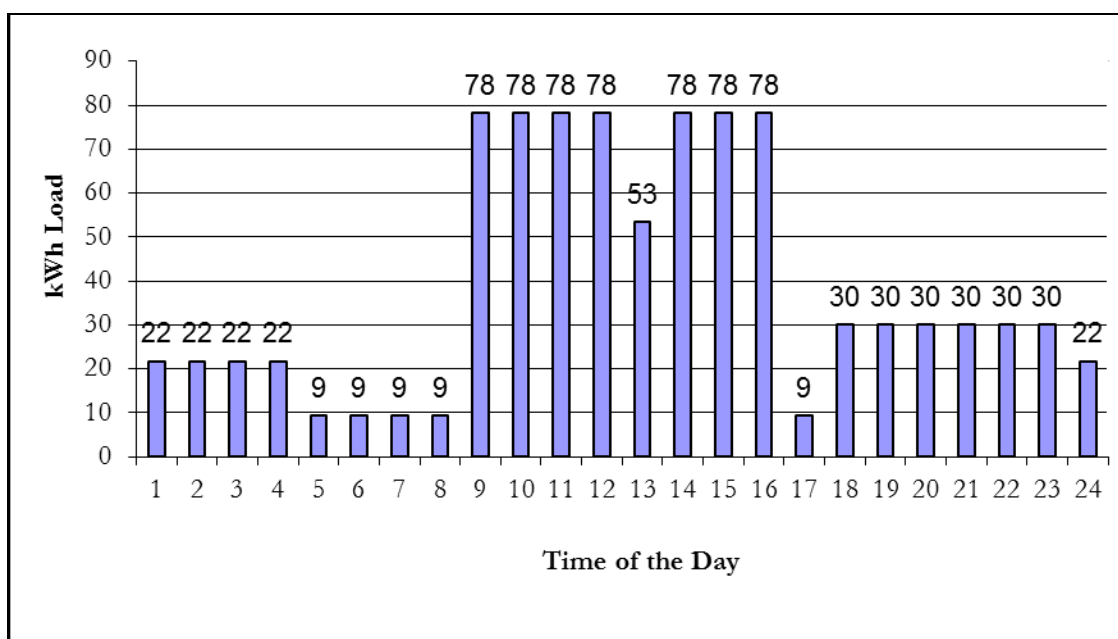


Figure 3.16: Estimated Daily Load Profile

According to the load profile, peak load in 24 hours will be 78kW during 9am to 12pm and 2pm to 4pm. Prime capacity of the selected generator is 100kVA or 80kW which is higher than the peak load.

Generator will start automatically when the energy stored in the battery goes below the allowable threshold. Higher capacity generator will help to charge the batteries quickly along with providing electricity to the customers.

In addition to that, generator can also work in parallel with the battery if needed for bigger inductive loads e.g. irrigation pumps. The selected generator of such capacity will be able to supply electricity to run the peak load even in case of low solar generation, to charge battery banks in rainy and foggy days, to avoid system shutdown or to back up high current driven commercial loads.

5 DESCRIPTION OF THE PHYSICAL ENVIRONMENT

5.1 General

The baseline environmental quality is assessed through field studies within the impact zone for various components of the environment, viz. air, noise, water, land and socio-economic, etc. The primary objective of identifying and describing existing environmental conditions is to provide an understanding of the baseline conditions prior to undertaking any development activities.

Data was collected from secondary sources for the macro-environmental setting like climate (temperature, rainfall, humidity, and wind speed), physiography, geology etc. First hand information have been collected to record the micro-environmental features within and adjacent to the project area. Collection of primary information includes extrapolating environmental features on proposed project design, tree inventories, location and measurement of socio-cultural features adjoining proposed project area. Ambient air, noise, and water quality samples were collected in terms of environment quality to prepare a baseline database. Consultation was another source of information to explain local environmental conditions, impacts, and suggestions, etc.

The following section describes the baseline environment into three broad categories:

- Physical Environment- factors such geology, climate and hydrology;
- Biological Environment- factors related to life such as flora, fauna and ecosystem; and
- Socio-economic Environment- anthropological factors like demography, income, land use and infrastructure.

5.2 Physical Environment

Physical environment denotes the physical features that occur naturally (air, water, soil, atmosphere, etc.). In order to depict the existing physical environment in the project area, a few of the major parameters are considered like geology & soil, ambient air, noise, surface & ground water, etc.

5.2.1 Climate

Although less than half of Bangladesh lies within the tropics, the presence of the Himalaya mountain range has created a tropical macroclimate across most of the east Bengal land mass. Bangladesh can be divided into seven climatic zones (Rashid 1991). According to the classification, the project area is located in the South-western region climatic zone (Figure 5.1).

South-Eastern zone: It comprises the Chittagong sub-region and a strip of land extending from southwest Sundarbans to the south of Comilla. The hills over 300m in height have north-eastern zone climate. The rest of the area has a small range of temperature, rarely goes over a mean of 32°C and below a mean of 13°C. Rainfall is heavy, usually over 2,540 mm. In winter dew fall is heavy. Like other parts of the country, the project area is heavily influenced by the Asiatic monsoon, and it has these three distinct seasons:

- Pre-monsoon hot season (from March to May),
- Rainy monsoon season (from June to October), and
- Cool dry winter season (from November to February).

The pre-monsoon hot season is characterized by high temperatures and thunderstorms. April is the hottest month in the country with mean temperatures ranging from 27°C in the east and south, to 31°C in the west-central part of the country. After April, increasing cloud-cover reduces the temperature. Wind direction is variable during this season, especially during the early part. Rainfall, mostly caused by thunderstorms, at this time can account for 10 to 25 percent of the annual total.

The rainy monsoon season is characterized by southerly or south-westerly winds, very high humidity, heavy rainfall and long periods of consecutive days of rainfall. The monsoon rain is caused by a tropical depression that enters the country from the Bay of Bengal. About 90% of the annual precipitation occurs during the five-month monsoon season from May to September.

The cool dry season is characterized by low temperatures, cool air blowing from the west or northwest, clear skies and meager rainfall. The average temperature in January varies from 17°C in the south west and south-eastern parts of the country to 20°C to 21°C in the coastal areas. Minimum temperatures in the extreme in late December and early January reach between 7°C to 8°C.

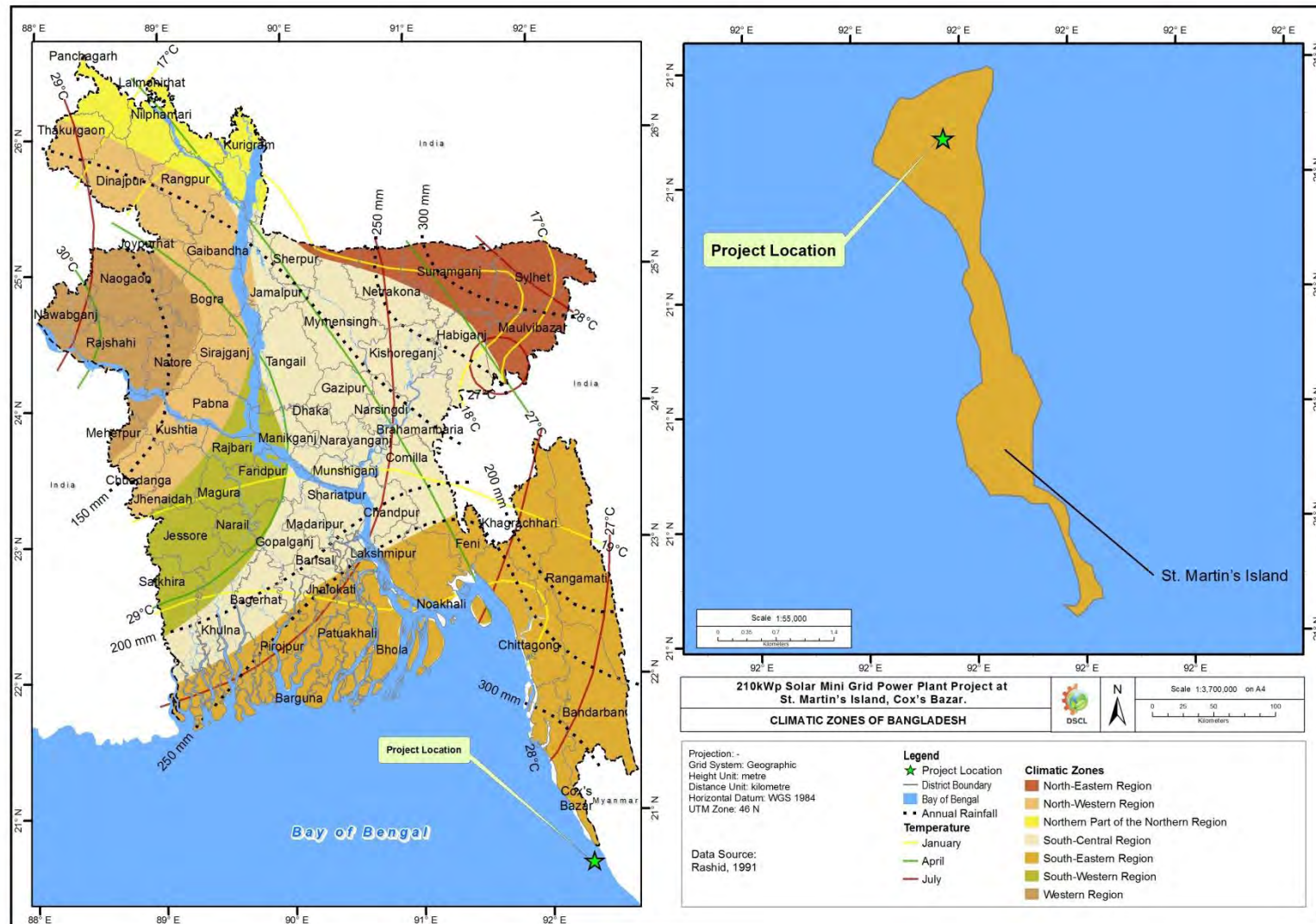


Figure 5.1: Climatic Zones of Bangladesh

Temperature

Long-term average monthly temperature data (1977-2012) collected at Teknaf weather station of Bangladesh Meteorological Department. The highest average recorded temperature in this weather station was 32.2°C in May. The lowest average recorded temperature was found in the month of January which was 14.9°C. Both of the average monthly temperature graphs show that this area faces high temperature from March to June and lowest temperature during winter remains from December to February in the year.

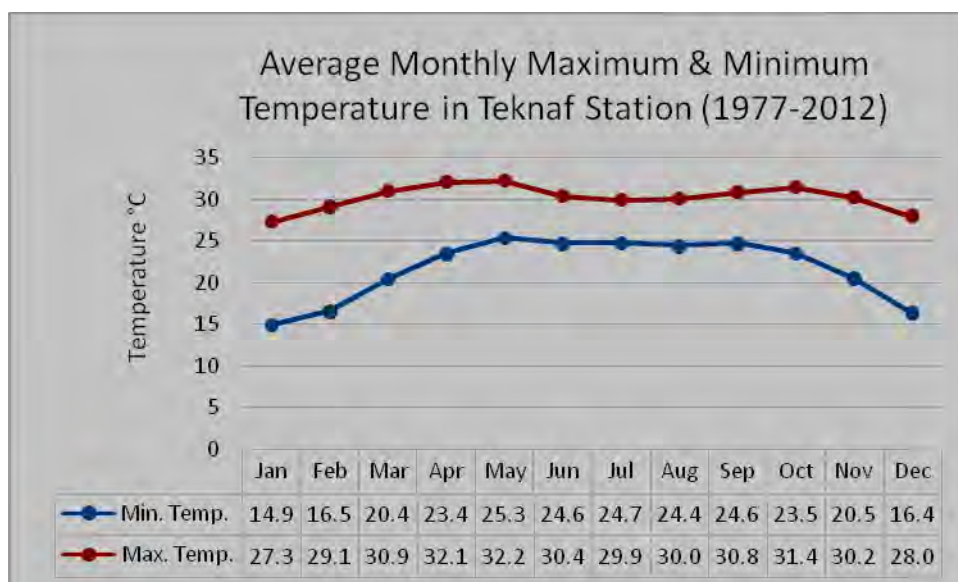


Figure 5.2: Average Monthly Maximum and Minimum Temperature

Rainfall

The rainfall data collected from the above stated station represents that maximum rainfall occurs during June to August and the lowest rainfall occurs in November to April during winter season. Statistical data of 1977 to 2012 shows that Teknaf stations experience almost 1100mm rainfall during monsoon. In the month of November to February of winter season the rainfall occurred in the region of Teknaf weather station was 3 mm to 70 mm.

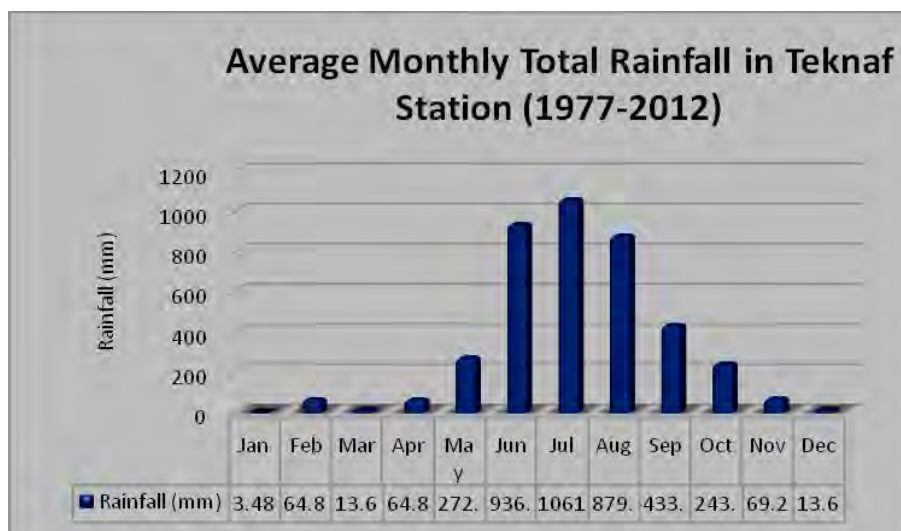


Figure 5.3: Average Monthly Total Rainfall

Humidity

Humidity remains high in summer and comparatively low in winter season. The statistical data of humidity from 1977 to 2012 indicates that humidity in the above two stated areas maximized in June to October in the year which is ranges from 75% to 82%. On the other hand, humidity falls 65.7% to 76.1% in February, March and April during the winter season in the Teknaf station area (Figure 5.4).

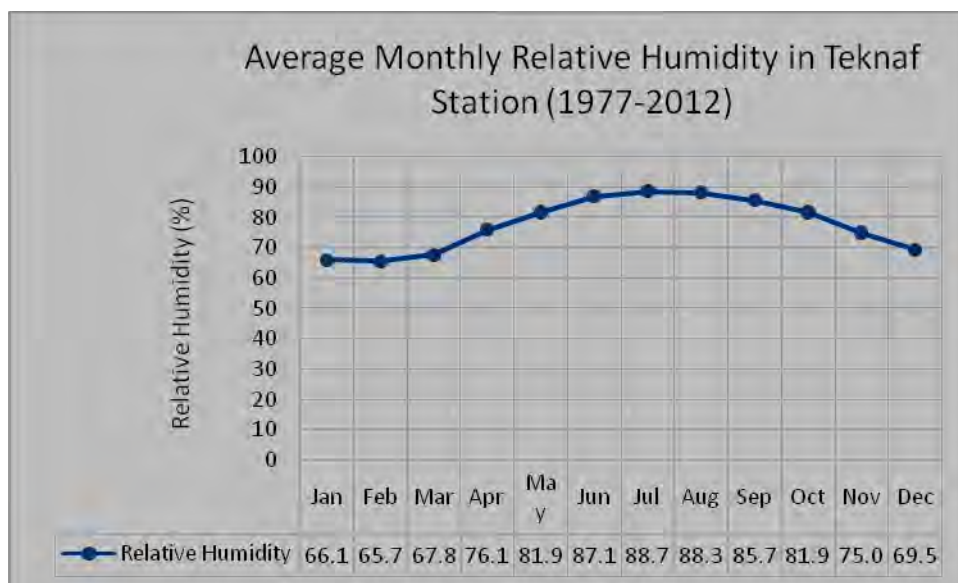


Figure 5.4: Average Monthly Relative Humidity

Wind Speed

From November-February the prevailing winds are from the north-west, from March-May from the south-west and from June-September from the south-east. It is recorded that the wind speeds mostly remain in the range of 1.8 – 3.85 m/s. But in the winter months it remains in the range of 0.66-2.82 m/s. The statistical wind speed data from 1977 to 2013 (Figure 5.5) shows that average wind speed remained maximum with 3.4m/s in March. The minimum wind speed was 1.4m/s in the month of December in the area of Teknaf weather station.

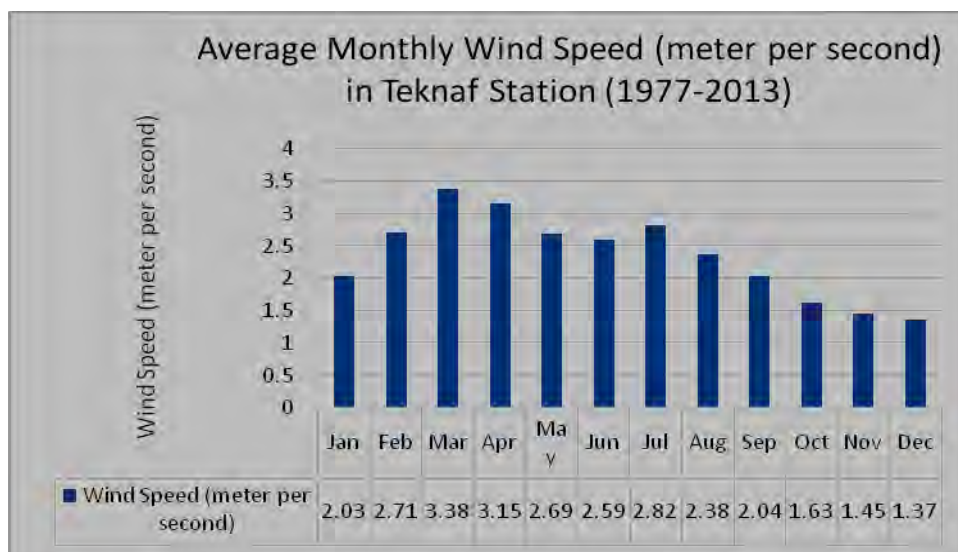


Figure 5.5: Average Monthly Maximum Wind Speed

Sunshine

The statistical sunshine data from 1977 to 2013 (Figure 5.6) shows that average sunshine remained maximum with 9.0 hours in both January and February. The minimum sunshine was 3.00 hours in the month of July in the area of Teknaf weather station. With a decreasing trend in May and rising in August.

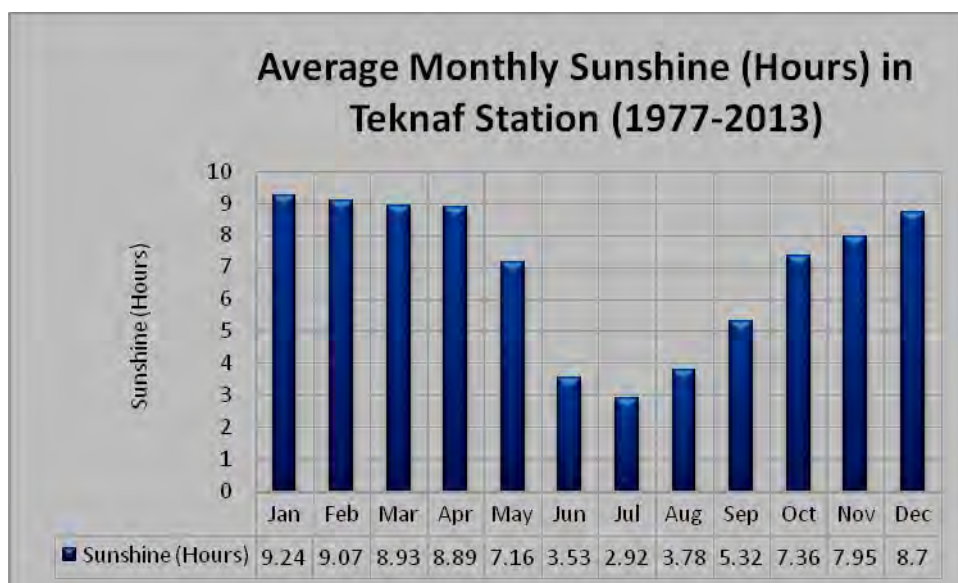


Figure 5.6: Average Monthly Sunshine Hours

Cloud Coverage

The statistical cloud coverage data from 1977 to 2013 (Figure 5.7) shows that average cloud coverage remained maximum from 6 octas to 5 octas during June to September. The minimum cloud coverage was less than 1.0 octas in the month of January in the area of Teknaf weather station.

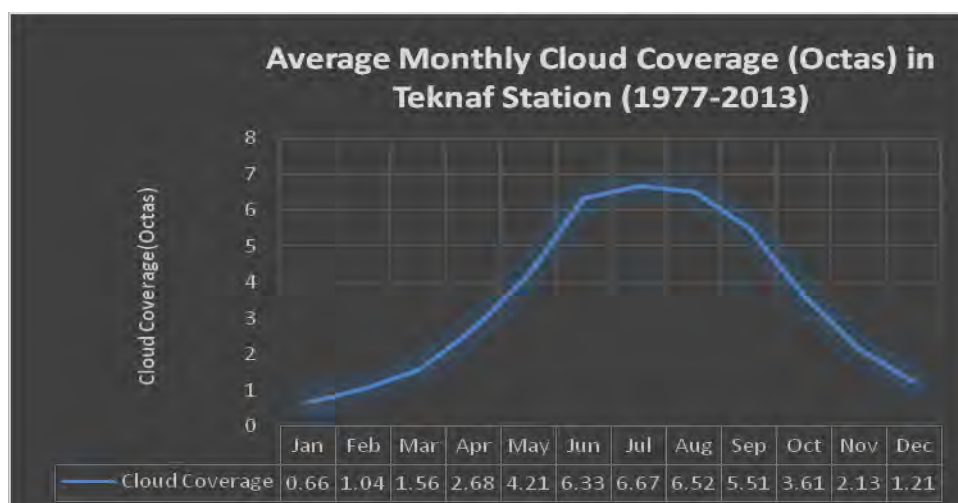


Figure 5.7: Average Monthly Cloud Coverage

Solar Radiation

The monthly solar radiation is estimated using GIS for the area of St. Martins Island. The Figure 5.8 shows the average monthly solar radiation in a year at the proposed project location.

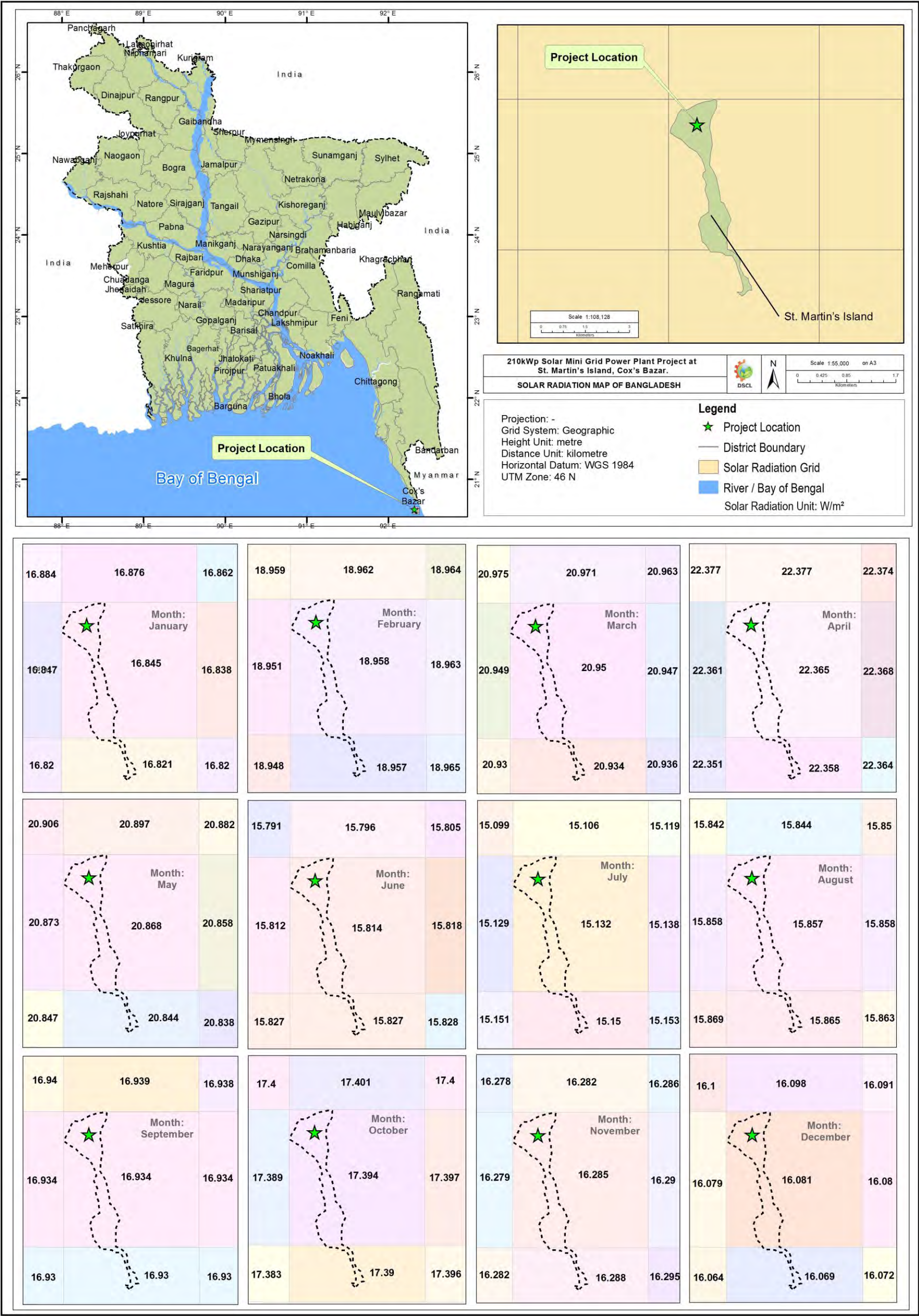


Figure 5.8: Average Monthly Solar Radiation at St. Martins Island

5.2.2 Ambient Air Quality

Ambient air quality refers to the background air quality levels in a region, characterized by concentrations of various pollutants in the atmosphere. The presence of air pollutants and their concentrations depends on the type of polluting sources, and other factors that influence their flow and dispersion. Diesel generators are the main source of air emissions. The consultant team measured air quality in two locations during day and night.



Figure 5.9: Air Quality Monitoring at Project Site

Ambient air quality measurements are essential to provide a description of the existing conditions or the baseline against which changes can be measured and to assist in the determination of potential impacts of the proposed Solar Mini-grid Power Plant air quality. Air quality test has been conducted on 6th April 2016 at the proposed project site and the test results (see Appendix A) is given in the below Table 5.1. According to Bangladesh National Ambient Air Quality Standards from the Environmental Conservation Rules, 1997 which was amended on 19th July 2005 vide S.R.O. No. 220-Law/2005; any of the measures parameter of the local ambient air does not exceed Bangladesh standard.

Table 5.1: Test Results of Ambient Air Quality Analysis

Parameter	Unit	Project Site		Bazar site		Bangladesh Standard**	Duration (hours)	Weather Condition	Method of Analysis
		Day	Night	Day	Night				
PM _{2.5}	µg/m ³	29.47	28.40	30.41	32	65	24	Sunny	Gravimetric
PM ₁₀	µg/m ³	37.29	36.53	42.17	41.32	150	24		Gravimetric
SPM	µg/m ³	68.47	72.49	75.93	79.68	200	8		Gravimetric
SO ₂	µg/m ³	2.95	4.13	3.84	4.21	365	24		West-Geake
NO _x	µg/m ³	16.41	18.32	18.26	21.62	100	24		Jacob and Hochheiser

Parameter	Unit	Project Site		Bazar site		Bangladesh Standard**	Duration (hours)	Weather Condition	Method of Analysis
		Day	Night	Day	Night				
CO*	mg/m ³	<1	<1	<1	<1	10	8		CO Meter

Note:

* CO concentrations and standards are 8-hourly only.

** 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.

- PM_{2.5} – Fine Particulate Matter.
- PM₁₀ - Respirable Dust Content
- SPM – Suspended Particulate Matter
- SO₂ – Sulphur Di-oxide
- NO_x— Oxides of Nitrogen.
- CO – Carbon Monoxide

5.2.3 Noise Level

Excessive noise is a potential issue for both human and biological receivers and can potentially cause a range of negative issues, from mild annoyance and moderately elevated levels of aggression to significant disturbance of behavioral patterns and in severe cases temporary or permanent hearing loss. According to World Health Organization's Guidelines for Community Noise (1999), daily sound pressure levels of 50 decibels (dB) or above can create discomfort amongst humans, while ongoing exposure to sound pressure levels over 85 dB is usually considered the critical level for temporary hearing damage.

The noise level of the surroundings of the project area is insignificant. The proposed site is an open land currently not in used for agriculture or other commercial purposes. However, there is negligible sound pollution from the sound deck of the nearby villages. Noise level has been monitored at inside and outside of the project location (Appendix 2) during day and night time (Figure 5.9). Results of the noise level monitored along with details of the sampling locations have been showed in Table 5.2. The results show that time weighted average value of the sound monitored at inside and outside of the project area did not exceed the standard fixed for the respective areas. But at night time, one noise measurement showed slightly higher value due to natural events of some dogs was barking continuously.



Figure 5.10: Noise Level Monitoring in the Project Area

Table 5.2: Noise Level at Different Locations of Project Area

Location	GPS Location	Land Use Category	Time	Noise Level (dBA)
Bazar Area Day (1)	20.63294°N 92.32646°E	Commercial	12:50 pm	58.05
Bazar Area Day (2)	20.63306°N 92.32689°E	Commercial	2:00 pm	52.97
Bazar Area Day (3)	20.63289°N 92.32746°E	Commercial	3:08 pm	56.31
Bazar Area Night (1)	20.63294°N 92.32646°E	Commercial	11:00 pm	48.21
Bazar Area Night (2)	20.63306°N 92.32689°E	Commercial	11.30pm	49.20
Bazar Area Night (3)	20.63289°N 92.32746°E	Commercial	12.00 am	46.57
Project Site Day (1)	20.62978°N 92.32288°E	Project Site	4.00 pm	44.53
Project Site Day (2)	20.62969°N 92.32258°E	Project Site	5.00 pm	42.54
Project Site Day (3)	20.62958°N 92.32279°E	Project Site	6.00 pm	46.26
Project Site Night (1)	20.62978°N 92.32288°E	Project Site	8.00 pm	39.22
Project Site Night (2)	20.62969°N 92.32258°E	Project Site	8.30 pm	36.42
Project Site Night (3)	20.62958°N 92.32279°E	Project Site	9.00 pm	45.82
<i>Notes:</i> ▪ Land use category is based on the classification provided in the Noise Pollution Control Rules (2006) ▪ Shaded cells indicate noise levels in excess of Noise Pollution Control Rules ambient noise limits for a given land use area ▪ The sound level standards for residential area are 55 dBA , for silent area 50 dBA and for commercial area 70 dBA at day time ▪ Noise Level is the average noise recorded over the duration of the monitoring period				

5.2.4 Physiography

In the context of physiography, Bangladesh can be divided into three broad categories based on topography, physical features, and geological history (Brammer, 1996):

1. Floodplains
2. Terraces
3. Hills

Within these 3 broad categories, a number of authors have further divided the land surface into a series of Physiographic Units based on a combination of topographical/landscape features, underlying geology and surface soils (Brammer, 1996, Rashid, 1991, Morgan and McIntyre, 1959). The most recent study was undertaken by the Soil Resource Development Institute (SRDI) who further refined the previous classifications into 26 Physiographic Units (20 primary units and 6 sub-units) based on an assessment of more recent and detailed data (SRDI, 1997).

The project lies in St. Martin's Island is a dumb-bell- shaped sedimentary Continental Island located on the eastern flank of an anticline, which like Chittagong may be part of the Arakan Yoma- Naga folded system (Warrick et. al., 1993).. The project area falls in the St. Martin's Island physiographic unit (Figure 5.11). The surface area of the Island is about 8 km² depending on the tidal level. The Island is almost flat with an average height of 2.5m above mean sea level (MSL), rising to a maximum of 6.5m high cliffs along the eastern coast of Dakhin Para.

5.2.5 Topography

Topography is the configuration of a land surface including its relief and contours, the distribution of mountains and valleys, the patterns of rivers, and all other features, natural and artificial, that produce the landscape. Although Bangladesh is a small country, it has considerable topographic diversity. It has three distinctive features: (i) a broad alluvial plain subject to frequent flooding, (ii) a slightly elevated relatively older plain, and (iii) a small hill region drained by flashy rivers.

The general topography of the project area is relatively flat. The topography of the specific project location is 10.85 – 35 m a.m.s.l (Figure 5.12). Topographically the cluster of the project location is almost flat, with many depressions, natural water bodies.

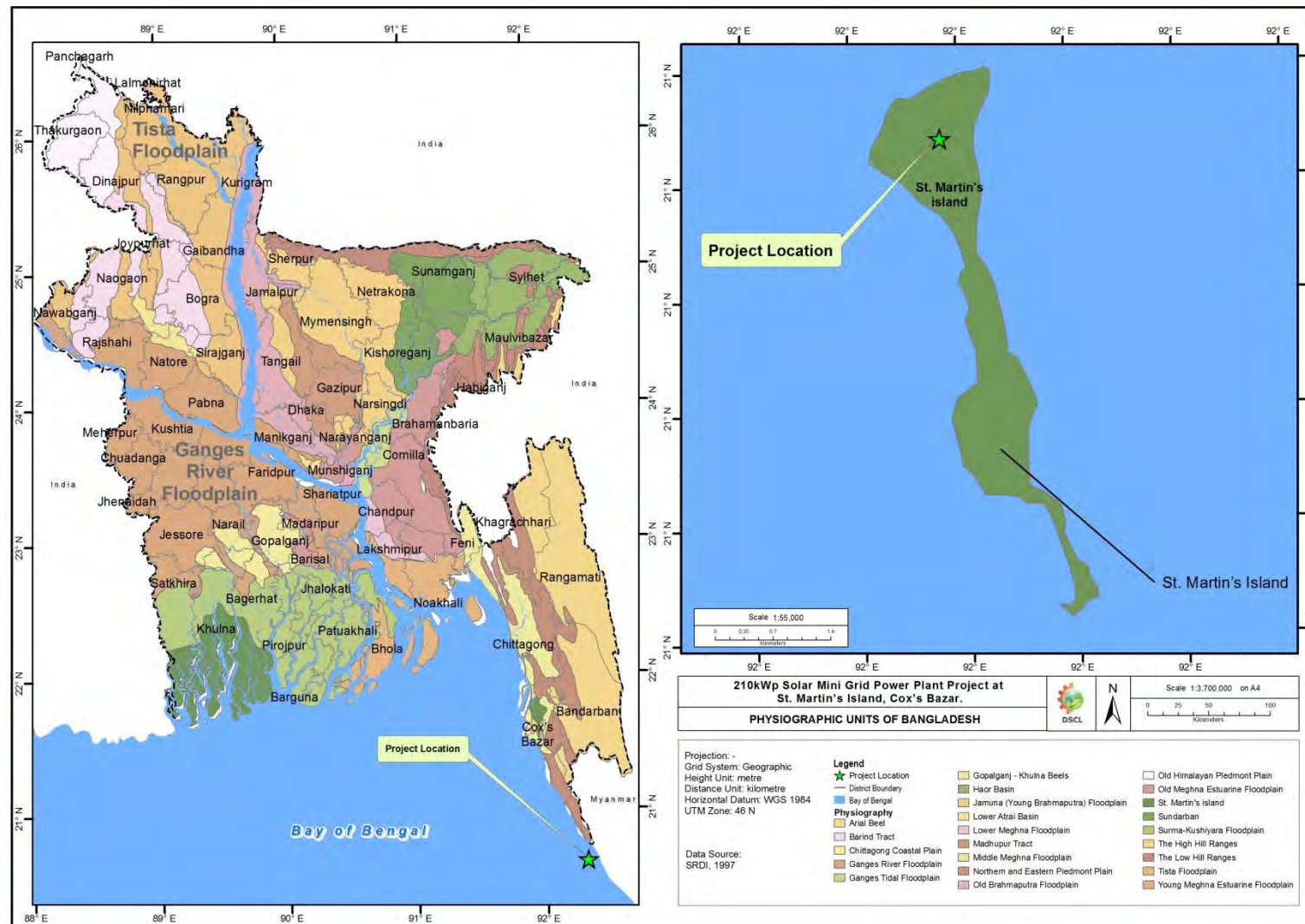


Figure 5.11: Physiographic Sub Regions of Bangladesh

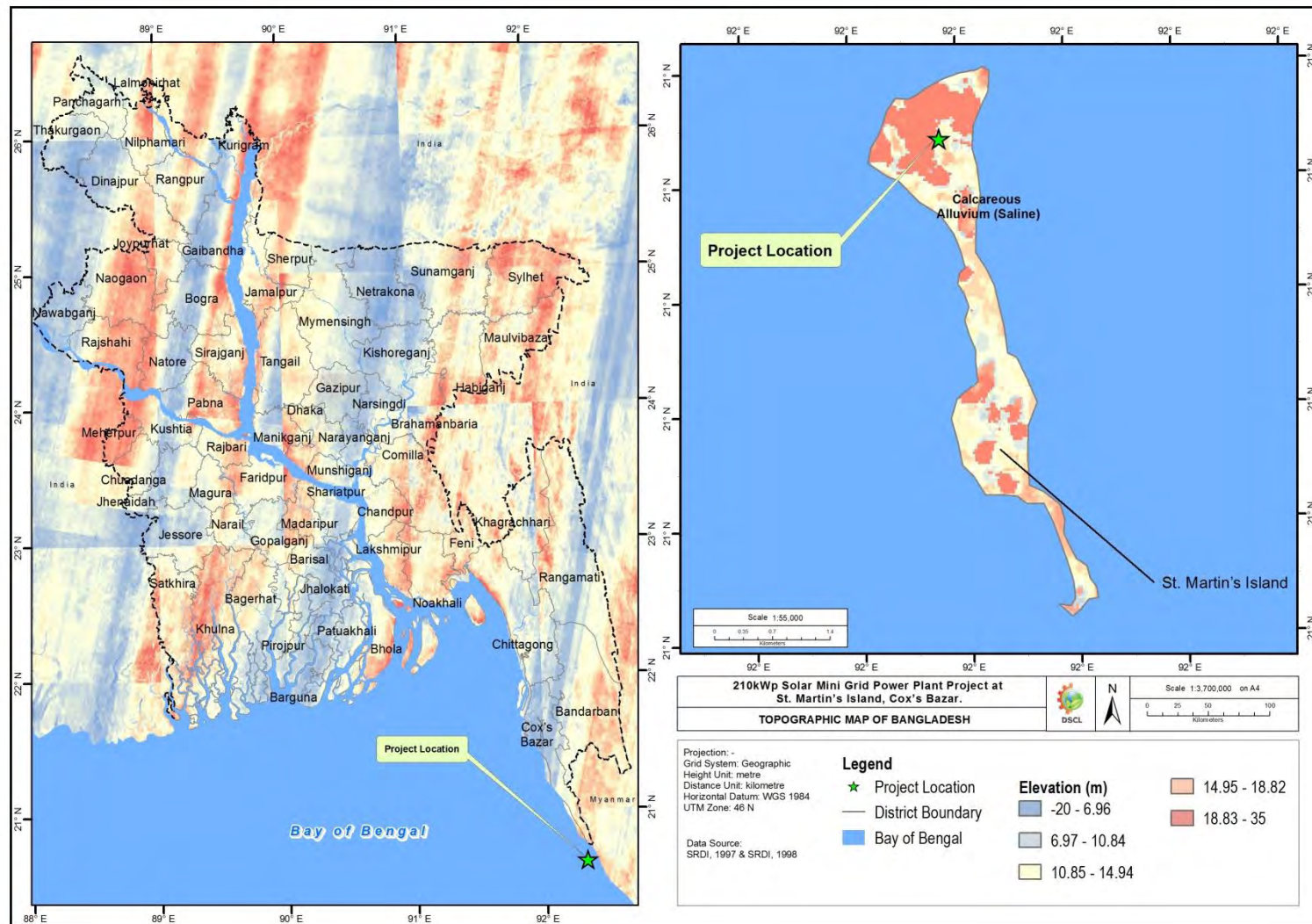


Figure 5.12: Topographic Elevation of the Project Area

5.2.6 Geology

A sequence of marine sedimentary rocks is exposed on the Island, ranging in age from Late Miocene (around 11.6 to 5.3 million years before present) to Recent. The base rock is grey to bluish-grey Girujan Clay Shale (Pliocene - 5.3 to 2.6 million years before present) inter-bedded with subordinate sandstone. Above this is a layer of St. Martin Limestone (Pleistocene - 2.6 million to 12,000 years before present), which is coquinoïd³, dirty white, coarse grained, bedded and partly consolidated along with cream colored coral clusters, and includes the fossil bearing Dakhin Para formation. This is overlain by the Holocene (from 12,000 years before present till today) coquina bed, which is continuation of the St. Martin Limestone formation.

The surface deposits (Holocene) of beach sand, which is medium to coarse grained, and light grey to grey with recent shell fragments, lie above the limestone Banglapedia (2008).

With the gradual relative increase in sea level, dead shell fragments were thrust toward the shore of the Island by wave action and finally heaped up as a narrow ridge forming the coquina horizon along the present southeast border of the island. Coquina is also known as shelly limestone, and it is best exposed in a 6.5 m high cliff of 166 m length along the eastern coast of Dakhin Para. It is composed entirely of broken and crushed shells of molluscs, small crustaceans (Ostracoda), Foraminifera⁴, and corals held together by calcareous cement. Within this rock tiny shells are often found unbroken, while the rock overall is brown with a grey weathered surface, and is cross-bedded, loose and friable. Many of the shells within the rocks are similar to those currently found strewn over the beach. Micro-palaeontological investigation of samples of coquina has revealed the presence of Foraminifera including: *Elphidium crispum*, and *Amphistegina radiata*. Radiocarbon dating of a 3 m notch of the coquina limestone cliff located in the central coast of Dakhin Para indicates an age of about 450 years at the base and 292 years at the top. From this coquina cliff the present mean rate of uplift of the island can be calculated as 19 mm/year. The generalized geological feature of the project area is shown in the geological map of Bangladesh (Figures 5.13).

The structure is simple and is represented by an anticlinal uplift. The island lies on the eastern flank of the anticline. A little of the axis of the anticline is traceable along the west coast of Dakshinpara. The exposed portion of the axis runs NNW to SSE, approximately parallel to the island. There is a fault along the northwestern shoreline with a trend nearly parallel to the axis. The fault seems to be reverse in nature with the eastern side as the upthrown block. The anticline is slightly asymmetrical with a monoclinal swing on the eastern flank. The bedrock on the eastern flank near the axis dips very gently at an angle of 3° to 5° towards the east, increasing eastwards to 10° to 12°. The monoclinal swing gives a high dip of 30° and above at Siradia. Very little of the western flank is exposed above the sea which records a dip of 6° towards the west. The monoclinal swing gives the anticline a box-like shape. The birth of the island is related to the regional tectonics of Southeast Asia.

³A limestone consisting of coarse, unsorted, and often unbroken shelly materials that have accumulated in place without subsequent transportation or agitation, and generally having a fine-grained matrix.

⁴ Tiny amoeboid protists, most smaller than 1 mm, which make a shell or "test" of limestone.

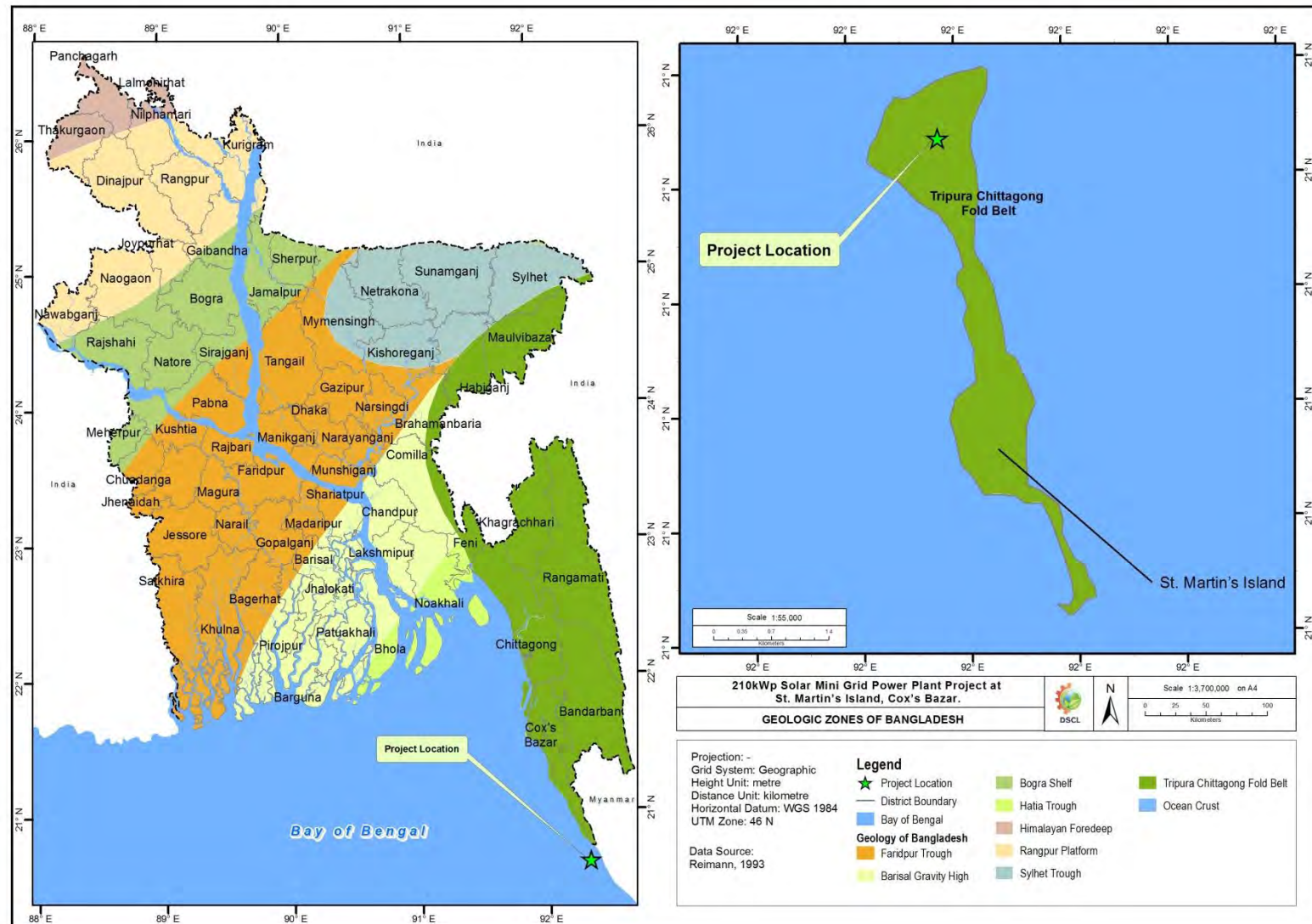


Figure 5.13: Geology of Bangladesh

5.2.7 Geomorphology

The main shoreline features are sandy beaches and dunes, where the main sediments are alluvial sands. The beaches and dunes of the southern part of the Island have a higher carbonate content compared to the northern Uttar Para beaches. Most carbonates comprise mollusc shell fragments. The sandy beach in the north and north-east stretches 300-400m into the sea. The western beach is sandy but the sub-tidal area consists of a bed of boulders.

Coastal dunes are widespread immediately above the beach and along the shorelines. This dune system is particularly well developed around the middle part of the island. The dunes of St. Martin's are of two types: high and low dunes. Highdunes are up to 6 m in height and are mostly found on the western side of Golachipa. Dunes along the north- west and south-west corners of the island are low, undulating and broadly extended. These dune systems act as a natural defence against storms and tidal surges, when they help to save lives and properties.

The topsoil of the main three parts of the Island (Uttar Para, Madhya Para and Dakhin Para) consists of alluvial sands mixed with marine calcareous (primarily molluscan in origin) deposits. Scattered throughout the area are small clumps of coral colonies, many still in growth position. A large shallow lagoon is located in the middle of Uttar Para. The lagoon has been largely converted into agricultural fields, and is connected to the sea at high tide by a narrow tidal channel on the west coast. The remaining flooded part of the lagoon has an area of about 0.4 km² with a depth of 1 m or less.

Uttar Para is separated from Madhya Para and Dakhin Para by a narrow neck of land known as Galachipa. Galachipa is a beach and dune environment. Similarly the surface deposits on Cheradia have a high content of molluscan shells compared to the northern parts of the island.



Rocks of fanciful forms can be found on the beach

One of the significant geomorphologic features of St. Martin's Island is the development of a spit bar at its southern end. This typical spit bar landform is about 2 km long and less than 100 m wide. This bar has been formed due to deposition and movement of fine to medium grained sand materials (consisting of alluvial sand and littoral carbonates) by wave and tidal currents. It connects Dakhin Para with the only smaller islands that form part of St. Martin's

Island: three small islands of which the middle one is the largest, and which collectively are known as Cheradia. The peaks of these islands are less than 3 m above MSL and become disconnected from Dakhin Para by nearly 1 m deep water at high tide. These small islands are composed of relatively coarser sand particles with frequent shale fragments, broken coral debris and foraminifera, and are overlaid on nearly all sides by stony corals and boulders. The middle one of the three small islands has an undulating surface with a sub-basin on its top which is slightly submerged during extreme high tides. These three islands can be classified as “vegetated sand islands”, since they have developed from the accumulation of both alluvial sands and calcareous littoral deposits. During low tide, they are connected with Dakhin Para by the spit bar which has accumulated on the top of a rocky inter-tidal reef.



Rocky Beach

A number of non-vegetated rocky outcrops are found on the north-west coast of Uttar Para. These supra-tidal outcrops are the seaward continuations of the rocky inter-tidal zone. Almost the entire coastline of St. Martin's Island is fringed by a rocky inter-tidal zone unique in Bangladesh. The width of the rocky inter-tidal at spring low tides varies from 100 to 400 m. The rocky inter-tidal is formed by small and large boulders, which according to Alam and Hassan (1998) have a close affinity with the bed rocks of the Island. In addition, many of the spherical boulders are calcareous concretions. Coral boulders are also present, but these are relatively rare and in no place do they form a coherent feature that can be called a coral reef. The presence of relatively well preserved dead coral colonies in the upper and middle inter-tidal suggests that the island has been uplifted in relatively recent times.

The recent uplift of St. Martin's is evident from the presence of large *Porites* micro-atolls, which are found in the lower inter-tidal on the north-west coast of Uttar Para. The morphology of these micro-atolls suggests that the relative sea level has dropped by about 15 cm during the last 150 years or so. This rough estimate is based on the size and average growth rates of the microatolls. Clearly this is an exciting area for new research, as it along with the dating of the cliff sediments, contradicts recent global trends for rising mean sea levels.

The sedimentary boulders, calcareous concretions, sandstone and shale found in the inter-tidal area extend into the sub-tidal zone. Most of the inshore area around the Island comprises

of a shelf, this is covered by a layer of sedimentary boulders that vary greatly in size. While they provide a very suitable substrate for the settlement of coral larvae, as is evident from relatively high recruitment rates of juvenile corals, the boulders are very susceptible to overturning and shifting by the heavy seas that are frequently generated by cyclonic storms and tidal surges. The growing corals on the boulders are thus damaged or destroyed when the substrate boulders move. This rocky sub-tidal zone is much wider along the west coast than along the east coast. A number of offshore rocky reefs along the west coast become exposed during low spring tides.



Transparent sea water of St. Martin's

5.2.8 Water Resources

Bangladesh is located over a subsiding basin of tectonic origin overlain with a great thickness of sedimentary strata. This sedimentary stratum is an unconsolidated alluvial deposit of recent age overlaying marine sediments. The recent delta and alluvial plains of the Ganges, Brahmaputra and the Meghna Rivers constitute the upper formation.

Surface circulation in the Bay of Bengal is determined by the monsoon winds and to some extent by the hydrological characteristics of the open part of the Indian Ocean. The prevailing winds reverse twice during the year. They blow from the south-west during May-September and from the north-east during November-January with the transition taking place during the months in between.

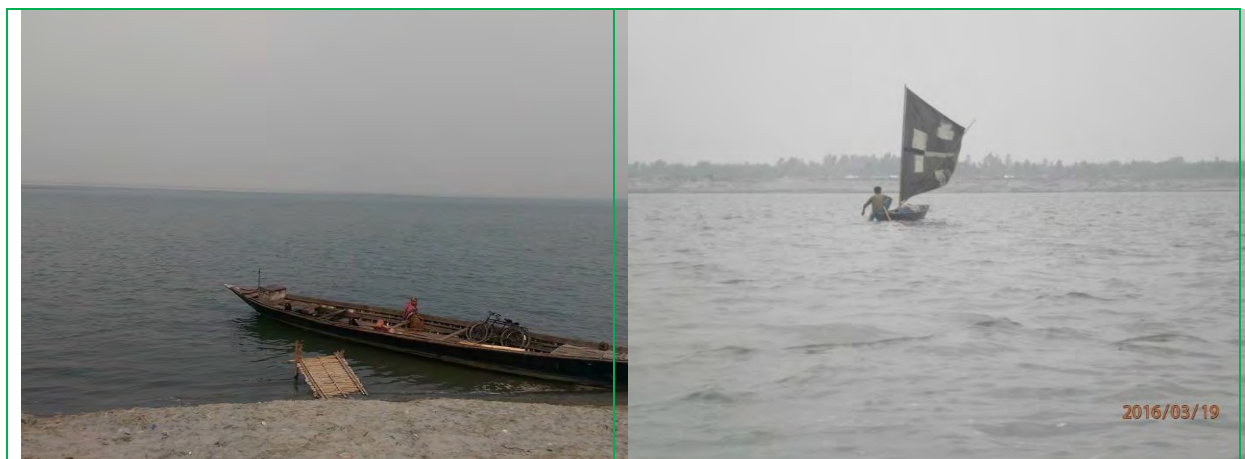
Forced by these winds, circulation in the Indian Ocean has a general eastward direction during summer and westward during winter. The inflow of freshwater from the Ganges-Brahmaputra Delta into the Bay of Bengal has a significant impact: these reversing currents carry low salinity Bay of Bengal water into more saline Arabian Seawater and vice versa playing a crucial role in maintaining the freshwater - saltwater balance of the North Indian Ocean. The massive inflow of freshwater and sediment from the Ganges and Brahmaputra Rivers, and locally from the Naf River, is also an important factor influencing the flora and fauna of the Island. Thus, coral reef development is inhibited due to low water salinity, high turbidity and the soft substrates present.

Being very porous and permeable, the shelly limestones of the Island provide an excellent aquifer wherever they occur beneath the alluvium. The shelly limestone and recent marine sand are the chief sources of fresh water. The rocks underlying these two formations are mostly impervious Tertiary shale and calcareous sandstone.

As rain water cannot flow downward through these rocks, it accumulates either in the shelly limestone or in the marine sand. The shelly limestone that underlies the village of Jinjira averages 1.2 m (four feet) thick and is overlain by 0.6-1.2 m (2-4 feet) of soil. Drinking and irrigation water is obtained by sinking shallow wells 1.5-3 m (5-10 feet) to the level of the Tertiary rocks.

From secondary information it is found that the surface salinity in the coastal parts of the Bay of Bengal oscillates from 10 to 25 ppt (parts per thousand, ie grams per kilogram of sea water). Coastal seawater is significantly diluted with freshwater throughout the year, although the inflow of river water is greatly reduced during winter. The coastal water salinity of St. Martin's Island, as measured during the dry season (Tomasick, 1997), fluctuates between 26 and 35 ppt. It is expected that the salinity level drops below this level due to increased freshwater discharge from the Naf River during the rainy season (July-October).

Dissolved oxygen (DO) concentration in the surface waters around St. Martin's Island ranges from 4.56 to 6.24 mg/L in December. The highest value of 6.24 mg/L of DO was found at Badam Bunia, where as the lowest value was recorded at St.Martin's Bazar (Hossain et al., 2006).



Water Bodies in the Project Area

▪ **Surface Water**

The project area is surrounded by the sea water. Fresh water sources are limited in island. People use the water from the natural water bodies for washing, bathing and irrigation purposes.

The overall quality of surface water around the project site and its surroundings varies throughout the year. Typically water quality improves during the monsoon due to the influx

of fresh rainwater, and worsens during the dry season as water evaporates and the concentration of contaminants increases.

On 6th April 2016, surface water sample was collected by environmental team from two locations near the project area. The Department of Public Health Engineering (DPHE) analyzed the sample. The result (Appendix C) of the surface water sample and the GoB standards for fishing water (ECR, 1997) are shown in Table 5.3. The concentration levels of COD and BOD parameters for SW-2 were found higherset by the DoE, GoB, it indicates that there may be connection with sea. Since it is coral stony island that's why COD level may be higher.

From secondary report it is to be noted that water transparency measured in December fluctuated from 0.62 m near St. Martin's Bazar, where the water is heavily affected by human pressure, (Hossain et al., 2006). This low light penetration is the consequence of many factors like COD, BOD, and TDS etc.



Figure 5.14: Surface Water Sampling from the Project Location

Table 5.3: Results for Surface Water Field Sample

Water Quality Parameters	Unit	Concentration Present		Inland Water Standard for Fish, DOE	Method of Analysis
		Deil Para; 20.63404°N, 92.32700°E	Purbo Para, Word-06; 20.62995°N, 92.32426°E		
pH*	---	8.7	9.1	6.5-8.5	pH Meter
Total Dissolved Solids (TDS)*	mg/l	1.05	12.69	-	TDS Meter
Dissolved Oxygen (DO)	mg/l	2.16	1.39	5 or more	Multimeter
Chemical Oxygen Demand (COD)	mg/l	36	760	NYS	CRM
Biochemical Oxygen Demand (BOD)	mg/l	10	48	6 or less	5 Days Incubation
Salinity	%0	1.15	45	NYS	Multimeter

* Onsite Test Using Field Test Kit

Source: Lab Analysis by DPHE

Being very porous and permeable, the shelly limestones of the Island provide an excellent aquifer wherever they occur beneath the alluvium. The shelly limestone and recent marine sand are the chief sources of fresh water. The rocks underlying these two formations are mostly impervious Tertiary shale and calcareous sandstone.

As rain water cannot flow downward through these rocks, it accumulates either in the shelly limestone or in the marine sand. The shelly limestone that underlies the village of Jinjira averages 1.2 m (four feet) thick and is overlain by 0.6-1.2 m (2-4 feet) of soil. Drinking and irrigation water is obtained by sinking shallow wells 1.5-3 m (5-10feet) to the level of the Tertiary rocks.



Water Bodies in the project area

However, there is now a scarcity of drinking water on the island. Only a few ponds and several tube wells supply water for drinking as well as for cultivation. Deforestation and large scale expansion of agriculture have adversely impacted the ground water lens of the island. The shallow wells used for crop irrigation may reduce availability of potable water. Increasing salinity in some tube wells has been reported. Throughout the wet season until January, the water table in St. Martin's Island is within the range of 0.3- 2.1 m (1-7 feet) below the surface. However, in March and April most of the wells go dry and ground water is confined to the areas where the shelly limestone is more than 1.8 m (6 feet) thick.

The needs of the local population and the large annual influx of tourists during the dry season have created a great demand for freshwater, leading to a drop in the water table. This demand will only increase in the near future. Already there is a shortage of water for two or three months before the wells are replenished by summer rains in May and June.

▪ **Sea Water**

Surface circulation in the Bay of Bengal is determined by the monsoon winds and to some extent by the hydrological characteristics of the open part of the Indian Ocean. The prevailing winds reverse twice during the year. They blow from the south-west during May-

September and from the north- east during November-January with the transition taking place during the months in between. Forced by these winds, circulation in the Indian Ocean has a general eastward direction during summer and westward during winter. The inflow of freshwater from the Ganges-Brahmaputra Delta into the Bay of Bengal has a significant impact: these reversing currents carry low salinity Bay of Bengal water into more saline Arabian Sea water and vice versa playing a crucial role in maintaining the freshwater-saltwater balance of the North Indian Ocean (Vinayachandran and Kurian, 2008).

The massive inflow of freshwater and sediment from the Ganges and Brahmaputra Rivers, and locally from the Naf River, is also an important factor influencing the flora and fauna of the Island. Thus, coral reef development is inhibited due to low water salinity, high turbidity and the soft substrates present.

Tides

The Island experiences normal semi- diurnal tides, i.e. two high and two low tides during a period of 24 hours and 52 minutes (Banglapedia, 2008). The mean tidal range at Shahpuri Island (about 9 km north-east of St. Martin's Island) in the Naf estuary is 1.87 m. It is expected that somewhat similar, probably lower, tidal ranges occur at St. Martin's Island.

Temperature

The mean annual temperature of the surface water of the Bay of Bengal is about 28°C. The maximum temperature is observed in May (30°C) and the minimum (25°C) occurs in January-February (Banglapedia, 2008; Vinayachandran and Kurian, 2008).

Salinity

The surface salinity in the coastal parts of the Bay of Bengal oscillates from 10 to 25 ppt (parts per thousand, ie grams per kilogram of sea water). Coastal seawater is significantly diluted with freshwater throughout the year, although the inflow of river water is greatly reduced during winter. The coastal water salinity of St. Martin's Island, as measured during the dry season (Tomasick, 1997), fluctuates between 26 and 35 ppt. It is expected that the salinity level drops below this level due to increased freshwater discharge from the Naf River during the rainy season (July-October).

Transparency

Water transparency measured in December fluctuated from 0.62 m near St. Martin's Bazar, where the water is heavily affected by human pressure, to 3.9 m at Galachipa (Hossain et al., 2006). This low light penetration is the consequence of many factors. In addition to silt discharged by the Naf, the combined action of wind generated waves, ocean swell and high velocity tidal currents cause re-suspension of bottom sediments (fine sand; silts and mud). A Secchi depth⁵ of over 7 m is required for optimal growth of reef- building corals. Since corals are light- sensitive organisms, the turbid coastal waters of St. Martin's Island are a key environmental factor limiting the development of coral reefs. Dissolved oxygen (DO) concentration in the surface waters around St. Martin's Island ranges from 4.56 to 6.24 mg/L

⁵A measure of water transparency based on the maximum depth at which a standardised disk is just visible from the surface.

in December. The highest value of 6.24 mg/L of DO was found at Badam Bunia, whereas the lowest value was recorded at St.Martin's Bazar (Hossain et al., 2006).

The effects of aquatic pollution on coral communities are not well understood, however, there is evidence that pollution and other human activities have degraded the quality of water surrounding St. Martin's Island and have adverse impacts on the health, development and survival of corals and associated biodiversity (Hossain et al., 2006).

▪ **Groundwater**

There is now a scarcity of drinking water on the island. Only a few ponds and several tube wells supply water for drinking as well as for cultivation. Deforestation and large scale expansion of agriculture have adversely impacted the ground water lens of the island. The shallow wells used for crop irrigation may reduce availability of potable water. Increasing salinity in some tube wells has been reported.

Throughout the wet season until January, the water table in St. Martin's Island is within the range of 0.3- 2.1 m (1-7 feet) below the surface. However, in March and April most of the wells go dry and ground water is confined to the areas where the shelly limestone is more than 1.8 m (6 feet) thick.

The needs of the local population and the large annual influx of tourists during the dry season have created a great demand for freshwater, leading to a drop in the water table. This demand will only increase in the near future. Already there is a shortage of water for two or three months before the wells are replenished by summer rains in May and June.

Being very porous and permeable, the shelly limestones of the Island provide an excellent aquifer wherever they occur beneath the alluvium. The shelly limestone and recent marine sand are the chief sources of fresh water. The rocks underlying these two formations are mostly impervious Tertiary shale and calcareous sandstone.

Drinking and irrigation water is obtained by sinking shallow wells 1.5-3 m (5-10 feet) to the level of the Tertiary rocks. The shallow wells used for crop irrigation may reduce availability of potable water. Increasing salinity in some tube wells has been reported.

It is reported that throughout the wet season until January, the water table in St.Martin's Island is within the range of 0.3- 2.1 m (1-7 feet) below the surface. However, in March and April most of the wells go dry and ground water is confined to the areas where the shelly limestone is more than 1.8 m (6 feet) thick.

The needs of the local population and the large annual influx of tourists during the dry season have created a great demand for freshwater, leading to a drop in the water table. This demand will only increase in the near future. Already there is a shortage of water for two or three months before the wells are replenished by summer rains in May and June.

On 6th April 2016, groundwater sample was collected by environmental team from more than one tube well near the project area. The Department of Public Health Engineering (DPHE) analyzed the sample. The result (see Appendix D) of the groundwater sample and the GoB standards for drinking water (ECR, 1997) are shown in Table 5.4. All the parameters

concentration levels are within the acceptable limit of Bangladesh drinking water quality standard set by DoE.



Figure 5.15: Water Sampling from the Project Location

Table 5.4: Results for Groundwater Field Sample

Parameters	Unit	Concentration Present		Drinking Water Quality Standard, DOE	Method of Analysis
		Purbo Para, Word-06; 20.63272°N, 92.32645°E	Purbo Para, Word-06; 20.62924°N, 92.32246°E		
pH*	---	7.5	7.4	6.5-8.5	pH Meter
Total Dissolved Solids (TDS)*	mg/l	0.57	1.65	1000	TDS Meter
Alkalinity	mg/l	340	330	-	Trimetric
Chloride (Cl ⁻)	mg/l	210	850	150-600 in case of Coastal area standard value is 1000	Trimetric
Iron (Fe)	mg/l	<LOQ	<LOQ	0.3-1.0	AAS
Arsenic (As)	mg/l	0.002	0.001	0.05	AAS
Salinity	‰	0.52	1.73		Multimeter

* Onsite Test Using Field Test Kit

Source: Lab Analysis by DPHE

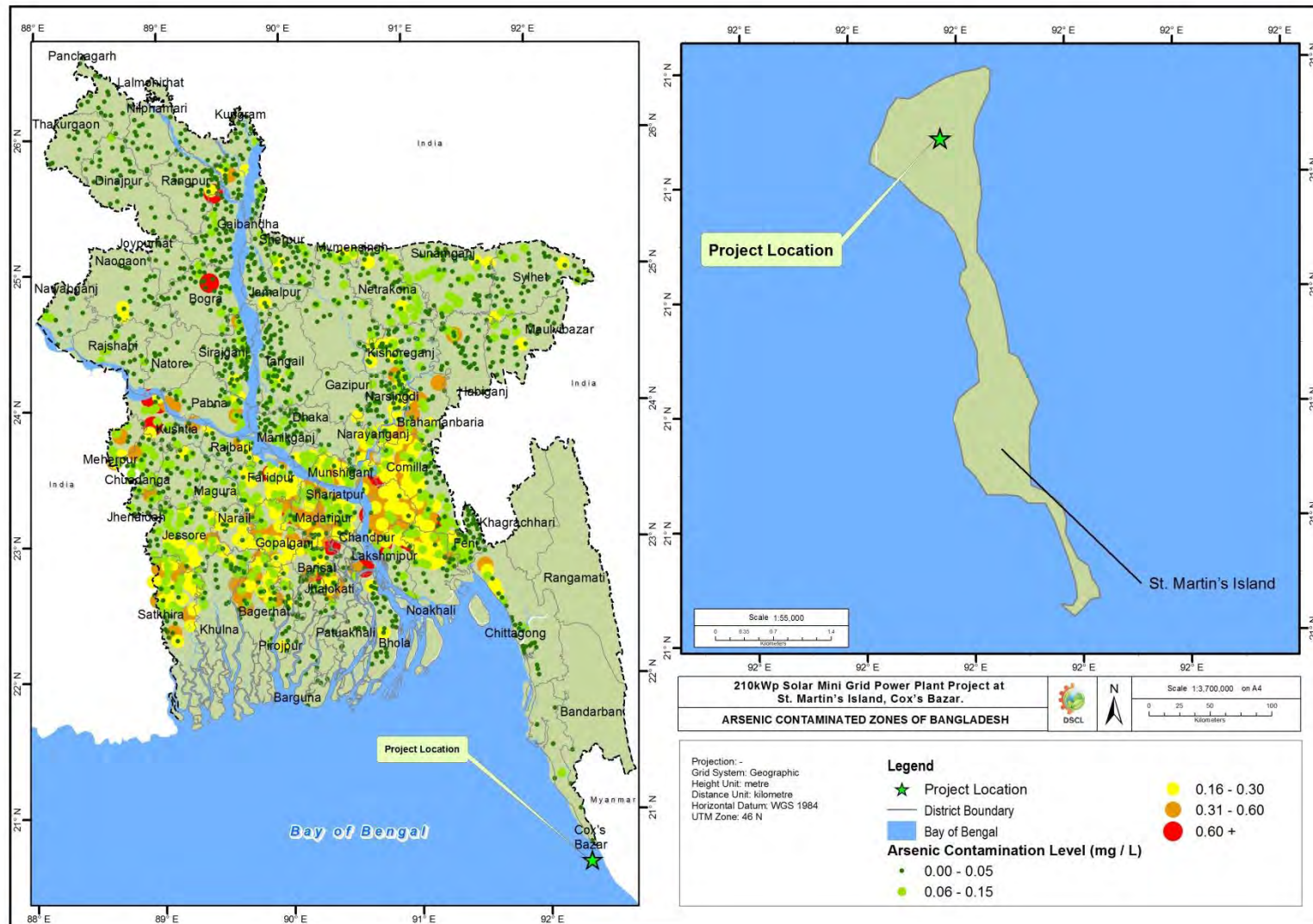


Figure 5.16: Arsenic Concentrations in Groundwater

5.2.9 Soil Quality

The main shoreline features are sandy beaches and dunes, where the main sediments are alluvial sands. The beaches and dunes of the southern part of the Island have a higher carbonate content compared to the northern Uttar Para beaches. Most carbonates comprise mollusc shell fragments. The sandy beach in the north and north-east stretches 300-400 m into the sea. The western beach is sandy but the sub-tidal area consists of a bed of boulders. The topsoil of the main three parts of the Island (Uttar Para, Madhya Para and Dakhin Para) consists of alluvial sands mixed with marine calcareous (primarily molluscan in origin) deposits. Scattered throughout the area are small clumps of coral colonies, many still in growth position. A large shallow lagoon is located in the middle of Uttar Para. The lagoon has been largely converted into agricultural fields, and is connected to the sea at high tide by a narrow tidal channel on the west coast. The remaining flooded part of the lagoon has an area of about 0.4 km² with a depth of 1 m or less. The soil of the area falls in Calcareous Saline of Bangladesh general soil classification (Figure 5.16):

- **Calcareous Saline (7):** Calcareous Alluvium Soils are stratified or raw alluvium throughout or below the cultivated layer. They are calcareous throughout or part of it and lack in having diagnostic subsoil horizon. This alluvium on the active Ganges floodplain mainly comprises brownish grey to pale brown sandy and silty deposits, which are moderately calcareous. Soils on the Lower Meghna estuarine floodplain are slightly calcareous grey to olive, finely stratified silts. They are mainly Calcaric Fluvisols. (Banglapedia, 2015).

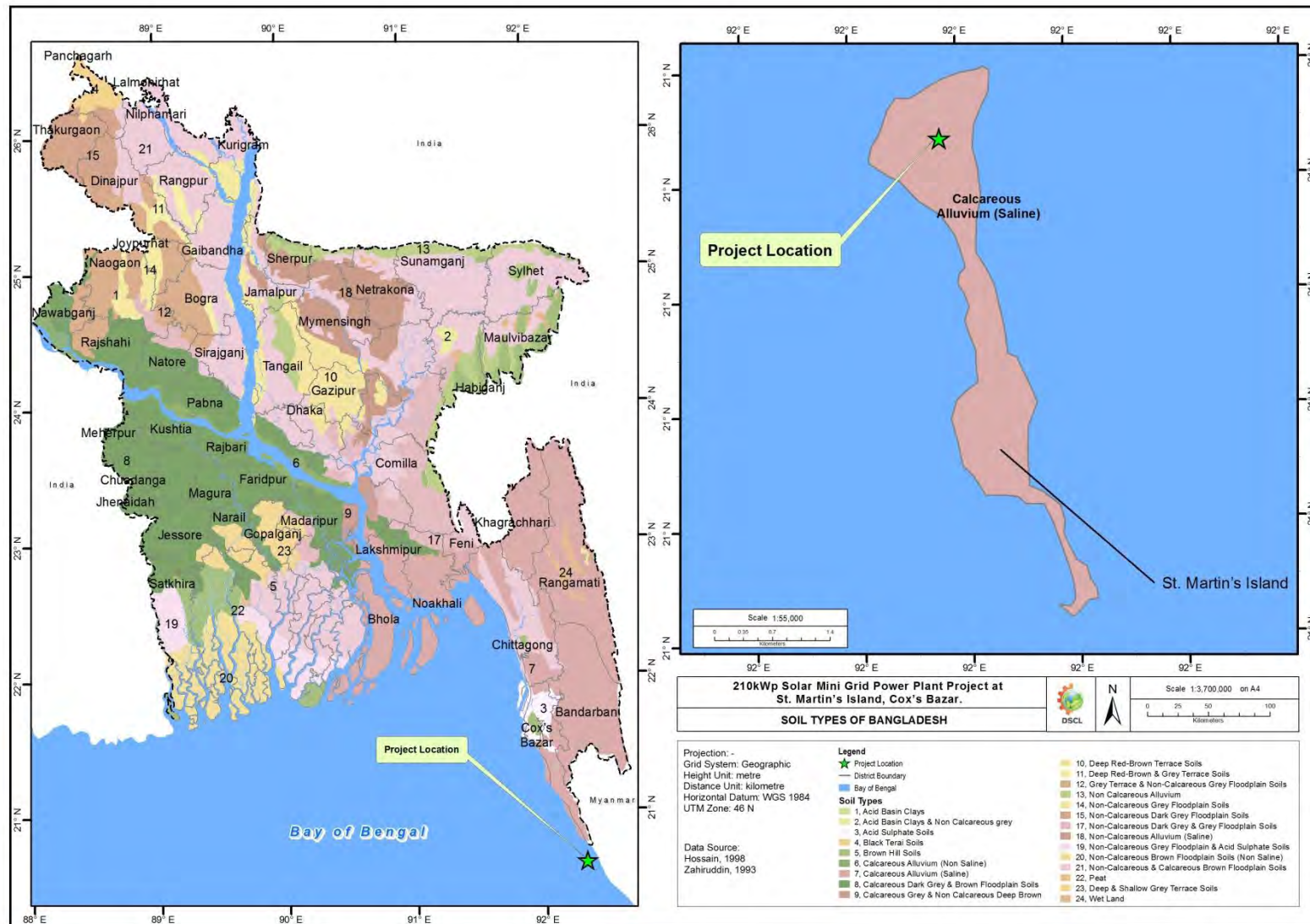


Figure 5.17: General Soil Categories of Bangladesh

5.2.10 Agro-ecological Zones within the Project Area

A 1988 study carried out by the United Nations Development Program (UNDP) classified Bangladesh into a series of Agro-ecological Zones (AEZs) based on an assessment of commonalities in characteristics such as physiography, soil types, climate and drainage. In total, 34 regions were identified and characterized, however this information has been updated and further refined on numerous occasions since the original study was undertaken. The purpose of assessing the AEZs within the project area is to establish a broad overview of expected soil conditions which can be compared against more detailed, Upazila-level data sources.

The most recent assessment was completed by the Soil Resource Development Institute (SRDI, 1998) which classified Bangladesh into 30 AEZs. The project area contains the below AEZ (refer Figure 5.17), namely:

- i. **St. Martin Coral Island** (8.0 sq km) this small but distinctive region occupies the whole of St Martin's Island in the extreme south of the country. The area has very gently undulating old beach ridges and inter-ridge depressions, surrounded by sandy beaches. The soils are developed entirely on old and young coral beach sands. Calcareous alluvium is the only general soil type of the area. General fertility level is low with poor moisture holding capacity (Banglapedia, 2015).

The nature and soil characteristics of this zone influence the crops and cropping patterns within the region.

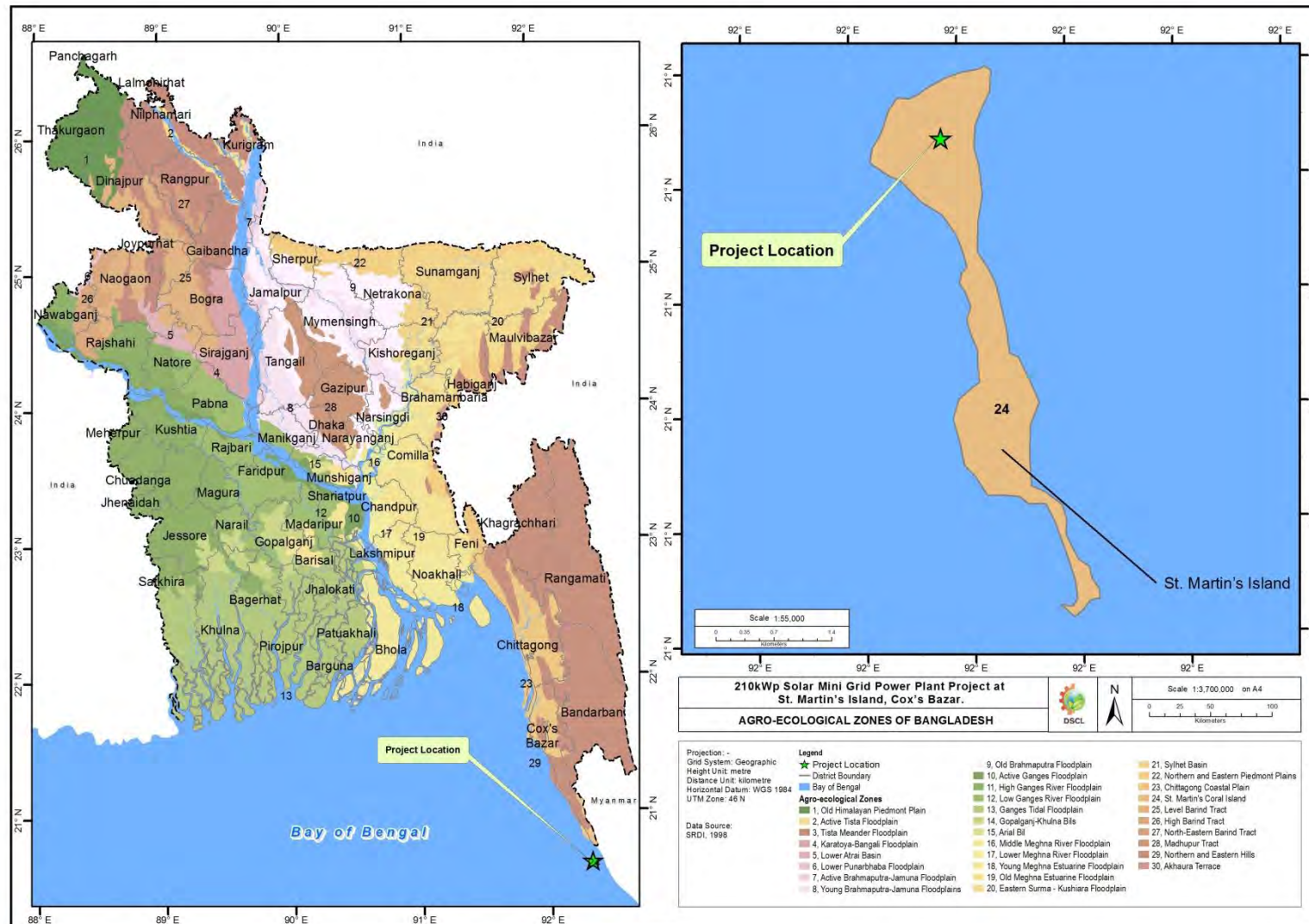


Figure 5.18: Agro-ecological Zones of Bangladesh

5.2.11 Seismicity

Bangladesh is situated in one of the most tectonically active regions in the world. Here is where three major plates meet (the Indian Plate, the Tibet Sub-Plate, and the Burmese Sub-Plate). The project area is located over the Indian Plate, which is moving north. However due to the location of relevant plates, fault lines and hinge zones, Bangladesh itself is divided into three seismic zones (Table 5.5), based on the ranges of the seismic coefficient (*note: the seismic coefficient is a measure of how strong an earthquake has the potential to be based on a combination of the mass of the plate and the seismic forces acting on it, as well as how frequently these quakes are likely to occur*). As per the seismic zone map (Figure 5.18), project area falls in the zone II comprising the south-eastern part of Bangladesh. It means the project area is prone to medium seismic intensity. There is no evidence of major earthquakes in the project areas in the recent past.

Table 5.5: Seismic Zonation of Bangladesh

Zoning	Area Mercalli Scale	Bask Seismic Coefficient
I	North and eastern regions of Bangladesh (Seismically most active)	0.08
II	Lalmai, Barind, Madhupur Tracts, Dhaka, Comilla, Noakhali and western part of Chittagong Folded belt.	0.05
III	Khulna division S-E Bangladesh (Seismically relatively quiet)	0.04

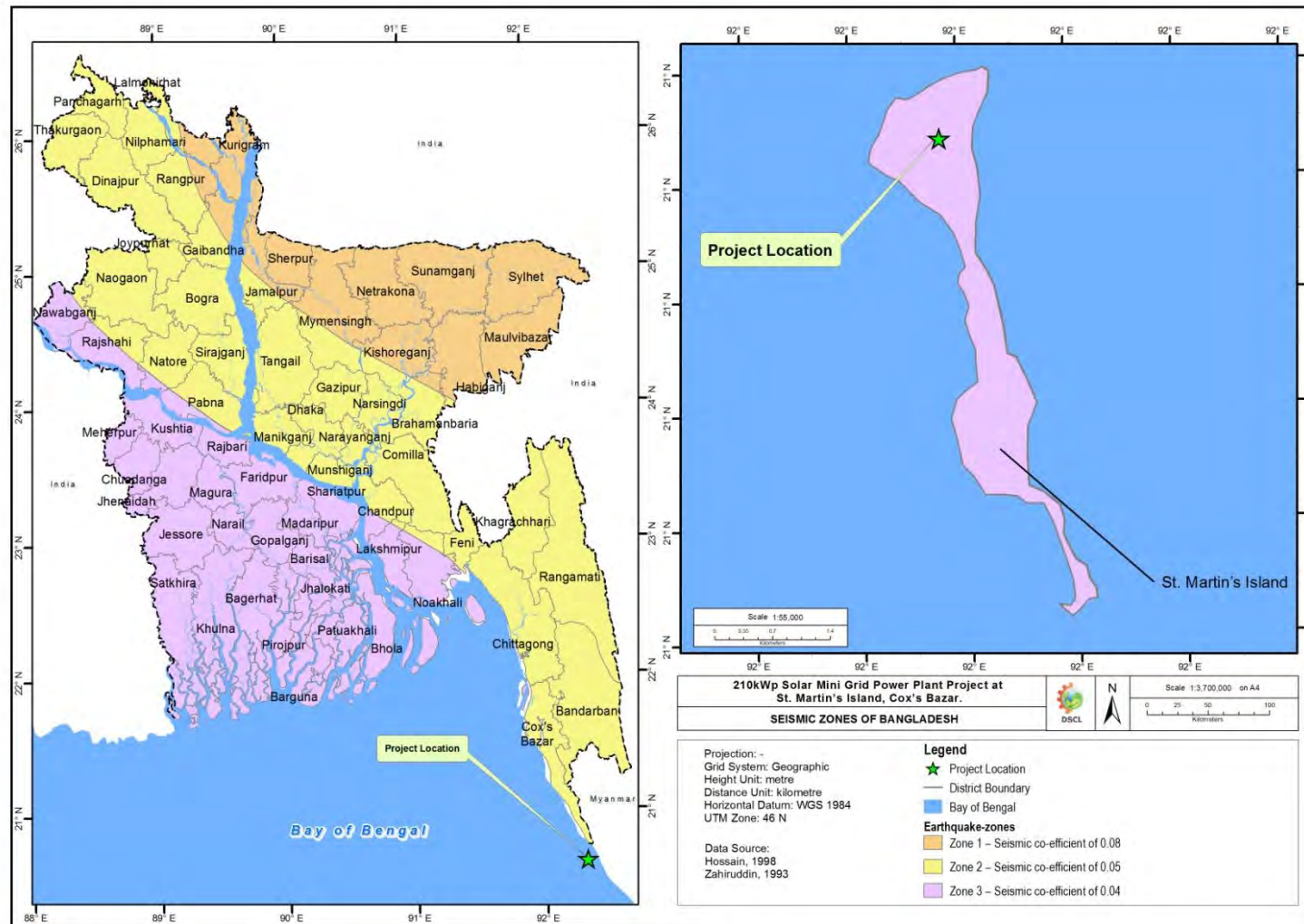


Figure 5.19: Seismic Zones within Bangladesh
 (Source: Hossain, 1988 & Zahiruddin, 1993)

5.3 Climate Change and Natural Disaster

Building large solar power plants requires significant long-term investment so understanding impacts from climate change will aid financial planning, technology selection, and energy output projections. Climate change and its associated impacts will be experienced through changing temperatures and precipitation, rising sea levels, changes in the frequency and severity of climate extremes and in the dynamics of hazardous conditions (IPCC, 2007). Developing countries are considered to be particularly susceptible to climate change because of their exposures and sensitivities to climate-related extremes, and especially because of their limited adaptive capabilities to deal with the effects of hazardous events. Given this limited capacity to adapt, they are considered to be particularly vulnerable to damages associated with climate, just as they are particularly vulnerable to other stresses.

Climate change is a global issue. The world's climate is changing and will continue to change in the coming century. Climate Change is basically the change in climate over a time period that ranges from decades to centuries. It is a normal part of the Earth's natural variability, which is related to interactions among the atmosphere, ocean, and land, as well as changes in the amount of solar radiation reaching the earth. However, the term "climate change" is defined by the United Nations Framework Convention on Climate Change (UNFCCC) as "A change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods" (IPCC, 2007). The risks associated with these changes are real but highly uncertain. Societal vulnerability to the risks associated with climate change may exacerbate ongoing social and economic challenges, particularly for those parts of societies in developing countries dependent on resources that are sensitive to changes in climate.

Bangladesh is recognized worldwide as one of the most vulnerable countries to the impacts of climate change. This is due to dominance of floodplains, low elevation from the sea, high population density, high levels of poverty, and overwhelming dependence on nature, its resources and services. The country has a history of extreme climatic events claiming millions of lives and destroying past development gains. The people and social system have knowledge and experience of coping with the effects of such events—to some degree and extent. Historically, Bangladesh is trying to adapt with the changing environment. The Intergovernmental Panel on Climate Change (IPCC) has identified the country as one of the most vulnerable countries to climate change, which may severely affect lives and livelihoods of millions of Bangladeshi people in coming decades. In this regard, Bangladesh has already prepared the National Adaptation Programme on Action (NAPA) and Climate Change Strategy and Action Plan (MoEF, 2005 and MoEF, 2009).

According to the fourth assessment, report of IPCC, continued greenhouse gas emissions at or above current rates would cause further warming and induce many changes in the global climate system during the 21st century, which would very likely be more severe than those observed during the 20th century would.

Photovoltaic (PV) electricity generation depends on solar irradiance, named surface-downwelling shortwave (that is, wavelength interval 0.2–4.0 μm) radiation (RSDS) by climate models, and other atmospheric variables affecting panel efficiency, namely surface air temperature (TAS) and surface wind velocity (VWS). Climate change may therefore affect PV power generation and its temporal stability for a given panel fleet.

The effects of climate change, particularly sea level rise, pose significant threats to the whole region of South Asian Seas. As a result of global warming, the penetration of heat into the ocean leads to the thermal expansion of the water; this effect, coupled with the melting of glaciers and ice sheets, results in a rise in sea level. Sea level rise will not be uniform globally but will vary with factors such as currents, winds, and tides; as well as with different rates of warming, the efficiency of ocean circulation, and regional and local atmospheric (e.g., tectonic and pressure) effects. It is estimated that sea level would rise, on average, about 5 mm/yr, within a range of uncertainty of 2–9 mm/yr. (IPCC 2004).

Recent global increases in reef ecosystem degradation and mortality (the “coral reef crisis”) appear to be sending a clear message that the rate and nature of recent environmental changes frequently exceeds the adaptive capacity of coral organisms and communities. The coral crisis is almost certainly the result of complex and synergistic interactions among local-scale human-imposed stresses and global-scale climatic stresses. Documented human stresses include increased nutrient and sediment loading, direct destruction, habitat modification, contamination, and the very important chronic indirect effects of over fishing.

The major climate change factor that is becoming increasingly important for coral communities is rising ocean temperatures, which have been implicated in chronic stress and disease epidemics among corals, as well as in the occurrence of increasing numbers of mass coral bleaching episodes. High water temperatures stress corals leading to “bleaching”- the expulsion of colourful, symbiotic algae that corals need for survival, growth, and reproduction.

Also of concern are increases in atmospheric concentrations of carbon dioxide (CO_2) from fossil fuel combustion that will drive changes in surface ocean chemistry. The higher in the atmosphere, the greater the amount of CO_2 dissolved in the surface ocean. Higher dissolved CO_2 increases ocean acidity and lowers the concentration of carbonate which corals and other marine organisms use, in the form of calcium carbonate, to build their skeletons. Thus, continued growth in human emissions of CO_2 will further limit the ability of corals to deposit the calcium carbonate minerals that are the structural building materials of coral reefs, and they will fail to recover from bleaching events or other forms of stress.

During field survey it is observed that more than fifty diesel generator run in every day. It continually increases the CO_2 concentration to the air in the Island. After implementation of the project it can be assumed that CO_2 concentration may be reduced in the air because of people use the CO_2 free solar technology for power.

5.3.1 Climate Change and Other Environmental Threats

The effects of climate change, particularly sea level rise, pose significant threats to the whole region of South Asian Seas. As a result of global warming, the penetration of heat into the ocean leads to the thermal expansion of the water; this effect, coupled with the melting of glaciers and ice sheets, results in a rise in sea level. Sea level rise will not be uniform globally but will vary with factors such as currents, winds, and tides; as well as with different rates of warming, the efficiency of ocean circulation, and regional and local atmospheric (e.g., tectonic and pressure) effects. It is estimated that sea level would rise, on average, about 5 mm/yr, within a range of uncertainty of 2–9 mm/yr (IPCC 2004). Recent global increases in reef ecosystem degradation and mortality (the “coral reef crisis”) appear to be sending a clear message that the rate and nature of recent environmental changes frequently exceeds the adaptive capacity of coral organisms and communities. The coral crisis is almost certainly the result of complex and synergistic interactions among local-scale human-imposed stresses and global-scale climatic stresses. Documented human stresses include increased nutrient and sediment loading, direct destruction, coastal habitat modification, contamination, and the very important chronic indirect effects of over fishing. The major climate change factor that is becoming increasingly important for coral communities is rising ocean temperatures, which have been implicated in chronic stress and disease epidemics among corals, as well as in the occurrence of increasing numbers of mass coral bleaching episodes. High water temperatures stress corals leading to “bleaching” — the expulsion of colourful, symbiotic algae that corals need for survival, growth, and reproduction. Also of concern are increases in atmospheric concentrations of carbon dioxide (CO₂) from fossil fuel combustion that will drive changes in surface ocean chemistry. The higher the concentration of CO₂ in the atmosphere, the greater the amount of CO₂ dissolved in the surface ocean. Higher dissolved CO₂ increases ocean acidity and lowers the concentration of carbonate which corals and other marine organisms use, in the form of calcium carbonate, to build their skeletons. Thus, continued growth in human emissions of CO₂ will further limit the ability of corals to deposit the calcium carbonate minerals that are the structural building materials of coral reefs, and they will fail to recover from bleaching events or other forms of stress.

6 DESCRIPTION OF THE ECOLOGICAL ENVIRONMENT

The unique island of St. Martin's, the only place in Bangladesh where coral colonies are found, is a natural treasure of Bangladesh that attracts thousands of tourists. The Island also has an important ecological value as one of the few remaining nesting places in the region for several species of globally threatened marine turtles, as well as being a flyway and wintering site for migratory birds of the East Asian and Austral Asian region.

St. Martin's Island is not only significant for its biodiversity value, but also important for Bangladesh in defining its Exclusive Economic Zone and delineating its sea boundary in accordance with the United Nations Convention on the Law of the Sea.

Unfortunately, unregulated tourism has become detrimental for the health of this unique ecosystem. Unless tourists visiting St. Martin's Island quickly adopt ecologically responsible behavior, the unique flora and fauna of the Island that has experienced tragic changes over the last two decades will continue to be degraded.

Some Do's and Don'ts for St. Martin's Island:

Dos:

- Do observe and photograph birds and other wildlife
- Do walk along the shoreline and admire the views and sea life
- Do make use of locally run restaurants
- Follow the rules of ECA which are available now in brochures, signs and posters in the island and can be obtained from DoE.

Don'ts:

- No fishing in the designated sanctuary areas
- No hunting or disturbance of birds and wildlife
- No collection of wild plants
- No grazing except in designated areas
- No discharge of chemicals or pollution
- No loud noises or fires
- No littering—please take any waste packaging or materials that you bring back to the mainland when you leave
- No collection or purchase of corals(alive or dead),shells or sea urchins

6.1 Eco-system Diversity

A cross-section of the different habitats and eco-systems that makeup St. Martin's Island would show a transition from terrestrial to marine habitats. In addition to the dry land of the Island, the key habitats are shallow water marine habitats, including rocky and sandy inter-tidal habitats, offshore lagoons, rocky sub-tidal habitats, coral aggregations, sea grass beds, soft coral habitats and offshore soft-bottom habitats.



Underwater scene

6.1.1 Rocky Habitat

The whole terrestrial part of the Island was once a rocky habitat but this has gradually been altered through the removal of rocks and boulders for agriculture. Now much of the land is cultivated and of very limited ecological and bio-diversity interest. However, a small area of rocky land remains at Shil Bania, south of Dakhin Para Morong (lake), and west of the Coast Guard base. The majority of this area is covered with giant boulders similar to those of the inter-tidal zone, with some lowland pools. This rocky land is the last remaining habitat for reptile species that are rare on the Island such as garden lizards *Calotes* spp., Two banded Monitor *Varanus salvator*, Monocellate or Bengal cobra *Naja kaouthia*; birds of scrubby habitat; and native herbs, shrubs and climbers. The rocky ground and shallow pools provide an excellent terrestrial microhabitat, especially during winter. This 100 ha area is the last remaining rocky area on the Island and has not yet been cleared, probably as the boulders are large and difficult to remove. However, local people are actively removing these rocks to improve the land for cultivation.

6.1.2 Sand Dunes and Beach

The sand dunes on the Island were much better developed and higher during the 1980s. The dunes are in an increasingly degraded state, with those of the north western part of the Island at Kona Para and Golachera, now severely eroded. This degradation has also resulted in a loss of associated dune flora (the dominant species are *Pandanus fascicularis* (previously *P. odoratissimus*), *Ipomea pescaprae*, grasses *Panicum repens* and *Paspalum vaginatum*, and sedges *Cyperus* spp. and *Fimbristylis* spp.). The dunes and especially the beach are a vital part of the natural character of the Island. The continued health of the sand dunes and beach is very important for the protection of local people from predicted sea level rises (which are likely to have a major impact on the Island). The beach is the breeding habitat for globally threatened turtles, and a wintering habitat for shorebirds. The dunes act as a filter for

rainwater as it recharges the groundwater. They also prevent sand being blown inland by winds. Winter winds and tidal forces accelerate the erosion of dunes that have had vegetation removed. Natural regeneration is possible if current factors affecting the health of the dunes are controlled, including infrastructure development, the clearing of dunes and dune vegetation adjacent to hotel areas, the collection of dune vegetation for fuel wood and pedestrian traffic (Molony et al, 2006).



6.1.3 Lagoons and Wetlands

Several lagoons and wetlands associated with mangrove and floodplain areas occur on the Island, and once probably provided important habitats for birds. There are three lagoons on the Island. The lagoons on Uttar Para and Dakhin Para have now become muddy swamps with shallow water and are only connected to the sea at high tide through shallow creeks. But the 40 ha lagoon that lies between the southern end of Dakhin Para and the three small islands comprising Cheradia retains shallow water and is protected by widespread boulders and stone corals. The lagoons in the north are older in origin and show a longer sequence of evolution, while the lagoon in the south is much younger and is under active marine influence (Kabir, 2006). Since the 1960s the two northern lagoons have been gradually converted into paddy fields, and this process is still ongoing. This conversion has eliminated most of the original wildlife found in these lagoons. The areas of some smaller wetlands located in the southern part of the island have also been reduced.



Wetlands of the Southern Part of the Island

6.1.4 Mangrove Habitat

At one time the Island probably had a significant area of mangrove vegetation, but most of this has been degraded (Tomascik, 1997). In 1996, mangrove forests covered only 2.4 ha (6.1 acres) (MoEF, 2001a). The top canopy was dominated by *Lumnitzera racemosa*, but a total of 29 mangrove species were recorded of which nine were common. Since then, the mangrove forest has been cleared almost solely to assert land rights and to facilitate the recognition of land ownership. Currently there is only a very small remaining mangrove patch in Dakhin Para consisting mostly of *Sonneratia apetala* mixed with Sea Holly *Acanthus ilicifolius*, Grey Mangrove *Avicennia marina* and *Hibiscus tiliceous*. The potential for this residual mangrove patch to restore and regenerate is unclear (Molony, 2006), even though in principle it is protected having been identified as a core zone of the St. Martin's Island Environmentally Critical Area.



The Only Mangroves Left is This Small Patch in the South of the Island

6.1.5 Mudflats

Within the inter-tidal zone there is a small mudflat area (known as Gaitta Banya) located at the southern end of the western beach. The marine invertebrates found here make it an important foraging area for shorebirds. High levels of human activity in the preferred roosting areas for shorebirds in the north of the Island have made the mudflat area increasingly important for birds. The mudflat is also the only habitat on the Island for the Yellow-lipped Sea Krait or Colubrine Amphibious Sea Snake *Laticauda colubrina* and also supports mud crabs and a large population of fiddler crabs (Molony et al, 2006). While there are currently no factors adversely affecting this mudflat area, it faces the threat of alteration in the future, for example for hotel construction.



6.1.6 Other Inter-tidal Habitats

A generalized zonation of east coast benthic communities along an inshore-to-offshore gradient starting from the lower inter-tidal is shown in the following diagram (Figure 6.1).

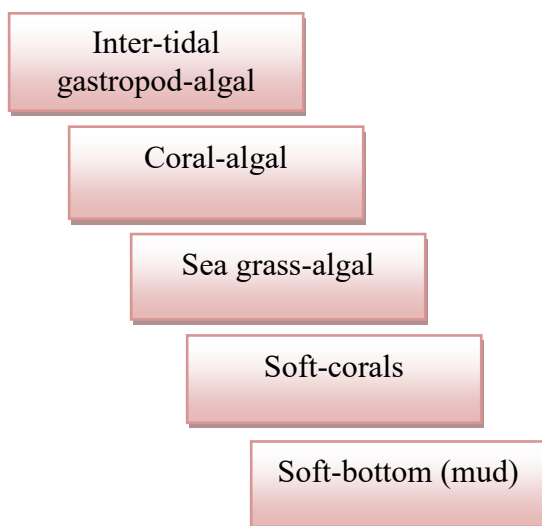


Figure 6.1: Generalized Zonation of East Coast Benthic Communities

The zonation of benthic communities on the west coast is shown in Figure 6.2.

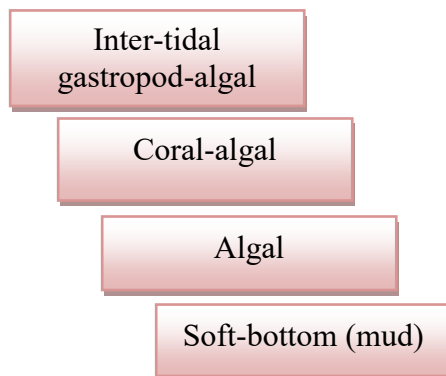


Figure 6.2: Generalized Zonation of West Coast Benthic Communities

With the exception of the north eastern corner, the Island's entire inter-tidal zone is fringed with numerous boulders that extend for anything from a few meters to a few hundred meters into the sub-tidal zone. These boulders, of all shapes and sizes, originate from the bedrock and provide a diverse microhabitat for numerous marine species sheltering from tidal influences. The upper portion of the rocky habitat is mostly dry during low tide and contains dead coral colonies. The lower inter-tidal area hosts a wide diversity of marine life, including corals, mollusks, echinoderms, barnacles, crabs, and algae. It also provides a huge number of rock pools of various sizes where small reef fish forage for the duration of the ebb tide. Inter-tidal zone rocky habitat covers 150-250 ha.

6.1.7 Marine Habitats

The rocky sub-tidal habitat from the seaward margin of the inter-tidal zone to about 1,000 m offshore supports a diverse coral community which can be classified as a veneering coral community. Out of the 15 reef-building scleractinian (stony or hard) coral families, 10 are present on the Island, represented by approximately 22 genera and 66 species. Of these, 39 species have been identified alive around the Island. In addition 14 species of soft coral have been recorded, growing in water up to a depth of 7 m. Sea grass meadows and algal flora associated with extensive coral reefs were discovered in 1997 by Tomascik (MoEF, 2001a). Thus, beyond the inter-tidal zone, the habitats, ecosystems and life forms that surround the Island are relatively poorly known. Other than observation of fish catches landed on St. Martin's Island there has been little study and little published on the areas one or more kilometers beyond the shore. It is possible that these areas could host marine life of high biodiversity significance, such as deeper water corals. Surveys of this marine zone are a research priority.



Dead Coral Colony, St. Martin's Island

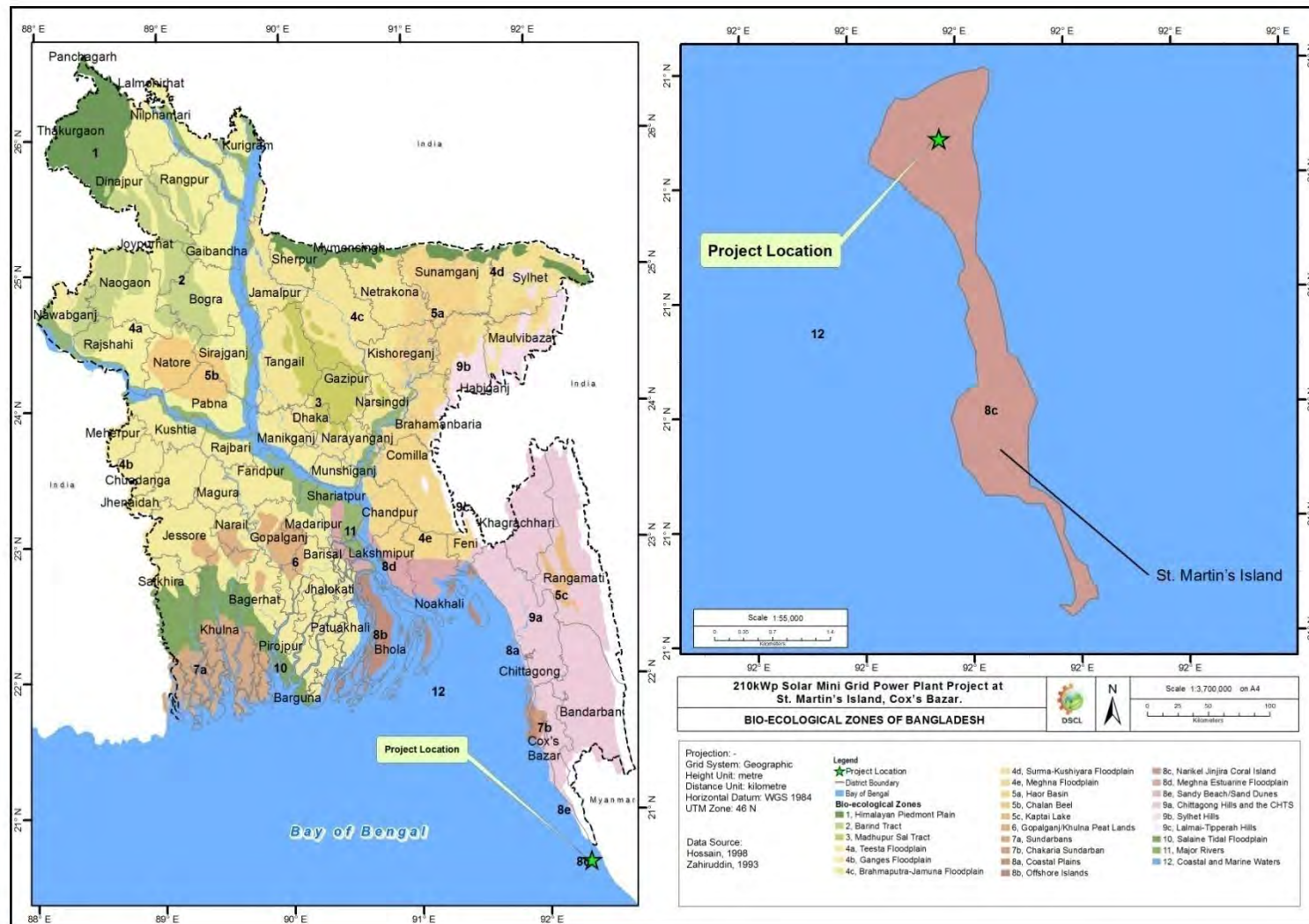


Figure 6.3: Bio-ecological Zones of Bangladesh

6.2 Flora

6.2.1 Terrestrial Vegetation

Since St. Martin's Island is by origin a sedimentary continental island, which was connected to the mainland of the Teknaf peninsula as recently as 6,000-7,000 years ago, the flora of the Island is similar to that of the mainland. However, it has been significantly changed due to human interventions since the island was first settled in the 1880s.

At that time the Island most probably was covered with evergreen forest reportedly with an abundance of teak trees (Tomascik, 1997). Following loss of the original forest, continuing intensive agriculture, and the recent increased number of tourists have further changed the vegetation and landforms of the island resulting in the loss of many of the flora and fauna species that once were abundant on the Island. St. Martin's Island still has quite diverse vegetation because the remaining native species have been supplemented by a considerable number of cultivated and introduced species. Recent floral surveys recorded 260 plant species including 150 herbs, 32 climbers, 25 shrubs and 53 trees, belonging to 58 families (Zaman, 2006). Aquatic vegetation has been less well studied, but recent surveys identified 151 species of benthic and drifted algae including a number of marine red algae (Aziz et al., 2008), and 18 species of bryophytes.

6.2.2 Trees

Among the naturally occurring trees, two species of *Pandanus* (locally called *keya*) and one species of *Streblus* dominate (Zaman, 2006). A number of trees such as coconut palms have been introduced and planted by the local inhabitants to obtain food, fibre, fuel, and construction materials for houses and boats. As noted earlier the small strips of mangroves on Dakhin Para at Cheradia and Gola Chipa hold a very small mangrove formation mostly of *Sonneratia apetala* and *Lumnitzera racemosa*.

6.2.3 Palm Trees

Coconut Palm *Cocos nucifera* (locally called *Narikel*) is abundantly cultivated on the Island and has given the Bangla name of St. Martin's – Narikel Jhinjira. Despite this name, the coconut palm is an exotic (nonnative) species which is planted by local people for fruits, fibre and fuel. During a survey conducted in 2006, researchers found more 15,000 coconut palms on the Island (Zaman, 2006). Three other species of Palmae occur on the island, namely: Areca Nut Palm *Areca catechu* (locally called *supari*), Asian Palmyra Palm *Borassus flabellifer* (locally called *taal*), and Silver Date Palm *Phoenix sylvestris* (locally called *khejur*). All were brought from the mainland and are cultivated by local people for various purposes, including use by local people as astringents, stimulants, and laxatives (Zaman, 2006).



Palm Tree Plantation

6.2.4 Moraceae

Streblus asper (locally called *shaora*) is considered to be the most abundant tree on the Island, and is known by several common English names, including Siamese Rough Bush, Khoi, and Toothbrush Tree. The leaves are 5-10 cm (2-4 inches) long, rigid, oval-shaped, irregularly toothed, and borne on small slender stems (petioles). The tree has a number of uses. It has been important in papermaking in some countries of South Asia for 700 years and is used by local people to treat fever and diarrhoea (Zaman, 2006).



6.2.5 Mangrove Species

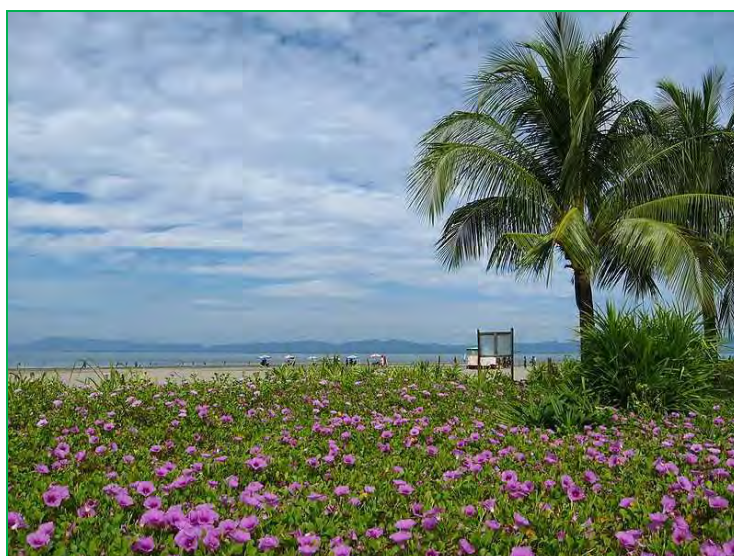
In the remnant patch of mangrove forest are found the following mangrove associated species: *Acanthus ilicifolius*, *Hibiscus tiliceous*, *Excoecaria agallocha*, *Avicennia marina* and *Clerodendrum inerme*. *Aegialitis rotundifolia*, an early coloniser, has disappeared from the Island (MoEF, 2001a). *Streblus asper* and *Vitex trifoliata* are also found among the crevices formed by rocks, adjacent to a swamp supporting the young mangrove formation.



6.2.6 Shrubs and Herbs

6.2.6.1 Shrubs

Areas of shrubs are dominated by the abundant *Vitex trifolia* (locally known as *nil nishinda*) and *Vitex negundo*, both belonging to the Amiaceae family, and by some species of Leguminosae. *Vitex trifolia* is a large coastal shrub reaching up to 5 m in height. The stems are covered by soft hairs (tomentose). The individual flowers have purple to violet two-lipped corollas that are approximately 5 mm long. The fleshy fruits are about 6 mm in diameter and contain four small black seeds. This plant occurs naturally along coastlines from tropical East Africa as far east as French Polynesia. The Five-leaved Chaste-Tree *Vitex negundo* is a large, aromatic shrub, the stems have a square cross-section and are covered in dense soft whitish hairs (quadrangular and tomentose). This plant has anti-inflammatory, antibacterial, antifungal and analgesic properties, and both plants are used by local people to treat rheumatic fever (Zaman, 2006). The rattan *Calamus guruba* (locally called *jali bet*) also occurs naturally on the Island.



Screw Pines

One of two dominant tree genera, Pandanaceae, is represented by two species, namely the screw pines *Pandanus fascicularis* (formerly *P. odoratissimus*) locally called *keya* and *Pandanus foetidus* (locally known as *keyawata*). Both species occur in mangrove forests but are now cultivated on the sand dunes along the shore line. Pandanus functions virtually as a fence around the Island, protecting inland areas from the elements of wind, water and sand. Pandanus is important for sand dune formation, maintaining dune structure and protecting the shoreline from wind and water erosion. Local people use both species for medicinal purposes, to treat asthma (*keyawata*) and skin disease (*keya*). Pandanus trees have been planted extensively along the coastline, particularly near homesteads as fences and windbreaks, but they are also collected or cut for fuelwood, and cleared for infrastructure development and dwellings. The mature fruits are collected to sell to tourists as curios, and are also dried for fuel wood, and the dried seeds are eaten by children. Pandanus are declining because of cutting, and the removal of the whole plant is a serious problem as its root system stabilises beach and dune sediments. As the plants propagate both vegetatively and via seed, the collection of fruits may not seriously affect the natural regeneration of the plants (Molony *et al.*, 2006).



Shrub of Screw Pine

6.2.6.2 Herbs

The main herb of note is the Beach Morning Glory or Goat's Foot *Ipomoea pes-caprae* (locally called *Shagor lota*). This is an abundant creeping vine belonging to the Convolvulaceae family. It grows on the upper parts of beaches and endures salt spray. This common salt tolerant plant has seeds that float and are unaffected by salt water, and can be found along sandy shores throughout the tropical Atlantic, Pacific and Indian Oceans.

Indigenous Onion

A small-bulbed variety of onion *Allium* sp. (Family Alliaceae) is indigenous to the Island and is cultivated nowhere else in Bangladesh. Its yield performance, relative cost and the non-availability of quality seed makes it susceptible to replacement by non-indigenous varieties. While the onion is already a reasonably popular purchase item among tourists, its promotion as indigenous would probably improve sales. The onion represents one aspect of the cultural heritage of the Island (Molony *et al.*, 2006). So far 154 species of marine algae have been identified, mainly from the Island's inter-tidal and littoral zone. Marine algae form an

important source of nutrients for the myriads of animal life in the sea which feed directly on them or prey on animals that eat algae. Besides the larger species of algae, microscopic organisms such as diatoms, occurring as thick plankton, are the chief source of food for many mollusks, crustaceans, tunicates, and fish (Chowdhury, 2006). The larger species, commonly known as seaweed, play an important role in protecting soil from erosion and in enhancing sedimentation by holding the organic and inorganic components of brackish water during the monsoon. Seaweed is thus very important for improving and protecting beach structure (Molony *et al*, 2006). While marine algae grow luxuriously *on* the undisturbed boulders, they are threatened by harvesting, the indiscriminate removal of boulders, the use of seine nets, and possibly shore pollution. Seaweed is harvested in large quantities by the local community for trading to Myanmar. It is normally collected from the beach between February and April and is traded in its dry form, measured by weight. In 2001, 20 boatloads of 2-3 metric tons each were traded (Islam, 2001).



A Wide Diversity of Marine Algae

6.3 Fauna

6.3.1 Echinoderms (Sea Stars, Sea Urchins, Sea Cucumbers)

A total of only nine species belonging to eight genera in four classes of the phylum Echinodermata have been identified to species level from the Island, these comprise four species of sea urchin, one species of sea star, three species of nudibranchs, and one species of sea cucumber. There are also a number of species of brittle stars present, but these are cryptic and no collection or attempt to identify the species present has been made (Tomascik, 2007).



Echinoderms are Found in the Island

6.3.2 Cnidaria (Jellyfishes, Corals, Sea Anemons)

The coral communities of the Island are highly significant as there are only a few examples worldwide where coral communities dominate rock reefs as they do at St. Martin's. The coral colonies are affected by many factors, both natural and anthropogenic. Only four species of sea urchins, namely *Echinotrix diadema*, *Echinotrix calamaris*, *Echinometra mathaei* and *Echinostrephus aciculatus*, are found in the rocky subtidal habitats of St. Martin's Island (Tomascik, 1997). Four species of colorful nudibranchs have been recorded in the shallow subtidal rocky reefs: *Joruna funebris*, *Glossodoris atromargina*, a *Chromodoris* sp. and an unidentified species (Tomascik, 1997). The sea cucumber *Holothuria atra* occurs in very low numbers due to over-exploitation (Islam, 2001). According to Tomascik (1997), the natural environmental conditions around the Island are marginal for the development and survival of coral communities, which places even more importance on the management of factors affecting coral that are within our control. Natural constraining factors include low salinity, high turbidity (affecting light availability), substrate disturbance as a result of heavy seas, high nutrient concentrations, the effects of water circulation and tides, cyclonic storms, the possible effect of earthquakes on the unstable (boulder) substrate of the site, and relative sea level changes (as a result of ongoing uplift) (Molony *et al*, 2006). Coral communities extend to about 200 m offshore of St. Martin's Island. Corals are found around most of the Island, but their abundance and cover is generally low. Based on limited quantitative data from quadrat surveys of the south-east around Cheradia, where corals are more abundant than in other areas, the density estimate of corals is 1.3 colonies/m. In this area, corals cover 7.6% of the rocky substrate. The diversity of the coral community on St. Martin's Island can be classified as low with low species dominance, meaning that no species dominates. So far 66 coral species of 22 genera have been recorded. The genera *Porites*, *Favites*, *Goniopora*, *Cyphastrea*, and *Goniastrea* are the most abundant. In terms of coral coverage, *Porites* is by far the most important genus. In relative terms, almost all other coral genera, perhaps with the exception of *Acropora*, can be viewed as rare (Tomascik, 1997). The soft coral community off the east coast of St. Martin's Island is a unique feature of the subtidal zone. Soft corals belong to the subclass Octocoralia, and are represented by three orders: Helioporacea, Alcyonacea, and Pennatulacea. The dominant families of soft corals around the Island are: gorgonian sea fans (Plexauridae, Acanthogorgiidae, Subergorgiidae and Malithaeidae); small sea fans (Anthothelidae); and sea whips (Ellisellidae). Many of the sea fans and sea whips have attached crynoids (Crynoidea), or feather stars, on them. The most abundant crynoids are *Cenometra bella* (which at St. Martin's is always attached to soft corals) and *Tropiometra afra* (which is also found attached to rocks). Tomascik (page 50, 1997) also reported that "Another important group of anthozoans (Anthozoa) in the lower inter-tidal and shallow subtidal are the zoanthids (Zoanthidae). The genus *Palythoa* dominates and covers many large boulders. Other anthozoans observed in the subtidal are *Nemanthus* sp. (Nemanthidae), *Telemactis* sp. (Isophellidae), and *Discosoma* spp. (Discomatidae)."

6.3.3 Mollusks

Marine mollusks are the most abundant large invertebrates found on the Island, however, they are declining due to unregulated harvesting. A total of 187 species of mollusks have

been recorded from the Island (MoEF, 2001b). Of these, 44 species are gastropods and the rest are bivalves. Numerically, the most abundant among the gastropod molluscs are Littorinidae (periwinkles), Neritidae (nerites), Trochidae (top shells), Cypraeidae (cowries), Muricidae (murex) and Conidae (cone shells). Tomascik, (1997) reported the presence of some economically important gastropods which at that time were abundant, e.g. *Conus striatus*, *Conus textile* and *Conus geographes*, and also two economically important gastropods that are heavily depleted worldwide - *Trochus niloticus* and *Turbo marmoratus*.

6.3.4 Crustaceans (Lobsters, Crabs, Shrimps)

Over 12 species of crab have been recorded from the Island, including commercially important crab species such as the mangrove crab *Scylla olivacea*, which is widely distributed in the Bay of Bengal (Islam, 2006). Some of the other crab species recorded are: Red Egg Crab *Atergatis integerrimus*, Moon Crab *Matuta lunaris*, Flower Moon Crab *Matuta planipes*, Crucifix Crab *Charybdis feriatus*, Flower Crab *Portunus pelagicus*, Three-spot Swimming Crab *Portunus sanguinolentus*, Giant Mud Crab *Scylla serrata*, Crenate Swimming Crab *Thalamita crenata*, Soldier Crab *Dotilla myctiroides*, Horned Ghost Crab *Ocypode ceratophthalma*, and Horseshoe Crab *Carcinoscorpius rotundicanda*. Crabs of the genus *Scylla* are strongly associated with mangrove areas throughout the Indian Ocean and form the basis of substantial fishery and aquaculture operations elsewhere, but not at St. Martin's Island.



Some of the Diverse Crabs that Wander the Beaches of the Island

In addition two species of fiddler crab are found around the Island:

- I. **Marsh or Mud Fiddler Crab *Uca pugnax***, this species prefers muddy habitats, and digs its burrow above the high-tide line, then creates a mud ledge to shade the entrance to its burrow. It is the smallest fiddler crab of the Bay of Bengal; its body is less than an inch (2.5 cm) wide.
- II. **Sand Fiddler Crab *Uca pugilator***, this is a fairly small species that prefers sandy habitats and does not generally survive in silty mud. Sand Fiddlers are lighter-coloured than the other species. Hermit crabs, which comprise of several species, can

be found on or just off the coasts of St. Martin's Island in bushy areas. Hermit crabs insert their abdomens into abandoned gastropod mollusc shells that they carry about with them to protect their soft bodies. The hermit crabs that live in the coastal waters and along the shores of St. Martin's Island belong to the family Paguridae. They are omnivorous and consume plant and animal detritus as well as live benthic organisms. They are most abundant along Golachipa, Cheradia and Uttar Para beaches where enormous numbers of gastropod shells are washed up. Local people report that hermit crabs are most often seen at nighttime under keya trees.

6.3.5 Horseshoe Crabs

Horseshoe crabs are benthic or bottom-dwelling organisms found in both estuarine and continental shelf habitats, often among seaweed beds across much of the world's oceans. Horseshoe crabs are not true crabs, and actually are closer in form to spiders and scorpions. They are one of the oldest classes of marine arthropods and have not changed much in the last 350 to 400 million years. They are often called a "living fossil" and are related to extinct water scorpions. Scientists believe that horseshoe crabs were among the dominant creatures some 300 million years ago. Adult horseshoe crabs feed primarily on marine worms and shellfish, including rector clams and soft-shelled clams. Horseshoe crabs play an important ecological role in the food web. Adults are an important component in the diet of juvenile turtles. The mass spawning of horseshoe crabs at high spring tides in North America produces vast quantities of eggs that provide a seasonal abundance of food for several fish and bird species. For example, in Delaware Bay in the USA millions of migratory shorebirds, particularly Red Knot, refuel on horseshoe crab eggs and are now in decline due to over harvesting of the crabs. Human use of the horseshoe crab began thousands of years ago and continues to the present day. Of all its uses, the horseshoe crab is most important to us in medicine, where it has helped us make great strides in eye research, in ensuring that our medicines are free of dangerous bacteria, in the development of wound healing bandages. Any drug produced by a pharmaceutical company must pass a test using a component obtained from the blue coloured blood of horseshoe crabs.

6.3.6 Fishes

A total of 234 species of fish have been identified from the waters around the Island, 89 of which are coral associated species, and only 16 of which are freshwater fish. Though coral reefs have not developed the coral community supports fish fauna characteristic of coral reef environments. The most abundant coral or reef-associated herbivores are the damsel fish (Pomacentridae), parrot fish (Scaridae) and surgeon fish (Acanthuridae). Important coral or reef associated predators found here are Serranidae (groupers), Lutjanidae (snappers) and Lethrinidae (emperors). Five species of butterfly fish (Chaetodontidae) have been recorded from the Island, as has one species of angel fish *Pomacanthus annularis* (Pomocanthidae). Croakers (Sciaenidae) are also present. Other notable species that have been landed from deeper water by fishing boats operating from the Island include the world's largest fish the Whale Shark *Rhincodon typus* a filterfeeder on plankton that is considered to be globally vulnerable to extinction, and Hammerhead Shark *Sphyrna* sp. with its bizarre shaped head.



Fish Diversity of the Island

6.3.7 Reptiles and Amphibians

A total of 27 reptile species from 11 families of 3 orders have been recorded from the Island; of them 11 species are locally threatened. All five species of marine turtle known to occur in Bangladesh have been reported in the area, and all five species are globally threatened. The turtles comprise: Olive Ridley Turtle *Lepidochelys olivacea* (endangered), Hawksbill Turtle *Eretmochelys imbricate* (critically endangered), Green Turtle *Chelonia mydas* (endangered), Loggerhead Turtle *Caretta caretta* (endangered) and Leatherback Turtle *Dermochelys coriacea* (critically endangered). Three species – the Olive Ridley, Hawksbill and Green Turtles – are known to nest on the Island. Nesting populations of marine turtles on the Island were high several decades ago but have declined significantly. Green Turtles were once the most common species to nest here, but this no longer seems the case; the local community and fishers report a decline in the number of nesting females of 70- 80% over the last 30 years (Rashid and Islam, 2005). Observations of natural hatchling emergence, which were once common, are now reduced to zero, with any hatching dependent on protection by NGOs. Islam (2001) recorded the emergence of 144 adult Olive Ridley Turtles and 21 Green Turtles between January 2000 and June 2001, of which those successful in nesting numbered 141 and three respectively. No Hawksbill Turtles were recorded during this period – the last recorded observation of a Hawksbill Turtle was in 1998 (M.Z. Islam, pers. comm., 11 July 2006). The main nesting beach for the Olive Ridley Turtle is Shil Banyar Gula at the western beach – 80-90% of the Olive Ridley nests recorded in 2000- 01 occurred on this 1,000 m beach stretch (Islam, 2001); while the main nesting beach for the Green Turtle is Badam Gonya, a small (100 m) stretch of sand at the southern end of the western beach. In addition to NGO initiatives, in 2007 the Department of Environment, through the Coastal and Wetland Biodiversity Management Project, recruited local people as environmental guards to protect

marine turtles. This has significantly increased turtle nestling and numbers of hatchlings, has improved public awareness, and generated some income for local people. However the long-term future of this initiative is uncertain. The continued protection of turtle breeding and foraging habitat on and around the Island, and other protective measures such as avoiding turtle catch by boats operating from or around the Island, are important for the conservation of the species both locally and globally.



Nesting Marine Turtles – One the Main Biodiversity Treasures of the Island

The beach and sand dune nesting habitat of marine turtles at the site is increasingly degraded. The main problem is the construction of a coastal embankment by the piling of loose boulders along a considerable length of the east and west coasts. Degradation of sand dunes and development and increased human activity along the shoreline is also affecting nesting habitat. The construction of boulder embankments has severely reduced access to nesting sites above the high tide mark and has led to turtles either being unable to nest, or nesting within the tidal area where the eggs are washed out by the tide. Prior to construction of the embankment, nesting was widespread throughout the west of the Island (Islam, 2001); now the turtles either turn back or start digging their nests then find boulders hidden beneath the sandy surface and reattempt to nest elsewhere. The maintenance of rock free areas is required for the continued nesting of marine turtles at the site. Sand dune degradation due to both natural and man made causes needs to be arrested in order to maintain this important nesting habitat. Human movement in nesting areas also needs to be controlled (Molony *et al*, 2006). Other reptiles include, among others, Two-banded Monitor *Varanus salvator*, six species of terrestrial and freshwater snakes (including Monocellate Cobra *Naja kaouthia*, and Dog-faced Water Snake *Cerberus rynchops*), four species of sea snakes, several lizards and four species of freshwater turtle. Information on the sea snakes of St. Martin's Island is scanty, so far the following species have been reported: Narrow-headed or Slender Sea Snake *Microcephalophis gracilis*, Black-banded or Blue-lipped Sea Krait *Laticauda laticaudata*,

Yellow-lipped Sea Krait *Laticauda colubrine*, and Hook-nosed Sea Snake *Enhydrina schistosa*. The Island supports four amphibian species: the Common Asian Toad *Bufo melanostictus*, and three frog species – Skipper Frog *Euphlyctis cyanophlyctis* (formerly *Rana cyanophylctis*), Indian Bull Frog *Hoplobatrachus tigerinus* (formerly *Rana tigerina*) and Spotted Tree Frog *Polypedates maculatus* (formerly *Rhacophorus maculatus*).

6.3.8 Olive Ridley Turtle

The Olive Ridley is one the two smallest sea turtle species in the world, weighing up to 100 pounds (45 kilograms) and reaching only about 2 feet (65 centimetres) in shell length. These turtles are solitary, preferring the open ocean. They migrate hundreds or even thousands of miles (kilometres) every year, and come together as a group only once a year for the “arribada”, when females return to the beaches where they hatched and lumber onshore to nest. During nesting, they use the wind and the tide to help them reach the beach. Females lay about 100 eggs in one nest, but may nest up to three times a year. The Olive Ridley is mostly carnivorous, feeding on such creatures as jellyfish, snails, crabs, and shrimp. They will occasionally eat algae and seaweed as well. Though the Olive Ridley is widely considered the most abundant of the marine turtles, by all estimates, it is in trouble. Rough estimates put the worldwide population of nesting females at about 800,000, but its numbers have declined precipitously. Many governments have passed legislation to protect Olive Ridleys, but still eggs are taken and nesting females are slaughtered for their meat and shells. Fishing nets also take a large toll, frequently snagging and drowning these turtles despite pressure for use of turtle exclusion devices on trawl nets (National Geographic).

6.3.9 Birds

St. Martin's Island lies on the boundary or overlap zone of the East Asia-Australasian Flyway and the Central Asian Flyway and provides a stepping stone for a number of migratory wader or shorebird species. A total of 85 species of birds have been confirmed from the Island (35 resident species and 50 migratory species) (Annex 6). Although 107 species were claimed during a survey in 2000-01 (Islam, 2001). The mid-winter surveys conducted as part of the Asian Waterbird Census in 2008 and 2009 and other recent visits have recorded 43 waterbird species, of these Swift or Greater Crested Tern *Sterna bergii* and Lesser Crested Tern *Sterna bengalensis* are scarce in Bangladesh, and Pacific Reef Heron *Egretta sacra* is a rare vagrant, but the other species occur in other coastal areas of Bangladesh. Species recorded include, for example: Ruddy Shelduck *Tadorna ferruginea*, Whimbrel *Numenius phaeopus*, Eurasian Curlew *Numenius arquata*, Common Sandpiper *Actitis hypoleucos*, Pacific Golden Plover *Pluvialis fulva*, Kentish Plover *Charadrius alexandrinus*, Lesser Sand Plover *Charadrius mongolus*, Brownheaded Gull *Larus brunnicephalus*, Great Egret *Casmerodius albus*, Little Egret *Egretta garzetta*, Yellowbilled or Intermediate Egret *Egretta intermedia*, and Indian Pond Heron *Ardeola grayii*. A survey in 2000-01 (Islam, 2001) recorded the near threatened (BirdLife International, 2008) Black-bellied Tern *Sterna acuticauda*. Shore bird surveys conducted over the eight years 1997-2004 for two to three days in each winter revealed a decline in both bird species diversity and abundance (M.Z. Islam, pers. comm., 5 August 2006). A count of 3,062 individuals in 1997 declined dramatically to only 356 individuals in 2004, a decrease of 88%. The mean number of species recorded for the period was 19.6, with

a minimum of 17 and a maximum of 23, of which only one species showed an increase in abundance over the period and all others showed a decrease in abundance. The decline in wintering waterbirds including shorebirds can be attributed to the loss of wilderness and expansion of agriculture and human habitation. Also the main season for wintering birds coincides with the peak tourist season on the Island, during which time large areas of preferred shoreline habitat are inundated with tourists (Molony *et al.*, 2006). On the other hand, the populations of some terrestrial birds associated with human habitation have increased, including: Feral/Rock Pigeon *Columba livia* and Black Drongo *Dicrurus macrocercus* and it is likely that other species commonly found in towns and buildings may invade the Island as the human population and visitor numbers increase.



Birds are Found in the Island

6.3.10 Mammals

A total of 19 species of mammals were reported from the Island during a survey in 1995-1996, of which none of the land-based mammals are carnivorous. However, four of the marine mammals reported there have not been confirmed in Bangladesh waters (Ahmad *et al.*, 2009) and so are treated as unconfirmed here (Blue Whale *Balaenoptera musculus*, Humpback Whale *Megaptera novaeangliae*, Common Dolphin *Delphinus delphis*, and Melon-headed Dolphin *Peponocephala electra*). Four marine mammals from the area surrounding the Island are listed in the 2006 IUCN Red Data Book of Threatened Species. The waters around St. Martin's Island are considered likely to be visited by six species of marine mammals or cetaceans: Indo- Pacific Humpbacked Dolphin *Sousa chinensis* (listed as Data Deficient by IUCN), Indian Ocean Finless Porpoise *Neophocaena phocaenoides*, Irrawaddy Dolphin *Orcaella brevirostris*, Indo-Pacific Bottlenose Dolphin *Tursiops aduncus*, Pantropical Spotted Dolphin *Stenella attenuate* and Spinner Dolphin *Stenella longirostris*. Smith *et al.* (2008) observed Indo- Pacific Bottlenose Dolphin (listed as Data Deficient by IUCN) and Pantropical Spotted Dolphin; while Molony *et al.* (2006) reported Irrawaddy Dolphin (listed as Data Deficient by IUCN, but as critically endangered within Bangladesh), Indian Ocean Finless Porpoise (listed as Data Deficient by IUCN), and Spinner Dolphin. However, the diversity and abundance of cetacean species is still unclear. All the marine mammal species found around St. Martin's Island are under severe anthropogenic pressure. Some species are affected by loss of habitats. For example, the distribution of the Pantropical Spotted Dolphin is reported to be closely correlated with mangrove ecosystems, therefore, after the clearing the mangrove forests in St. Martin's Island, the probability of appearance of

Pantropical Spotted Dolphin is low. However, the major factor affecting cetaceans here is the intensity and type of fishing activity in cetacean habitat. Fishing by-catch is the major problem for small cetacean species, particularly from the use of gill nets, set bag nets, seine nets, trawl nets and long lines. The widely-used low-cost drifting gill net used for commercial fishing is responsible for a high proportion of cetacean by-catch and may be the single greatest threat to cetaceans worldwide. The small cetaceans generally are not strong enough to break free from the nets which prevent them from coming to the surface for air, and so they drown. Despite having a special sympathy for cetaceans, the fishers of St. Martin's Island admit that it is impossible to avoid cetacean bycatch when using strong filament nets to catch their target species. Cetacean mortality as a result of by-catch and entanglement apparently occurs in Bangladesh on a scale unheard of in the scientific community (Molony et al, 2006).



Bottlenose Dolphins are Found in the Island

6.4 Some Species of Conservation Significance

All the native species of flora and fauna of St. Martin's Island are under significant anthropogenic impact. Thus all the species of marine algae are treated as nationally threatened species. Similarly the echinoderms, cnidaria, mollusks and crustaceans have become of national conservation concern due to overexploitation. All of the marine turtle species occurring on and around the Island are globally threatened with extinction. Although the Island does not host significant numbers of threatened bird species, the numbers of wintering migrant water birds have declined considerably, and this is thought to be a direct result of increasing human use of the shoreline.

6.4.1 Olive Ridley Turtle *Lepidochelys olivacea* (Endangered)

This is one of the smallest sea turtles with a dark olive-green shell with a high dome, and is widely distributed in tropical seas. It usually grows up to 100 lbs (50 kg) and 30 inches (0.8 m) long, and is an omnivore feeding on crabs, shrimps, sea grasses algae, fish, and molluscs. It has declined mainly due to being caught and drowned in trawl nets. This species still commonly nests around the Bay of Bengal including small numbers on the Island.

6.4.2 Hawksbill Turtle *Eretmochelys imbricate* (Critically Endangered)

This sea turtle with a sharp curved beak and a serrated edge to its shell is widely distributed in tropical seas. It reportedly grows up to 3.3 feet (1 m) long and a weight of around 176 lbs (80 kg), and is usually found in shallow waters near corals where it feeds on invertebrates especially sea sponges which are toxic to other animals. Its population has declined because it has been caught for its shell which is the main source of tortoise shell, and its nesting beaches are disturbed. This species used to nest on the Island but was last seen here in 1998.

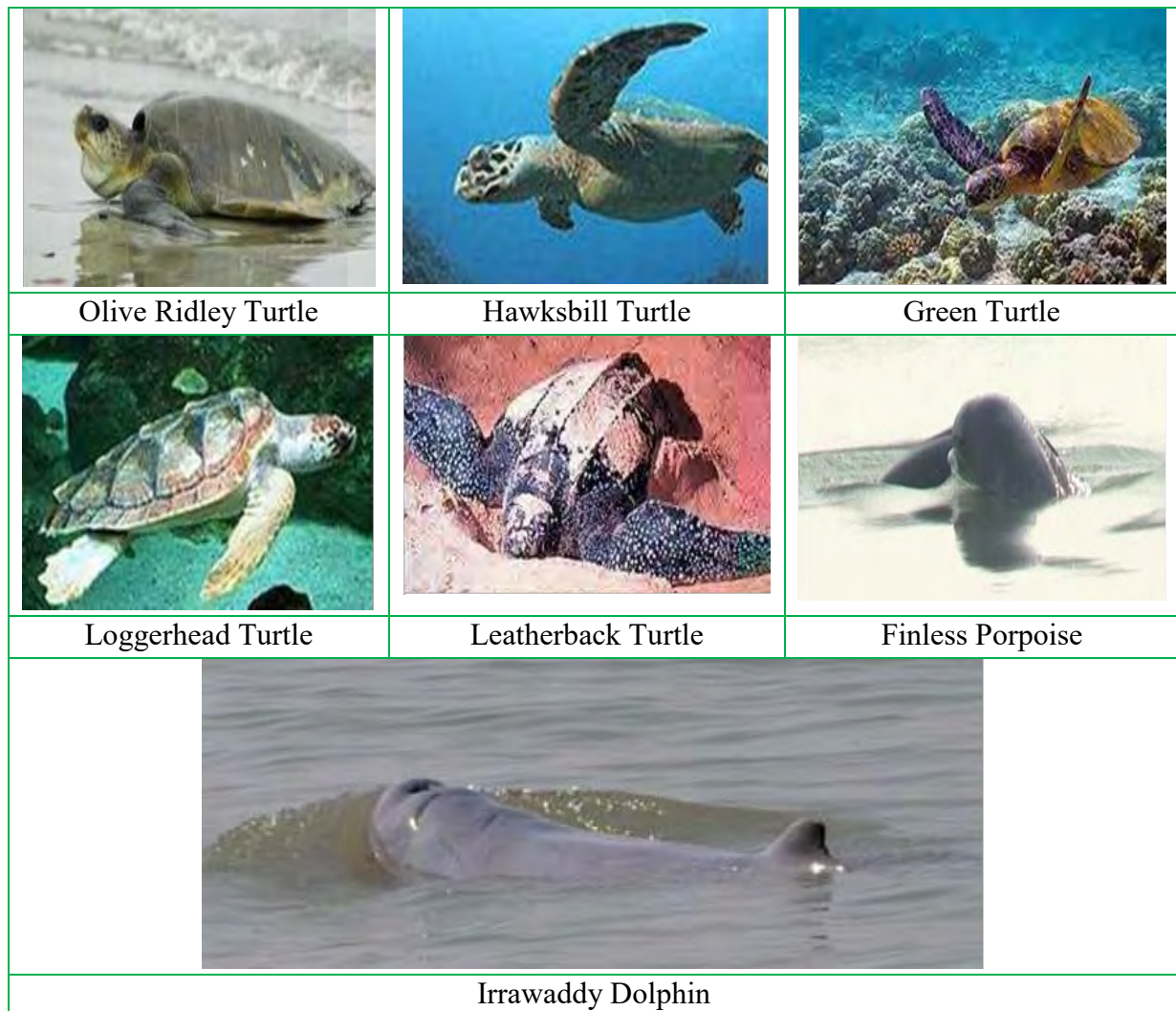


Figure 6.4: Species of Conservation Significance in the Island

6.4.3 Green Turtle *Chelonia mydas* (Endangered)

This sea turtle with an olive-brown to black shell and without a hook on its beak is widely distributed in tropical and temperate seas. It reportedly grows up to 700 lbs (315 kg) and 5 feet (1.5 m) long, and is a herbivore feeding only on sea grasses and seaweeds. It was once intensively hunted for its meat for making turtle soup and also suffers loss in fishing nets. This species still nests in small numbers on the Island.

6.4.4 Loggerhead Turtle *Caretta caretta* (Endangered)

This sea turtle with a reddish brown shell and a large head is widely distributed in tropical and temperate seas. It reportedly grows up to 800 lbs (364 kg) and 3.5 feet (1.1 m) long, and feeds on molluscs, crustaceans, fish, jellyfish, crabs, and shrimps. It was once intensively hunted for its meat and eggs, but this species is also killed for its shells, which are used to make items such as combs. As a result, both subspecies are now internationally protected.

6.4.5 Leatherback Turtle *Dermochelys coriacea* (Critically Endangered)

This is the largest sea turtle in the world and instead of a scaly shell its back is covered in thick leathery grey to black skin with long ridges running down its back. It is widely distributed in most of the world's oceans, although it nests in the tropics, and is better able to cope with cold than other turtles, having been recorded diving to 1,200 m depth. It normally grows to 2 m long and 250-700 kg in weight, although the largest recorded was 3 m long and over 900 kg. It specialises in eating jellyfish. It has declined mainly from harvesting of its eggs and by being caught and drowned in the nets of ocean going fishing vessels.

6.4.6 Irrawaddy Dolphin *Orcaella brevirostris* (Vulnerable)

This dolphin has a rounded head without a beak, and is grey with a paler belly, and has a small dorsal fin. It grows to just over 2 m long and about 115-130 kg in weight. It usually lives in small groups of up to six animals and eats fish, crustaceans and squid. It lives mostly in shallow, brackish and fresh turbid waters at the mouths of rivers in south-eastern Asia and Australasia. This includes the coast of Bangladesh where recent studies have found an important population. Unfortunately this mammal is sometimes caught and drowned or killed in fishing nets in Bangladesh waters.

6.4.7 Finless Porpoise *Neophocaena phocaenoides* (Vulnerable)

This small grey cetacean has a rounded head with no beak, and has no dorsal fin just a thin ridge down its back. It normally grows to 1.7 m long and a weight of 70 kg. It lives in coastal waters, including fresh water, around the Indian and Pacific Oceans from the Persian Gulf to Japan.

6.5 Bird Migration

It is quite a lengthy journey for human visitors to St. Martin's Island, not only involving a boat from Teknaf, but also a long road journey from the cities of Bangladesh or abroad. But many of the birds you can see here have flown much further – thousands of kilometers across continents, forests, deserts and mountains to be here. To rest and refuel on the way, these birds use the wetlands in different countries. Water birds concentrate in flocks in a few sites in winter and are especially at risk from hunting and disturbance on the Island. They depend on our remaining wetlands, such as St Martin's Island, just as much as the lands they visit in the breeding season. We have a global responsibility to protect migratory birds and the wetlands they depend on.



Whimbrel *Numenius phaeopus*
(40-46 cm) This long-legged shorebird with a down-curved bill breeds in the northern marshes that extend across Europe, Siberia and Canada. Some of the birds that breed in Siberia spend the winter on the Island.



Ruddy Turnstone
Arenaria interpres
(23 cm) This small shorebird with a short bill and bright harlequin plumage of black, white and chestnut breeds in the tundra north of the Arctic Circle. It gets its name from its habit of turning over stones and flotsam along the shoreline in search of small invertebrates.



Brown-headed Gull
Larus brunnicephalus
(42 cm) This gull spends the winter in wetlands of northern India and Bangladesh. They fly across the high peaks of the Himalayas to reach their breeding grounds around lakes in Tibet and Mongolia.



Barn Swallow
Hirundo rustica
This small (18 cm) bird breeds throughout the northern hemisphere. Our birds breed in China and southern Siberia, and catch insects in flight while migrating during the daytime.

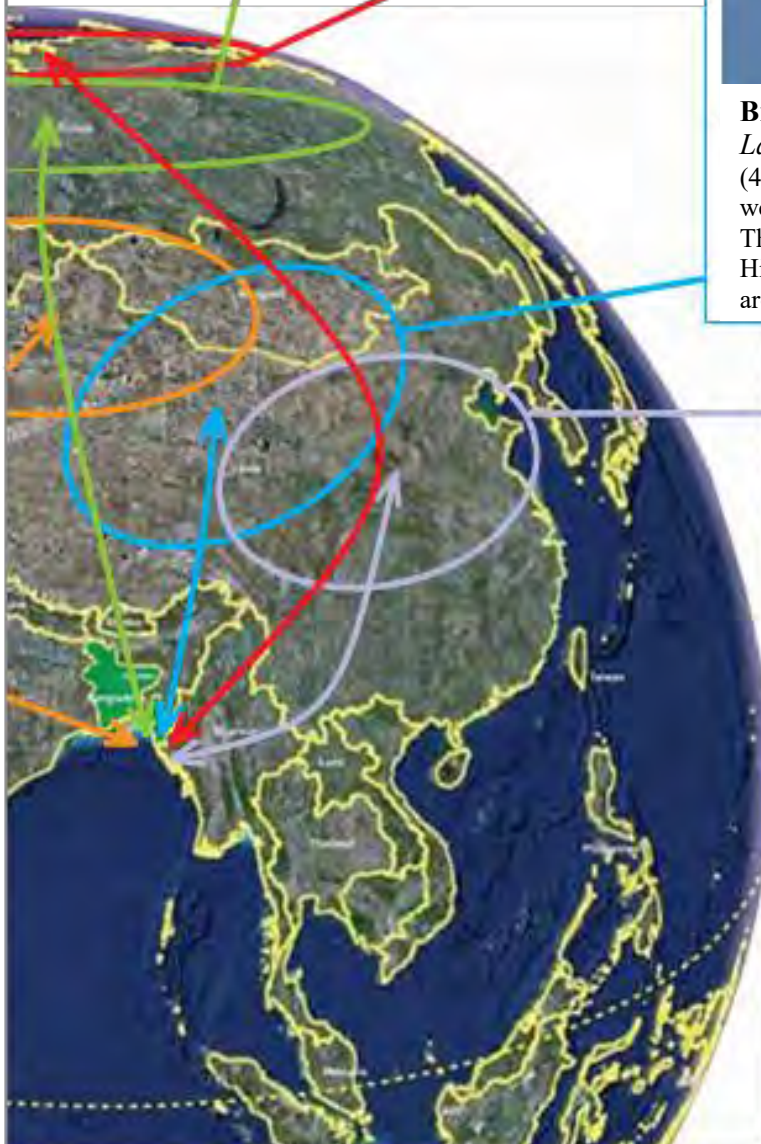


Table 6.1: List of Plants in the Project Area

Sl. No.	SpeciesName	LocalName(s)	FamilyName
1	<i>Abelmoschusmoschatus</i>	Kalokasturi	Malvaceae
2	<i>Abrusprecatorius</i>	Kunch	Leguminosae
3	<i>Acaciatarnesiana</i>	Bilatibabul	Leguminosae
4	<i>Achyranthesaspera</i>	Apang	Amaranthaceae
5	<i>Adenosmaindianum</i>	Borokesuti	Scrophulariaceae
6	<i>Aegicerascorniculatum</i>	Halse	Myrsinaceae
7	<i>Ageratumconyzoides</i>	Fulkuri	Compositae
8	<i>Altemantheraparonychiodes</i>		Amaranthaceae
9	<i>Altemanthera sessilis</i>	Chanchi	Amaranthaceae
10	<i>Alysicarpusvaginalis</i>	Pannata	Papilionaceae
11	<i>Amaranthusgangeticus</i>		Amaranthaceae
12	<i>Amaranthus spinosus</i>	Kantanotey	Amaranthaceae
13	<i>Amaranthus viridis</i>	Noteyshk	Amaranthaceae
14	<i>Amisophcellus axillaris</i>		Commelinaceae
15	<i>Ammaniabaccifera</i>	Dadmari	Lythraceae
16	<i>Anisomelesindica</i>	Gobura	Ladiatae
17	<i>Atylosiascarabaeoides</i>	Banukalai	Leguminosae
18	<i>Bacopamonniara</i>	Brahmishak	Scrophulariaceae
19	<i>Bergiaammannioides</i>		Elatinaceae
20	<i>Bergia capensis</i>	lalkesuria	Elatinaceae
21	<i>Blumeaaurita</i>		Compositae
22	<i>Blumealaciniata</i>		Compositae
23	<i>Boetraaviarepens</i>	Punarnava	Nyctaginaceae
24	<i>Brachiariadistachya</i>		Gramineae
25	<i>Caesalpiniaacrista</i>	Letkanta	Caesalpinoideas
26	<i>Calotropisgigantea</i>		Asclepiadaceae
27	<i>Calycopterisfloribunda</i>	Akanda	Asclepiadaceae
28	<i>Cannaindica</i>	Goachelata	Combretaceae
29	<i>Canscoradiffusa</i>	kalabati	Cannaceae
30	<i>Carissacarandas</i>	kanrancha	Gentianaceae
31	<i>Cassiaoccidentalis</i>	Borokalkesunda	Laguminosae
32	<i>Cassiatora</i>	Toraj	Laguminosae
33	<i>Cassytha filiformis</i>	Akashbel	Cassythaceae
34	<i>Cassiaoccidentalis</i>	Borokalkesunda	Laguminosae
35	<i>Cyperuscompressus</i>	chancha	Cyperaceae
36	<i>Cyperus iria</i>	Barachancha	Cyperaceae
37	<i>Cyperuskyllinga</i>	Nirbishi	Cyperaceae
38	<i>Cyperus sp.</i>		Cyperaceae
39	<i>Cyperus substramineus</i>		Cyperaceae
40	<i>Cyperus tenuispica</i>		Cyperaceae
41	<i>Cyrtococcum accrescens</i>		Gramineae
42	<i>Dactyloctenium aegyptiacum</i>	Makra	Gramineae
43	<i>Daturametel</i>	Duttara	Solanaceae
44	<i>Dentellarepens</i>	Bhuopat	Rubiaceae
45	<i>Derris sp.</i>		Leguminosae
46	<i>Desmodium triflorum</i>	Kulaliya	Leguminosae
47	<i>Desmodium umbellatum</i>		Leguminosae
48	<i>Digitaria longiflora</i>		Gramineae
49	<i>Dimeria ornithopoda</i>		Gramineae
50	<i>Echinochloa colonum</i>	Shymaghas	Gramineae

Sl. No.	SpeciesName	LocalName(s)	FamilyName
51	<i>Echinochloa colonum</i>	Kalokeshi	Compositae
52	<i>Eleocharis congesta</i>	Barokeruti	Cyperaceae
53	<i>Eleusine indica</i>	Malangakuri	Gramineae
54	<i>Eragrostis coarctata</i>		Gramineae
55	<i>Eragrostis pooides</i>		Gramineae
56	<i>Eragrostis tenella</i>	koni	Gramineae
57	<i>Eriocaulon luzulaefolium</i>		Eriocaulaceae
58	<i>Eriocaulon</i> sp.		Eriocaulaceae
59	<i>Eriochloa procera</i>	Nalghas	Gramineae
60	<i>Euphorbia hirta</i>	Ghaspata	Euphorbiaceae
61	<i>Euphorbia thymifolia</i>	Dudhia	Euphorbiaceae
62	<i>Ficus</i> sp.		Moraceae
63	<i>Fimbristylis acuminata</i>		Cyperaceae
64	<i>Fimbristylis miliacea</i>	Barajabani	Cyperaceae
65	<i>Flagellaria indica</i>	Banschand	Flagellariaceae
66	<i>Glycin max</i>	Soabean	Leguminosae
67	<i>Grangea herbaceum</i>	Karpas	Malvaceae
68	<i>Grangea madaraspata</i>	Nagphul	Compositae
69	<i>Grewia</i> sp.		Tiliaceae
70	<i>Hedyotis corymbosa</i>	Khetpapra	Rubiaceae
71	<i>Hilotropium indicum</i>	Hatishur	Boraginaceae
72	<i>Hibiscus tiliaceus</i>	Bola	Malvaceae
73	<i>Hydrocotyles ibthorpioides</i>		Umbrelliferae
74	<i>Hygrophila phlomisoides</i>		Acanthaceae
75	<i>Hygrophila polysperma</i>		Acanthaceae
76	<i>Hygrophila quadrivalvis</i>		Acanthaceae
77	<i>Hyptis suaveolens</i>		Labiatae
78	<i>Ichnocarpus frutescens</i>		Apocynaceae
79	<i>Ipomoea mexicana</i>	Dudlata	Convolvulaceae
80	<i>Ipomoea pes-caprae</i>		Convolvulaceae
81	<i>Ischamun indicum</i>		Gramineae
82	<i>Jatropha curcas</i>		Euphorbiaceae
83	<i>Justicia gendarussa</i>		Acanthaceae
84	<i>Lantana camara</i>		Verbenaceae
85	<i>Launaea pinnaefida</i>		Compositae
86	<i>Leucas zeylanica</i>		Labiatae
87	<i>Limnophila repens</i>	Dondokalas	Scrophulariaceae
88	<i>Lindernia antipoda</i>		Scrophulariaceae
89	<i>Lindernia rotundifolia</i>		Scrophulariaceae
90	<i>Lindernia</i> sp.		Scrophulariaceae
91	<i>Linum usitatissimum</i>		Linaceae
92	<i>Ludwigia hyssopifolia</i>		Onagraceae
93	<i>Luffa cylindrica</i>		Cucurbitaceae
94	<i>Lumnitzera racemosa</i>		Combretaceae
95	<i>Merremia umbellata</i>		Convolvulaceae
96	<i>Murdannia nudiflora</i>		Commelinaceae
97	<i>Najas graminea</i>		Najadaceae
98	<i>Operculina turpethum</i>		Convolvulaceae
99	<i>Oroxylum indicum</i>		Bignoniaceae
100	<i>Pandanus foetidus</i>		Pandanaceae
101	<i>Pandanus odoratissimus</i>		Pandanaceae
102	<i>Paspalum vaginatum</i>		Gramineae

Sl. No.	SpeciesName	LocalName(s)	FamilyName
103	<i>Phaulopsisdorsiflorus</i>		<i>Acanthaceae</i>
104	<i>Phragmiteskarka</i>		<i>Gramineae</i>
105	<i>Phylanodiiflora</i>		<i>Verbebnaceae</i>
106	<i>Phyllanthusdistichus</i>		<i>Euphorbiaceae</i>
107	<i>Phyllanthusreticulatus</i>		<i>Euphorbiaceae</i>
108	<i>Physalisminima</i>		<i>Solanaceae</i>
109	<i>Pongamiapinnata</i>		<i>Leguminosae</i>
110	<i>Portulacaoleracea</i>		<i>Portulacaceae</i>
111	<i>Pouzolziaindica</i>		<i>Urticaceae</i>
112	<i>Psophocarpustetragonolobus</i>		<i>Leguminosae</i>
113	<i>Ricinuscommunis</i>		<i>Euphorbiaceae</i>
114	<i>Rotalabeccifera</i>		<i>Lythraceae</i>
115	<i>Rotalaindica</i>		<i>Lythraceae</i>
116	<i>Rungiapectinata</i>		<i>Acanthaceae</i>
117	<i>Saccharumarundinaceum</i>		<i>Gramineae</i>
118	<i>Scirpuserectus</i>		<i>Cyperaceae</i>
119	<i>Scirpussupinus</i>		<i>Cyperaceae</i>
120	<i>Scirpustriquetar</i>		<i>Cyperaceae</i>
121	<i>Scopariadulcis</i>		<i>Scrophulariaceae</i>
122	<i>Sesuviumprotulacastrum</i>		<i>Aizoaceae</i>
123	<i>Sideacuta</i>		<i>Malvaceae</i>
124	<i>Sidacordifolia</i>		<i>Malvaceae</i>
125	<i>Sidacordata</i>		<i>Malvaceae</i>
126	<i>Solanumtorvum</i>		<i>Solanaceae</i>
127	<i>Sporobolustremulus</i>		<i>Gramineae</i>
128	<i>Stictocardiatiliaefolia</i>		<i>Convolvulaceae</i>
129	<i>Streblusasper</i>		<i>Urticaceae</i>
130	<i>Tephrosiapurpurea</i>		<i>Leguminosae</i>
131	<i>Tetragymmaabactolatum</i>	Bonnil	<i>Vitaceae</i>
132	<i>Thespesiapopulnea</i>		<i>Malvaceae</i>
133	<i>Tinosporacordifolia</i>		<i>Menispermaceae</i>
134	<i>Triumfettaabacteata</i>		<i>Tiliaceae</i>
135	<i>Urenalobata</i>		<i>Malvaceae</i>
136	<i>Vernoniaapatula</i>	Kuksin	<i>Compositae</i>
137	<i>Vitexnegundo</i>		<i>Verbenaceae</i>
138	<i>Vitextrifolia</i>		<i>Verbenaceae</i>
139	<i>Vitexnegundo</i>	Nishinda	<i>Vitaceae</i>
140	<i>Wahlenbergia gracilis</i>		<i>Companulaceae</i>
141	<i>Wahlenbergiamarginata</i>		<i>Companulaceae</i>
142	<i>Woodfordiafruticosa</i>		<i>Lythraceae</i>
143	<i>Xanthiumindicum</i>	Dhaiphul	<i>Compositae</i>
144	<i>Zizphusmauitiana</i>	Kulaiya	<i>Rhamnaceae</i>

6.6 Protected Areas and Red Book Species

Many wildlife species are in stress in Bangladesh, many more are endangered/ threatened and a large number already faced extinction. The status of faunal species in Bangladesh has been published by IUCN (2000). According to the IUCN findings this country has lost 10% of its mammalian fauna, 3% avifauna and 4% reptiles over the last 100 years. More than 50 species are presently critically endangered in Bangladesh of which 23 species are already declared as

endangered in the Red Data Book of IUCN. In addition, 83 species are commercially threatened and are included in the appendices of Convention on International Trade in Endangered Species (CITES).

All the native species of flora and fauna of St. Martin's Island are under significant anthropogenic impact. Thus all the species of marine algae are treated as nationally threatened species. Similarly the echinoderms, cnidaria, molluscs and crustaceans have become of national conservation concern due to overexploitation.

All of the marine turtle species occurring on and around the Island are globally threatened with extinction.

Although the Island does not host significant numbers of threatened bird species, the numbers of wintering migrant water birds have declined considerably, and this is thought to be a direct result of increasing human use of the shoreline.

The species of conservation significance of the island are Olive Ridley Turtle *Lepidochelys olivacea* (Endangered), Hawksbill Turtle *Eretmochelys imbricata* (Critically Endangered), Green Turtle *Chelonia mydas* (Endangered), Loggerhead Turtle *Caretta caretta* (Endangered), Leatherback Turtle *Dermochelys coriacea* (Critically endangered), Irrawaddy Dolphin *Orcaella brevirostris* (Vulnerable), Finless Porpoise *Neophocaena phocaenoides* (Vulnerable) etc.

St. Martin itself is an environmentally protected area. But the project activity may not be anticipated directly. Other potential factor like tourism may increase, it can destroy St. Martin ecosystem. But proper implementation of laws, regulation & guideline, proposed management plan can reduce the anticipated impact. Figure 5.5 shows that no environmental sensitive area is present around the project region.

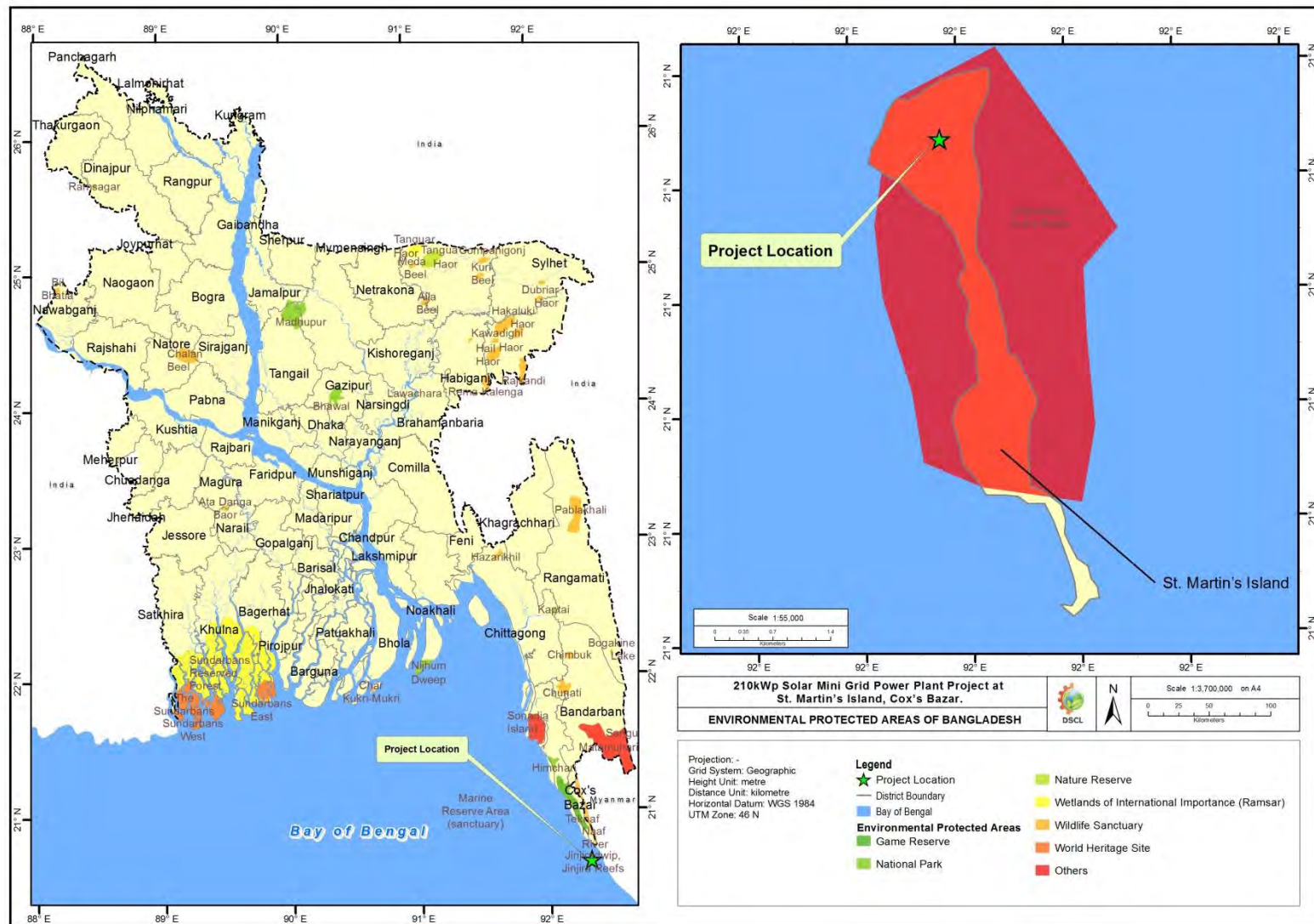


Figure 6.5: Environmental Protected Areas of Bangladesh

7 DESCRIPTION OF THE SOCIOECONOMIC CONDITIONS

It is essential for every development project, whether small or large, to understand the social, human and economic aspects of the primary stakeholders, i.e., people living in and around the project site. The following tools and techniques were used to collect the relevant data/information on the social and economic aspects of affected people:

- Literature review and
- Focus Group Discussion (FGD);

In addition, data obtained from secondary sources were compared with the primary data/information gathered during the study. Data on population, age/sex composition, household patterns, and sources of drinking water, sanitation facility, and ownership of agricultural land were enumerated from the latest community series census published by the Bangladesh Bureau of Statistics (BBS).

There are currently 1,200 households and approximately 8,000 people living on St. Martin's Island according to data obtained from the Union Parishad office. The voter registry showed that there were 1,342 males and 1,379 females registered. Households are found in clusters and are scattered in the North and South of the Island.

Historically, the first people to settle on St. Martin's Island apparently came from what is now Myanmar with 13 families arriving some 200 years ago. Those who currently identify themselves as islanders are descendents of these original families. Over the years, other people from mainland Bangladesh, and particularly from around the Noakhali area, have settled on the island as well. Most of these people are originally fishers and fish processors by trade, with seaweed collection for trade with Myanmar constituting an important seasonal activity in the past, although this has declined in importance in recent years.

In addition to those settled on the island there are between 2,000 to 3,000 people from outside who move seasonally to the island and are involved mostly in tourism-related activities and construction work. There is also a group of 50-60 *rohinga* families from Myanmar who settled on the island between 15-20 years ago and are now well established there, having married into the local population in many cases and being particularly active as fishing crew (as they reportedly accept lower wages compared to local fishers).

There are one local markets (Haat) within 3 km of the proposed project site. As per survey, 70 Hotels/guest house/cottage/resort, 13 restaurant, 158 different types of shops, 1 madrasa, 6 mosque, 1 ten bed hospital, coast guard office & camp, Naval base, Weather office in the proposed location. The range of profession includes van puller, business, farmer, service etc.

It is to be noted from survey that, 25% currently have electricity by SHS. It has been also observed in the results of the surveys that 95.15% shops and 99% households are interested in

having electricity from the proposed solar mini-grid project. Besides, 45% of the respondents earn less than BDT 10,000 per month and another 40% of the respondents earn between BDT 10,001-20,000 per month. The remaining earns more than BDT 20,000 per month. From the survey it can also be noted that most of the households are very close to the project site. Notably, during the site visit, the local people expressed their willingness to avail electricity from the Project.

7.1 Administrative Structure

It is important to highlight the administrative setup as framed by District and Municipal boundaries of the Project area, as those will be referred to many times throughout the ESIA document.

The project is located at St. Martin Union of Teknaf Upazila of Cox'sbazar District. St Martin's Island a small island in the northeast of the Bay of Bengal, about 9 km south of the Cox's Bazar-Teknaf peninsular tip and forming the southernmost part of Bangladesh. It is about 8 km west of the northwest coast of Myanmar at the mouth of the river naf. The local people call it Narikel Jinjira. It is almost flat and is 3.6m above the mean sea level. The 9.66 km wide channel between the mainland and the island is much shallower than the open sea southwest of the island. There are reefs from 10-15 km to the west-northwest.

The island is governed by a Union Parishad which is the lowest rural administrative and local government unit in Bangladesh. A Union Parishad consists of 12 members including three members exclusively reserved for women. A Chairman heads the group and members are elected from the different wards of the island. They are primarily responsible for agricultural, industrial and community development within the local limits of the Union. However, from the information gathered from the Union Parishad members and the local people, it was evident that the island was effectively governed directly from the mainland Teknaf and Cox's Bazar administration.

The local government arrangements for Bangladesh are outlined in the box below.

Position of the Island in the Local Government/Administration tiers Prime Minister/Ministry Civil Division (7 in the county) headed by Divisional Commissioner (Government Official) District headed by Deputy Commissioner (Government Official) Cox's Bazar Upazilla Nirbahi (Executive) Officer (Government Official) - Teknaf Union Parishad headed by elected Chairperson (the Island) St. Martin's Island
--

7.2 Demographic Information

With an estimated 164.4 million inhabitants and an annual population growth rate of 1.4%, Bangladesh is considered to be one of the most densely populated countries in the world (UNFPA, 2010). The The population is about 6,700 and most of them are fishermen

belonging to 850 families. The population density is likely by the late 2000s to be about 700 persons per km² (Banglapedia, 2015).

The present population of the Saint Martin Island is 8170 and the numbers of households are 896. A large majority of married men (981) on the island have one wife, 58 married men have two wives and six married men have three wives. Thus, there are 1518 married adults on the island. The total number of children in the 896 households is 2518. Children below 12 years of age account for 43.2% of the population while those above 12 years of age represent 26.1% of the island's population. The sex ratio in the child population is roughly 1:1. Married adults represent 30.7% of the total population.

7.3 Government Offices Present in the Island

A number of government offices are present on the island and these are listed below.

1. Border Guard of Bangladesh (BGB)
2. Bangladesh Naval Forces
3. Bangladesh Coast Guard
4. Bangladesh Police
5. Hospital (Ministry of Health)
6. Department of Environment (Ministry of Environment and Forests)
7. Weather Department (Prime Minister's Office)
8. Light House (Ministry of Ships and Ports)
9. Post office (Ministry of Communication)

7.4 Environmental Groups and Committee

Various environmental groups and committees are active on the island and these are listed here.

1. Village Conservation Groups (VCGs) headed by one person in each village – 5 VCGs covering villages of St. Martin's Island
2. Union ECA Coordination Committee headed by the concerned Union Chairperson of St. Martin's Island
3. Upazilla ECA Coordination Committee Upazilla Nirbahi Officer (UNO) Teknaf
4. District ECA Coordination Committee headed by the concerned Deputy Commissioner (DC) Cox's Bazar
5. Central ECA Coordination Committee in the Ministry of Environment and Forests headed by the Minister

7.5 Associations

A number of associations are also present on the island and represent the interests of different groups of people involved in fisheries related livelihoods.

1. Trawler Services Association - Mechanized boats/trawlers carrying passengers between Teknaf (mainland) and the island
2. Fishermen Association - for the welfare of the fishermen of the island
3. Fish Traders Association - who deals (buy from the fishermen who catch fishes in the sea), in fishes.

7.6 Community Infrastructure

The island's infrastructure however seems to have developed primarily with the comfort of tourists in mind rather than that of the inhabitants. The only way to reach St. Martin's Island is by ferry from Teknaf. During the winter months, when seas are calm, there is a lot of traffic to and from the mainland with 7 ferries catering to the tourists who visit the island mainly for day trips. However, during the rainy season, the island is isolated from the mainland and can be difficult to reach. The only mode of transport on the island is by cycle rickshaw van and most people walk from place to place as there is no road on which vehicles can travel. Tourists use speed boats to go to visit Cheradia Island. Electricity is generated by diesel generators and supplied to the local community for 5 hours a day. All the hotels and resorts on the island have their own generators. The below photographs provides an overview of the infrastructure available on St. Martin's Island.



Modes of Transport on St. Martin's Island

7.7 Land use

From the 1940s onwards it is reported that land was gradually converted to paddy cultivation, and from the 1960s onwards this involved converting the main lagoon to cultivation. All the land of the Island is privately- owned, with the exception of 18.7 hectares at Cheradia which was purchased by Ministry of Environment and Forest, and some small areas on which public buildings have been constructed. Lands at the project area are open space not used as agriculture. The area at where the project is proposed characterized by agricultural ecosystem. The main vegetation is coconut, betel nut and bamboo. Coconut trees are abundant and more concentrated in the Jinjira area. The soil of the island is not so fertile. The main agricultural products are onion, watermelon and some rice. A land use map is given in Figure 7.1.

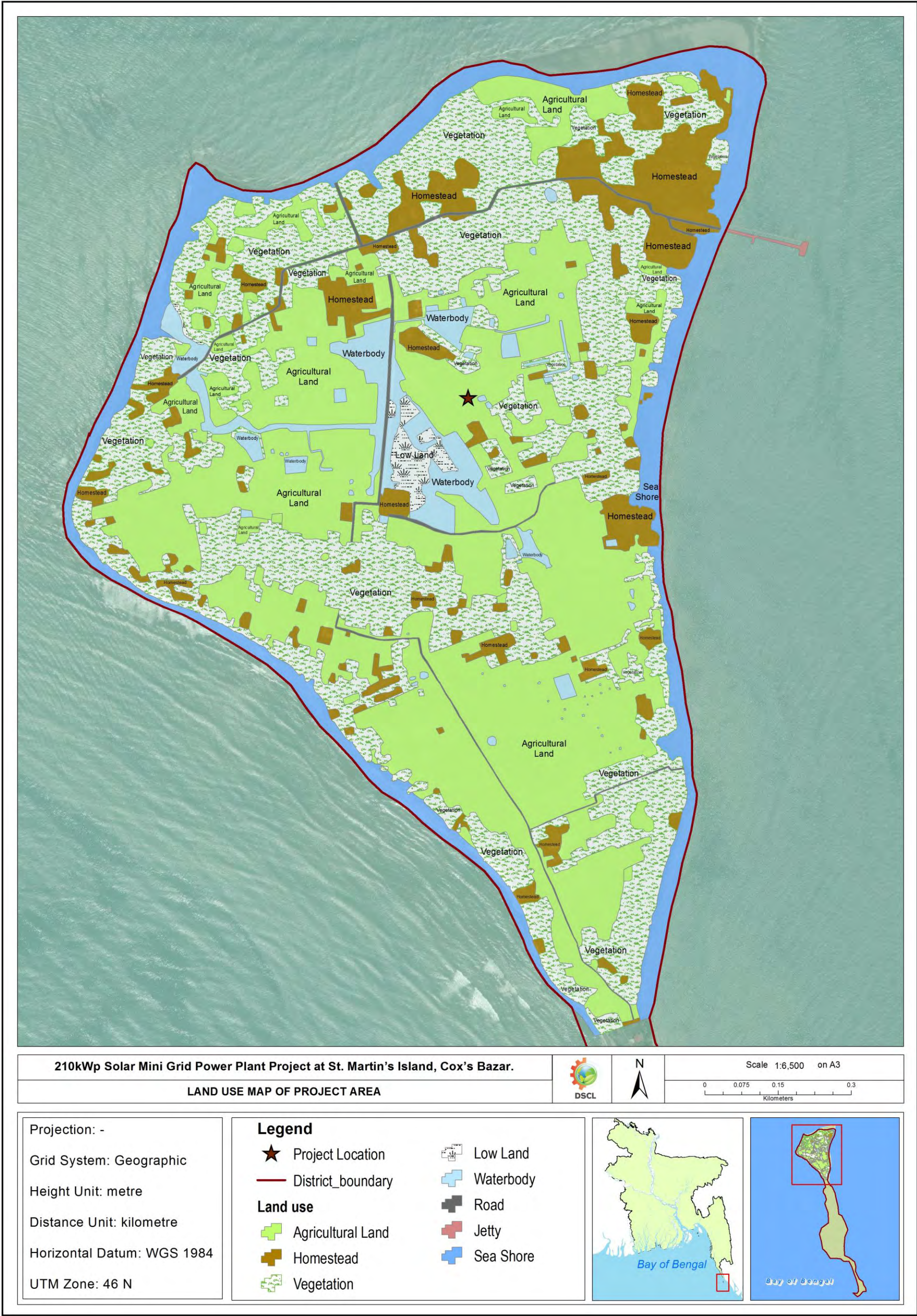


Figure 7.1: Land Use Map of the Project Area

7.8 Transports and Communications

The project area is connected with the main land by waterways. The modes of transport in the island are motorbike, and van. People of this island are connected with mobile network for regular communication.



Accessible Route to Project Site

7.9 Agriculture

About 116 ha of land on the Island are cultivated, with homestead gardens occupying a further 7.4 ha, representing in total 37% of land use (POUSH, 2006a). Farming mainly occurs in the north of the Island (Uttar Para) with the main crops being chilli and watermelon. An indigenous small bulb onion variety is also cultivated and a small amount of maize is intercropped with chilli. A small amount of transplanted Aman rice is cultivated in the rainy season.

Planted trees, particularly coconut, have replaced much of the original vegetation. Thus in field survey and secondary literature it is found that about 25,000 Coconut Palms were recorded on the Island. Homestead coconut gardening is an important source of income.

Agriculture is causing the ongoing destruction of habitats, especially the clearing of rocky land for cultivation and the filling in of lagoons. Additional problems are the cultivation of exotic and hybrid plants and the use of chemical pesticides and fertilizers.

7.10 Livestock and Crop Ownership

Livestock in the island seems to be insufficient to meet the local demand. There are 360 cows on the island owned by 143 households (26.7% of all households) whereas 329 goats owned by 87 households (16.3% of households). There are 5216 chickens owned by 53 households (9.9% of households). Coconut is an important cash crop in the island. There are 9127 coconut trees in the island, however, only 116 families (21.7% of households) own coconut

trees. In addition, 85 families cultivate fruit trees such as papaya and banana. There are 467 fruit trees in the island. The people of the Saint Martin Island live in relative isolations with few amenities that are widely available in other communities. Lack of basic amenities such as education, sanitation, basic health care, electricity has resulted in community hardship and poverty. An important issue that needs to be addressed is whether the socio-economic impoverishment of the local community will affect conservation measures or not, considering the fact that the local community is resources based.

Livelihoods allow people to secure the basic necessities of life, such as food, water, shelter and clothing. Engaging in livelihoods activities involves acquiring the knowledge, skills, social network, raw materials, and other resources to meet individual or collective needs on a sustainable basis. Fishing (including shrimp fry collection), fish drying, the sale of coconuts, and agriculture are the most common sources of livelihood. A small number of people are engaged in rickshaw van pulling (mainly for tourists). During survey it is found that occupations of 850 households showed that 45% were engaged in fishing, 22% in business, 13% in farming, 10% in service and 10% in labour.

7.11 Poverty

Almost all the families of this island are engaged with some earning activities. During the field visit it was observed that people usually go to the town or further for better income. Many of them stay abroad and sending remittance to their families. Female usually remain at home and do the household work. Among the employed people most are working in fishing, some work in farming, van puller etc. and rest are doing service. According to the poverty map of Bangladesh 2010 prepared by BBS/WFP/ World Bank, the project area falls under 16% or less.

7.12 Education

There is one school/college on the island which teaches up to Grade 11 starting from this year (2015). There are also 1 government primary school, 2 non-government primary schools and 15 *madrassa/mokthob* where religious studies are undertaken. 34% of the population is reported to have never attended school. 55% have a primary education, 10% senior school certificate and less than 1% have a higher school certificate or degree.

7.13 Health Services and Sanitation Facilities

A hospital building exists on the island but it has been closed for some time and there are no doctors or nurses on the island. Local midwives known as *dhatris* help women through childbirth. There are 9 pharmacies that provide medicines for the sick and the pharmacist plays the role of doctor on the island. For more significant ailments, the islanders have to go to the mainland to get treated and often children die due to lack of health facilities on the island. During the time the team visited the island there was a floating hospital, The Rongdhonu Friendship Hospital, anchored near the island. We were informed that it was the

first time such facilities were provided to the islanders and that the floating hospital was to stay in St. Martin's Island for 21 days.

All families own a house, however, only 48 households (5% of all households) have sanitary toilets. The lack of sanitary facilities on the island is alarming. Most of the young children suffer from skin disorders and internal parasites (i.e., worms), largely due to poor hygiene. According to the local health service providers, this is possibly due to a large number of dog population on the island. The lack of sanitation facilities on the island causes severe problems during the rainy season when the groundwater often becomes contaminated. It is found that the groundwater is the source of drinking water in the island and pumped by tube wells. Only 395 households have this facility. As green coconut is available in the island, tourists often prefer green coconut water as an alternative to tube well.

7.14 Water and Sewarge

Water for drinking, cooking and bathing is obtained from tube wells with hand pumps and there are 600 wells on the island. The tourist hotels and "resorts" have running water that is dispensed from overhead storage tanks and motor pumps. Only 48% of the population has a toilet in their households. Toilets do not have septic tanks and the sewage is not treated on the island before it is disposed into the marine environment.

7.15 Fishing

The majority of the household heads in the Saint Martin Island are fishermen, and therefore, fishing is the dominant earning source in the island. However, many fishermen have alternative options related to farming (mainly paddy and vegetable cultivation) and other businesses. Figure 7.1 provides information on the primary occupation of household heads in the Saint Martin Island.

7.16 Coastal and Marine Activities

The survey team conducted focus group discussions with fishers and other islanders to learn about the livelihood opportunities available on St. Martin's. As a visualization technique, they used resource and activity mapping. From this, it emerged that the islanders are well aware of the ecological goods and services found in St. Martin's Island. They were able to illustrate the seasonal calendar for activities as well as a seasonal calendar for the availability of fish species. They also participated in making a resource and activity map for St. Martin's Island.

7.17 Current Electricity Consumption Condition

During the assessment of the project, both the financial and economic value of the Island has been considered. It is estimated that the mini-grid project will reduce 16,608 liter kerosene and 103,600 liter of diesel use in total. As an effect, it will reduce CO₂ emission upto 318 tons per year.

Blue Marine Energy Ltd. have surveyed total 691 no's household, 94 no's shop, 17 no's restaurant and 71 no's resorts which needs around 4 MW-HR electricity per day. To meet the demand of the above surveyed consumers a 1MWp Solar plant is required. Besides these, Coast guard, Navy and others government agencies require approximately 2MW-HR load per

day. Based on the above data, a total 6 MW-HR electricity requires for the existing potential users in this Island. However, mini grid would be able to provide only 1 MW-HR per day.

The survey conducted by Blue Marine Energy Ltd. and later verified by IDCOL finds that the number of diesel generators in the area is 85 of which 80 will be replaced due to electricity will be offset from electricity connection from mini-grid. The breakdown of estimated yearly load consumption of different customer category is given below-

Table 7.1: Estimated Yearly Load Consumption

Entity	Yearly load consumption (kwh)	Yearly load consumption per customer (kwh)
Households	67142	200
Shop	45384	334
Restaurants	5549	264
Resorts	34545	1570
Mosque/madarsa	2125	212.5
Cold storage	46720	46720
Ice factory	98550	98550
Workshop	6592	6592
Total	306607	154442

Percentage wise load consumption is shown in the following pie chart-

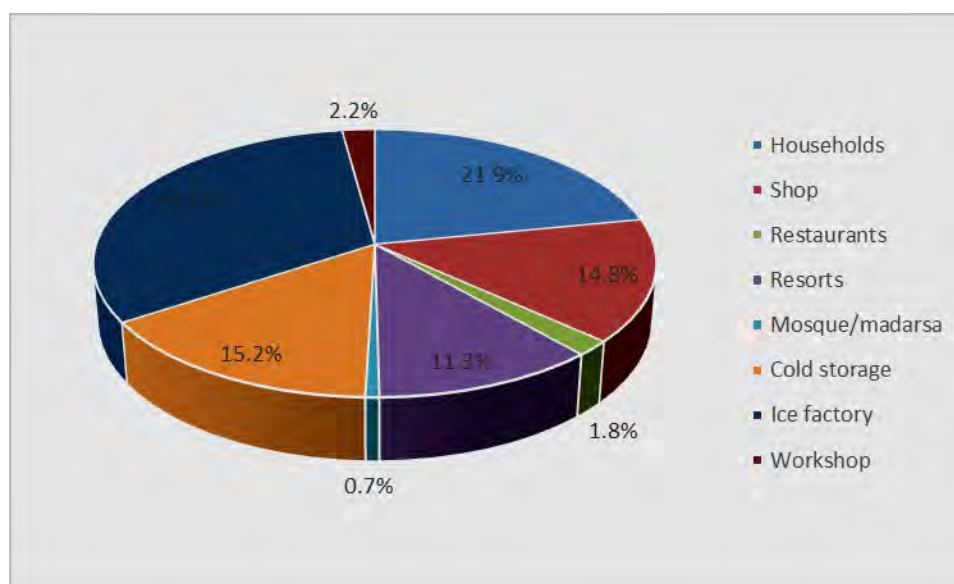


Figure 7.2: Percentage of Load Consumption Pie Chart

During the assessment of the project, both the financial and economic value of the Island have been considered. It is estimated that the mini-grid project will reduce 16,608 liter kerosene and 103,600 liter of diesel use in total. As an effect, it will reduce CO₂ emission up to 318 tons per year. The calculation is derived based on the following assumptions:

7.18 Livelihoods

Livelihoods on the island mainly revolve around coastal and marine activities. The seasonal calendar for activities in Figure 7.3 shows that the households have multiple sources of

income and rely on fisheries, shell collection, agriculture, animal rearing and tourism-associated businesses. The main livelihood opportunities occur during the winter season from October to March. June to August is the Hilsa (*Tenualosa ilisha*) fisheries season and at that time 100% of the fishers concentrate on Hilsa fishing. Fishing primarily for household consumption, using single hooks and line, cast nets and shore seines, is carried on by about 5% of the fishers throughout the year.

Seasonal Calendar												
	Winter		Hot season			Monsoon					winter	
Gear used and Activity	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Bhasha Jal (drift Surface gillnet 4.5 cm)	100% of fishers target Hilsha					100% fishers						
Bhasha Jal (nylon 2.5 cm)	flying fish, mogil sp, milk fish and others											
Shila Jal (bottom set gill net)										40 % of fishers		
Dooba Jal (drifting sunken gill net)	50% of Fishers										50 % of fishers	
Flying Fish (Basha Jal further out)											40% fishers	
Jaki Jal (cast net)	Approximately 15-20 fishers /day in the inland waters and coast											
Tana Jal (shore seine)	Approximately 5% fishers around the island sandy beaches											
Single Hook & Line	Target sp snapper, grouper											
Drying Fish	100 % of fisher HH											
Shell Collection (coral area)	6 households										12 HH	
Shell area (shore)	6 households											
Agriculture (paddy)							35% of HH					
water melon, vegetables (chili, onion, brinjal, potato)												
Coconut	99% of HH											
Tourism guest houses and allied businesses	30 % HH											
Animal rearing (goat,cow,hen)	50% of HH											

Figure 7.3: Seasonal calendar for key livelihoods activities on St. Martin's Island



Figure 7.4: Resource activity Map of St. Martin's Island

Most of the men of the island are primarily fishermen and many also undertake fish drying and processing. Agriculture is also an important employment activity with women and children helping out in the work. With the island increasingly becoming more popular as a tourist destination for Bangladeshis from the mainland, tourism is playing a steadily larger role in employment. However, many of the tourist facilities (resorts and hotels) are owned and controlled by businessmen from off the island and islanders realise limited benefits from tourism. The local businesses catering to the tourists are souvenir shops, sea food restaurants and van pullers located near the jetty. A significant proportion of the land on the island is now owned by these mainland businessmen. Local land owners who have sold their land to outsiders often move to the south of the island which was previously uninhabited.

Figure 7.2 shows a resource activity map, of St. Martin's Island. The map was prepared during a focus group discussion with fishers in Dakhinpara and later validated with another group of fishers in Uttarpara. This shows how St. Martin's Island is made up of different habitats and ecosystems. The habitats found include rocky shores, rocky terrestrial habitat, coral colonies, sand dunes, screw pines, mangroves and wetland. All these habitats are now threatened due to human activity and changes in land use. The wetland in Dakhinpara is threatened as it has been recently purchased by entrepreneurs from Dhaka for the construction of a tourist resort. Some of these threatened areas are illustrated in 7.3.



Figure 7.5: Habitats under threat due to land use changes on St. Martin's Island

Figure 7.6 shows the seasonal calendar for fish species availability. One can note from the seasonal calendars and the resource activity calendar that the fishers have very good traditional knowledge of the ecological goods and services found in and around St. Martin's Island and they time their activities accordingly.

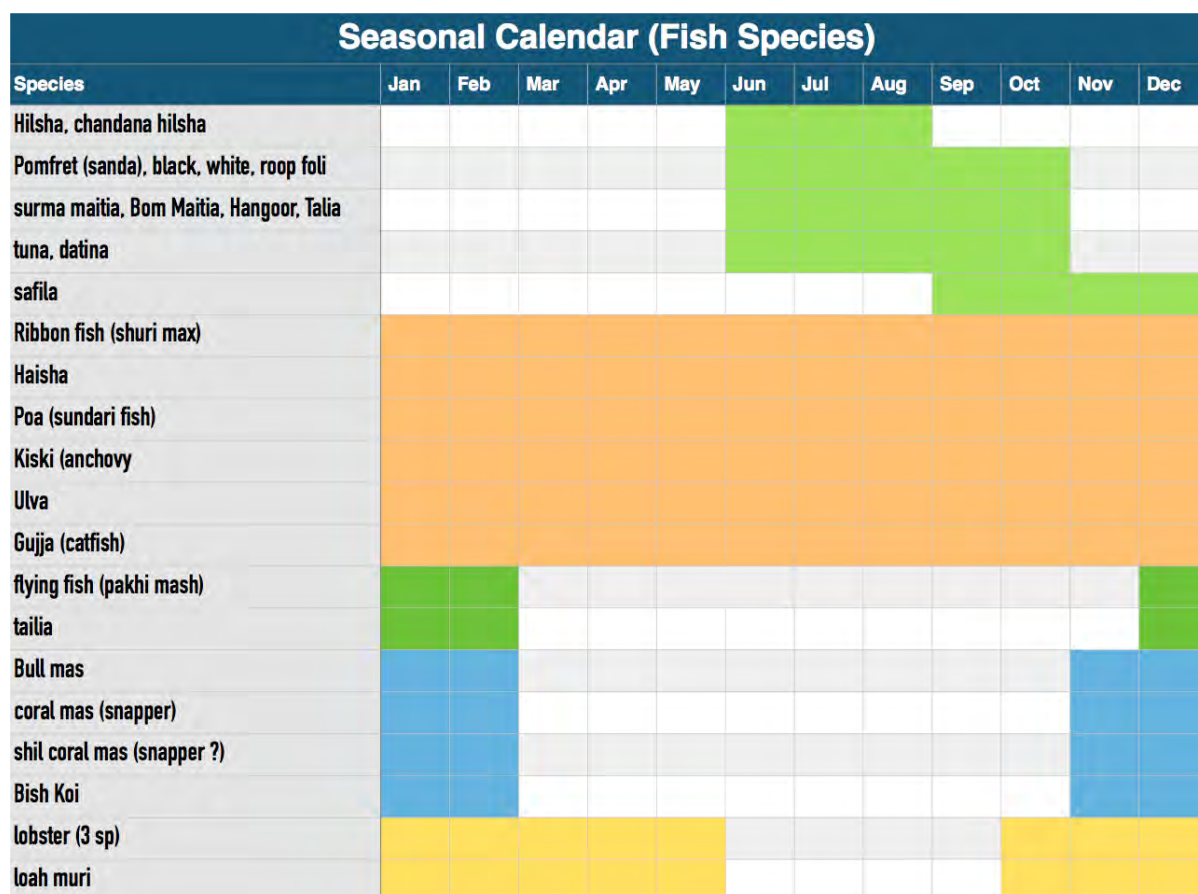


Figure 7.6: Seasonal calendars (fish species)

7.19 Material Style of Life

Four types of dwelling units are found on the island. These are similar to the dwelling units found in the coastal areas of Cox's Bazar district. The followings types of houses are found in the island:

- **House made of polythene:** 10% of the Island dwellings have a roof and wall made of polythene and bamboo and pillars of bamboo and tree branches (*Pandanus* sp.). Floor is of soil.
- **One roof house:** 1% of the dwellings have a roof made of galvanised tin sheet, wall of bamboo/galvanised tin sheet/bricks and a floor of soil.
- **Two roof houses:** 40% of the dwellings have a roof made of 2 separate parts and made of galvanised tin sheet, concrete pillars or coconut poles, walls of galvanised tin sheets or wood, and a cement floor.
- **Four roofs galvanised tin sheet/tin-shed house:** Approximately 48% of the dwellings have roofs made of 4 separate parts of galvanised tin sheeting, walls of tin sheets, bricks/stone and cement and CC floor.
- **Building:** 1% of the island buildings have roof made of re-enforced concrete or re-enforced concrete and mud tiles.

60% of the houses have no toilets and no electricity. We were told by the UP chairperson that the islanders have to get written permission from the environment department to construct toilets. Most islanders use a kerosene wick lamp for lighting and firewood for cooking. A few houses have solar panels but most are dependent on the 4 community generators to provide electricity for 4-5 hours in the evening from 6-10 p.m. The situation is slightly better at the north end of the island where electricity is supplied from a diesel generator from 6-11 p.m. every day.



Figure 7.7: House types on St. Martin's Island

7.20 Status of Women

Women are not very visible on the island as they do not venture outside their home space. There are no self-help groups. As a result of affirmative action measures introduced by the government, 3 women are members of the Union Parishad as per government rules. The most influential people of the islands are the 12 members of the Union Parishad since they have more exposure with people from outside the island such as with the navy, coast guard, etc. To understand the situation of women the participants collected two illustrative stories of women with different positions in society.

7.21 Tourism

Bangladesh has no significant tourist industry. If well planned, it can be a useful development tool that can bring substantial benefits to remote areas such as St.Martin's Island. Thousands of tourists from all regions of Bangladesh that visit the island are an important, as yet untapped, resource for future conservation efforts. Development of small-scale community based ecotourism, to satisfy national demand for new travel destinations, is available option on St.Martin's Island that needs to be promoted. It is also clear that due to environmental limitations (e.g. limited supply of fresh water, cyclone prone area) large-scale tourism development is not advisable. The implementation of 'ecotourism' project, only possible with active participation of local people and effective protected area management plan. It may be mentioned that government of Bangladesh declared St. Martin's Island as an 'Ecologically Critical Area (ECA)' with other five ECA's and proposed a number of guidelines for sustainable management of those areas (ECR, 1997).

The importance of tourism can be considered as a major source of revenue and can play an important role in the economic development of Bangladesh. Tourism is widely seen as an

important potential contributor to economic and social development in Third World countries. Tourism is also relevant to strategies for sustainable development and environmental rehabilitation in areas with great landscape and cultural values. Tourism business is essential to economies because of the direct effect on employment, the balance of payment and society in terms of educational and cultural benefits. The problems of declining terms of trade for agricultural products and high levels of protection against manufactures, many developing countries have turned to tourism as a possible alternative source of growth and devoted resources for the development of this sector and thus, the sector has become a major economic activity with in developing countries often contributing more foreign currency than traditional primary commodity exports.

Tourism is concentrated in the winter, particularly December and January, when the Island is most accessible, while the remainder of the year sees hardly any tourists. A major problem resulting from tourism is uncontrolled and inadequate waste management. Untreated sewage is piped directly into the sea, or stored in open ponds, adversely affecting marine and ground water quality.

Thus the existing pattern of tourism in the peak season is considered to be unsustainable and far beyond the carrying capacity of the Island. The Island has a good potential for responsible ecotourism, but there is currently only mass tourism. This marginalizes local people as very little, if any, money generated from tourism remains in the Island, because all the tourism investors are outsiders. Hence the growth of tourism on the Island since the early nineties hardly contributes to economic development on the Island but it seriously damages natural resources.

7.22 Recreational Activities

The social need for recreation has been identified as compulsory. The island people have very limited access to recreational activities. There is no such dedicated place or regular activities as recreational purpose. However, there are some houses have bought television but all the people do not have ability to buy the valuable means of recreation. Additionally, without having access to electricity the available television is not worthy at all in some times. Because of the lacking of electricity people in this area are not interested to establish any recreational center at all.

7.23 Archaeological and Cultural Heritage

There is no archeological structure within this project. However, some religious structures are found within the project influence area. A list of such cultural physical properties has been given in Appendix F of this ESIA report.

7.24 Environmental and Social Hotspot

The socio-cultural aspects include the educational institutions, hospitals/health centres, religious structures, cultural structures, burial grounds, market places, water bodies, etc., few of which would be affected directly and indirectly through implementation of the project. Such sites could be termed as Environmental Hotspots in relation to project activities and,

hence, need to be dealt carefully during the construction phase. Locations of major environmental hotspots in the project area are shown in the Figure 7.8. A detail list of the cultural and sensitive areas located within 1 km radius of the project area is presented in Appendix F.

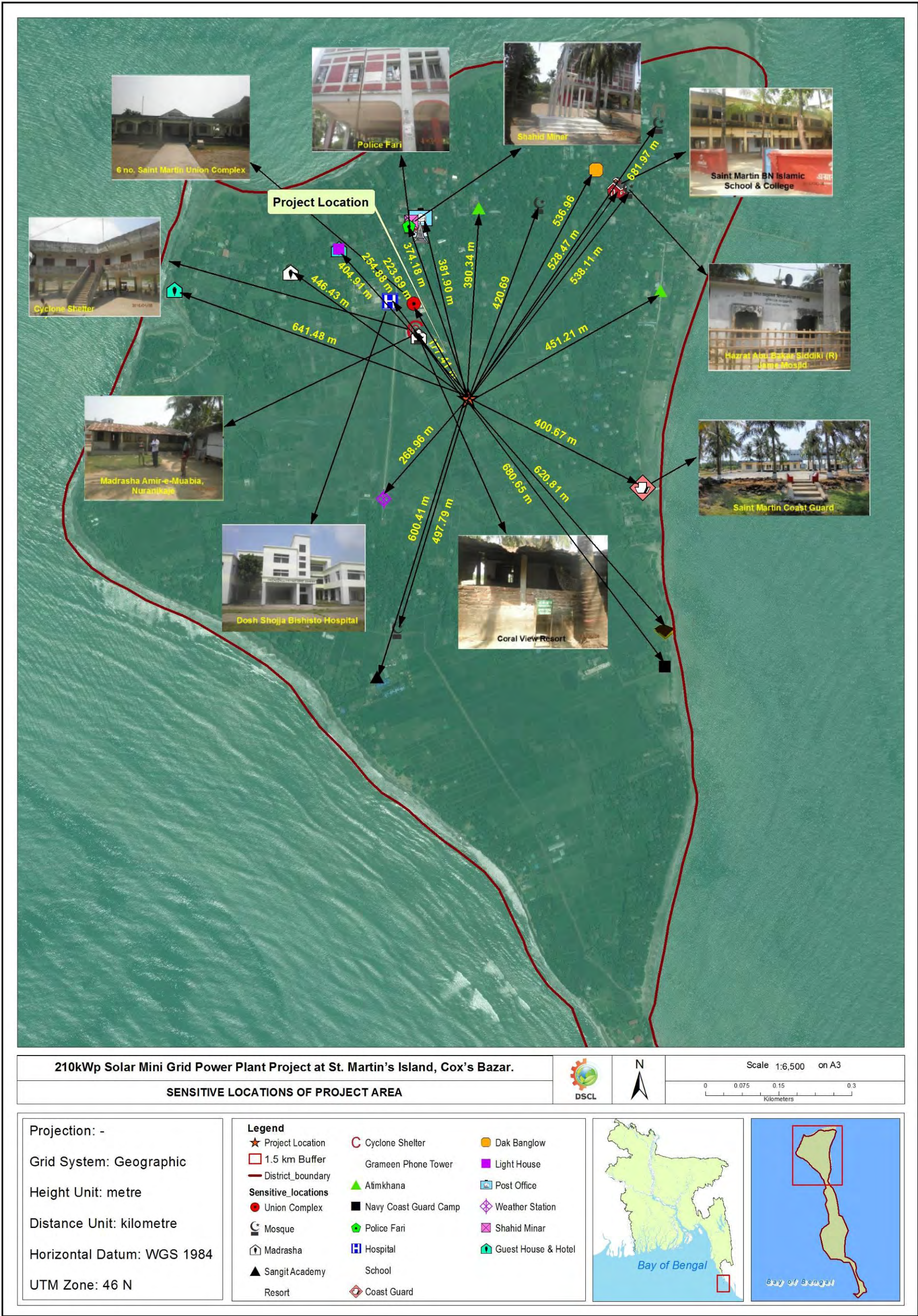


Figure 7.8: Cultural and Sensitive Structures within 1 km Radius of the Project Location (Google Earth Map)

8 ANALYSIS OF PROJECT ALTERNATIVES

8.1 General

An ESIA should describe a range of reasonable alternatives to the proposed project or to the location of the proposed project site that could feasibly avoid or lessen any significant environmental impacts of the proposed project while attaining most of the project's basic objectives. An ESIA also must compare and evaluate the environmental effects and comparative merits of the alternatives. This chapter describes alternatives considered but eliminated from further consideration (including the reasons for elimination), and compares the environmental impacts of several alternatives retained with those of the proposed project.

The range of feasible alternatives is selected and discussed in a manner to foster meaningful public participation and informed decision making. Among the factors that may be taken into account when addressing the feasibility of alternatives are environmental impacts, site suitability, economic viability, social and political acceptability, technological capacity, availability of infrastructure, general plan consistency, regulatory limitations, jurisdictional boundaries, and whether the proponent could reasonably acquire, control, or otherwise have access to an alternative site. An ESIA need not consider an alternative whose effects could not be reasonably identified, whose implementation is remote or speculative, and that would not achieve the basic project objectives.

The proposed project has the potential to have significant adverse effects on visual amenity; air quality; noise; biological resources; cultural resources; geology/soils; GHG emission; hazards and hazardous materials; hydrology and water quality; land use and planning; noise; public services; transportation and traffic; and utilities and service systems within the County. Even with the mitigation measures described in Chapter 10 of this ESIA, impacts in some of these issue areas would be significant and unavoidable. Therefore, this section discusses alternatives that are capable of avoiding or substantially lessening effects on these resources. Section 8.2 below, restates the project objectives. Section 8.3 summarizes the project. Section 8.4 presents alternatives to the proposed project that were considered but eliminated for further analysis. Section 8.5 presents alternatives fully analyzed in this ESIA and provide a comparison of alternatives. Section 8.6 makes a determination about the environmentally superior alternative.

8.2 Project Objectives

The following objectives have been established for the proposed project and will aid decision makers in the review of the project and associated environmental impacts:

The objectives for the proposed project are to:

- Electrification of remote rural area.
- Increasing the livelihood of the local people.
- Increase the socio-economic status of the area.

8.3 Proposed Project Summary

The Project is located at Saint Martin's Island which is located on the southern-most tip of Bangladesh, roughly between 20°34'-20°39' N and 92°18'-92°21' E and 17 kilometers off Taknaf, the most southern main land of Bangladesh.. The Global Positioning System (GPS) coordinate of the project site is 20°37.788'N and 92°19.354'E. The specific location of this project is at Konapara village of ward no. 6 in this island (Figure 3.2). The project site is located in the island where the Bay of Bengal is 2.5 Km far to the north, 5 km to the south, ~1 Km to the east and 1 Km to the west. The site is on an open land currently not in use for agriculture or other commercial purposes, and is adjacent to some rural settlements.

The proposed Project involves setting up of a 250 kWp of solar minigrid power plant project at this island by Blue Marine Energy Limited. The proposed system will include 250 kWp solar mini-grids along with a diesel backup generator to meet the energy demand of the area. Once completed, the Project is expected to go into commercial operation in December 2016 and supply electricity to the adjacent 850 households, 70 Hotels/guest house/cottage/resort, 13 restaurants, 158 different types of shops, 1 madrasa, 6 mosques, 1 ten-bed hospital, coastguard office & camp, Naval base, Weather office in the Saint Martin Island.

8.4 Alternatives Eliminated from Further Consideration

Alternatives may be eliminated from detailed consideration in an ESIA if they fail to meet most of the project objectives, are infeasible, or do not avoid or substantially reduce any significant environmental effects. Alternatives that are remote or speculative, or the effects of which cannot be reasonably predicted, also do not need to be considered. Blue Marine Energy Limited considered several alternatives to reduce project impacts on aesthetics and agriculture resources, and cumulative impacts on aesthetics, agriculture resources, air quality, and biological resources. The following alternatives were initially considered but were eliminated from further consideration in this ESIA because the alternatives do not meet project objectives or were infeasible.

8.4.1 Other Energy (Wind) Alternative

This alternative would involve the use of wind energy as an alternative to development of a solar site. Similar to solar power, power from the wind is an alternative to energy production from nonrenewable resources like coal and oil, or nuclear sources. Wind energy provides several benefits, including, but not limited to the following:

- Wind is a renewable and infinite resource.
- The generation of wind energy does not produce any air emissions, including carbon dioxide (GHG).
- Although wind energy requires a significant upfront capital investment, it is a free resource after the capital cost of installation (excluding maintenance).
- In addition, energy production from wind power would not require the significant water usage associated with coal, nuclear, and combined-cycle sources.

Commercial wind farms typically use three-bladed turbines that range in size from 300 feet

up to 500 feet in height, with blades of 150 feet in length that are pointed into the wind by computer-controlled motors. The wind farm would consist of a group of wind turbines placed where sufficient and consistent wind resources exist and electrical power transmission infrastructure is located. The individual turbines would be interconnected with a medium-voltage power collection system and a communications network. Similar to solar energy production facilities, wind energy production facilities also require substations, which would increase the medium-voltage electrical current through a transformer before connection to the high-voltage transmission system. Compared with traditional energy sources, the environmental effects of wind power are relatively minor.

Unlike the proposed project, wind turbines would have the potential to impact avian species in the local area. The development of wind farms would also typically result in greater adverse aesthetics impacts due to the height of the turbines. Agriculture resources would also still be impacted by the presence of wind turbines and associated facilities. Additionally, wind energy production facilities do not reduce short-term construction-related air quality emissions.

While the project area has been identified as suitable for solar projects based on the solar insolation levels (the amount of solar radiation energy) in the area, wind energy production is not well-suited to the project site due to relatively low wind speeds and directionality sufficient to drive wind turbines. No significant facilities have been developed in the project vicinity due to the lack of adequate wind resources.

As noted above, alternatives may be eliminated from detailed consideration in an ESIA if they fail to meet most of the project objectives, are infeasible, or do not avoid or substantially reduce any significant environmental effects. Therefore, this alternative was eliminated from further consideration because:

- It would result in additional/greater impacts than the proposed project (aesthetics and biological resources);
- It would not substantially reduce the significant environmental impacts associated with aesthetics, agriculture resources, air quality and biological resources;
- It would fail to meet the objectives for the proposed project; and
- The project site is not suited for wind energy production; therefore, a wind energy production facility would not generate as much electricity as solar equipment.
- Wind energy is uncommon in Bangladesh and the production material is not available.

8.4.2 Alternative Site

Relocation option to a different site is an option available for the project implementation. At the moment, there are no alternative sites for the proposed development (i.e. the project proponent doesn't have an alternative site). This means that the proponent has to look for the land if relocation is proposed and land is not available and if available it will be too expensive for the proponent to realize his dream.

Looking for the land to accommodate the scale and size of the project and completing official transaction on it may take a long period. In addition, it is not a guarantee that such land would be available. It's also worth noting that the said project is already underway in terms of seeking development approvals in various government departments.

The project proponent would spend another long period of time on design and approvals of the plans by the relevant government departments. The project design and planning before the stage of implantation would call for cost; already encountered in the proposed development i.e. whatever has been done and paid to date would be counted as a loss to the proponent. Assuming the project will be given a positive response (after relocation) by the relevant authorities including DoE, it (project) would have been delayed for a long period before implementation. This would also lead to a situation like No Action Alternative. In consideration of the above concerns and assessment of the current proposed site, relocation is not a viable option.

8.5 Alternatives Selected for Analysis

The following four alternatives have been determined to represent a reasonable range of alternatives that have the potential to feasibly attain most of the basic objectives of the proposed project but which may avoid or substantially lessen any of the significant impacts of the proposed project. The “Environmentally Superior” Alternative, as required is described in Section 5.5, Environmentally Superior Alternative. The following alternatives are analyzed in detail below:

- Alternative A: No Project
- Alternative B: Reduced Project (Avoid Williamson Act Contract and Prime Agricultural Lands)
- Alternative C: Build-Out of Existing Land Use
- Alternative D: No Utility-Solar Development—Distributed Commercial and Industrial Rooftop Solar Only

Table 8.1 provides a summary of the relative impacts and feasibility of each alternative. A complete discussion of each alternative is provided below.

Table 8.1: Summary of Development Alternatives

Alternative	Description	Basis for Selection and Summary for Analysis
Proposed Project	250 kWp standalone AC coupled solar photovoltaic mini grid power plant on 2.40 acres	-
Alternative A: No Project Alternative	• Existing land use designations and zoning designations would remain. • No Development would occur on site. • Site would remain as	Avoids significant impacts.

	agricultural land.	
Alternative B: Reduced Project Alternative	45 kWp on 0.44 acres	Avoids significant impacts to agricultural lands.
Alternative C: Build-Out of Existing Land Use Alternative	Existing land use designation will be build out.	Several environmental impacts reduced whereas others increase.
Alternative D: No Utility Solar Development – Distributed Commercial and Industrial Rooftop Solar Only	250 kWp of photovoltaic solar distributed on rooftops throughout the region.	Avoids significant impacts to visual amenity, air quality and ecological resources.

8.5.1 Alternative A: No Project Alternative

The No Project Alternative in respect to the proposed project implies that the status quo is maintained. This option is most suitable alternative from an extreme environmental perspective as it ensures non-interference with the existing conditions. However, the project activities have already been started. This option will however, involve several losses both to the project proponent and the donor organization. The property will remain under-utilized. The No Project Option is the least preferred from the socio-economic and partly environmental since if the project is not done.

- The economic benefits especially during construction i.e. provision of jobs for skilled and non-skilled workers will not be realized.
- There will be no generation of income by the developer to the Government.
- The local skills would remain under-utilized.
- No employment opportunities will be created who will work in the project area.
- Discouragement for donors to allot this level of standard and affordable developments.

8.5.1.1 Impacts Compared to Project Impacts

8.5.1.1.1 Visual Amenity

In contrast to the proposed project, the project site under the No Project Alternative would remain under agricultural production, largely vacant and undeveloped. Under the No Project Alternative, solar arrays and other project components would not be developed at the project site and no views of the project area would be altered. The area surrounding the project site is mostly under agricultural production and undeveloped land. Under the No Project Alternative, no impact to the undeveloped nature of the project area would occur. Therefore, because the project site would remain unchanged under the No Project Alternative, this alternative would result in fewer impacts than the proposed project.

8.5.1.1.2 Air Quality

During construction, air quality emissions associated with the project would be equal to, if not greater than the existing farming operations. Following the construction period (during project operations), the proposed project would likely produce less air pollution than existing land uses by removing gas- and diesel-powered farming equipment and vehicles

(e.g., tractors, crop dusting, haul trucks) and ground-disturbing activities (e.g., planting, harvesting, plowing), and replacing them with the minor vehicle and equipment emissions and minimal soil disturbance associated with the solar facility. In addition, the proposed project would decrease regional air pollutant emissions by reducing the demand for new fossil-fuel-burning power generation facilities. Therefore, there would be greater long-term air pollution impacts resulting from the No Project Alternative than the proposed project.

8.5.1.1.3 Terrestrial Ecology

According to ecological surveys performed at the project site, some sensitive plant and animal species have the potential to be located within 1 kilometer of the project site or on the site itself. Under the No Project Alternative, no new construction and/or operational activities would result, and impacts would generally not be increased. There would be fewer impacts to biological resources from the No Project Alternative as compared to the proposed project. The project-level impacts resulting from the proposed project would be less than significant with mitigation. Implementation of the No Project Alternative would successfully avoid project-level impacts to biological resources by minimizing the potential loss of sensitive species habitat onsite.

8.5.1.1.4 Archaeology and Cultural Resources

Field surveys indicate the presence of very few cultural resources on the project site. Mitigation measures are provided to reduce impacts to these resources to below a level of significance. Under the No Project Alternative, the project site would remain as is, and no ground disturbing activities would occur. Therefore, unlike the proposed project, the No Project Alternative would not have the ability to accidentally uncover potentially significant cultural, archaeological, or paleontological resources which may be located beneath the surface project site. There would be no impact to cultural resources, and no mitigation measures would be necessary. Accordingly, there would be fewer impacts from the No Project Alternative than the proposed project.

8.5.1.1.5 Soil

Implementation of the No Project Alternative would result in a continuation of existing land uses. The site is expected to continue to be used in its current capacity and condition. No change in geology or soils conditions would occur with this alternative.

8.5.1.1.6 Dust & Exhaust Emissions

Unlike the proposed project, the No Project Alternative would not involve construction activities or operation of a solar generating facility; therefore, heavy equipment operation, truck deliveries, and construction worker commute trips would not be utilized and increased dust and exhaust emissions would not occur as a result. The No Project Alternative would have fewer impacts than the proposed project during the project's construction period, but would result in greater impacts during the proposed project's operational period. Because the construction period is temporary and is anticipated to last for only three years, whereas the operational period is anticipated to last for many decades, the long-term impact of the No Project Alternative on air quality is greater than the impact of the proposed project.

8.5.1.1.7 Waste Generation

If the No Project Alternative is implemented, the proposed project would not be implemented. It is expected that there would be no change at the project sites relative to their current agricultural practices, and expected current use of pesticides, fertilizers, and fuels for farming equipment. No change regarding existing on-site hazards or potential use of hazardous materials is expected.

8.5.1.1.8 Water Quality

The No Project Alternative would not result in degradation of surface water quality in the adjacent rivers, channels and ponds due to disposal of solid wastes, sewage effluent, and dredged materials, accidental spillage of petroleum products, cement, bentonite and noxious chemicals. Accordingly, there would be fewer impacts from the No Project Alternative than the proposed project.

8.5.1.1.9 Land Use

Under the No Project Alternative, the project site would remain undeveloped and vacant. Similar to the proposed project, the No Project Alternative would not physically divide an established community. The project site is not within the boundaries of any natural community conservation plan, therefore no impact would occur. No land filling will be required under no project alternative. Nonetheless, because no degradation of the surrounding agricultural land will occur, there would be fewer impacts from the No Project Alternative than the proposed project.

8.5.1.1.10 Noise

If the No Project Alternative is implemented, short-term construction activities of the PV solar project and long-term operation of the PV solar project would not occur and the associated noise levels would not be generated. The No Project Alternative would result in the continuation of agricultural use-related noise levels at the site. The No Project Alternative would eliminate the project-specific less than significant short-term construction noise impacts.

8.5.1.1.11 Traffic

In contrast to the proposed project, there would be no development associated with the No Project Alternative. Therefore, the No Project Alternative would not have the potential to affect traffic volumes on nearby roadways as a result of either construction activities. Because transportation and traffic impacts associated with construction of the project would be greater than existing agricultural operations, the No Project Alternative would result in fewer impacts as compared to the proposed project.

8.5.1.2 Conclusion

8.5.1.2.1 Avoid or Substantially Lessen Project Impacts

The No Project Alternative would reduce the significant and unavoidable impacts of the proposed project related to air quality (project-level and cumulative). This alternative would also result in fewer impacts to archaeological and cultural resources, water quality, land use, and traffic, but would result in greater long-term impacts associated with air quality and

exhaust emissions.

8.5.1.2.2 Attainment of Project Objectives

Alternative A, the No Project Alternative, would not meet any of the project objectives.

8.5.1.2.3 Comparative Merits

The No Project Alternative would avoid some impacts associated with the proposed project's short-term, long-term, and cumulative impacts, but would result in a greater long-term and cumulative impacts in certain environmental issue areas. Unlike the proposed project, this alternative would not have significant and unavoidable impacts associated with air quality (project-level and cumulative). Long-term air quality and emissions impacts would be substantially greater with the No Project Alternative. In addition, this alternative would not meet any of the project's objectives.

8.5.2 Alternative B: Reduced Project Alternative

Under the Reduced Project Alternative, development would involve an 82 percent reduction in project size. The project under this alternative would consist of an approximate 45 kWp solar PV generating facility on 0.44 acres. Under this alternative, the following specific project components could be reduced in number or size in comparison to the proposed project:

- A solar field of PV panels and associated improvements (e.g., access roads, fencing, secondary access drives, combiners, etc.),
- An electrical collection system (transformer and inverter) that aggregates the output from the PV panels and converts the electricity from DC to AC,
- The transmission to the transmission line, and Project substations.

8.5.2.1 Impacts Compared to Project Impacts

The following discussion evaluates the potential environmental impacts associated with the Reduced Project Alternative, when compared to the impacts of the proposed project.

8.5.2.1.1 Visual Amenity

A reduction in project size under the Reduced Project Alternative would result in less modification of the existing environment, and would therefore result in fewer impacts to visual amenity than the proposed project. However, a smaller solar energy facility covering one bigha would continue to have a significant and unavoidable impact on aesthetics as the landscape and character of the project area would change from vacant and undeveloped or agricultural operations to a solar energy facility.

8.5.2.1.2 Air Quality

During the construction period, overall air quality emissions associated with the Reduced Project Alternative would be less than the proposed project, because there would be less land area disturbed. No significant and unavoidable air quality impacts are expected with the proposed project; therefore, the Reduced Project Alternative construction period air quality

impacts would also be less than significant. However, because there would likely be some overlap of construction periods for the various projects in the cumulative analysis, cumulative construction-period emissions are likely to exceed thresholds of significance and result in cumulatively significant impacts. Therefore, cumulative air quality impacts associated with construction of the Reduced Project Alternative would, like the proposed project, be significant and unavoidable. Following the construction period (during project operations), the proposed project would produce less air pollution than the Reduced Project Alternative as no farming would occur, meaning there would be no gas- and diesel-powered farming equipment and vehicles (e.g., tractors, crop dusting, haul trucks) and ground-disturbing activities (e.g., planting, harvesting, plowing) associated with agricultural operations. These activities and operations would be replaced with the minor vehicle and equipment emissions and minimal soil disturbance associated with the solar facility. In addition, the proposed project would decrease regional air pollutant emissions by reducing the demand for new fossil-fuel-burning power generation facilities more than the Reduced Project Alternative. Therefore, there would be fewer long-term air pollution benefits resulting from the Reduced Project Alternative than the proposed project.

8.5.2.1.3 Terrestrial Ecology

Both the proposed project and Reduced Project Alternative would result in the development of a project site that consists of undeveloped agricultural lands. Although the Reduced Project Alternative would result in less development of the project site, as compared to the proposed project, the Reduced Project Alternative would still require the implementation of mitigation measures in order to reduce the severity of potential impacts to biological resources. Similar to the proposed project, the Reduced Project Alternative has some potential to result in impacts to burrowing owls, nesting raptors, migratory birds and other sensitive non-migratory bird species. However, with the implementation of the avoidance, minimization and mitigation measures outlined, these impacts would be reduced to a level of less than significant. The Reduced Project Alternative would use the same gen-tie route, so the impacts associated with loss of habitat along that route would not be reduced; however, because the Reduced Project would cover less land, less burrowing owl foraging habitat would be lost. Nonetheless, because the Reduced Project Alternative would develop less of the project site as compared to the proposed project, impacts from this alternative would be slightly less than the proposed project.

8.5.2.1.4 Archaeology and Cultural Resources

Under the Reduced Project Alternative, less of the project site would be disturbed, reducing the likelihood of accidental discovery of potentially significant cultural, archaeological, or paleontological resources which may be located beneath the surface project site. There would be less of an impact to cultural resources, although mitigation measures would still be necessary. Accordingly, there would be fewer impacts from the Reduced Project Alternative than the proposed project.

8.5.2.1.5 Soil

The Reduced Project Alternative would generally have impacts to geology and soil that are similar to, or the same as, the proposed project. During construction, the amount of soil

disturbances would be similar to, or the same as, the project. The increased setbacks would decrease the size of the PV array; however, some level of site clearing and shallow grading would still be required for the perimeter landscape. This alternative would include the same facilities described for the proposed project. The character of on-site soils and the depth of the groundwater table make the potential for liquefiable materials to be present beneath the site.

8.5.2.1.6 Dust & Exhaust Emissions

Similar to the proposed project, the Reduced Project Alternative would result in short-term exhaust emissions during construction activities, albeit to a lesser degree than the proposed project. However, impacts from both construction-related and cumulative exhaust emissions for each project would still be less than significant without implementation of mitigation measures. Once operational, both projects would begin to offset emissions by reducing the amount of fossil fuels burned to generate other forms of electricity. However, the proposed project would offset significantly more emissions from fossil-fuel-based energy sources, as compared to the Reduced Project Alternative. The proposed project would also result in reduced emissions on the project site by eliminating the use of diesel-powered farm equipment. Given that both the proposed project and the Reduced Project Alternative would ultimately result in a net decrease in emissions, operational impacts for both projects would be less than significant. However, because the proposed project would offset far more emissions than the Reduced Project Alternative, there would be fewer long-term emissions benefits resulting from the Reduced Project Alternative than the proposed project.

8.5.2.1.7 Waste Generation

The Reduced Project Alternative would have similar impacts to the proposed project related to construction and decommissioning because this alternative would be a reduced-sized version of the proposed project at the same site and using the same PV technology, and the same mitigation measure would be implemented to reduce the potential for spills to occur and to manage spills that do occur. Its difference is that this alternative would have a larger setback distance from the surrounding roads. The Reduced Project Alternative would create a less than significant hazard to the public and the environment through the routine transport, use, or disposal of hazardous materials. The Reduced Project Alternative would also create a less than significant impact with mitigation related to an inadvertent release during construction of hazardous materials into the environment. Overall, impacts regarding hazards and hazardous materials would be essentially the same for this alternative as for the proposed project.

8.5.2.1.8 Water Quality

The Reduced Project Alternative would result in small degradation of surface water quality in the adjacent rivers, channels and ponds due to disposal of solid wastes, sewage effluent, and dredged materials, accidental spillage of petroleum products, cement, bentonite and noxious chemicals. Therefore, because both projects would result in less than significant impacts with adherence to all applicable regulations, impacts to hydrology and water quality from the Reduced Project Alternative would be similar as compared to the proposed project.

8.5.2.1.9 Land Use

With approval of all discretionary requests, both the proposed project and the Reduced Project Alternative would be consistent with the land use and zoning designations at the project sites, and neither project would conflict with any applicable land use plans, policies or regulations. Similar to the proposed project, the Reduced Project Alternative would not be located between housing developments or communities; therefore, this alternative would not physically divide an established community. Accordingly, because both the proposed project and the Reduced Project Alternative would require approval of discretionary requests in order to maintain consistency with all applicable land use plans, impacts from the Reduced Project Alternative would be similar to those resulting from the proposed project.

8.5.2.1.10 Noise

If the Reduced Project Alternative is implemented, short-term construction/decommissioning and long-term operation would result in slightly lower maximum noise levels to surrounding areas due to the increased setbacks for project facilities from the road networks surrounding each of the sites when compared to the proposed project. In addition, construction and decommissioning activities would likely occur for a slightly shorter duration compared to the project. Similar to the project, the Reduced Project Alternative would result in less than significant short-term construction/decommissioning and long-term operational impacts from noise and vibration.

8.5.2.1.11 Traffic

Although the Reduced Alternative would involve fewer construction vehicle trips, potential impacts to traffic volumes on nearby roadways would not differ substantially in comparison to the proposed project. Similar to the proposed project, impacts from construction and operational vehicle trips for the Reduced Project Alternative would be less than significant without implementation of mitigation. Nonetheless, because the Reduced Project Alternative would result in slightly fewer construction trips, this alternative results in fewer impacts than the proposed project.

8.5.2.2 Conclusion

8.5.2.2.1 Avoid of Substantially Lessen Project Impacts

Compared to the proposed project, the Reduced Project Alternative would result in fewer impacts to aesthetics, terrestrial ecology, air quality (construction period/short-term), archaeological and cultural resources, and traffic, but would result in greater long-term impacts associated with air quality and exhaust emissions.

8.5.2.2.2 Attainment of Project Objectives

Alternative B, the Reduced Project Alternative, meets all project objectives. However, it meets certain objectives to a lesser degree than the proposed project. Among these are:

- Assist in achieving exhaust emissions reduction objectives to the maximum extent possible based on anticipated transmission facility capacity and reserved queue position.

- Ensure that the project can be constructed, and power provided at a competitive price.

8.5.2.2.3 Comparative Merits

The Reduced Project Alternative would reduce impacts associated with visual amenity, air quality (project-level), ecological resources, archaeological and cultural resources, and traffic, when compared to the proposed project. Despite a reduction in their severity, significant and unavoidable impacts to air quality (cumulative) would remain.

The Reduced Project Alternative would have similar impacts associated with water quality, land use, when compared to the proposed project. Once operational, this alternative would result in greater impacts to air quality and exhaust emissions than the proposed project.

Therefore, the Reduced Project Alternative would reduce impacts in most environmental issue areas as compared to the proposed project.

8.5.3 Alternative C: Build-Out of Existing Land Use Alternative

Under Alternative C: Build-Out of Existing Land Use Alternative, the project site could be developed to the maximum intensity allowed under the land use designations of the plan of Blue Marine Energy Limited. This alternative would yield a number of residential units with agricultural and grazing uses, including breeding and/or grazing of animals. Under this alternative, no utility scale solar PV panels would be developed, as those entitlements do not currently exist on-site.

8.5.3.1 Impacts Compared to the Project Impacts

The following compares environmental impacts associated with the Build-Out of Existing Land Use Alternative to those identified for the proposed project.

8.5.3.1.1 Visual Amenity

Under the Build-Out of Existing Land Use Alternative, the project site would be developed with a number of residential units with agricultural and grazing uses, including breeding and/or grazing of animals. Development of the project site with structures other than solar panels would not necessarily reduce the environmental impacts associated with the proposed project. Similar to the proposed project, the project site under the Build-Out of Existing Land Use Alternative would be fully developed with residential and agricultural operations; therefore, views of the project area would be altered from their undeveloped condition. Therefore, although different structures would be built, the Build-Out of Existing Land Use Alternative would still impact the aesthetic character of the project site. Accordingly, impacts to aesthetic resources resulting from implementation of the Build-Out of Existing Land Use Alternative would be similar to those of the proposed project.

8.5.3.1.2 Air Quality

Both the proposed project and the Build-Out of Existing Land Use Alternative would result in short-term construction emissions. However, it is likely that the Build-Out of Existing Land Use Alternative would require more equipment and potentially a longer construction period to construct the necessary infrastructure (e.g., utility lines, water quality facilities, etc.), site

improvements, and buildings, which would result in significantly higher short-term air quality impacts. The specific levels of emissions to determine which air emissions standards would be violated are not known until a final site plan, infrastructure needs analysis, and an accompanying phasing plan is developed. However, because construction emissions under the Build-Out of Existing Land Use Alternative would likely be much greater than the proposed project, this alternative would result in significant cumulative level construction-related air quality emissions.

Once operational, emissions associated with the proposed project would be minor and limited to maintenance and monitoring activities only. The facility would reduce future regional air pollution by taking the place of fossil-fuel-burning power generation, or reducing the need for construction of additional polluting facilities. Conversely, operational emissions associated with the development of a number of residential units with agricultural and grazing uses, including breeding and/or grazing of be greater due to increased traffic and other emissions sources. Therefore, although the exact amount of operational emissions cannot be ascertained for the Build-Out of Existing Land Use Alternative at this time, it can be assumed that emissions would be higher than the proposed project. As such, impacts to air quality during operation of the Build-Out of Existing Land Use Alternative would be greater as compared to the proposed project.

8.5.3.1.3 Terrestrial Ecology

Both the proposed project and the Build-Out of Existing Land Use Alternative would result in the development of a previously undeveloped project site. Therefore, similar to the proposed project, it is anticipated that the Build-Out of Existing Land Use Alternative would also require the implementation of mitigation measures in order to reduce the severity of potential impacts to ecological resources. The transmission line corridors would not be built out. This would reduce some of the biological impacts associated with the project. However, this alternative would result in fewer project-level impacts to various species because a reduced amount of total acreage would be developed. However, the exact level of significance is not known until a site plan is created and biological impacts associated with the plan can be assessed. Therefore, impacts to biological resources from the Build-Out of Existing Land Use Alternative would be less than those of the proposed project.

8.5.3.1.4 Archaeology and Cultural Resources

Field surveys indicate the presence of a number of cultural resources on the project site. Mitigation measures are provided to reduce impacts to these resources to below a level of significance. The Build-Out of Existing Land Use Alternative would require similar mitigation measures be instituted to reduce impacts to below a level of significance. Impacts to cultural resources from the Build-Out of Existing Land Use Alternative would be similar to those resulting from the proposed project.

8.5.3.1.5 Soil

Both the proposed project and the Build-Out of Existing Land Use Alternative would result in impacts to geology and soil that are similar to, or the same as, the proposed project. During construction, the amount of soil disturbances could be greater, or the same as, the project.

The character of on-site soils and the depth of the groundwater table make the potential for liquefiable materials to be present beneath the site. Actions required by law would reduce the risks of seismic ground-shaking hazards, and would ensure that all impacts related to seismic ground shaking would be less than significant.

8.5.3.1.6 Dust & Exhaust Emissions

Similar to the proposed project, the Build-Out of Existing Land Use Alternative would result in short-term exhaust emissions during construction activities for potential residences on the three sites. However, unlike the Build-Out of Existing Land Use Alternative, as a solar PV generating facility, its ongoing operations would offset exhaust emissions generated by fossil-fuel-based sources of energy. Conversely, the Build-Out of Existing Land Use Alternative would continue to generate operational exhaust emissions throughout the life of the proposed development from increased traffic, operation of residential and agricultural operations, with no offsets, and therefore a net gain of exhaust emissions would result. Therefore, because the Build-Out of Existing Land Use Alternative would result in a net gain of exhaust emissions impacts from this alternative would be greater as compared to the proposed project.

8.5.3.1.7 Waste Generation

The Build-Out of Existing Land Use Alternative at the project sites would continue their current agricultural practices, and expected current use of pesticides, fertilizers, and fuels for farming equipment. In comparison to the proposed project, the on-site hazards or potential use of hazardous materials would be greater.

8.5.3.1.8 Water Quality

The proposed project would only require grubbing and light grading during construction. The Build-Out of Existing Land Use Alternative would likely require changes to the landscape and drainage patterns of the portion of the project sites where development would occur (residential area). Construction of these areas could also result in the discharge of wastewater and urban runoff at the project sites.

The proposed project would reduce site pervious by less than one percent; the Build-Out of Existing Land Use Alternative would likely reduce preciousness by a much higher percentage.

Once operational, water demand associated with the proposed project would be minimal and limited to maintenance activities (i.e., panel washing) only; the required water would be less than baseline demand (current agricultural usage). Conversely, operational water demand associated with the development of residences and continued agricultural operations, as proposed under this alternative, would be significantly greater. As such, impacts to water supplies during operation of the Build-Out of Existing Land Use Alternative would be greater as compared to the proposed project.

In summary, the Build-Out of Existing Land Use Alternative results in similar impacts related to flooding, erosion, and siltation, but greater impacts than the proposed project to groundwater recharge and water usage. Accordingly, impacts to hydrology and water quality

from the Build-Out of Existing Land Use Alternative would be greater as compared to the proposed project.

8.5.3.1.9 Land Use

Unlike the proposed project, the Build-Out of Existing Land Use Alternative would not conflict with the existing general plan land use designations at the project site; therefore, this alternative would not require approval of certain discretionary requests such as a Specific Plan Amendment. However, with approval of all discretionary requests, the proposed project would also be consistent with the land use and zoning designations at the project site and would not conflict with any applicable land use plans, policies, or regulations. Similar to the proposed project, the Build-Out of Existing Land Use Alternative would not be located between housing developments or communities; therefore, this alternative would not physically divide an established community.

Because the Build-Out of Existing Land Use Alternative would not require approval of certain discretionary requests in order to maintain consistency with all applicable land use plans, there would be fewer impacts to land use and planning from the Build-Out of Existing Land Use Alternative than the proposed project.

8.5.3.1.10 Noise

If the Build-Out of Existing Land Use Alternative is implemented, short-term construction would result in slightly lower maximum noise levels to surrounding areas due to the reduced amount of structures being built at the same time and continued operation of agricultural operations when compared to the proposed project. Similar to the project, the Build-Out of Existing Land Use Alternative would result in less than significant short-term construction impacts from noise and vibration.

8.5.3.1.11 Traffic

Both the proposed project and the Build-Out of Existing Land Use Alternative would result in short-term increases in traffic volumes on local streets as a result of construction vehicles and equipment traveling to and from the project site. However, it is likely that the Build-Out of Existing Land Use Alternative would require more equipment and a significantly longer construction period to construct the necessary infrastructure (e.g., utility lines, water quality facilities, etc.), site improvements and buildings. While the precise length of the construction period cannot be known until a site plan, infrastructure needs analysis, and an accompanying phasing plan is developed, the construction of a number of residences and continued agricultural operations would require more time than the proposed construction period of the solar project on all three sites, and also necessitate more construction workers required for the proposed project. Therefore, it is likely that the Build-Out of Existing Land Use Alternative would result in significantly greater construction-period traffic and transportation impacts.

Once operational, additional vehicle trips associated with the proposed project would be minor and limited to maintenance and monitoring activities and commute trips. Conversely, operational vehicle trips associated with the development of a number of residences and continued agricultural operations would be greater due to the nature and intensity of the land uses. Therefore, although the exact amount of operational vehicle trips cannot be ascertained

for the Build-Out of Existing Land Use Alternative at this time, it can be assumed that vehicle trips would be higher than the proposed project. As such, impacts to traffic and transportation during operation of the Build-Out of Existing Land Use Alternative would be greater as compared to the proposed project.

8.5.3.2 Conclusion

8.5.3.2.1 Avoid or Substantially Lessen Project Impacts

While this alternative would reduce impacts to agricultural lands, biological resources, and land use and planning the Build-Out of Existing Land Use Alternative would not avoid the significant and unavoidable impacts of the proposed project related to air quality. The Build-Out of Existing Land Use Alternative would also result in fewer impacts to land use and planning as compared to the proposed project. However, this alternative increases project impacts related to air quality, exhaust emissions, waste generation, water quality, and traffic.

8.5.3.2.2 Attainment of Project Objectives

Alternative C, the Build-Out of Existing Land Use Alternative, would not meet any of the project objectives.

8.5.3.2.3 Comparative Merits

The Build-Out of Existing Land Use Alternative would reduce impacts associated with agricultural lands, biological resources, and land use and planning when compared to the proposed project. The Build-Out of Existing Land Use Alternative would have similar impacts associated with visual amenity, cultural resources, soils, noise, when compared to the proposed project. This alternative would result in greater impacts to air quality, emissions, waste generation, water quality, and traffic than the proposed project.

8.5.4 Alternative D: No Utility Scale Solar Development Distributed Commercial and Industrial Rooftop Solar Only Alternative

This alternative would involve the development of a number of geographically distributed small to medium solar PV systems within existing developed areas, typically on the rooftops of commercial and industrial facilities situated throughout the project area.

Under this alternative, no new land would be developed or altered. However, depending on the type of solar modules installed and the type of tracking equipment used (if any), a similar or greater amount of acreage (i.e., greater than 4.5 bighas of total rooftop area) may be required to attain proposed project's capacity of 249.6 kWp of solar PV generating capacity. Because of space or capital cost constraints, many rooftop solar PV systems would be fixed-axis systems or would not include the same type of sun-tracking equipment that would be installed in a freestanding utility-scale solar PV project and, therefore, would not attain the same level of efficiency with respect to solar PV generation. This objective would enable the generation of 249.6 kWp of electricity, but it would be for on-site use only. This alternative assumes that rooftop development would occur primarily on commercial and industrial structures due to the greater availability of large, relatively flat roof areas necessary for efficient solar installations.

This alternative would involve a number of installation locations across the area, many of which would require discretionary action, such as design review, or zone variances, depending on local jurisdictional requirements. Similar to the proposed project, this alternative would be designed to operate year-round using PV panels to convert solar energy directly to electrical power. Power generated by such distributed solar PV systems would typically be consumed on site by the commercial or industrial facility without requiring the construction of new electrical substation or transmission facilities.

Like utility-scale PV systems, the area of rooftops or other infrastructure required per kWp of electricity produced is wide ranging, which is largely due to site-specific conditions (e.g., solar insolation levels, intervening landscape or topography, PV panel technology, etc.).

8.5.4.1 Impacts Compared to Project Impacts

8.5.4.1.1 Visual Amenity

This alternative would reduce aesthetics impacts compared to the proposed project. Under this alternative, vacant land would not be developed to accommodate solar panels, but rather existing developed areas would be modified. In many cases, the installation of solar panels on large commercial and industrial rooftops would be visually unobtrusive or unnoticeable from receptors at ground level. In other circumstances, the installation of rooftop solar panels may be visible, but would not likely affect the visual character or scenic quality of an area, because the character or quality of an area has already been altered as a result of the building's construction. The exceptions may be if rooftop solar were proposed on historic buildings, which could affect the historic character and integrity of the buildings. Implementation of this alternative would require historic surveys and investigations to evaluate the eligibility of potentially historic structures that are over 50 years old, and either avoidance of such buildings, or incorporation of design measures to minimize impacts on historic integrity of historically-significant structures. This alternative would also have less than significant aesthetic impacts as the proposed project.

8.5.4.1.2 Air Quality

This alternative would reduce impacts on air quality compared to the proposed project. Under this alternative, the project site would remain agricultural or vacant land, and only developed areas would be modified. No construction activities or ground disturbance would occur. Vehicular mobile-source emissions from commuting workers associated with installation of the equipment under this alternative would be similar to the construction worker trip emissions generated by the proposed project. However, these emissions would be spread out over a larger area, and potential impacts would be lower. During operations, this alternative would have the same beneficial impacts on air quality as the proposed project.

8.5.4.1.3 Terrestrial Ecology

This alternative would reduce impacts on biological resources compared to the proposed project. Under this alternative, the project site would remain agricultural or vacant land, and only developed areas would be modified. As a result, there would be no potential for disturbance of sensitive or endangered species because no construction or operational

activities would occur. Potential loss of foraging habitat for burrowing owls would be avoided. Thus, this alternative would have fewer biological impacts than the proposed project.

8.5.4.1.4 Archaeology and Cultural Resources

This alternative would reduce impacts on cultural resources compared to the proposed project. Under this alternative, the project site would remain agricultural or vacant land, and only developed areas would be modified, and there would be no potential for disturbance or damage to identified or concealed cultural resources at or near the project site. If rooftop solar were proposed on historic buildings, this alternative could affect the historic character and integrity of the buildings. Implementation of this alternative would require historic surveys and investigations to evaluate the eligibility of potentially historic structures that are over 50 years old, and either avoidance of such buildings, or incorporation of design measures to minimize impacts on historic integrity of historically-significant structures. Therefore, the potential impact on cultural resources would be less than the impact under the proposed project.

8.5.4.1.5 Soil

This alternative would reduce impacts associated with geologic conditions. Under this alternative, the project sites would remain agricultural land, and only developed areas would be modified, and there would be no potential for disturbance to undeveloped land. Under this alternative, the number of sun-tracking structures built would be reduced and rooftop solar would be developed, and no potential impacts would occur. Impacts to geology and soils under this alternative would be slightly less as compared to the proposed project.

8.5.4.1.6 Dust & Exhaust Emissions

This alternative would reduce construction-period exhaust emissions compared to the proposed project. This alternative would involve construction activities, but would be at a much smaller scale than the proposed project. Much fewer heavy equipment operation and large truck deliveries would be required to implement this alternative, and construction emissions that contribute to emissions would be reduced. Trips by commuting workers to install rooftop equipment would be spread out over a larger area when compared with construction worker trip emissions of the proposed project, and potential impacts would be lower. During project operations, the potential offsets or displacement of emissions, compared with traditional gas- or coal-fired power plants, would be realized to the same degree as they would under the proposed project because of reduced renewable power generating potential. Thus, exhaust emissions from this alternative would be less than those of the proposed project during construction, and emissions reductions would be similar to those of the proposed project during operations.

8.5.4.1.7 Waste Generation

Although Alternative D would result in the development of fewer PV panels as compared to the proposed project, this alternative would still result in hazardous waste generated during the construction period and would consist of liquid waste, including cleaning fluids, dust

palliative, herbicides, and solvents. Alternative D would have reduced ground disturbing construction activities, therefore, this alternative would reduce impacts related to these hazardous materials.

8.5.4.1.8 Water Quality

This alternative would reduce impacts on water quality compared to the proposed project. Under this alternative, no construction would occur and drainage patterns on the project site would not be altered. However, water use with a continuation of the current agricultural land uses on the project site would be significantly higher than those that would exist with implementation of the proposed project. Overall, there are unique environmental benefits related to water quality present with implementation of either the proposed project or this alternative, and the impacts of the two proposals are therefore judged to be similar.

8.5.4.1.9 Land Use

Installation of rooftop solar would be consistent with current zoning as well as existing land use plans, policies, and regulations. This alternative would also achieve the goals and policies relative to accommodating renewable energy facilities. As there would be no large-scale solar field, no decommissioning plan would need to be prepared as a mitigation measure. However, the placement of solar panels on other structures throughout the region would result in unknown entitlement requirements, depending on the project location, zoning, land use, and potential environmental impacts on the site and surrounding areas. Impacts to land use and planning related to this alternative are therefore assumed to be similar to those of the proposed project.

8.5.4.1.10 Noise

Because more solar panels may be required, there may be an increase in the transportation related noise near sensitive receptors. Therefore, impacts from noise generating activities would be greater than the proposed project.

8.5.4.1.11 Traffic

This alternative would require a similar number of vehicular trips to transport and install the solar panels. However, the trips would be more dispersed and would not congregate in one location, thereby reducing impacts on surrounding roadways. This alternative would have nominal effects on transportation and traffic, and impacts would be reduced compared to the proposed project.

8.5.4.2 Conclusion

8.5.4.2.1 Avoid or Substantially Lessen Project Impacts

This alternative would result in fewer impacts to ecological resources, archaeological and cultural resources, soils, and traffic. Similar impacts compared to the proposed project would result from this alternative in the areas of air quality, exhaust emissions, water quality, and land use. Therefore, for most environmental issue areas, this alternative would result in fewer environmental impacts, both short-term and long-term, when compared to the proposed project.

8.5.4.2.2 Attainment of Project Objectives

Alternative D, the No Utility-Scale Solar Development Alternative, would not meet the following project objectives:

- Locate solar power plant facilities as near as possible to electrical transmission facilities with anticipated capacity and reserved queue position.
- Ensure that the project can be constructed, and power provided at a competitive price.

8.5.4.2.3 Comparative Merits

The No Utility-Scale Solar Development Alternative would reduce impacts associated with ecological resources, archaeological and cultural resources, soils, and traffic when compared to the proposed project. Impacts related to air quality, exhaust emissions, water quality, and land use would be similar to those of the proposed project.

Additionally, this alternative would achieve most of the project objectives, such as assisting in achieving the State's RPS and GHG reduction objectives, siting panels on disturbed areas and using a proven and available solar PV technology. This alternative however includes a number of drawbacks, including, but not limited to the following:

- There would be difficulties with respect to build out of the system within a timeframe that would be similar to that of the proposed project.
- Given the distributed nature of such a network of facilities, management and maintenance would not be as efficient, and total capital costs would likely be higher.
- The requirement to negotiate with a large number of individual property owners to permit placement of solar panels on rooftops.
- The difficulty of ensuring proper maintenance of a large number of smaller solar installations.
- The lack of an effective electricity distribution system for large numbers of small electricity producers.

Given the size of the proposed project, the project objectives, the need to arrange a suitable assemblage of participating commercial and industrial properties and the challenges stated above, it is impractical and infeasible to propose a distributed generation project of this type and still proceed within a reasonably similar timeframe.

8.5.5 Comparison of Alternatives

Table 8.2: Comparison of Alternatives

Environmental Resource	Alternative A: No Project	Alternative B: Reduced Project	Alternative C: Build Out of Existing Land Use	Alternative D: No Utility Scale Solar Development
Visual Amenity	Fewer	Fewer	Similar	Similar
Air Quality	Fewer	Fewer	Fewer	Fewer
Ecological	Greater	Fewer	Greater	Similar

Environmental Resource	Alternative A: No Project	Alternative B: Reduced Project	Alternative C: Build Out of Existing Land Use	Alternative D: No Utility Scale Solar Development
Resources				
Archaeological and Cultural Resources	Fewer	Fewer	Fewer	Fewer
Soils	Fewer	Fewer	Similar	Fewer
Dust & Exhaust Emissions	Similar	Similar	Similar	Fewer
Waste Generation	Similar	Similar	Greater	Fewer
Water Quality	Fewer	Similar	Greater	Similar
Land Use	Fewer	Similar	Fewer	Similar
Noise	Fewer	Fewer	Similar	Greater
Traffic	Fewer	Fewer	Greater	Fewer
Meet Project Objectives?	NO	YES	NO	NO
Reduce Significant and Unavoidable Impacts?	YES	YES	NO	YES

8.5.6 Environmentally Superior Alternative

As presented in the comparative analysis above, and as shown in Table 5.2, the Environmentally Superior Alternative for the proposed project would be Alternative A, or the No Project alternative. This alternative would avoid all significant and unavoidable impacts that would occur under the proposed project. No substantially adverse and long-term impacts would occur to the environment as a result of this alternative. This alternative would also result in fewer impacts to visual amenity, agricultural and forest resources, biological resources, cultural resources, hydrology and water quality, land use, noise, and traffic as compared to the proposed project, but the failure to construct a renewable energy production facility results in increased impacts in the long-term to air quality and exhaust emissions.

Alternative D, or the No Utility-Scale Solar Development—Distributed Commercial and Industrial Rooftop Solar Only, similarly avoids significant impacts to agriculture resources, biological resources, cultural resources, public services and traffic and transportation.

Alternative B like the No Project Alternative, reducing the scale of the project increases long-term impacts to air quality and emissions. Alternative C would include the build-out of existing land use designations in the project area, resulting the preservation of agricultural areas and no impacts in the land use and planning categories. However, increased development in the area, without the inclusion of a renewable energy generation facility, would significantly increase impacts in several other environmental issue areas, including air quality, emissions, waste generation, water quality, and traffic.

9 PUBLIC CONSULTATION AND DISCLOSURE

9.1 General

Public Consultation is a tool for managing two-way communication between the project sponsor and the public. Its goal is to improve decision-making and build understanding by actively involving individuals, groups and organizations with a stake in the project. This involvement will increase a project's long term viability and enhance its benefits to locally affected people and other stakeholders. Stakeholder engagement is an integral part of ESIA good practice and is a statutory requirement of the national ESIA legal framework in Bangladesh and within the World Bank (WB) Policy on Environmental and Social Safeguards. The consultation program for the Project is based on informed consultation and participation in line with ESIA requirements with affected people, and is designed to be both fair and inclusive. Consultation activities have been conducted during the environmental survey of the ESIA in April 2016.

9.2 Objectives

The objective of stakeholder consultation is to ensure that a participatory approach takes place, which in turn documents concerns of all stakeholder groups and makes sure that such concerns are considered, responded to, and incorporated into the decision making process of the development. Stakeholder consultation needs to be a two-way communication process that imparts information to stakeholders, but also obtains additional and on-the-ground information from them. Stakeholder consultation and engagement must take place at the inception phase of the ESIA process and implemented all through the study period.

The specific objectives of this chapter are to:

- Summarize Developer, national and international legal & policy requirements for stakeholder engagement;
- Describe and identify the stakeholders affected and/or with an interest in the Project;
- Summarize stakeholder engagement and consultation conducted to date;
- Describe how the views and issues raised have informed and influenced the development of the Project; and
- Outline the future plans and approach to stakeholder engagement.

9.3 Consultation with Various Stakeholders

A stakeholder is defined as any individual or group who is potentially affected by the proposed Project or can they affect the proposed Project directly or indirectly. Stakeholder consultation is an inclusive process for sharing information that enables stakeholders to understand the risks, impacts, and opportunities of a development or project, allowing them to express their views and articulate their perceptions towards it.

Through the project preparation stage extensive consultations/FGDs have been arranged during the conduct of the ESIA surveys. The details of FGDs are given in the following Table 9.1. The findings of these of these FGDs are summarized in Table 9.2 and the details of these FGDs are given in Appendix G.

Table 9.1: Details of FGDs

FGD No.	Type of Participants	No. of Participants
1	Local People	15
2	Local People	10
3	Local People	15
Total		40



Figure 9.1: Photos of Focus Group Discussions (FGD)

Table 9.2: Summary of the FGDs

Questions to the Groups	Participants opinion, comments and suggestions
Are you aware about the activities of this Solar Mini-Grid Power Plant construction project in this Island? If yes, how do you?	Yes, the project proponent has shared this information with us. The owner will establish Solar Power Plant and will distribute electricity among us.
How the project will impact on surrounding environment?	Construction of this solar mini grid power plant, surrounding environment may impact but temporary. Air pollution and noise pollution will influence on surrounding environment. Agricultural land will decrease because of the implementation of this project. The project proponent should take proper attention regarding to reduce these impacts. The waste materials should be maintained properly and it should not be kept at open place.
Is there any industry that pollutes air? If have please mention.	There is no such industry that pollutes air. Only generators pollute the surrounding air in this island. There are approximately 55 different capacities generators have been used to generate electricity in the island. Almost 5 liter diesel burned for every generator in every day (Only at night time- some 7pm to 12pm & some 7 pm to 6am),
Do you think any air pollution would affect the surrounding environment due to this project construction and operation activities? If yes how to mitigate?	The air quality will not anticipate significantly because of construction activities. Through more traffic will run to carry construction materials which will increase dust around the roadside but this would not be harmful to local people. Construction of building for workers shed and other facilities will decrease the local air quality temporarily.

Questions to the Groups	Participants opinion, comments and suggestions
	As the project site is beside some residential dwellings so there is minor possibility of anticipated impact but proper care about battery, sensitive equipment etc. should minimize the anticipated impact. The proponent needs to take some attention to reduce this impact.
Is there any noisy activity that disturb surrounding environment?	No. There is no such significant noisy activity in this island. Only people gathering in bazaar & beach site, different kind of sound deck and local vehicles (Van and bike honking) make noisy activity but that is not significant anticipated impact.
Do you predict any noise pollution would affect the surrounding environment due to the project activities during construction and operation? If yes, how to mitigate?	The noise level will increase because of running construction machineries and movement of workers. The effect will be temporary. After the construction is finished, the noise level will come back to its original level. Still, there should be proper noise barrier or boundary wall at the noise source.
Is there any water pollution activity found?	No, water pollution sources are not significant anticipated impact.
Do you think any impact on water quality due to project activities? If yes, how to mitigate?	There is no problem with the ground and the surface water quality because of the Solar Power Plant construction. However, the project proponent should confirm that no accidental spillage or washout of hazardous/waste material to surrounding water bodies during construction; particularly in the monsoon.
What are the significant species (flora & fauna) that are found in the water body?	Different types of Corals found in the sea.
Can you tell significant terrestrial flora and fauna species in this island?	Some general terrestrial trees such as Coconut, Kyea, Betel Nut, Akasmoni, Jackfruit, Banana, Jaugas, Kodom and Shimul trees etc Among the fauna Buffalo, Cow, Goat, Pigeon, Duck, Chicken, different types of snakes. There are several avian also present in this island.
Do you think that the solar mini grid power project will affect your livelihood? If yes, how to assess?	Yes, by this project unskilled and poor women can develop their skills. They will help their family by earning money as well as help to national economy. The local economy will develop after having the access of electricity. The education status of this area will develop. The educational institution will be able to teach computer lesson to their students after having the electricity which is now not possible. Business sector will increase here and more tourists will come to visit this island. As now they are using home based solar panel and diesel-based generator for getting electricity, after commercially operation of this solar mini grid will also reduce air pollution.

Questions to the Groups	Participants opinion, comments and suggestions
	The project proponent should consider more households under the grid as well as the electricity generation should be increased.
Coral reef is the most significant species found in this area. Do you think Coral reef would affect the project activities?	Coral reef is far away from project site. Coral reef will not be affected due to project activities.
How far away from the project area the coral reef species exist?	Coral reefs contribute to local economies through tourism. Coral reef is far away from project site. It is almost 2-3 km far from project site.
Is any other wildlife (birds, snakes, crabs, etc.) available in the area?	No
Is the proposed project are inundated during flood? If yes, how much?	Hence, the area is an island. The area is flood affected area especially during high flood time. During monsoon period low lying areas are flooded.
Are you in favor of this project? Why?	Yes, we appreciate the initiative. This will influence the other people to take initiative of such kind project. In the long run it will help to develop the economic and social condition in this area.

10 ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

10.1 General

This section identifies the overall impacts on the physical, biological and socio-economic environment of the project area. An environmental impact is defined as any change to an existing condition of the environment. Identification of potential impacts has been done on the basis of baseline data collected from secondary and primary sources. Environmental impacts assessment was carried out considering present environmental setting of the project area, and nature and extent of the proposed activities.

An Environmental and Social Impact Assessment (ESIA) presents the key instrument by which it is possible to eliminate these problems, as well as that a special attention within the ESIA needs to be paid to:

- Avoid rough estimates, predictions and assessments based only on textual comments;
- The assessment of impacts of the planned project that will be based not only on identification of majority of impacts but also on consideration of different aspects of possible impacts.

Here, it is of particular importance to choose a method which is based on the application of MCDM (Multiple Criteria Decision Making) in the field of environmental protection, because the use of the MCDM enables an analysis of different aspects of project impacts necessary for making decisions which optimize effects of certain activities relative to the capacity of space and environmental capacity. Methods based on the MCDM have a wide application in environmental and social impact assessment of proposed projects.

The Leopold matrix has been chosen as a suitable method. There are several major reasons why precisely this approach to ESIA has been chosen as appropriate for further development:

- The Leopold matrix presents a framework approach to impact assessment of a project because of which it is possible to creatively work on its further development;
- It is widely applicable in carrying out an ESIA for different types of projects. Given that it has been used for many decades now, its major principles are known to scientific and professional circles, thereby implying that the elaboration of the obtained results will be understandable to many scientists and experts;
- The way of presenting the results can be appropriate for overcoming the existing problems in the realization of solar projects in Bangladesh because descriptive and rough assessment of possible impacts is avoided in the practice of carrying out an ESIA;
- Leopold matrix fits in the framework MCDM method.

In this ESIA, we refer to the Leopold matrix as one of the pioneering and widely used approaches to impact assessment, which was the first comprehensive listing of environmental and socio-economic factors. This matrix is two-dimensional, where the stages of almost any type of construction project (actions) are assessed in relation to the existing environmental

characteristics and conditions that may be affected during the execution of those actions.

10.2 Methodology of the Leopold Matrix

The Leopold matrix was conceived by geologist Luna B. Leopold and his colleagues in 1971, as a response to the US Environmental Policy Act of 1969, which didn't give clear instructions to the Federal Government agencies for preparing an impact report or for examining the environmental effects of the projects that an agency plans. The Leopold matrix addressed this challenge by 'providing a system for the analysis and numerical weighting of probable impacts'. As pointed out by the creators of the Leopold matrix, there is a clear advantage of using the matrix 'as a checklist or reminder' of the large scope of actions and impacts on the environment that can relate to the proposed actions (Leopold, Clarke, Hanshaw, & Balsley, 1971).

According to the Leopold matrix method, ESIA should consist of three basic elements: a) a listing of the effects on the environment that the proposed development may induce, including the estimate of the magnitude of each of the effects; b) an evaluation of the importance of each of listed effects (e.g., regional vs. local); and c) a summary evaluation, which is a combination of magnitude and importance estimates.

The format of Leopold matrix evolves around 8,800 possible interactions since the number of actions listed on the horizontal axis in the sample matrix is 100, and the number of environmental factors listed on the vertical axis of this matrix is 88. As the authors of this method pointed out, there are, however, only a few of the interactions that would deserve comprehensive consideration due to their expressed magnitude and importance, varying between 25 and 50 interactions on average for a typical project (Leopold, Clarke, Hanshaw, & Balsley, 1971).

In order to achieve higher efficiency of the matrix, a starting point is to check each significant action listed in a horizontal axis. The experience often proves that 'only about a dozen actions will be important' (Leopold, Clarke, Hanshaw, & Balsley, 1971). Each checked action is evaluated in terms of magnitude of effect on environmental factors that are listed in the vertical axis. In the matrix, across each box where significant interaction is expected, a slash (/) is placed diagonally from upper right to lower left angle of the block. In the text which accompanies the Leopold matrix, the evaluator has to indicate whether the assessment is for short-term or long-term impacts. Then, in the upper left-hand angle of each box with a slash, the evaluator should place a number from 1 to 10, which indicates the magnitude of the possible impact, where 10 represents the greatest magnitude of impact and 1 the least (no zeros should be assigned). The scale of importance (placed in the lower right-hand angle of each box with a slash) may also range from 1 to 10, with the same principle applied – the higher the value, the higher the importance. Assignment of numerical value for importance is based on subjective judgment of a multi-disciplinary team working in the ESIA. In addition to assigning the numerical values to each marked box, plus (+) or minus (-) sign can be used to show whether an impact is beneficial or adverse.

The ESIA is a discussion of the individual boxes marked with greater numbers for magnitude and importance. This is commonly applied to a simplified or reduced matrix, which consists

only of those actions and environmental characteristics that have been identified as interacting. The rating scheme requires quantification that expresses evaluator's judgment (line of reasoning) in terms of probable impacts. This scheme then enables the reviewer to systematically follow the evaluator's standpoints, to assist in identifying points of agreement and disagreement.

Although most matrices are developed for specific application, Leopold matrix is quite general. That is a plus point for its wider application, as well as the fact that the method can accommodate both quantitative and qualitative data.

There is an opportunity in the Leopold matrix to double count impacts, therefore the method is not mutually exclusive. One of the strongest points of the Leopold matrix is that it draws a clear line and safeguards evaluator's opinion from the value judgments and political interference by policy makers. This is achieved by disaggregated presentation of detailed assessment results, leaving policy makers with full responsibility for the evaluation synthesis and for drawing its policy implications, and such point has been accepted as an evaluation standard for decades.

10.3 Environmental and Social Impact Assessment Using Leopold Matrix

For the analysis of possible impacts of certain activities and procedures during the construction of the solar mini grid power plant and its exploitation on the environmental elements, 3 possible factors, which are actually activities on the realization of the solar project, have been singled out from a wider list of potential factors of impacts that can be expected for such type of interventions in nature. Although it is possible to partially determine aggregate, i.e. average assessment of impact factors for each of these components, we consider that it is sufficiently appropriate and functional to present them as a whole. The fact is that some of them are synergistic ones, mutually reinforcing their effects, so that this matching of information should be maintained in the analysis. A synthetic presentation of endangering factors is given through mean values and not through aggregate assessment, which will be later scaled.

Impact factors have been evaluated separately for each environmental component relevant for the scope of this study, and scored on a scale from 0 to 5 for **impact magnitude**, according to the following scale:

- 0 – no observable effect;
- 1 – low effect;
- 2 – tolerable effect;
- 3 – medium high effect;
- 4 – high effect;
- 5 – very high effect (devastation).

In addition to the standard form of the Leopold matrix, the following criteria have also been used: **Impact significance** with designations from L to M, according to the following scale:

- L – limited impact on location;

O – impact of importance for the area;

R – impact of regional character;

N – impact of national character;

M – impact of cross-border character.

Impact probability with designations from M to I, according to the following scale:

M – impact is possible (probability of less than 50%);

V – impact is probable (probability of over 50%);

I – impact is certain (100% probability).

Impact duration with designation P (occasional/temporary) and D (long-term/permanent).

Furthermore, physical, biological and socio-cultural environmental characteristics of the subject location have been separated and, within them, 14 environmental components have been defined.

Effects of impact factors have been assessed for environmental components of the subject location (!). The results of the analysis are shown in the following tables for all environmental components and impact factors in the form of Leopold matrix, and then elaborated in an appropriate way.

Table 10.1: Matrix of Magnitude of the Impact Factors on Environmental Components

	Blue Marineaged Impact Factors	PROJECT ACTIVITIES			Sum of IF Values by Types	Average Values
		Planning & Construction Phase	Operation Phase	Decommissioning Phase		
Physical Components	Land filling/Earthworks			0	4	1.33
	Infrastructure & Utilities				0	1.33
	Geology & Hydrology	4	2		4	2.67
	PV Panels, Battery	0	4	0	0	1.33
	Backup Generator	0	3	0	3	1
	Air Quality	1	1	2	4	1.33
	Noise	2	2	2	6	2
	Waste Generation	4	0	0	4	1.33
Biological Components	Diversity of Flora	1	1	0	2	0.67
	Diversity of Fauna	1	1	0	2	0.67
Sociocultural Components	Socioeconomic Conditions	0	0	0	0	0
	Landscape and Visual	3	1	0	4	1.33
	Land Use	0	0	0	0	0
	Health & Safety	2	1	2	5	1.67
Cumulative Values of IF according to Environmental Factors		22	16	12		
Average		1.57	1.14	0.86	IF = 1.19	

Table 10.2 Matrix of Significance of the Impacts of Factors on Environmental Components

	Blue Marineaged Impact Factors	PROJECT ACTIVITIES		
		Planning & Construction Phase	Operation Phase	Decommissioning Phase
Physical Components	Land filling/Earthworks	L		
	Infrastructure & Utilities			R
	Geology & Hydrology	R	R	R
	PV Panels, Battery		L	
	Backup Generator		L	
	Air Quality	R	R	R
	Noise	L	L	L
	Waste Generation	L		
Biological Components	Diversity of Flora	N	N	
	Diversity of Fauna	N	N	
Sociocultural Components	Socioeconomic Conditions			
	Landscape and Visual	L	L	
	Land Use	R		
	Health & Safety	L	L	L

Table 10.3: Matrix of Probability of the Impact of Factors on Environmental Components

	Blue Marineaged Impact Factors	PROJECT ACTIVITIES		
		Planning & Construction Phase	Operation Phase	Decommissioning Phase
Physical Components	Land filling/Earthworks	I		
	Infrastructure & Utilities			V
	Geology & Hydrology	V	V	V
	PV Panels, Battery		V	
	Backup Generator		I	
	Air Quality	I	V	I
	Noise	I	V	V
	Waste Generation	V		
Biological Components	Diversity of Flora	I	V	
	Diversity of Fauna	I	V	
Sociocultural Components	Socioeconomic Conditions			
	Landscape and Visual	V	V	
	Land Use			
	Health & Safety	V	V	V

Table 10.4: Matrix of Duration of the Impact of Factors on Environmental Components

	Blue Marineaged Impact Factors	PROJECT ACTIVITIES		
		Planning & Construction Phase	Operation Phase	Decommissioning Phase
Physical Components	Land filling/Earthworks	P		
	Infrastructure & Utilities			D
	Geology & Hydrology	D	D	P
	PV Panels, Battery		D	
	Backup Generator		D	
	Air Quality	D	D	P
	Noise	D	D	P
	Waste Generation	P		
Biological Components	Diversity of Flora	D	D	
	Diversity of Fauna	D	D	
Sociocultural Components	Socioeconomic Conditions			
	Landscape and Visual	P	D	
	Land Use			
	Health & Safety	P	D	P

St. Martin's Island is one of the most popular tourist destinations in Bangladesh. The island annually attracts thousands of tourists because of its beautiful land and seascapes and clear sea water. St. Martin's Island has an important ecological value as one of the few remaining nesting places in the region for several species of globally threatened marine turtles, as well as being a wintering site for migratory birds. Due to its favourable and unique environmental conditions, it is the only place in Bangladesh where coral colonies are found.

Potential environmental impacts associated with the proposed project activities of both the projects are classified as:

- (i) Impacts during pre-construction/design phase
- (ii) Impacts during construction phase and
- (iii) Impacts during operation phase.
- (iv) Impacts during decommissioning phase

Qualitative and quantitative techniques have been applied for direct and indirect impact identification. Impacts are classified as being insignificant, minor, moderate and major. Impacts are described in the sections below.

10.4 Corridor of Impact (CoI)

The corridor of the proposed Impact (CoI) was delineated as the extent, which has direct or indirect impact of project. All direct impacts are constrained within the project boundary. Indirect impacts could be beyond the project boundary. According to the Department of Environment (DoE) guideline the project impact area is divided into two sections. One, those related to the project. Another section is those related to the background environmental features of the project site. This should cover not only the project site in proper, but generally an area of 1km radius around the site. In this project the farm area have been considered as core impact zone and 1km as buffer zone for better understanding.

10.5 Pre-construction Phase

Following is the brief description of impacts Blue Marineaged during the Pre-construction/Design Phase:

10.5.1 Land Use / Land-filling

Impact

The Project site location does not conflict with any of the relevant governmental entities formal planning context. The project initiator has bought this land from the owner with a good value so there is no conflict in land use for the project purpose. In addition, the Project site does not provide any major value to local communities. Therefore, there are no anticipated impacts during the planning phase of the Project. However, the proposed solar power plant will be in the agricultural land which might ultimately degrade surrounding agricultural land as well. There will be some major impacts due to land-filling: Pollution from overflow of filled earth (dredged materials); Erosion from the filled materials and side slope of filled lands.

Mitigation

The project developer is to take responsibility of minimizing environmental impact on the surroundings by following the project's environmental management plan (EMP). For example, the developer should advise contractor to must fenced the proposed area so that the surrounding agricultural land will not be disturbed. Since these activities are to be performed temporarily the minimum impact is expected to be acceptable. Land-filling for side slope of filled lands should be done only within the boundary line of the project to avoid damage to adjacent agricultural land, crops, trees or any other properties. In case of damage by any construction activity, adequate compensation should be paid to the owner in time

10.5.2 Flood Hazards

Impact

The Project site is subject to potential risk of local flood hazards during the rainy season and especially during flash flood events. Such risks must be taken into consideration throughout the planning phase of the Project as they could inflict damage to the Project and its various components.

Mitigation

The Solar Power Plant area is in a risk of flooding due to its topography, rainfall storm pattern, soil type, etc. and the area needs to be protected from potential floods. The project developer should undertake a flood risk study which will generally aim to determine flood quantities within the Solar Power Plant area and to estimate peak flood to determine the peak flow for the return period of 50 years. The study will identify the required hydraulic design structure which would be able to convey the flows safely and prevent flood risks for the infrastructure elements within the Solar Power Plant under the responsibility of project developer.

10.6 Construction Phase

Environmental effects of the construction phase are expected to be temporary. Construction impacts are considered to be minimal as all the construction works will be carried out within the site boundary of the procured land and will be controlled via the mitigation measures defined in the EMP section. Following is the brief description of impacts Blue Marineaged during the construction phase.

10.6.1 Visual Amenity

Impact

The construction activities that are likely to create a visual intrusion and a disruption to aesthetics include: materials lay down, excavation, backfilling, and spoil.

The project site consists of areas that are sparsely vegetated or have no vegetative covers, and hence no trees or bushes will need to be removed as part of construction. Also, there are some close communities such as some residences that would be within the visual radius of the project. Therefore, visual intrusions are anticipated to be limited to employees. Hence, the visual effects of the construction will be of low significance within the project area and

largely limited to effect only employees living in the company's temporary camp facilities during construction (if any).

Mitigation

The contractor must be careful while doing construction works as though the adjacent agricultural practices and close communities do not hamper.

10.6.2 Water Resources

Impact

Surface water quality in the adjacent rivers, channels and ponds might insignificantly degrade during construction stage due to disposal of solid wastes, sewage effluent, and dredged materials, accidental spillage of petroleum products, cement, bentonite and noxious chemicals. The problem will be more dangerous if the construction work will continue even in the monsoon when the flood occurrence is very high. There will have no major impacts on ground water quality due to the construction of solar power plant.

Mitigation

In order to minimize the adverse impact on water quality, the following mitigation measures are proposed:

- The contractor will dispose of the debris material to a designated disposal site.
- All reasonable measures will be taken to prevent the wastewater produced in construction from entering into creek and stream.
- Contractor's camp will be provided with sanitary latrines that do not pollute surface waters.
- The ground water in the project area has been used for different purposes like drinking and irrigation, hence proper mitigation measures must be ensured at construction site to avoid any spillage and leakage of oil. All the staffs at construction areas must be refrained of discharge any liquid wastes on the ground.

10.6.3 Noise

Impact

Construction activities for solar power plant will contribute to noise impacts. There are several noise generating activities such as opening access roads to construction personnel camp and facilities (if needed), earthworks, haulage activities, excavation, backfilling, and installation of PV panels, and other equipment within the facility in addition to noise sources generated from machinery and equipment on site.

The project site is far from any cultural, religious site but there are some residences. These are the closest sensitive location to the project area. Hence, it can be said that the project site could not be a potential source of noise. However, some reptiles and mammals, within the project area can potentially be driven away from the site due to the sound levels.

Mitigation

The following identifies the mitigation measures to be applied by the Contractor / Blue Marine Energy Ltd. during the construction phase and which include:

- If noise levels were found to be excessive, construction activities should be stopped until adequate control measures are implemented;
- Apply adequate general noise suppressing measures. This could include the use of well-maintained mufflers and noise suppressants for high noise generating equipment and machinery, developing a regular maintenance schedule of all vehicles, machinery, and equipment for early detection of issues to avoid unnecessary elevated noise level, etc.; and

Comply with the Occupational Safety and Health Administration (OSHA) requirements and the Bangladesh Codes to ensure that for activities associated with high noise levels, workers are equipped with proper Personal Protective Equipment (e.g. Earmuffs).

10.6.4 Air Quality

Impact

The main impacts associated with construction activities will be:

- 1) **Dust generation:** resulting from earthworks such as leveling, grading, excavation works and movement of vehicles across dirt/unpaved roads, especially during windy conditions.
- 2) **Exhaust emissions:** Exhaust emissions of SO₂, NO_x, CO, CO₂, and PM₁₀, PM_{2.5} will be attributed predominantly to the operation of the construction plant and road vehicles such as movement of vehicles during construction works. These emissions will be limited to the project area and are anticipated to be generated in small concentrations and dispersed rapidly within the area leading to an impact of low significance. This means that these effects are localized and temporary which implies that any deterioration in air quality at project location is unlikely to be significant and is expected to be transient.

Mitigation

The following identifies the mitigation measures to be applied by the Contractor during the construction phase (to prevent impacts caused by their construction activities and which are within their control) and which include:

- If dust or pollutant emissions were found to be excessive, construction activities should be stopped until the source of such emissions have been identified and adequate control measures are implemented;
- Comply with the Occupational Safety and Health Administration (OSHA) requirements and the Bangladesh Codes to ensure that for activities associated with high dust levels, workers are equipped with proper Personal Protective Equipment (e.g. masks, eye goggles, breathing equipment, etc.);
- Apply basic dust control and suppression measures which could include:
- Regular watering of all active construction areas.

- Proper planning of dust causing activities to take place simultaneously in order to reduce the dust incidents over the construction period.
- Proper management of stockpiles and excavated material (e.g. watering, containment, covering, bunding).
- Proper covering of vehicles transporting aggregates and fine materials
- Develop a regular inspection and scheduled maintenance program for vehicles, machinery, and equipment to be used throughout the construction phase for early detection of issue to avoid unnecessary pollutant emissions.

10.6.5 Soil

Impact

Construction activities are expected to result in significant soil loss. The excavation, leveling and other earthworks are the possible source to disturb the soil due to the removal of top soil, which could trigger soil erosion process. Additionally, the proposed project area is flood prone and needs huge amount of land filling. The total area is 2.40 acres.

The other source of impact to soil is waste generation from construction material, accidental leakage of fuel, oil, or chemicals stored within a bounded area causing direct contamination to soil which may degrade lower layers of soil depending on the amount of spills.

Mitigation

Assuming that spill response plans shall be in place by the contractor, it is anticipated that impacts to soil resulting from these activities will be likely, with a marginal consequence, yielding medium impact significance.

The filling material should be collected from the approved source dredging location with proper care so that no spillage will be happen. Retention wall or water proof boundary with plastic material should be constructed before the dredged material placement to prevent the spillage from site to adjacent agricultural land.

10.6.6 Terrestrial Ecology

Impact

The activities anticipated during the construction phase will include earthworks, excavations, grading, site leveling, asphaltting, paving and the operation of construction machinery and equipment. However, according to the baseline description, the project area does not encompass natural systems, which means that no significant flora and fauna are present.

As a result, construction activities are not anticipated to pose any risks on the terrestrial ecology within or in the vicinity of the project site.

However, it may cause temporary disturbance to resident birds with ground nests due to noise, dust and particulate emissions, and possible illegal hunting by construction workers. Moreover, reptiles present within the project site may temporarily move to adjacent locations during construction activities, however are expected to return back as construction is completed.

Mitigation

The following identifies the mitigation measures to be applied by the Contractor during the construction phase and which include:

- Before construction commences, undertake a fauna survey (through an ecological expert) to identify the presence of any key faunal species of importance (reptiles and mammals). Should viable populations of such key species exist within the Project site then it should be relocated outside of construction active areas;
- Ensure that the fencing constructed for the Project site allows for the natural movement of small faunal species within the area. This could include for example a fence with an appropriate gap between the ground level and the first rail or strand (around 30cm);
- Implement proper management measures to prevent damage to the natural vegetation of the site. This could include establishing a proper code of conduct and awareness raising / training of personnel and good housekeeping which include the following:
 - Prohibit hunting at any time and under any condition by construction workers onsite
 - Ensure proper storage, collection, and disposal of waste streams generated
 - Restrict activities to allocated construction areas only, including movement of workers and vehicles to allocated roads within the site and prohibit off-roading to minimize disturbances
 - Avoid unnecessary elevated noise levels at all times. In addition, apply adequate general noise suppressing measures.
- A compensatory forestation will be done on an area of minimum 33% of the plant area which is around 0.8 acre. As the power plant, will run by solar power, the shadow of the planted trees may hamper this. So, the compensatory forestation will either be done in a distribution manner throughout the island or a social forestation program will be arranged.

10.6.7 Waste Generation

Impact

Improper management of non-hazardous and hazardous waste generated during construction may lead to impacts on soil, water, visual environment, in addition to health and safety of workers.

Non-hazardous waste includes paper, wood, plastic, scrap metals, glass and mud.

Hazardous waste includes absorbent material, batteries, tires, metal drums, empty chemical containers, waste oil from machinery lubricants, etc.

Mitigation

All waste generated at construction site will be managed as per Contractor's Waste Management procedures. Domestic wastewater generated at site will be collected in septic tanks. These shall be transported to the nearest approved municipal wastewater handling facility, and solid wastes shall be disposed of in a secured area for trash.

10.6.8 Employment Opportunities

Impact

Positive benefits of the project may arise either from short-term job opportunities during construction, or long-term job opportunities during operation. It is important that construction and operation jobs to be targeted to the local people within *Munmiar Char* where feasible.

Recommendation

Contractor as far as practicable will recruit construction workers from amongst the locals where possible, and shall maintain gender equity while employing the locals. Priority shall always be given to people from amongst the PAPs and from those unemployed and belong to the lower income group. Additional benefits will be derived by setting aside-areas within contractor camps/labour shed for local people to sell their products or to provide additional services to the workers. Replacement on a suitable location in a better form will be done with the help and consent of the affected local community.

10.6.9 Health and Safety

Impact

The construction activities include site preparation, infrastructure utilities installation, building structures. Therefore, there will be potential impacts on workers' health and safety due to exposure to risks through construction activities that lead to accidents causing injuries and death. Construction works and activities bear frequent accident and health risks for both the laborers and the public general, with varying direct and indirect consequences. Therefore, the project authority needs to make provision for specific medical services, workers insurance policies and indemnities, emergency provisions and a rescue/evacuation plans in case of major accidents.

Mitigation

The Contractor, under the supervision of developer, will be committed to ensure all health and safety measures are in place to prevent accidents and/or reduce the consequences of non-conformance events. The contractor shall ensure all prospect risks during construction phase are assessed and all prevention and mitigation measures are in place accordingly. The contractor shall ensure all workers during construction comply with safety producers through training, awareness and supervising. Moreover, the contractor shall provide all appropriate resources (Personnel Protective Equipment) including hard helmet, nose mask, boot, goggles etc. onsite to ensure providing first aid for personnel in case of occurrence emergencies.

The project authority will be requested to prepare an approved Construction Environmental Action Plan (CEAP), which will, among others, delineate all work safety aspects he intends

to apply. Focal points of the CEAP will relate to means, type and number of protective clothing, safety precautions at specific work sites, first aid, rescue plans, work hours, and all intended measures for avoiding or proper clearance of hazardous substances, including fueling operations, transport and handling of hazardous materials and explosives, securing measures etc. The CEAP will further explain methods and volumes for using any local resource, and how to address common risks associated with public safety. The project authority will disclose the CEAP with the local stakeholders for further developments on the health and safety issue.

10.6.10 Traffic

Impact

During the construction phase traffic is expected to increase to a certain degree due to the nature of activities that will take place such as the transport of equipment and materials to and from the site through the surrounding road network. Additional traffic load will be evident at certain times during the day, especially if there are slow moving heavy vehicles transporting material to and from the site.

Vehicle traffic can cause congestion on road networks around and within the site and thereby leading to potential accidents.

The above potential traffic impacts can possibly occur during the construction, especially during working hours. However, this is considered a short-term impact. This impact is likely to happen but is not anticipated to cause any permanent effect on the receiving environment.

Mitigation

Proper Traffic Management Plan (TMP) should be prepared by the contractor during starting of construction and follow it strictly.

10.6.11 Archaeology and Cultural Resources

Impact

The field visits conducted and it is found that there are schools, madrashas, mosques, graveyards and health complex present at the project site. So, it is concluded that there is no anticipated impact from construction on these receptors; therefore the impact assessment process for this receptor has yielded the low significance.

Mitigation

This impact is temporary and minor negative in nature. Mitigation measures will include:

- Timely completion of the construction work and provision of alternative routes during the construction;
- Establishment of construction site camp and labour camp must maintain proper distance from the cultural sites.

10.7 Operational Phase

Due to increased activities and efficient operational systems, there will be some impacts on the environmental set-up in the project area, which are discussed hereunder. In order to

achieve sustainability of the development works, it is necessary to ensure the effectiveness of mitigation measures even after construction, as some adverse environmental impacts may result from the operation of the project facilities. Therefore, in order to reap the full environmental benefits of the activities and ensure environmental enhancement it would be necessary to implement the following which are beyond the purview of this project and may require national level involvement.

10.7.1 Visual Amenity

Impact

The presence of a large area of PV panels is not expected to constitute a risk for glare since it is situated far from any significant areas, nor residential dwellings, moreover, no potential visual disturbance to birds are expected given the fact, and as a result, there is no migratory birds fly way over the project area.

Mitigation

It is not anticipated that visual impacts will be generated due to the PV system design, which is specifically designed to include dark, light-absorbing materials and covered with an anti-reflective coating (ARC) for glass surfaces, which reduces the reflectance from PV panels to 2.5%-2.6% while at the same time improving their efficiency.

It is essential to point out that the intensity of light reflected from a PV module surface depends on factors such as the amount of sunlight reaching the surface and will therefore vary based on, among others, geographic location, time of year, cloud cover, and PV module orientation.

10.7.2 Water Resources

Impact

The surface water bodies may get flooded and polluted due to uncontrolled release of contaminated storm-water/runoff from plant area. The pollutants associated with the plant activities include, hydrocarbons, heavy, corrosive products and suspended solids including insoluble heavy metals as colloidal materials from plant chemicals such as batteries etc.

Groundwater may get polluted due to contaminated runoff chemical materials. Additionally, the project may lead to faster infrastructure development near the project area. This will exert stress on the availability of groundwater in the project area.

Mitigation

The following mitigation measures are proposed to attenuate water quality related impacts:

- Prior to operation, an emergency response plan for spills of hazardous materials and oil will be prepared.
- The surface water quality monitoring will also be carried out at defined intervals and for environmental quality monitoring parameters suggested in the Environmental Monitoring Plan. If these parameters are above the prescribed limits, suitable control measures will be taken;

- Groundwater quality monitoring will be carried out as per schedule suggested in the Environmental Monitoring Plan.

10.7.3 Noise

Impact

The solar power as a facility is not considered to exhibit any significant noisy operations, although the facility's inverters and transformers may produce noise, but this is not considered a serious issue, since they will not generate any significant noise. In addition, there are some close by sensitive receptors such as a school and some residential dwellings within the project site.

In addition, noise generated from inverters is only heard when distance is close (i.e. within 1-2 m, however, as distance increases, noise will be greatly reduced, not to mention that they do not generate noise during night time. The most significant noise source of this solar power plant is from the backup diesel generator (150 kVA). To ensure smooth electric supply the project proponent will run diesel generator in case of any disharmony. The diesel generator will create discomfort sound level around the project area which may affect to the surrounding inhabitants. Photovoltaic (PV) systems make no noise and cause no pollution in operation. Solar energy is clean, silent, and freely available.

Mitigation

These noise impacts are not considered to significantly harm animals nor cause impacts on a population level. However, the noise from diesel generator needs to take action for mitigation. The project proponent should establish the generator inside an insulated room to keep the environment free from sound pollution. Noise barrier should also be given around the generator room as a mitigation measure from noise pollution. The increased noise levels are considered occupational noises that require occupational health and safety measures. The worker inside the project area should use earmuffs during the operation of diesel generator.

10.7.4 Air Quality

Impact

No emissions are expected to be released during the operation phase, due to the fact that solar PV power plants do not release greenhouse gases or any toxic pollutants during their operation, as a result, no impacts on ambient air quality are anticipated during the operation phase. There will be environmental impacts of emission of greenhouse gas, Ozone depletion, photochemical smog, eutrophication and acidification and also health effects on people due to battery maintenance.

It is worth mentioning that solar power plants have very low air emissions of air pollutants such as sulfur dioxide, nitrogen oxides, carbon monoxide, volatile organic compounds, and the greenhouse gas carbon dioxide during operations compared to fossil fuel power generation facilities, since solar power plants do not involve combustion processes.

Mitigation

The project developer shall be committed to control emitted dust and gaseous pollutant from such operations through the proposed emission control procedures described in the environmental management plan (EMP) included in this report.

Service and maintenance is very important as to have a battery system to run efficiently and with least possible replacement of batteries and related environmental impacts. Only purchase batteries from a source that can ensure that used batteries can be returned for environmental friendly recycling. Alternatively replaced batteries must be recycled locally.

Photovoltaic (PV) is now a proven technology which is inherently safe as opposed to some dangerous electricity generating technologies. Photovoltaic systems make no air pollution and cause no pollution in operation. PV panel should be clean and maintenance regularly for dust free. The supplier will collect wastage PV panels for maintenance and destroy and they will be responsible for management of PV panels and battery.

10.7.5 Soil

Impact

Soil impacts during operation phase are limited to accidental spillage of lubricant, fuel and other chemicals that may potentially cause soil degradation. However, since the project area is designated for solar projects near roadside and settlements area, they do not have any agricultural significance. Another most significant source of soil pollution is the damage of battery and PV panels in case of major accidents. These contain chemicals and may be harmful for soil quality.

Mitigation

Through implanting spill response procedures, and proper storage and handling of any chemicals on site, the impact probability will be reduced. The project proponent should check these devices regularly and have to replace the damaged and expired or bad devices. However, if possible, the damaged and expired devices should be maintained properly and recycled.

10.7.6 Terrestrial Ecology

Impact

The project area does not encompass any natural systems. The anticipated impacts on terrestrial ecology is considered low, however, activities such as vehicular movement, may cause disturbance to resident birds and their ground nests.

Mitigation

The anticipated impacts on terrestrial ecology are considered low and hence no particular mitigation measure should be followed. However, the vehicular movement should be very limited and proper attention should be given to minimize the disturbance on surrounding ecological environment.

10.7.7 Waste Generation

Impact

Lead-Acid Battery: One of the most important components of solar mini-grid power plant is Lead-acid battery. Improper disposal and recycling of lead acid storage batteries result in lead sulfate contamination in lands and water bodies. Through percolation, lead sulfate can contaminate groundwater and transfer up the food chain.

Waste generated during operation phase will be limited to wastewater from maintenance and cleaning activities in addition to domestic waste (due to workers domestic activities).

PV modules: PV modules wastes are the other waste besides the lead-acid battery and few other solid wastes generated during the operational stage. These include end-of-life solar PV modules, electrical wastes, metallic wastes and stationary wastes of office works etc.

Ground-mounted PV solar arrays are typically made up of panels of silicon solar cells covered by a thin layer of protective glass attached to an inert solid underlying substance (or “substrate”). While the vast majority of PV panels currently in use are made of silicon, certain types of solar cells may contain cadmium telluride (CdTe), copper indium diselenide (CIS), and gallium arsenide (GaAs). All solar panel materials, including the chemicals noted, are contained in a solid matrix, insoluble and non-volatile at ambient conditions, and enclosed. Therefore, releases to the ground from leaching, to the air from volatilization during use, or from panel breakage, are not a concern.

Others: Waste generation during the operation phase is considered part of daily operations, therefore, it is not considered to have any significant impacts to the environment or health of personnel present on site.

Mitigation

The lead-acid battery which will be used in the project has a 7-years warranty. During entire life-time these will only need to be refilled with water sometimes. After the life period is ended each battery will be collected by the supplier-manufacturer and will be duly recycled. However, a proper temporary storage facility is needed for the wasted batteries to avoid potential lead contamination.

Photovoltaic (PV) is now a proven technology which is inherently safe as opposed to some dangerous electricity generating technologies. Photovoltaic systems make no air pollution and cause no pollution in operation. PV panel should be clean and maintenance regularly for dust free. The supplier will collect wastage PV panels for maintenance and destroy and they will be responsible for management of PV panels and battery.

10.7.8 Employment Opportunities

Impact

During the operation phase job opportunities will be created for executing the project activities. Local people can be involved in the project activities as per their skill.

Mitigation

During the recruitment of workers and other professionals, local poor and distressed people followed by project affected people and poor women should be given priority as per their competence and skill. While recruiting and giving wage gender equity must be maintained.

10.7.9 Health and Safety

Impact

There are many hazards associated with a solar PV power plant if sufficient precautions are not taken during the operation stages. The impact origins are in the following sectors:

- Entering of lead (Pb) into human body from lead-acid battery
- Acid hazard during battery handling
- Leaching of materials from broken or fire damaged PV modules
- Emergency Fire Hazard
- Electrocution of workers
- Electromagnetic radiation from PV modules

Entering of lead into human body from lead-acid battery: Lead can enter body in two ways: by breathing or by swallowing it. Lead Sulfide dust enters the body through breathing. Very fine lead particles may penetrate into the lungs result in absorption in the bloodstream. In addition, there is an impending threat for the workers due to the inhalation of lead fumes. Long exposure to lead pollution may result the adverse impact to nervous system and causes headaches, dizziness, irritability, memory problems, and disturbance in sleep. It can affect the digestive system and cause nausea, vomiting, constipation, appetite loss, and abdominal pain. Lead also affects formation of blood and can result in anemia. Too much lead can also cause miscarriages and stillbirths when pregnant women are exposed to lead. In men, the sperm can be affected and this may result in infertility.

Acid hazard during battery handling: The potential risk of workers being damaged by acid who are handling lead-acid battery is apparent. Blue Marine Energy Ltd. will not store any acid in the project site as the batteries will need only to be refilled with water sometimes. However, acid spilling during watering process or acid splash on to the workers body is not deniable.

Leaching of materials from broken or fire damaged PV modules: The potential for chemical releases appears to be small since the chemicals are present in the sealed PV modules when completed installations of photovoltaic systems for power generation. Releases are likely to occur only due to fires or other unusual accidents. Cadmium could be a potential concern in this setting with thin-film technologies, as would arsenic and zinc to a lesser extent. Other chemicals that have inhalation toxicity factors are present only during the manufacturing process. Solar PV modules may contain heavy metals like lead, mercury, cadmium, chromium, polybrominated biphenyls (PBBs), or brominated diphenylethers (PBDEs) etc. Leaching of metals from the installed modules is not likely to be a concern, as documented in a study by Steinberger (1998). Leaching from small cells used in electronic devices is also

unlikely to be a concern, given the small amounts of chemicals present and the sealed nature of the devices.

Emergency Fire Hazard: Since this is a power plant, the plant has always some risks of fire hazards. Electrical equipment is the main source of a potential fire hazard. In the event of fire catching a solar module, it is theoretically possible for hazardous fumes to be released and inhalation of these fumes could pose a risk to human health. However, researchers do not generally believe these risks to be substantial given the short-duration of fires and the relatively high melting point of the materials present in the solar modules. Moreover, the risk of fire at ground-mounted solar installations is remote because of the precautions taken during site preparation including the removal of fuels and the lack of burnable materials mostly glass and aluminum contained in a solar panel.

Electrocution of Workers: Risk of electrocution of workers during performing duties in a power plant is always present. Faulty electrical equipment, electric short circuits, exposed electrical wires may be the chief sources of electrocution. Damaged PV modules with exposed high voltage conductor also present high risk of electrocution.

Electromagnetic radiation from PV modules: The strength of electromagnetic fields produced by photovoltaic systems do not approach levels considered harmful to human health established by the International Commission on Non-Ionizing Radiation Protection. Moreover the small electromagnetic fields produced by photovoltaic systems rapidly diminish with distance and would be indistinguishable from normal background levels within several yards.

Mitigation

The project developer shall ensure all risks from operation activities to be assessed and to establish specific work procedures for tasks during operation phase including all safety prevention and mitigation measures to avoid non-conformance events.

The Contractor, under the supervision of developer, will be committed to ensure all health and safety measures are in place to prevent accidents and/or reduce the consequences of non-conformance events. The contractor shall ensure all prospect risks during construction phase are assessed and all prevention and mitigation measures are in place accordingly. The contractor shall ensure all workers during construction comply with safety producers through training, awareness and supervising. Moreover, the contractor shall provide all appropriate resources (Personnel Protective Equipment) onsite to ensure providing first aid for personnel in case of occurrence emergencies.

10.7.10 Traffic

Impact

Impacts from traffic are not expected to occur during the operation phase due to minimal number of personnel present within the project site. Therefore, increased traffic load is not considered a significant impact.

Mitigation

This impact is temporary and minor negative in nature and can be mitigated by providing proper alternative traffic management plan during operation of the power plant.

10.8 Decommissioning Phase

The main mitigation and monitoring measures to minimize or reduce the environmental and social impacts during decommissioning are anticipated to be similar to those identified for the construction phase. However, some of the major impacts are described below.

10.8.1 Visual Amenity

Impact

During the dismantling of the solar power plant, removal of ancillary facilities, and the rehabilitation of the project area (if needed), visual intrusions will be likely.

Mitigation

Their consequence will be negligible due to fact that such impact would be temporary (over a short period). Moreover, the actual dismantling of the solar power plant will reduce or remove the visual impacts witnessed during the operation phase.

10.8.2 Noise

Impact

The decommissioning activities of dismantling the solar power plant and removing the ancillary facilities are associated with potential increased noise levels. The receptors of the increased noise level will be only the workers of decommissioning activities.

Mitigation

As the only receptors will be the workers at the site and within the proposed facilities within the vicinity of the solar power plant, these increased noise levels are considered occupational noises that require occupational health and safety measures.

10.8.3 Air Quality

Impact

Similar to construction, the decommissioning phase is anticipated to generate dust and exhaust emissions. Decommissioning activities will involve site preparation, dismantling and disassembling of the components of the solar power plant facility, clearance of the site, and rehabilitation if needed.

Mitigation

The project developer shall be committed to control emitted dust and gaseous pollutant from such operations through the proposed emission control procedures described in the environmental management plan (EMP) included in this report.

10.8.4 Soil

Impact

During the decommissioning phase, the decommissioning activities are anticipated to have an impact of medium significance to soil. This is due to possible accidental leakage of fuel, oil, or chemicals during demolition activities.

Mitigation

Proper environmental protection measures should be followed to prevent or control the occurrence of such incidences. Take proper attention in removing the PV panels to prevent any damage as it contains chemicals and might be harmful for soil quality.

10.8.5 Terrestrial Ecology

Impact

The activities associated with decommissioning will involve dismantling of the solar power plant and removal its facilities. This is a temporary phase that could result in some additional noise and dust disturbances. These activities are not anticipated to harm any flora elements due to absence or scarcity of vegetative cover within and around project area, provided dust suppression measures and other procedures are followed. On the other hand, decommissioning activities may cause disturbance to bird species.

Mitigation

The mitigation measures should be the same as it was considered during the construction phase since the decommissioning activities will be same as construction phase.

10.8.6 Waste Generation

Impact

Waste generated during decommissioning limited to non-hazardous and inert wastes such as scrap metals, paper, wood, plastic, given that the contractor will adhere his waste management procedures.

Similar to the construction phase, potential generation of hazardous waste includes absorbent material, batteries, tires, metal drums, empty chemical containers, waste oil from machinery lubricants, etc.

It is not expected that hazardous wastes will be generated from dismantling the solar power plant since the project developer will opt for recycling PV panels of the facility.

PV modules and others: PV modules wastes are the other waste besides the lead-acid battery and few other solid wastes generated during the operational stage. These include end-of-life solar PV modules, electrical wastes, metallic wastes and stationary wastes of office works etc.

Ground-mounted PV solar arrays are typically made up of panels of silicon solar cells covered by a thin layer of protective glass attached to an inert solid underlying substance (or “substrate”). While the vast majority of PV panels currently in use are made of silicon, certain types of solar cells may contain cadmium telluride (CdTe), copper indium diselenide

(CIS), and gallium arsenide (GaAs). All solar panel materials, including the chemicals noted, are contained in a solid matrix, insoluble and non-volatile at ambient conditions, and enclosed. Therefore, releases to the ground from leaching, to the air from volatilization during use, or from panel breakage, are not a concern.

End-of-Life Solar Panels: The solar PV panels that will be used in the project will have a life span of 25 years. Disposal of wasted solar PV modules is very important because if not properly decommissioned, the greatest health risk from end-of-life crystalline solar modules arises from lead containing solders. Under the right conditions it is possible for the lead to leach into landfill soils and eventually into water bodies.

While the solar cell is the heart of a photovoltaic system, on a mass basis it accounts for only a small fraction of the total materials required to produce a solar panel. The outer glass cover constitutes the largest share of the total mass of a finished crystalline photovoltaic module (approximately 65%), followed by the aluminum frame (~20%), the ethylene vinyl acetate encapsulant (~7.5%), the polyvinyl fluoride substrate (~2.5%), and the junction box (1%). The solar cells themselves only represent about four percent (4%) of the mass of a finished module.

Mitigation

The following identifies the mitigation measures to be applied by all involved entities:

- Ensure that hazardous materials are stored in proper areas and in a location where they cannot reach the land in case of accidental spillage. This includes storage facilities that are of hard impermeable surface, flame-proof, accessible to authorized personnel only, locked when not in use, and prevents incompatible materials from coming in contact with one another.
- Maintain a register of all hazardous materials used and accompanying Material Safety Data Sheet (MSDS) must present at all times. Spilled material should be tracked and accounted for;
- If spillage on soil occurs, spill must be immediately contained, cleaned-up, and contaminated soil disposed as hazardous waste;
- Proper decommissioning and recycling of solar panels both ensures that potentially harmful materials are not released into the environment and reduces the need for virgin raw materials. In recognition of these facts, the photovoltaic industry is acting voluntarily to implement product take-back and recycling programs at the manufacturing level.

10.8.7 Employment Opportunities

Impact

Short-term job opportunities may be arise during decommissioning, however, this can negatively impact permanent personnel at the solar power plant since the facility will cease its operations, therefore permanent staff may lose their jobs.

Although this impact is very unlikely given that fact that an upgrade is expected for the facility during its post-design life, however, the consequence is considered critical to permanent personnel if the facility underwent decommissioning, yielding a low impact significance.

Recommendation

Preference should be given to employing the local communities in various positions.

10.8.8 Health and Safety

Impact

The decommissioning activities will include equipment dismantling and demolishing facilities at project site. As all project components will be recycled after decommissioning, the prospect risks from decommissioning phase will be limited to dismantling and demolishing activities including moving all recyclable components to their final destination. There will be potential impacts on workers' health and safety due to exposure to risks through decommissioning activities.

Mitigation

The project developer will be committed to ensure all health and safety measures are in place to prevent accidents and/or reduce the consequences of non-conformance events. The developer shall ensure all prospect risks during decommissioning phase are assessed and all prevention and mitigations measures are in place accordingly.

10.8.9 Traffic

Impact

The anticipated impacts during decommissioning are similar to those for the construction phase, where the heavy machinery that transports disassembled parts of the project solar power plant facility might be of more significance than normal vehicles and pickups.

Mitigation

Proper management actions with adequate mitigations can reduce significantly such anticipated impacts.

11 ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

11.1 General

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

11.2 Objectives

This ESMP aims at ensuring the application of the mitigation and monitoring measures needed to reduce and control the various environmental and social impacts associated with the implementation of the proposed project.

The key objectives of the ESMP are summarized below:

- Minimizing any adverse environmental, social and health impacts resulting from the project activities;
- Conducting all project activities in accordance with relevant Bangladesh Legislation and applicable World Bank guidelines.
- Implementation of on-going environmental monitoring programs;
- Periodic review of the Environmental Management programs to allow for iterative improvement;
- Ensure that all stakeholder concerns are addressed.

Overall, this EMP aims at ensuring the application of the mitigation and monitoring measures needed to reduce and control the various environmental and social impacts associated with the implementation of the proposed project.

11.3 Environmental and Social Management Plan (ESMP)

On the basis of identification of the environmental impacts and recommended mitigation measures linked with the Solar Mini-grid Power Plant project activities, an ESMP has been prepared which will be followed at the pre-construction, construction, operation and decommissioning stages. While preparing the ESMP, medium and significant impacts are taken into consideration to recommend possible mitigation measures. A mitigation measure will be considered as successful when it complies with the Environmental Quality Standards (EQS), policies, legal requirements set by JICA Guidelines for Environmental and Social Considerations / World Bank Safeguard Policies, and DoE environmental guidelines & other relevant GoB legal requirements. In absence of DoE's own EQS, other relevant international or other recognized organization's quality standard will be applied.

Table 11.1: Environmental and Social Management Plan (ESMP) of Solar Mini-grid Power Plant Project

Aspect	Key Potential Impact	Mitigation Measures	Frequency	Performance Indicator	Responsibility	Legal Requirements
Pre-construction Phase						
Land Use / Land-filling	The proposed plant will degrade surrounding agricultural land.	Fence the proposed area so that the surrounding agricultural land will not be disturbed. Land-filling for side is not possible due to environmental restrictions from Government authorities.	Quantity of land use	Consideration of minimum use of agricultural land.	Project developer	▪ National Land use Policy, 2001 ▪ National Environmental Policy, 1992 ▪ National Environmental Management Action Plan, 1995 ▪ Industrial Policy, 1986 ▪ Private Sector Power Generation Policy of Bangladesh, 1996 ▪ Policy Guideline for small Power Plants in Private Sector, 1997
Flood Hazards	Flood may damage the Project and its various components.	Should undertake a flood risk study to determine flood quantities within the plant area and to estimate peak flood to determine the peak flow for the return period of 50 years.	no. of flood	Consideration of flood hazard in project design	Project developer	
Construction Phase						
Earthworks	Soil erosion from the fill material, changes in existing landscape.	▪ The contractor shall ensure that the fill material is collected from only the approved sources and not from any illegal dredging site. ▪ Construct the retention wall	Weekly	The fill material is collected from the approved sources.	Contractor	▪ Environmental Pollution Control Ordinance, 1977 ▪ Environmental Conservation Rules

Aspect	Key Potential Impact	Mitigation Measures	Frequency	Performance Indicator	Responsibility	Legal Requirements
		properly so that erosion will not happen. ▪ Make sure that the filling material is not collected from the agricultural land.				(ECR), 1997
Visual Amenity	Visual impacts from construction activities such as materials lay down, excavation, Backfilling	The contractor shall ensure general cleanliness and good housekeeping practice at the project site at all times.	Daily	▪ Good housekeeping and tidiness of work areas within the project site. ▪ The fill material is maintained in a clean and tidy manner.	Contractor	▪ National Land use Policy, 2001 ▪ National Environmental Policy, 1992 ▪ National Environmental Management Action Plan, 1995
Air Quality	▪ Dust generation due to construction activities. ▪ Exhaust Emissions due to operation of construction plant and machinery.	▪ Setting an appropriate site speed limit to reduce dust generation from vehicles travelling over unmade surfaces. ▪ During construction dust generated on unpaved roadways and work areas should be controlled by the application of water on an “as needs” basis. ▪ Unnecessary handling of dusty materials will be avoided such as minimising drop heights when loaders dump soils into trucks. ▪ Train workers to handle construction materials and debris during construction to reduce fugitive emissions. ▪ Ensure adequate maintenance and	Daily	▪ No visible dust plumes originating From construction sites. ▪ Regular machineries maintenance records.	Contractor	▪ Environmental Pollution Control Ordinance, 1977 ▪ Environmental Conservation Rules (ECR), 1997 ▪ Environment Court Act, 2000 ▪ Bangladesh Climate Change Strategy and Action Plan (2008)

Aspect	Key Potential Impact	Mitigation Measures	Frequency	Performance Indicator	Responsibility	Legal Requirements
		inspection of vehicles to minimize exhaust emissions. Not running engines for longer than is necessary.				
Noise	Increased noise levels during to construction & machinery	▪ The contractor shall use heavy equipment, machinery, and fuels in compliance with national regulations. The contractor shall perform regular maintenance on all equipment, vehicle and machinery to prevent noise emissions. ▪ The contractor shall limit idling of engines when not in use to reduce its contribution to noise emissions.	Every week and after receiving any complaints from worker or third parties.	Compliance with DoE and National guideline limits for Environmental noise at sensitive receptors.	Contractor	▪ Environmental Pollution Control Ordinance, 1977 ▪ Noise Pollution Control Rules (2006)
Terrestrial Ecology	Potential disturbance to birds	▪ Minimize human and vehicular contact with fauna, including their burrows / nests and feeding grounds. ▪ Waste shall be stored on site within closed container, especially food remnants to avoid attracting birds on site.	Daily	N/A	Contractor	▪ Bangladesh Wildlife Preservation Order 1973 and Revision 2008 (Draft) ▪ National Forest Policy and Forest Sector Review (1994, 2005) ▪ The Forest Act 1927, Amendment 2000 (Protected, village Forests and Social Forestry) ▪ National Biodiversity Strategy and Action Plan (2004)
Soil	Soildisturbance due to removal	▪ A spill prevention and response plan shall be prepared by the	Weekly	▪ Number of spills or incidents to be	Contractor	▪ Environmental Pollution Control

Aspect	Key Potential Impact	Mitigation Measures	Frequency	Performance Indicator	Responsibility	Legal Requirements
	of top soil,potential accidental spillage	contractor in order to control any inadvertent leakage or spillage. Spill response measures shall be implemented (as necessary) to contain and clean up any contaminated soil. - Construction of bunds around relevant work and storage areas. Bunds in areas of hazardous chemical storage (including temporary storage) should be lined to contain accidental spillage and minimize the potential for migration to the underlying soil. - Any spilled chemical shall be immediately collected and disposed of in accordance with Spill Prevention and Response Plan and MSDS. - Contractor shall ensure that a spill kit and adequate PPE is available at the site for emergency cleanup activities in case of chemical/oil spillage. - To control soil erosion surface run-off should be collected from all paved working areas into retention ditches to restrict concentration of flows		recorded during onsite audits. Training records of Personnel trained in spill response procedures must be filed		Ordinance, 1977 The Environment (Pollution Control) Act, 1995
Waste Generation	Improper management and handling	The contractor shall segregate storage for different types of wastes, such as hazardous, non-hazardous	Daily	Compliance with Waste management procedures.	Contractor	Environmental Pollution Control Ordinance, 1977

Aspect	Key Potential Impact	Mitigation Measures	Frequency	Performance Indicator	Responsibility	Legal Requirements
	ofhazardous and non-hazardouswaste during construction.	recyclable construction material, plastic, paper, etc. to facilitate proper disposal. ▪ The contractor shall provide a separate storage area for hazardous materials. The hazardous materials/products must be labeled with proper identification of its hazardous properties. ▪ Chemical waste shall be stored in accordance with the provisions of Material Safety Data Sheets (MSDS). The contractor shall keep MSDS onsite. ▪ The contractor shall establish regular intervals for waste collection and disposal as per contractor's waste management procedures. ▪ The sanitary and organic wastes shall be collected in a septic tank to be installed on site and disposed off regularly.		▪ Current and Complete records of regular waste pickup and disposal.		▪ The Environment (Pollution Control) Act, 1995 ▪ Environmental Conservation Rules (ECR), 1997
Traffic	Additional traffic load due to transport of equipment and materials to and from the site through the surrounding road network	▪ The contractor to ensure that all trucks and vehicles accessing the facility are operated by licensed operators. ▪ Pedestrians Safety: All project vehicles and trucks shall comply with the proposed speed limits ▪ Ensure adequate maintenance and inspection of vehicles ▪ Presence of flagman at the	Continuously	▪ No complains or concerns from traditional users of the area's roads routes are received during the construction activities. ▪ No incidents or accidents (collisions)	Contractor	

Aspect	Key Potential Impact	Mitigation Measures	Frequency	Performance Indicator	Responsibility	Legal Requirements
		entrance and exit of the project site in order to control vehicles and truck movement.		are recorded		
Health and Safety risks	▪ Potential of exposure to safety events such as tripping, working at height activities, fire from hot works, smoking, failure in electrical installation, mobile plant and vehicles, and electrical shocks. ▪ Exposure to health events during construction activities such as manual handling and musculoskeletal disorders, hand-arm vibration, temporary or permanent hearing loss, heat stress, and dermatitis.	▪ All construction equipment used for the execution of the project works shall be fit for purpose and carry valid inspection certificates and insurance requirements. ▪ Risk assessment shall be prepared and communicated prior to commencement of work for all types of work activities on site. ▪ Provide walkways that are clearly designated as a walkway; all walkways shall be provided with good conditions underfoot; signposted and with adequate lighting. ▪ Signpost any slippery areas, ensure proper footwear with a good grip is worn for personnel working within slippery areas. ▪ Avoid work at height where it reasonably practicable to do so, e.g. by assembly at ground level. ▪ Prevent any person falling a distance liable to cause personal injury e.g. by using a scaffold platform with double guard-rail and toe boards; ▪ Arrest a fall with equipment to minimize the distance and	Continuously	▪ Total Recordable Incidence Rate (TRIR) ▪ Lost Time Incidence Frequency ▪ Fatal Accident Rate ▪ Number of safety Training performed ▪ Number of nonconformance events Reports. ▪ Medical Treatment Case (MTC) ▪ HSE Training Hours		▪ Bangladesh Labour Law, 2006

Aspect	Key Potential Impact	Mitigation Measures	Frequency	Performance Indicator	Responsibility	Legal Requirements
		consequences of a fall, e.g. safety nets, where work at height cannot be avoided or the fall prevented. ▪ Carry out fire risk assessment for the construction areas, identify sources of fuel and ignition and establish general fire precautions including, means of escape, warning and fighting fire. ▪ Set up a system to alert workers on site. This may be temporary or permanent mains operated fire alarm. ▪ Fire extinguishers should be located at identified fire points around the site. The extinguishers shall be appropriate to the nature of the potential fire. ▪ Establish and communicate emergency response plan (ERP) with all parties, the ERP to consider such things as specific foreseeable emergency situations, organizational roles and authorities, responsibilities and expertise, emergency response and evacuation procedure, in addition to training for personnel and drills to test the plan ▪ Ensure all plant machines and vehicles are regularly inspected, serviced and maintained; ensure all staff assigned is trained and				

Aspect	Key Potential Impact	Mitigation Measures	Frequency	Performance Indicator	Responsibility	Legal Requirements
		competent to operate plant machines and vehicles. ▪ Ensure clear signages are in place, such as Warning of speed limits, obstructions, allowable widths/heights...etc. ▪ Electrical equipment must be safe and properly maintained; works shall not be carried out on live systems. ▪ Only competent authorized persons shall carry out maintenance on electrical equipment, adequate Personal Protective Equipment (PPE) for electrical works must be provided to all personnel involved in the tasks. ▪ Lock-Out / Tag-Out (LOTO) system shall be implemented during any electrical works. ▪ Adequate number of staff and first aiders shall be on site in accordance with Bangladesh Labor Law requirements. ▪ First aid kit with adhesive bandages, antibiotic ointment, antiseptic wipes, aspirin, non-latex gloves, scissors, thermometer, etc. shall be made available by the contractor on site. ▪ Emergency evacuation response shall be prepared by the contractor and relevant staff shall be trained				

Aspect	Key Potential Impact	Mitigation Measures	Frequency	Performance Indicator	Responsibility	Legal Requirements
		through mock-up drills. ▪ Ensure all equipment is suitable for jobs (safety, size, power, efficiency, ergonomics, cost, user acceptability etc.), provide the lowest vibration tools that are suitable and can do the works. ▪ Ensure all tools and other work equipment are serviced and maintained in accordance with maintenance schedules and manufacturer's instructions. ▪ Regular noise exposure assessments and noise level surveys of noisy areas, processes and equipment shall be carried out in order to form basis for remedial actions when necessary. ▪ As far as reasonably practical, all steps to reduce noise exposure levels of employees by means other than that of personal protective equipment shall be taken, such as reducing exposure times, enclosures, silencers, machine covers, etc. ▪ Awareness training sessions should be established and provided to all personnel involved during the construction phase in order to highlight the heat related illnesses of working in hot conditions such as heat cramps, heat exhaustion, heat				

Aspect	Key Potential Impact	Mitigation Measures	Frequency	Performance Indicator	Responsibility	Legal Requirements
		stroke, dehydration. ▪ Ensure adequate quantities of drinking water are available at different locations within the site, ▪ Provision of sun shades at different locations within the site. ▪ Eliminate the risk of exposure whenever possible, provide proper PPE wherever necessary and to ensure that there are satisfactory washing and changing facilities. ▪ Ensure that all workers exposed to a risk are aware of the possible dangers. They should be given thorough training in how to protect themselves and there should be effective supervision to ensure that the correct methods are being used.				
Operation Phase						
Visual Amenity	Potential glare from PV panels	The used technology has Anti-Reflective coating (ARC) that significantly reduces the reflectance of the Panels (from 2.5% to 2.6% only).	N/A	N/A	Project Developer	▪ National Land use Policy, 2001 ▪ National Environmental Policy, 1992 ▪ National Environmental Management Action Plan, 1995
PV panels, Battery	The most significant source of soil pollution is the damage of	Service and maintenance is very important as to have a battery system to run efficiently and with least possible replacement of batteries and	Continuously	Compliance with DoE Regular machineries maintenance records.	Project Developer	▪ Environmental Pollution Control Ordinance, 1977 ▪ Environmental

Aspect	Key Potential Impact	Mitigation Measures	Frequency	Performance Indicator	Responsibility	Legal Requirements
	battery and PV panels in case of major accidents. These contain chemicals and may be harmful for soil quality. There will be environmental impacts of emission of greenhouse gas, Ozone depletion, photochemical smog, eutrophication and acidification and also health effects on people due to battery maintenance. Besides the lead-acid battery and wasted PV modules few other solid wastes generated during the operational stage. These include end-of-life solar PV modules, electrical wastes, metallic wastes and stationary wastes of	related environmental impacts. Only purchase batteries from a source that can ensure that used batteries can be returned for environmental friendly recycling. Alternatively replaced batteries must be recycled locally. Photovoltaic (PV) is now a proven technology which is inherently safe as opposed to some dangerous electricity generating technologies. Photovoltaic systems make no air pollution and cause no pollution in operation. PV panel should be clean and maintenance regularly for dust free. The supplier will collect wastage PV panels for maintenance and destroy and they will be responsible for management of PV panels and battery. The project proponent should check these devices regularly and have to replace the damaged and expired or bad devices. However, if possible, the damaged and expired devices should be maintained properly and recycled.				Conservation Rules (ECR), 1997 ■ Environment Court Act, 2000

Aspect	Key Potential Impact	Mitigation Measures	Frequency	Performance Indicator	Responsibility	Legal Requirements
	office works etc.					
Backup Generator	The most significant noise source of this solar power plant is from the backup diesel generator. To ensure smooth electric supply the project proponent will run diesel generator in case of any disharmony. The diesel generator will create discomfort sound level around the project area which may affect to the surrounding inhabitants.	However, the noise from diesel generator needs to take action for mitigation. The project proponent should establish the generator inside an insulated room to keep the environment free from sound pollution. Additionally, the generator should be upwardly enclosed with the noise reduction canopy. Noise barrier should also be given around the generator room as a mitigation measure from noise pollution. The increased noise levels are considered occupational noises that require occupational health and safety measures. The worker inside the project area should use earmuffs during the operation of diesel generator.	Continuously	Compliance with DoE Regular machineries maintenance records.	Project Developer	- Environmental Pollution Control Ordinance, 1977 - Environmental Conservation Rules (ECR), 1997 - Environment Court Act, 2000
Air Quality	Very low air emissions of air pollutants such as sulfur dioxide, nitrogen oxides, carbon monoxide, volatile organic compounds, and the greenhouse gas carbon dioxide.	- Check regularly to identify potential source of air pollutants. - Replace the damaged and expired tools, equipment, PV panels and batteries as soon as it is noticed.	Daily	- No visible dust plumes originating from project site. - Regular machineries maintenance records.	Project Developer	- Environmental Pollution Control Ordinance, 1977 - Environmental Conservation Rules (ECR), 1997 - Environment Court Act, 2000 - Bangladesh Climate Change Strategy and Action Plan (2008)

Aspect	Key Potential Impact	Mitigation Measures	Frequency	Performance Indicator	Responsibility	Legal Requirements
Noise	Significant sound pollution from backup generator	- Establish the generator inside an insulated room and use noise reduction canopy to keep the environment free from sound pollution. - Noise barrier should also be given around the generator room. - The worker inside the project area should use earmuffs during the operation of diesel generator.	Every week and after receiving any complaints from worker or third parties.	Compliance with DoE and National guideline limits for Environmental noise at sensitive receptors.	Project Developer	- Environmental Pollution Control Ordinance, 1977 - Noise Pollution Control Rules, 2006
Terrestrial Ecology	Potential disturbance and harm to birds	- Minimize human and vehicular contact with resident birds including their burrows / nests and feeding grounds. - Ground nests found on site shall be translocated outside the project boundary. - Waste shall be stored on site within closed container, especially food remnants to avoid attracting birds on site.	Weekly	No reported harm to birds.	Project Developer	- Bangladesh Wildlife Preservation Order 1973 and Revision 2008 (Draft) - National Forest Policy and Forest Sector Review (1994, 2005) - The Forest Act 1927, Amendment 2000 (Protected, village Forests and Social Forestry) - National Biodiversity Strategy and Action Plan, 2004
Waste Generation	- Expired lead-acid battery and potential threat to environment. - Solid wastes	- Collected the lead-acid battery for recycling after the warranty period. - A proper temporary storage facility is needed for the wasted batteries to avoid potential lead	Continuously	- Compliance with Waste management procedures. - Current and Complete records of	Project Developer	- Environmental Pollution Control Ordinance, 1977 - The Environment (Pollution Control)

Aspect	Key Potential Impact	Mitigation Measures	Frequency	Performance Indicator	Responsibility	Legal Requirements
	from PV modules which contains toxic metals. ▪ Besides the lead-acid battery and wasted PV modules few other solid wastes generated during the operational stage. These include end-of-life solar PV modules, electrical wastes, metallic wastes and stationary wastes of office works etc.	contamination. ▪ Collect the domestic waste in septic tanks to treat according to the approved procedure.		regular waste pickup and disposal.		Act, 1995
Soil	Potential spillage of stored oil and chemicals	▪ Specific procedures shall be developed for the removal of waste or spilled fuel, oil and contaminated soil at approved disposal facilities. ▪ Proper storage for chemicals and fuel within confined areas on site and adopting proper safety measures when handling those chemicals to prevent their leakage and infiltration into the soil.	▪ Post rainfall Event ▪ Weekly	Maintain readily available records of all workers training on spill response procedures.	Project Developer	▪ Environmental Pollution Control Ordinance, 1977 ▪ The Environment (Pollution Control) Act, 1995
Health and Safety	▪ Entering of lead into human body from lead-acid battery ▪ Acid hazard	▪ Provide walkways that are clearly designated as a walkway; all walkways shall be provided with good conditions underfoot; signposted and with adequate	Continuously	▪ Total Recordable Incidence Rate (TRIR) ▪ Lost Time Incidence Frequency	Project Developer	▪ Bangladesh Labour Law, 2006

Aspect	Key Potential Impact	Mitigation Measures	Frequency	Performance Indicator	Responsibility	Legal Requirements
	during battery handling - Leaching of materials from broken or fire damaged PV modules - Emergency Fire Hazard - Electrocution of workers - Electromagnetic radiation from PV modules - Slipping and tripping, working at height activities - Lead can enter body in two ways: by breathing or by swallowing it. Lead Sulfide dust enters the body through breathing. Very fine lead particles may penetrate into the lungs result in absorption in the bloodstream. - The potential risk of workers being damaged by acid	lighting. - Ensure all works and storage areas are tidy, all material deliveries shall be planned to minimize accumulated materials at project site. - Signpost any slippery areas, provide proper footwear during working within slippery areas. - Carry out fire risk assessment during operation to identify sources of fuel and ignition and establish general fire precautions including, means of escape, warning and fighting fire. - Set up a system to alert workers on site. This may be temporary or permanent mains operated fire alarm. - Fire extinguishers should be located at identified fire points around the site. The extinguishers shall be appropriate to the nature of the potential fire. - Establish and communicate emergency response plan with all parties, the ERP to consider such things as specific foreseeable emergency situations, organizational roles and authorities, responsibilities and expertise, emergency response and evacuation procedure, in addition to training for personnel's.		- Number of safety Training performed - Number of nonconformance events.		

Aspect	Key Potential Impact	Mitigation Measures	Frequency	Performance Indicator	Responsibility	Legal Requirements
	who are handling lead-acid battery is apparent. - As a power plant, the plant has always some risks of fire hazards. Electrical equipment is the main source of a potential fire hazard. - Risk of electrocution of workers during performing duties in a power plant is always present.	- Adequate first aiders shall be on site in accordance with Bangladesh Labour Law requirements. - First aid kit with adhesive bandages, antibiotic ointment, antiseptic wipes, aspirin, non-latex gloves, scissors, thermometer, etc. shall be made available by the contractor on site.				

Decommissioning Phase

- The solar power plant facility is considered a large scale long-term investment that will contribute to economic benefits to the country through provision of power supply, designed in accordance with best practice, taking into account all relevant national and internal codes and legislation.
 - The design life of the facility will be approximately 20 years. Therefore, the post-design life is expected to involve rehabilitation, upgrading and modernization of the facility, with a possible expansion (retrofitting and addition of new technology).
- As a result, impacts from decommissioning are not expected to arise in the near future unless retrofitting and upgrade of the facility was not feasible. However, this, ESIA Study has considered potential decommissioning impacts in case there was a need for the facility to be dismantled and end operations.
- As can be noted from the impact assessment chapter 8, no impacts with high significance are anticipated to take place during decommissioning of the project since all facilities will be removed, solar power plant decommissioned, and PV panels will be dismantled and sent for recycling or disposal.
 - The main mitigation and monitoring measures to minimize or reduce the environmental and social impacts during decommissioning are anticipated to be similar to those identified for the construction phase.
 - Therefore, to avoid repetition, please refer to Table 9.1 for detailed mitigation measures that are overlap with decommissioning as well.
 - The solar PV panels that will be used in the project will have a life span of 25 years. Disposal of wasted solar PV modules is very important because if not

Aspect	Key Potential Impact	Mitigation Measures	Frequency	Performance Indicator	Responsibility	Legal Requirements
		properly decommissioned, the greatest health risk from end-of-life crystalline solar modules arises from lead containing solders. Under the right conditions it is possible for the lead to leach into landfill soils and eventually into water bodies. - While the solar cell is the heart of a photovoltaic system, on a mass basis it accounts for only a small fraction of the total materials required to produce a solar panel. The outer glass cover constitutes the largest share of the total mass of a finished crystalline photovoltaic module (approximately 65%), followed by the aluminum frame (~20%), the ethylene vinyl acetate encapsulant (~7.5%), the polyvinyl fluoride substrate (~2.5%), and the junction box (1%). The solar cells themselves only represent about four percent (4%) of the mass of a finished module. - Proper decommissioning and recycling of solar panels both ensures that potentially harmful materials are not released into the environment and reduces the need for virgin raw materials. In recognition of these facts, the photovoltaic industry is acting voluntarily to implement product take-back and recycling programs at the manufacturing level.				

11.4 Environmental Monitoring Plan

11.4.1 General

An Environmental Monitoring Plan will be prepared to provide guidelines for environmental management plan during the construction and operation phases of the solar mini grid Power Plant. The environmental components that will be monitored are those that will be positively or negatively affected, or expected to be affected, by construction activity. Environmental management is a sustainable way of planning, arranging, supervising, organizing, and developing the environment for the maintenance of the preservation of natural resources and the prevention or reduction of damage to the environment. The major environmental impact, monitoring method, responsible organization, and expense for each environmental item in the construction and operation phases for the proposed development are listed in Table 11.2.

11.4.2 Objectives

The objective of environmental monitoring during the construction and operation phases is to compare the monitored data against the baseline condition collected during the study period to assess the effectiveness of the mitigation measures and the protection of the ambient environment based on national standards. The main objectives of the pre-construction, construction and operation phase monitoring plans will be to:

- Monitor the actual impact of the works on physical, biological and socioeconomic receptors within the project area for indicating the adequacy of the ESIA;
- Recommend mitigation measures for any unexpected impact or where the impact level exceeds that anticipated in the ESIA;
- Ensure compliance with legal and community obligations including safety on construction sites;
- Ensure the safe disposal of excess construction materials.
- Appraise the adequacy of the ESIA with respect to the project's predicted long-term impacts on the physical, biological and socio-economic environment;
- Evaluate the effectiveness of the mitigation measures proposed in the EMP and recommend improvements, if and when necessary;

Table 11.2: Environmental Monitoring Plan

Environmental Components	Parameters/ Units	Standards/ Guidelines	Monitoring Period/ Frequency/ Sampling, No/year	Responsibility	
				Implementation	Supervision
Pre-Construction Stage					
Air Quality	SO ₂ , NO _x , CO, SPM, PM _{2.5} , PM ₁₀	Air quality standard by DoE, Bangladesh	Once	Contractor	SSREL
Noise Level	dB(A)	Noise Pollution Control Rules (2006)	Once	Contractor	SSREL
Water Quality	Surface water: pH, TDS, Salinity, DO, COD, BOD ₅	Surface water quality standard by DoE, Bangladesh	Once	Contractor	SSREL
	Groundwater: pH, Alkalinity, Fe, Cl ⁻ , TDS, As, Salinity	Groundwater quality standard by DoE, Bangladesh	Once	Contractor	SSREL
Construction Stage					
Air Quality	SO ₂ , NO _x , CO, SPM, PM _{2.5} , PM ₁₀	Air quality standard by DoE, Bangladesh	Once	Contractor	SSREL
Dust	Dust control	Air quality standard by DoE, Bangladesh	Once	Contractor	SSREL
Noise Level	dB(A)	Noise Pollution Control Rules (2006)	Once	Contractor	SSREL
Water Quality	Surface water: pH, TDS, Salinity, DO, COD, BOD ₅	Water quality standard by MoEF, Bangladesh	Once	Contractor	SSREL
	Groundwater: pH, Alkalinity, Fe, Cl ⁻ , TDS, As, Salinity	Water quality standard by MoEF, Bangladesh	Once	Contractor	SSREL
Soil Pollution	▪ Check liquid waste is carried out by experienced personnel and in proper way ▪ Careful and proper handling of oil and	Monitoring	Regularly	Contractor	SSREL

Environmental Components	Parameters/ Units	Standards/ Guidelines	Monitoring Period/ Frequency/ Sampling, No/year	Responsibility	
				Implementation	Supervision
	other hazardous liquids				
Waste	- Check storage, transportation, disposal, handling of hazardous waste - Waste and effluents to be collected and disposed safely from camp. - Wastes and garbage from construction sites to be disposed safely	Monitoring	Weekly	Contractor	SSREL
Health and Safety	- Check quality of food and accommodation at construction camp; - Check safe water supply, hygienic toilet at camp, construction of drain at camp site; - Check toilets are close to construction site; - First Aid Box with required tools and medicines; - The heavy construction material to be handled and stored safely putting due care on public safety; - Heavy construction materials at construction site to be stored and handled safely; and - Check of personal protective equipment (PPE) for worker at the sites	Monitoring	Regularly	Contractor	SSREL
Operation Stage					
Air Quality	SO ₂ , NO _x , CO, SPM, PM _{2.5} , PM ₁₀	Air quality standard by	1/year (5	SSREL	DOE/IDCOL

Environmental Components	Parameters/ Units	Standards/ Guidelines	Monitoring Period/ Frequency/ Sampling, No/year	Responsibility	
				Implementation	Supervision
		DOE, Bangladesh	year)		
Noise Level	dB(A)	Noise Pollution Control Rules (2006)	1/year (5 year)	SSREL	DOE/IDCOL
Water Quality	Surface water: pH, TDS, Salinity, DO, COD, BOD ₅	Water quality standard by DOE, Bangladesh	1/year (5 year)	SSREL	DOE/IDCOL
	Groundwater: pH, Alkalinity, Fe, Cl ⁻ , TDS, As, Salinity		1/year (5 year)	SSREL	DOE/IDCOL
Accident and Public Safety	Record of accidents, different level of disabilities/fatalities.	None Specific	-----	SSREL	DOE/IDCOL
PV panels, and Battery	Chemicals		1/year (5 year)	SSREL	DOE/IDCOL
Soil Quality	Heavy metals		1/year (5 year)	SSREL	DOE/IDCOL
Decommissioning Stage					
Air Quality	SO ₂ , NO _x , CO, SPM, PM _{2.5} , PM ₁₀	Air quality standard by DOE, Bangladesh	Once	Contractor	SSREL /IDCOL
Dust	Dust control	Air quality standard by DOE, Bangladesh	Once	Contractor	SSREL /IDCOL
Noise Level	dB(A)	Noise Pollution Control Rules (2006)	Once	Contractor	SSREL /IDCOL
Water Quality	Surface water: pH, TDS, DO, COD, BOD ₅	Water quality standard by MoEF, Bangladesh	Once	Contractor	SSREL /IDCOL
	Groundwater: pH, Alkalinity, Fe, Cl ⁻ , TDS, As	Water quality standard by MoEF, Bangladesh	Once	Contractor	SSREL /IDCOL
Soil Pollution	- Check liquid waste is carried out by experienced personnel and in proper way - Careful and proper handling of oil and	Monitoring	Regularly	Contractor	SSREL /IDCOL

Environmental Components	Parameters/ Units	Standards/ Guidelines	Monitoring Period/ Frequency/ Sampling, No/year	Responsibility	
				Implementation	Supervision
	other hazardous liquids ▪ Careful and proper handling of PV panels and batteries				
Waste	▪ Check storage, transportation, disposal, handling of hazardous waste ▪ Careful and proper handling of PV panels and batteries ▪ Waste and effluents to be collected and disposed safely from camp. ▪ Wastes and garbage from worker sites to be disposed safely	Monitoring	Weekly	Contractor	SSREL /IDCOL
Health and Safety	▪ Check quality of food and accommodation at worker camp; ▪ Check safe water supply, hygienic toilet at camps, construction of drain at camp sites; ▪ Check toilets are close to construction site; ▪ First Aid Box with required tools and medicines; ▪ The heavy construction material to be handled and stored safely putting due care on public safety; and ▪ Check of personal protective equipment (PPE) for worker at the sites	Monitoring	Regularly	Contractor	SSREL /IDCOL

11.5 Inhouse Monitoring System

Blue Marine Energy Limited is aiming to implement this electricity generation project at this environmentally sensitive location which will require the implementation of multi-year mitigative and monitoring actions, as defined in the Environmental and Social Impact Assessments. This company will be responsible for ensuring that the pre-construction, construction and operating period mitigative and monitoring tasks defined in the ESIA's ESMP are completed on time and in a technically sound manner. An Environmental Specialist will be engaged during pre-construction, construction and the operating period. During these periods mitigation and monitoring will require field surveys, analyses and technical reporting to IDCOL and/or DoE. As of today, Blue Marine Energy Limited has no such capability and will fill this gap by upgrading its skills in all aspects of environmental management, environmental assessment, environmental sampling design, data collection, analysis, reporting, and ESMP implementation. Blue Marine Energy Limited will recruit at least one environmental safeguard staff for implementing the prepared ESMP under this ESIA for the solar mini grid project at St. Martin's Island.

11.6 Environmental Budget

The estimated budget for implementation of the mitigation and monitoring measures proposed in the ESMP is presented in Table 11.3. The overall costs of the ESMP will comprise:

- Environmental monitoring through sample collection and analysis;
- Any remedial measures necessary to reduce or avoid environmental damage;
- Designing and implementing all mitigating and enhancement measures;

The total budget is estimated as BDT 18,38,200. This budget does not include the decommissioning stage since the minimum operation period is 20 year and the rate will vary largely from the present cost.

Table 11.3: Environmental Budget for Solar Mini-grid Power Plant Project

Component	Item	Unit	Quantity	Rate (in BDT)	Amount (BDT)
PRE-CONSTRUCTION STAGE					
Air Quality	Measuring air quality	No.	1	55,000	55000
Noise	Measuring ambient noise level	No.	5	8,000	40000
Water Quality	Surface water quality measurement	No.	1	10,000	10000
	Groundwater quality measurement	No.	1	10,000	10000
Salary	Environmental Specialist	Month	3	30000	90000
	SUB TOTAL (PRE-CONSTRUCTION STAGE)				205000
CONSTRUCTION STAGE					
Air Quality	Measuring air quality	No.	2	55,000	110000
Noise	Measuring ambient noise level	No.	5	8,000	40000

Component	Item	Unit	Quantity	Rate (in BDT)	Amount (BDT)
Water Quality	Surface water quality measurement	No.	1	10,000	10000
	Groundwater quality measurement	No.	1	10,000	10000
Soil	Maintenance cost in soil conservation	Lump sum			40000
Dust Management	Water sprayer / watering	Covered in Engineering Cost			
Waste disposal and management	Disposal and management of construction waste and solar panels of individual households	Lump sum			100000
Construction Safety	General Safety (provision of PPE like ear muffs, gloves etc.)	Lump sum			20000
Health	Health check-up camps for construction workers	Camp	-	5,000	10000
Salary	Environmental Specialist	Month	12	30,000	360000
SUB TOTAL (CONSTRUCTION STAGE)					700000
OPERATION STAGE					
Air Quality	Monitoring air quality	No.	5 (1/year)	55,000	275000
Noise	Monitoring ambient noise level	No.	5 (1/year)	8,000	40000
Water	Monitoring surface water quality	No.	5 (1/year)	10,000	50000
	Monitoring ground water quality and levels	No.	5 (1/year)	10,000	50000
Salary	Environmental Specialist	Month	15	30,000	450000
SUB TOTAL (OPERATION STAGE)					865000
ESTABLISHMENT and TRAINING					
Training	Environmental training and awareness	Lump sum	As per training details	20,000	35000
Management Information System		Lump sum	-	10,000	15000
SUB TOTAL (ESTABLISHMENT and TRAINING)					50000
SUB TOTAL (Pre-construction, Construction, Operation, establishment and training)					18,20,000
CONTINGENCIES @ 10 % on total Environmental Costs					18,200
GRAND TOTAL (in BDT)					18,38,200

12 ENVIRONMENTAL AND SOCIAL BENEFIT

12.1 Introduction

Renewable energy is recognized internationally as a major contributor in protecting our climate, nature, and the environment as well as providing a wide range of environmental, economic, and social benefits that will contribute towards long-term global sustainability.

Solar mini-grids are an ideal alternative to grid electricity in remote villages that do not have grid connectivity. And because mini-grids are independent entities, they can also be controlled and managed without presenting threats to the conventional grid. Such distributed energy systems also provide more reliable electricity, as any outages or interruptions to electricity supply can be quickly identified and corrected. One of our most effective power generation solutions is the Mini-Grid. It is a very reliable, independent, cost effective solution with low operation and maintenance costs.

It is also a centralized solution, which means it acts like a small power plant, utilizing a local electricity distribution network and saving the hassle of installing and maintaining hundreds of small consumer systems. This makes it a very efficient and convenient solution for municipalities, governments, NGOs and investors who want to transform the lives of people in remote communities.

It is a particularly beneficial solution for areas lacking access to national grid electricity or where chances of connecting to the grid are low. Indeed, a hybrid Mini-Grid power system functioning as an autonomous entity can provide almost the same quality and services as the national grid. The solution is for 24 hours a day, 365 days a year, using battery storage to provide service at night and on rainy days.

Increasing the supply of renewable energy would allow replacing carbon-intensive energy sources and significantly reducing global warming emissions. Generating electricity from renewable energy offers significant public health benefits. The air and water pollution emitted by coal and natural gas plants is linked to breathing problems, neurological damage, heart attacks, and cancer.

Solar mini-grid systems generate electricity with no associated air pollution emissions. While solar mini-grid energy systems emit some air pollutants, total air emissions are generally much lower than those of coal and natural gas-fired power plants. In addition, solar energy requires essentially no water to operate and thus do not pollute water resources or strain supply by competing with agriculture, drinking water systems, or other important water needs.

12.2 Energy and Climate Concern

The negative environmental impacts from generating electricity through conventional fossil fuel burning at thermal power plants are very well known. This most importantly includes air pollutant emissions such as ozone, sulfur dioxide (SO₂), Nitrogen Dioxide (NO₂), particulate

matter, and other gases which are the cause of some serious environmental concerns such as smog, acid rain, health effects, and many others.

In addition, the burning of fossil fuels results in carbon dioxide emissions; a primary greenhouse gas emitted through human activities which contributes to global warming. The main human activity that emits CO₂ is the combustion of fossil fuels for electricity production and transportation. Concurrently, global climate change has become an issue of concern and so reducing greenhouse gas emissions have also emerged as primary issues to be addressed as the world searches for a sustainable energy future.

Electricity produced using solar energy emits no greenhouse gases (GHGs) or other pollutants. As with any electricity-generating resource, the production of the PV systems themselves requires energy that may come from sources that emit GHGs and other pollutants. Since solar PV systems have no emissions once in operation, an average traditional PV system will need to operate for an average of four years to recover the energy and emissions associated with its manufacturing. A thin-film system currently requires three years. Technological improvements are anticipated to bring these timeframes down to one or two years. Thus, a residential PV system that can meet half of average household electricity needs is estimated to avoid 100 tons of carbon dioxide (CO₂) over a 30-year lifetime.

12.3 Energy and Livelihood Concern

The belief that the provision of electricity in rural areas can bring about desired socio-economic changes (increased economic opportunities, improved health and education facilities). First, it is argued that electrification only brings changes to resource-rich households, and second, that it drains the resource-scarce rural economy. However, changes in electrified areas might demonstrate some positive outcomes. In response to the availability of electricity, village people could find various productive uses for it.

The development of micro-enterprises in rural areas is linked with the increase in access and use of grid electricity services, leading to changes in micro-enterprises, and changes in livelihood characteristics of entrepreneurs, employees and community members in areas where these enterprises are located. Micro-enterprises are important in their role as contributors to the economy of the rural poor especially women, technological development of rural people and in their potential for employment creation.

12.4 Energy and Economy Concern

Energy is a foundation stone of the modern industrial economy. Energy provides an essential ingredient for almost all human activities: it provides services for cooking and space/water heating, lighting, health, food production and storage, education, mineral extraction, industrial production and transportation. Modern energy services are a powerful engine of economic and social development, and no country has managed to develop much beyond a subsistence economy without ensuring at least minimum access to energy services for a broad section of its population. Throughout the world, the energy resources available to them and their ability to pay largely determine the way in which people live their lives. Nevertheless, it

is critical to recognize that what people want are the services that energy provides, not fuel or electricity per se. Many factors play a role in influencing energy supply, not least of which is its availability, price and accessibility. The regional endowment of energy sources and the pace at which they are developed and distributed are not uniform around the world.

The last two centuries have seen massive growth in the exploitation and development of energy sources, and the world has gained many benefits from these activities. The magnitude of energy consumed per capita has become one of the indicators of development progress of a country, and as a result, energy issues and policies have been mainly concerned with increasing the supply of energy. This approach is now seen as a vision that needs challenging. In the last two years, countries around the world have added almost as much new solar photovoltaic (PV) capacity as had been added since the invention of the solar cell. Nearly 38,000 megawatts of PV came online in 2013, a new annual record. In all, the world's installed PV generating capacity is now close to 140,000 megawatts. Falling costs and effective policies continue to drive tremendous growth in solar power.

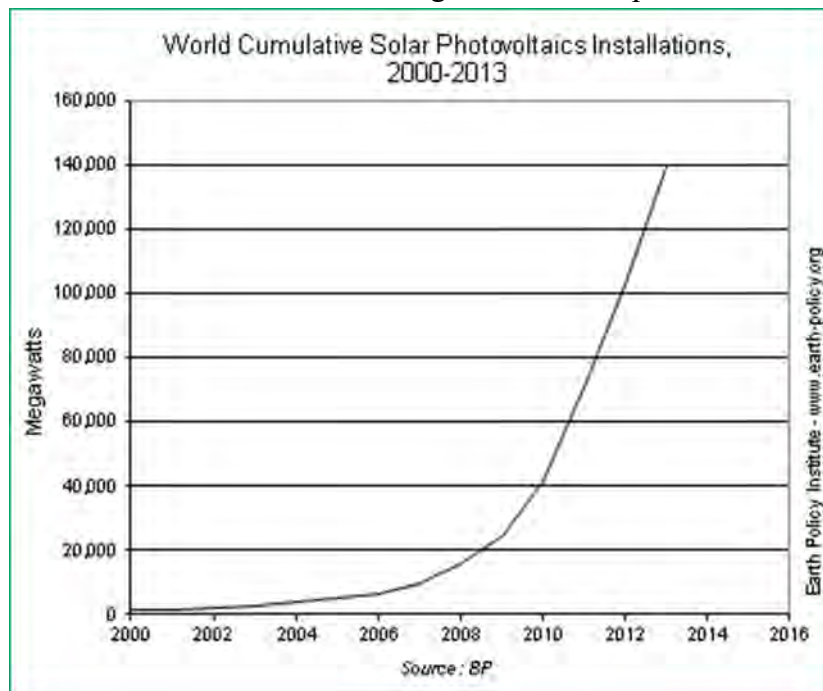


Figure 12.1: Trends of World Solar Energy Growth

PV remains the most rapidly growing energy technology by a wide margin. Indeed, global PV installations for 2014 should reach at least 40,000 megawatts, expanding world PV capacity by another 30 percent. As concerns about climate change grow, solar PV has firmly established itself as an integral player in the transition from fossil fuels.

13 CONCLUSION

13.1 Conclusion

According to the above analysis, we can conclude that, if the recommended mitigation measures and environmental management processes are adopted properly, the project will be environmentally sound and sustainable.

Primarily the national economy will be benefitted by the project. Benefits in the project area will be significant except for some short term employment and business opportunities during the construction phase. However, the needs of the solar photovoltaic power plant are obvious and for that the livelihood of the area will be developed. Developed livelihood will directly influence the growth of economy of the area.

During the construction stage, there will be some negative impacts of the project. There are no significant cumulative adverse impacts during operation that are identifiable at this stage. The construction impacts should be very predictable and manageable, and with appropriate mitigation few residual impacts are likely. Additional human and financial resources will be required to improve environmental capability, and to progress and achieve necessary statutory compliance and environmental clearance certification for the project or associated activities that also require environmental assessment and environmental permits under the environmental laws of Bangladesh.

The project is expected to have a small "environmental footprint". Endangered or protected species of flora or fauna are reported at the project site should be carefully managed by the Contractor and Executing agency. The proposed project activities have no significant adverse environmental impact so far as a time bound execution program with application of advanced construction technology is ensured. The mitigation measures are well within such codes and practices of construction and operation of the proposed project.

13.2 Recommendations

Adequate provisions have been made for the environmental mitigation and monitoring of predicted impacts, along with their associated costs. Adverse impacts if noticed during implementation will be mitigated using appropriate design and management measures. The potential cumulative and residual impacts of the project classify as not a highly sensitive or complex.

The EMP, its mitigation and monitoring programs, contained herewith shall be included within the Bidding documents for project works. The Bid documents state that the contractor shall be responsible for the implementation of the requirements of the EMP through his own Site Specific Environmental Management Plan which will adopt all of the conditions of the EMP. This ensures that all potential bidders are aware of the environmental requirements of the project and its associated environmental costs.

The EMP and all its requirements shall then be added to the contractor's contract, thereby making implementation of the EMP a legal requirement according to the contract. To ensure compliance with the EMP the contractor should employ an environmental specialist to monitor and report project activities throughout the project construction phase.

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APPENDIXES

Appendix A: Air Quality Monitoring Methodology

Air Quality Parameter	Equipment
Suspended Particulate Matter (SPM)	LATA Envirotech APM 250 Combined PM-10/ PM-2.5 Sampler
Respirable Suspended Particulates (RSP) - PM ₁₀	LATA Envirotech APM 250 Combined PM-10/ PM-2.5 Sampler
Oxides of Nitrogen (NOx)	LATA Envirotech LES 411
Sulfur Dioxide (SO ₂)	LATA Envirotech LES 411
Carbon Monoxide	HTC Carbon Monoxide Meter CO-01
Measured Parameters	
AIR Suspended particulate matter (SPM)	
PM ₁₀	
Oxides of Nitrogen (NOx)	
Sulfur dioxide (SO ₂)	
Carbon monoxide (CO)	

A. Procedure

- The aerosol masses of both Suspended particulate matter (SPM) and coarse particle (PM₁₀) will be determined by the weighing (Gravimetric measurement) (after moisture equilibration at 22 degree temperature and 50% moisture) the filter papers before and after the exposure. For weighing, a five decimal OHAUS analytical balance, model AR 1140 will be used.
- The gaseous air pollutants (NOx and SO₂) will be collected by passing the air through particular absorbent solutions in individual impinger at a constant flow rate (100 to 200 ml/min). The absorbent solutions finally analyze and determine in UV-Visible Recording Double Beam Spectrophotometer (A Shimadzu UV visible model UV-160A). Individual wavelength will be used as a UV source for NOx and SO₂. 560 nm wavelength passes through absorbent reagent for SO₂ and 540 nm wavelength for NO₂. The parameters SPM, PM₁₀, SO₂ and NOx are expressed in microgram/m³.
- For the determination of CO, HTC Carbon Monoxide Meter CO-01 will be used and value is expressed in ppm.

		
High Volume Sampler	Gaseous Sampling Attachment LES 411	HTC Carbon Monoxide Meter CO-01

B. Sample preparation for the analysis in SPM/PM₁₀

Digestion procedure for glass micro fiber & Millipore filter paper

- The Millipore filter paper (for PM₁₀) will be placed in a 150 mL squat beaker. Added 0.5 g solid potassium chlorate followed by 100 mL of 20% v/v HNO₃. Covered the beaker with a watch glass and simmer the contents for 15 min on a hot plate. Then move the beaker to the edge of the hot plate after it will cool somewhat and evaporated the liquid to dryness overnight. Cooled the beaker and contents and added 20.00 mL concentrated HCl. Warmed the beaker to about 80°C and added 80.0 mL of the 0.4% EDTA solution. Allowed the mixture to stand for 30 min and then stirred well with a glass rod. Elemental determination will be made as described above. Acid, reagent, and filter paper blanks must be carried through the complete procedure.

Sample dissolution procedure

- The beaker will be removed from the hot plate and allows cooling. The mixture will be filtered to a 10 mL volumetric flask and dilute to the mark with di-ionized water.

Blank solution preparation

- One unexposed glass fiber filter paper will be digested and prepared the blank solution by following the same procedure as an exposed filter.



C. Analysis of Gaseous Pollutants

Analysis of SO₂:

- Step – 1: Preparation of reagents for sampling
 - o Absorbing reagent (TCM, 0.04) – Dissolved 10.86 gm mercuric chloride + 0.066 gm EDTD = 6.0 gm potassium chloride in 1000 ml distilled / deionized water
 - o Caution: - Highly poisonous if spilled on skin, flush off water immediately
- Step -2 : Analysis
 - o For preparation of calibration curve
 - o Stock iodine solution (0.1N) → Working iodine solution (0.01N) → Starch indicator → Primary standard potassium iodate solution → Stock sodium thiosulphate solution (0.1N)

$$\bullet \text{ SO}_2 \text{ concentration } (\mu\text{g}/\text{m}^3) = \frac{C \times A \times 1000 \times D}{V \times B}$$

Where,

C = SO₂ Curve Value (μg in 25 ml)
 A = Absorbing reagent Taken for Sampling (ml)
 V = Volume of air Passed (lit)
 B = Volume taken for sampling analysis (ml)
 1000 = Conversion factor liter to m₃
 D = dilution factor

Analysis of NO_x

- Step – I Preparation of reagent
 - o For sampling
 - o Absorbing Reagent:
 - o Dissolved 4.0 gm Sodium Hydroxide + 1.0 gm Sodium Arsenite in 1000 ml deionized/distilled water.
 - o Caution: Arsenic Compound is highly toxic Avoid contact with skin and especially with eyes. Do not take internally
- Step – II Than analysis
 - o Solution 'A':
 - o Dilute 5.0 ml of stock Nitrite Solution (1000 μg NO₂/ml) to 500ml with Deionized Water.

- o This Solution 1 ml = 10 µg NO_x
- o *Solution 'B' :*
- o Dilute 25ml of solution 'A' (10 µg/NO₂) to 250 ml absorbing Reagent.
- o This Solution 1 ml = 1 µg NO_x
- o *Note :* Prepare fresh daily
- o This solution used for NO_x calibration curve preparation.

- Step - III Chemical analysis of sample

Analysis of CO

- Preparation for the analysis of CO
 - o The CO will be measured from the real time data collected shows in the monitoring device's LCD monitor.

Appendix B: Air Quality Test Result



DSCL

Multidisciplinary Development Consultants

DSCL Environmental Laboratory

Name of the Project	210kWp Solar Mini Grid Power Plant at St. Martin's Island, Cox's Bazar
Project Address	Village –PurboPara ,Union –St. Martin's Island, Upazila - Teknaf, District –Cox's Bazar.
GPS Location	20.62975°N, 92.32270°E
Description of Sample	Ambient Air Quality Test Result; Samples Collected for 8 hours
Sample Collector	Collected by DSCL Personnel
Sampling Date	7 th April, 2016

Test Result of Ambient Air Quality Analysis

Parameter	Unit	Project Site		Bangladesh Standard**	Duration (hours)	Weather Condition	Method of Analysis
		Day	Night				
PM _{2.5}	µg/m ³	29.47	28.40	65	24	Sunny	Gravimetric
PM ₁₀	µg/m ³	37.29	36.53	150	24		Gravimetric
SPM	µg/m ³	68.47	72.49	200	8		Gravimetric
SO ₂	µg/m ³	2.95	4.13	365	24		West- Geake
NO _x	µg/m ³	16.41	18.32	100	24		Jacob and Hochheiser
CO*	mg/m ³	<1	<1	10	8		CO-meter

Note:

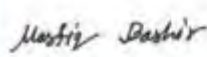
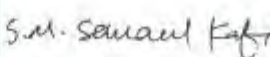
* CO concentrations and standards are 8-hourly.

** 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.

Note:

- PM_{2.5} – Fine Particulate Matter.
- PM₁₀ – Respirable Dust Content
- SPM – Suspended Particulate Matter
- SO₂ – Sulphur Dioxide
- NO_x – Oxides of Nitrogen.
- CO – Carbon Monoxide



Test Performed By:  Masfiq Bashir Jr. Environmental Specialist	Approved By:  S.M. Sanaul Kafil General Manager (Water & Environment)
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Development Solutions Consultant Ltd.
 House-35 (A-2), Road-15, Nikunja-2R/A,
 Khilkhet, Dhaka-1229, Bangladesh. Tel: +8804478035444
 Email: dscl@dsclbd.com Web: www.dsclbd.com



DSCL

Multidisciplinary Development Consultants

DSCL Environmental Laboratory

Name of the Project	210kWp Solar Mini Grid Power Plant at St. Martin's Island, Cox's Bazar
Project Address	Village –St. Martin Bazar, Union –St. Martin's Island, Upazila – Teknaf, District –Cox's Bazar.
GPS Location	20.63300°N, 92.32700°E (Bazar Site)
Description of Sample	Ambient Air Quality Test; Samples Collected for 8 hours
Sample Collector	Collected by DSCL Personnel
Sampling Date	7 th April, 2016

Test Result of Ambient Air Quality Analysis

Parameter	Unit	Bazar Area		Bangladesh Standard**	Duration (hours)	Weather Condition	Method of Analysis
		Day	Night				
PM _{2.5}	µg/m ³	30.41	32	65	24	Sunny	Gravimetric
PM ₁₀	µg/m ³	42.17	41.32	150	24		Gravimetric
SPM	µg/m ³	75.93	79.68	200	8		Gravimetric
SO ₂	µg/m ³	3.84	4.21	365	24		West- Geake
NO _x	µg/m ³	18.26	21.62	100	24		Jacob and Hochheiser
CO*	mg/m ³	<1	<1	10	8		CO-meter

Note:

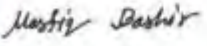
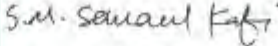
* CO concentrations and standards are 8-hourly.

** 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.

Note:

- PM_{2.5} – Fine Particulate Matter.
- PM₁₀ – Respirable Dust Content
- SPM – Suspended Particulate Matter
- SO₂ – Sulphur Dioxide
- NO_x – Oxides of Nitrogen.
- CO – Carbon Monoxide



Test Performed By:  Masfiq Bashir Jr. Environmental Specialist	Approved By:  S.M. Sanaul Kafi General Manager (Water & Environment)
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Appendix C: Noise Level Test Result



DSCL

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DSCL Environmental Laboratory

Name of the Project 210kWp Solar Mini Grid Power Plant Project at Saint Martin's Island
 Project Address Village – Purbo para, Union – Saint Martin, Upazila - Teknaf, District – Cox's Bazar
 Description of Sample Noise Level
 Sample Collector Collected by DSCL Personnel
 Sampling Date 7th April 2016

Noise Level Analysis

SL#	Sampling Location	GPS Location	Zone*	Time	Noise Level dB (A)	Bangladesh Standard dB (A)**	Remarks
1.	Project Site-01 (Day)	20.62978°N 92.32288°E	Residential area	04:00 PM	44.53	55	Low
2.	Project Site-01 (Night)	20.62978°N 92.32288°E	Residential area	08:00 PM	45.82	45	High***
3.	Project Site-02 (Day)	20.62969°N 92.32258°E	Residential area	05:00 PM	42.54	55	Low
4.	Project Site-02 (Night)	20.62969°N 92.32258°E	Residential area	08:30 PM	36.42	45	Low
5.	Project Site-03 (Day)	20.62958°N 92.32279°E	Residential area	06:00 PM	46.26	55	Low
6.	Project Site-03 (Night)	20.62958°N 92.32279°E	Residential area	09:00 PM	39.22	45	Low

Note:

* According to Environmental Quality Standard 1997 and subsequent amendment in 2006

** Bangladesh Standard for Noise Level at different types of areas (as per Noise Pollution (Control) Rules, 2006)

*** Noise level were high for project site because during noise test there was a wedding ceremony at night near the project site.



S.M. Sanaul Kafi

S.M. Sanaul Kafi
 General Manager (Water & Environment)

Masfiq Bashir

Masfiq Bashir
 Jr. Environmental Specialist

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DSCL

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DSCL Environmental Laboratory

Name of the Project 210kWp Solar Mini Grid Power Plant Project at Saint Martin's Island
 Project Address Village – Saint Martin Bazar, Union – Saint Martin, Upazila - Teknaf,
 District – Cox's Bazar
 Description of Sample Noise Level
 Sample Collector Collected by DSCL Personnel
 Sampling Date 7th and 8th April 2016

Noise Level Analysis

SL#	Sampling Location	GPS Location	Zone*	Time	Noise Level dB (A)	Bangladesh Standard dB (A)**	Remarks
1.	Bazar Area-01 (Day)	20.63294°N 92.32646°E	Commercial Area	12:50 PM	58.05	70	Low
2.	Bazar Area-01 (Night)	20.63294°N 92.32646°E	Commercial Area	11:00 PM	48.21	60	Low
3.	Bazar Area-02 (Day)	20.63306°N 92.32689°E	Commercial Area	02:00 PM	52.97	70	Low
4.	Bazar Area-02 (Night)	20.63306°N 92.32689°E	Commercial Area	11:30 PM	49.20	60	Low
5.	Bazar Area-03 (Day)	20.63289°N 92.32746°E	Commercial Area	03:00 PM	56.31	70	Low
6.	Bazar Area-03 (Night)	20.63289°N 92.32746°E	Commercial Area	12:00 AM	46.57	60	Low

Note:

* According to Environmental Quality Standard 1997 and subsequent amendment in 2006

** Bangladesh Standard for Noise Level at different types of areas (as per Noise Pollution (Control) Rules, 2006)



S.M. Sanaul Kafi

S.M. Sanaul Kafi
 General Manager (Water & Environment)

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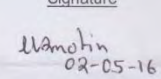
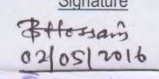
Appendix D: Test Result of Surface Water

	Government of the People's Republic of Bangladesh Office of the Chief Chemist Department of Public Health Engineering Central Lab, 38-39, Mohakhali C/A, Dhaka-1212 Phone: 88-02-9881927, Fax: 88-02-9882003, Email: wqmsc_central_lab@yahoo.com	
Lab Memo: 409/ Sr. Chemist, DPHE, CL, Dhaka.		Date: 02/05/2016
Physical /Chemical/ Bacteriological Analysis of Water Sample		
Sample ID: CEN2016050005	Sample Receiving date: 10/04/2016	
Ref. Memo No: DSCL/2016/Nill & Dated: 10/04/2016	Sample Source: Surface Water	
Sent by: Md. Shafiqur Rahman, Environmental Specialist, DSCL, Dhaka, Bangladesh.	Dist: Cox's Bazar, Upa: Teknaf	
Care Taker: St.martin SW -01	Union: St.martin Dwip, Vill.: Dhali Para, Ward No 03	
Sample Collection date: 09/04/2016	Date of Testing: 10/04/2016 - 02/05/2016	

LABORATORY TEST RESULTS:

Sl.#	Water quality parameters	Bangladesh Standard	Concentration present	Unit	Analysis Method	LOQ
1	Biochemical Oxygen Demand (BOD)	0.2	10	mg/L	5 days Incubation	-
2	Chemical Oxygen Demand (COD)	4.0	36	mg/L	CRM	-
3	Dissolved Oxygen (DO)	6.0	2.16	mg/L	Multimeter	-
4	Salinity	-	1.15	‰	Multimeter	-

Comments: Sample was collected & Supplied by client.
 N.B: CRM-Closed Reflex Methods, LOQ- Limit of Quantitation.

Test Performed by: 1.) Name: Mahabuba Sabina Motin Designation: Sample Analyzer Signature:  02-05-16 2.) Name: Md. Saiful Alam Khosru Designation: Sample Analyzer Signature:  02-05-16 নমুনা বিশ্লেষণ জনস্বাস্থ্য প্রকৌশল, পরিদপ্তর কেন্দ্রীয় পরীক্ষাগার মহাখালী, ঢাকা	Countersigned/Approved by: 1.) Name: Md. Biplab Hossain Designation: Senior Chemist Signature:  02/05/2016 মোস্তাফিজ হোসেন সিনিয়র কেমিস্ট জনস্বাস্থ্য প্রকৌশল পরিদপ্তর কেন্দ্রীয় পরীক্ষাগার মহাখালী, ঢাকা। 2.) Name: Designation:
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Page 1 of 1

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Lab Memo: 409/ Sr. Chemist, DPHE, CL, Dhaka.

Date: 02/05/2016

Physical /Chemical/ Bacteriological Analysis of Water Sample

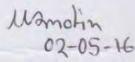
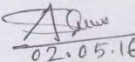
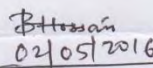
Sample ID: CEN2016050006	Sample Receiving date: 10/04/2016
Ref. Memo No: DSCL/2016/Nill & Dated: 10/04/2016	Sample Source: Surface Water
Sent by: Md. Shafiqur Rahman, Environmental Specialist, DSCL, Dhaka, Bangladesh.	Dist: Cox's Bazar, Upa: Teknaf
Care Taker: St.martin SW -02	Union: St.martin Dwip, Vill.: Purbo Para, Ward No -06
Sample Collection date: 09/04/2016	Date of Testing: 10/04/2016 - 02/05/2016

LABORATORY TEST RESULTS:

Sl.#	Water quality parameters	Bangladesh Standard	Concentration present	Unit	Analysis Method	LOQ
1	Biochemical Oxygen Demand (BOD)	0.2	48	mg/L	5 days Incubation	-
2	Chemical Oxygen Demand (COD)	4.0	760	mg/L	CRM	-
3	Dissolved Oxygen (DO)	6.0	1.39	mg/L	Multimeter	-
4	Salinity	-	45	‰	Multimeter	-

Comments: Sample was collected & Supplied by client.

N.B: CRM-Closed Reflex Methods, LOQ- Limit of Quantitation.

Test Performed by: 1.) Name: Mahabuba Sabina Motin Designation: Sample Analyzer Signature:  02-05-16 2.) Name: Md. Saiful Alam Khosru Designation: Sample Analyzer Signature:  02.05.16 নমুনা বিশ্লেষণ লেবোরেটরি কেন্দ্রীয় পরীক্ষাগার মহাখালী, ঢাকা	Countersigned/Approved by: 1.) Name: Md. Biplab Hossain Designation: Senior Chemist Signature:  02/05/2016 2.) Name: Designation: মোঃ বিপ্লব হোসেন সিনিয়র কেমিস্ট জনস্বাস্থ্য প্রকৌশল অধিদপ্তর কেন্দ্রীয় পরীক্ষাগার মহাখালী, ঢাকা।
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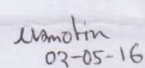
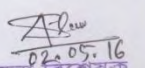
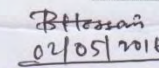
Appendix E: Test Result of Groundwater

	Government of the People's Republic of Bangladesh Office of the Chief Chemist Department of Public Health Engineering Central Lab, 38-39, Mohakhali C/A, Dhaka-1212 Phone: 88-02-9881927, Fax: 88-02-9882003, Email: wqmsc_central_lab@yahoo.com	
Lab Memo: 409/ Sr. Chemist, DPHE, CL, Dhaka.		Date: 02/05/2016
Physical /Chemical/ Bacteriological Analysis of Water Sample		
Sample ID: CEN2016050003		Sample Receiving date: 10/04/2016
Ref. Memo No: DSCL/2016/Nill & Dated: 10/04/2016		Sample Source: Tube Well
Sent by: Md. Shafiqur Rahman, Environmental Specialist, DSCL, Dhaka, Bangladesh.		Dist: Cox's Bazar, Upa: Teknaf
Care Taker: St.martin GW -01		Union: St.martin Dwip, Vill.: Purbo Para
Sample Collection date: 09/04/2016		Date of Testing: 10/04/2016 - 02/05/2016

LABORATORY TEST RESULTS:

Sl.#	Water quality parameters	Bangladesh Standard	Concentration present	Unit	Analysis Method	LOQ
1	Alkalinity	-	340	mg/L	Titrimetric	-
2	Arsenic (As)	0.05	0.002	mg/L	AAS	0.001
3	Chloride	150-600	210	mg/L	Titrimetric	-
4	Iron (Fe)	0.3-1	<LOQ	mg/L	AAS	0.05
5	Salinity	-	0.52	‰	Multimeter	-

Comments: Sample was collected & Supplied by client.
 N.B: AAS- Atomic Absorption Spectrophotometer, LOQ- Limit of Quantitation.

Test Performed by: 1.) Name: Mahabuba Sabina Motin Designation: Sample Analyzer Signature  02-05-16 2.) Name: Md. Saiful Alam Khosru Designation: Sample Analyzer Signature  02.05.16 নমুনা বিশ্লেষক জনস্বাস্থ্য প্রকৌশল অধিদপ্তর কেন্দ্রীয় পরীক্ষাগার মহাখালী, ঢাকা	Countersigned/Approved by: 1.) Name: Md. Biplab Hossain Designation: Senior Chemist Signature  02/05/2016 মোঃ বিপ্লব হোসেন সিনিয়র কেমিস্ট জনস্বাস্থ্য প্রকৌশল অধিদপ্তর কেন্দ্রীয় পরীক্ষাগার মহাখালী, ঢাকা। 2.) Name: Designation:
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Page 1 of 1

	Government of the People's Republic of Bangladesh Office of the Chief Chemist Department of Public Health Engineering Central Lab, 38-39, Mohakhali C/A, Dhaka-1212 Phone: 88-02-9881927, Fax: 88-02-9882003, Email: wqmsc_central_lab@yahoo.com	
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Lab Memo: 409/ Sr. Chemist, DPHE, CL, Dhaka.

Date: 02/05/2016

Physical /Chemical/ Bacteriological Analysis of Water Sample

Sample ID: CEN2016050004	Sample Receiving date: 10/04/2016
Ref. Memo No: DSCL/2016/Nil & Dated: 10/04/2016	Sample Source: Tube Well
Sent by: Md. Shafiqur Rahman ,Environmental Specialist , DSCL, Dhaka, Bangladesh.	Dist: Cox's Bazar, Upa: Teknaf
Care Taker: St.martin GW -02	Union: St.martin Dwip, Vill.: Ward No 06
Sample Collection date: 09/04/2016	Date of Testing: 10/04/2016 - 02/05/2016

LABORATORY TEST RESULTS:

Sl.#	Water quality parameters	Bangladesh Standard	Concentration present	Unit	Analysis Method	LOQ
1	Alkalinity	-	330	mg/L	Titrimetric	-
2	Arsenic (As)	0.05	0.001	mg/L	AAS	0.001
3	Chloride	150-600	850	mg/L	Titrimetric	-
4	Iron (Fe)	0.3-1	<LOQ	mg/L	AAS	0.05
5	Salinity	-	1.73	‰	Multimeter	-

Comments: Sample was collected & Supplied by client.

N.B: AAS- Atomic Absorption Spectrophotometer, LOQ- Limit of Quantitation.

Test Performed by: 1.) Name: Mahabuba Sabina Motin Designation: Sample Analyzer Signature: <i>M. Sabina Motin</i> 02-05-16 2.) Name: Md. Saiful Alam Khosru Designation: Sample Analyzer Signature: <i>AS</i> 02-05-16 নমুনা বিশ্লেষক জনস্বাস্থ্য প্রকৌশল অধিদপ্তর কেন্দ্রীয় পরীক্ষাগার মহাখালী, ঢাকা	Countersigned/Approved by: 1.) Name: Md. Biplab Hossain Designation: Senior Chemist Signature: <i>B. Hossain</i> 02/05/2016 মোঃ বিপ্লব হোসেন সিনিয়র কেমিস্ট জনস্বাস্থ্য প্রকৌশল অধিদপ্তর কেন্দ্রীয় পরীক্ষাগার মহাখালী, ঢাকা। 2.) Name: Designation:
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Appendix F: Important Sensitive Locations in the PIA

Name	Location		Description	Photo
	N	E		
Saint Martin BN Islamic School & College	20.63355°	92.32574°	This is the open university in this Island.It is Two- storied building.	
Central Jame Mosjid	20.63326°	92.32421°	It is central in the island. There is a small water reservoir in front of the mosjid.	
Rahmania Atimkhana, Saint Martin	20.63325°	92.32303°	A tin shade orphanage beside the central jame mosjid.	

Name	Location		Description	Photo
	N	E		
Saint Martin (10) Dosh Shojja Bishisto Hospital	20.63158°	92.32123°	A ten-bedded layout hospital which is not yet operational .	
6 no. Saint Martin Union Complex	20.63153°	92.32170°	The 6 no. Saint Martin union complex is situated near the local hospital.	
Cyclone Shelter	20.63104°	92.32170°	There is shelter beside the union complex. It is used during any cyclone. This cyclone shelter is 'L' shaped.	

Name	Location		Description	Photo
	N	E		
Madrasha Amir-e-Muabia, Nuranikaji	20.63093°	92.32177°	Thismadrasha is in front of the cyclone shelter.	
Mosjid	20.63093°	92.32177°	This mosque is situated near the project site.	
Saint Martin Weather Station	20.62795°	92.32098°	There is aweather station near the project site. It is not yet operational.	

Name	Location		Description	Photo
	N	E		
Baitul Jannah Jame Masjid & Darul Jannah Islamia Atimkhana	20.62551°	92.32116°	Baitul Jannah Jame Masjid and Darul Jannah Islamia orphanage is located at 20.62551°N and 92.32116°E.	
CREED Sangit Academy	20.62467°	92.32074°	This is only one musical learning academy in the Saint Martin's Island.	
Zinzira Govt. Primary School	20.63305°	92.32175°	This is the government primary school in the Saint Martin's Island.	

Name	Location		Description	Photo
	N	E		
Saint Martin Post Office	20.63310°	92.32188°	A post office is situated beside the Zinzira Govt. Primary School.	
Shahid Minar	20.63304°	92.32170°	There is a Shahid Minar in front of Police Fari.	
Police Fari Mosjid	20.63297°	92.32165°	The police fari is near the Zinzira Govt. Primary School. At ground floore there is police fari mosjid.	

Name	Location		Description	Photo
	N	E		
Wapda Guest House	20.63258°	92.32026°	Wapda Guest house is	
Saint Martin Light House	20.63258°	92.32026°	Saint Martin Light house is a bright light at the top, located near Wapda Guest house regarding to serve as a navigational aid and to warn boats of dangerous areas. It is like a traffic sign on the island.	
Baituch Salam Jame Mosjid	20.63218°	92.31930°	It is a tin shade mosjid.	

Name	Location		Description	Photo
	N	E		
Baituch Salam Madrasha	20.63218°	92.31930°	It is a tin shade madrasha.	
Saint Martin Dak Banglow	20.63389°	92.32535°	Saint Martin Dak Banglow is situated at 20.63389°N and 92.32535°E.	
Hazrat Abu Bakar Siddiki (R) Jame Mosjid	20.63349°	92.32597°	Hazrat Abu Bakar Siddiki (R) Jame mosjid is at the bazar area.	

Name	Location		Description	Photo
	N	E		
Baitul Izzat Jame Mosjid	20.63467°	92.32660°	A tin shade mosjid situated at north side of the island.	
Islamic Research Centre Hafez khana & Atimkhana	20.63250°	92.32653°	This is a islamic research centre.	
Saint Martin Coast Guard	20.62800°	92.32605°	Saint Martin coast guard area is situated at 20.62800°N and 92.32605°E.	

Name	Location		Description	Photo
	N	E		
Coral View Resort	20.62538°	92.32640°	This coral view resort is situated in the Saint Martin coast guard area.	
Navy Coast Guard Camp	20.62469°	92.32637°	There is a navy coast guard camp in the coast guard area.	
Grameen Phone Tower	20.63285°	92.32186°	There is a grameen phone tower in this island.	

Name	Location		Description	Photo
	N	E		
Sumudra Bilas	20.63193°	92.31702°	This cottage is situated on the west side. This cottage is owned by the famous Bangladeshi writer, late Dr. Humaun Ahmed. It has 6 rooms, which are well decorated.	
Saint Martin Bazar	20.63300°	92.32700°	Saint Martin Bazar consists of more than 50 local shops.	
Coral Beach	20.63198°	92.31713°	It is a long coral beach at the west side of the island. In front of Shamudra Bilash cottage. It is the most sensitive location in this island.	

Appendix G: Details of FGDs with Attendance List

CONSULTATION NO- 1

SITE: SAINT MARTIN BAZAR, SAINT MARTIN ISLAND, TEKNAF, COX'S BAZAR.

DATE: 7th April, 2016

TIME: 04:00 PM TO 04:40 PM.

Outcome of the Consultation

A consultation meeting was held during 04:00 pm to 04:40 pm on 7th April 2016 at Saint Martin Bazar of Saint Martin Island. All the participants were local people from several professions(e.g., businessman, van-driver, service holder, fisherman, village police etc). Total 15 (fifteen)people participated in the meeting. In consultation meeting; environmental and social issues were examined. The main focus was to dig out information on how does indiscriminate use of natural resources cause social and environmental degradation or benefit by implementing the proposed project with using several natural resources. The issue on potential impact of construction works has also been raised.

During the consultation the participants appreciated the new project explaining their desires and expectations. The project will increase and improve the quality of their life.

Additionally, some of the participants are not included in to the grid line and will not be benefited because of the project implementation. They want the project proponent to extend their capacity so that the non-privileged families will get the facilities. Moreover, as the consultation was held at the bazar area and many of them were businessmen so they were expecting more electricity to expand their business.

No major impact will take place due to the implementation of this project. Most of the people argued that they are willing to endure the negative impact to some extent for the sake of this project which they believe will improve their livelihood.

Suggestions:

- There should be effective mitigation measures in order to reduce noise pollution. Improved technology might mitigate the noise pollution.
- Surface water and soil pollution should be controlled by monitoring the runoff of hazardous or chemical waste materials to the surroundings.
- Air pollution from the constructional materials and machineries will create minor problem. Contractor should spray water during material transportation and use cover for air pollution sources if possible.
- Waste management because of the project implementation should be monitored and the proponent has to take responsibility of this management.
- Local employment need to be created in the future project construction and operation phases which can be a good option for livelihood development.

Environmental Assessment (IEE & EIA) of Solar Mini Grid Power Plant at St. Martin Island

Focus Group Discussions (FGDs)

List of Participants

Focus Group No. 1 (one) Date 07.04.16 Time 4:00 PM

Location Saint Martin Bazar

Sl No.	Name	Age	Occupation	Telephone No.	Signature
1	(মহাশয়) মনজি	৪০	শ্রমিক	০১৬১২৩৫৫৫৫	[Signature]
2	(ম: খান)	২২	শ্রমিক	০১৬১২৩৫৫৫৫	[Signature]
3	(ম: মুনীর)	৩৬	শ্রমিক		[Signature]
4	মহাশয় মনজি	৪৪	শ্রমিক		[Signature]
5	মুনীর	৪৬	শ্রমিক	০১৭৭২০৭০৭০	[Signature]
6	শ্রমিক (মুনীর)	৪০	শ্রমিক		[Signature]
7	(মহাশয়) মনজি	২৫	শ্রমিক	০১৬১২৩৫৫৫৫	[Signature]
8	(মহাশয়) মনজি	২৬	শ্রমিক	০১৬১২৩৫৫৫৫	[Signature]
9	মুনীর	৩৩	শ্রমিক	০১৬৭৪০৩৬৬৬	[Signature]
10	(মহাশয়) মনজি	২৩	শ্রমিক	০১৭৭৭০৭৭৭০	[Signature]
11	মুনীর মনজি	৩২	শ্রমিক	০১৭২৭৬৩৭৭৩	[Signature]
12	মুনীর মনজি	৩০	শ্রমিক		[Signature]
13	মুনীর মনজি	২৫	শ্রমিক		[Signature]
14	(মহাশয়) মনজি	২৩	শ্রমিক	০১৬২০২০২০	[Signature]
15	মুনীর মনজি	২২	শ্রমিক	০১৬১২৩৫৫৫৫	[Signature]

CONSULTATION NO- 2

SITE: PURBO PARA, SAINT MARTIN ISLAND, TEKNAF, COX'S BAZAR

DATE: 7th April, 2016

TIME: 06:00 PM TO 06:45 PM

Outcome of the Consultation

A consultation meeting was held during 06:00 pm to 06:45 pm on 7th April 2016 at Purbo Para beside the project site. The consultation meeting was conducted with the local people (e.g., businessman, service holder, student, cook, van-driver, fisherman, politicians etc.). Total 10 (ten) people participated in the meeting. In consultation meeting; environmental and social issues were examined. The main focus was to dig out information on how does indiscriminate use of natural resources cause social and environmental degradation or benefit by implementing the proposed project with using several natural resources. The issue on potential impact of construction works has also been raised.

Most of participants appreciated because of the benefit from the proposed project. They also discussed about noise, water and soil pollution issue that are evolving because of existing the future possibilities. They expect improved technology and good management practice to minimize the problem.

Their main attention was on the educational development because of this project implementation. As they are not capable to teach computer lesson and to take the classes in a multimedia class room hence they think that they are far behind from the national educational context. This project implementation will open the opportunity to them. Additionally, their student will be able to study at home during night because of having electricity. Some other participants were worried about the monthly charge of using electricity of this project. If the charge is more than theirs afford, most of them will continue using their own solar panel those they are currently using.

Suggestions:

- There should be effective mitigation measures in order to reduce noise pollution. Improved technology might and proper management plan would help to mitigate the noise pollution.
- Surface water and soil pollution should be controlled by monitoring the runoff of waste materials to the surroundings.
- Air pollution from the construction materials and emission from machineries might create minor problem but this is acceptable for their better future.
- The capacity of this project should be extended to add more business and agricultural entities into the grid connection.
- The existing solar panel of every individual household should be collected sometimes with little payments from the owner for proper disposal or management by the project proponent or any responsible authority.
- Monthly charge of using electricity from the solar mini grid should be local people's affordable rate.
- Local employment need to be created in the future project construction and operation phases which can be a good option for livelihood development.

Environmental Assessment (IEE & EIA) of Solar Mini Grid Power Plant at St. Martin Island

Focus Group Discussions (FGDs)

List of Participants

Focus Group No. 2 (Two) Date 07.04.16 Time 6:00 PM

Location Purbo Para (ward No. 6)

Sl No.	Name	Age	Occupation	Telephone No.	Signature
1	স্বপ্না	২২	শ্রমিক	০১৬৮৭৭৭৭৭	
2	স্বপ্না	২৫	শ্রমিক (মহিলা)	০১৬৮৭৭৭৭৭	
3	স্বপ্না	৩০	শ্রমিক (মহিলা)	০১৬৮৭৭৭৭৭	
4	স্বপ্না	৩০	শ্রমিক (মহিলা)	০১৬৮৭৭৭৭৭	
5	স্বপ্না	২৪	শ্রমিক		
6	স্বপ্না	৩২	শ্রমিক (মহিলা)		
7	স্বপ্না	৩২	শ্রমিক		
8	স্বপ্না	৪২	শ্রমিক		
9	স্বপ্না	৪০	শ্রমিক		
10	স্বপ্না	৪০	শ্রমিক		
11					
12					
13					
14					
15					

CONSULTATION NO- 3

SITE: DELPARA, SAINT MARTIN ISLAND, TEKNAF, COX'S BAZAR

DATE: 8th April, 2016

TIME: 02:00 PM TO 02:30 PM

Outcome of the Consultation

A consultation meeting was held during 02:00 pm to 02:30 pm on 8th April 2016 at Delpara beside the Saint Martin Bazar area. The consultation meeting was conducted with the local people (e.g., teacher, businessman, student, fisherman, politicians etc.). Total 15 (fifteen) people participated in the meeting. In consultation meeting; environmental and social issues were examined. The main focus was to dig out information on how does indiscriminate use of natural resources cause social and environmental degradation or benefit by implementing the proposed project with using several natural resources. The issue on potential impact of construction works has also been raised.

Most of participants appreciated because of the benefit from the proposed project. They also discussed about noise, water and soil pollution issue that are evolving because of existing the future possibilities. They expect improved technology and good management practice to minimize the problem.

Their main attention was on the overall development because of this project implementation. Because of this power plant, there will be continuous electricity so that tourist will be more than present. Again they are also concern about the pollution caused by tourist and the power plant failure during any natural calamities.

Suggestions:

- There should be effective mitigation measures in order to reduce noise pollution. Improved technology might and proper management plan would help to mitigate the noise pollution.
- Surface water and soil pollution should be controlled by monitoring the runoff of waste materials to the surroundings.
- Air pollution from the construction materials and emission from machineries might create minor problem but this is acceptable for their better future.
- Project proposed land should high so that it can be avoided by any serious flooding. Proper cautions should be taken for any natural calamities.
- Local employment need to be created in the future project construction and operation phases which can be a good option for livelihood development.

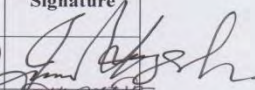
Environmental Assessment (IEE & EIA) of Solar Mini Grid Power Plant at St. Martin Island

Focus Group Discussions (FGDs)

List of Participants

Focus Group No. 3 Date 08.09.16 Time 2:00 PM

Location Dulpara, Saint Martin Island

Sl No.	Name	Age	Occupation	Telephone No.	Signature
1	শ্রীমান মোহন চন্দ্র	38	শ্রমিক	০১৬৫৫৭১৪৭৭	
2	মিঃ মঞ্জুর রহমান	২০	চাষ	০১৬৫৫৭১৪০২	
3	মিঃ মঞ্জুর	২০	চাষ (মজুর)	০১৬৫৫৭১৪০২	
4	মিঃ মঞ্জুর	২০	চাষ (মজুর)	০১৬৫৫৭১৪০২	
5	মিঃ মঞ্জুর	২০	চাষ (মজুর)	০১৬৫৫৭১৪০২	
6	মিঃ মঞ্জুর	২০	চাষ (মজুর)	০১৬৫৫৭১৪০২	
7	মিঃ মঞ্জুর	২০	চাষ (মজুর)	০১৬৫৫৭১৪০২	
8	মিঃ মঞ্জুর	২০	চাষ (মজুর)	০১৬৫৫৭১৪০২	
9	মিঃ মঞ্জুর	২০	চাষ (মজুর)	০১৬৫৫৭১৪০২	
10	মিঃ মঞ্জুর	২০	চাষ (মজুর)	০১৬৫৫৭১৪০২	
11	মিঃ মঞ্জুর	২০	চাষ (মজুর)	০১৬৫৫৭১৪০২	
12	মিঃ মঞ্জুর	২০	চাষ (মজুর)	০১৬৫৫৭১৪০২	
13	মিঃ মঞ্জুর	২০	চাষ (মজুর)	০১৬৫৫৭১৪০২	
14	মিঃ মঞ্জুর	২০	চাষ (মজুর)	০১৬৫৫৭১৪০২	
15	মিঃ মঞ্জুর	২০	চাষ (মজুর)	০১৬৫৫৭১৪০২	

Appendix H: List of Marine Algae found in the St. Island (Molony et al., 2006)

SpeciesName	FamilyName	Status
<i>Acrochaetiumbengalicum</i>	Rhodophyceae	VU
<i>Acrochaetiumcrassipes</i>	Rhodophyceae	VU
<i>Goniotrichum alsidii</i>	Rhodophyceae	VU
<i>Erythrocladiasubintegra</i>	Rhodophyceae	VU
<i>Erythrotrichiacarnea</i>	Rhodophyceae	VU
<i>Liagoraceranoides</i>	Rhodophyceae	VU
<i>Actinotrichia fragilis</i>	Rhodophyceae	VU
<i>Scinaia complanate</i>	Rhodophyceae	VU
<i>Galaxaurafastigiata</i>	Rhodophyceae	VU
<i>Gelidiellatenuissima</i>	Rhodophyceae	VU
<i>Gelidium pusillum</i>	Rhodophyceae	VU
<i>Jania adhaerens</i>	Rhodophyceae	VU
<i>Jania angulata</i>	Rhodophyceae	VU
<i>Amphiroa fragilissima</i>	Rhodophyceae	VU
<i>Melobesia confervicola</i>	Rhodophyceae	VU
<i>Hypneamus ciformis</i>	Rhodophyceae	VU
<i>Hypnea pannosa</i>	Rhodophyceae	VU
<i>Sarconema jurcellatum</i>	Rhodophyceae	VU
<i>Catenella impudica</i>	Rhodophyceae	VU
<i>Champia parvula</i>	Rhodophyceae	VU
<i>Chrysomenia okamuri</i>	Rhodophyceae	VU
<i>Halymaniaduchassaigii</i>	Rhodophyceae	VU
<i>Asparagopsis taxiformis</i>	Rhodophyceae	VU
<i>Antithamnion sp.</i>	Rhodophyceae	VU
<i>Callithamnion sp.</i>	Rhodophyceae	VU
<i>Centroceras clavulatum</i>	Rhodophyceae	VU
<i>Ceramium fastigiatum</i>	Rhodophyceae	VU
<i>C. gracillimum</i>	Rhodophyceae	VU
<i>C. tenerimum + others spp.</i>	Rhodophyceae	VU
<i>Dasyapedicillata</i>	Rhodophyceae	VU
<i>Calliblepharissp.</i>	Rhodophyceae	VU
<i>Heterosiphoniasp.</i>	Rhodophyceae	VU
<i>Caloglossaleprieuri</i>	Rhodophyceae	VU
<i>Vanvoorstiacoccinea</i>	Rhodophyceae	VU
<i>Cottoniella filamentosa</i>	Rhodophyceae	VU
<i>Polysiphonia denudata</i>	Rhodophyceae	VU
<i>Polysiphonia mollis</i>	Rhodophyceae	VU
<i>Tolypocladiaglomerulata</i>	Rhodophyceae	VU
<i>Acanthophora specifera</i>	Rhodophyceae	VU
<i>Bostrychia radicans</i>	Rhodophyceae	VU
<i>Bostrychia tenella</i>	Rhodophyceae	VU
<i>Herposiphonia dendroidea var.</i>	Rhodophyceae	VU
<i>Herposiphonia tenella fa. Secumda</i>	Rhodophyceae	VU
<i>Laurencia obtusa + others spp.</i>	Rhodophyceae	VU
<i>Lithothamnion sp.</i>	Rhodophyceae	VU

<i>Crouaniaattenuata</i>	Rhodophyceae	VU
<i>Lophocladia trichocladus</i>	Rhodophyceae	VU
<i>Ectocarpus breviararticulatus</i>	Phaeophyceae	VU
<i>E. rhodochortonoides</i> + <i>othersp.</i>	Phaeophyceae	VU
<i>Giffordia irregularis</i>	Phaeophyceae	VU
<i>Giffordia mitchelliae</i>	Phaeophyceae	VU
<i>Giffordia allsae</i>	Phaeophyceae	VU
<i>Giffordia thyrsoideus</i>	Phaeophyceae	VU
<i>Feldmannia columellaris</i>	Phaeophyceae	VU
<i>Feldmannia elachistaeformis</i>	Phaeophyceae	VU
<i>Feldmannia indica</i>	Phaeophyceae	VU
<i>Feldmannia vaughani</i>	Phaeophyceae	VU
<i>Sphacelaria tribuloides</i>	Phaeophyceae	VU
<i>S. novae-hollandiae</i> f.	Phaeophyceae	VU
<i>Dectyotabratayresii</i>	Phaeophyceae	VU
<i>Dectyotadechotoma</i>	Phaeophyceae	VU
<i>Dectyotadivaticata</i>	Phaeophyceae	VU
<i>Dectyota friabilis</i>	Phaeophyceae	VU
<i>Dectyotapatens</i>	Phaeophyceae	VU
<i>Dictyopteris australis</i>	Phaeophyceae	VU
<i>Dictyopteris</i> sp.	Phaeophyceae	VU
<i>Lobophora variegata</i>	Phaeophyceae	VU
<i>Padina australis</i>	Phaeophyceae	VU
<i>Padina tenuis</i>	Phaeophyceae	VU
<i>Padina gymnospora</i>	Phaeophyceae	VU
<i>Padina pavonica</i>	Phaeophyceae	VU
<i>Padina sanctae-crucis</i>	Phaeophyceae	VU
<i>Padina tetrastromatica</i>	Phaeophyceae	VU
<i>Padina vickersiae</i>	Phaeophyceae	VU
<i>Myriactula aravica</i>	Phaeophyceae	VU
<i>Chnoospora implexa</i>	Phaeophyceae	VU
<i>Colpomenia sinuosa</i>	Phaeophyceae	VU
<i>Hydroclathrus clathratus</i>	Phaeophyceae	VU
<i>Rosenvingea intricata</i>	Phaeophyceae	VU
<i>Rosenvingea orientalis</i>	Phaeophyceae	VU
<i>Rosenvingea sanctae-crucis</i>	Phaeophyceae	VU
<i>Sargassum caryophyllum</i>	Phaeophyceae	VU
<i>Sargassum flavicans</i>	Phaeophyceae	VU
<i>Sargassum ilicifolium</i>	Phaeophyceae	VU
<i>Sargassum piluliferum</i>	Phaeophyceae	VU
<i>Sargassum vulgare</i>	Phaeophyceae	VU
<i>Sargassum wightii</i>	Phaeophyceae	VU
<i>S. spp. (unidentified)</i>	Phaeophyceae	VU
<i>Enteromorpha clathrata</i>	Chlorophyceae	VU
<i>Enteromorpha compressa</i>	Chlorophyceae	VU
<i>Enteromorpha intestinalis</i>	Chlorophyceae	VU
<i>Enteromorpha prolifera</i>	Chlorophyceae	VU
<i>Ulvalactuca</i>	Chlorophyceae	VU
<i>Chaetomorpha aerea</i>	Chlorophyceae	VU

<i>Chaetomorpha brachygona</i>	Chlorophyceae	VU
<i>Chaetomorpha gracilis</i>	Chlorophyceae	VU
<i>Chaetomorpha linum</i>	Chlorophyceae	VU
<i>Lolacapillaris</i>	Chlorophyceae	VU
<i>Lolaimplexa</i>	Chlorophyceae	VU
<i>Lolatortuosa</i>	Chlorophyceae	VU
<i>Rhizoclonium grandae</i>	Chlorophyceae	VU
<i>Rhizoclonium hookeri</i>	Chlorophyceae	VU
<i>Rhizoclonium kernerii</i>	Chlorophyceae	VU
<i>Rhizoclonium riparium</i>	Chlorophyceae	VU
<i>Cladophora echinus</i>	Chlorophyceae	VU
<i>Ocellularia margaretiifera</i>	Chlorophyceae	VU
<i>Ocellularia martini</i>	Chlorophyceae	VU
<i>Ocellularia subbrevis</i>	Chlorophyceae	VU
<i>Ocellularia tenuis</i>	Chlorophyceae	VU
<i>Lyngbya allorgei</i>	Chlorophyceae	VU
<i>L.confervoides</i> & <i>L.contorta</i>	Chlorophyceae	VU
<i>L.hieronymusii</i>	Chlorophyceae	VU
<i>L.hlutea</i>	Chlorophyceae	VU
<i>L.magnifica</i>	Chlorophyceae	VU
<i>Hydrocoleum cantharidosum</i>	Chlorophyceae	VU
<i>Microcoleus chthonoplastes</i>	Chlorophyceae	VU
<i>Plectonema wollei</i>	Chlorophyceae	VU
<i>Anabaena variabilis</i>	Chlorophyceae	VU
<i>Nostoc commune</i>	Chlorophyceae	VU
<i>Scytonema siculum</i>	Chlorophyceae	VU
<i>Scytonema salyeriense</i>	Chlorophyceae	VU
<i>Calothrix confervicola</i>	Chlorophyceae	VU
<i>Calothrix parasitica</i>	Chlorophyceae	VU
<i>Calothrix crustacea</i>	Chlorophyceae	VU
<i>Calothrix scopulorum</i>	Chlorophyceae	VU
<i>Calothrix rarietina</i>	Chlorophyceae	VU
<i>Halophiladecipiens</i>	Hydrocharitaceae	VU
<i>Halodule pinifolia</i>	Cymodoceaceae	VU
<i>Halodule uninervis</i>	Cymodoceaceae	VU

Appendix I: List of Birds Species

Sl. No	English Name	Scientific Name	Local Name
<i>ANATIDAE</i>			
1	Ruddy Shelduck	<i>Tadorna ferruginea</i>	Khoira Chokachoki
2	Common Shelduck	<i>Tadorna tadorna</i>	Pati Chokachoki
3	Eurasian Wigeon	<i>Anas penelope</i>	Eureshio Shithihash
4	Northern Shoveler	<i>Anas clypeata</i>	Utturey Khuntehash
<i>PICIDAE</i>			
5	Eurasian Wryneck	<i>Jynx torquilla</i>	Eureshio Gharbetha
<i>UPUPIDAE</i>			
6	Eurasian Hoopoe	<i>Upupa epops</i>	Pati Hoodhood
<i>DALCELONIDAE</i>			
7	White-throated Kingfisher	<i>Halcyon smyrnensis</i>	Dholagola Machranga
8	Black-capped Kingfisher	<i>Halcyon pileata</i>	Kalatupi Machranga
9	Collared Kingfisher	<i>Todiramphus chloris</i>	Dholaghar Machranga
<i>MEROPIIDAE</i>			
10	Green bee-eater	<i>Merops orientalis</i>	Shobuj Shuichora
11	Chestnut-headed bee-eater	<i>Merops leschenaulti</i>	Khoira matha Shuichora
<i>CUCULIDAE</i>			
12	Plaintive Cuckoo	<i>Cacomantis merulinus</i>	Koroon Papai
13	Asian Koel	<i>Eudynamis scolopacea</i>	Eshio Kokil
<i>CENTROPODIDAE</i>			
14	Greater Coucal	<i>Centropus sinensis</i>	Boro Kubo
<i>APODIDAE</i>			
15	Asian Palm Swift	<i>Cypsiurus balasiensis</i>	Asho Talbatashi
<i>TYTONIDAE</i>			
16	Barn Owl	<i>Tyto alba</i>	Lokkhi Pecha
<i>COLUMBIDAE</i>			
17	Common Pigeon	<i>Columba livia</i>	Gola Paira
18	Spotted Dove	<i>Streptopelia chinensis</i>	Tila Ghughu
19	Eurasian Collared Dove	<i>Streptopelia decaocto</i>	Eurashio Konthighughu
<i>RALLIDAE</i>			
20	Common Moorhen	<i>Gallinula chloropus</i>	Pati Panmurgi
<i>SCOLOPACIDAE</i>			
21	Pin-tailed Snipe	<i>Gallinago stenura</i>	Lenja Chega
22	Common Snipe	<i>Gallinago gallinago</i>	Pati Chega
23	Black-tailed Godwit	<i>Limosa limosa</i>	Kala Lej Jurali
24	Bar-Tailed	<i>Limosa lapponica</i>	Daag Lej Jurali
25	Whimbrel	<i>Numenius phaeopus</i>	Nata Gulinda
26	Eurasian Curlew	<i>Numenius arquata</i>	Eureshio Gulinda
27	Spotted Redshank	<i>Tringa erythropus</i>	Tila Lalpa
28	Common Redshank	<i>Tringa totanus</i>	Pati Lalpa
29	Common Greenshank	<i>Tringa nebularia</i>	Pati Shobujpa
30	Wood Sandpiper	<i>Tringa glareola</i>	Bon Batan
31	Terek Sandpiper	<i>Xenus cinereus</i>	Terek Batan
32	Common Sandpiper	<i>Actitis hypoleucos</i>	Pati Batan
33	Ruddy Turnstone	<i>Arenaria interpres</i>	Laal Nuribaan
34	Sanderling	<i>Calidris alba</i>	Sanderling
35	Broad-billed Sandpiper	<i>Limicola falcinellus</i>	Motathuto Batan
<i>CHARADRIIDAE</i>			

36	Pacific Golden Plover	<i>Pluvialis fulva</i>	Proshanto Shonajiria
37	Grey Plover	<i>Pluvialis squatarola</i>	Metey Jiria
38	Little-ringed Plover	<i>Charadrius dubius</i>	Choto noth Jiria
39	Greater Sand Plover	<i>Charadrius Leschenaulti</i>	Boro Dhuljiria
40	Lesser Sand Plover	<i>Charadrius Mongolus</i>	Choto Dhuljiria
GLAREOLIDAE			
41	Oriental Pratincole	<i>Glareola Maldivarum</i>	Udoi Babubatan
LARIDAE			
42	Great Black-headed Gull	<i>Larus ichthyaetus</i>	Palashi Gangchil
43	Brown-headed Gull	<i>Larus Brunnicephalus</i>	Khoiramatha Gangchil
44	Common Black-headed Gull	<i>Larus ridibundus</i>	Kalamatha Gangchil
45	Gull-billed Tern	<i>Gelochelidon nilotica</i>	Kalathot Panchil
46	Caspian Tern	<i>Sterna caspia</i>	Kaspian Panchil
47	Lesser Crested Tern	<i>Sterna bengalensis</i>	Bangla Tikipanchil
48	Swift Tern (Great Crested)	<i>Sterna bergii</i>	Boro Tikipanchil
49	Common Tern	<i>Sterna hirundo</i>	Pati Panchil
50	Little Tern	<i>Sterna albifrons</i>	Choto Panchil
51	Black-bellied Tern	<i>Sterna acuticauda</i>	Kalapet Panchil
52	Whiskered Tern	<i>Chlidonias hybridus</i>	Julphi Panchil
ACCIPITRIDAE			
53	Osprey	<i>Pandion haliaetus</i>	Machmural
54	Shikra	<i>Accipiter badius</i>	Pati Shikrey
FALCONIDAE			
55	Common Kestrel	<i>Falco tinnunculus</i>	Pati Kestrel
56	Peregrine Falcon	<i>Falco peregrinus</i>	Peregrin Shahin
ARDEIDAE			
57	Great Egret	<i>Casmerodius albus</i>	Boro Boga
58	Yellow-billed Egret	<i>Egretta intermedia</i>	Majhla Boga
59	Pacific Reef Heron	<i>Egretta sacra</i>	Proshanto Shoiloboga
60	Grey Heron	<i>Ardea cinerea</i>	Dhupni Bok
61	Indian Pond Heron	<i>Ardeola grayii</i>	Deshi Kanibok
62	Striated Heron	<i>Butorides striata</i>	Khude Bok
63	Black-crowned Night Heron	<i>Nycticorax nycticorax</i>	Kalamatha Nishibok
LANIIDAE			
64	Brown Shrike	<i>Lanius cristatus</i>	Khoira Latora
65	Long-tailed Shrike	<i>Lanius schach</i>	Lenja Latora
CORVIDAE			
66	Large-billed Crow	<i>Corvus macrorhynchos</i>	Dar Kak
67	Black-naped Oriole	<i>Oriolus chinensis</i>	Kalaghar Benebou
68	Black-hooded Oriole	<i>Oriolus xanthornus</i>	Kalamatha Benebou
69	Black Drongo	<i>Dicrurus macrocercus</i>	Kala Fingrey
70	Ashy Drongo	<i>Dicrurus leucophaeus</i>	Kalche Fingrey
MUSCICAPIDAE			
71	Blue rock Thrush	<i>Monticola solitarius</i>	Nil Shiladama
STURNIDAE			
72	Asian Glossy Starling	<i>Aplonis panayensis</i>	Ashio Telshalik
73	Rosy Starling	<i>Sturnus roseus</i>	Golapi Kathshalik
HIRUNDINIDAE			
74	Barn Swallow	<i>Hirundo rustica</i>	Metho Ababil

75	Red-rumped Swallow	<i>Hirundo daurica</i>	Lalkomor Ababil
<i>ALAUDIDAE</i>			
76	Oriental Skylark	<i>Alauda gulgula</i>	Udoi Ovrobhorot
<i>NECTARINIIDAE</i>			
77	Purple-rumped Sunbird	<i>Leptocoma zeylonica</i>	Begunikomor Moutushi
78	Purple Sunbird	<i>Cinnyris asiaticus</i>	Beguni Moutushi
<i>PASSERIDAE</i>			
79	White Wagtail	<i>Motacilla alba</i>	Dhola Khonjon
80	Citrine Wagtail	<i>Motacilla citreola</i>	Sitrin Khonjon
81	Yellow Wagtail	<i>Motacilla flava</i>	Holdey Khonjon
82	Grey Wagtail	<i>Motacilla cinereal</i>	Metey Khonjon
83	Olive-backed Pipit	<i>Anthus hodgsoni</i>	Jolpaipith Tulika
84	Baya Weaver	<i>Ploceus philippinus</i>	Deshi Babui
85	Scaly-breasted Munia	<i>Lonchura punctulata</i>	Tila Munia

Appendix J: Term of Reference (TOR) for Approval on Environmental Impact Assessment (ESIA) Report Preparation

TERMS OF REFERENCE

ENVIRONMENT ASSESSMENT REPORT OF 250kWp OF SOLAR MINI-GRID POWER PLANT PROJECT AT ST. MARTIN'S ISLAND, COXS BAZAR

BACKGROUND

The major objective of the Rural Electrification and Renewable Energy Development Project (REREDP II) of Infrastructure Development Company Limited (IDCOL) is to increase access to clean energy in rural areas through renewable energy. It will support: (i) increased access to electricity in rural areas through renewable energy; (ii) large-scale dissemination of more efficient cook stoves and fuels for cooking; and (iii) improved technical and institutional efficiency in the power sector. The proposed additional financing (AF) will contribute towards increasing access to electricity in remote rural areas where grid electricity is not economically viable.

It is understood that mini-grid/micro-grid (solar based system) does not associate with air pollution during operational phase. The primary concerns related to environmental, health, and safety issues are associated with improper manufacturing and disposal of expired lead-acid battery. The project components primarily deal with the solar panels, batteries and generators (which will use as back up). The Environment and Social assessment is required to identify the major environmental and social impacts and formulate required environmental and social management measures. IDCOL as well as all relevant development partners and stakeholders participating in REREDP II have agreed the environmental and social requirements needed for processing the financing of each sub-component. The project is designated as environmental Category B (partial assessment) according to OP/BP of the World Bank and only one environmental safeguard policy OP/BP 4.01 has been triggered.

EHS measures in case of bio-gas plant: According to the Department of Environment, Bangladesh-“ if any cattle farm belongs to 10 cattle in urban area or 25 cattle in rural areas, the project has been categorized as **Orange A** category”, meaning that it requires a brief Environmental Impact Assessment Report (IEE). In case of poultry- “the numbers are up to 250 and up to 1000 respectively.” But “if any cattle farm belongs to more than 10 cattle in urban area or more than 25 cattle in rural areas, the project has been categorized as **Orange B**

category”, meaning that it requires detail Environmental and Social Impact Assessment Report (ESIA). For any commercially operated biogas project, there should be an environmental and social impact assessment (ESIA) by the project sponsor for any number of cattle's/birds or any location (urban or rural). The environmental and social assessment report is to be submitted to IDCOL, which could be shared with stakeholders.

Please note that, according to DOE concern- all power generation project has been categorized as RED category.

Legislative bases for ESIA or IEE in Bangladesh are the Environmental Conservation Act 1995 (ECA'95) and the Environmental Conservation Rules 1997 (ECR'97). Department of Environment (DOE), under the Ministry of Environment and Forest (MOEF), is the regulatory body responsible for enforcing the ECA'95 and ECR'97. Other law of Bangladesh like Renewable Energy Policy of Bangladesh (2008), Bangladesh Labor Law (2006), etc. will be obliged for the project. Which will also be guided by the World Bank's Safeguards (Relevant Policies) mainly OP 4.01 Environmental Assessment, ADB's Safeguards Policy Statement (SPS) 2009 and other related operational manual (OM Section F1/BP) will be triggered for this project.

Please note that in the Social Impacts:

In the REREDP II project, No land acquisition or displacement of people (with or without title) from private or public lands is permitted in the project. In areas where IP populations are generally found a screening procedure will be followed to identify relevant groups and communities. A brief social assessment will be conducted to describe the general project area, social conditions in the project area including distribution of population in the project area, a brief discussion of the local economy and primary sources of income, A consultation and communication plan will be prepared and implemented (as has been done in previous project phase) to clearly disseminate project information and gather feedback regarding the needs and priorities of IPs so that awareness raising, training etc. can be properly tailored. The communication process must be carefully documented by the project proponents, including keeping photographs and participant's lists. All sessions and communications modes must be in local languages and follow the customs and norms of local communities. The third party monitoring mechanism will assess the safeguards compliance on a yearly basis.

CONTENTS OF THE REPORT SHOWN BELOW:

ESIA Report:

A. Executive Summary:

This section will describe the project activities, critical environmental and social issues, significant findings and recommended actions.

B. Introduction:

This section will cover the following aspects:

- i. Background of the project (In brief)
- ii. Scope of the ESIA study
- iii. Study methodology in details
- iv. Limitation of the study

C. Policy, Legal and Administrative Framework

This section will cover the following aspects:

- i. General
- ii. Bangladesh Environmental Conservation ACT (ECA) 1995
- iii. Bangladesh Environmental Conservation Rules, 1997
- iv. Renewable energy Policy of Bang, 2008
- v. Remote Area Power Supply Systems (RAPSS) guideline of 2007
- vi. Bangladesh Labor Law, 2006
- vii. National Biodiversity Strategy and Action Plan for Bangladesh, Ministry of environment and Forest, 2004
- viii. World Bank's Guidelines on Environmental and Social Safeguards Policies
- ix. ADB Guidelines on Environmental and Social Safeguards
- x. JICA Guidelines on Environmental and Social safeguards
- xi. Justification of the project on the basis of DOE, WB/ADB/JICA

D. Description of the Project:

This section will cover the following aspects:

- i. Background and Rational of the Project
 - Information of the proposed project history;
 - Rationale for the proposed project;
 - Outline of the Project objectives;
- ii. Project Site and Location

- Description of the location of the proposed project with maps (if site is an isolated island please describe all side lengths from the mentioned canal/ river/sea)
 - Nearby communities, designated environmentally sensitive area and heritage sites (For solar mini grid buffer zone should be 1 km, cattle based farm or poultry based farm it should be 500 or 250 meters (depend on the farm size).
- iii. Technical Aspects
- Description of the proposed project components
 - Project equipment and civil works
 - Provision of information on proposed emission, effluent and surface water erosion control technologies (If required)

E. Baseline Environmental Condition (By assuming 1 Km/500m/250m radius air shed depends on the project) [Please note: Secondary data is enough for IEE report]

- i. Administrative Information
- ii. Demographic Information
- iii. Geological Condition
- iv. Terrestrial Flora
- v. Terrestrial Fauna
- vi. Meteorological Condition (Rainfall, Temperature, Humidity, Wind speed) [at least 5 years data need to be analyses]
- vii. Air Quality[Please note: Air monitoring is depend on the locations' sensitivity]
 - **The presence of SPM, SO_x, NO_x, CO, PM₁₀, PM_{2.5}**
 - While measuring air quality- DOE approved technology is to be followed
 - Conduct air dispersion model by an US EPA approved model
- viii. Noise Quality
 - While measuring noise quality, DOE approved technology is to be followed
 - There should be hourly monitoring of baseline noise according to the guideline of DOE and WB/ADB
- ix. Surface and Ground water quality

- Surface: (testing of : pH, TDS, DO, COD, BOD)
- Ground: (testing of: pH, Arsenic,TDS, alkalinity, Cl, Fe,)
- x. Project location from flood level
- xi. Soil Quality
- xii. Seismicity
- xiii. Biological Environment (explain about Bio-ecological environment, Terrestrial Ecosystem , Protected areas and red book species)
- xiv. Vulnerability to Climate Change and Natural hazard
 - Explain in detail about how the project will be affected by the climate change impact
 - Explain how the project is vulnerable to various natural calamities including flood, earthquake, drought, cyclone and so on

F. Baseline Socio-economic Condition

(For solar mini grid buffer zone should be 1 km, cattle based farm or poultry based farm it should be 500 or 250 meters (depend on the farm size)).

- i. Distribution of population in the project area in terms of religion, age, sex, income occupation and their relevance with the project
- ii. Physical and cultural resources (school, college, madrasa, mosque,, temple, church etc.) in the project area
- iii. Availability of Indigenous settlement(if required)
- iv. Communication facility

G. Analysis of Project Alternatives

- i. Reason to choose the technology
- ii. Site Alternative

H. Stakeholder Consultation and disclosure

The consultation will include key informant interview, focus group discussion (male & female) and public consultation. The consultation will be documented with required facts, figures and evidence including participant list with contact details, photographs.

I. Grievance Redress Mechanism

This section will describe the grievance redress framework

J. Anticipated Environmental and Social Impacts and Mitigation Measures

- i. General

- ii. Corridor of Impact (CoI)
- iii. Pre-construction Phase
 - Land use
 - Flood Hazards
- iv. Construction Phase, Operational Phase and Decommissioning Phase (Content in below for all phases)
 - Visual Amenity
 - Air Quality
 - Noise
 - Soil
 - Water Resources
 - Terrestrial Ecology
 - Waste Generation
 - Health and Safety
 - Employment Opportunities
 - Traffic
 - Archaeology and cultural resources
- v. Summary of Anticipated Impacts

K. Environmental and Occupational Management Plan

This section deals with the set of mitigation management measures to be taken to avoid, reduce, mitigate or compensate for adverse environmental, occupational and social impacts with the institutional arrangement, monitoring schedule, parameters to be monitored and so on including tentative monitoring budget.

L. Environmental and Social Benefit

This section will discuss how the project will provide benefits in environmental sector and social life.

M. Conclusion

This section will provide the conclusion drawn from the assessment and provides recommendations

Appendix K: Permission Letter for Environmental Study from the Ministry of Environment and Forest

Recd
12/01/21
24
12/21

গণপ্রজাতন্ত্রী বাংলাদেশ সরকার
পরিবেশ ও বন মন্ত্রণালয়
পরিবেশ শাখা-৩
www.mee.gov.bd

নং প্রকল্প/পরিবেশ/৩/৮/পছা-০১/২০১১/১৫৯

তারিখঃ ০৬.০৩.২০১৬ খ্রি।

বিষয়ঃ বিধি মোতাবেক প্রয়োজনীয় ব্যবস্থা গ্রহণ প্রসঙ্গে।

স্বঃ ঃ ট্র মেরিন এনার্জি লিমিটেড এর পত্র বা.বিএমএএল/প্রশা/২০১৬/৩৮; তারিখঃ ২৫.০১.২০১৬ খ্রি।

উপর্যুক্ত বিষয়ে জনাব মোহাম্মদ মাহবুবুর রহমান পাটোয়ারী, ব্যবস্থাপনা পরিচালক, ট্র মেরিন এনার্জি লিমিটেড, প্রধান কার্যালয়ঃ লাল ভবন (২য় তলা), ১৮ রাজউক এ্যাভিনিউ, ঢাকা-১০০০ হতে প্রাপ্ত সূত্রস্থ পত্র ও সংযুক্ত কাগজাদির জ্ঞানলিপি প্রত্যক্ষ করে প্রেরণ করা হলো। পরে উল্লিখিত সেন্টমেন্ট ইপে ইভকল এর আর্থিক সহযোগিতায় ২৫০ কিলোওয়াট সোলার বিন্যাস উত্পাদনের নিমিত্ত পরিবেশগত ছাড়পত্র প্রদান বিষয়ে বিধি মোতাবেক প্রয়োজনীয় ব্যবস্থা গ্রহণের জন্য নির্দেশক্রমে অনুরোধ করা হলো।

সংযুক্তিঃ বর্ণনামতে।

(রোকসানা তারানুম)
সিনিয়র সহকারী সচিব
ফোনঃ ৯৫৭৭২২৩

মহাপরিচালক
পরিবেশ অধিদপ্তর
আগারগাঁও, ঢাকা।

অনুলিপিঃ

০১। সচিব মহোদয়ের একান্ত সচিব, পরিবেশ ও বন মন্ত্রণালয়।

০২। জনাব মোহাম্মদ মাহবুবুর রহমান পাটোয়ারী, ব্যবস্থাপনা পরিচালক, ট্র মেরিন এনার্জি লিমিটেড, প্রধান কার্যালয়ঃ লাল ভবন (২য় তলা), ১৮ রাজউক এ্যাভিনিউ, ঢাকা-১০০০।

103

	বাংলাদেশ গণপ্রজাতন্ত্রী বাংলাদেশ সরকার ডনং সেন্টমার্টিন ইউনিয়ন পরিষদ নবিবেশ জিজিয়া, উপজেলাঃ টেকনাফ, জেলাঃ কক্সবাজার। চেহাখম্যান	জিলাপদ
সূত্রঃ	তারিখঃ	২০ ০৩ ২০২০
	প্রত্যয়ন পত্র এই মর্মে প্রত্যয়ন করা যাইতেছে যে, <i>হুমায়ুন</i> ব্রু-মেরিন এনার্জি লিঃ কর্তৃক আমার ইউনিয়নে সোলার মিনিগ্রিড স্থাপন করে উক্ত ইউনিয়নের জনগণের বিদ্যুতের চাহিদা পূরণ ও উন্নয়ন মূলক কার্যক্রম করার লক্ষ্যে কাজ করে যাচ্ছে। উক্ত কার্যক্রমে স্থানীয় সরকার কর্তৃপক্ষ হিসেবে আমি ব্রু-মেরিন এনার্জি লিঃ কে সাধুবাদ জানাই, তাদের সার্বাঙ্গীন মঙ্গল কামনা করি।	
	 <i>হুমায়ুন</i> ২০-০৩-২০২০ আবদুর রহমান চেহাখম্যান পদে ডনং সেন্টমার্টিন ইউনিয়ন পরিষদ টেকনাফ, কক্সবাজার।	
০ জনগণের শ্রমকে শ্রুতি মিত ০ সত্যকর্মে ন্যস্তন ০ গান্ধী বাপান পরিতোষ বর্জিত ০ জনাই পতি ০ পরিবার পদ্ধতিয়া ইমানে অম ০		

Appendix M: Site Clearance Certificate from DoE Coxsbazar

	গণপ্রজাতন্ত্রী বাংলাদেশ সরকার পরিবেশ অধিদপ্তর, কক্সবাজার জেলা কার্যালয় সায়মন রোড, ঝাউতলা, কক্সবাজার সদর, কক্সবাজার। E-mail: coxsbazar@doe.gov.bd www.doe.gov.bd ফোন : ০৩৪১-৬২২৩২।	নম্বর- ০১
স্মারক নং-২২.০২.২২০০.২১৩.৭২.০৭.১৬. ১৮০		তারিখ- ০১/১১/১৪২৩ বঙ্গাব্দ ১৩/১০/২০১৭ খ্রিস্টাব্দ
বিষয়: ব্রু মেরিন এনার্জি লিমিটেড, ২৫০ কিলোওয়াট সৌরবিদ্যুৎ উৎপাদন নামক শিল্প প্রতিষ্ঠানের অবস্থানগত ছাড়পত্র (শ্রেণীঃ লাল)।		
আবেদনকারী প্রতিষ্ঠান ব্রু মেরিন এনার্জি লিমিটেড, বঙ্গবন্ধু পূর্ব পাড়া, মোকং সেটমার্টিন, টেকনাফ, কক্সবাজার ২৫০ কিলোওয়াট সৌরবিদ্যুৎ উৎপাদন নামক শিল্প প্রতিষ্ঠানের অবস্থানগত ছাড়পত্রের জন্য ০১/০৮/২০১৬ তারিখের আবেদনপত্র ও আনুষ্ঠানিক কাগজপত্র পর্যালোচনা এবং সংশ্লিষ্ট এলাকা কক্সবাজার জেলা কর্তৃক সরেজমিনে পরিদর্শন প্রতিবেদন, পরিবেশ অধিদপ্তর সদর দপ্তর চাকর ছাড়পত্র বিষয়ক কমিটির গত ১৪/০৩/২০১৭ ও ১৫/০৩/২০১৭ ইং তারিখে অনুষ্ঠিত ৪০৫ তম সভার ৯-০১ নম্বর জমিকে বর্ণিত সিদ্ধান্তের আলোকে নিম্নবর্ণিত শর্তে অবস্থানগত ছাড়পত্র প্রদান করা হলো।		
শর্তাবলীঃ ১. প্রকল্পটিতে উল্লিখিত অন্যান্য বিষয়ের মধ্যে আইইই প্রতিবেদনে বর্ণিত সকল মিটিগেশন মেজার্স যথাযথভাবে বাস্তবায়ন করতে হবে। ২. আইইই প্রতিবেদনের সাথে সংশ্লিষ্ট OIR- এর জিজ্ঞাসিত ইআইএ প্রতিবেদন প্রদান করতে হবে এবং উক্ত ইআইএ প্রতিবেদন পরিবেশ অধিদপ্তরের অনুমোদনের নিমিত্তে পেশ করতে হবে। ৩. ইআইএ প্রতিবেদনে এ প্রকল্প সূচী গার্মারি পদার্থের নিঃসরণ এবং বস্তুকণ (Particulate Matters) নির্গমণ পরিবেশ সংরক্ষণ বিধিমালা, ১৯৯৭-এ উল্লিখিত মানমাত্রার মধ্যে বাষ্প, কুণি ও ধূসার পুনঃব্যবহারের ব্যবস্থা, বর্জ্য ব্যবস্থাপনার ক্ষেত্রে প্রতিটি রিডাকশন স্টেজের বিস্তারিত ও বাস্তবসম্মত বর্ণনা এবং ১০০% ওয়াটার রিসাইক্লিং-এর বিষয় অন্তর্ভুক্ত করতে হবে। ৪. ইআইএ প্রতিবেদনে নিজস্ব লোকবল ও ইকুইপমেন্ট-এর সমন্বয়ে ইন-হাউজ এনভায়রনমেন্টাল মনিটরিং সিস্টেম গড়ে তোলার বিষয়ে প্রয়োজনীয় কার্যক্রম ও আর্থিক প্রয়োজনীয়তা অন্তর্ভুক্ত করতে হবে। ৫. ইআইএ অনুমোদিত না হলে যন্ত্রপাতির অনুকূলে L/C খোলা যাবে না। ৬. প্রকল্প চক্রের ন্যূনতম ৩৩% জায়গা উপযুক্ত প্রজাতির ফলজ ও বনজ গাছ লাগিয়ে সবুজায়ন করতে হবে। ৭. কর্মরত শ্রমিকদের পেশাগত স্বাস্থ্য রক্ষার্থে সকল ব্যবস্থা যেমনঃ হার্ড হেলমেট, নোজ মাস্ক, বুট, গ্লোব ইত্যাদির ব্যবস্থা রাখতে হবে। ৮. ১-৭ এর সিদ্ধান্ত বাস্তবায়ন পূর্বক পরিবেশগত ছাড়পত্রের জন্য আবেদন করতে হবে। ৯. এ ছাড়পত্র ভূমির মালিকানা স্বত্ব নির্ধারণ করে না। ১০. পরিবেশগত ছাড়পত্র ব্যতিরেকে প্রকল্প চালু করা যাবে না।		

১১. প্রকল্প বাস্তবায়নকালীন সময়ে মহামান্য হাইকোর্ট বা পরিবেশ অধিদপ্তর কর্তৃক অন্য কোন নির্দেশনা প্রদত্ত হলে তা যথাযথভাবে অনুসরণ করতে হবে।
১২. এই অনাপত্তিপত্র ভূমির মালিকানা স্বত্ত্ব নির্ধারণ করে না।

✓ ব্যবস্থাপনা পরিচালক
ব্লু মেরিন এনার্জি লিমিটেড
লাল ভবন, ১৮ রাজউক এ্যাভিনিউ,
মতিঝিল বা/এ
ঢাকা-১০০০।


সরদার শরীফুল ইসলাম
সহকারী পরিচালক
ফোনঃ ০৩৪১-৬২২৩২
৩

Appendix N: Permission from Director General of Department of Environment for Site Clearance Certificate

গণপ্রজাতন্ত্রী বাংলাদেশ সরকার
পরিবেশ অধিদপ্তর
পরিবেশ ভবন, ই-১৬, আগারগাঁও
শেরেবাংলা নগর, ঢাকা-১২০৭।
www.doe.gov.bd

File
Mahmud

স্মারক নং ২২.০২.১৫০০.২০১.৭২.০২৩.১৬/২৮

তারিখ : ০২/১০/১৪২৩ বঙ্গাব্দ।
০৬/০২/২০১৭ খ্রিস্টাব্দ।

বিষয় : ব্লু মেরিন এনার্জি লিমিটেড কর্তৃক প্রতিবেশগত সংকটাপন্ন এলাকা হিসেবে ঘোষিত সেন্ট মার্টিন দ্বীপে সৌর শক্তি ব্যবহারের মাধ্যমে ২৫০ কিলোওয়াট নবায়নযোগ্য বিদ্যুৎ উৎপাদন ও সরবরাহ প্রকল্পের অনুকূলে অবস্থানগত ছাড়পত্র প্রদান প্রসংগে।

উপর্যুক্ত বিষয়ের বরাতে জানানো যাচ্ছে যে, ব্লু মেরিন এনার্জি লিমিটেড কর্তৃক প্রতিবেশগত সংকটাপন্ন এলাকা হিসেবে ঘোষিত সেন্ট মার্টিন দ্বীপে সৌর শক্তি ব্যবহারের মাধ্যমে ২৫০ কিলোওয়াট নবায়নযোগ্য বিদ্যুৎ উৎপাদন ও সরবরাহ প্রকল্পের অবস্থানগত ছাড়পত্রের জন্য পরিবেশ অধিদপ্তর, কক্সবাজার জেলা কার্যালয়ে আনুষঙ্গিক কাগজপত্রসহ নির্ধারিত ফরমের মাধ্যমে করা হয় (পরিশিষ্ট '১')। অবস্থানগত ছাড়পত্রের জন্য উদ্যোক্তা কর্তৃক পূরণকৃত আবেদনপত্র ছাড়াও প্রকল্পের মূলধন অনুযায়ী নির্ধারিত ছাড়পত্র ফি-র চালান, স্থানীয় কর্তৃপক্ষের অনাপত্তিপত্র, সাধারণ তথ্যাবলী, লোকেশন ম্যাপ, মৌজা ম্যাপ, জমির মালিকানা সংক্রান্ত কাগজপত্র, প্রস্তাবিত আইএ-র কার্যপরিধি (TOR) সহ প্রাথমিক পরিবেশগত সমীক্ষা প্রতিবেদন (Initial Environmental Examination-IEE) প্রতিবেদন দাখিল করা হয়েছে (পরিশিষ্ট '২' থেকে '৮')। পরিবেশ অধিদপ্তরের কক্সবাজার জেলা অফিস কর্তৃক প্রস্তাবিত প্রকল্পের অবস্থান সরেজমিন পরিদর্শনপূর্বক মতামতসহ নথিটি পরিবেশ অধিদপ্তর, চট্টগ্রাম বিভাগীয় কার্যালয়ের মাধ্যমে সদর দপ্তরে প্রেরণ করা হয় (পরিশিষ্ট '৯')।

২। পরিবেশ অধিদপ্তর, সদর দপ্তরের পরিবেশগত ছাড়পত্র বিষয়ক কমিটির ৪০২তম সভায় উদ্যোক্তা কর্তৃক দাখিলকৃত কাগজপত্র এবং সংশ্লিষ্ট জেলা অফিসের পরিদর্শন প্রতিবেদন ও বিভাগীয় দপ্তরের মতামত পর্যালোচনা করা হয়। পর্যালোচনান্তে দেখা যায় যে, প্রস্তাবিত প্রকল্পটির অবস্থান কক্সবাজার জেলার টেকনাফ উপজেলার সেন্ট মার্টিন ইউনিয়নের সেন্ট মার্টিন দ্বীপের উত্তর অংশে। প্রকল্পের মোট জায়গার পরিমাণ ২.৪ একর। প্রকল্প স্থানটির ধরন খিলা জমি। এলাকাটি কক্সবাজার টেকনাফ উপজেলার সেন্টমার্টিন দ্বীপের উত্তর অংশের একটু নীচু এলাকা। এলাকাটিতে জোয়ার ভাটার পানি প্রবেশ করে এবং কিছু বিচ্ছিন্ন ম্যানগ্রোভ গাছ দেখা যায়। প্রস্তাবিত প্রকল্পের উত্তর দিকে সেন্টমার্টিন হাসপাতাল। দক্ষিণ দিকে নারিকেল বাগান এবং গ্রাম্য ঘর বাড়ী। দক্ষিণ পূর্ব দিকে সেন্টমার্টিন আবহাওয়া কেন্দ্র এবং উত্তর পূর্ব দিকে ইউনিয়ন পরিষদ অফিস। পূর্ব দিকে দ্বীপের মধ্যকার পাকা সড়ক এরপর কিছু নীচু জায়গা এবং আনুমানিক ২০০ মিটার দূরে বাংলাদেশ নৌ বাহিনীর সেন্টমার্টিন ঘাটি। পশ্চিম দিকে ২/৩ টি রিসোর্ট এরপর সমুদ্র। পরিবেশ অধিদপ্তর কর্তৃক বাস্তবায়িত কোষ্টাল এন্ড ওয়েস্টল্যান্ড বায়োডাইভার্সিটি প্রকল্প (সিডব্লিউবিএমপি) কর্তৃক প্রণীত সেন্ট মার্টিন দ্বীপের খসড়া ম্যানেজমেন্ট প্ল্যান অনুসারে প্রস্তাবিত প্রকল্পটির অবস্থান ম্যানেজড রিসোর্স জোন ও সাসটেইনেবল রিসোর্স জোনের মধ্যবর্তী রেখার উত্তর দিকে। প্রস্তাবিত প্রকল্পে উৎপন্ন বিদ্যুৎ স্থানীয় জনবসতিতে সরবরাহ করা হবে মর্মে উল্লেখ করা হয়েছে। উল্লেখ্য, পরিবেশ ও বন মন্ত্রণালয় হতে গত ২৯/০৬/১৯৯৯ তারিখের পবম/৪/৩৩/৩৮/৯৯/৪৩১ সংখ্যক স্মারকের মাধ্যমে জারীকৃত প্রজ্ঞাপনের মাধ্যমে সেন্ট মার্টিন দ্বীপকে প্রতিবেশগত সংকটাপন্ন এলাকা হিসেবে ঘোষণা করা হয়েছে এবং এই দ্বীপে যে কোন ধরনের প্রকল্প গ্রহণের ক্ষেত্রে সচিব, পরিবেশ ও বন মন্ত্রণালয় থেকে অনুমোদন গ্রহণ করতে হবে মর্মে উক্ত প্রজ্ঞাপনে বলা হয়েছে (পরিশিষ্ট '১০')।

৩। এখানে উল্লেখ্য যে, পরিবেশ সংরক্ষণ বিধিমালা, ১৯৯৭ এর বিধি-৭ এ পরিবেশগত ছাড়পত্র প্রদানের উদ্দেশ্যে পরিবেশের উপর প্রভাব বিস্তার এবং অবস্থান অনুযায়ী সকল শিল্প প্রতিষ্ঠান ও প্রকল্প-কে সবুজ, কমলা-ক, কমলা-খ ও লাল এই চারটি শ্রেণীতে ভাগ করা হয়েছে। পরিবেশ সংরক্ষণ বিধিমালা, ১৯৯৭ এর তফসিল-১ অনুসারে বিদ্যুৎ উৎপাদন কেন্দ্র লাল শ্রেণীভুক্ত কিন্তু, সৌর বিদ্যুৎ উৎপাদন প্রকল্প পরিবেশ সংরক্ষণ বিধিমালা, ১৯৯৭ এর তফসিল-১ এর তালিকা বহির্ভূত। তবে, এই প্রকল্পের কারণে প্রতিবেশগত সংকটাপন্ন এলাকা হিসেবে ঘোষিত সেন্ট মার্টিন দ্বীপের জীববৈচিত্র্য ও পরিবেশ যেন বিঘ্নিত না হয় সে বিষয়টি বিশেষভাবে লক্ষ্য রেখে আলোচ্য প্রকল্পটিকে লাল শ্রেণীভুক্ত বিবেচনা করে উদ্যোক্তা কর্তৃক আইইই প্রতিবেদনের সাথে প্রস্তাবিত আইইএ-র কার্যপরিধি (ToR) দাখিল করা হয়েছে। এ ধরনের প্রকল্পের ক্ষেত্রে বিধি অনুযায়ী প্রথমে অবস্থানগত ও পরবর্তীতে আইইএ অনুমোদন এবং সর্বশেষে পরিবেশগত ছাড়পত্র প্রদানের বিধান রয়েছে।

৪। প্রস্তাবিত প্রকল্পটি ব্যক্তিগত জমিতে নির্মাণ করা হবে এবং এটি নির্মাণ ও পরিচালনার ক্ষেত্রে সকল ধরনের পরিবেশগত ব্যবস্থাপনা গ্রহণ করা হবে মর্মে আইইই প্রতিবেদনে উল্লেখ করা হয়েছে। দেশের বিদ্যুৎ চাহিদা পূরণে নবায়নযোগ্য পরিবেশবান্ধব সৌরশক্তির মাধ্যমে বিদ্যুৎ উৎপাদনকে পরিবেশ অধিদপ্তর সর্বদা সহযোগিতা প্রদান করে আসছে। কারণ, বর্তমানে সেন্ট মার্টিন দ্বীপে ব্যক্তিগত পর্যায়ে ডিজেল জেনারেটরের মাধ্যমে বিদ্যুৎ উৎপাদন ও সরবরাহ করা হচ্ছে যা পরিবেশবান্ধব নয়। আলোচ্য সৌর বিদ্যুৎ প্রকল্প বাস্তবায়িত হলে ডিজেল জেনারেটরসমূহ বন্ধ হয়ে যাবে মর্মে আইইই প্রতিবেদনে উল্লেখ করা হয়েছে। তবে, এই প্রকল্পের

কারণে প্রতিবেশগত সংকটাপন্ন এলাকা হিসেবে ঘোষিত সেন্ট মার্টিন দ্বীপের জীববৈচিত্র্য ও পরিবেশ যেন বিঘ্নিত না হয় সে বিষয়টি বিশেষভাবে লক্ষ্য রাখতে হবে। সদর দপ্তরের পরিবেশগত ছাড়পত্র বিষয়ক কমিটির ৪০২তম সভায় আলোচ্য প্রস্তাবিত প্রকল্পটির অনুকূলে অবস্থানগত ছাড়পত্র প্রদানের বিষয়ে সিদ্ধান্ত গ্রহণের লক্ষ্যে পরিবেশ ও বন মন্ত্রণালয়ে প্রেরণের জন্য সিদ্ধান্ত গৃহীত হয় (পরিশিষ্ট '১১')।

৫। এক্ষেত্রে, আলোচ্য প্রস্তাবিত প্রকল্পের অনুকূলে কক্সবাজার জেলা অফিস কর্তৃক নিম্নবর্ণিত বিশেষ শর্তের সাথে বিধি মোতাবেক প্রয়োজ্য ও প্রচলিত শর্ত আরোপ করে অবস্থানগত ছাড়পত্র প্রদানের বিষয়টি সদয় বিবেচনা করা যেতে পারে :

- (ক) অবকাঠামোগত উন্নয়নের আওতায় অন্যান্য বিষয়ের মধ্যে আইইই প্রতিবেদনে বর্ণিত সকল মিটিগেশন মেজার্স যথাযথভাবে বাস্তবায়ন করতে হবে।
- (খ) আইইই প্রতিবেদনের সাথে দাখিলকৃত TOR- এর ভিত্তিতে আইইই প্রতিবেদন প্রণয়ন করতে হবে এবং উক্ত আইইই প্রতিবেদন পরিবেশ অধিদপ্তরের অনুমোদনের নিমিত্তে পেশ করতে হবে।
- (গ) আইইই প্রতিবেদনে এ প্রকল্পের কার্যক্রমের ফলে পারিপার্শ্বিক পরিবেশের উপর সৃষ্ট প্রভাব ও তা নিরসনে গৃহীতব্য ব্যবস্থাপনার ডিটেইল পরিকল্পনা অন্তর্ভুক্ত করতে হবে। প্রতিবেদনে অন্যান্যের মধ্যে Spent lubricating oil, oil Filter এবং Sludge ব্যবস্থাপনার বিবরণী ও ড্রেনেজ প্লান অন্তর্ভুক্ত থাকতে হবে।
- (ঘ) আইইই প্রতিবেদনে নিজস্ব লোকবল ও ইকুইপমেন্ট-এর সমন্বয়ে ইন-হাউজ এনভায়রনমেন্টাল মনিটরিং সিস্টেম গড়ে তোলার বিষয়ে প্রয়োজনীয় কারিগরী ও আর্থিক প্রস্তাবনা অন্তর্ভুক্ত করতে হবে।
- (চ) আইইই অনুমোদিত না হলে আমদানীতব্য যন্ত্রপাতির অনুকূলে L/C খোলা যাবে না।
- (ছ) সংশ্লিষ্ট বিষয়ে অভিজ্ঞ মাল্টিডিসিপ্লিনারী টিমের মাধ্যমে আইইই প্রণয়ন করতে হবে।
- (জ) কোন অবস্থাতেই প্রাকৃতিক অবস্থার পরিবর্তন, পরিবর্ধন বা অন্য কোন বেআইনী নির্মাণ কাজ করা যাবে না।
- (ঝ) এই প্রকল্পের কোন কার্যক্রমের মাধ্যমে স্বাভাবিক পানি প্রবাহ ও নিষ্কাশন ব্যবস্থাকে বাঁধাগ্রস্ত করা যাবে না। প্রকল্প এলাকায় জলাবদ্ধতা দূর করার জন্য নিজস্ব উদ্যোগে ড্রেন নির্মাণ করতে হবে।
- (ঝ) প্রকল্পের আওতায় অবকাঠামোগত কার্যক্রম পরিচালনার ক্ষেত্রে সৃষ্ট দূষণ নিয়ন্ত্রণের জন্য প্রয়োজনীয় সকল ব্যবস্থা গ্রহণ করতে হবে। ডেমস্টিক তরল বর্জ্য পরিশোধন ও অপসারণের ক্ষেত্রে উপযুক্ত ব্যবস্থা গ্রহণ করতে হবে।
- (ঞ) সকল সেবামূলক সংস্থার সাথে সমন্বয় বজায় রেখে প্রকল্পের কার্যক্রম পরিচালনা করতে হবে।
- (ট) প্রকল্প এলাকার ন্যূনতম ৩৩% জায়গা উপযুক্ত প্রজাতির ফলজ, বনজ ও ঔষধী প্রজাতির গাছ লাগিয়ে সবুজায়ন করতে হবে।
- (ঠ) প্রকল্প এলাকায় সৃষ্ট কঠিন বর্জ্য পরিকল্পিত উপায়ে সংগ্রহপূর্বক যথাযথ ব্যবস্থাপনার মাধ্যমে পরিবেশসম্মত উপায়ে অপসারণ করতে হবে।
- (ড) সোলার প্যানেল স্থাপনের ফলে পারিপার্শ্বিক পরিবেশের উপর কোন বিরূপ প্রভাব পরিলক্ষিত হলে বা বিরূপ প্রভাব পড়ার সম্ভাবনা দেখা দিলে তাৎক্ষণিকভাবে পরিবেশ অধিদপ্তরকে অবহিত করতে হবে। পরিবেশ অধিদপ্তরের নির্দেশনা মোতাবেক সোলার প্যানেলটির কার্যক্রম বন্ধ, অপসারণ বা অন্য কোন কার্যক্রম গ্রহণে বাধ্য থাকবে।
- (ঢ) 'ক' - 'ড'-এর সিদ্ধান্ত বাস্তবায়নপূর্বক পরিবেশগত ছাড়পত্রের জন্য আবেদন করতে হবে।
- (ণ) পরিবেশগত ছাড়পত্র ব্যতিরেকে প্রকল্প চালু করা যাবে না।

৬। বর্ণিত অবস্থার প্রেক্ষিতে, ৫ নং অনুচ্ছেদে বর্ণিত শর্ত সাপেক্ষে ব্লু মেরিন এনার্জি লিমিটেড কর্তৃক প্রতিবেশগত সংকটাপন্ন এলাকা হিসেবে ঘোষিত সেন্ট মার্টিন দ্বীপে সৌর শক্তি ব্যবহারের মাধ্যমে ২৫০ কিলোওয়াট নবায়নযোগ্য বিদ্যুৎ উৎপাদন ও সরবরাহ প্রকল্পের অনুকূলে অবস্থানগত ছাড়পত্র প্রদানের বিষয়টি বিবেচনার জন্য অনুরোধ করা হলো।

সংযুক্তি : বর্ণনা মোতাবেক।

(মোঃ রইছউল আলম মন্ডল)
সহ-পরিচালক

সচিব
পরিবেশ ও বন মন্ত্রণালয়
বাংলাদেশ সচিবালয়, ঢাকা।

অনুলিপি :

- ১। পরিচালক, পরিবেশ অধিদপ্তর, চট্টগ্রাম আঞ্চলিক কার্যালয়, চট্টগ্রাম।
- ২। সহকারী পরিচালক, পরিবেশ অধিদপ্তর, কক্সবাজার জেলা অফিস, কক্সবাজার।
- ৩। ব্যবস্থাপনা পরিচালক, ব্লু মেরিন এনার্জি লিমিটেড, লাল ভবন, ১৮ রাজউক এ্যাভিনিউ, মতিঝিল বা/এ, ঢাকা-১০০০।

Appendix O: Responses on DoE Comments for IEE Report for Further Improvement

SL	Comments	Responses
1	Why the solar mini-grid electricity supply cost is less than present diesel based generator? Describe in the rationale chapter	Updated in Section 3.4, paragraph 9 to 13, Page No. 36
2	Describe about the total Electricity Consumption in house hold basis in Saint Martin Island.	Updated in Section 7.17, Page No. 1115-1116
3	Describe the positive and negative impacts (if present) of conventional electricity supply system replaced by solar mini-grid system.	Updated in Section 3.5, Page No. 37-39
4	Describe about the environmental protected areas in the legal chapter	Updated in Section 2.11, Page No. 19-21
5	Update project land area in the IEE report	Updated in the respective places
6	Describe properly about the battery management and recycling process	Updated in Section 10.7.7 (para 1), Page No. 172
7	Another company already got the site clearance on solar mini-grid project for Saint Martin Island. Therefore, you have to describe about your project that why this is important than the other one.	Added in section 3.7, page 40
8	Visual photographs within the project site should be added in the IEE report	Added in Figure 3.1, 3.2 and 3.3, Page No. 26 and 27
9	Prepare Google map with distance from the project location for surrounding structures	Updated in section 7.25 (Figure 7.7), Page No. 125
10	Describe about the opposite reflection of solar panel (in Technical section)	Updated in Section 4.3, Page No. 44
11	Describe about the land classification (According to AC Land) for the project site	Updated in Section 3.2, Page No. 32
12	Will the project site require land filling? If yes or no, describe	Updated in Section 3.6 (figure 3.11), Page No. 40
13	Describe about the standalone generator and its uses timing	Updated in Section 4.1, (Point iv), Page No. 42