



Department of Fisheries
Ministry of Fisheries and Livestock

Environmental and Social Impact Assessment

for Government Shrimp Estate Chakaria, Cox's Bazar;
BFDC; BMC and Canals

Volume I: Main Report



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Center for Environmental and
Geographic Information Services

**Environmental and Social Impact Assessment
for Government Shrimp Estate Chakaria, Cox's Bazar;
BFDC; BMC and Canals**

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Acknowledgments

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Table of Contents

Acknowledgments	i
The Study Team	iii
List of Tables	xi
List of Figures	xvi
Abbreviations and Acronyms	xxiii
1. Executive Summary	1
2. General Information	11
2.1 Project and Project Proponent.....	11
2.2 EIA Consultant	11
2.2.1 ESIA Study Team.....	11
3. Legislative Framework, Guidelines, and Standards	15
3.1 Introduction.....	15
3.2 Environmental Policy and Regulatory Framework.....	15
4. Project Design and Description	17
4.1 Project Background	17
4.2 Needs of the Project.....	18
4.2.1 Project Rationale	18
4.2.2 Project Objectives.....	18
4.2.3 Project Benefits	19
4.3 Study Objectives.....	19
4.4 Limitations.....	20
4.5 Description of the Sub-Projects.....	20
4.5.1 Rehabilitation of 10- and 11-acre Chakaria Shrimp Estate, Chakaria, Cox's Bazar	21
4.5.2 BFDC Harbor at Chattogram.....	21
4.5.3 Brood Management Center	25
4.5.4 Canal Rehabilitation for Cluster Farming	26
4.6 Sub-Project Size.....	27
4.6.1 Land Area and Tenancy	27
4.6.2 Land Readiness.....	28
4.7 Sub-Project Location.....	28
4.7.1 Administrative Location.....	28
4.7.2 Geographical Location.....	29
4.8 Site Accessibility.....	39
4.9 Site Design and Layout.....	53
4.9.1 Reconciliation of CSE Afforestation Plan and Design.....	53

4.10	Sub-Project Activities.....	53
4.10.1	Pre-Construction Stage	53
4.10.2	Construction Stage.....	54
4.10.3	Post-Construction/ Operation Stage.....	55
4.11	Benchmarks Around the Sub-Projects.....	55
4.12	Study Area.....	56
4.13	Sub-Project Extension Potential.....	56
4.13.1	Chakaria Shrimp Estate	57
4.13.2	BFDC Harbor at Chattogram.....	57
4.13.3	Brood Management Center	57
4.13.4	Canal Rehabilitation for Cluster Farming	57
4.14	Sub-Project Implementation Schedule.....	57
4.15	Technology Selection and Process Description.....	58
4.15.1	Chakaria Shrimp Estate	58
4.15.2	BFDC Harbor at Chattogram.....	58
4.15.3	Brood Management Center	59
4.15.4	Canal Rehabilitation for Cluster Farming	60
4.16	Site Development.....	60
4.17	Environmentally Sensitive Areas.....	60
4.17.1	Environmental Hotspots	60
4.17.2	Important Ecosystems and Biodiversity Areas	61
4.17.3	Governmentally Declared Forests.....	65
4.17.4	Highly Important Agricultural Land.....	65
4.18	Civil Structure and Urban Facilities	66
4.18.1	Chakaria Shrimp Estate	66
4.18.2	BFDC.....	66
4.19	Resources and Utility Demand.....	66
4.20	Material Storage and Handling	67
4.21	Manpower Loading.....	67
4.22	Waste Types and Calculation.....	68
4.22.1	Non-Hazardous Wastes	68
4.22.2	Hazardous Wastes.....	71
4.23	Pollution Potential.....	71
4.24	Alternative Analysis.....	73
4.24.1	Location Alternative for BMC.....	73
5.	Description of Baseline Scenario of Physical Environment.....	77
5.1	Geomorphology and Topography.....	77

5.1.1	Geomorphological Settings for CSE	77
5.1.2	Geomorphological Settings for BMC at DFTC, Teknaf	90
5.1.3	Geomorphological Settings for BFDC.....	106
5.1.4	Topography of the Sub-Projects	113
5.2	Geological Settings	114
5.2.1	Tectonic Setting of the Study Areas.....	114
5.2.2	Physiography of the Study Area.....	117
5.2.3	Seismicity of the Study Area	118
5.3	Soil and Land Resources	120
5.3.1	Agro-Ecological Zone	120
5.3.2	Land Type	122
5.3.3	Soil Texture	123
5.3.4	Land Use	124
5.4	Climate and Meteorology	129
5.4.1	Chakaria Shrimp Estate (Station ID: 11925 at Kutubdia, Cox's Bazar)	129
5.4.2	BFDC (Station ID:11921 at Chattogram).....	130
5.4.3	Canals under Satkhira District (Station ID:11610 at Satkhira)	132
5.4.4	Canals under Khulna and Bagerhat Districts (Station ID: 11604 at Khulna)	133
5.5	Historical Change of the Project Site	135
5.5.1	Rehabilitation of 10- and 11-acre Chakaria Shrimp Estate, Chakaria, Cox's Bazar	135
5.6	Hazard, Risk and Vulnerability	136
5.6.1	Natural Hazards	136
5.6.2	Anthropogenic Hazards.....	166
5.7	Water Resources	167
5.7.1	Hydrological Condition of the Sub-Project Sites	167
5.7.2	Surface Water Level	179
5.7.3	Groundwater Level.....	187
5.8	Environmental Quality	193
5.8.1	Air Quality.....	193
5.8.2	Water Quality	196
5.8.3	Acoustic Noise.....	211
5.8.4	Soil Quality	213
6.	Description of Baseline Scenario of Biological Environment.....	219
6.1	Ecological Resources.....	219
6.1.1	Bio-Ecological Zone	219
6.1.2	Ecosystem and Biodiversity.....	219

6.1.3	Limnological Aspects	239
6.1.4	Potential Vector for Diseases	249
6.1.5	Forest and Wildlife	251
6.2	Fisheries Resources	255
6.2.1	Chakaria Shrimp Estate	255
6.2.2	BMC Area at DFTC, Teknaf.....	270
6.2.3	BFDC Harbor at Chattogram.....	274
6.2.4	Canal Rehabilitation for Cluster Farming	279
6.3	Agricultural Resources	290
6.3.1	Farming Practices.....	290
6.3.2	Cropping Pattern and Intensity.....	290
6.3.3	Crop Yield and Production	294
6.3.4	Irrigation Status	297
6.3.5	Crop Production Constraint.....	297
6.4	Livestock Resources	297
6.4.1	Population and Fodder	297
6.4.2	Livestock and Poultry Diseases.....	298
7.	Description of Baseline Scenario of Socio-Economic Environment.....	299
7.1	Administrative Area and Location.....	299
7.2	Demographic Profile of the Study Area.....	300
7.2.1	Age Composition.....	301
7.3	Livelihoods	301
7.3.1	Employment Status	301
7.3.2	Field of Activity	302
7.4	Land Holding and Tenure.....	303
7.4.1	Land Holding and Tenure Procedures of CSE	303
7.5	Education	303
7.5.1	Literacy	303
7.6	Living Standards	305
7.6.1	Housing Condition	305
7.6.2	Drinking Water.....	305
7.6.3	Sanitation Facility.....	306
7.6.4	Electricity Coverage	307
7.6.5	Health Condition.....	307
7.7	Poverty	307
7.7.1	Poverty Rate Index.....	307

7.8	Social Safety Nets	308
7.9	Social Facilities/ Amenities	309
7.9.1	Road Network	309
7.9.2	Navigation Route	309
7.9.3	Markets	309
7.9.4	Cyclone Shelters and Others	309
7.10	Gender Issues	309
7.11	Small Ethnic Community	311
7.12	Cultural/ Historical Sites and Heritage	312
7.13	Security Concern	312
8.	Stakeholder Consultation and Disclosure	313
8.1	Introduction	313
8.2	Regulatory Regime	313
8.2.1	DoE Guidelines	313
8.2.2	Lender's Guidelines	313
8.3	Stakeholder Identification and Mapping	313
8.3.1	Primary Stakeholder	314
8.3.2	Secondary Stakeholder	314
8.3.3	Disadvantaged and Vulnerable Individuals or Groups	314
8.4	Stakeholder Engagement Plan	314
8.5	Summary of the Feedback from the Stakeholders	314
8.5.1	Key Issues Discussed During the Consultations, FGDs and KIIs	314
8.5.2	Knowledge about the Project	315
8.5.3	People's Perception	316
8.5.4	People's Attitude regarding Project Implementation	316
8.5.5	Occupation Pattern of the Local People within the Study Area	316
8.5.6	Potential Positive Impacts for the Project Implementation	317
8.5.7	Potential Adverse Impacts from the Project Interventions	317
8.5.8	Suggestions for Mitigation	317
8.5.9	Consultation with Women	318
8.5.10	Consultation with Local Government Authorities and Government Departments	319
8.5.11	Public Consultation and Disclosure Meetings on the Implementation of Rehabilitation of 10- and 11-acre Chakaria Shrimp Estate	321
8.5.12	Documentation of the Process and Results of Consultation	334
8.5.13	Concluding Remarks	335
8.6	Grievance Redress	336
9.	Potential Risks, Impacts, and Mitigation Measures	337

9.1	Preamble.....	337
9.2	Potential Risks, and Impact Assessment and Corresponding Mitigation Measures	337
9.2.1	Pre-construction Stage.....	337
9.2.2	Construction and Operation Stage	337
9.3	Beneficial Impacts and Enhancement Measures.....	379
9.3.1	Biological Impacts and Enhancement Measures.....	379
9.3.2	Socio-Economic Impacts	381
10.	Environmental and Social Management Plan.....	383
10.1	Introduction.....	383
10.2	Objective	383
10.3	Environmental and Social Management Plan.....	383
10.4	Mitigation Plan.....	384
10.5	Environmental and Social Monitoring Budget.....	390
10.6	Institutional Arrangement.....	405
10.6.1	Proposed Institutional Strengthening of Sub-Project Management Units.....	406
10.7	Cost Estimates for Institutional Strengthening	408
10.8	Summary of All Budgets.....	408
11.	Indirect Project Benefits and Measures Proposed Beyond Compliance	411
11.1	Preamble.....	411
11.2	Indirect Project Benefits of CSE.....	411
11.2.1	Economic Benefits.....	411
11.2.2	Social Benefits.....	411
11.2.3	Environmental Benefits.....	412
11.3	Touristic View of CSE- An Indirect Project Benefit	412
11.4	Measures Under Corporate Social Responsibility	412
11.5	Use of ETP Rejected Water for Diverse Uses	413
11.6	Greenbelt Development	414
11.7	Carbon Sequestration in CSE	416
11.8	Closing.....	417
12.	Conclusions and Recommendations.....	419
12.1	Conclusions	419
12.2	Recommendations.....	420
	References	423
	Appendix 1: The IFC EHS Guidelines 2007 (Wastewater and Ambient Water Quality)	427
	Appendix 2: Participant List and Some Photographs of Public Consultation and Disclosure Meeting at Cox's Bazar	435
	Appendix 3: Matching of Contents of ESIA Report with the Contents of EIA Report as in Schedule 11 of ECR 2023 (DoE Approved ToR).....	441

Appendix 4: Newspaper Advertisements, Attendance List, Photographs and Meeting Minutes of PDM	443

List of Tables

Table 2.1: Team Composition for the Study.....	12
Table 2.2: Team Composition for Additional Members of the Study	13
Table 4.1: List of Canals to be Rehabilitated for Scaling Up Cluster Farming.....	26
Table 4.2: Details of 10- Acre and 11-Acre Plots of CSE.....	27
Table 4.3: Administrative Locations of the Canals under Three Coastal Districts	28
Table 4.4: Geographical Locations of the Canals under Three Coastal Districts	30
Table 4.5: Study Area based on the Sub-Projects	56
Table 4.6: Physical Features of the Substation (1600 KVA).....	59
Table 4.7: Manpower Loading for the Sub-project Sites during Construction Period.....	67
Table 4.8: Estimation of Kitchen Waste during Land Development.....	68
Table 4.9: Estimation of Concrete and Wood Waste during Construction Stage	70
Table 4.10: Pollution Potential and the sources of Pollution within the Sub-Project Sites.....	71
Table 4.11: Indicators of Alternative Analysis and Significance	74
Table 4.12: Scoring Table	75
Table 5.1: Historical Map and Satellite Images used in this Study	93
Table 5.2: Variation in Sinuosity of the Naf River in Reach 1	98
Table 5.3: Variation in Sinuosity of the Naf River in Reach 2	98
Table 5.4: Variation in Sinuosity of the Naf River in Reach 3	98
Table 5.5: Average Width of the Naf River in Reach 1	99
Table 5.6: Average Width of the Naf River in Reach 2	100
Table 5.7: Average Width of the Naf River in Reach 3	100
Table 5.8: Erosion-Accretion in the Naf River in Reach 1	101
Table 5.9: Erosion-Accretion in the Naf River in Reach 2	101
Table 5.10: Erosion-Accretion in the Naf River in Reach 3	102
Table 5.11: Erosion-Accretion in the Karnaphuli River.....	108
Table 5.12: Variation in sinuosity of the Karnaphuli River	112
Table 5.13: Average Width	112
Table 5.14: A Generalized Stratigraphic Succession (Tectonic Province-3) of the Study Areas	115
Table 5.15: Stratigraphic Units of the Cenozoic and Quaternary Sediments within the Bengal	116
Table 5.16: The Regional Earthquake History of Bangladesh for Last 475 Year	119
Table 5.17: The Coverage of AEZ within the Study Areas of the Sub-Project Sites.....	121

Table 5.18: The Coverage of Land Type of the Study Areas of the Sub-Project Sites.....	123
Table 5.19: Information of Soil Texture within the Study Areas of the Sub-Project Sites	124
Table 5.20: Land Use and Land Cover Information of the Study Areas of the Sub-Project Sites.....	126
Table 5.21: Wind Speed and Duration Time for 20, 30, 50 and 100 Years Return Period	130
Table 5.22: Changes of CSE over the Time Period.....	136
Table 5.23: Major Cyclones Hitting the Bangladesh Coast.....	137
Table 5.24: Flood frequency analysis of BWDB Station (Saflapur) at Maheshkhali Channel	139
Table 5.25: Flood frequency analysis of annual maximum water level at Matamuhuri River BWDB Station (Chiringa)	139
Table 5.26: Summary of Input Data of the Hydrologic/ Hydrodynamic Models.....	142
Table 5.27: Major Cyclone Storms List with its Nature of Phenomenon and Landfall Area	148
Table 5.28: Sub-Catchment Area of 6 Polders in Hectare	156
Table 5.29: Yearly Maximum Rainfall of Kutubdia for Different Rainfall Event.....	157
Table 5.30: Rainfall for Different Return Periods in Kutubdia (in mm)	159
Table 5.31: Goodness of Fit Test (1-day Rainfall).....	160
Table 5.32: Goodness of Fit Test (2-day Cumulative Rainfall)	160
Table 5.33: Goodness of Fit Test (3-day Cumulative Rainfall)	160
Table 5.34: Goodness of Fit Test (5-day Cumulative Rainfall)	160
Table 5.35: Goodness of Fit Test (10-day Cumulative Rainfall)	160
Table 5.36: Summary of Goodness of Fit Test.....	161
Table 5.37: Maximum Runoff Calculation for existing land use for each sub catchments.....	161
Table 5.38: Flood frequency analysis of annual maximum water level at Betna-Kholpetua River BWDB Station (Kalaroa)	162
Table 5.39: Flood frequency analysis of annual maximum water level at Betna-Kholpetua River BWDB Station (Benarpota)	163
Table 5.40: Flood frequency analysis of annual maximum water level at Ichamati (Western Border) River BWDB Station (Basantapur).....	163
Table 5.41: Flood frequency analysis of annual maximum water level at Ichamati (Western Border) River BWDB Station (Kaikhali).....	164
Table 5.42: Flood frequency analysis of annual maximum water level at Kobadak River BWDB Station (Tala Magura).....	164
Table 5.43: Flood frequency analysis of annual maximum water level at Bhadra River BWDB Station (Dumuria)	164
Table 5.44: Flood frequency analysis of annual maximum water level at Gorai-Madumati-Haringhata-Baleswar River BWDB Station (Off take at Atharobanka)	165
Table 5.45: Flood frequency analysis of annual maximum water level at at Aliapur Khal Daratona River BWDB Station (Bagerhat)	165
Table 5.46: Average, 75%, 80% and 90% dependable flow at Lama on the Matamuhuri River.....	186

Table 5.47: Air Quality Monitoring Locations.....	194
Table 5.48: Air Quality Monitoring Result.....	195
Table 5.49: Surface and Ground Water Quality Sampling Locations	196
Table 5.50: In-situ Test Results of Surface Water Quality	198
Table 5.51: Surface Water Quality Analysis Results Tested by the BCSIR Lab	200
Table 5.52: Surface Water Quality Analysis Results Tested by the DPHE Lab.....	202
Table 5.53: Surface Water Quality Analysis Results Tested by the CEGIS Lab	204
Table 5.54: In-Situ Test Results of Ground Water Monitoring.....	207
Table 5.55: Ground Water Quality Analysis Results Tested by the BCSIR Lab	208
Table 5.56: Ground Water Quality Analysis Results Tested by the DPHE Lab.....	208
Table 5.57: Ground Water Quality Analysis Results Tested by the CEGIS Lab	209
Table 5.58: Acoustic Noise Level Monitoring Result	211
Table 5.59: Soil Salinity Information of the Study Areas of the Sub-Project Sites.....	213
Table 5.60: Concentration of Different Parameters in Soil within the Study Areas.....	215
Table 5.61: Concentration of Organic Matter, pH, and Phosphorus in Soil within the Catchment Areas of the Canals for Cluster Farming	216
Table 5.62: Concentration of Potassium, and Sulphur in Soil within the Catchment Areas of the Canals for Cluster Farming.....	217
Table 6.1: Ecosystem Services with Subclass of the Study Area of CSE	222
Table 6.2: Ecosystem Services with Subclass of the Study Area of BFDC Harbor at Chattogram.....	223
Table 6.3: Ecosystem Services with Subclass of the Study Area of BMC	223
Table 6.4: Ecosystem Services with Subclass of the Study Area of the Canals.....	224
Table 6.5: Existing Mangrove, and Aquatic Species in CSE Area.....	225
Table 6.6: Existing major terrestrial Species	226
Table 6.7: Major Terrestrial Species in BFDC harbor,Chittagong.....	228
Table 6.8: Existing terrestrial Species in BMC	229
Table 6.9: Existing mangrove Species in BMC.....	230
Table 6.10: Common avifaunal species of the project area of CSE	232
Table 6.11: List of Amphibians, Chordata, Reptiles, Arthropods and Mollusca.....	233
Table 6.12: Common Avifaunal Species of the Project Area	234
Table 6.13: List of Major Amphibians, Reptiles and Mollusca.....	234
Table 6.14: Common Avifaunal Species of the Project Area	235
Table 6.15: List of Major Amphibians, Reptiles, Arthropod and Mollusca.....	235
Table 6.16: Faunal Distribution of the Study Area	237
Table 6.17: Plankton and Benthos Sampling Locations from CSE, BFDC, and BMC	240
Table 6.18: Plankton and Benthos Sampling Locations from Canals for Cluster Farming	240

Table 6.19: Qualitative Assessment of Zooplankton of the CSE, BFDC, and BMC	243
Table 6.20: Qualitative Assessment of Zooplankton of the Canals for Cluster Farming	243
Table 6.21: Qualitative Assessment of Phytoplankton of the CSE, BFDC, and BMC	245
Table 6.22: Qualitative Assessment of Benthos Group of the CSE, BFDC, and BMC	248
Table 6.23: Qualitative Assessment of Benthos Group of the Canals for Cluster Farming	248
Table 6.24: Fish Habitat Area within the Study Area.....	258
Table 6.25: Different Primary Productivity within the Study Area	259
Table 6.26: Different Species Diversity Index at Sampling Site of the Study Area	260
Table 6.27: Breeding Season of the Important Fish and Shell Fish Species within the Study Area	262
Table 6.28: List of Culture Species Investigated in the Gher within the Study Area	264
Table 6.29: Different types of disease is found in the shrimp farm of Chakaria	265
Table 6.30: Adaptive Measures for Farm Management.....	266
Table 6.31: Aquaculture Inputs for Different Farming System in the Study Area.....	266
Table 6.32: Aquaculture Inputs for Different Farming System in the Study Area.....	267
Table 6.33: Fish habitat Area within the Study Area.....	272
Table 6.34: A list of Fish Species Observed within the Study Area	273
Table 6.35: Fish Habitat Area within the Study Area.....	277
Table 6.36: A list of Fish Species Observed within the Study Area.....	277
Table 6.37: Habitat Assessment within the Study Area.....	280
Table 6.38: Fish Habtat and Biodiversity of the Canals for Cluster Farming.....	281
Table 6.39: A List of Fish Species Observed within the Study Area.....	287
Table 6.40: Fish Production within the Study Area.....	289
Table 6.41: Cropping Pattern and Intensity of the Study Area	292
Table 6.42: Crop Production of the Study Area.....	295
Table 6.43: Livestock Diseases in the Study Area.....	298
Table 7.1: Administrative Area of the Sub-Projects.....	299
Table 7.2: Demographic Characteristics of the Study Area of the Sub-Projects.....	301
Table 7.3: Percentage of Population in the Age Group.....	301
Table 7.4: Employment Status of the Study Area.....	302
Table 7.5: Major Field of Activity in the Study Area	302
Table 7.6: Literacy Rate within the Study Area	303
Table 7.7: Housing condition within the Study Area.....	305
Table 7.8: Drinking Water Facility within the Study Area	306
Table 7.9: Sanitation Facility within the Study Area	306
Table 7.10: Sources of Electricity Coverage in the Study Area	307
Table 7.11: Poverty Status in the Study Area	307

Table 7.12: Ethnic Population in Study Area.....	312
Table 8.1: Inventory and Summary of the Key Informant Interviews (KII).....	319
Table 8.2: People's Opinions at Public Consultation Meeting	322
Table 8.3: Meeting Outcomes	324
Table 8.4: PDM Findings.....	329
Table 8.5: Formal Consultation Meetings by Location and Date.....	334
Table 8.6: Personal Details of the Interviewees	334
Table 9.1: Summary of Impact Evaluation on Drainage Congestion during Construction and Operation Stages	339
Table 9.2: Necessary Measures for Drainage Congestion	341
Table 9.3: Summary of Impact Evaluation on Waste Generation during Construction and Operation Stages	342
Table 9.4: Necessary Measures for Generating Wastes	345
Table 9.5: Summary of Impact Evaluation on Air Quality during Construction and Operation Stages	347
Table 9.6: Sources of Noise and Activities	349
Table 9.7: Summary of Impact Evaluation on Acoustic Noise during Construction and Operation Stages	350
Table 9.8: Summary of Impact Evaluation on Water Quality during Construction and Operation Stages	353
Table 9.9: Mitigation Measures for Air Quality.....	355
Table 9.10: Mitigation Measures on Ambient Noise Level	356
Table 9.11: Mitigation Measures on Water Quality	357
Table 9.12: Summary of Impact Evaluation on Accidental Event during Construction and Operation Stages	359
Table 9.13: Necessary Measures for Accidental Event.....	360
Table 8.14: Summary of Impact Evaluation on Vegetation during Construction and Operation Stages	362
Table 9.15: Summary of Impact Evaluation on Wildlife Habitat during Construction and Operation Stages	363
Table 9.16: Necessary Measures for the Damages of Vegetation and Wildlife Habitat.....	364
Table 9.17: Summary of Impact Evaluation on Fish Habitat during Construction and Operation Stages	367
Table 9.18: Summary of Impact Evaluation on Fish Migration during Construction and Operation Stages	369
Table 9.19: Summary of Impact Evaluation on Fish Species Composition during Construction and Operation Stages	370
Table 9.20: Summary of Impact Evaluation on Grazing Ground during Construction and Operation Stages	370

Table 9.21: Necessary Measures for the Impacts on the VESCs under Fisheries Resources	371
Table 9.22: Summary of Impact Evaluation on Socio-Economic Issues during Construction and Operation Stages	374
Table 9.23: Mitigation Measures on Socio-Economic Issues	378
Table 10.1: Mitigation Plan	385
Table 10.2: Monitoring Budget for CSE.....	390
Table 10.3: Monitoring Budget of BFDC Harbor at Chattogram.....	394
Table 10.4: Monitoring Budget of Brood Management Center (BMC) Area at DFTC, Teknaf.....	398
Table 10.5: Monitoring Budget of Canal Rehabilitation for Cluster Farming under Satkhira, Khulna, and Bagerhat Districts	401
Table 10.6: Budget for EHS Staff	407
Table 10.7: Proposed Budget for Institutional Strengthening and Capacity Building.....	408
Table 10.8: The Summary of the Budget	409
Table 11.1: Estimated budget for CSR	413
Table 11.2: Details of Plantation Types and Cost for Afforestation of the Study Area	415

List of Figures

Figure 4.1: The Location of the Components based on which Activities of BFDC has been Considered	23
Figure 4.2: Map of CSE on Satellite Image.....	33
Figure 4.3: Map of BFDC Study Area on Satellite Image	35
Figure 4.4: Map of BFDC Study Area on Satellite Image	37
Figure 4.5: Accessibility Map of CSE.....	41
Figure 4.6: Accessibility Map of BFDC	43
Figure 4.7: Accessibility Map of BMC	45
Figure 4.8: Accessibility Map of the Canals under Satkhira District.....	47
Figure 4.9: Accessibility Map of the Canals under Khulna District	49
Figure 4.10: Accessibility Map of the Canals under Bagerhat District.....	51
Figure 4.11: Important Habitat Sites within CSE; DFTC, Teknaf; and BFDC, Chattogram	61
Figure 4.12: Consequent Change in Mangrove within the Study Area of CSE.....	62
Figure 4.13: Fishing Cat Habitat in Study Sites.....	63
Figure 4.14: Fishing Cat in Natural Habitat of Chakaria	65
Figure 5.1: Map of the Study Area	78
Figure 5.2: Variation in sinuosity of the Maheshkhali River	79

Figure 5.3: Variation in sinuosity of the Bura Matamuhuri River	79
Figure 5.4: Variation in sinuosity of the Matamuhuri River	80
Figure 5.5: Average Width of the Maheshkhali River	80
Figure 5.6: Average Width of the Bura Matamuhuri River.....	81
Figure 5.7: Average Width of the Matamuhuri River.....	81
Figure 5.8: Erosion-Accretion in Maheshkhali Channel.....	82
Figure 5.9: Erosion-Accretion in Bura Matamuhuri River.....	83
Figure 5.10: Erosion-Accretion in Matamuhuri River	83
Figure 5.11: Erosion-Accretion from 1989-2001	84
Figure 5.12: Erosion-Accretion from 2001-2009	85
Figure 5.13: Erosion-Accretion from 2009-2015	86
Figure 5.14: Erosion-Accretion from 2015-2020	87
Figure 5.15: Char Development from 2001-2020	89
Figure 5.16: Char Area from 2001-2020	90
Figure 5.17: Map Showing the Study Area.....	91
Figure 5.18: Physiographic Units of the Naf River	93
Figure 5.19: Historical Development of the Naf River.....	95
Figure 5.20: Annual Minimum Water Levels at Teknaf Station.....	96
Figure 5.21: Map showing the three Reaches of the Naf River	97
Figure 5.22: Comparison among the Sinuosities of the Three Reaches.....	99
Figure 5.23: Comparison among the Average Width of Three Reaches.....	100
Figure 5.24: Erosion-Accretion in Reach 1	101
Figure 5.25: Erosion-Accretion in Reach 2	102
Figure 5.26: Erosion-Accretion in Reach 3	102
Figure 5.27: Erosion and Accretion in the Naf River from 1989 to 2000.....	103
Figure 5.28: Erosion and Accretion in the Naf River from 2000 to 2011.....	104
Figure 5.29: Erosion and Accretion in the Naf River from 2011 to 2022.....	105
Figure 5.30: Map Showing the Study Area.....	106
Figure 5.31: Historical Development of Karnaphuli River	107
Figure 5.32: Eroded and Accreted Area (1989-2020)	108
Figure 5.33: Erosion and Accretion in the Karnaphuli River from 1989 to 1997.....	109
Figure 5.34: Erosion and Accretion in the Karnaphuli River from 1997 to 2010.....	110
Figure 5.35: Erosion and Accretion in the Karnaphuli River from 2010 to 2020.....	111
Figure 5.36: Comparison among the Sinuosities	112
Figure 5.37: Changes in Width.....	113
Figure 5.38: Monthly Average Rainfall.....	129

Figure 5.39: Annual Rainfall	129
Figure 5.40: Monthly Averaged Maximum and Minimum Temperature.....	130
Figure 5.41: Monthly average Relative Humidity.....	130
Figure 5.42: Monthly Variation of Average Wind Speed at Kutubdia	130
Figure 5.43: Monthly Average Sunshine Hours Per Day at Kutubdia	130
Figure 5.44: Monthly Maximum and Average Rainfall.....	131
Figure 5.45: Annual Rainfall	131
Figure 5.46: Monthly Average of Maximum and Minimum Temperature of Chattogram.....	131
Figure 5.47: Monthly Relative Humidity	131
Figure 5.48: Monthly Maximum and Average of Maximum of Wind Speed	132
Figure 5.49: Monthly Variation of Sunshine Hours.....	132
Figure 5.50: Monthly Maximum and Average Rainfall.....	132
Figure 5.51: Annual Rainfall	132
Figure 5.52: Monthly Average of Maximum and Minimum Temperature of Chattogram.....	133
Figure 5.53: Monthly Relative Humidity	133
Figure 5.54: Monthly Maximum and Average of Maximum of Wind Speed.....	133
Figure 5.55: Monthly Variation of Sunshine Hours.....	133
Figure 5.56: Monthly Maximum and Average Rainfall.....	134
Figure 5.57: Annual Rainfall	134
Figure 5.58: Monthly Temperature (°C) at Khulna	134
Figure 5.59: Monthly Relative Humidity	134
Figure 5.60: Monthly Maximum and Average of Maximum Wind Speed	135
Figure 5.61: Monthly Variation of Sunshine Hours.....	135
Figure 5.62: El Niño and La Niña Patterns across the Topical Pacific Ocean.....	137
Figure 5.63: Computational Domain of Eastern Hill Regional Model	141
Figure 5.64: The Maximum Flood Inundation for 1 in 10 Return Period in Chakaria Upazila	143
Figure 5.65: The Maximum Flood Inundation for 1 in 20 Return Periods in Chakaria Upazila	144
Figure 5.66: The Maximum Flood Inundation for 1 in 100 Return Periods in Chakaria Upazila.....	145
Figure 5.67: Storm Surge Tracks of Last 50 Years Over Chattogram Coastal Zone	146
Figure 5.69: Water Level of 1991 Cyclone Event in Chittagong.....	150
Figure 5.70: The Maximum Flood Inundation for 50cm Sea Level Rise in Chakaria Upazila	151
Figure 5.71: The Maximum Flood Inundation for 65 cm Sea Level Rise in Chakaria Upazila	152
Figure 5.72: The Maximum Flood Inundation for 95 cm Sea Level Rise in Chakaria Upazila	153
Figure 5.73: Six Selected Polders for Chakaria in the Southeastern Zone	155
Figure 5.74: Hydrological Network of the CSE.....	169
Figure 5.75: Hydrological Network around the BFDC Harbor at Chattogram	171

Figure 5.76: Hydrological Network around the BMC Area at DFTC, Teknaf.....	172
Figure 5.77: Hydrological Network around the Canals under Satkhira District	176
Figure 5.78: Hydrological Network around the Canals under Khulna District.....	177
Figure 5.79: Hydrological Network around the Canals under Bagerhat District.....	178
Figure 5.80: Monthly Variation of Water Level of BWDB Station (Saflapur) at Maheshkhali Channel	179
Figure 5.81: Monthly Variation of Water Level at Matamuhuri River BWDB Station (Chiringa)	179
Figure 5.82: Monthly Variation of Water Level at Karnaphuli River BWDB Station (Chattogram)....	180
Figure 5.83: Monthly Variation of Water Level at Naf River BWDB Station (Teknaf)	181
Figure 5.84: Monthly Variation of Water Level at Aliapur Khal Daratona River BWDB Station (Bagerhat).....	181
Figure 5.85: Monthly Variation of Water Level at Betna-Kholpetua River BWDB Station (Kalaroa)	182
Figure 5.86: Monthly Variation of Water Level at Betna-Kholpetua River BWDB Station (Benarpota)	182
Figure 5.87: Monthly Variation of Water Level at Bhadra River BWDB Station (Dumuria)	183
Figure 5.88: Monthly Variation of Water Level at Gorai-Madumati-Haringhata-Baleswar River BWDB Station (Off take at Atharobanki)	183
Figure 5.89: Monthly Variation of Water Level at Gorai-Madumati-Haringhata-Baleswar River BWDB Station (Nazirpur)	184
Figure 5.90: Monthly Variation of Water Level at Ichamati (Western Border) River BWDB Station (Basantapur).....	184
Figure 5.91: Monthly Variation of Water Level at Ichamati (Western Border) River BWDB Station (Kaikhali)	185
Figure 5.92: Monthly Variation of Water Level at Kobadak River BWDB Station (Tala Magura)	185
Figure 5.93: Dependable flow for Lama Station on the Matamuhuri River.....	187
Figure 5.94: Depth of Groundwater from the Station ID-COX002 (1984-2013) near the Matamuhuri River	188
Figure 5.95: Depth of Groundwater from the Station ID- COX004 (1984-2013) near Matamuhuri River	188
Figure 5.96: Depth of Groundwater from the Station ID- THA001 (1984-2013) near the Karnaphuli River	189
Figure 5.97: Depth of groundwater from the ground surface of Station THA002 (1984-2013) near the Karnaphuli River.....	190
Figure 5.98: Depth of Groundwater from the Station ID- GT1519900 (1996-2018).....	192
Figure 5.99: Depth of Groundwater from the Station ID- GT4751900 (1994-2021).....	193
Figure 6.1: The Schematic Portrays Reflect the Major Ecosystems of the Study Area	220
Figure 6.2: Major Ecosystem of the Canals under Khulna, Bagerhat, and Satkhira Districts.....	221
Figure 6.3: Land Use of the Study Area of CSE.....	222
Figure 6.4: Land Use of the Study Area of BFDC Harbor at Chattogram.....	223

Figure 6.5: Land Use of the Study Area of Brood Management Center	224
Figure 6.6: A View of Major Terrestrial Vegetation in CSE, BFDC Harbor, and BMC Areas.....	230
Figure 6.7: Wild Fauna within the Study Areas of the Sub-Projects.....	236
Figure 6.8: Some Pictures of Collecting Samples from the Study Areas	242
Figure 6.9: Species Based Zooplankton (%) for CSE, BFDC, and BMC.....	244
Figure 6.10: Species Based Zooplankton (%) for Canals for cluster Farming.....	244
Figure 6.11: Species Based Benthic (%) for CSE, BFDC, and BMC.....	246
Figure 6.12: Species Based Benthic (%) for Canals for Cluster Farming.....	247
Figure 6.13: Jaleshwar Aquatic Plant at Ramgar Shrimp Gher	249
Figure 6.14: Gewa Plant Beside the Shrimp Gher at Badarkhali.....	249
Figure 6.15: A Folk of Black Headed Ibis in Chakaria	250
Figure 6.16: Little Heron at Teknaf BMC	250
Figure 6.17: Area Changes in Mangrove in CSE.....	251
Figure 6.18: Distance of Protected Sites from the Study Area of CSE	252
Figure 6.19: Distance of Protected Sites from the Study Area of BFDC Harbor at Chattogram.....	253
Figure 6.20: Distance of Protected Sites from the Study Area of BMC at DFTC, Teknaf	254
Figure 6.21: Fish Habitat in the Study Area	256
Figure 6.22: Fish Habitat in the Study Area	257
Figure 6.23: Percentage of Fish Habitat within the Project and Study Area.....	258
Figure 6.24: Percentage of Family-Wise Species Composition in the Study Area	260
Figure 6.25: Spatial and Temporal Cluster of Fish Assemblage Based on Bray–Curtis Similarity Matrix	261
Figure 6.26: Migration Extent of Major Migratory Fish Species within the Study Area.....	261
Figure 6.27: Culture Pattern of Shrimp and Salt Culture in Chakaria	262
Figure 6.28: Shrimp Farm/Gher Preparation within the Study Area	263
Figure 6.29: Shrimp PL Collection.....	263
Figure 6.30: Water Exchange Gate of Shrimp Farm/Gher	264
Figure 6.31: Shrimp Production Flow Chart in Chakaria	265
Figure 6.32: Percentage of Fish Production within the Study Area.....	268
Figure 6.33: Shrimp Production Impacting Variables	268
Figure 6.34: Value Chains of Shrimp within the Study Area.....	269
Figure 6.35: Picture of Fish Pond within the Study Area	270
Figure 6.36: Fish Habitat within the Study Area.....	271
Figure 6.37: Fish Habitat within the Study Area.....	275
Figure 6.38: Fish Habitat in the Study Area	276
Figure 6.39: Partial Pictures of the Canals for Cluster Farming.....	287

Figure 6.40: Glimpse of Livestock within the Study Area	297
Figure 7.1: Portrayal of School Attending and Not Attending Rate in terms of Age Groups	305
Figure 7.2: Poverty Status in Study Area	308
Figure 7.3: Gender based School Attendance	310
Figure 8.1: Consulting with Local People within the Study Area of the Sub-Projects.....	316
Figure 8.2: Conducting FGDs at Various Locations within the Study Areas.....	318
Figure 8.3: FGD with women at Koralkhali village, Chakaria	319
Figure 8.4: KII with Various Government Officials	321
Figure 10.1: Organogram of SCMFP, DoF	405
Figure 10.2: Organogram of Chattogram BFDC.....	406
Figure 10.3: Organogram of SCMFP-PMU Proposed by the Consultant.....	407
Figure 10.4: Proposed Institutional Framework for EMP Implementation.....	408
Figure 11.1: Plantation Design for CSE	415
Figure 11.2: Plantation Design for the Canals for Cluster Farming	416

Abbreviations and Acronyms

ADB	Asian Development Bank
AEZ	Agro-ecological Zone
AOI	Area of Influence
ARIPA	Acquisition and Requisition of Immovable Property Act
BAP	Biodiversity Action Plan
BBS	Bangladesh Bureau of Statistics
BOBLME	Bay of Bengal Large Marine Ecosystem
BECA	Bangladesh Environmental Conservation Act
BEZ	Bio-Ecological Zones
BFDC	Bangladesh Fisheries Development Corporation
BFRI	Bangladesh Fisheries Research Institute
BMC	Brood Management Center
BMD	Bangladesh Meteorological Department
BMEP	Biodiversity Monitoring and Evaluation Plan
BNBC	Bangladesh National Building Code
BP	Bank Procedure
BRDB	Bangladesh Rural Development Board
BSGSM	Bangladesh Standards and Guidelines for Sludge Management
BTS	Black Tiger Shrimp
BWDB	Bangladesh Water Development Board
CBA	Collective Bargaining Agent
CBD	Convention on Biological Diversity
CDA	Chattogram Development Authority
CEGIS	Center for Environmental and Geographic Information Services
CEP	Coastal Embankment Project
CESAP	Construction Environmental and Social Action Plan
CHS	Community Health and Safety
CITIES	Convention on International Trade in Endangered Species
CMB	Central Monitoring Basin
CoC	Code of Conduct
COD	Chemical Oxygen Demand
CSC	Construction Supervision Consultant
CSE	Chakaria Shrimp Estate
CSR	Corporate Social Responsibility
DAE	Department of Agriculture Extension
DBH	Diameter at Breast Height
DDM	Department of Disaster Management

DEM	Digital Elevation Model
DFO	District Fisheries Officer
DFTC	Demonstration Farm and Training Center
DG	Director General
DO	Dissolve Oxygen
DoE	Department of Environment
DoF	Department of Fisheries
DPD	Deputy Project Directors
DPHE	Department of Public Health Engineering
DPP	Development Project Proforma/Proposal
DTW	Deep Tube Wells
EAAA	Ecologically Appropriate Area of Analysis
EBRD	European Bank for Reconstruction and Development
EC	Electrical Conductivity
ECA	Ecologically Critical Area
ECC	Environmental Clearance Certificate
ECR	Environmental Conservation Rule
EEZ	Exclusive Economic Zone
EHS	Environmental, Health, and Safety
EHSGs	Environmental, Health, and Safety Guidelines
EMS	Early Mortality Syndrome
ENSO	El Niño-Southern Oscillation
EPC	Engineering, Procurement, and Construction
ERP	Emergency Response Plan
ES	Environmental and Social
ESA	Environmentally Sensitive Areas
ESF	Environmental and Social Framework
ESHS	Environmental and Social Health, and Safety
ESS	Environmental and Social Standards
ESCOPs	Environmental And Social Codes of Practices
ESIA	Environmental and Social Impact Assessment
ESMF	Environmental and Social Management Framework
ESMP	Environmental and Social Management Plan
ESMoP	Environmental and Social Monitoring Plan
ETP	Effluent Treatment Plant
FAO	Food and Agriculture Organization
FFWC	Flood Forecasting and Warning Center
FGD	Focused Group Discussion
FLID	Fisheries and Livestock Information Department

FMP	Fisheries Management Plan
FRSS	Fisheries Resources Survey System
GBM	Ganges, Brahmaputra and Meghna
GBV	Gender-Based Violence
GDP	Gross Domestic Product
GIIP	Good International Industry Practices
GIS	Geographic Information System
GIS	Gas Insulated Switchgear
GO	Government Organization
GoB	Government of Bangladesh
GRC	Grievance Redress Committee
GRM	Grievance Redress Mechanism
Gum	Gumble
HDI	Human Development Index
HRAC	Hazard Risks Assessment Codes
HSG	Hydrologic Soil Group
HYV	High Yielding Variety
IA	Implementing Agency
IDA	International Development Association
IEE	Initial Environmental Examination
IFC	International Finance Corporation
ILO	International Labour Organization
IMD	Indian Meteorological Department
IMDMCC	Inter-Ministerial Disaster Management Coordination Committee
INGO	Implementing NGO
IPCC AR	Intergovernmental Panel on Climate Change Assessment Report
IPMP	Integrated Pest Management Plan
IRC	Incident Response Center
ISO	International Organization for Standardization
IUCN	International Union for Conservation of Nature
JHA	Job Hazard Analysis
JTWC	Joint Typhoon Warning Centre
KDA	Khulna Development Authority
KII	Key Informant Interview
LCS	Labor Contracting Society
LGI	Local Government Institutions
LGRC	local level Grievance Redress Committee
LN	Long Normal
LMOs	Living Modified Organisms

LP	Log Pearson
MoA	Ministry of Agriculture
MCA	Multi-Criteria Analysis
MD	Managing Director
MDL	Minimum Detection Limit
MEAs	Multilateral Environmental Agreements
MFF	Mangrove for Future
MoEF	Ministry of Environment and Forest
MoFL	Ministry of Fisheries and Livestock
MoL	Ministry of Land
NBSAP	National Biodiversity Strategy and Action Plan
NCA	Net Cropped Area
ND	Normal Distribution
NDMC	National Disaster Management Council
NEMAP	National Environment Management Action Plan
NG	Net Gain
NGO	Non-Government Organization
NID	National Identification Card
NNL	No Net Loss
NWRD	National Water Resources Database
OHS	Occupational Health and Safety
O & M	Operation and Maintenance
OP	Operation Policy
OSHA	Occupational Safety and Health Administration
PAH	Polycyclic Aromatic Hydrocarbons
PCM	Public Consultation Meeting
PCR	Physical Cultural Resources
PD	Project Director
PDM	Public Disclosure Meeting
PGCB	Power Grid Company of Bangladesh
PIO	Project Implementation Office
PIU	Project Implementation Unit
PL	Post Larvae
PM	Particulate Matter
PME	Powered Mechanical Equipment
PMO	Project Management Office
PMP	Pest Management Plan
PMU	Project Management Unit
PPE	Personal Protective Equipment

PS	Performance Standard
RAJUK	Rajdhani Unnayan Kartripakkha
RAP	Resettlement Action Plan
RCC	Reinforced Cement Concrete
RDA	Rajshahi Development Authority
RDPP	Revised Development Project Proforma/Proposal
RFI	Request for Inspection
RFO	Regional Fisheries Office
RH	Relative Humidity
RPF	Resettlement Policy Framework
RR	Rainfall Runoff
RRA	Rapid Rural Appraisal
RS	Remote Sensing
SAP	Strategic Action Programme
SCC	Site Clearance Certificate
SCMFP	Sustainable Coastal and Marine Fisheries Project
SCS-CN	Soil Conservation Service Curve Number
SDF	Social Development Foundation
SE	Supervision Engineer
SEA- SH	Sexual Exploitation and Abuse and Sexual Harassment
SEO	Secondary Education Office
SEP	Stakeholder Engagement Plan
SoD	Standing Orders
SOP	Standard Operating Procedures
SPF	Specific Pathogen-Free
SPM	Suspended Particulate Matter
SPME	Specified Powered Mechanical Equipment
SPS	Safeguard Policy Statement
SRDI	Soil Resource Development Institute
STDEV	Standard Deviation
STW	Shallow Tube Wells
SSO	Social Services Office
SUFO	Senior Upazila Fisheries Officer
TAN	Total Ammonia Nitrogen
TDA	Transboundary Diagnostic Analysis
TDS	Total Dissolve Solid
TL	Team Leader
TSS	Total Suspended Solid
UFO	Upazila Fisheries Officer

UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNISYS	United Information Systems
UNO	Upazila Nirbahi Officer
USA	United States of America
VESCs	Valued Environmental and Social Components
WARPO	Water Resources Planning Organization
WAO	Women Affairs Office
WBG	World Bank Group
WCS	Wildlife Conservation Society
WFD	White Feces Disease
WHO	World Health Organization
WL	Water Level
WSD	White Spot Disease
WSSV	White Spot Syndrome Virus
WTP	Water Treatment Plant
XEN	Executive Engineer

1. Executive Summary

Introduction

The 'Sustainable Coastal and Marine Fisheries Project (SCMFP)' is an umbrella Project of Department of Fisheries (DoF) that aims to increase the contribution of coastal and marine fisheries and aquaculture sustainably to the national economy and ensure access of the fishing communities to alternative livelihood activities in an environment-friendly manner. In line with this, DoF has taken an initiative for the development and rehabilitation of infrastructures under four (04) sub-projects: (i) Rehabilitation of 10-, and 11-acre shrimp estate and 48-acre Shrimp Demonstration Farm at Chakaria, Cox's Bazar, (ii) Development Works for Sustainable Management of BFDC Harbor at Chattogram, (iii) Establishment of Specific Pathogen Free - Black Tiger Shrimp (SPF-BTS) Brood Management Center (BMC) close to DFTC at Teknaf, and (iv) Desilting and re-habilitation of existing canals under Khulna, Bagerhat and Satkhira Districts with the concept of implementing the cluster shrimp farming. The overarching objective of the SCMFP is to explore greater opportunity from the coastal and marine fisheries resources, along with promoting sustainable management of fisheries stock and environment to reduce poverty and improve livelihood of the coastal community. SCMFP as a whole would explore the greater opportunity through promoting sustainable management of coastal and marine fisheries resources and would reduce poverty and improve livelihood of the coastal community.

Legislatives

The ESIA Study has been conducted following Environmental Conservation Rules (ECR 2023) and World Bank's Operation Policy (OP)/Bank Procedure (BP). The proposed project consists of four sub-projects, each with its own potential risks and impacts. According to ECR 2023, the overall project is classified as "RED Category," which mandates conducting an Environmental and Social Impact Assessment (E/SIA) study. Similarly, the project falls under 'Category B' according to the World Bank's Environmental Safeguard Policies. This study is necessary to obtain approvals, including the Site Clearance Certificate (SCC) before project implementation and the Environmental Clearance Certificate (ECC) before project operation.

Study Method

A mixed-method approach has been applied in this study by blending the quantitative and qualitative information. The combination of quantitative and qualitative data has been collected both from primary and secondary sources, which eventually has created a platform of understanding the dynamics of the assignment. The ESIA has been conducted by following the ECR 2023 and EIA Guidelines for Industries 2021 of DoE, the World Bank's Policy/Procedure (OP/ BP), and General Guidelines of IFC 2007 (Environmental, Health, and Safety).

Project Brief

The Chakaria Shrimp Estate (CSE) Sub-project, located at Badarkhali, Chiringga, Pashchim Bara Bheola, and Saharbil Unions under Chakaria Upazila of Cox's Bazar District, provisions the interventions like re-habilitation of internal canals, construction of hydraulic structures and afforestation on the peripheral dyke.

BFDC Harbor, located at Char Patharghata Union under Karnaphuli Upazila of Chattogram District, possesses installation of a three-phase transformer with the necessary distribution lines, development of modern fish processing plant, installation of an Effluent Treatment Plant (ETP), a Water Treatment Plant (WTP), two deep tube wells, five-ton fork lifter and firefighting arrangements.

Canal Rehabilitation sub-project with the provision of re-excavation of 18 canals and repairing or constructing of hydraulic structures at the mouth of those canals, located at 11 Upzilas of Khulna, Satkhira and Bagerhat Districts, to be implemented in the Shrimp Cluster Area.

The Brood Management Center (BMC) sub-project having provision of construction of shrimp hatchery and other facilities, located at Teknaf Pourashabha, Ward No. 1 under Teknaf Sadar Upazila, Cox's Bazar District.

Study Area

The study area considered for the CSE is 1 km buffer area from the peripheral dyke, for BFDC it is 1 km radial from the substation, for Cluster Shrimp area canals, it is the catchment area of the respective canal and for BMC it is 1 km buffer area from the Site boundary.

Under BMC, shrimp hatchery will be established and for this, 1 km buffer area from shrimp hatchery has been considered as study area.

No land acquisition would be required for implementing the sub-projects except BMC, which may be taken as lease through inter departmental Agreement of the Government bodies from the Department of Forest.

The mangrove forest patches in and around CSE host a wide variety species including shorebirds that roam regularly and different migratory birds that roost in the winter. The site is close to the Medhakacchapia National Park, a protected area, having forest coverage supporting with wildlife. Ecologically, the BFDC site is less diverse and far away from any designated forest. The BMC site is in the Teknaf Ecologically Critical Area (ECA) and close to mangrove patch having abundance of waterfowl. The cluster canal sites have minor patches of mangrove vegetation along with inland vegetation.

The better suitable location for implementing BMC has been identified at the premise of DFTC of Teknaf through an alternative analysis between DFTC and CSE locations.

Description of Baseline Scenario of Physical Environment

All of the sub-project sites are morphologically stable with insignificant bankline shifting despite located under the physiographic units of Chattogram Coastal Plains (CSE, BFDC & BMC) and Gopalganj Khulna Beels, Ganges River Floodplains and Ganges Tidal Floodplains (Cluster Shrimp Farm Canals).

The sites belong to complex topographies having the tendency of seasonal flooding, minor erosion and accretion along the intervened area rivers. The hydraulic structures of the sub-projects are mostly not in function due to various reasons, such as siltation in front of the structures, salinity and snail attachment induced corrosion. Siltation of riverbed at the cluster shrimp area causes propagation of flood, which is further aggravated by the silted-up canals.

Seismically, CSE, BFDC, and BMC are located under Earthquake Zone III whereas the cluster shrimp farm canals are located under Earthquake Zone-I and II (BNBC 2020).

The dominating land uses of CSE are shrimp farms, BFDC are built-up area, BMC are aquaculture and cluster shrimp farm area are rice-cum-shrimp/fish cultivation.

Climate and Meteorology: The climate of the sub-project sites in the southeast coastal belts is humid, tropical monsoon, with a hot and rainy summer and a dry winter, and in the southwest it indicates rising temperature and natural calamities.

Hazard, Risk and Vulnerability: The major natural hazards experienced by the sub-project sites include tidal flooding, cyclone with storm surge, sea level rise, salinity intrusion, coastal erosion, heat wave, bacterial and viral infections to shrimp farms, etc. The anthropogenic hazards include robberies, hooliganism, encroachment, etc. are particularly observed in CSE area.

Water Resources: CSE study area is bordered by the Maheshkhali Channel, Bura Matamuhuri River, and Matamuhuri River. BFDC comprises of the estuary of the Karnaphuli River. On the other hand, the BMC area is located near the Naf River estuary which flows along the Northern and Eastern Hills. Apart from that, there are two significant khals such as Hachkar Khal and Kaikhali Khal for BMC sub-Project site. The canals of the cluster shrimp farm area are distributed over Khulna by six (06), Satkhira by five (05) and Bagerhat by seven (07). It is observed that seven (07) out of 18 canals are originated from the flood plain and fall into various rivers.

Local people use deep tube wells for groundwater for potable purpose in CSE and BMC. However, supply water is used in BFDC. In addition, around 1000 tons of ground water is withdrawn daily through deep tube well near existing fish processing plant for supplying the ships for potable purposes. On the other hand, most of the catchment areas of the cluster farming canals deep tube wells are used for potable purpose but because of salinity and arsenic concentration some of the tube wells are not useable.

Environmental Quality: Air quality monitoring reveals all criteria pollutants are under the permissible limits as per Air Pollution (Control) Rules 2022 and IFC EHS 2007 Guidelines except PM_{2.5}, which has exceedances in dry period monitoring at two locations, BFDC Jetty site and Training Dormitory at DFTC. The reason identified is the ongoing construction activities at BFDC and vessel movement near jetty.

Water quality monitoring reveals fluctuations in measured parameters at all sub-projects but still under the permissible limits as per ECR 2023 and IFC EHS Guidelines 2007 except COD, which has exceedances at dry period at all monitoring sites. The major reason identified is the water flow is too low to flush waste materials. Exceedances are also observed in ammonium levels at the sampling locations under cluster shrimp farm's canals, possibly due to animal husbandry and usage of NH₃-based fertilizers.

Acoustic noise levels are observed under the permissible limits as per Noise Pollution (Control) Rules 2006 for most of the sites while other sites have marginal exceedances. Movement and honking of vessels may be the major reasons of such exceedances.

Description of Baseline Scenario of Biological Environment

Ecological Resources: The ecological characteristics of the sub-project sites vary with the distinguished geophysical locations of the sub-projects. The ecology of the CSE influenced by both natural and anthropogenic environment. It possesses a diverse landscapes of mangrove forests, salt pans, and agricultural areas, supporting a range of plants, mollusks, insects, birds, and small mammals. The mangrove forest patches located around CSE support a wide variety of resident and migratory birds along with rarely observed fishing cat, an endangered species (IUCN Red List, 2015).

Despite fragility of the ecosystem, CSE still maintains the delicate balance of nature through cycling nutrients, regulating climate, and offering shelter for a diverse range of species. The Parabon around CSE plays a crucial role as natural barriers, protection from wave and other environmental threats.

The BFDC Harbor site is a built environment, dominated with terrestrial ecosystem having planted forests and orchards. The wildlife supported by this ecosystem is composed of a fewer variety of species.

BMC area in Teknaf is dominated with beach and mangrove ecosystems, rich in coastal biodiversity. The mangrove ecosystem provides support in creating natural barrier, regulating coastal erosion, carbon sequestration and dwellings of various species including wetland birds.

The canals for cluster farming areas support diverse ecosystems with coastal fisheries, shrimp, forests, and other natural resources. These ecosystems regulate oxygen and carbon dioxide levels and provide essential resources like food, water, and medicines, protect from cyclones and erosion.

There are some important areas for biodiversity located around CSE and BMC areas. These are: Sonadia Island, an ecologically critical area (ECA), supports birds and turtles; the Medakachapia, Dulhazra and Cox's Bazar-Teknaf Peninsula (ECA) have also great ecological importance as they support a wide variety of biodiversity.

Fisheries Resources: Shrimp Estate in Chakaria emerges as a key hub for fisheries resources, with a primary focus on shrimp aquaculture. The CSE spans across about 7022 acres, subdivided into plots of ten and eleven acres each, in which, 468 plots measuring ten acres and 119 plots measuring eleven acres including an additional 18 plots of 48-acre shrimp demonstration farm.

The river systems like Matamuhuri, Bura Matamuhuri River, and Maheshkhali Channel around the CSE, play a key role in supplying saline water for shrimp farming. Snails play an important role in controlling parasites and algae, improving water quality, and oxygenating sediment, which supports sustainable aquaculture and benefits both farmers and the ecosystem. However, they are also attracted by the materials of the hydraulic structures (civil structures in the canals: sluice gate) to get nutrient from those and make them damaged.

CSE comprises about 3,035 ha of shrimp aquaculture and 480 ha of capture fishery habitats. Siltation of the habitats has been causing hindrances to breeding, grazing, and migration for fish and consequently hindering leveraging local economy through producing less shrimp than expected and creating employments. Despite, snails have much contribution to the ecosystem and water quality environment, they also share the common food of shrimp. This phenomenon underpins that shrimp production may get shock from the propagation of snails largely. Nevertheless, even considering the mentioned issues, CSE habitats produce about 2,401 MT of finfish and shrimp whereby shrimp contributes about 91.2% and finfish shares the rest.

Currently, shrimp farming follows traditional to extensive aquaculture practice along with salt cultivation at the suitable farms/ghers. Stocking of shrimp post larvae (PL) is done from two sources, such as wild PL from rivers and hatchery-bred PL. Shrimp farming faces several barriers, such as spread of infectious diseases, pollution, natural hazards and calamity, absent of modern aquaculture techniques disseminated to the farmers, market fluctuations, inadequate fish marketing infrastructures, etc.

The only designated fish landing center close to CSE is Choarfari Bazar at Shahar Beel Union, which is in a shabby condition. On an average, 2500- 3000 kg of fish per day with finfish to shellfish ratio is currently 30:70 is landed in Choarfari Fish Landing Center during monsoon.

The project site possesses some derelict ponds which have no fishery activities.

The BFDC site does not possess any fishing and fish farming activities. There is a Fish Processing Plant having processing capacity of 3,360 tons of fish annually, averaging 16 tons daily. It engages 30-50 contract workers, dominated by women.

The cluster shrimp farming canals, spanning over three coastal districts i.e., Khulna, Satkhira and Bagerhat, are largely silted up and cannot provide expected water exchange services to the shrimp farms. The hydraulic structures like sluice gates at the mouth of the canals are not in function appropriately and also affect the subsistence fishing. This phenomenon evolves conflicts between agriculture and fisheries.

Agricultural Resources: The CSE site does not have any agriculture practice except some peripheral cultivations. Salt cultivation stands as a significant practice in the project site. The BFDC site is a built-

up area having some orchards and devoid of agriculture practice. The BMC site also has no agriculture practice.

Livestock Resources: Local people in and around the CSE site rear cattle, buffalo, goats, chickens, and ducks. During the monsoon season (July-October), grazing land goes underwater, leaving rice straw as the primary source of fodder.

Baseline Socio-Economic Environment

The CSE study area spans over five (05) unions under two (02) Upazilas of Cox's Bazar District having population of about 29,430 with male and female ratio of 100 to 99.2 and about 60.4% of the population belongs to active age group of 15-64 years. The major workforce of 31.1% employed population is engaged in shrimp and salt farming activities. The average literacy rate is 71.3% and the housing condition is dominated by Kutcha house with about 61%.

The BFDC study area falls under Char Patharghata Union of Karnaphuli Upazila and Ward no. (28, 29, 30, 31, 33) under Sadarghat Pourashava of Chattogram District, having population of about 52,253 with male and female ratio of 100 to 92.1 and about 66.1% of the population belongs to active age group of 15-64 years. The major workforce of 39.6% employed population is engaged in service and industry activities. The average literacy rate is 85.9% and the housing condition is dominated by Pucca house with about 72%.

The BMC study area belongs to Teknaf Union of Teknaf Upazila and Ward no. (1, 2, 3, 4, 7) of Teknaf Pourashava of Cox's Bazar District, having population of about 12,859 with male and female ratio of 100 to 97.4 and about 58.9% of the population belongs to active age group of 15-64 years. The major workforce of 31.1% employed population is engaged in service and industry activities. The average literacy rate is about 69% and the housing condition is dominated by Semi Pucca house with about 33%.

The study area of the cluster farming canals sub-project site spans over nine (09) unions under four (04) Upazilas of Bagerhat District, five (05) unions under two (02) Upazilas of Khulna District, and eleven (11) unions under six (06) Upazilas of Satkhira District, having population of about 4,15,124 with male and female ratio of 100 to 102.1 and about 68% of the population belongs to active age group of 15-64 years. The major workforce of 34.3% employed population is engaged in agriculture sub-sectors and service activities. The average literacy rate is about 78.6% and the housing condition is dominated by Kutcha house with about 59%.

Stakeholder Consultation and Disclosure

The findings of formal and informal stakeholder consultations carried out severally with different levels of occupational groups underscore the following concerning issues, such as open leasing process, security system, PL buying and selling including management etc. They emphasize on giving priority to the local people in leasing the land for cultivating shrimp. They appreciate the creation of employment opportunity to the local people, improvement of communication infrastructures, resolving flooding problems and other utility facilities in the study areas as applicable.

At all the stages of the consultation processes the involvement of women was significant and provides encouraging suggestions to get them involved in various works as per their expertise and generate more employment opportunities to them with womanly civic facilities in the work stations.

Valued Environmental and Social Components

The Valued Environmental and Social Components (VESC), has been identified based on different approaches including Delphi Method, expert judgment, and through a brainstorming session among team members. The environmentally and socially sensitive receptors were given emphasis in identifying the VESCs and based on which impacts of the interventions have been assessed.

Potential Risks, Impacts and Mitigation Measures

The potential impacts, adverse and beneficial, assessed for the interventions considered under the sub-projects are summarized below by resources in different stages with necessary measures. Here, it is to notify that according to the sub-Project wise activities, other than social issues, risks and impacts have been considered during construction and operation stages.

Hydrological Resources: Rehabilitation of hydraulic structures will conventionally be done by creating a bypass canal as the existing broken or shabby structures are not removed from the site. Bifurcation of flow during operation will slow down it and accelerate siltation close to the structures both at upstream and downstream. Unauthorized dumping of debris generated at the construction site and improper management of re-excavated earth may provoke drainage congestion in the internal canals and create problem for the pedestrian movement those use the canal dyke as road or walkway.

To overcome unwanted drainage congestion, unregulated scattering /throwing of waste should be prohibited; and ESCOP 4: Drainage Management should be followed during construction stage.

Waste Generation: The study estimates three types of wastes, to be generated in implementation of the sub-projects: perishable: Kitchen waste, non-perishable: Concrete and wooden debris, and organic solid waste: Sewage waste (Ref. Section 3.18.1). Unconventional disposal of such wastes in the open environment might cause water contamination, nuisance and bad smell. In consequence, contamination to the receiving waterbodies may be a reason of threat to the aquatic lives and human being as well.

To minimize bad smell from the sewage waste, a septic tank with soak well should be implemented at the construction site and discharge these wastes considering national standard (Schedule 3 of ECR 2023) for sanitary wastewater discharges or the indicative guideline values applicable to sanitary wastewater discharges of IFC EHS Guidelines 2007 (Wastewater and Ambient Water Quality); good housekeeping should be adopted for kitchen waste collection and disposal; glasses, plastics, recyclable and reusable wastes etc. may be segregated at source and manage separately in designated colored bins.

Impacts on Environmental Quality:**Air Quality**

Movement of construction vehicles (BFDC), machineries (CSE, BFDC, BMC & Cluster Canals), demolition of civil structures (CSE & BFDC), take away vehicles for debris and tree logs (CSE & BFDC) and loading & unloading of construction materials at sites might cause generation of dust and gaseous emission. The contaminated air of the intervened areas may temporarily affect the laborer's health (CSE, BMC & Cluster Canals) and community health in addition to laborer's health (BFDC) (Ref. Section 9.2.2).

To avoid dust emission, earthen roads should be avoided while transporting the construction materials, machineries, debris, tree logs etc. Restriction of burning waste materials may minimize the exhaust emission in the ambient air; fencing should be provided around the project site before starting the construction works; construction materials should be covered tarpaulin to limit producing dust particles in the ambient air. In addition, water should be sprayed regularly for suppressing fugitive dust; air quality monitoring should be undertaken during the construction stage at the sub-project sites near the sensitive receptors to ensure ambient air quality remains within the limits defined by

Acoustic Noise

Noise would be generated during tree felling (BFDC), demolition of abandoned civil structures (CSE, BFDC and BMC), and operation of construction machineries and vehicular movement might cause

annoyance to the laborer's (CSE, BFDC and BMC) and community in addition to laborers (BFDC) (Ref. Section 9.2.2).

Construction works should be restricted during day time only; workers should use earmuff while conducting construction activities; movable noise attenuation measures would be erected around pumps, trucks, and other noisy equipment when operating in close proximity to residential areas for reducing noise.

Water Quality

Wastes like cement, brick wash water, trash materials, scrap wood, paper, etc. generated at the construction sites; kitchen waste from laborer camp; and spilled-oils from oil containment/storage area/equipment/vehicles/vessels, etc. may contaminate the receiving waterbodies. This may cause the intervened waters with excessive nutrients, turbidity, heavy metals, organic pollutants, etc.

Spillage of oil, and bilge water during excavation (CSE & Cluster Canals), and water transportation (CSE & BFDC) may also contaminate water and consequently may hamper the resident aquatic lives (Ref. Section 9.2.2).

To overcome this issue, ESCOP 1: Waste Management, ESCOP 3: Water Resources Management, and ESCOP 6: Erosion and Sediment Control should be followed. In addition, unauthorized disposal of solid waste and waste water should be prohibited into nearby open water; Awareness program should be implemented to the fishers and the local people and legal enforcement should be properly executed.

Accidental Event: Ref. Section 3.18.1, around 20,124 Ton, 363 Ton, 1286 Ton of debris would be generated from CSE, BFDC, and BMC areas. Therefore, around 2013, and 37 dump trucks with capacity of 10 Ton and 257 dump trucks with capacity of 5 Ton would be required for carrying the debris from the sub-project sites respectively. As a result, additional movement of vehicles would increase road traffic and susceptibility to accidental events.

On the other hand, carrying generated debris to be generated from the demolition of civil structures from the CSE to the boat ghat using water transport may increase vessel traffic and susceptibility to accidental events.

To minimize the accidental event, access to the sub-project sites should be restricted for the local community; adequate number of danger signs, symbols are placed properly at the loading and unloading locations; no unfit vehicles such as dump trucks, construction material trucks/lorries, etc. and other machines should be allowed to be in use; ESCOP 14: Road Transport and Road Traffic Management, and ESCOP 15: River Transport Management should be followed properly.

Ecological Resources: Tree felling and vegetation clearance (CSE, BFDC & BMC) may hamper the localized ecosystem and dependent habitats of wildlife species under avian fauna, amphibians, reptiles and pieces. It may also shrink the opportunity of carbon sink to some extent.

Therefore, marginal and amphibian plantations with local flora along river levees should be implemented to enhance vegetation; conduct awareness programs on plant, fish, and wildlife preservation to mitigate resource overexploitation; select suitable locations for mangrove plantations and appropriate native species for success, while executing a plantation plan using indigenous species around proposed water control structures.

Annoyance from the construction site noise to be generated from the operation of rotatory equipment and disturbances from the human interference may cause displacement of resident wildlife and deterrent to migratory birds from roosting. Re-excavation of soil from canal bed may cause mortalities to invertebrates and crustaceans. Increasing turbidity during re-excavation would deteriorate habitat quality and relocation of fishes, and other aquatic organisms. snakes etc. Impeding

the snail's movement due to sluice gate may hamper the propagation of biodiversity and reduce the opportunity of bio-purification of water.

Native vegetation should be replant for restoring disturbed habitats as wildlife shelter; temporary wildlife fencing should be installed to prevent animal injuries.

Fisheries Resources: Fishes of the intervened canals may be suffered from respiratory problems and intaking of primary producers temporarily due to re-excavation induced turbidity in the water column. This disturbance can harm fish and other aquatic life by reducing food supplies and excavating spawning beds and also through suffocation and starvation.

In this regard, re-excavation schedule be selected considering fish spawning seasons (November to March); design of the embankments should be prepared with gentle slopes and vegetation to mimic natural riverbanks, enhancing habitat complexity.

In addition, removal of silt from the canal bed through re-excavation can temporarily disrupt the habitations of demersal fish species. These habitats are expected to be reinstated over the course of three to five years. Re-excavation of canals temporarily hamper the longitudinal fish migration. However, in the long run removal of sediment from the canal may facilitate the fish migration largely. This in-turn would support the balance in species composition. Damage to sessile demersal fish, eggs, fry, larvae and juveniles during re-excavation may cause substantial loss to species composition of the intervened area, which may also affect the next progeny.

Any accidental leakage of oil, spillage of contaminants, or dumping of solid waste or debris into water can potentially affect canal habitats.

To overcome this situation, a confinement area should be built by very minute mesh size (0.5 cm) net so that small fish and juvenile do not enter into construction site; indiscriminate fishing of brood and fry fishes should be prohibited along the canal.

Improper operation of Effluent Treatment Plant (ETP) in treating the rejected water of fish processing plant of BFDC, including organic waste and chemicals, can pollute the receiving water bodies. This pollution can lead to eutrophication, habitat degradation, and harm to life of different fishes.

Repair & renovation of existing sluice gates might alter the natural flow of water, which may impede the passage or lateral migration of the low velocity (0.5m/s–0.6m/s) tolerant fishes (i.e., SIS, small carps, gobids, etc.) during operation phase. On the other hand, canal re-excavation though temporarily may hamper longitudinal migration of fishes.

Hence, engineering design for sluice gate should consider the migratory fish species, their velocity tolerances and swimming speeds. Since majorly small fishes perform lateral migration, so the velocity in a range of 0.5 m/s to 1.5 m/s should be maintained through the structures; alternative routes for fish migration during excavation activities should be ensured; fish passage through the canal by-pass while rehabilitating the sluice gates to allow fish migration and minimize barriers to fish movement should be facilitated. In addition, flow velocities and turbulence levels should be within the permissible ranges that do not hinder snail movement or cause excessive local bed scouring; enhance riparian and aquatic vegetation around sluice gates to provide refuges and stable substrates for snails.

Socio-Economic Environment: Fish theft is a recurring problem in the shrimp estate, and CSE area faces frequent incidents of fish robberies, with local perpetrators demanding monthly payments. In addition, disputed land leasing system may cause social conflict among the local people.

A Police station or camp should be implemented in the nearest area to the shrimp estate to mitigate this issue. During conducting the PCM, respective authority (SUFO) ensured that firstly, the security would be assigned officially to the Ansar. A police station will be built afterwards at the 48-acres of Shrimp Demonstration area to handle the issue.

Women working in construction may experience sexual harassment, gender-based violence, and other forms of workplace abuse.

EPC should provide necessary training on the zero tolerance of SEA/SH and other forms of GBV under the project; separate facilities should be provided for women at workstation such as: separate toilet, living places etc.; arrangement of baby care at workstation for the working women may be provided if necessary; a complaint box ought to be maintained so that women can voice their concerns and be shielded from sexual harassment and GVM.

Apart from negative impacts, the proposed sub projects may also bring some positive impacts in all contexts (socio-economic, environmental and biodiversity). Implementing and promoting sustainable shrimp farming practices can set an example for other local farmers which eventually can help preserve important fish habitat areas, contributing to overall ecosystem health. In addition, cluster farming practices in the coastal belt will reduce the risk factor of fish and shrimp farming. Efficient use of resources like water and land can serve as a model for sustainable agricultural practices. Moreover, investing in mangrove restoration can help protect coastal areas and enhance biodiversity.

On the other hand, through construction and maintenance of roads and transport facilities can benefit the entire community. In addition, better access to electricity, water, and communication infrastructure as a result of the project can improve local living conditions. Numerous jobs in farming, processing, and associated industries would be created, thereby local unemployment would be reduced. Moreover, local employees can improve their skills, increasing their employability in other sectors through various training programs to be organized by the DoF. The increased economic activity can lead to the growth of local markets and services as well. Hence, living standards of the local people would be increased. Accordingly, higher family incomes can enable better educational opportunities for their children.

Environmental and Social Management Plan

A set of Environmental and Social Management Plans (ESMPs) including budget has been prepared and mentioned in Chapter 11. In total, the budget including Environmental and Social Management Plan (ESMP), Environmental and Social Monitoring Plan (ESMoP), Institutional arrangement, Indirect project benefits, and Department of Environment (DoE) approval cost for the four sub-projects has been estimated to around BDT 186 million.

Indirect Project Benefits and Measures Proposed Beyond Compliance: The proposed project aims to deliver a myriad of indirect project benefits though; the Project might have sensitivity to environment and thus measures to go beyond regulatory requirements are introduced in the ESIA and ESMP. By fostering local economic growth, creating employment opportunities, and enhancing community welfare, the project will serve as a catalyst for regional development. Moreover, the shrimp estate is committed to advancing environmental stewardship through innovative conservation techniques, robust ecosystem management, and proactive mitigation strategies that safeguard biodiversity. These efforts underscore our dedication to not only meeting but exceeding industry standards, thereby promoting long-term ecological balance and socio-economic prosperity.

Benefits of value chain related actors like farmers, processors, suppliers, distributors and retailers each will be benefited from the industry beyond direct economic gains. Employment opportunities, skill development, improved transportation, enhanced utilities, support of local businesses and market expansion are identified as indirect economic benefits of the project. Higher living standards as social sector benefit and promotion of best practices technology in shrimp farming, resource management, mangrove reforestation as environmental sector benefits have been evaluated in this chapter. Moreover, increased touristic view will influx tourists and that will provide indirect benefits.

As a part of Corporate Social Responsibility (CSR) improved health facilities for the poor, appropriate security measures, providing public toilets at different hot spots, training program for the local youth etc. have been suggested.

The water treated by ETP may be used in the agricultural irrigation, aquaculture, industrial applications, horticulture and construction activities. Greenbelt development has been proposed in each sub-projects and these greenbelts will have significant potential of carbon sequestration.

Conclusions and Recommendation

In conclusion, by implementing the sub-projects, the Government of Bangladesh (GoB) through the Department of Fisheries (DoF) will be able to make the coastal and marine fisheries into a sustainable condition which in turn contribute to the national economy and poverty reduction. For implementing the sub-projects, the project authority would offer job opportunities for a large section of people during the life time where the local people will get priority based on their skills. Overall, it is expected that with the mitigations in place, the proposed project would be environmentally friendly. Therefore, considering all the measures and ESMPs and ESMoPs are in place and comprehending the importance of the project nationally, an ESIA approval may be obtained from the Department of Environment (DoE) before implementation of the Project.

In the end, it is recommended that the findings and suggestions of the ESIA Study should be considered and executed in Project planning, design and operation stages; all activities under construction and operation stages should be implemented according to ESMP; the contractor's environmental experts shall have to prepare Site Specific Environmental Management Plan (SEMP) to adapt with the working time and conditions; the local people (not the owner) dependent on the land and their livelihood should be considered for compensation including alternative scope of livelihood opportunity; at all levels, the stakeholders should be engaged and grievances of the local people should be addressed meticulously and timely. In case of not addressable, the communication specialist considered under the PMU should resolve it by discussing the issues with the community representatives.

Besides, to involve women into various works under fish products-based ventures including other works based on their skills and expertise, employment opportunities should be expanded for the women with equitable wages and with work station-based womanly civic facilities; encourage women entrepreneurship by developing skill in fish and fish products-based ventures and accessing to financial resources and macro finance-based credit; vocational training should be provided and necessary awareness should be built up to the women to ensure women's active participation in community-based resource management and decision-making processes.

2. General Information

2.1 Project and Project Proponent

Project Name	:	Improving Infrastructures and Production Practices under ‘Sustainable Coastal and Marine Fisheries Project (SCMFP)’: a) Rehabilitation of 10 and 11-acre Chakaria Shrimp Estate (CSE); b) Development Works for Sustainable Management of Bangladesh Fisheries Development Corporation (BFDC) Harbor in Chattogram; and c) Rehabilitation of Canals in Khulna, Bagerhat and Satkhira Districts.
Proponent's Name	:	Department of Fisheries (DoF)
Contact Address	:	Department of Fisheries, Matshya Bhaban, Ramna, Dhaka-1000, Bangladesh.
Responsible Officer	:	S. M. Moniruzzaman
Designation	:	Project Director/
Phone Number	:	+8801715384861
E-mail address	:	pdscmfpdof@fisheries.gov.bd
EIA related Inquiry	:	Monish Kumar Mondal
Designation	:	Deputy Project Director
Phone Number	:	01715346829
E-mail address	:	scmfpdpdpro@fisheries.gov.bd

2.2 EIA Consultant

Consultant's Name	:	Center for Environmental and Geographic Information Services (CEGIS)
Contact Address	:	F-14/E Agargaon Administrative Area, Sher-E-Bangla Nagar, Dhaka-1207, Bangladesh
Responsible Officer	:	Deeba Farzana Moumita
Designation	:	Project Manager/ Senior Specialist
Phone Number	:	+8801913941367
E-mail address	:	fmoumita@cegisbd.com

2.2.1 ESIA Study Team

A multidisciplinary team has been formed for conducting the Environmental and Social Impact Assessment (ESIA) Study. The team members with their expertise and signature are presented in **Table 2.1**.

Table 2.1: Team Composition for the Study

Sl. No.	Name of the Staff	Assigned Position	Area of Expertise	Signature
Key Experts				
1	Md. Sarfaraz Wahed	ESIA Expert/ Team Leader (TL)	ESIA/ Water Resource Management	
2	Mohammed Mukteruzzaman	Coastal Aquaculture Specialist	Fisheries Resources/ Biodiversity/ ESIA /Natural Resource Management	
3	Muhammad Shifuddin Mahmud	Sociologist	Sociology/ Anthropology/ Livelihood	
4	Engr. Md. Aminul Islam	Civil Engineer	Civil Engineer	
5	Abu Sayed Md. Faysal	Environmental Quality Specialist	Environmental Science/ Environmental Modelling	
6	Faisal Ahmed	Communication and Stakeholder Engagement Specialist	Sociology/ Anthropology/ Gender	
7	Bhuiya Md. Tamim Al Hossain	Climate Change Specialist	Climate Change	
Non-Key Experts				
8	Deeba Farzana Moumita	DIA Specialist and Project Leader	Disaster Management/ ESIA/ Risk and Hazard Modelling	
9	Premanondo Debnath	RS and GIS Analyst	Remote Sensing/ GIS/ Drone Survey	
10	Sanjib Sarker Shawon	Assistant Engineer (Water Resources)	Water Resources Management/ Civil Engineer	
11	Md. Arshad	Research Assistant	Field Survey/ Data Processing	
12	Md. Eusuf Sarker	Research Assistant	Field Survey/ Data Processing/ Environmental Quality	
13	Md. Rayhan Hossain	Research Assistant	Field Survey/ Data Processing	
14	Sharmin Akhter	Research Assistant	Field Survey/ Data Processing	

Additional team members are also involved for completing the tasks of the Study and their names and positions are presented in **Table 2.2**.

Table 2.2: Team Composition for Additional Members of the Study

Sl. No.	Name of the Staff	Assigned Position
1	Md. Amanat Ullah	Ecologist and Green Belt Planner
2	Md. Wahiduzzaman Kallol	ESMP Specialist
3	Sharif Tanver Ahammad	Limnologist
4	Md. Mutasim Billah	Occupational Health and Safety Specialist
5	Rafiqul Islam	Chemist
6	Abdul Halim Farhad Sikder	Agriculture Specialist
7	Gazi Md. Riasat Amin	Hydrologist and Modeler
8	Md. Atikul Islam	Jr. Fisheries Specialist
9	Md. Billal Hossain Majumder	GIS Specialist
10	Md. Tazbiul Islam	Jr. Ecologist
11	Md. Masuk Rahman	Jr. Biodiversity Specialist
12	A B M Mostain Billah	Field Officer and Stakeholder Engagement Specialist
13	Shah Imran Ahsan Chowdhury	Land use Mapping and Drone Survey Specialist
14	Dewan Mohammad Ariful Islam	Jr. Geologist

3. Legislative Framework, Guidelines, and Standards

3.1 Introduction

The Government of Bangladesh (GoB) has the statutory requirements in terms of regulations, rules, policies, and directives to safeguard the environment from the development activities. This chapter has addressed the statutory requirements, which are triggered due to implementation of the Project and their applicability to restrain the ambient environmental and social conditions of each sub-project from the predicted adverse impacts. In addition, this chapter has mentioned the lender's requirements for the project as per their own set of guidelines, standards, and requirements to maintain the integrity of the environment of the intervened area.

3.2 Environmental Policy and Regulatory Framework

The proposed Project has four (04) sub-projects, having separate considerations on potential risks and impacts individually. Considering the sub-project activities and according to the ECR 2023, the project as a whole fall under 'RED Category Project', hence, requires conducting ESIA Study for obtaining necessary approvals, such as Site Clearance Certificate (SCC) before implementation and Environmental Clearance Certificate (ECC) before operation of the Project. Considering the sub-project activities at various stages of the sub-project implementation, followings are the relevant national and international policies and legislative frameworks those are triggered by these sub-projects:

Sector-wise Relevant Bangladesh Legislations/ Policies/ Act/Rules/ Regulations	
<i>Environmental Conservation and Climate Change Issues</i>	<i>Water Resources</i>
- Environmental Conservation Rules (ECR) 2023 - National Environment Policy 2018 - National Climate Change Strategy and Action Plan 2009 - The Environment Court Act, 2000 - National Environment Management Action Plan, 1995 - The Bangladesh Environmental Conservation Act of 1995 (BECA, 1995) and Amendments	- Bangladesh Water Rules 2018 - The Bangladesh Water Act 2013 - National Coastal Zone Management Policy 2005 - The National Water Policy (1999) - National Policy for Safe Water Supply & Sanitation 1998 - The Embankment and Drainage Act 1958 (East Bengal Act No. I of 1953)
<i>Environmental Quality</i>	<i>Waste Management</i>
- Air Pollution (Control) Rules, 2022 - Noise Pollution (Control) Rules 2006	- National 3R Strategy for Waste Management, 2015 - Bangladesh Standards and Guidelines for Sludge Management (BSGSM) 2015 - Solid Waste Management
<i>Land and Agricultural Resources</i>	<i>Biodiversity and Ecological Resources</i>
- Salt Policy, 2022 - The Acquisition and Requisition of Immovable Property Act, 2017 - National Land Use Policy, 2001 - Chringri/ Shrimp-Mahal Management Policy, 1998 - Salt Mahal Management Policy, 1992	- National Biodiversity Strategy and Action Plan for Bangladesh 2021 - Biodiversity Act 2017 - Wildlife (Protection and Safety) Act 2012 - The Forest Act, 1927 and Amendment Act 2000 - The National Forest Policy (1994) - Territorial Waters and Maritime Zones Act 1974 - Bangladesh Private Forest Act, 1956
<i>Safety Rules</i>	<i>Energy Sector</i>
- Fire prevention Act, 2003 - The Fire Services Ordinance 1959	- Electricity Rules, 2020 - Electricity Grid code-2019

Sector-wise Relevant Bangladesh Legislations/ Policies/ Act/Rules/ Regulations	
• The Dangerous Cargoes Act, 1953 • The Explosives Act, 1884	• National Energy Policy 1995
<i>Fisheries Resources</i>	<i>Relevant Other National Rules, Laws, and Legislations</i>
• Marine Fisheries Act 2020 • Shrimp Policy 2014 • Hatchery Act 2010 • Fish Feed and Animal Feed Act 2010 • The Protection and Conservation of Fish Rules, 1985; Amended Rule 8(1A), 2000 • National Fisheries Policy, 1998 • Fish and Fish Products (Inspection and Quality Control) Rules 1997 • Shrimp Cultivation Tax Act 1992 • East Bengal Protection and Conservation of Fish Act, 1985 • Marine Fisheries Ordinance 1983 • Fish and Fish Products (Inspection and Quality Control), Ordinance, 1983 • Private Fisheries Protection Act, 1889 • Electricity Rules, 2020 • Electricity Grid code-2019 • National Energy Policy 1995	• Industrial Policy, 2022 • Standing Orders on Disaster, 2010 • Bangladesh Labor Law (2006) • Export policy, 1997-2002 • The Motor Vehicle Ordinance, 1983 • Building Construction (Amendment) Act, 1952 • The Employment of Children Act, 1938 • Ports Act, 1908 • The Fatal Accidents Act, 1855
Applicable World Bank Policies	Ratified International Conventions
• OP/BP 4.01: Environmental Assessment • OP/BP 4.04: Natural Habitats • OP 4.09: Pest Management • OP 4.10: Indigenous Peoples • OP 4.11: Physical Cultural Resources (PCR) • OP/BP 4.12: Involuntary Resettlement • OP/BP 4.36: Forests • OP/BP/GP 7.50: Projects in International Waterways • OP 7.60: Projects in Disputed Areas • WB Policy 2010: The World Bank Policy on Access to Information • Performance Standard (PS) - 4: Community Health, Safety, and Security.	• Strategic Action Plan for Bay of Bengal 2012, endorsement; 2016 signed by MoFL/ MoEF of GoB • Nagoya Protocol 2010 • Mangrove for Future (MFF) 2007 • Cartagena Protocol on Biosafety to the Convention on Biological Diversity, 2003 • Convention on Biological Diversity (CBD) 1992 (Rio De Janeiro) • The Law of the Sea Convention, 1982 • Protocol Waterfowl Habitat 1982 • C155 - Occupational Safety and Health Convention, 1981 • Bonn 1979 (Germany) • C148 - Working Environment (Air Pollution, Noise and Vibration) Convention, 1977 • Prevention and Control of Occupation Hazards 1974 • The Convention on International Trade in Endangered Species (CITES) of Wild Fauna and Flora Convention/ Washington Convention 1973 • Ramsar Convention 1971 • International Convention on the Protection of Birds 1950

The compliance requirement and their corresponding applicability of the above mentioned international and national rules/policy/act/guidelines/framework etc. have been detailed out in **Annex E**.

4. Project Design and Description

4.1 Project Background

The Government of Bangladesh (GoB) with the International Development Association (IDA) of the World Bank Group have taken a two-phased investment Project through the Department of Fisheries (DoF), naming as ‘Sustainable Coastal and Marine Fisheries Project (SCMFP)’ to sustainably increase the contribution of coastal and marine fisheries and aquaculture to the national economy, poverty reduction and access of the fishing communities to alternative livelihood activities in an environment-friendly manner. The Department of Fisheries (DoF) will execute the Project based on the findings of the design, specifications and layout, and also the findings of this Environmental and Social Impact Assessment (ESIA) Report under the guidance of the Ministry of Fisheries and Livestock (MoFL).

The first phase of the SCMFP is a five (05) years’ period Project which possesses four (04) broad components: (i) enabling sustainable fisheries sector investments and growth; (ii) improving infrastructures and production practices; (iii) community empowerment and livelihoods transformation; and (iv) project management and monitoring. Component no. (ii) is designed to address four (04) Sub-Projects, such as (a) Rehabilitation of 10- and 11-acre Chakaria Shrimp Estate (CSE), (b) Development Works for Sustainable Management of Bangladesh Fisheries Development Corporation (BFDC) Harbor in Chattogram, (c) Implementation of a Brood Management Center (BMC) at DFTC, Teknaf, and (d) Rehabilitation of Canals in Khulna, Bagerhat and Satkhira Districts.

The underlying idea of implementing the Project interventions is to follow the environmental approach as a part of the due diligence. The proposed sub-projects have diversified activities/ interventions in different areas having different conditions and sensitivities. These interventions have separately been included under different categories as per the Environmental Conservation Rules (ECR) 2023. At this outset, DoF has entered into an Agreement with the Center for Environmental and Geographic Information Services (CEGIS) on 25 September 2023 for conducting the consultancy services of “EIA/ SIA for Government Shrimp Estate Chakaria, Cox’s Bazar, BFDC, BMC and Canals”.

Under this Agreement, CEGIS has already conducted the Environmental and Social (ES) Screening Study to sort out the items of each sub-project which would be considered for a detailed ESIA Study. While conducting the ES Screening, the environmentally and socially sensitive elements were checked against the proposed interventions considered under the sub-projects to assess the impacts. According to the study findings, the re-excavation of more than 5 km of internal canals under the CSE, and the management of re-excavated material fall under RED category; while the rest of the interventions (**Ref to the Section 4.10: Sub-Project Activities**) fall under ORANGE category as per ECR 2023. This indicates that the entire sub-project is considered as a RED category project. On the other hand, according to the World Bank Group (WBG) Guidelines, the proposed interventions under CSE fall under ‘Category B’. Henceforth, this sub-project needs a detailed Environmental and Social Impact Assessment (ESIA) study to assess the potential risks and impacts for the sub-project-wise proposed interventions and vice versa; with corresponding suggestions of mitigation/ enhancement measures and recommendation of Environmental and Social Management and Monitoring Plan with budget for obtaining necessary approval from respective authorities before implementing them individually for each Sub-Project.

Similarly, for the other sub-projects, e.g; excavation of ponds and construction of civil structures under sub-project (b); re-excavation of canals and management of excavated materials under sub-project (d) fall under RED category; and construction of Effluent Treatment Plant (ETP), Water Treatment Plant (WTP), implementation of substation and distribution line etc. under sub-project (c) fall under

ORANGE Category as per ECR 2023. While, all the interventions under the aforementioned three sub-projects, fall under 'Category B' as per WBG Guidelines and needs to conduct ESIA Study.

This Report focuses on the ESIA Study for each of the sub-projects emphasizing on the proposed interventions, especially those which are under RED Category as per ECR 2023. The Report would be prepared by following the ECR 2023 and World Bank's Operation Policy (OP)/Bank Procedure (BP) along with World Bank Group guidelines and standards including International Finance Corporation (IFC) General Environmental Health and Safety guidelines and standards.

4.2 Needs of the Project

Bangladesh lies within the world's largest densely populated delta, the Ganges-Brahmaputra-Meghna, which is one of the richest aquatic resources. With a view to strengthen and maximize the potentiality of the marine and coastal fisheries sector of the country in an environmentally and socially acceptable way, the sustainable coastal and marine fisheries project could offer an important pathway that will enable it to contribute in the sustainable economic development and poverty reduction of the country.

In order to implement the activities of the sub-projects, as mentioned above, in an integrated fashion, ensuring environmental and social sustainability, certain infrastructural development works as well as livelihood interventions in the target communities have been taken up by the Proponent. The major interventions include, rehabilitation of canals, renovation and construction of buildings and demolition of abandoned structures, establishment of fish processing plant, installation of power sub-station etc. The details of interventions of each sub-project are mentioned in **Section 4.5**.

4.2.1 Project Rationale

The fisheries sector contributes significantly to the national economy of Bangladesh in terms of food supply and food security, employment generation and foreign currency earning. Fish provides around 60 percent of animal protein consumed in Bangladesh. The contribution of coastal and marine fisheries to the total production of the country is quite substantial (nearly 28%). Besides bringing these national benefits, the coastal and marine fisheries of Bangladesh, as a part of global fisheries, bears global significances by virtue of its food value, biodiversity and natural balance. The government recognizes the potential of coastal and marine fisheries and plans to introduce by any means a more intensive, organized and sustainable management with the inclusion of coastal inhabitants who are involved in fisheries. Several key sectoral challenges necessitate government interventions and investments to enable responsible public-private sector interactive growth. These include 1) formulation of an effective regulatory framework for managing coastal and marine fisheries; 2) establishment and strengthening of public and private sector infrastructures for enabling private sector investments; and 3) finding ways and means in both public and private sectors to capacitate improved fisheries management and sustainable production. The SCMFP is aimed at satisfying those requirements through adequate support and institutional capacity building.

4.2.2 Project Objectives

The overarching objective of the SCMFP is to explore greater opportunity from coastal and marine fisheries resources, while promote sustainable management of fisheries stocks and environment to reduce poverty and improve livelihoods of the coastal community.

For the fulfillment of this objective, the SCMFP has been divided into four components in the first phase in which the second component focuses on Improving Infrastructure and Production Practices (**Ref. to Section 4.1**). The second component is further divided into the following sub-components: (i) Infrastructure improvements for coastal belt capture and culture fisheries, (ii) value chain and food safety, and (iii) boosting coastal aquaculture productivity. The sub-components are comprehended to materialize the following specific objectives:

- To develop infrastructure and enhance production facilities for coastal belt fisheries (capture and culture).
- To up-scale cluster farming for shrimp to disseminate best lessons learned from cluster farming approaches
- To strengthen community led fisheries management and transform livelihoods in poor fishing communities by facilitating to recover fish stocks and reducing dependence on coastal fishing.

Achieving these objectives lead to an intermediate objective of improving quality to ensure food safety and higher value capture from export-oriented fishery and mariculture.

For achieving the objective, the development works considered under the four sub-projects are mentioned in the **Section 4.10**.

4.2.3 Project Benefits

CSE: The proposed interventions would assist in proper management of the 10 and 11- acres of the shrimp ponds as mentioned in **Section 4.5.1**, through rehabilitating the hydraulic structures and the internal canals; a well-designed peripheral dyke might be used as road and would eventually enhance the communication system within the shrimp estate; afforestation program would create the associate environment of the CSE rich in biodiversity. On the other hand, implementing a fish landing center within the study area, would facilitate export facilities and contribute to the national economy.

BFDC: The provision of WTP and ETP would prevent the generated waste water from the fish processing unit, and mix with the nearby surface water sources; the water from newly implemented two deep tube wells would be used for commercial purpose; establishing new substations with capacities of 750kVA and 1600 kVA, and underground distribution line would fulfill the future demand of BFDC.

BMC: By establishing a BMC at DFTC, Teknaf, DoF would produce a good quality of SPF which would eventually promote the improve quality to ensure food safety and higher value capture from export-oriented fishery and mariculture.

Canals under Khulna, Bagerhat, and Satkhira Districts: The proposed interventions under this sub-project are to re-habilitate the selected eighteen canals under Satkhira, Khulna, and Bagerhat Districts (Ref. to **Table 4.1: List of Canals to be Rehabilitated for Scaling up Cluster Farming** under **Section 4.5.4**) through which water management would be smooth for the cluster farming practices which would lead an optimum output. Drainage system of those areas would be upgraded so that water might not overtop both the banks of the canals during heavy rainfall. In addition, local people would be able to use the dyke as roadway to transport crops, vegetables and fisheries including shrimps to the designated places if the excavated soil is dumped and compacted on it (dyke).

The SCMFP as a whole would explore the greater opportunity through promoting sustainable management of coastal and marine fisheries resources and would reduce poverty and improve livelihood of the coastal community.

4.3 Study Objectives

The objective of the study is to assess the impact of the proposed interventions to be implemented under Component- 2 and its sub- components on the coastal and marine environment addressing the major social and ecological issues and provide suggestive management measures to adopt in the detailed project planning. This includes preparation of IEE and ESIA studies including preparation of ESMP for the proposed activities including any Resettlement Action Plan (RAP) or Small Ethnic Community Development Plan (SECDP).

However, **Ref. to the Section 4.1**, the four sub-Projects combinedly need to conduct ESIA study directly as per ECR 2023. Hence, no IEE study has not been conducted for the Project. Therefore, to meet the environmental regulation of Bangladesh for obtaining Environmental Clearance Certificate (ECC) from the Department of Environment (DoE) and to align with the World Bank's Operation Policy (OP)/Bank Procedure (BP), for obtaining necessary approval from the lender (WBG) for the proposed interventions under each sub-project as per site conditions on turnkey basis. The specific objectives are:

- To delineate the baseline scenario for each sub-project;
- To assess the environmental and socio-economic impacts with necessary evaluation;
- To prescribe relevant mitigation and enhancement measures;
- To assess potential impacts for climate change and natural & man-made hazards, and to recommend the possible mitigation/ adaptive measures;
- To analyze the occupational hazards and risks and to suggest probable measures; and
- To formulate Environmental Management Plan and Environmental Monitoring Plan with respective budgets.
- A detailed field survey will be conducted and identify the number of existing households are there within any of the sub-project site; if so, RAP study would be conducted and report would be prepared;
- Based on the primary and secondary data, small ethnic community would be identified (if any) within the sub-project sites, site specific Small Ethnic Community Development Plan (SECDP) would be prepared.

4.4 Limitations

CSE: The major limitation for this study is its accessibility. There is no road connectivity inside the CSE, hence, one should have to take speed boat or other mechanized boats to reach the designated place in the estate. Moreover, in field planning, tidal conditions need to be considered. On the other hand, during field visit the study team observed some land entitlement issues at the 48-acres of demonstration area. Another risk recorded in the Estate was robbery. Hence, during data collection, it was felt unsafe. and uncongenial.

BFDC: No considerable limitation was observed for this sub-project.

BMC: There was a limited access to Teknaf area due to military ambush and launching of airstrikes by Myanmar Samorik Junta to retaliate the Arakan Army's airstrikes along Bangladesh border during the study period. However, the study team visited the project site including some parts of the study area as well and collected necessary data and environmental samples from pre-selected locations from the field. Rest of the information under the study area has been incorporated in the Report based on the literature review and secondary information.

Canals under Khulna, Bagerhat, and Satkhira Districts: Some of the canals enrolled under this project were not in good shape in terms of their physical existence, remoteness of locations, mixed reaction of local people, etc. With such limitations, the study under this sub-project has been completed with the valuable and effective support of local DoF officials.

4.5 Description of the Sub-Projects

There are four (04) sub-projects under this Project interventions. The overviews under these sub-projects are given as follows:

4.5.1 Rehabilitation of 10- and 11-acre Chakaria Shrimp Estate, Chakaria, Cox's Bazar

Current Status:

- Within the last 30-year lease period, natural calamities occurred and largely damaged the infrastructures, such as: peripheral dykes, plot dykes, and water entry and discharge gates.
- The plots and connecting canals have been silted up as there was no silt cleaning activities for long span of time.
- The law-and-order situation is poor due to inaccessibility and very low coverage of electricity.
- Land connectivity is poor for the transportation of materials used in shrimp farms (Post Larvae (PL), feed etc.) and produced shrimp to the landing sites, while waterway is the only means of transport.
- There is no irrigation facility during the dry season due to lack of electricity. In this context, lessees are more interested in salt farming instead of shrimp farming.
- There is no or a very limited police outpost in the shrimp plot area to control anarchy and fish stealing.
- Encroachment of government property is underway for which legal action has been undertaken.
- In the Regional Fisheries Office (RFO) at Cox's Bazar, there is a provision of a total of 70 staff, including 50 in the RFO and 20 in the Project Management Office (PMO). Currently, there is only 15 staff in the RFO and 8 in the PMO, which is causing a hindrance to the management of CSE.

4.5.2 BFDC Harbor at Chattogram

The Bangladesh Fisheries Development Corporation (BFDC) is located just beside the Chattogram Fishing Port, on the left bank of the Karnaphuli River. The BFDC area accommodates a Fish Processing Plant, Dockyard, Marine Fisheries Academy, Auction Site and Cold Storage, two (02) jetties on the Karnaphuli River, two (02) Electrical Sub-stations with the capacity of 750kVA (old) and 1600kVA (new) and four (04) deep tubewells (Two existing and two proposed) through which around 1,060 MT of water could be withdrawn daily. **Figure 4.1** shows the locations of the components under BFDC Campus based on which the activities would be undertaken.

Electrical GIS Substation and Distribution Line

There would be one three phase 1600 kVA transformer with necessary circuit breakers, isolators, capacitor bank, insulators, current transformers, control panels etc. of rated capacity in a Gas Insulated Switchgear (GIS) system. Because of the GIS system, less space would be required, hence, land acquisition will not require. Generally, 1600kVA GIS substation requires a minimum of around 0.5 acres of land. However, this would be installed within the premise of BFDC where existing substation is placed. For this case, a 1600 kVA transformer would be installed only to increase the capacity of the load. Hence, no additional land would be required.

The Distribution lines would be underground type (**Figure 4.1**). According to the location, the underground distribution lines would be within the premises of BFDC and no settlement areas would be disturbed. However, while laying the distribution lines other utility service lines should be checked. The specification for Electrical Substation and distribution line is given in the **Annex 5** under the **Volume II: Annexures of Main Report**.

Modern Fish Processing Plant

Currently, there is a provision of developing a Modern Fish Processing Plant within the BFDC Campus. The capacity of this Plant would be 500 MT. The fish landing center is currently located on the opposite side of the fish processing plant on the right bank of the Karnaphuli River.

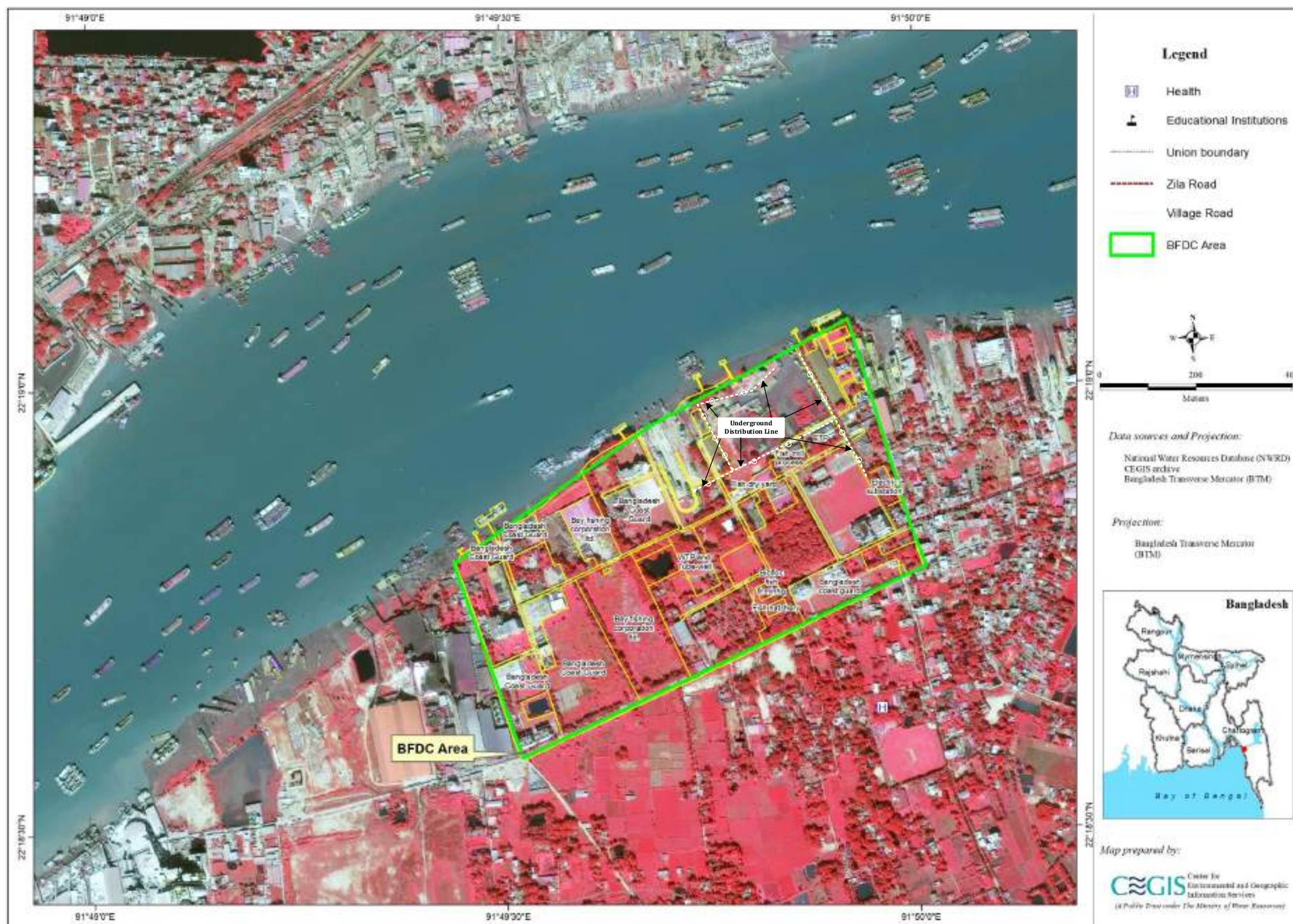


Figure 4.1: The Location of the Components based on which Activities of BFDC has been Considered

An Effluent Treatment Plant (ETP) would be constructed as shown in the **Figure 4.1** for the treatment of the effluent that might be generated from the Fish Processing Plant. After proper treatment, the water would be released to the nearby Karnaphuli River.

Specification of the Modern Fish Processing Plant has been given in the **Annex 6** under the **Volume II: Annexures of Main Report**.

Water Treatment Plant, and Deep Tube Well

In the Water Treatment Plant, ground water is withdrawn by the existing deep tubewells and would be withdrawn by the proposed deep tube wells which would be treated in a reverse osmosis plant the treated water would then be provided to BFDC for potable and other purpose like Fish washing at the Fish Processing Plant, cleaning, and supplying fresh drinking and potable water to the Ships as commercial basis.

Two deep tube wells would be installed having the distance of 20-25 m between each other (as shown in the **Figure 4.1**) and would be at least 1500ft deep for withdrawing the fresh water.

Necessary specifications are given in the **Annex 7**, and **Annex 8** under the **Volume II: Annexures of Main Report**.

Fork Lifter

A Five (05) Ton fork lifter with the capacity of 5000 kg at the safe working load at the 500 mm at the load center. In such case, the load capacity of side shifter would be 4500 kg, and a Two (02) Ton with the capacity of 1500 kg at the safe working load at the 500 mm at the load center would be implemented under this sub-project. The length and width of the fork face would be about 2800 mm and 2000 mm respectively for both capacity of fork lifter. The detailed specification is given in the **Annex 9** under the **Volume II: Annexures of Main Report**.

Fire Fighting Arrangement

A complete firefighting system would be installed within the BFDC Campus. The detailed specification of supply & installation of the Complete fire pump and distribution line with all related accessories are given in the **Annex 10** under the **Volume II: Annexures of Main Report**.

4.5.3 Brood Management Center

DoF has proposed two alternative sites for the Brood Management Center (BMC); one is the 48- acre Demonstration Ponds at CSE and the another is at Demonstration Farm and Training Center (DFTC), Teknaf. Based on the Alternative analysis result (Ref. to **Section 4.24**), the DFTC, Teknaf would be the suitable location for implementation of BMC.

It is located on the right bank of the Naf River. The site is suitable for implementing the BMC as the required saline water for the PLs could be easily collected from the canals connected with the Naf River. However, according to the field observation, this location is under the Department of Forest. Hence, before, implementing BMC, land acquisition would be required. This may be done between the DoF and the Forest Department. The site is easily accessible by roadways as well as riverways.

The area is dominant with terrestrial vegetation and different timber plants. Herbs are distributed scattered on the project site. Though little cormorant is observed in the area, urban birds are randomly seen in the area. No notable wildlife is present at the project site. However, the sub-project was initially planned but later dropped due to legal issues related to the land.

4.5.4 Canal Rehabilitation for Cluster Farming

The selected canals are planned to be rehabilitated for supporting the cluster shrimp farms, and general information of these canals are given in **Table 4.1**. A detailed description including observation on these canals are attached in **Annex 11** under the **Volume II: Annexures of Main Report**. In addition, repairing or constructing of hydraulic structures might be implemented at the mouth of those canals which are connected to the large rivers. Most of these canals have already been silted up and the average depth is about 1.25m to 2m. According to the design details of these canals, the depth of canal re-excavation will be confirmed.

Table 4.1: List of Canals to be Rehabilitated for Scaling Up Cluster Farming

Sl. No.	Name of Canal	Upazila	District	Length (km)	Width (m)	Area (ha)	Estimation Excavated Soil Volume (Cum)
1	Mora Jopjopia Nodi	Botiaghata	Khulna	3	50	15	1,51,532.42
2	Dohar Khal	Digholia		2.5	103	25.75	36,595.00
3	Nagkati Khal			2	14	2.80	57,232.64
4	Rajapur Khal			2.5	13	3.25	-
5	Bollobi Khal	Rupsha		4	12	4.80	-
6	Atshotobigha Khal (Starting from Tepukhali Cyclone Center to Daiburir Gher)	Debhata	Satkhira	2.5	10	2.50	2,11,942.29
7	Magra Khal	Kolaroa		1.85	6.5	1.2	63,383.25
8	Dhaskhathi Khal Shishutala	Tala		6	50	30	3,23,371.53
9	Mahandi Khal			1.5	70	1.20	1,57,263.65
10	Madhobkhali Khal (From Shalta River to Masranga Mauza/ Doani Khal)			3	25	7.5	23,375.06
11	Kalmeghar Khal (Kallanpur Sluice gate to shoaliya Bridge)	Shaymnagar		1.7	12	2.04	1,23,084.60
12	Andigram khal	Mollahat	Bagerhat	5	10	5	47,895.60
13	Gajdurer Khal	Chitalmari		1.8	7.2	1.3	28,117.00
14	Char Dakatia Goger Khal			1.2	5.79	0.69	36,597.50
15	Burir Khal			4	22.86	9.14	93,064.27
16	Kumbkhali Khal	Rampal		1	7.5	0.75	44,867.80
17	Jibon Khalir khal	Kachua		3.5	15	5.25	1,84,295.62
18	Shoilodubir Khal			3	16	4.8	10,9841.01
Total				50.05	449.85	122.97	14,47,099.18

Source: Design Consultant through Department of Fisheries (DoF)

4.6 Sub-Project Size

4.6.1 Land Area and Tenancy

Chakaria Shrimp Estate

The total size of CSE area is about 7000 acres, which is mainly used for shrimp farming and salt cultivation. The shrimp plots are divided into 588 plots, in which 468 plots comprise of 5000 acres are of 10- acre size while 119 plots comprise of 2000 acres are of 11-acre size. The plot details are given in the following **Table 4.2**.

Table 4.2: Details of 10- Acre and 11-Acre Plots of CSE

Sl. No.	Features	Unit	Measured Value	Measured Value
			10- Acre Plot	11- Acre Plot
01	Total Land Size	Acre	5,000	2,000
02	Shrimp Plots	No.	468	119
03	Plot Tenants/Lessees	No.	375	119
04	Peripheral Dyke/Bheri Bandh	km	58.3	15.53
05	Sluice Gate	No.	20	07
06	Length of Canal	km	55.36	15.53
07	Water Supply Canal	km	30.05	35
08	Total Canal	km	85.41	35

The land tenancy status of CSE is characterized by a lease system under the custodianship of DoF (**Ref. to Annex 39: Land Ownership Document (Land Lease Document)** under the **Volume II: Annexures of Main Report**). The tenure of the current lease is for 20 years which will be ended in 2032. The historical lease information is given as follows:

- 1st Phase Lease – for a period of 10 years (1986-1996)
- 2nd Phase Lease – for a period of 15 years (1997-2011)
- 3rd Phase Lease – for a period of 20 years (2013-2032)

BFDC

The BFDC campus is located under the landmass of about 141 acres in which around 43 acres of land is currently used for various purposes of the BFDC. Rest of the lands are been leased for commercial purposes to various government and non-government bodies including to public for their use. The leased land might be taken by BFDC based on their requirement as per the Agreement.

BMC

The BMC area is located under the DFTC area in Teknaf Sadar under Cox's Bazar District. The proposed BMC site is under the landmass area of about 52 acres (around 21 ha) on the right bank of the Naf River.

Canal Rehabilitation for Cluster Farming

According to the information as mentioned in the **Table 4.1** under **Section 4.5.4**, the selected canals are to be re-excavated for managing the purpose of cluster shrimp farming. The excavated soil would be managed by compartmentalization techniques on the dyke of the canals. In this regard, existing dyke vegetation which is small in number would be cleared. A detailed description would be given in

the ecological baseline environment. A green belt plan has been provided in the **Section 11.6** under **Chapter 11**.

4.6.2 Land Readiness

Under the three (03) out of four (04) sub-projects, the interventions would be implemented within the premise of the bounded campus of DoF or given as lease to DoF from the Government. Hence, no additional land would be required for implementing the sub-Projects.

However, for implementing the BMC near the DFTC at Teknaf, the selected land is currently owned by the Department of Forest. This land may be taken from the Department of Forest, as lease through inter departmental Agreement of the Government bodies.

4.7 Sub-Project Location

4.7.1 Administrative Location

Chakaria Shrimp Estate

Administratively, the CSE is located at Badarkhali, Chiringga, Pashchim Bara Bheola, and Saharbil Unions under Chakaria Upazila of Cox's Bazar District.

BFDC

Administratively, Bangladesh Fisheries Development Corporation (BFDC) is located at Char Patharghata Union under Karnaphuli Upazila of Chattogram District.

BMC

The Brood Management Center would be implemented at the DFTC Campus of the Department of Fisheries. Administratively, this area is located at Teknaf Pourashabha, Ward No. 1 under Teknaf Sadar Upazila, Cox's Bazar District.

Canal Rehabilitation for Cluster Farming

Eighteen canals under the three (03) coastal districts are to be rehabilitated under this sub-project intervention. The administrative units are given in the following **Table 4.3**.

Table 4.3: Administrative Locations of the Canals under Three Coastal Districts

Sl. No.	Name of Canal	Union	Upazila	District
1	Mora Jopjopia Nodi	Gangarampur, Surkhali	Botiaghata	Khulna
2	Dohar Khal	Dighalia, Senhati	Digholia	
3	Nagkati Khal	Dighalia		
4	Rajapur Khal	Rangpur, Jugipole		
5	Bollobi Khal	T. S. Bahirdia, Lakhpur	Rupsha	
6	Atshotobigha Khal (Starting from Tepukhali Cyclone Center to Daiburir Gher)	Noapara	Debhata	Satkhira
7	Kalmeghar Khal (Kallanpur Sluice gate to shoaliya Bridge)	Shaymnagar	Shaymnagar	
8	Magra Khal	Balli, Kolaroa	Satkhira Sadar, Kolaroa	
9	Mahandi Khal	Khalil Nagar	Tala	

Sl. No.	Name of Canal	Union	Upazila	District
10	Dhaskhathi Khal Shishutala	Khalil Nagar		
11	Madhobkhali Khal (From Shalta River to Masranga Mauza/ Doani Khal)	Khalil Nagar		
12	Andigram khal	Gangni	Mollahat	Bagerhat
13	Gajdurer Khal	Char Baniari	Chitalmari	
14	Dakatia Khal	Char Baniari		
15	Burir Khal	Hizla, Kalatala		
16	Kumbkhali Khal	Rampal	Rampal	
17	Jibon Khalir khal	Raripara	Kachua	
18	Shoilodubir Khal	Raripara		

4.7.2 Geographical Location

Chakaria Shrimp Estate

The geographical location of this area is under the coordinates of 21°44'35.43"N, 92° 2'13.37"E; 21°44'13.88"N, 92° 2'30.32"E; 21°39'46.19"N, 92° 1'14.93"E; 21°39'24.58"N, 91°59'10.03"E; 21°40'37.51"N, 91°57'50.58"E; 21°42'41.05"N, 91°58'17.37"E; and 21°44'25.50"N, 92° 0'13.81"E. A Map of CSE in Satellite Image has been given in **Figure 4.2**.

BFDC

The geographical location of BFDC campus is under the coordinates of 22°19'8.48"N, 91°50'19.57"E; 22°19'1.16"N, 91°50'14.37"E; 22°18'37.85"N, 91°49'20.62"E; 22°18'51.27"N, 91°49'15.89"E; and 22°19'7.31"N, 91°49'43.72"E. However, the intervention area layout is supposed to be provided by BFDC in December 2023. The Study Area Map is shown in the **Figure 4.3**.

BMC

Geographically, BMC area is located under the coordinates of 20°53'4.95"N, 92°18'3.08"E; 20°53'4.12"N, 92°17'59.98"E; 20°52'52.70"N, 92°18'1.62"E; 20°52'52.04"N, 92°18'0.89"E; 20°52'49.14"N, 92°18'0.90"E; 20°52'48.56"N, 92°17'58.01"E; 20°52'34.60"N, 92°17'58.19"E; 20°52'35.34"N, 92°18'6.13"E; 20°52'36.82"N, 92°18'6.10"E; and 20°52'38.95"N, 92°18'11.44"E. The Satellite Image view of the BMC Area is shown in the **Figure 4.4**.

Canal Rehabilitation for Cluster Farming

The geographical locations of the canals are given in the following **Table 4.4**. District-wise Maps of the selected eighteen (18) canals are given in the **Figure A11.1**, **Figure A11.3**, and **Figure A11.5** in **Annex 11** under the **Volume II: Annexures of Main Report**.

Table 4.4: Geographical Locations of the Canals under Three Coastal Districts

Sl. No.	Name of Canal	Coordinates	Offtake	Outfall	District
1	Mora Jopjopia Nodi	22°42'17.70"N, 89°28'3.75"E; 22°41'45.75"N, 89°28'34.53"E; and 22°40'48.50"N, 89°28'32.32"E	Kazibachha River	Lower Salta River	Khulna
2	Dohar Khal	22°53'21.68"N, 89°33'34.81"E; and 22°53'3.66"N, 89°34'8.51"E	Atai River	Flood plain	
3	Nagkati Khal	22°52'34.22"N, 89°32'10.81"E; 22°52'32.26"N, 89°31'54.05"E; 22°52'20.97"N, 89°31'58.80"E; and 22°52'13.62"N, 89°31'53.44"E	Bhairab River	Flood plain	
4	Rajapur Khal	22°54'5.65"N, 89°28'57.04"E; 22°54'4.82"N, 89°28'32.39"E; and 22°53'18.42"N, 89°28'43.95"E	Asifut Khal	Flood plain	
5	Bollobi Khal	22°46'43.48"N, 89°39'10.91"E; 22°45'13.78"N, 89°39'11.17"E; and 22°45'6.04"N, 89°38'47.14"E	Attharobaki River	Old Passur River	
6	Atshotobigha Khal (Starting from Tepukhali Cyclone Center to Daiburir Gher)	22°33'26.06"N, 89° 2'36.55"E; and 22°32'58.45"N, 89° 1'28.57"E	Shapmara-Habra (Khutikkhali)	Flood plain	Satkhira
7	Magra Khal	22°49'58.69"N, 89° 4'32.46"E; and 22°48'59.20"N, 89° 4'27.22"E	Betna River	Flood plain	
8	Dhaskhathi Khal Shishutala	22°45'4.93"N, 89°18'41.89"E; 22°44'4.70"N, 89°17'44.56"E; 22°44'13.14"N, 89°18'26.87"E; and 22°44'38.98"N, 89°18'45.75"E	Paschim Salta River	Flood plain	
9	Mahandi Khal	22°45'2.96"N, 89°18'32.46"E; and 22°45'3.37"N, 89°17'59.00"E	Dhaskhathi Khal Shishutala	Flood plain	
10	Madhobkhali Khal (From Shalta River to Masranga Mauza/ Doani Khal)	22°44'12.18"N, 89°18'36.87"E; and 22°43'26.09"N, 89°18'2.59"E	Paschim Salta River	Flood plain	
11	Kalmeghar Khal (Kallanpur Sluice gate to shoaliya Bridge)	22°19'35.82"N, 89° 4'25.19"E; and 22°19'4.47"N, 89° 4'5.41"E	Madar Gang River	Madar Gang River, and Flood plain	Bagerhat
12	Andigram khal	22°53'40.39"N, 89°43'29.61"E; and 22°52'22.60"N, 89°44'3.06"E	Atharbanki River	Flood plain	

Sl. No.	Name of Canal	Coordinates	Offtake	Outfall	District
13	Gajdurer Khal	22°46'58.91"N, 89°54'14.14"E; and 22°46'46.83"N, 89°53'42.65"E	Char Dakatia Goger Khal	Flood plain	
14	Char Dakatia Goger Khal	22°47'24.20"N, 89°54'44.10"E; and 22°47'9.19"N, 89°54'3.00"E	Mora Chitra River	Gajdurer Khal	
15	Burir Khal	22°49'19.12"N, 89°54'59.72"E; and 22°49'16.18"N, 89°53'35.39"E	Mora Chitra River	Flood plain	
16	Kumbkhali Khal	22°35'14.93"N, 89°38'31.69"E; and 22°35'15.35"N, 89°37'59.84"E	Bogura River	Bogura River	
17	Jibon Khalir khal	22°36'48.65"N, 89°52'22.49"E; and 22°36'18.01"N, 89°51'42.15"E	Pangucchi River	Shoilodubir Khal	
18	Shoilodubir Khal	22°36'37.18"N, 89°51'55.38"E; 22°36'46.49"N, 89°51'2.59"E; and 22°36'40.26"N, 89°50'57.69"E; 22°36'20.81"N, 89°51'12.57"E; and 22°36'22.08"N, 89°51'29.03"E	Jibon Khalir khal	Flood Plain	

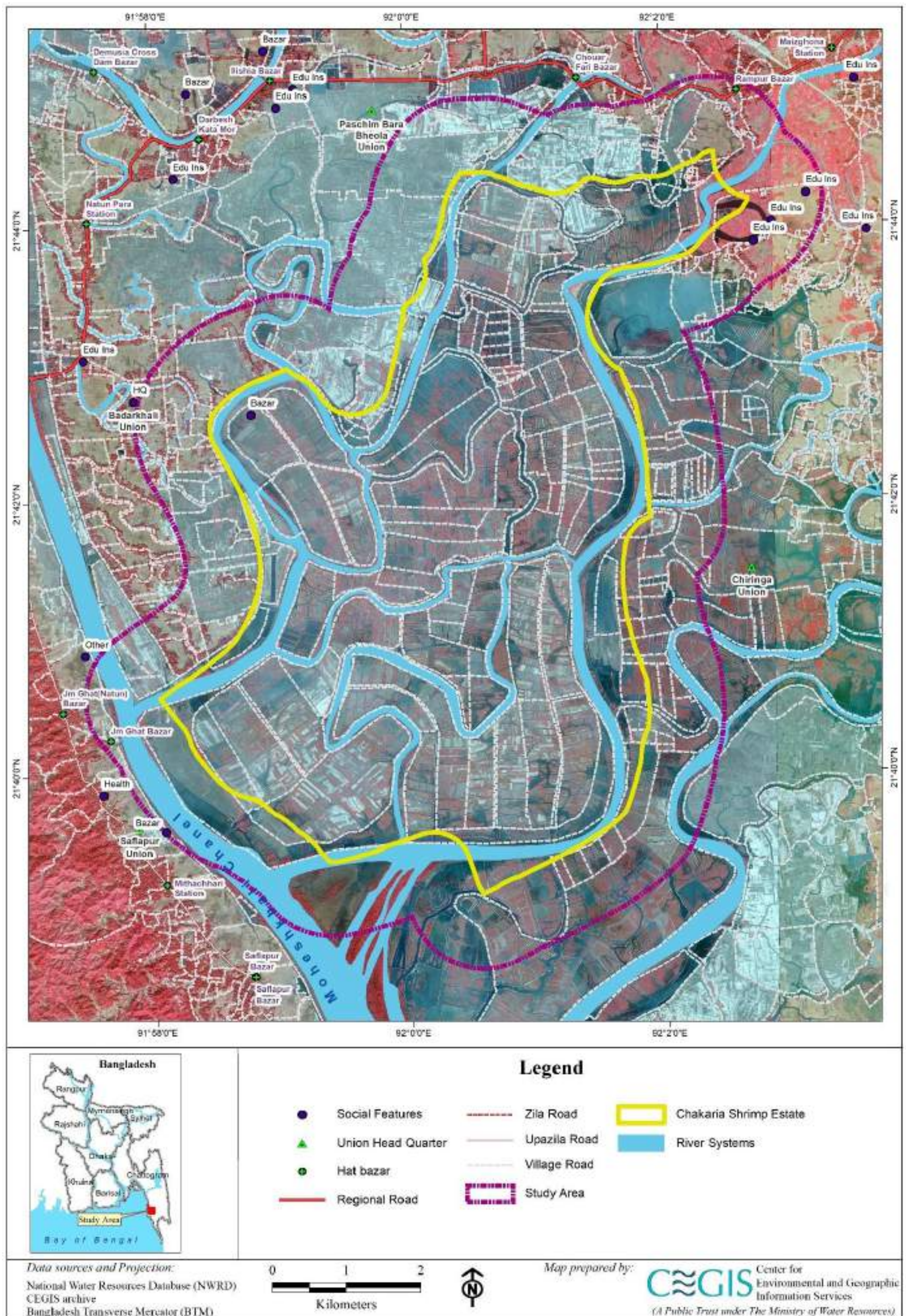


Figure 4.2: Map of CSE on Satellite Image

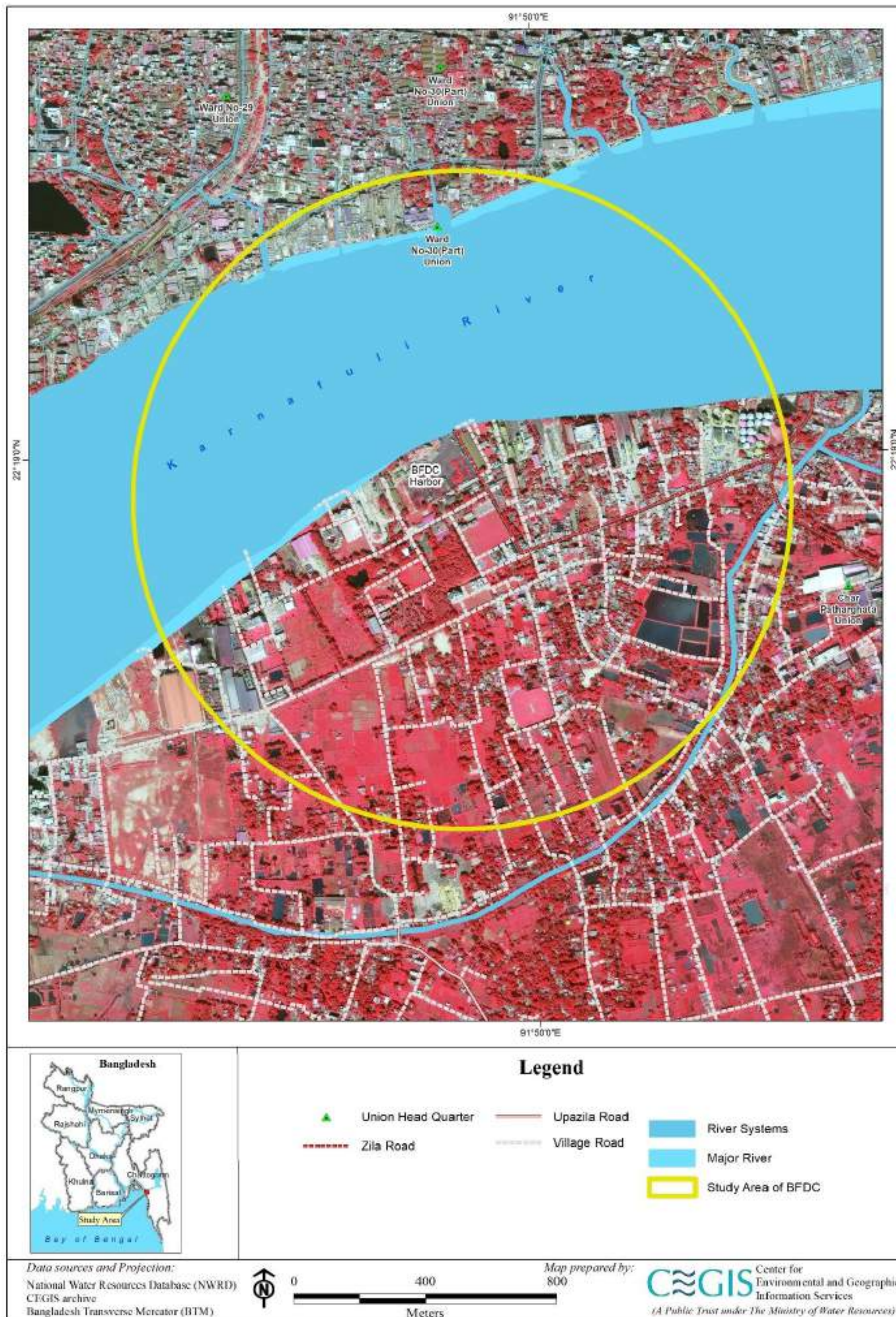


Figure 4.3: Map of BFDC Study Area on Satellite Image



Figure 4.4: Map of BFDC Study Area on Satellite Image

4.8 Site Accessibility

Chakaria Shrimp Estate

CSE is a remote area which connected the mainland usually with the internal canals which are also connected with Bura Matamuhuri River, Matamuhuri River, and the Maheshkhali Channel. These canals are used for feeding water to the shrimp farms and the local settlers use them for their communication using mechanized boat except some country boats. Chakaria is also accessible by roadway. However, waterway is preferable using speed boat or trawler (mechanized boat) to reach the shrimp farming area in 45-50 minutes from the Cox's Bazar Coast Guard Ghat. As the canals have tidal effect hence, one should consider the time of high tide and low tide to visit the shrimp farm areas. The Accessibility Map of CSE is shown in the **Figure 4.5**.

BFDC

The BFDC area is accessible through road and waterways from anywhere of the country. The Karnaphuli River is located on the North and the West side, the Boalkhali Canal is on the East and the Murari Khal is on the East and the Southside of the BFDC site. The Shahbazpur Channel and the Bay of Bengal are on the West side of the BFDC area. As the BFDC area is close to the Chattogram Port, ship, fishing boats, trawlers, speed boats and country boats anchor at this location. Large ships anchor near the jetty area so that necessary accessories can be transported to the destination and collect potable water, food and other things to the ships from this port. Large fishing boats also come to this port for loading processed fish and fishery products from the fish processing plant and export abroad. The Accessibility Map of BFDC sub-project is shown in the **Figure 4.6**.

BMC

The BMC area is also accessible through road and waterways from anywhere of the country. Accessibility Map of BMC area is shown in the **Figure 4.7**.

Canal Rehabilitation for Cluster Farming

The offtake or outfall of most of the canals under Khulna, Bagerhat, and Satkhira Districts are the nearby floodplain, hence, accessible mostly through waterways. To have access in these canals by road is very difficult by road. The district-wise connectivity Maps of these canals are given in the **Figure 4.8**, **Figure 4.9**, and **Figure 4.10**.

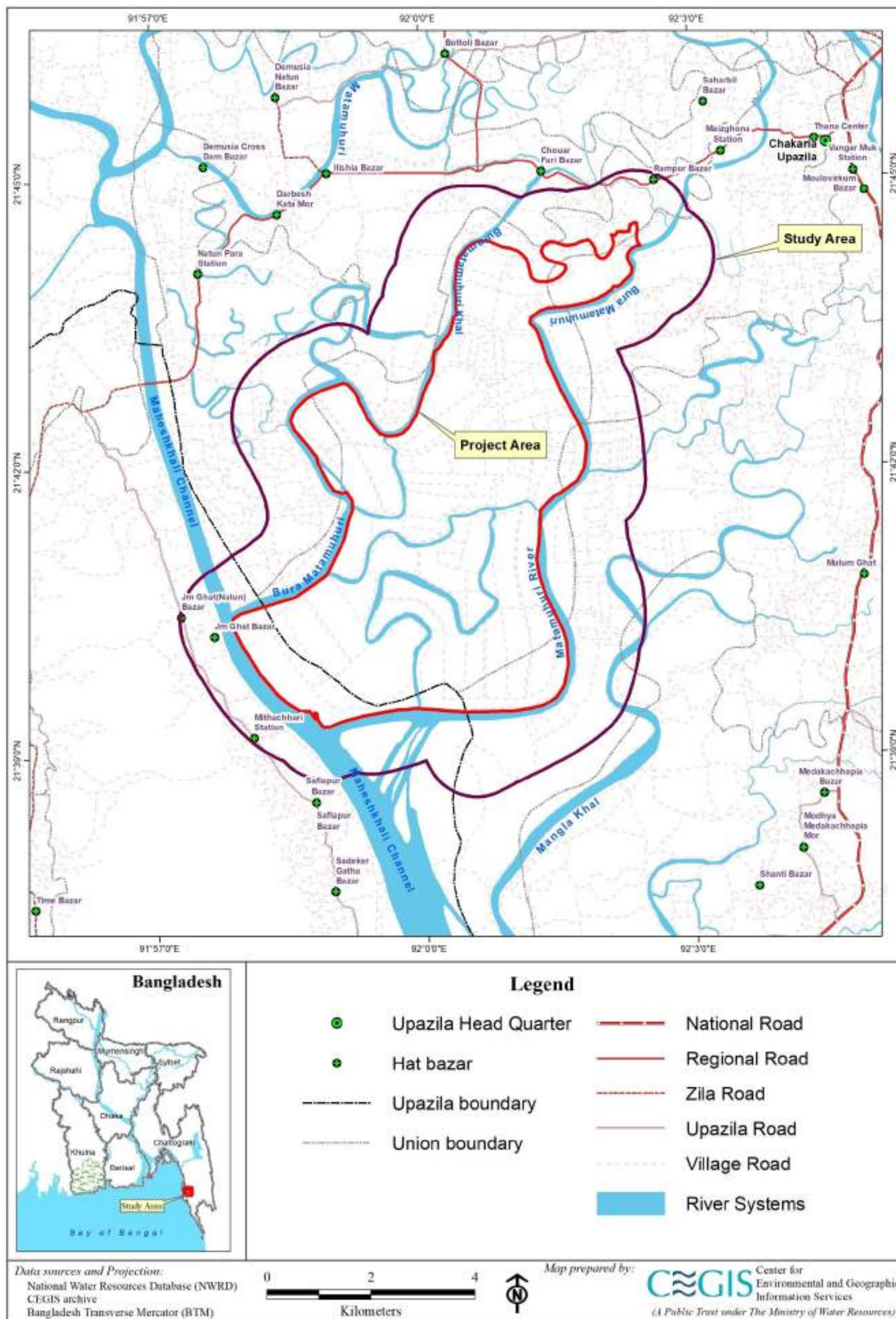


Figure 4.5: Accessibility Map of CSE

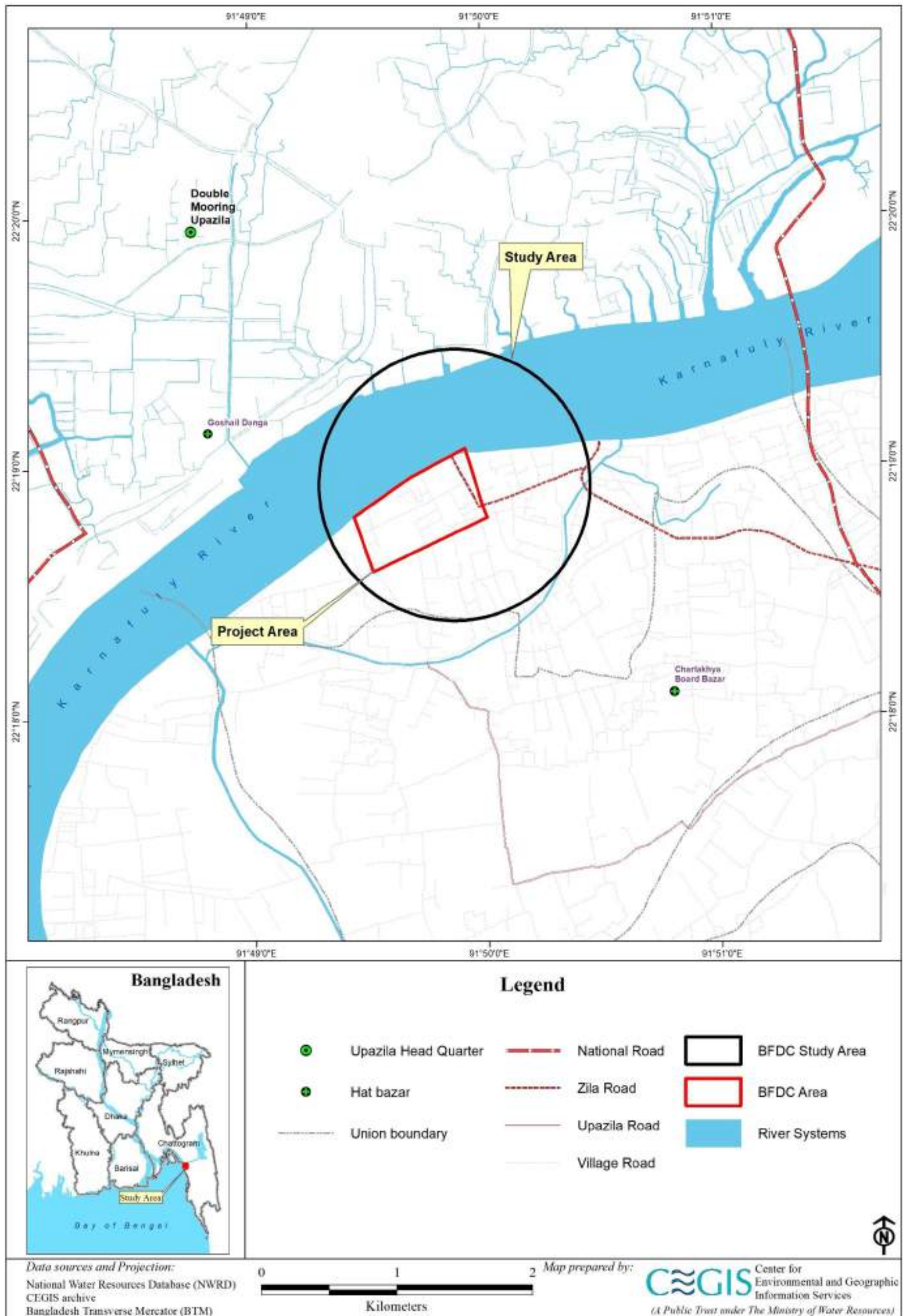


Figure 4.6: Accessibility Map of BFDC

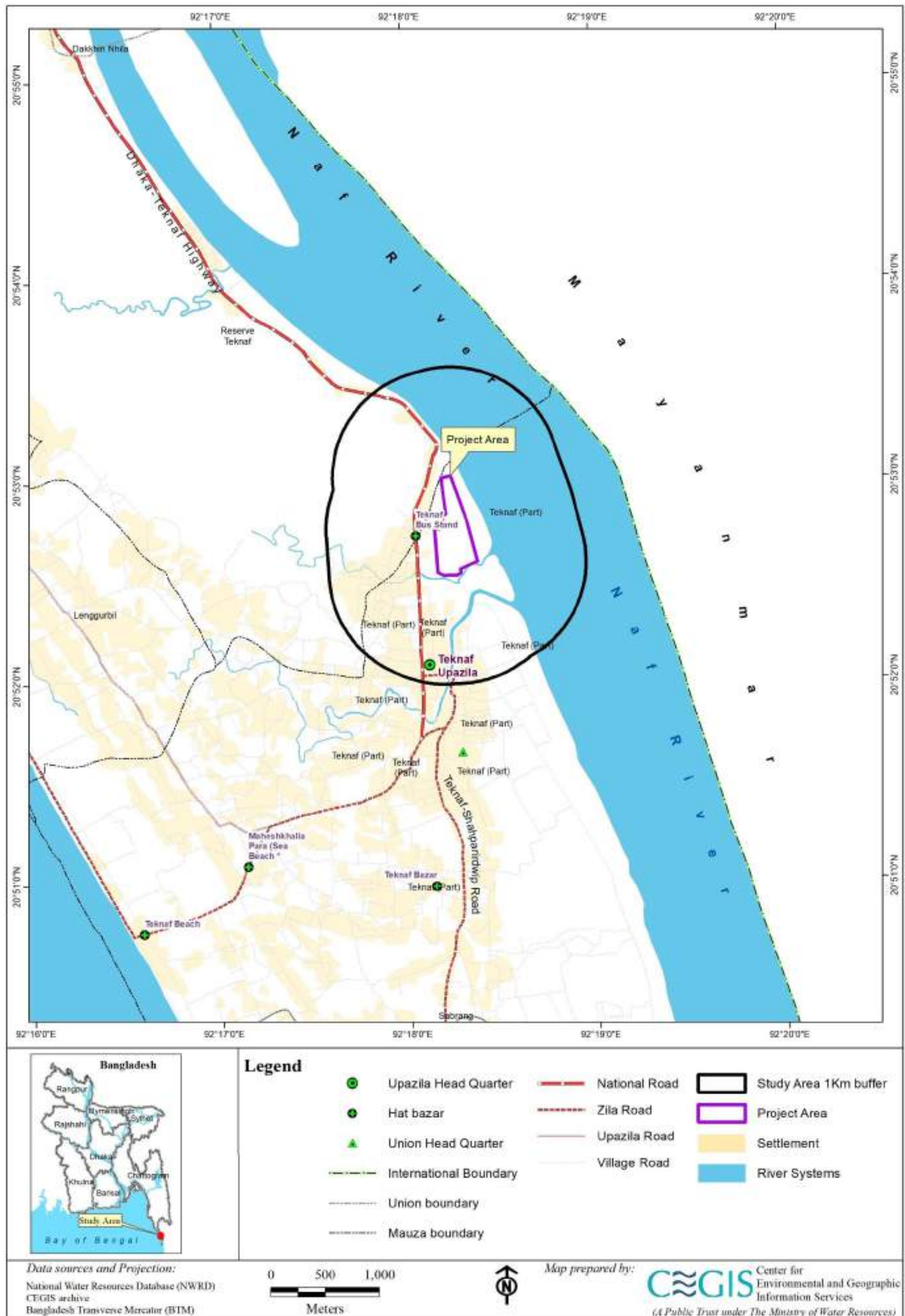


Figure 4.7: Accessibility Map of BMC

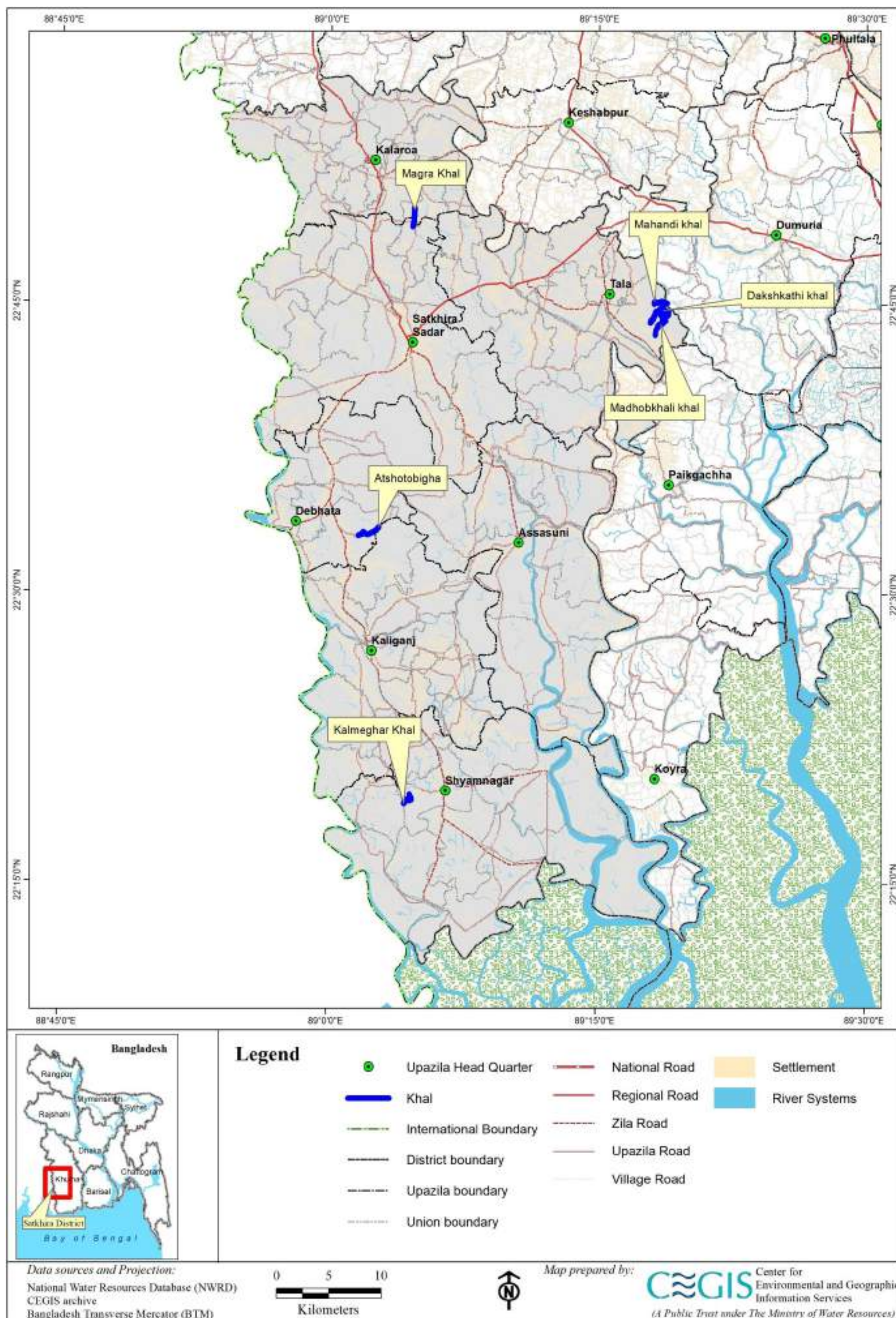


Figure 4.8: Accessibility Map of the Canals under Satkhira District

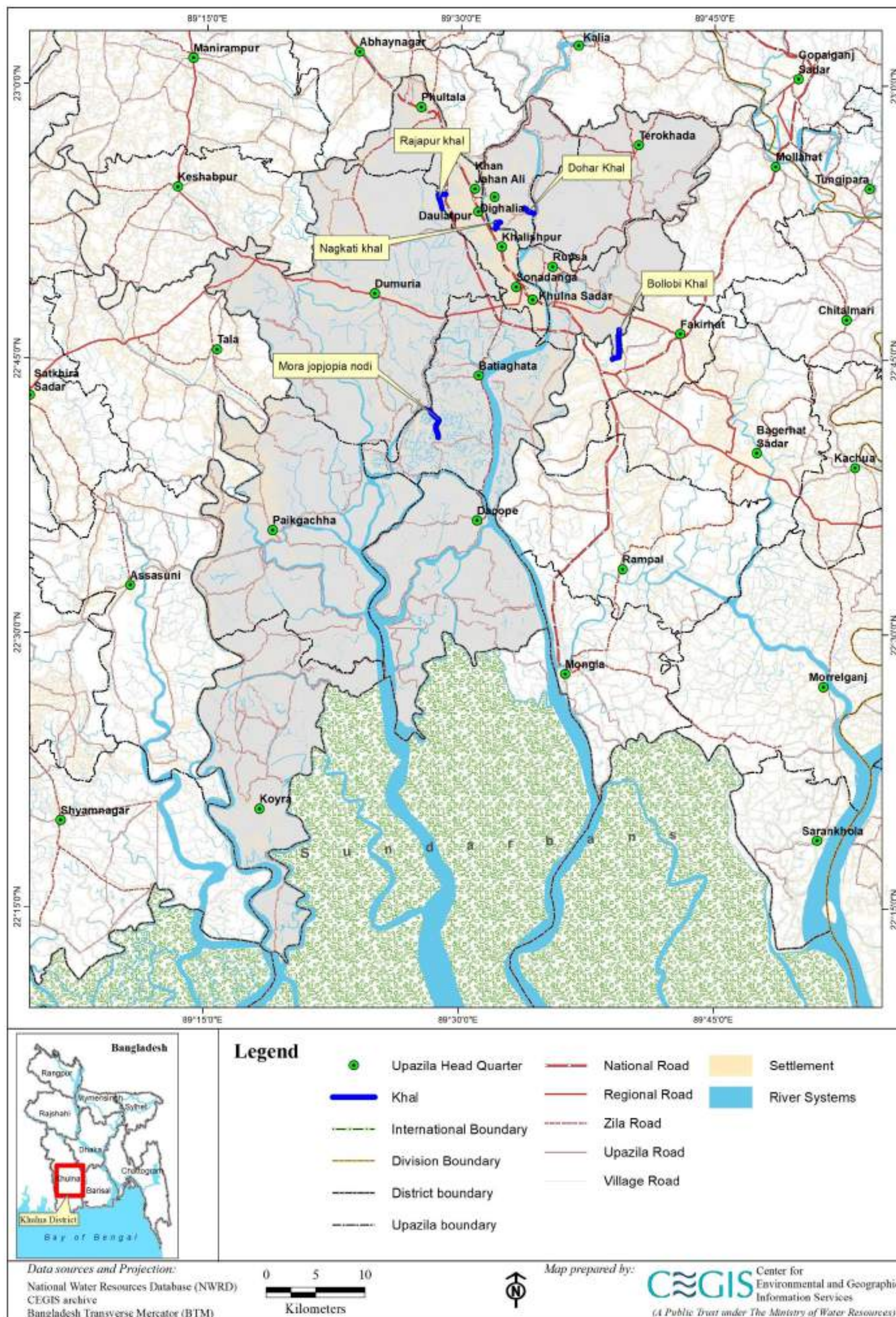


Figure 4.9: Accessibility Map of the Canals under Khulna District

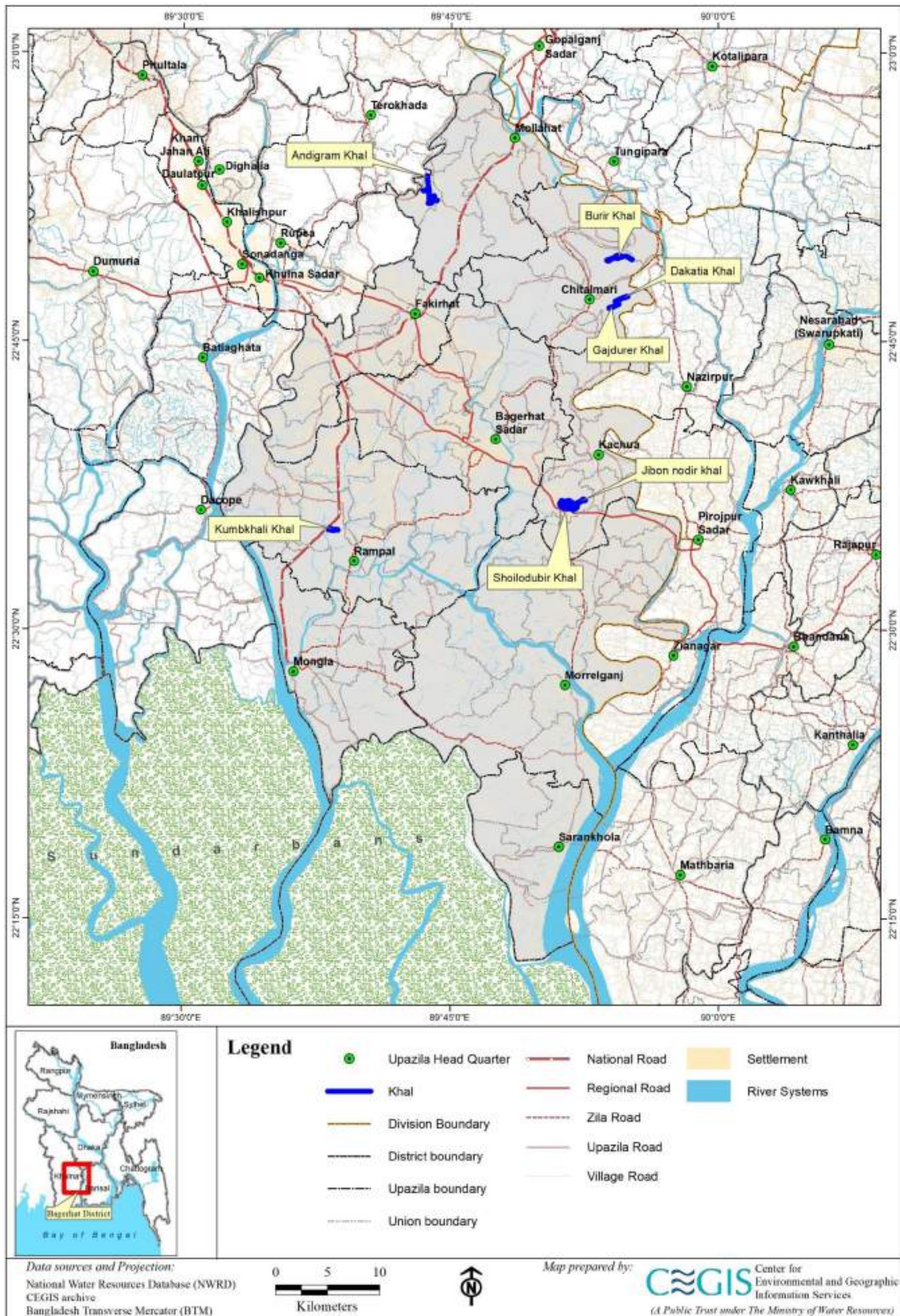


Figure 4.10: Accessibility Map of the Canals under Bagerhat District

4.9 Site Design and Layout

Within the CSE the internal canals would be re-excavated, hydraulic structures would be constructed in the internal canals, afforestation would be implemented on the peripheral dyke. The site design and layout has been shown in the **Annex 14** under the **Volume II: Annexures of Main Report**. The afforestation plan and design obtained from the engineering team given in **Annex 35** under the **Volume II: Annexures of Main Report** has been reviewed and checked the compatibility with the context. The Consultant observed that it needs some changes in afforestation plan and design layout and hence a 'Reconciliation of Afforestation Plan' has been recommended and provided in **Section 4.9.1** below.

The interventions would be implemented as per the layout in the BFDC Campus is shown in **Annex 14** under the **Volume II: Annexures of Main Report** as received from BFDC.

The layout plan for BMC and Canal Rehabilitation for Cluster Farming Sub-projects would be provided once the design consultant provides them through DoF.

4.9.1 Reconciliation of CSE Afforestation Plan and Design

Reviewing the afforestation plan and design, the Consultant has found following issues:

- Plantation on the top of the dyke might not be considered;
- Considering the soil texture, the sand fill level may be considered around 75mm instead of 300mm for bed preparation before constructing Herring-Bone-Bond (HBB) Road on the dyke;
- Fencing with barbed wire may be replaced closed to the top (2m from the edge of the road) instead of the location as shown in the drawing;
- The slope of dyke at river side should be maintained as 1:2 instead of 1:3;
- The slope of the dyke at the internal canal side should be maintained as 1:1.5 instead of 1:2.

Based on these observations, the Consultant has recommended reconciliation in afforestation plan and design and layout as given in the **Annex 36** of the **Volume II: Annexures of Main Report**.

4.10 Sub-Project Activities

The Sub-Project activities have been divided into three (03) separate stages considering the potential impacts which would be identified. The activities might be changed depending on the sub-projects and implementation strategies of the Project. The three stages are named as: Pre-construction, Construction and Operation stages. Stage-wise activities of each component are given below:

4.10.1 Pre-Construction Stage

- Review of relevant literatures and project documents (i.e., feasibility study and other relevant technical documents);
- Desk based secondary data collection and analysis;
- Review and finalize the design and drawings of the structures (from Feasibility Study);
- Examining of the documents regarding land acquisition/requisition/purchase;
- Review and study all relevant and applicable national and international laws, regulations, rules, policies, framework etc.;
- Procuring of the raw materials and associated items to the construction site; and
- Contractor(s) engagement and man power loading.

4.10.2 Construction Stage

Sub- Project 1A: Rehabilitation of 10, and 11-acre shrimp estate including associated canals Chakaria, Cox's Bazar

- Construction of temporary labor shed and sanitation facilities;
- Reconstruction of Embankment/ Peripheral Dyke;
- Rehabilitation of water supply and drainage canals;
- Repair & renovation of existing sluice gate;
- Construction of Guard Shed with sanitary and electrical facilities;
- Installation of on grid solar panels on embankment (peripheral dyke);
- Renovation of Fish Landing Center;
- Construction of herring bone road on embankment;
- Barbed wire fencing with Reinforced Cement Concrete (RCC) pillars

Sub- Project 1B: Rehabilitation of 48-acre Shrimp Demonstration Area, Rampur, Chakaria, Cox's Bazar

- Land development, levelling and land preparation;
- Construction of temporary labor shed and sanitation facilities;
- Repair and renovation or reconstruction of peripheral dyke with mechanical compaction and turfing;
- Rehabilitation of water supply canals, and re-excavation of drainage canal;
- Repair and renovation or reconstruction of existing sluice gate;
- Construction of 2 storied (with free ground floor) office building, guard shed cum store house including associated facilities;
- Construction of Police Fari;
- Construction of deep tube well and watch tower;
- Re-excavation of 4 nursery and 13 grow out ponds, pond inlet- outlet system aerator;
- Construction of herring bone road including soling, end-edging, road alignment from Rampur Bazar Chakaria;
- Barbed wire fencing with RCC pillars.

Sub- Project 2: Establishment of SPF-Black Tiger Shrimp (BTS) Brood Management Center (BMC) at DFTC, Teknaf

- Establishment of shrimp hatchery.

Sub- Project 3: Development works for sustainable management of BFDC harbour at Chattogram

- Electrical Sub-station with distribution line & accessories (2 MW/ 1600 KVA) including alternative back up supply Generator;
- Installation of deep tube well (2 nos.);
- Renovation of auction center cum training center;
- Construction of pre-processing zone with ICE Plant and chilled storage facilities
- Construction of modern processing factory 500 MT capacity with 4-6 chambers including storage and associate other facilities;
- Installation of complete Fire Fighting System of Fish Harbor;

- Construction of ETP; and
- Construction of Water Treatment Plant (WTP).

Sub- Project 4: Other Activities

- Desilting and rehabilitation of existing canals of cluster shrimp farms at different locations of Khulna, Bagerhat, and Satkhira; and
- Repairing and construction (as per suggestion of the Feasibility and ESIA Team) of hydraulic structures on the selected Canals.

4.10.3 Post-Construction/ Operation Stage

- Stage-wise plantation on the embankment/ peripheral dyke;
- Environmental and social monitoring including implementation of the ESMP; and
- Proper maintenance of the sub-projects.

4.11 Benchmarks Around the Sub-Projects

Chakaria Shrimp Estate

CSE is covered with the Shrimp Farming, and salt cultivation areas. There is no settlement on the Project Site. The Maheshkhali Channel is located on the South-Western side, the Bara Matamuhuri River on the Western side and the Matamuhuri River on the Eastern side of the CSE Project area. There is a landing center at the Badarkhali Union around 2 km on the west from the estate. Another landing center is the Choarfari Bazar, located at the Palakata Union with an aerial distance of about 1.3 km on the North of the estate.

BFDC

BFDC is close to the Chattogram Port, but there are two jetties at the BFDC premise on the left bank of the Karnaphuli River. The city area is on the other side of the river. The Korean Export Processing Zone is situated at an aerial distance of about 8.5 km on the South at Anwara; and the Karnaphuli Export Processing Zone at a distance of about 6.5 km on the South-West at Patenga from the BFDC Campus. Shah Amanat Bridge is on the East side of the BFDC at an aerial distance of about 3 km.

BMC

The BMC area is located on the right bank of the Naf River within the DFTC Campus of DoF and about 900m West from the Myanmar boarder on the Naf River. The township area is located on the South and South-West side, and the Teknaf Hill Forest is located on the North from the DFTC Campus.

Canal Rehabilitation for Cluster Farming

The important benchmarks for all the selected canals under the Satkhira, Khulna, and Bagerhat Districts are the Sundarbans and the Bay of Bengal. As these districts are located under coastal region, salinity intrusion and cyclone events are very prominent here. The nearest distance between closest canal (Kalmegher Khal) under Satkhira District and the Sundarbans is around 12 km. Similarly, distance between the Sundarbans and closest canal under Khulna District (Mora Jopjopia Nodi), and under Bagerhat District (Kumbkhali Khal) are around 19 km, and 15 km respectively. All the distances are the aerial distances.

4.12 Study Area

The Study area of each sub-project has been delineated considering the extent of the exposure that might be impacted due to the sub-project interventions or have some other connections in respect to shrimp clustering, landing sites. Following **Table 4.5** shows the extent of the study area with justifications.

Table 4.5: Study Area based on the Sub-Projects

Sl. No.	Sub-Projects	Study Area	Justification
1.	Rehabilitation of 10, and 11-acre Shrimp Estate Chakaria, Cox's Bazar	1.0 km buffer area from all sides of the CSE boundary except the Choarfari Landing Center for which the study area boundary extended up to 1.3 km only.	The CSE is surrounded by the rivers and canals with the highest width of about 350 m having the nearest settlements within the range of aerial distances of about 180m-250m, inhabitants of these settlements are largely depending on the CSE for carrying their livelihood in different means. On the other hand, the nearest landing center (Choarfari Bazar) is around 1.3 km aerial distance from the CSE. Considering the above aspects, the study area has been delineated as mentioned at the left side column.
2.	Development works for sustainable management of BFDC harbor at Chattogram	1 km radial area from the center of the substation area	Considering the activities under this sub-project, the potential hazard and risk might be generated from the sub-station area and the underground distribution lines. Hence, the study area has been considered as 1 km radial area from the substation site.
3.	SPF-Black Tiger Shrimp (BTS) Brood Management Center (BMC) at DFTC, Teknaf	1 km buffer area from the BMC Site boundary	SPF- BTS is very sensitive in respect to various meteorological conditions and human activities. Considering these aspects, the study area for the BMC has been delineated as 1 km buffer from the BMC Site boundary.
4.	Desilting and re-habilitation of existing canals of cluster shrimp farms at different locations of Khulna, Bagerhat and Satkhira Districts	Catchment area would be considered for respective canals under the mentioned Districts	It is assumed that the concern canal feeds to and drains water from the shrimp farms; and may also be used for irrigation purpose under the Khulna, Bagerhat, and Satkhira Districts. The water of each canal may be used within the catchment of respective canals. Hence, to assess the potential risks and impacts of the proposed intervention, the catchment area would be considered for the fisheries and social perspective.

4.13 Sub-Project Extension Potential

According to DoF, currently there is no provision of extension potential for any sub-projects. However, CEGIS has consulted with the local officials of DoF, BFDC, local government authority, and local people for their suggestion and recommendation for respective sub-projects.

Considering the consultation output and based on CEGIS expert judgment the following extension potential for the sub-projects may be considered.

4.13.1 Chakaria Shrimp Estate

Being located in the coastal region the internal canals within the CSE have tidal effects. This may cause siltation in the canals within a short period. Hence, it is recommended to monitor the siltation rate in the internal canals and take necessary actions for the canals i.e. rehabilitation of canals through re-excavation.

4.13.2 BFDC Harbor at Chattogram

With the concept of “Sustainable Coastal and Marine Fisheries Project”, to make it more effective, a sustainable maintenance of basin dredging at Chattogram Fish Port, BFDC may be required. In this regard, a letter has been issued to the DoF on 21 March 2024 (*Letter No: 33.03.1561.002.3.397.23*) which is attached in the **Annex 12** under the **Volume II: Annexures of Main Report**.

On the other hand, according to the XEN, BFDC; it would be very useful if the capacity of the Plant is increased up to 2000 MT so that fish landing, fish loading and unloading, selling, and storing could be placed at the disposal of BFDC and would eventually be considered as commercial activities of BFDC.

4.13.3 Brood Management Center

Currently there is no provision for project extension potential under this sub-project.

4.13.4 Canal Rehabilitation for Cluster Farming

Like CSE, all the canals are located in the coastal region, hence, these canals have tidal effects so siltation may occur within short period. Hence, it is recommended to monitor the siltation rate in the internal canals and take necessary actions for the canals such as: rehabilitation of canals through re-excavation.

According to local people, excavated soil may be dumped on the both dykes of the canals through compaction so that they can be used the dyke as rural road. This would also be helpful for monitoring the cluster farming as well as for transporting fish, shrimp, crops etc.

4.14 Sub-Project Implementation Schedule

Tentative dates for Sub-Project Implementation are given as follows:

Sl. No.	Sub-Project Name	Implementation Start Date	Completion Date
1.	Chakaria Shrimp Estate	End of May, 2024	By June, 2025
2.	BFDC Harbor at Chattogram	Mid of July, 2024	By June, 2025
3.	BMC at DFTC, Teknaf	End of May, 2024	By June, 2025
4.	Canal Rehabilitation for Cluster Farming	From June, 2024	By June, 2025

4.15 Technology Selection and Process Description

4.15.1 Chakaria Shrimp Estate

Considering the activities as mentioned in **Section 4.10**, the major task would be the rehabilitation of internal canals and renovation of hydraulic structures within the sub-Project site. These activities would be carried out considering the following process and technology:

Canal Excavation

For Main Canals: Dredging would be done and dredged soil would be dumped into the peripheral dyke so that waterflow would not be hampered.

For Internal Canals:

- Compartmentalization of the intervened canals by 500 m.
- A temporary bundh will be established and dewatering would be done if water is present (especially during wet period). This would take one day.
- Excavation of the canals would be done after establishing temporary bundh and dewatering work to the 500m segment. This would take one day.
- Water flow might be hampered for those two days.

Sluice Gate implementation

A diversion of the intervened canal would be constructed to divert waterflow to avoid disruption and allow water exchange in the connected shrimp farms during the construction period.

4.15.2 BFDC Harbor at Chattogram

Substation and Ancillaries

Physical Features

The proposed substation type is Gas Insulated Substation (GIS). The detailed specifications of the components under this sub-project are given in **Volume II: Annexures of Main Report** as shown in the annexes from **Annex 5** to **Annex 10**. The GIS system is narrated below:

Gas Insulated Substation (GIS): In GIS system, all the live components are enclosed in a grounded metal enclosure, then the whole system is housed in a chamber full of gas. Gas insulated sub-stations (GIS) primarily use sulphur hexafluoride (SF₆) gas as primary insulator. SF₆ is a non-toxic gas, maintains atomic and molecular properties even at high voltages, high cooling properties, and superior arc quenching properties.

In addition, it is safe. SF₆ has superior dielectric properties compared to other gases; thereby provide favorable insulation for the phase to phase and phase to ground moderation. In the sub-station setup, the gas is contained in a grounded metal enclosure containing the conductors, current and voltage transformers, circuit breaker interrupters, switches, and lightning arrestors.

Advantages

- The earthed metal enclosure makes a safe working environment for the attending personnel
- Compartmentalized enclosure of the live parts makes a very reliable system due to reduced disruption of the insulation system.

- By reducing the distance between active and non-active switchgear parts, less space is required for GIS than in the normal AIS system: Low maintenance requirements due to expedient design and protection against external elements.
- Under scheduled maintenance, SF6 neither ages nor depletes. There is no need to top up the gas levels throughout the equipment lifetime (approx. 40 years).
- Quick assembly due to extensive pre-assembly;

Disadvantages

- High installation costs compared to AIS systems
- Procurement and supply of SF6 gas may be a problem, especially in rough terrain and off-site locations. This further increases the costs
- High level of maintenance is required. This requires highly skilled personnel
- Internal faults tend to be very costly and severe when they occur. They often lead to long outage periods. For example, the use of impure gas, as well as presence of dust can lead to flashovers and explosions.

The sub-station has electrical specifications for voltage, switchgear, circuit breaker, transformer, and protection systems. The key physical features of the sub-stations are given in **Table 4.6**.

Table 4.6: Physical Features of the Substation (1600 KVA)

Features	Specification
Type	Proposed
Land requirement	N/A (owned by BFDC)
Switchyard Type	GIS
Capacity	1600 KVA
Voltage level	400/230 kV
Insulation Medium Power Circuit Breaker	SF6 GAS
Transformer	Oil immersed (1600 KVA, 11/0.415 KV); Rated capacity 1600 KVA; Rated Frequency: 50 Hz
Switchgear	2500 A (Sheet steel clad, dust and vermin proof, powder coated, free standing, floor mounting type, 415 V, 50 Hz)
Control System	Automated
Communication System	Optical fiber communication
Fault detector	Relays
Fire Protection System	Auto fighting water spray System
Earthing	8 sets
Earthing Blocks	50 mm x 300 mm x 8 mm copper bar
Generator	2 x 750kVA

4.15.3 Brood Management Center

Abandon building Demolition

There are two buildings which are currently abandoned. These buildings are to be demolished and some vegetation are to be cleared before implementing the Brood Management Center. Both the buildings are single storied old building and the areas of the buildings are around 67 sqm and 195 sqm respectively. Tentative debris to be generated from these two buildings are provided in **Table 4.9**

under **Section 4.22.1** and a detailed demolition plan is provided in **Section 2.1** under **Chapter 2** of **Annex A: ESMP Report**.

4.15.4 Canal Rehabilitation for Cluster Farming

The procedures to be followed during canal rehabilitation through re-excavation are:

- Preparation of 500 m segments.
- A temporary bundh will be established and dewatering would be done if water is present (especially during wet period). This would take one day.
- Excavation of the canals would be done after establishing temporary bundh and dewatering work to the 500m segment. This would take one day.
- Waterflow might be hampered for those two days.

4.16 Site Development

There is provision for constructing civil structures at BFDC, and BMC areas; hence, site development works are redundant for other two sub-projects. Under the BFDC sub-Project, 1600kV substation, modern fish processing plant, ETP, and WTP etc. are to be implemented (Ref. to the **Section 4.5.2: Figure 4.1**- Locations of the components as mentioned in the Figure) and are required to be cleared first. Around 192 number of timber trees including other vegetation are required to be cleared. On the other hand, a small number of vegetation including herbs, shrubs, and grassy vegetation would be cleared for implanting the Brood Management Center (BMC). Afterwards, landfilling and leveling would be done. As BFDC campus is already a raised land, hence, land development through earth filling would not be required. However, within the BMC area, there is also a provision of constructing administrative buildings for managing STF-BTS, hence, land development would be conducted considering the flood level analysis of that location.

4.17 Environmentally Sensitive Areas

Environmentally sensitive areas (ESAs) refer to regions or areas which are particularly vulnerable to environmental degradation, often due to their unique ecological characteristics, biodiversity, or the presence of fragile ecosystems. These areas discussing area considering with ecosystem at risk, protected areas, natural resource zones, fragile Landscapes, coastal and marine areas, water catchment areas. The following section discusses the details of the ESAs of the study areas of each sub-projects. Distances from the Sub-Project sites to the Protected Areas are given in the Table under **Annex 13** under the **Volume II: Annexures of Main Report**.

4.17.1 Environmental Hotspots

In Chakaria, shrimp sites have surrounding rich biodiversity areas where different migratory and shorebirds roam in the winter season. During field visits, black-headed ibis and northern solver are commonly seen at study sites. Fishing cats (endangered species as mentioned in the International Union for Conservation of Nature (IUCN) red list country status 2015) are rarely seen in Tinmokha and Charkhor sites of the study area.

Teknaf BMC is a marginal site along a mangrove passage near the Myanmar border, and it is a paradise of wetland bird-roaming sites. However, the Asian clawed otter (endangered, IUCN red list country status 2015) rarely visited the study sites. Despite the lack of documentation regarding their existence in that area, the information was obtained through key informant interviews with locals. In addition, BFDC Chattogram has few trees covered with urban birds and small mammals.

Figure 4.11 below shows the environmentally hotspots of three study sites.



Figure 4.11: Important Habitat Sites within CSE; DFTC, Teknaf; and BFDC, Chattogram

4.17.2 Important Ecosystems and Biodiversity Areas

The study area of Chakaria, which contains 109 ha of mangrove forest, is the most important ecosystem and biodiversity area among the three study sites. It allows as different migratory and wetland bird-roaming sites. It is part of an existing Chakaria mangrove forest and a newly plantation area. The entire Chakaria Sundarbans is now a barren area; stumps of trees are found all over, and only about 200 healthy trees are left. A number of factors have led to the destruction of this forest. These are: (i) removal of forest produces for fuelwood; (ii) overgrazing of cattle; (iii) spread of human settlements; (iv) fishing; and (v) shrimp culture. Between 1977 and 1982, an area of about 3,000 ha was transferred for shrimp farming and human settlement. The government policy of allowing the use of the reserved forest for shrimp farms and human settlement encouraged some people to make forest clearing indiscriminately. Nevertheless, studies indicate that Chakaria Sundarbans can still be rehabilitated with mangroves if biotic interference can be controlled.¹

¹ https://en.banglapedia.org/index.php/Chakaria_Sundarbans

The consequent changes in Mangrove in CSE during last 23 years is shown below in **Figure 3.12**:

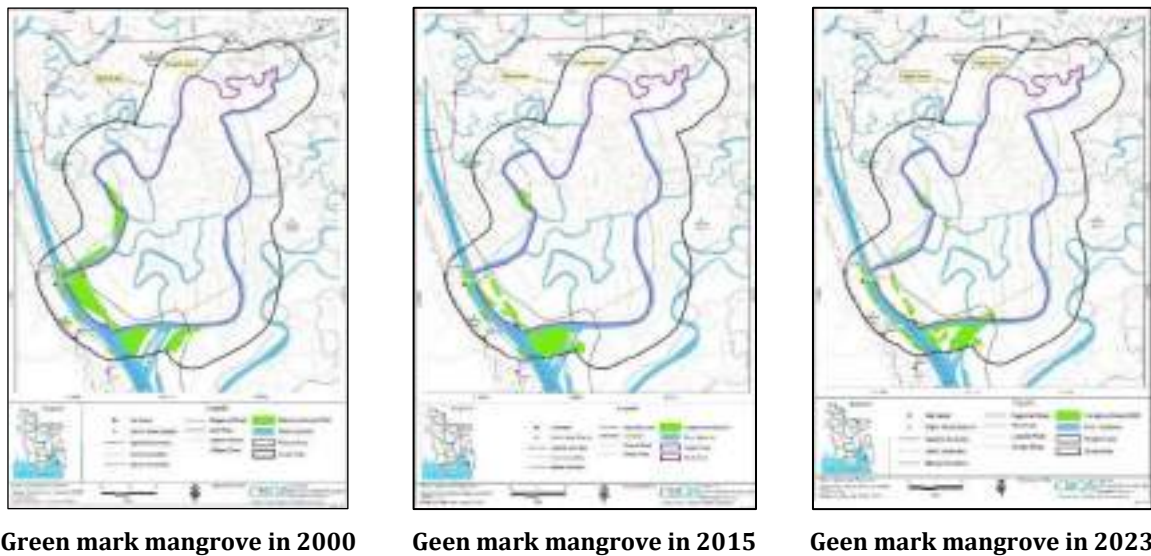


Figure 4.12: Consequent Change in Mangrove within the Study Area of CSE

Endangered Faunal Habitat

Habitat Assessment

Introduction: Conservation as well as management of biodiversity is key to protect the ecosystem and respective habitats. It is essential to assess the habitat before prescribing any measure needs for mending the ecosystem if there is any fragility. The discussed habitat in CSE provides a habitat for a diversified species, of which some are threatened in different scales as per IUCN Wildlife Red List 2015. As per the ESS6 of WB standards, presence of the endangered and critically endangered species triggers the critical habitat assessment, which may provide the proper information for conservation of the particular species.

Fishing Cat (*Prionailurus viverrinus*) Habitat: An endangered small feline and most enigmatic predator, and one of the largest among the 28 species of small cats found worldwide. They are excellent swimmers; mostly piscivorous and nocturnal in habit, usually inhabits in the vicinity of wetlands, along rivers, streams, oxbow lakes, swamps, and mangroves. Widely distributed in Bangladesh in different fragmented habitats. Habitat loss is one of the major threats particularly, transformation of wetlands remains high on the list facing the Fishing cat.

Critical Habitat Criteria of the ESS6 of the World Bank

As per ESS6, Critical Habitats are defined as areas with high biodiversity importance or value which explains about the habitat of significant importance to Critically Endangered or Endangered species, as listed in the IUCN Red List of threatened species or equivalent national approaches.

The fishing cat is considered as an endangered species of Bangladesh according to the IUCN Bangladesh assessment in 2015. The population is gradually declining throughout the country.

Habitat Identifying

In the study area this species is present and according to the perception of the local people and local forest range office, small population is still existing in the study area. During the project activities proper protection is essential for conserving this species from any types of anthropogenic stressors. Awareness creation is essential among the local people for conserving this.

The following map shows the habitat of Fishing Cat (*Prionailurus viverrinus*) in the study area.



Figure 4.13: Fishing Cat Habitat in Study Sites

Habitat Importance in the Project Area

The modified habitat of total study area is 77ha which is only around 1% of the total Study area of the CSE where the nocturnal fauna rarely browses as a feeding ground. Therefore, this fishing cat might be observed very rarely within CSE. The following picture (**Figure 4.14**) shows a fishing cat at Saflapur Union in the Maheshkhali Channel just at the border of the CSE.



Source: Field visit, June 2024

Figure 4.14: Fishing Cat in Natural Habitat of Chakaria

4.17.3 Governmentally Declared Forests

The sub-project, CSE in Chattogram Division is not fallen into any government-declared forest whereas the study area of BMC at Teknaf is fallen into the Ecologically Critical Area (ECA) boundary. Chakaria site is close to the Medhakaccapia National Park having forest coverage while the BFDC site is far away from any designated forest.

4.17.4 Highly Important Agricultural Land

Highly valuable agricultural lands, defined by their capacity in producing two or three crops annually, are mandated to remain untouched by any interventions according to the current policies of Bangladesh. Under this Project no identified study areas of the sub-projects contain such agricultural lands, except the Nagkati Khal under Khulna District.

According to field observation, only salt cultivation, shrimp, and fish farming are practiced in and around the study area of CSE. On the other hand, out of three (03) Districts, catchment areas of Khulna district, there is a very small amount of land in which two crops are cultivated. Rest of the catchment areas under Satkhira, Khulna, and Bagerhat Districts Boro crops; and Bagda, Golda, and white fishes are cultured.

However, it is important to note that the highly valuable agricultural lands do not fall within the project area of any canal especially within the catchment of Nagkati Khal. The project solely involves excavation in the Khal, and the excavated soil materials will be deposited exclusively in the levees of that specific Khal, ensuring no agricultural land to be utilized for soil dumping.

4.18 Civil Structure and Urban Facilities

A large number of civil structures and facilities are planned for the project. The possible civil and urban facilities to be constructed are listed below:

4.18.1 Chakaria Shrimp Estate

Infrastructures and civil structures for the shrimp estate facilities, administrative facilities, road network are given as follows:

- Shrimp Estate Facilities: These include hydraulic structures such as sluice gate (as shown in the Design and Layout in **Annex 14** under the **Volume II: Annexures of Main Report**), Landing Center, drainage, security fencing, pollution mitigation facilities (greenbelt on the peripheral dyke etc.;
- Road Network: These include access road, and internal road network

4.18.2 BFDC

Infrastructures and civil structures under BFDC sub-project are as follows:

- Substation Facilities: These include construction of substation and construction of underground distribution line. In the substation, there would be an Engine room, Control Room, boundary fencing with concrete pillar and barbed wire etc.
- WTP: All effluents generated from the Fish Processing Plant due to cleaning and washing of Fish and floor of the processing Plant, ice etc. shall be treated in accordance with the Environmental Conservation Rules, 2023 of DoE, World Bank, IFC Guidelines etc. whichever is stringent in the Water Treatment Plant before discharging the same to the Karnaphuli River. All effluent would be drained to the central monitoring basin (CMB) of RCC construction and then to Waste Water Treatment Plant for treatment. Quality of the effluents shall be measured, monitored and treated. After treatment, the liquid will be mostly used as gardening water for green belt, car wash and other internal purposes. In exceptional cases, the treated waste water will be drained out into the nearby river following GoB World Bank and other standards as applicable.
- Drainage Facilities: The surface water drainage system would be designed to effectively drain the site and collect and discharge the rainfall runoff without flooding roads. Clean storm water shall be collected and discharged to an on-site waste water settling pond and then to the permitted outfall structure. All the major and minor system of the storm water design should comply with the local authorities and national requirements and standards. The capacity of the surface water drainage system, including perimeter surface water runoff interceptor ditches, shall be designed in accordance to a fifty (50) year return period for rainfall. All buildings shall be provided with roof drainage for disposal of storm water and be connected to the station storm water drainage system
- Other Facilities: These include ETP, Fork Lifter, chiller etc.

The Design and Layout in **Annex 14** under the **Volume II: Annexures of Main Report**).

4.19 Resources and Utility Demand

Resources and utilities required to develop the Project include: construction materials, manpower, electricity, fuel, water, etc. Most of the Project components like excavator, Generator, Transformers etc. might be imported from abroad. Only materials like cement, MS rod, brick etc. and some small and minor tools and machineries will be used in the construction work from local sources. These items would be available in the local market or in the regional markets of Cox's Bazar and Chattogram for

CSE; BFDC; and BMC at DFTC, Teknaf. During the pre-construction and construction periods, labors of different discipline from unskilled to skilled level will be needed and they can be hired from the nearby locality. During installation and commissioning period, mostly skilled manpower will be required. Local skilled manpower can be hired locally or through advertisement in the national daily newspapers. Surface water of the Karnaphuli River may be used for construction.

The construction power can be taken from the nearest electricity distribution system of Power Grid Company of Bangladesh (PGCB).

4.20 Material Storage and Handling

Store yards opened and closed are to be constructed in the sub-project area especially for BFDC, and BMC for storing the equipment and machineries, construction materials and sum miscellaneous items. Open store yards are normally barbed wire fenced area to store mostly the construction materials like brick, MS rod, sand etc. After completion of construction excess materials will be sold through auction following the approved procedure. Closed store yards are normally constructed with corrugated iron sheet, iron bars and angles to store plant machineries, their components and some construction materials like cement. These materials will be taken from the store yards using truck, pick-ups, vans, buoy trucks etc. All heavy materials are to be loaded and unloaded using appropriate cranes.

4.21 Manpower Loading

Skilled and non-skilled manpower would be required in every stage (Ref. to **Section 4.10: Sub-Project Activities**) of each sub-project implementation. It may be noted that in all stages, the local people with prerequisite qualification and experience should be given preference over others.

As per the sub-project activities, as mentioned in **Section 4.10**, the number of manpower would be determined. In this case, most of the manpower would be required at the BFDC Campus for implementing a new substation with associated distribution line, fork lifter, installing ETP, WTP, Chiller, and constructing modern fish processing plant.

On the other hand, for re-habilitation of internal canals at CSE; and eighteen canals under Khulna, Bagerhat, and Satkhira District comparatively less manpower would be required.

It has been assumed that manpower would be required during construction stage for all the sub-Projects for implementing the Project activities. Tentative number of manpower is shown in the following **Table 4.7**.

Table 4.7: Manpower Loading for the Sub-project Sites during Construction Period

Sl. No.	Sub-Project Name	Labor No.		Mid Income level staff	High Income level staff
		Peak	Regular		
1	Chakaria Shrimp Estate	100	80	10	5
2	BFDC Harbor at Chattogram	75	50	5	3
3	BMC at DFTC, Teknaf	75	50	5	3
4	Canal Rehabilitation for Cluster Farming at Satkhira, Khulna, and Bagerhat Districts	4		1	
Total		254	180	21	11

4.22 Waste Types and Calculation

During various stages of the proposed Project, a significant quantity of wastes including solid & liquid, hazardous/ Non-hazardous, kitchen waste, sewage waste etc. would be generated. The wastes to be generated at the sub-project sites due to various activities are categorized into two types: Non-hazardous and Hazardous wastes. Again, Non-hazardous wastes have been categorized into Perishable Waste: Kitchen Waste, Non-perishable Waste, Other Solid Waste, and Organic Solid Waste/ Sewage Waste.

4.22.1 Non-Hazardous Wastes

The major solid wastes generated during construction stage would be from tree felling, vegetation clearing, land development and site preparation at 48- acres of shrimp demonstration area at CSE, BFDC Harbor and BMC area near DFTC at Teknaf. However, under the sub-project, “canal rehabilitation for cluster farming in Satkhira, Khulna and Bagerhat Districts”, existing vegetation like herbs, shrubs and grassy vegetation would be cleared from the dyke before starting the re-excavation works and dumping the excavated soil on it. Besides, kitchen wastes and sewage waste would be generated from the labor shed in CSE; BFDC Harbor at Chattogram; and BMC area at this stage.

In addition, solid wastes such as concrete pieces, small cut pieces of MS bars/rods, wood pieces, CI sheets etc. would be generated due to demolishing the existing abandon buildings in 48- acres shrimp demonstration area, and existing broken sluice gates under CSE; BFDC Harbor at Chattogram; and BMC area. On the other hand, during rehabilitating sluice gates with new structures; constructing new buildings like fish processing plant, substation etc. construction materials like concrete pieces, small cut pieces of MS bars/rods, plastic pieces, empty cement bags, empty cartons, waste papers, waste from worker’s colony, kitchen wastes, human wastes, etc. would be generated.

Perishable Waste

Ref. to **Table 4.7** in **Section 4.21** considering the number of manpower loading during peak work load, a number of labor sheds, staff room, sewage system, kitchen waste disposal system etc. would be implemented at the sub-project sites during the early stage of the construction stage.

Kitchen Waste: The labor shed would be constructed by the EPC contractor at the defined and pre-selected location within the sub-Project sites. A kitchen would also be constructed beside the labor shed. **Table 4.8** shows the estimation of kitchen waste to be generated during the construction stage from various sub-project sites. The detailed description of the calculation of the following calculation has been provided in **Annex 15: Manpower Loading and Waste Calculation for the Sub-Project Sites** of **Volume II: Annexures of Main Report**.

Table 4.8: Estimation of Kitchen Waste during Land Development

Sl. No.	Economic Classes of Employee	Sub-Project Name	Project Employee /Worker	Rate of Kitchen Waste Generation (kg/ day/capita) *	Total Generated Waste (kg/ day)
1	High-Income Group (Tk. >20,000/month)	Chakaria Shrimp Estate	5	0.56	2.8
2		BFDC Harbor at Chattogram	3		1.68
3		BMC Area at DFTC, Teknaf	3		1.68

Sl. No.	Economic Classes of Employee	Sub-Project Name	Project Employee /Worker	Rate of Kitchen Waste Generation (kg/ day/capita) *	Total Generated Waste (kg/ day)
4	Middle-Income Group (Tk. 10,000- Tk. 20,000/month)	Chakaria Shrimp Estate	10	0.5	5
5		BFDC Harbor at Chattogram	5		2.5
6		BMC Area at DFTC, Teknaf	5		2.5
7	Low-Income Group (Tk. < 10,000/month)	Chakaria Shrimp Estate	75	0.32	24
8		BFDC Harbor at Chattogram	43		13.6
9		BMC Area at DFTC, Teknaf	47		15
Total			195		68.8

Source: Jodder et. al. Generation and Characteristics of Household Solid Waste in Khulna City, Bangladesh, 2022

Non-perishable Waste

Non-perishable solid wastes like metal pieces, empty cartons, plastic materials, paper bags etc. would be generated at the construction sites.

Other Solid Waste

Vegetation Clearance and Civil Structure Demolition: A one storied (L x W x H: 20m x 11m x 4.5m), and a two storied (L x W x H: 17m x 12m x 4.5m) L- shaped buildings would be demolished which are currently not in use at 48- acres of shrimp demonstration area. It has been estimated that in total around 225 m³ of debris would be generated from these two buildings. On the other hand, around 5 numbers of tree (3 nos. of Akashmoni; a Coconut tree; and a Bullet Wood tree) would be felled and some grassy vegetation with some herbs and shrubs would be cleared. It has been estimated that in total an amount of 3.4 m³ (3 ton) of wooden debris and leaves would be generated from the mentioned vegetation. In addition, within the CSE, a number of sluice gates and guard sheds would be demolished during rehabilitating those structures. According to the design consultant, the volume of concrete waste to be generated due to structure rehabilitation within CSE would be around 7478 m³.

In addition, during field visit, the study team has learnt that five (05) structures would be demolished from BMC area at DFTC, Teknaf. During the inspection of the building of Demonstration Fisheries Training Center (DFTC), it was observed that the building, as used as training center earlier, is currently not in use due to damage of the structure. It cannot be reformed; hence, the Proponent has taken decision to demolish it. It has been calculated that an amount of around 224 cubic meter debris would be generated from this abandon structure. Likewise, the training center, the dormitories were also found as abandon which was used for the temporary residence for the trainees. Approximately, 258 m³, and 78 m³ concrete material would be generated from the dormitory of the trainees and the trainers respectively. There is another civil structure which was used as the office assistant resident, currently kept unused. It is assumed that around 638 m³ debris would be generated from this structure. In addition, an existing car parking was observed by the study team during field visit which is currently not in use. A tentative amount of 66 m³ debris might be generated from this car parking lot.

The BFDC Harbor sub-Project site is covered with a large amount of vegetation including herbs, shrubs, and hard wood trees of different sizes. It has been decided by the Proponent that most of the activities under this sub-project would be conducted without felling the trees and clearing the vegetation. However, an estimated 192 numbers of tree would be cut down (in which primarily Arjun and Akshmoni has been selected under a wood stand) for constructing the WTP, fish processing Plant, ICE and implementing two new tube wells. It is also estimated that around 90% of the tree species are under adult, and about 10% are sapling. Therefore, before construction, and land development activities vegetation would be cleared from the Project site. Hence, an estimated amount of 200 m³ (about 230 ton) of wooden debris might be generated at this stage. In this case, the average height and Diameter at Breast Height (DBH) of the hard wood trees and canopy coverage have been considered. The wooden debris may create aesthetic tiring, be reason of accidental events like cutting, burning, falling from height (during cutting down trees), income generation, etc. Cut down trees and wooden debris might be kept at a designated place for a short period and sold out to the relevant vendors to carry the debris outside the Project site. In addition, 522 m³ of concrete debris and about 300 kg CI sheet would be generated due to the demolition of abandoned structure.

On the other hand, on the both side dyke of the selected eighteen canals for cluster farming various trees such as: date tree, banana tree, palm tree etc. would be fell down. However, according to the Client, canal rehabilitation through re-excavation activities trees and existing vegetation area would be kept aside as much as possible.

An approximate calculation of the volume and weight of the generated waste in various sub-project areas is given in the following **Table 4.9**. During calculating the wastes, the type of material such as: concrete (including cement, sand, brick etc.) for buildings; iron for CI sheets; wooden debris from hard trees; leaves etc. have been considered as weight varies on the type of material.

Table 4.9: Estimation of Concrete and Wood Waste during Construction Stage

Sl. No.	Sub-Project Site	Source of Waste	Type of Waste	Volume (m³)	Weight (kg)	Weight (Ton)
1.	Chakaria Shrimp Estate	Hydraulic Structures (Sluice Gates) and Guard Sheds	Concrete waste	7478	1,79,47,200	19,783
2.		Buildings at 48-acres of Shrimp Demonstration Area	Concrete waste	225	3,06,628	337.5
3.		Trees and other vegetation	Wooden debris and leaves	3.4	-	3
Sub-Total				7,706.4		20,123.5
4.	BFDC Harbor at Chattogram	Old Chiller and two-storied building	Concrete waste	224	3,04,814	336
5.			Iron from CI sheets	0.6	300	0.33
6.		Trees and other vegetation	Wooden debris and leaves	30.6	-	27
Sub-Total				255.2		363.33
7.	BMC Area at DFTC, Teknaf	Old Buildings	Concrete waste	704	9,57,987	1056
8.		Trees and other vegetation	Wooden debris and leaves	200	-	230
Sub-Total				904		1286
Total				8865.6		21,772.83

Organic Solid Waste/ Sewage Waste

According to the total number of labors, supervisors, and the site engineers etc. (Ref. to **Table 4.7** under **Section 4.21**) organic solid waste/ sewage would be generated from the labor shed sewage system during construction stage. It has been estimated that approximately 8m³, 4.6m³, and 5m³ sewage² would be generated from the labor colony and officers' residence during this stage from the CSE, BFDC Harbor, and BMC sub-project sites respectively. During this stage, human wastes will be managed by constructing temporary sanitary latrines at the labor shed and staff residence. In this regard, a septic tank with the volume of about 4.5m³, 2.5m³, and 3m³ including a soak well may be constructed in the construction sites of the CSE, BFDC Harbor at Chattogram, and BMC Area at DTFC, Teknaf sub-project sites respectively which may be finally demolished and dressed with adjacent land. This waste would be cleaned after a certain time interval based on the requirement. The detailed description of this estimated values is given in **Annex 15: Manpower Loading and Waste Calculation for the Sub-Project Sites of Volume II: Annexures of Main Report**.

4.22.2 Hazardous Wastes

Sludge is a hazardous material which might be generated from the Effluent Treatment Plant (ETP), Water Treatment Plant (WTP) and Municipal wastes from the labor sheds. Sludge is a complex material with heterogeneous toxic substances that it inherits from a variety of origins/ sources. Hence, it has become a dire necessity to identify the nature of toxic contents in the sludge and judicious measures be taken for their safe disposal. The Sludge Management Plan has been given in **Annex A: ESMP**.

4.23 Pollution Potential

The potential sources of pollution based on probable impacts are given in the following **Table 4.10**.

Table 4.10: Pollution Potential and the sources of Pollution within the Sub-Project Sites

Sl. No.	Potential Pollution/ Impact	Sources
Physical Environment		
01.	Drainage Congestion	- Unauthorized dumping of the generated debris due to rehabilitation. - Re-excavation of internal canals at the CSE, drainage flow might be hampered in the river and other canals if the re-excavated soil is not managed properly.
02.	Waste Generation	- Kitchen of Labor Camp - Concrete Waste and Wooden Debris generation rehabilitation of abandoned civil structures, hydraulic structures at CSE - Wooden debris during vegetation clearances - Organic Solid Waste Generation from the labor colony and officers' residence

² Considering 0.29 wt.(kg)/ person/ day for 26 working days for Lower Income Group and 0.6 wt.(kg)/ person/ day for 22 working days for Medium and Higher Income Group.

Sl. No.	Potential Pollution/ Impact	Sources
03.	Environmental Quality	Air Quality • Rehabilitation and construction of new civil structures • Underground Cable installation at BFDC • Vehicular movement on the connecting roads • Exhaust emission from construction site generator, project vehicles, construction materials carrying vessels
		Acoustic Noise <u>Construction sites</u> • Site clearing and preparation; • Excavation, piling and concrete placement; • Erection of structures; • Concrete mixing and aggregate production systems; • Construction Camps / Ancillary Facilities; • Drilling activities; and • Haulage and general vehicle movements. <u>Mobile sources</u> • Engine running; • Hydraulic horns; • Loading and unloading activities.
		Water Quality • Contamination of water bodies by construction waste: e.g., cement, sand, bricks, etc., and other waste e.g., trash materials, scrap wood, paper, kitchen waste from construction camp, spilled-oils from oil containment/storage area/equipment/vehicles/vessels, etc. • Oil spillage from the vessel • Domestic waste from the labor camp and office building
04.	Accidental Event	• Increase of Vehicle Movement • Hamper of Underground utilities during cable trenching work
Ecological Resources		
05.	Vegetation Clearances	• Construction of site office, labor shed, stock yard, and material storage areas • Canal dykes' construction • Canal re-excavation and disposal of re-excavated materials alongside canals
06.	Wildlife Habitat	• Removal of riparian and mangrove vegetation • Disturbance from construction noise, equipment operations, and human interference • Disposal of excavated materials alongside rivers and canals • Excavation of soil from river bed • Increasing turbidity in the excavated locations
Fisheries Resources		
07.	Fish Habitat	• Rehabilitation of water supply and drainage canals, including re-excavation of canals, repairing of sluice gates, and reconstruction of embankments • Waste from fish processing plant of BFDC, including organic waste and chemicals
08.	Fish Migration	• Repair & renovation of existing sluice gate • Canal re-excavation activities

Sl. No.	Potential Pollution/ Impact	Sources
09.	Fish Species Composition	• Re-excavation activities
10.	Fish Production	• Construction Activities
11.	Grazing Ground	• Establishment of shrimp hatchery at BMC
Socio-Economic Environment		
12.	Shifting of temporary settlements	• Land development, levelling and land preparation; • Re-excavation of canals and dumping of soils on the dyke; • Construction of temporary labor shed and sanitation facilities; • Reconstruction of embankment/ peripheral dyke • Construction of guard shed with sanitary and electrical facilities; • Installation of on grid solar panels on embankment (peripheral dyke
13.	Security Issue	• Construction of Guard Shed with sanitary and electrical facilities • Construction of Police Fari • Land development, levelling and land preparation
14.	Occupational health and safety	• Construction activities
15.	Gender issues	• Construction activities
16.	Land holding	• Desilting and rehabilitation of the canals • Repairing and construction of hydraulic structures on the selected Canals

4.24 Alternative Analysis

The alternative analysis has been conducted for selecting a suitable location for implementing the Brood Management Center (BMC). In this regard, possible two (02) locations have been selected for implementing BMC; one is at 48- acres of Shrimp Demonstration area within the CSE sub-project site and considered as **Option 1**, and another one is within the premise of DFTC, Teknaf on the right bank of the Naf River which is considered as **Option 2**. Based on the outcomes of the Multi- Criteria Analysis (MCA) of these two sites, finally a suitable site has been selected and recommended for the sub-project implementation.

4.24.1 Location Alternative for BMC

Initially, possible options for implementing BMC have been suggested by the Proponent. Afterwards, the analysis has been conducted for the site selection based on the Physical, Biological, Socio-Economic, and Management of the BMC aspects. After that, through normalization technique an alternative analysis matrix has been prepared.

During the site selection process for BMC implementation, several parameters have been considered with particular emphasis on the distance from the airport, land ownership, biodiversity, environmental impacts, proximity to river or connected canal etc. With the consent of the Proponent, an initial survey was conducted through satellite images to have general idea for both the sites. Afterwards, the study team visited those sites and collected necessary information and an optimum mix of criteria has been set to identify the best suitable option between the two. Different indicators/factors considered for analyzing the suitability of the sites are presented below in **Table 4.11**. From the analysis, it has been revealed that **Option-2** would be the most suitable and preferred site for BMC implementation.

Table 4.11: Indicators of Alternative Analysis and Significance

Indicators	Significance
Access through waterways and roadways	Transportation is one of the key issues for the implementation of a Brood Management Center. As the SPF-BTS PLs are very sensitive, it is required to settle the PLs in the BMC after importing them from abroad by air route. As both the sites including the Cox's Bazar Airport are accessible through waterways, the PLs might be transported to the BMC from the airport easily. On the other hand, transporting PLs through roadways might cause accidental events which eventually cause loss of PL number or might affect the immunity system of them. Hence, the alternative option with less length makes it more economical. So, distance with shorter length is preferable in this case.
Water quality	Considering the consequence of the climate change impacts, and the natural hazardous prone sites may have impacts on water quality. The water quality might deteriorate also due to rise in surface temperature. These result impacts on shrimp's immunity system. Hence, comparatively good water quality would be beneficial for shrimp health and higher value is preferable.
Transportability	The transportation period is an important issue for the PLs due to their sensitivity. Therefore, less time period would be preferable.
Calmness	As the STF-BTS PLs are very sensitive, no interventions should be present within the buffer distance of 1 km from the BMC area. Therefore, more calmness would be preferable in this case.
Proximity to River/ Canal	Nearest distance from the canal/ river to the sub-project site would be more preferable.
Flooding event	Flooding event may affect for the loss of the high valued shrimp. Hence, considering the 100 years of return period of flood, less value of the water level during flood event would be preferable.
Cyclone and storm surge event	Both the sites are prone to cyclone hazard with storm surge. Therefore, higher distance from the land fall point of this hazard event to the sub-project site would be preferable.
Present land use	Land cover with less use of land such as fallow land would be preferable, hence higher value of would be good for this sub-project.
Tree felling/ vegetation clearing	Less number of tree felling and loss of less vegetation coverage would be preferable in this case so that dependent wildlife habitat would not be impacted.
Biological safety and security (Habitat Disturbance)	Disturbances to the wildlife habitat are likely to evade during any kind of development work. So, less habitat disturbance is preferable.
Risk factor based on land ownership	Land ownership is one of the very important issues for this sub-project implementation. If the land ownership documents are not properly maintained, grievance might be generated among the land owners. Hence, less risk factors would be preferable in this case.
BMC Management	This indicator depends on accessibility to the BMC area from anywhere in the country. In addition, proximity to daily needs for the employees to be stayed in the sub-project site is another important issue. Therefore, suitable option for living would be helpful for managing the whole process for the designated employees, hence, higher value would be preferable.

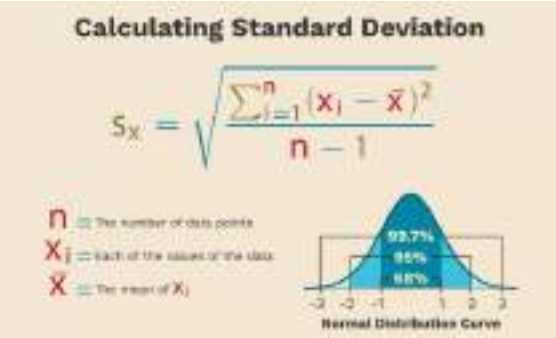
A multi-criteria-based matrix of an alternative analysis has been shown in **Table 4.12** followed in identifying the suitable site selection for the BMC.

As mentioned earlier, considering the Multi-Criteria Analysis (MCA) in terms of physical, biological, socio-economic and management aspects, **Option-2** has secured the highest score.

Table 4.12: Scoring Table

Sl. No.	Aspects	Indicators	Measuring Means	Measuring Unit	Option 1	Option 2	Score out of 10		Max	Min	Normalization		STDEV ³	1/STDEV	C	Weightage	Weighted Score out of 10	
							Option-1	Option-2			Option-1	Option-2					Option-1	Option-2
1	Physical Aspects	Access through waterways	Total Length	km	28.84	116.00	10.0	0.0	10.0	0.0	1.0	0.0	0.7	1.4	0.05	0.08	0.77	0.00
2		Access through roadways	Total Length	km	0.00	82.00	10.0	0.0	10.0	0.0	1.0	0.0	0.7	1.4		0.08	0.77	0.00
3		Water Quality	Analysis result from Lab and In-sito (scoring based on assumption)	Number (out of 10)	8	6	10.0	0.0	10.0	0.0	1.0	0.0	0.7	1.4		0.08	0.77	0.00
4		Calmness	Physical overview (scoring based on assumption)	Number (out of 10)	8.0	10.0	0.0	10.0	10.0	0.0	0.0	1.0	0.7	1.4		0.08	0.00	0.77
5		Proximity to River/ Khal	Distance from river/ canal to the site	m	150	80	0.0	10.0	10.0	0.0	0.0	1.0	0.7	1.4		0.08	0.00	0.77
6		Flooding Event	water level during flood event	mPWD	4.17	2.23	0.0	10.0	10.0	0.0	0.0	1.0	0.7	1.4		0.08	0.00	0.77
7		Cyclone and Storm Surge Event	Distance from landfall location to the site	km	6.45	4.45	10.0	0.0	10.0	0.0	1.0	0.0	0.7	1.4		0.08	0.77	0.00
8		Transportability	Approximate Time Required (Airport to Project Site)	hr	1.5	3	10.0	0.0	10.0	0.0	1.0	0.0	0.7	1.4		0.08	0.77	0.00
9		Present Land Use	Usage of land/ open area (scoring based on assumption)	Number (out of 10)	6	8	0.0	10.0	10.0	0.0	0.0	1.0	0.7	1.4		0.08	0.00	0.77
10	Biological Aspects	Tree Felling	Vegetation Coverage	Number	6.00	4.00	0.0	10.0	10.0	0.0	0.0	1.0	0.7	1.4		0.08	0.00	0.77
11		Biological Safety and Security	Endangered species/ Migratory birds (scoring based on assumption)	Number (out of 10)	8.00	5.00	10.0	0.0	10.0	0.0	1.0	0.0	0.7	1.4		0.08	0.77	0.00
12	Socio-Economic Aspects	Risk Factor	Land Ownership (Scoring based on Assumption)	Number (out of 10)	9.00	7.00	0.0	10.0	10.0	0.0	0.0	1.0	0.7	1.4		0.08	0.00	0.77
13	Management	Managing the Whole System	Suitability (Scoring based on assumption)	Number (out of 10)	5.00	8.00	0.0	10.0	10.0	0.0	0.0	1.0	0.7	1.4		0.08	0.00	0.77
Cumulative Score																1.0	4.62	5.38

³ Abbreviation of STDEV is “Standard Deviation”



5. Description of Baseline Scenario of Physical Environment

The Physical Environment covers the hydrology and drainage condition of the study area including morphological changes of the river(s) as located within the study area, meteorological condition, land use and land cover analysis, disaster proneness, environmental quality etc. Description of physical environment is given in the following sections.

5.1 Geomorphology and Topography

5.1.1 *Geomorphological Settings for CSE*

River Morphology

The study area is surrounded by three rivers. Maheshkhali Channel on the south-west, Bura Matamuhuri River on the north and north-west and Matamuhuri River on the east and south. These channels are linked with the upland rivers and the bay. The tidal process is dominant in these rivers. Fluvial flow in these rivers is in the decreasing phase as a result these rivers are getting narrower.

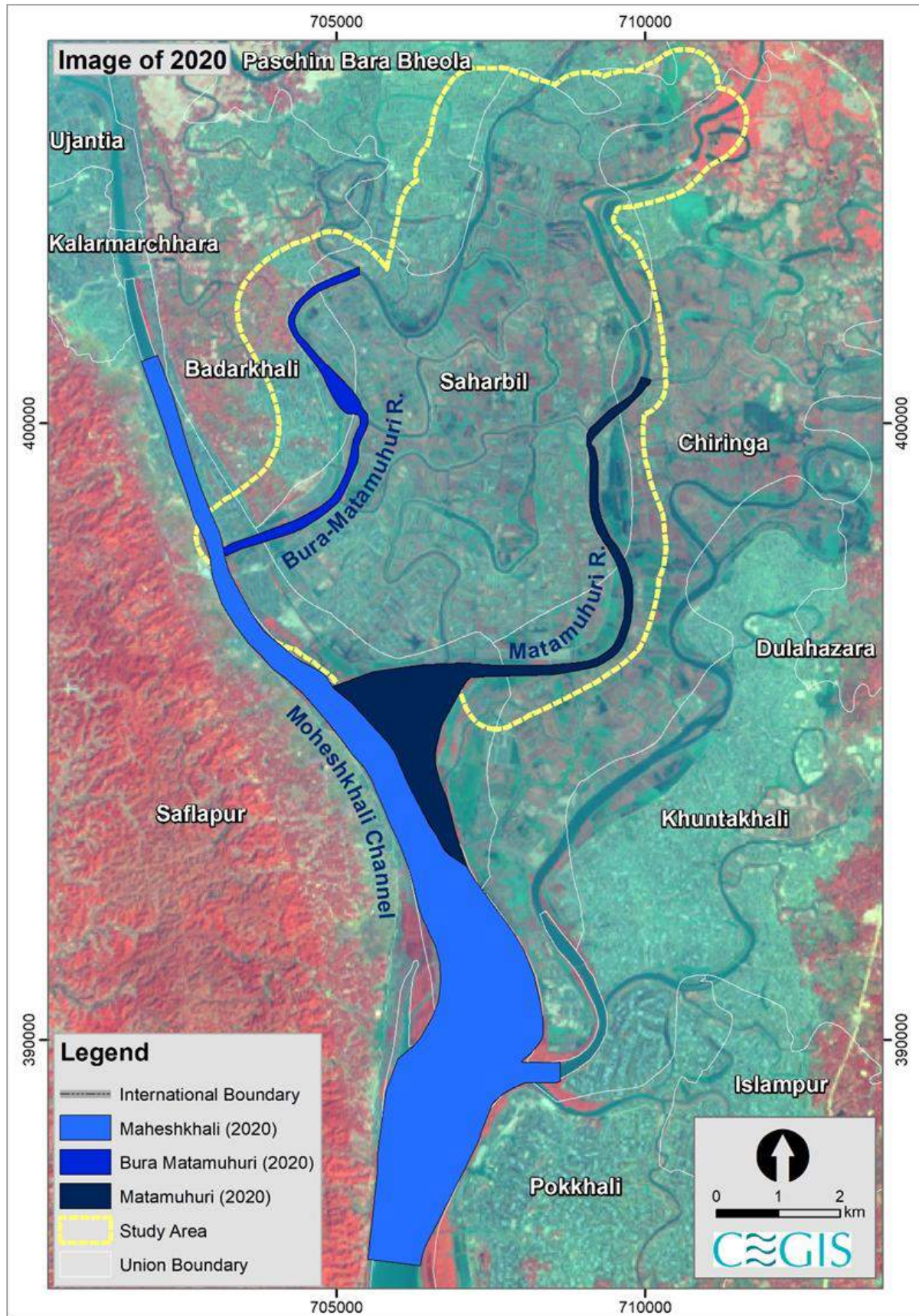


Figure 5.1: Map of the Study Area

Sinuosity

Sinuosity is the ratio of the meandering length of a river to its straight chord length. The sinuosity of the river has been measured for 1989 to 2020 for each of the three rivers. Lower values of sinuosity mean that the river course has not changed significantly and indicates stable characteristics of the river. **Figure 5.2**, **Figure 5.3**, and **Figure 5.4** show the variation in sinuosity of the Maheshkhali, the Bura Matamuhuri and the Matamuhuri Rivers. From graph it is seen that sinuosity of the Maheshkhali River follows a slight uptrend over the last 31 years, sinuosity of the Bura Matamuhuri River follows uptrend up to year 2009 and then it becomes stable, and sinuosity of the Matamuhuri River is almost unchanged over the last 31 years. In general, the increase in sinuosity of the rivers can be attributed to the significant accretion that took place in the last 31 years which is discussed in “Erosion and Accretion” part of this report.

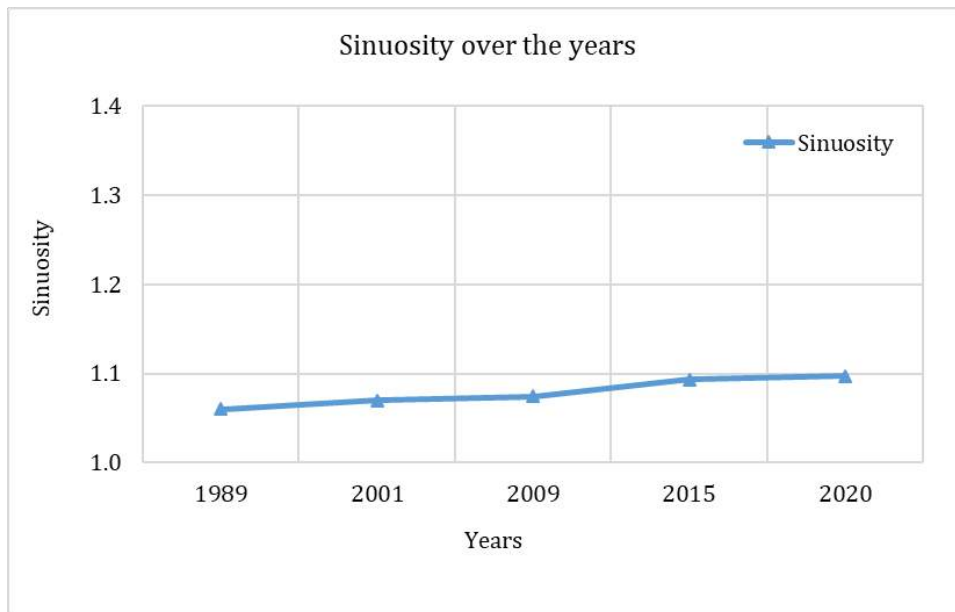


Figure 5.2: Variation in sinuosity of the Maheshkhali River

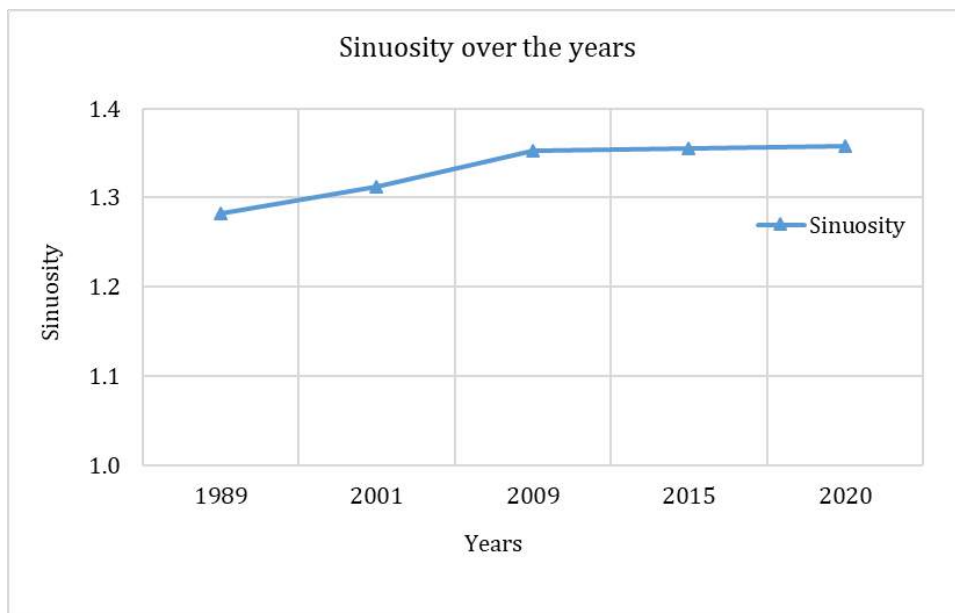


Figure 5.3: Variation in sinuosity of the Bura Matamuhuri River

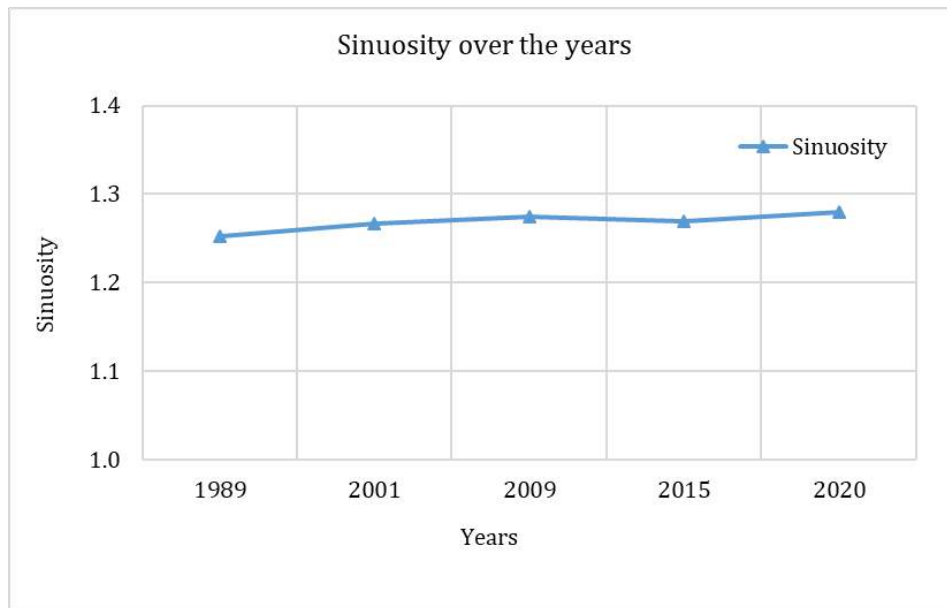


Figure 5.4: Variation in sinuosity of the Matamuhuri River

Average Width

The average width (also known as length-averaged width) for each reach was determined by dividing the polygon area (using ArcGIS tool) by the Center-Line length. The average width was calculated for five different years, as illustrated in **Figure 5.5** for the Maheshkhali Channel, **Figure 5.6** for the Bura Matamuhuri River, and **Figure 5.7** for the Matamuhuri River. It is observed that, between 1989 and 2020, the average width of Maheshkhali Channel decreased gradually from 111 m to 81m from the year 1989-2020. A similar trend continued in the Bura Matamuhuri River where the average width gradually decreased from 29 m in 1989 to 14 m in 2020. The average width of the Matamuhuri River decreased gradually from 58 m to 41m from 1989 to 2020.

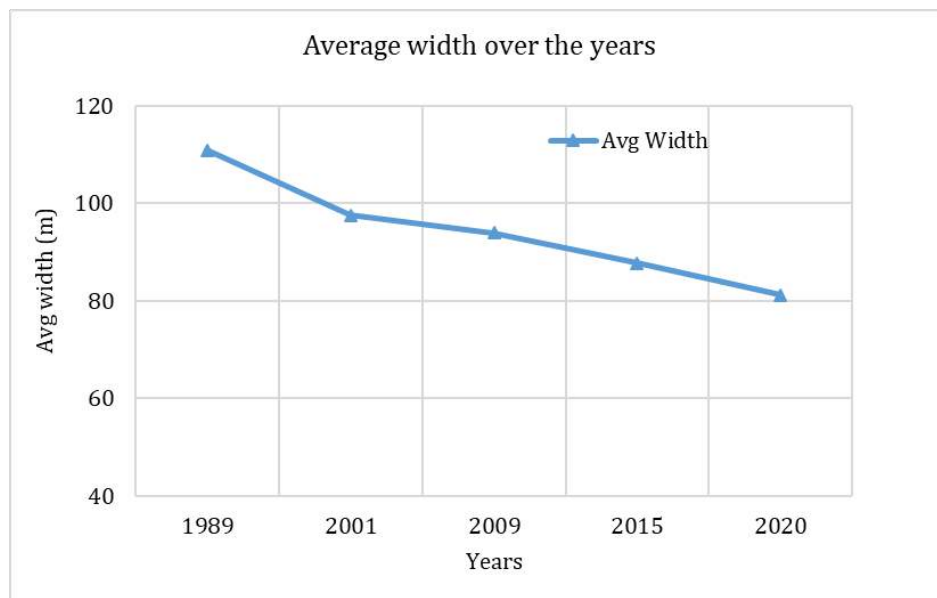


Figure 5.5: Average Width of the Maheshkhali River

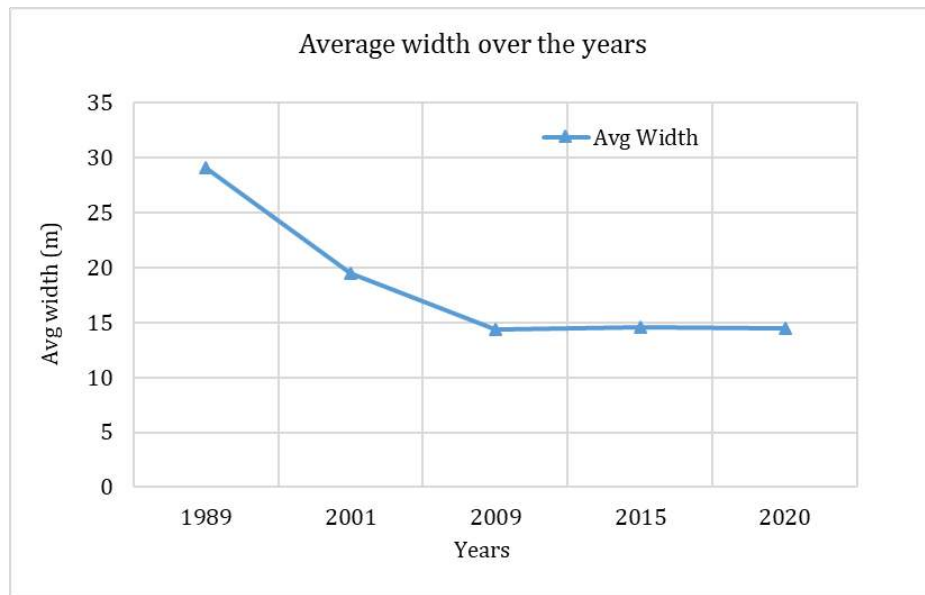


Figure 5.6: Average Width of the Bura Matamuhuri River

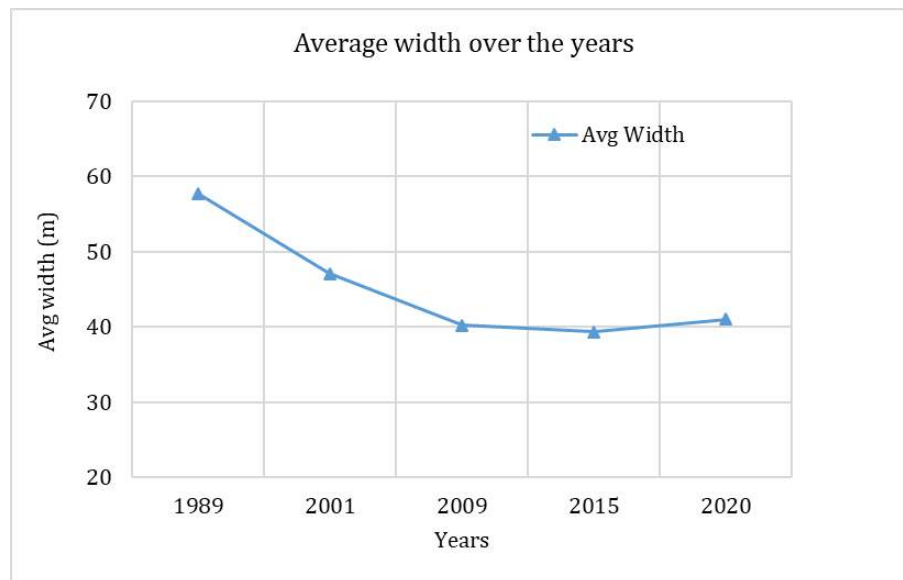


Figure 5.7: Average Width of the Matamuhuri River

Erosion and Accretion

Assessment of riverbank erosion is very important as rivers are very dynamic. Erosion of the Maheshkhali Channel, Bura Matamuhuri, and Matamuhuri Rivers was assessed for the time periods of 1989-2000, 2001-2009, 2009-2015, and 2015-2020.

Figure 5.8, **Figure 5.9**, and **Figure 5.10** depict the erosion and accretion patterns of the Maheshkhali Channel, Bura Matamuhuri, and Matamuhuri Rivers. As previously noted, bank erosion was assessed at various time intervals spanning from 1989 to 2020 (31 years). In all the three rivers, accretion was found to be greater than erosion during this time. From **Figure 5.8** which shows erosion-accretion in the Maheshkhali Channel, it is seen that accretion is maximum from 1989 to 2001 which is about 102 ha and then it follows a slight downtrend. However, almost no erosion is observed between 1989 and 2001, but after that some erosion is found and maximum erosion occurred in between 2015-2022, which is about 10 ha. **Figure 5.9** for the Bura Matamuhuri River shows that accretion was at its

maximum between 1989 and 2001, reaching almost 64 ha. After that, it follows a downtrend. Slight erosion is also observed (6 ha), which increased to 16 ha between 2001 and 2009. Afterward, it again became like that in 1989. Between 2009 and 2020 erosion and accretion almost become equal in this river indicating stability. From **Figure 5.10** for the Matamuhuri River, it is seen that accretion is maximum between 1989 and 2001 which is about 156 ha and then it follows downtrends. There is no erosion in 1989 which is 6 ha, but after that some erosion is found in 2001-2009 which is 7.6 ha and then it goes to downtrend.

In conclusion, it can be said that accretion was dominant in all the rivers from 1989 to 2009. After that, the accretion continued to decrease in the Bura Matamuhuri and Matamuhuri Rivers, although significant amounts of accretion were still observed in the Maheshkhali Channel. In the case of erosion, it has been relatively negligible in comparison across all the rivers over the last 31 years. The erosion and accretion for the years 1989-2001, 2001-09, 2009-15, and 2015-20 are also visually depicted in **Figure 5.11**, **Figure 5.12**, **Figure 5.13**, and **Figure 5.14** respectively.

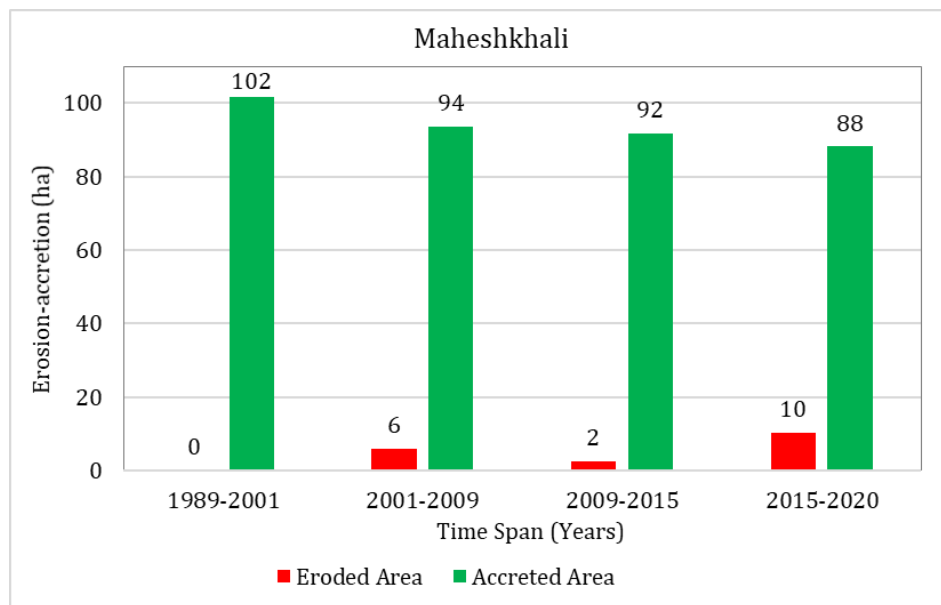
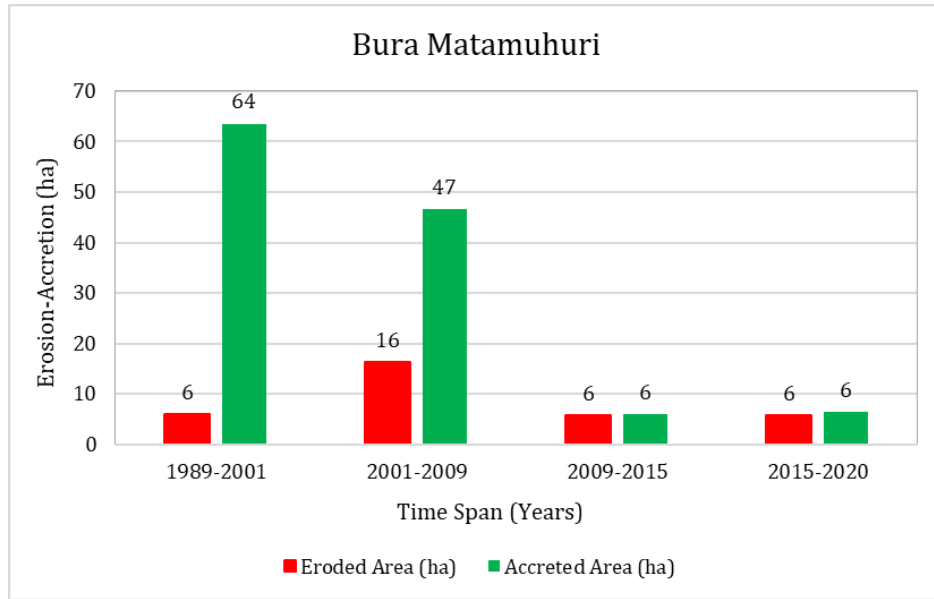
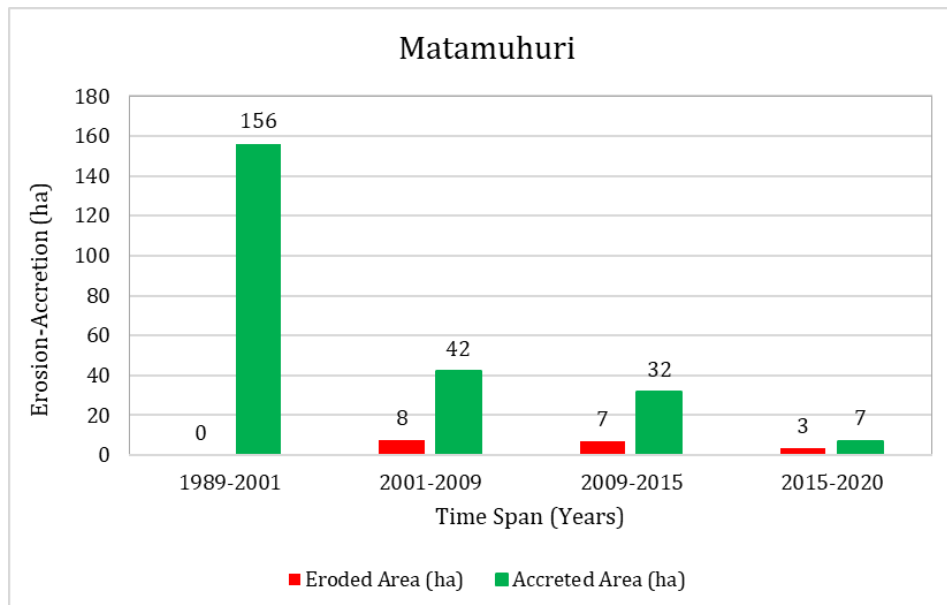


Figure 5.8: Erosion-Accretion in Maheshkhali Channel

**Figure 5.9: Erosion-Accretion in Bura Matamuhuri River****Figure 5.10: Erosion-Accretion in Matamuhuri River**

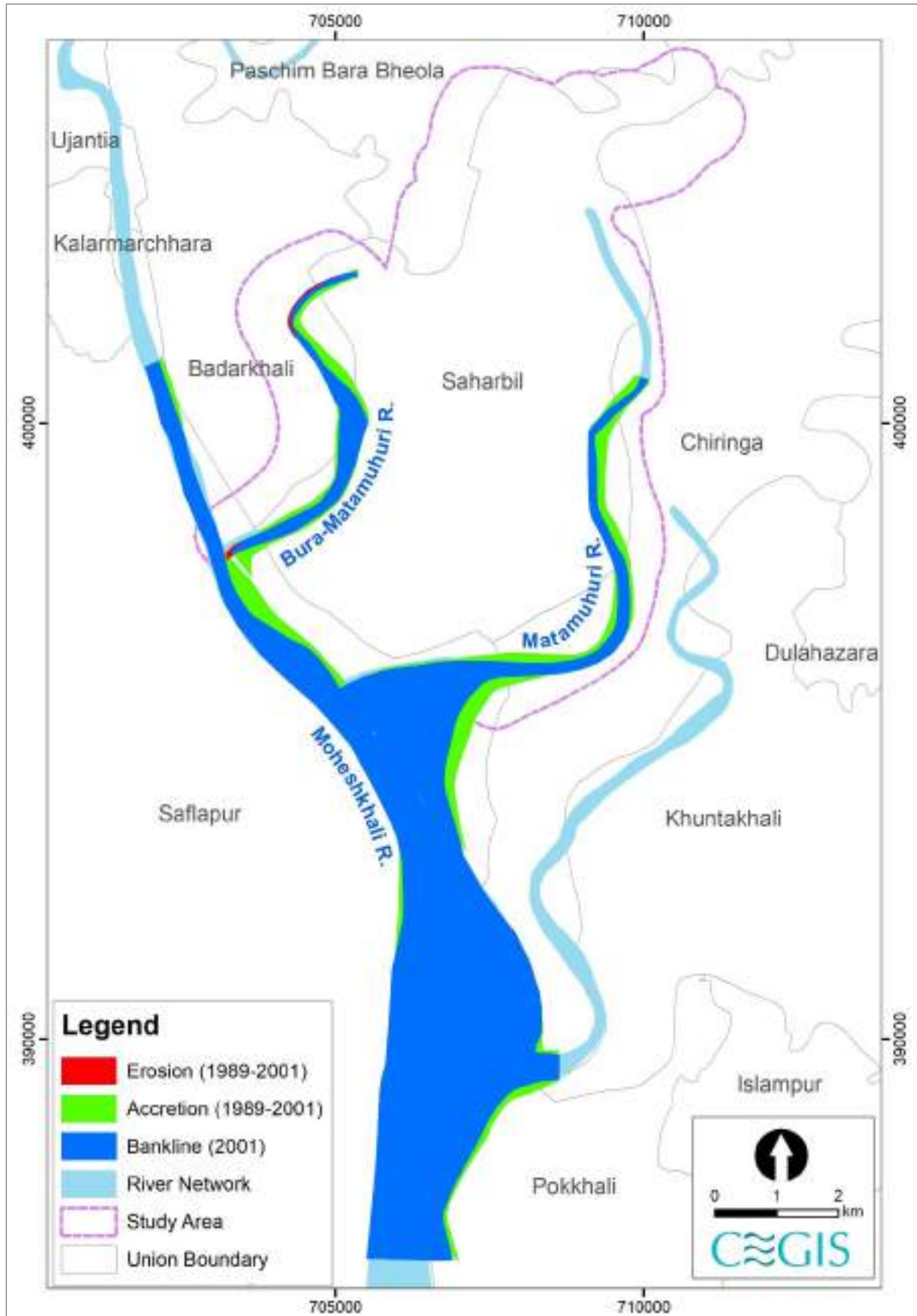


Figure 5.11: Erosion-Accretion from 1989-2001

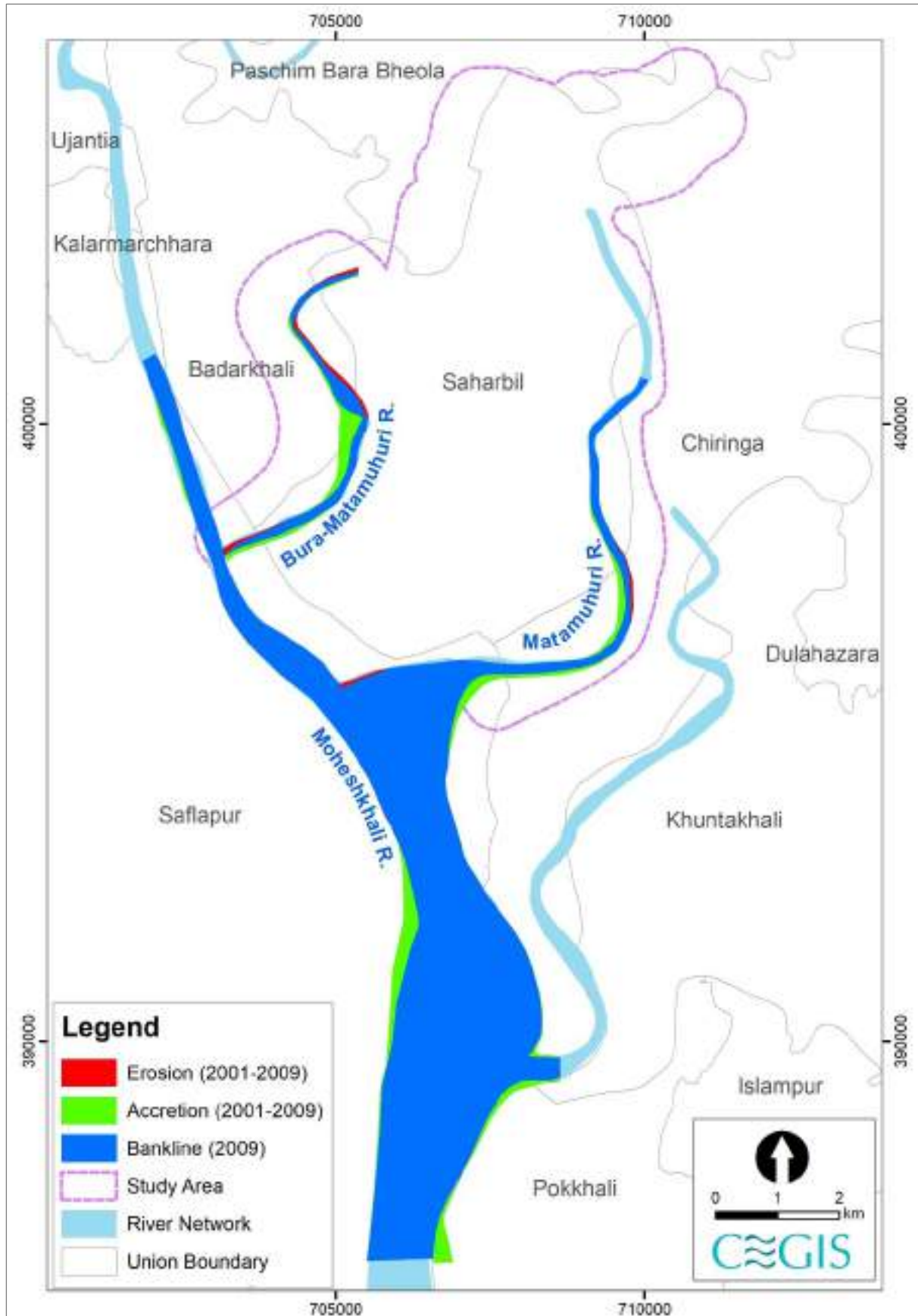


Figure 5.12: Erosion-Accretion from 2001-2009

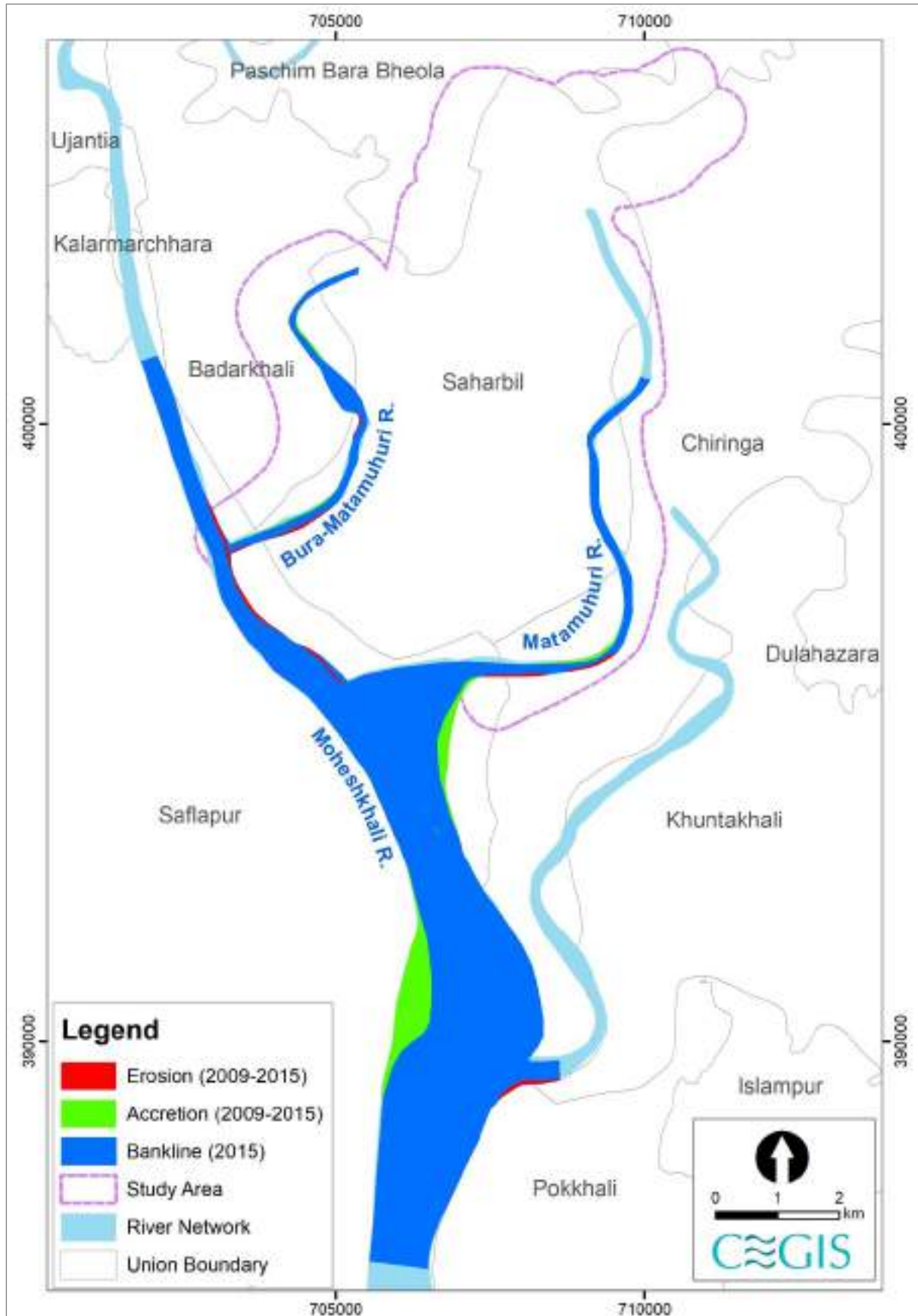


Figure 5.13: Erosion-Accretion from 2009-2015

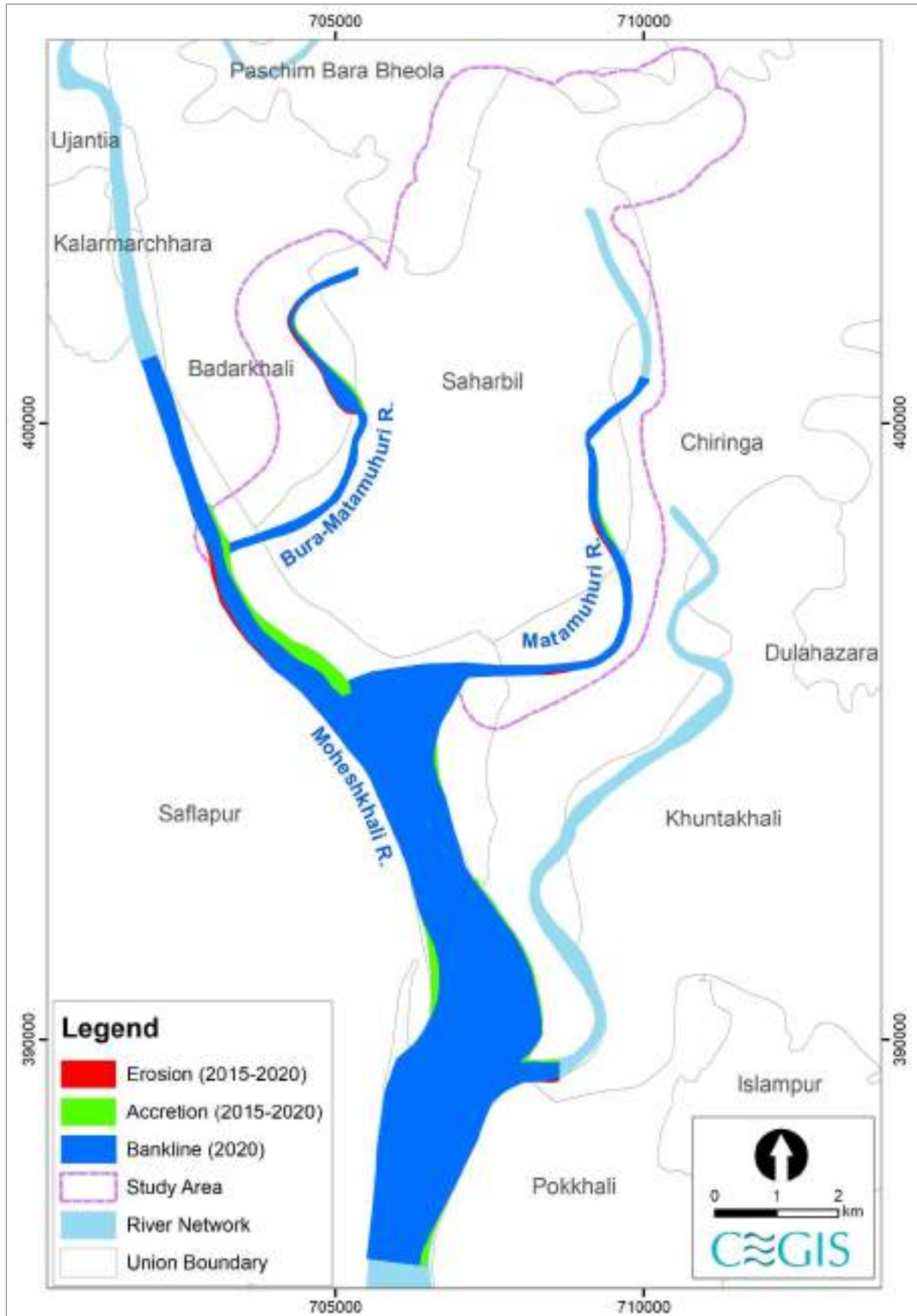


Figure 5.14: Erosion-Accretion from 2015-2020

Char Analysis

Satellite image analysis showed that a Char developed at the confluence of Matamuhuri River and Maheshkhali Channel during 1989-2001. The Char was digitized from the satellite images for the years of 2001, 2009, 2015 and 2020 and are shown in **Figure 5.15**. From Figure the figure, it is evident that from 2001 to 2020 the accretion process was dominant at the char as the area of the char followed an increasing trend. The area of the Char has been calculated for the years of 2001, 2009, 2015 and 2020 which are shown **Figure 5.16**. In 2001 the area of the char was 57 ha which became 195 ha in 2020 meaning about 140 ha area increased during the last 20 years.

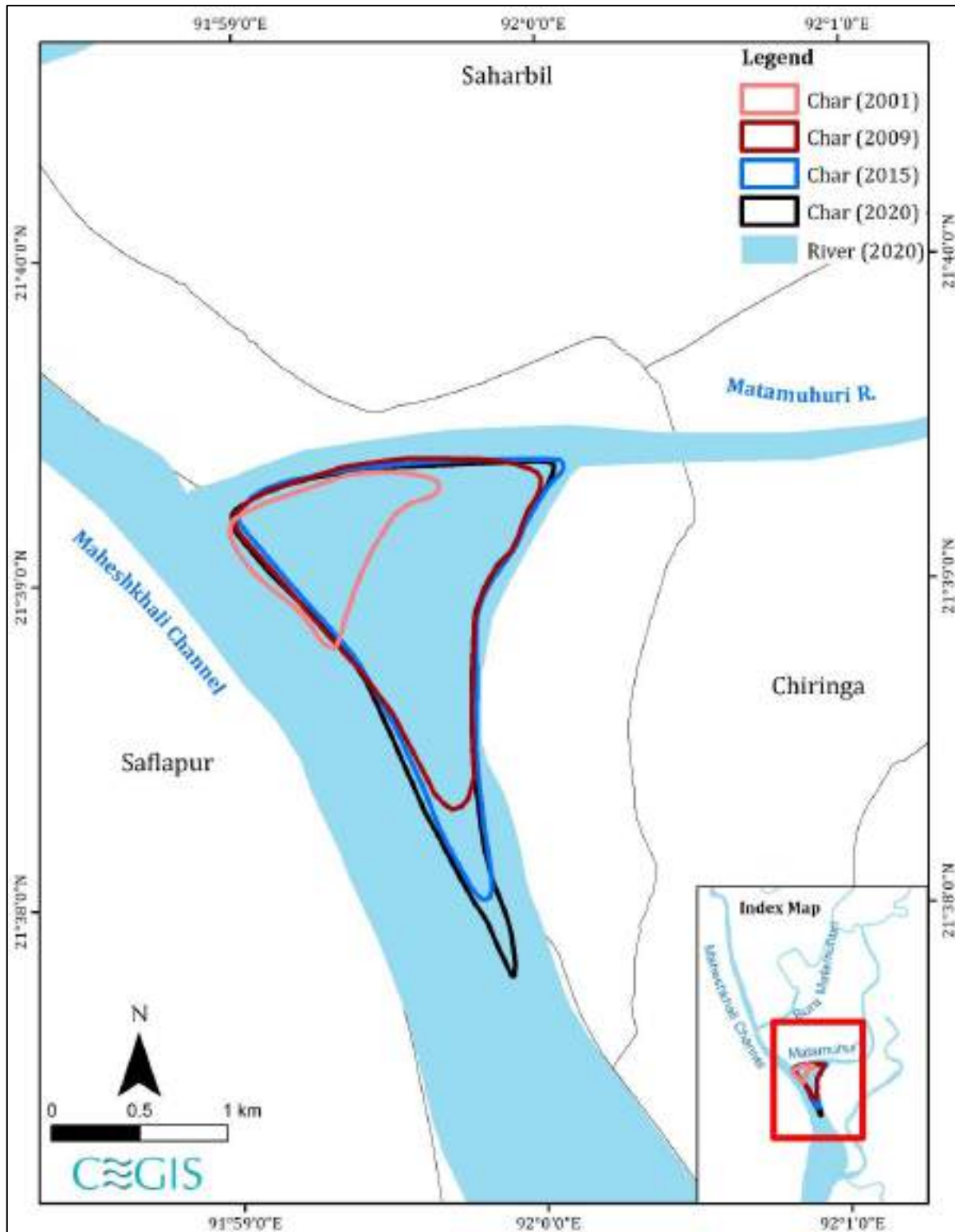


Figure 5.15: Char Development from 2001-2020

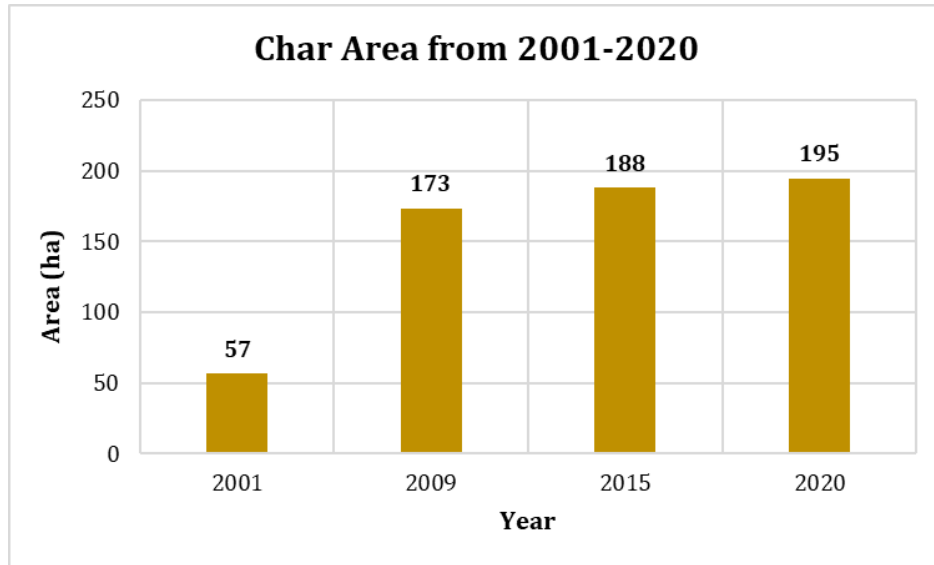


Figure 5.16: Char Area from 2001-2020

5.1.2 Geomorphological Settings for BMC at DFTC, Teknaf

The study area comprises of the BMC area located in vicinity of the Naf River estuary. In order to understand the morphological processes in the study area, it is important to understand the prevailing morphological conditions within the Naf River. The Naf is a transboundary river along the south-eastern border of Bangladesh with Myanmar. The river flows through Ukhia and Teknaf Upazila under Cox's Bazar district and meets the Bay of Bengal near Shahparir Dwip under Polder 68. The embankment of Polder 68 was totally damaged due to severe erosion of the right bank of Naf River from the sea. The embankment of Polder 68 is being re-constructed but its sustainability is under threat due to riverbank/shoreline erosion at many places. This study estimates the sinuosity, average width, and erosion-accretion in the Naf River which includes the BMC Area. The **Figure 5.17** shows the study area.

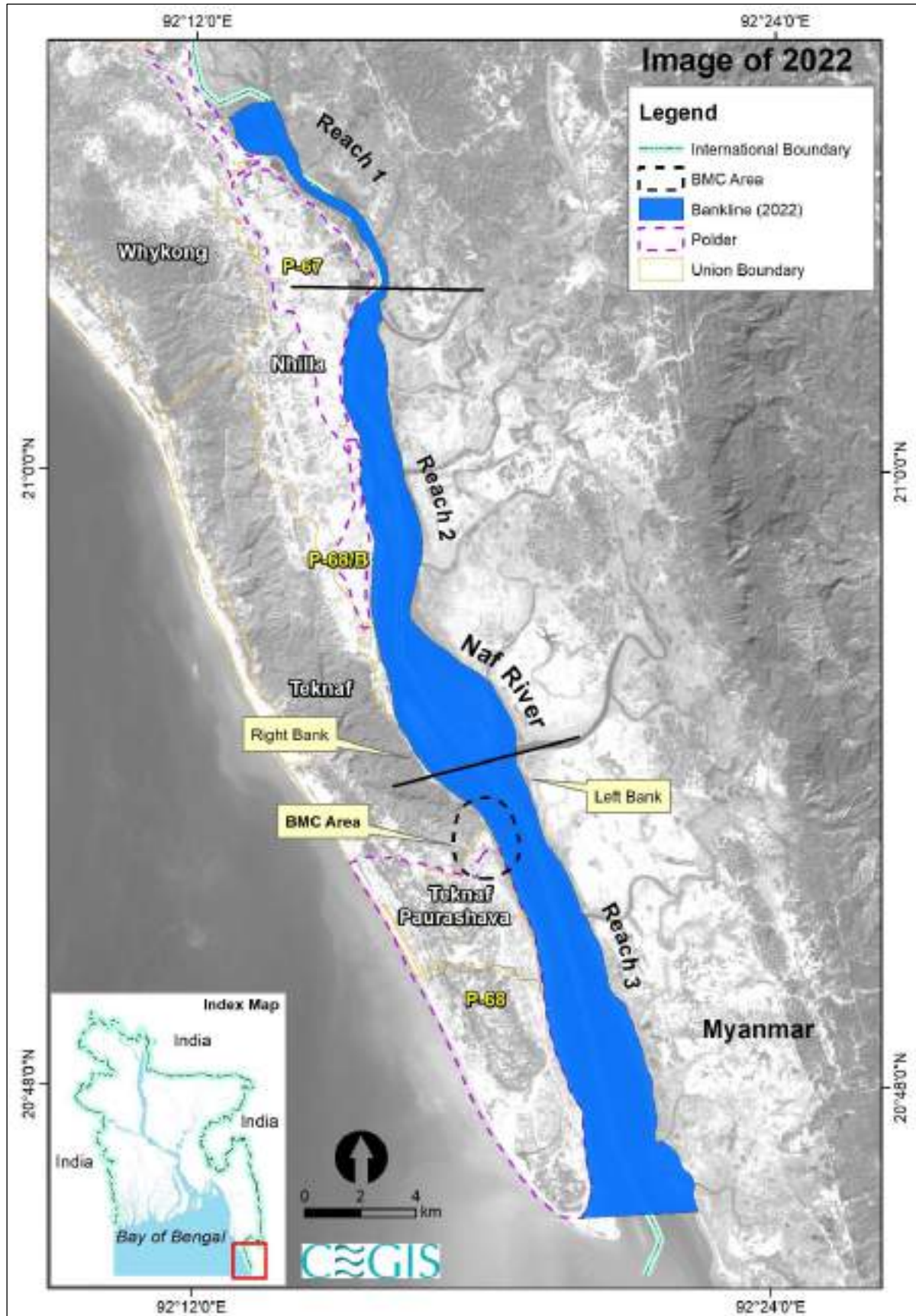


Figure 5.17: Map Showing the Study Area

Physiographical Setting

The Naf River lies on two Physiographical units in Bangladesh along its Right Bank. They are:

Northern and Eastern Hills

This physiographical area includes the country's hill areas. Relief is complex. Hills have been dissected to different degrees over different rocks. In general, slopes are very steep and few low hills have flat summits.

The major hill soils are yellow-brown to strong brown, permeable, friable, loamy; very strongly acidic and low in moisture holding capacity. However, soil patterns generally are complex due to local differences in sand, silt and clay contents of the underlying sedimentary rocks and in the amount of erosion that has occurred. Brown Hill soils are the predominant general soil types of the area. Organic matter content and general fertility level are low to medium with very low to low status of N and P.

Chattogram Coastal Plain

This physiographical area occupies the plain land in greater Chittagong District and the eastern part of Feni District. It is a compound unit of piedmont, river, tidal and estuarine floodplain landscapes. The major problem in these soils is high salinity during dry season (October to May).

Grey silt loams and silty clay loam soils are predominant. Acid Sulphate soils which are potentially strongly acidic occur in mangrove tidal floodplains. Non calcareous Grey Floodplain soils, non-calcareous Alluvium and Acid Sulphate soils are the major components of the general soil types of the area. General fertility level of the soils is medium and N and K are limiting. Status of S is low to optimum. Organic matter content is low to medium. The status of Zn and B is low to medium and that of N and P is very low to low.

A map showing the physiographic units is shown in **Figure 5.18** and descriptions of these units have been given below:

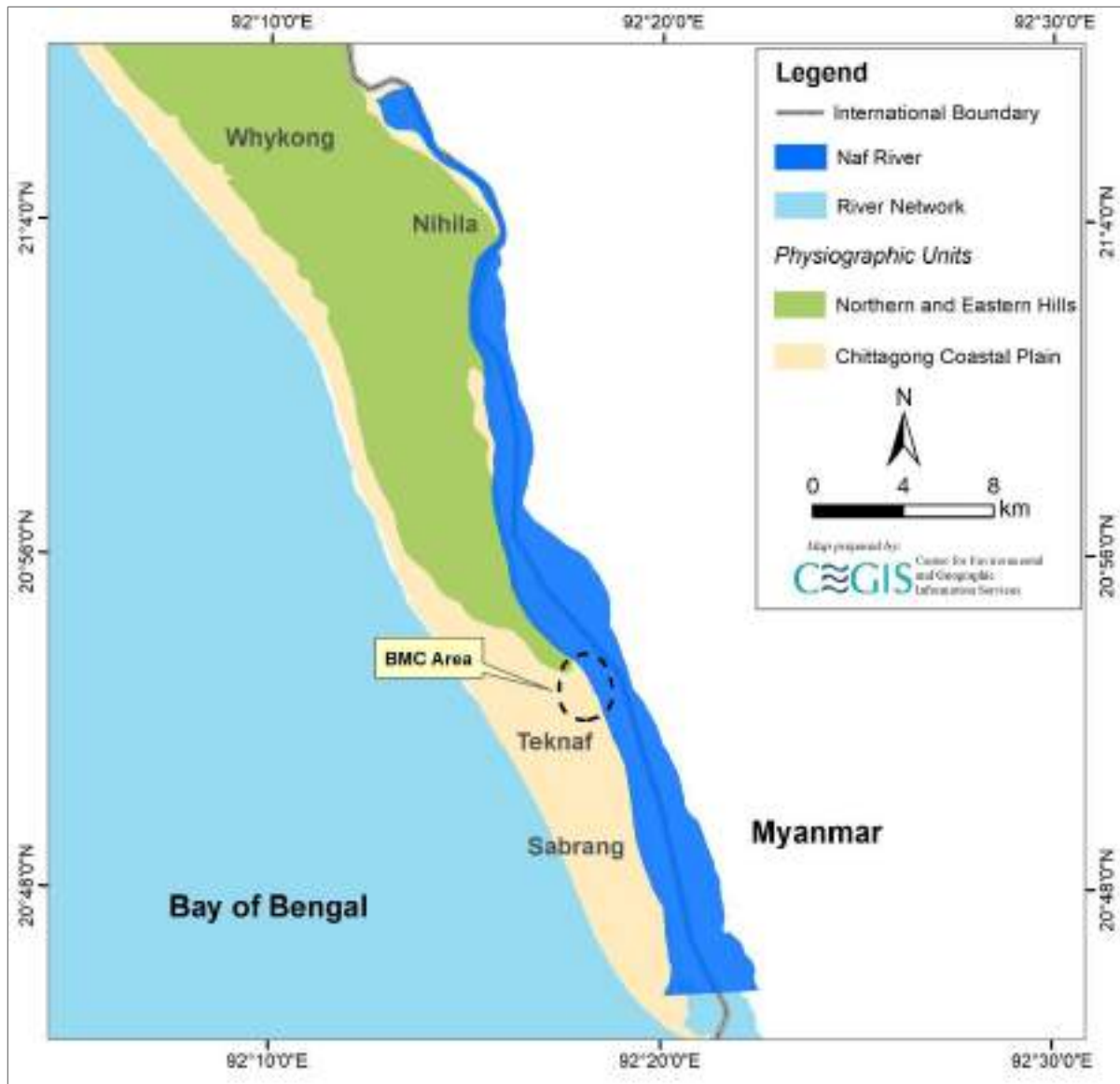


Figure 5.18: Physiographic Units of the Naf River

Data Used

Tassin's Map of 1840 and time series dry season Landsat images for the years 1989, 2000, 2011 and 2022 were collected from the CEGIS archive, and used for morphological study of the Naf River. **Table 5.1** contains a detailed description of the data used in this study. It should be noted that the Tassin's Map of 1840 has a resolution of 100 x 100 m, whereas all of the satellite images used have a resolution of 30 x 30m.

Table 5.1: Historical Map and Satellite Images used in this Study

River	Year	Data Type	Path-Row	Resolution
Naf	1840	Historical Map (Tassin's Map of 1840)	-	100 x 100 m
	1989	Landsat Image	135-46	30 x 30 m
	2000			
	2011			
	2022			

Methodology

Relevant reports, journals and literature were collected and reviewed to understand the prevailing morphological conditions within the study area. Moreover, time series satellite images were collected from CEGIS archives. Before starting any analysis, all the images were geo-referenced to have the same projection system. The projection system of “WGS 1984 UTM Zone 46 N, Datum-WGS 1984” was used in all the maps in this report.

After that, the maps and satellite images were analyzed to assess the historical development of the planform within the study area. This helped to assess the inherent morphological evolution of the shoreline and the island in the area.

Shoreline Delineation

Shoreline is a line that demarks land and water in the coastal area. There is no straightforward way to demark these two parameters of the Coastal area from the satellite images. There exists a sharp boundary between land and water where shoreline erosion is continuing. Due to the semi-diurnal tidal variation within a range of several meters, the existence of very wide (several hundred meters to a few kilometers) intertidal mudflat makes the demarcation very difficult and uncertain. Moreover, the boundaries of the land or intertidal mudflats are changing continuously. This also adds additional complicacy in delineating shoreline. In general shorelines include channels, islands chars and sand bars in the confluence of the Bay of Bengal.

The following guidelines were used for delineating shorelines.

- Land covered by Uri grass or any type of vegetation such as mangrove was considered as shoreline.
- If the width of the tidal creeks is less than 100 m, then it was considered as part of the shoreline.
- The area of an island greater than 0.01 km² was considered as a minimum unit of land. Shorelines delineated from time-series satellite images were used for the planform analysis and assessment of erosion/accretion.
- Intertidal mudflat zones were delineated separately and not considered as part of the shoreline as tidal variation changed their boundaries continuously.

Historical Development of the Naf River

To assess the historical dynamicity of this river, Tassin’s map of 1840 and Landsat images of 1989, 2000, and 2022 have been used which is presented in **Figure 5.19**. It is to be noted that the Map of 1840 is of 100 x100 m resolution and does have distortion. Therefore, the Tassin’s Map was brought of the same extent as the other Landsat images for better perspective understanding. It is seen that, from 1840 to the recent times, the width of the river at the upstream of the Naf River and in the Estuary (**Figure 5.19, Circle 1**). appeared to have decreased significantly. However, the opposite phenomenon seemed to have occurred near the Teknaf upazila where the width seems to have increased (**Figure 5.19, Circle 2**). Again, there is no significant change in the course of the river in the last 33 years (1989 to 2022) as evident from **Figure 5.19**.

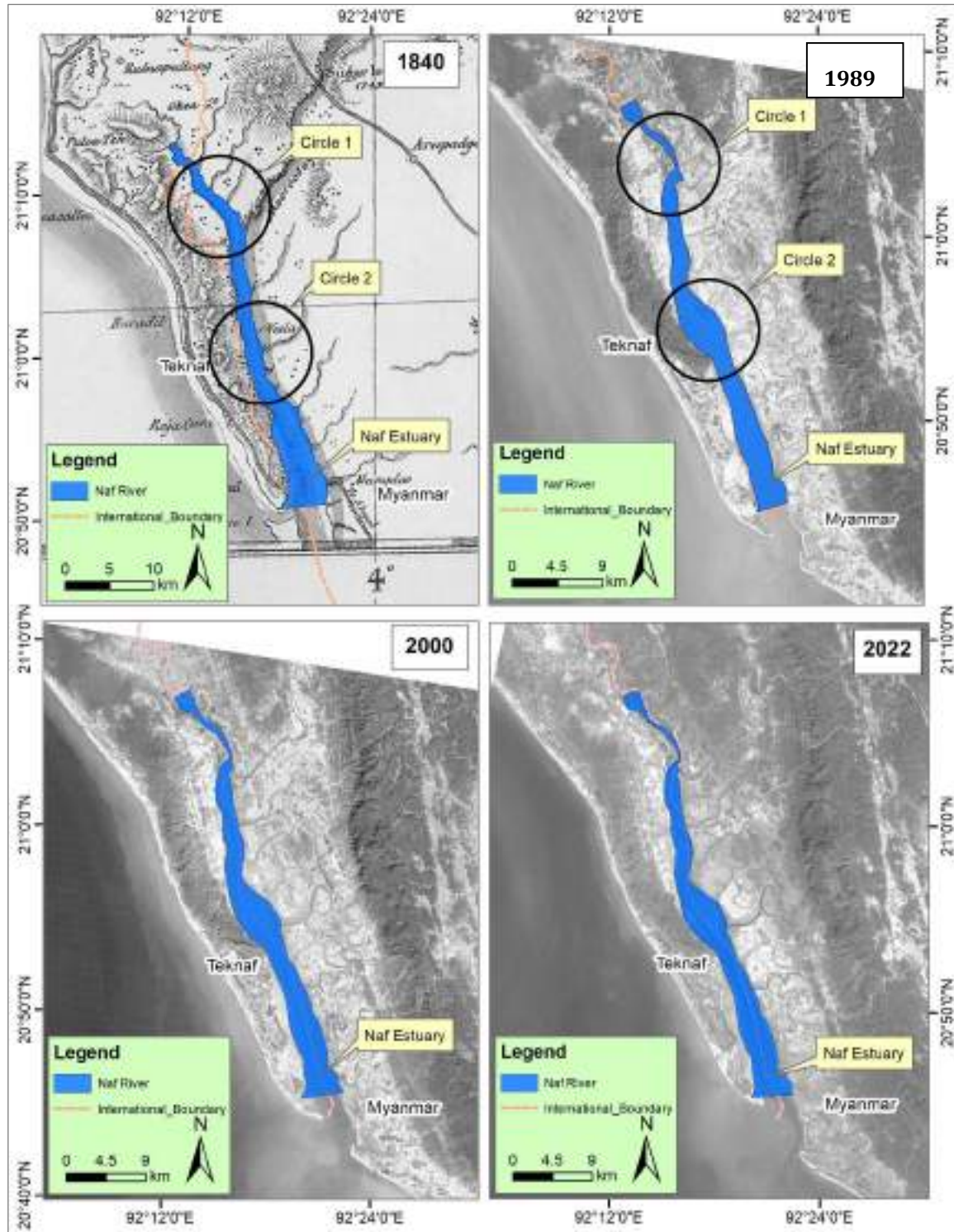


Figure 5.19: Historical Development of the Naf River

Water Level Analysis

Only the Teknaf Tidal Water Level Station of the Bangladesh Water Development Board (BWDB) lies along the Naf River. The yearly Maximum and Minimum Water Level (WL) data in this station were available from 1968 to 1988, collected from National Water Resources Database (NWRD). They are represented in a graphical form in **Figure 5.20**. It is observed that the maximum water level at Teknaf station shows almost a stable trend (varying between +0.47 to +2.23 m PWD), whereas minimum water level shows a decreasing trend (varying between -3.42 to -1.46 m PWD), within the period of analysis. However, there is unavailability of data from 1983 to 1985 and the data are available only up to 1988. Therefore, the hydrological condition of the Naf River could not be made with elaborate details. The **Figure 5.20** only gives an overview of the maximum and minimum water levels in the Naf River.

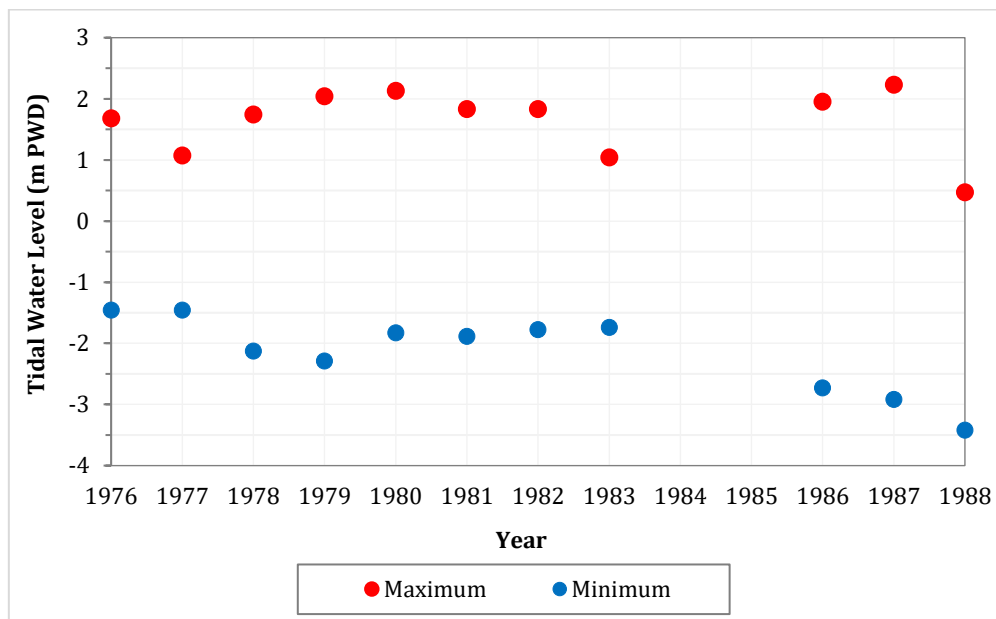


Figure 5.20: Annual Minimum Water Levels at Teknaf Station

Morphological analysis of Naf River

The sinuosity, average width, and erosion-accretion of the Naf River were analyzed to understand its morphological condition. For the analysis, the Naf River was divided into three reaches, namely; Reach 1, Reach 2, and Reach 3. A map showing the three reaches is shown below in **Figure 5.21**.

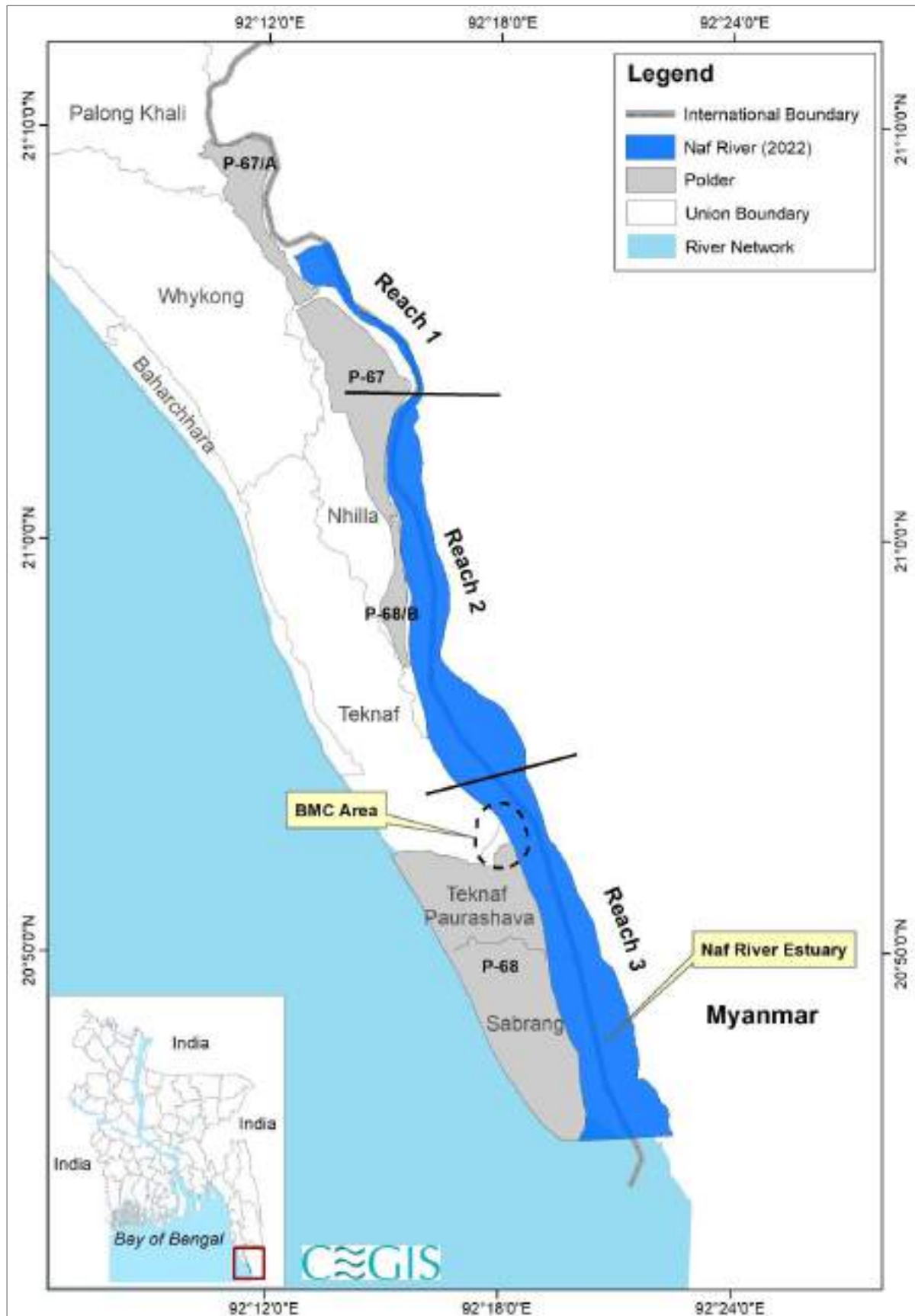


Figure 5.21: Map showing the three Reaches of the Naf River

Sinuosity

Sinuosity is the ratio of the meandering length of a river to its straight chord length. Sinuosity of the river has been measured for 1989 to 2022 for each of the three reaches (**Figure 5.21**). Lower values of sinuosity mean that the river course has not changed significantly and indicates stable characteristics of the river. **Tables 5.2, 5.3, and 5.4** shows the variation in sinuosity of the river over the last 33 years for each of the reaches. From the analysis, it is evident that the sinuosity of the river has mostly remained unchanged during this time. The sinuosity of the Naf River in Reach 3 (which also contains the Naf Estuary) shows the smallest values of sinuosity which implies that the reach is suitable for navigation due to its stable characteristics. The **Figure 5.22** shows the graphical representation of the sinuosities.

Table 5.2: Variation in Sinuosity of the Naf River in Reach 1

Year	Sinuosity
1989	1.05
2000	1.05
2011	1.05
2022	1.06

Table 5.3: Variation in Sinuosity of the Naf River in Reach 2

Year	Sinuosity
1989	1.07
2000	1.03
2011	1.04
2022	1.05

Table 5.4: Variation in Sinuosity of the Naf River in Reach 3

Year	Sinuosity
1989	1.02
2000	1.01
2011	1.01
2022	1.01

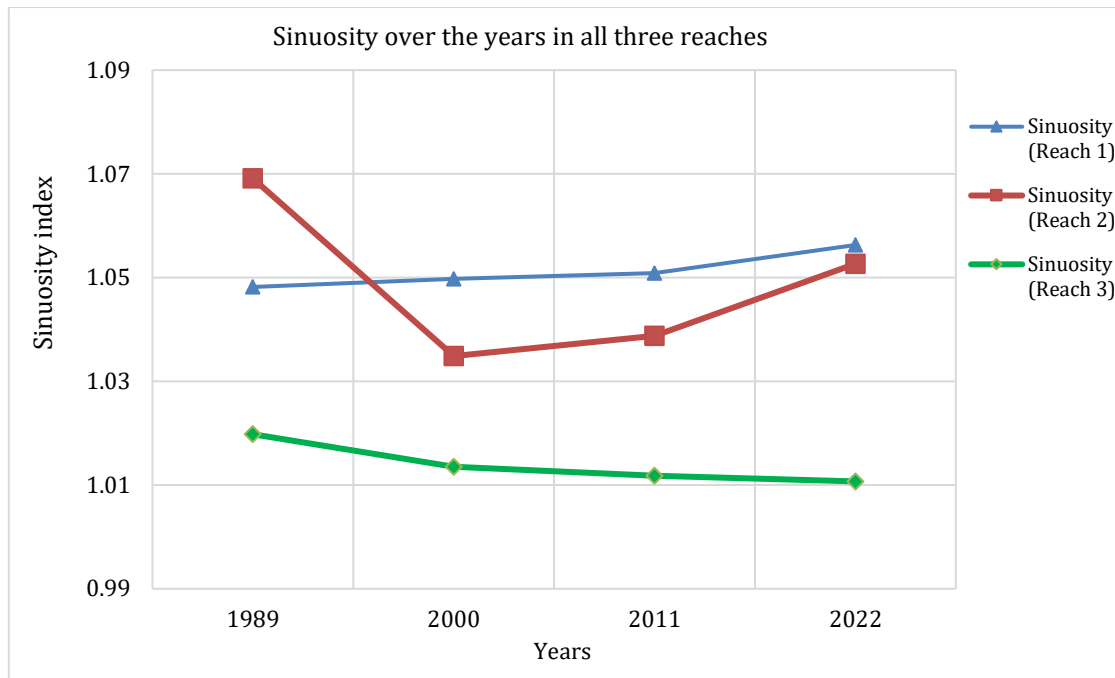


Figure 5.22: Comparison among the Sinuosities of the Three Reaches

Average Width

For the calculation of average width, the Naf River was divided into three reaches, namely Reach 1, Reach 2, and Reach 3 as shown below in **Figure 5.21**.

The average width (also known as length-averaged width) for each reach was determined by dividing the polygon area (using ArcGIS tool) by the Center-Line length. Average width was calculated for four different years as shown in **Table 5.5** to **Table 5.7**. It is observed that, between 1989 and 2022, the average width of Naf in Reach 1 (**Table 5.5**) decreased gradually from 766 m to 619 m. A similar trend continues in Reach 2 (**Table 5.6**) where the average width gradually decreases from 1953 m in 1989 to 1875 m in 2022. The Reach 3 (**Table 5.7**) which consists of the Naf River estuary shows irregular patterns and shows no definite trend in the change in its average width. Here, the width is seen to have increased between 1989 and 2000, but decreased between 2000 and 2011. However, no significant change in average width is observed between 2011 and 2022. The average width among the three reaches is compared in a graphical form in **Figure 5.23**.

Table 5.5: Average Width of the Naf River in Reach 1

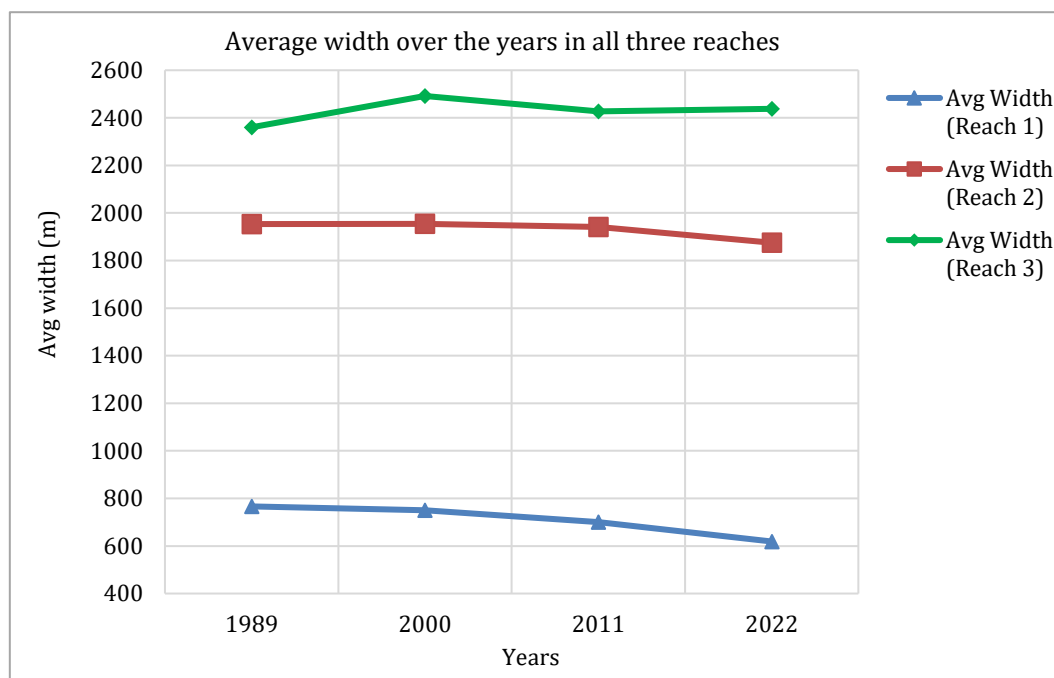
Year	Avg. width (m)
1989	766
2000	750
2011	700
2022	619

Table 5.6: Average Width of the Naf River in Reach 2

Year	Avg. width (m)
1989	1953
2000	1954
2011	1941
2022	1875

Table 5.7: Average Width of the Naf River in Reach 3

Year	Avg. width (m)
1989	2360
2000	2492
2011	2428
2022	2438

**Figure 5.23: Comparison among the Average Width of Three Reaches**

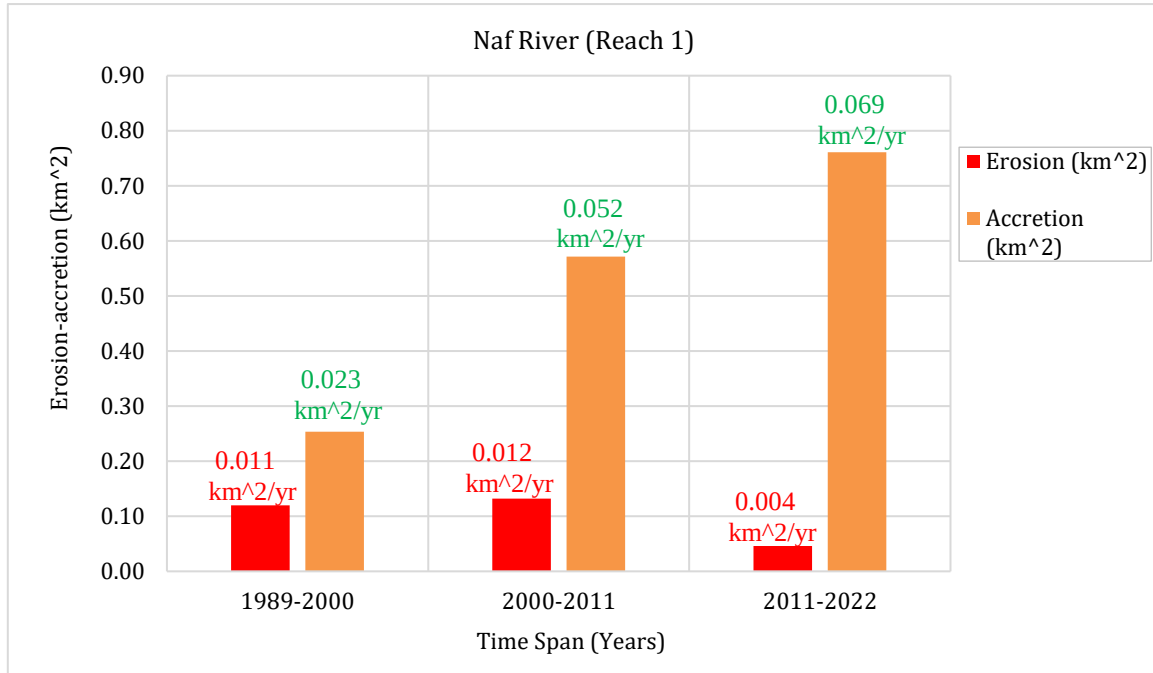
Erosion and Accretion

Assessment of riverbank erosion is very important as rivers are very dynamics, and also their shifting towards the east to the west is still a continuous process. Erosion of the Naf River was assessed for 1989-2000, 2000-2011, and 2011-2022 within the three reaches as mentioned before.

The Naf River is prone to both erosion and accretion. The **Tables 5.8, 5.9 and 5.10** represent the erosion and accretion rates in the Naf River in all the three reaches. The average rate of bank erosion was assessed during the period from 1989 to 2022 at different time intervals. The Naf River estuary lies in Reach 3 (**Figure 5.21**) of the Naf River. Here, a maximum erosion of 2.88 km² was observed between 1989 and 2000 (**Table 5.10** and **Figure 5.25**) with an erosion rate of 0.26 km²/yr. Between 2000 and 2011, maximum accretion of about 1.64 km² was found with the accretion rate being 0.15 km²/yr (**Table 5.10** and **Figure 5.25**). Recently (2011-2022), the erosion and accretion rates in Reach 3 are almost equal.

Table 5.8: Erosion-Accretion in the Naf River in Reach 1

Year	Duration	Erosion (km ²)	Erosion Rate (km ² /yr)	Accretion (km ²)	Accretion Rate (km ² /yr)	Net (km ²)
1989-2000	11	0.12	0.01	0.25	0.02	0.13
2000-2011	11	0.13	0.01	0.57	0.05	0.44
2011-2022	11	0.05	-	0.76	0.07	0.72

**Figure 5.24: Erosion-Accretion in Reach 1****Table 5.9: Erosion-Accretion in the Naf River in Reach 2**

Year	Duration	Erosion (km ²)	Erosion Rate (km ² /yr)	Accretion (km ²)	Accretion Rate (km ² /yr)	Net (km ²)
1989-2000	11	0.58	0.05	0.75	0.07	0.17
2000-2011	11	0.33	0.03	0.63	0.06	0.30
2011-2022	11	0.33	0.03	1.55	0.14	1.21

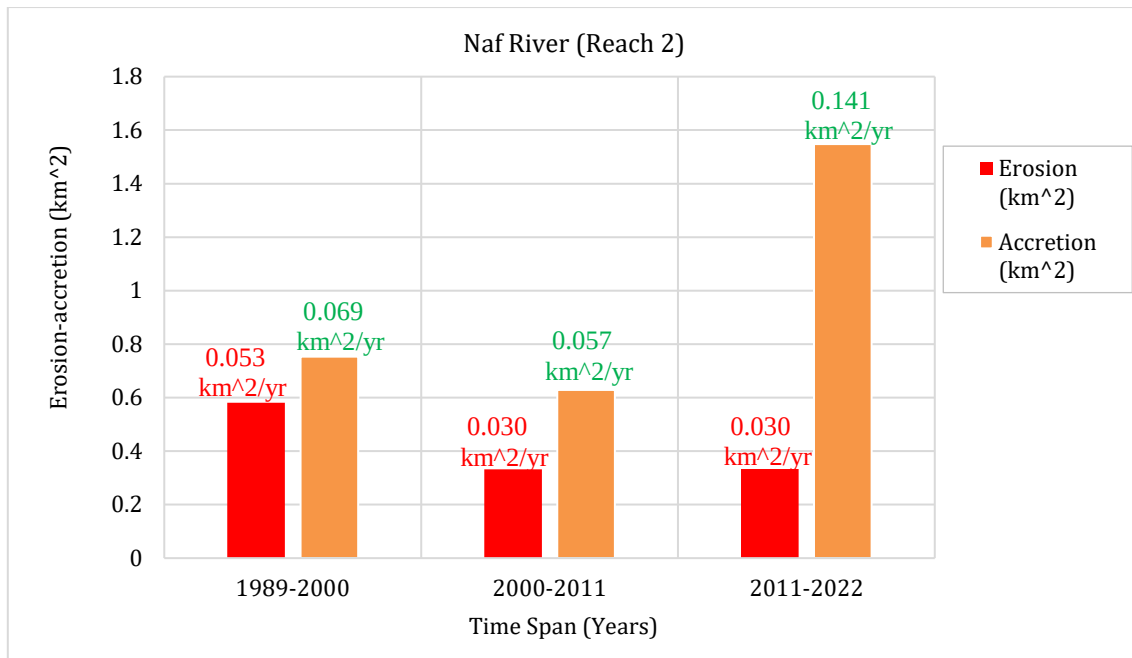


Figure 5.25: Erosion-Accretion in Reach 2

Table 5.10: Erosion-Accretion in the Naf River in Reach 3

Year	Duration	Erosion (km ²)	Erosion Rate (km ² /yr)	Accretion (km ²)	Accretion Rate (km ² /yr)	Net (km ²)
1989-2000	11	2.88	0.26	0.26	0.02	-2.63
2000-2011	11	0.34	0.03	1.64	0.15	1.30
2011-2022	11	0.86	0.08	0.79	0.07	-0.07

NB: Positive Sign (+ve) sign indicates Net Accretion and Negative Sign (-ve) indicates Net Erosion.

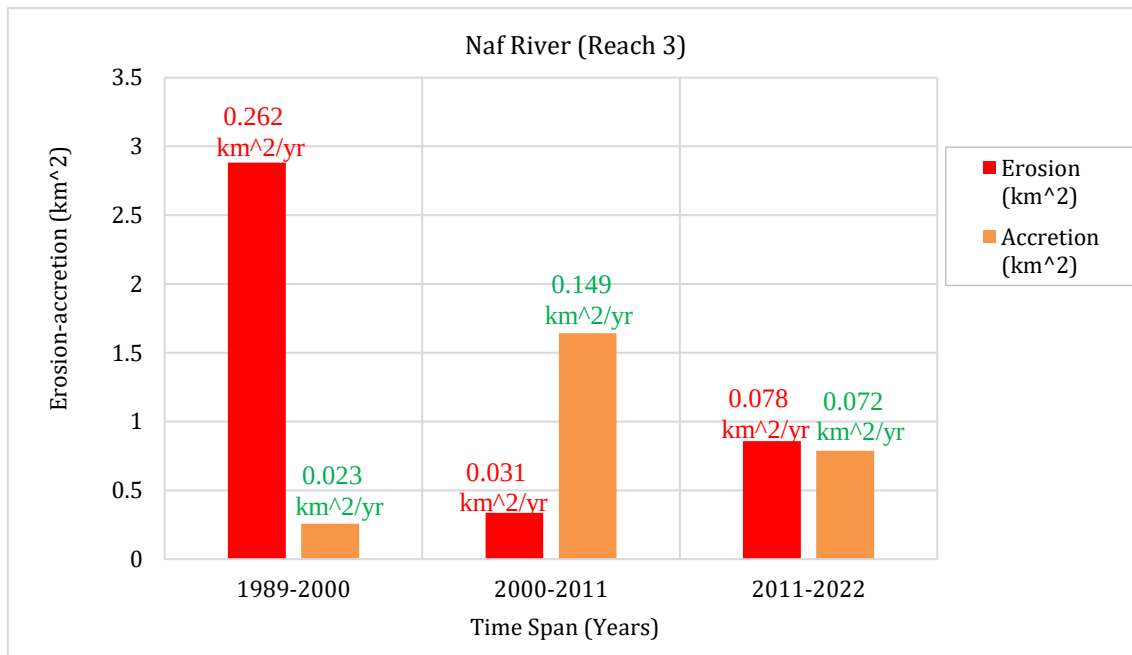


Figure 5.26: Erosion-Accretion in Reach 3

Maps showing the erosion and accretion in the three reaches of the Naf River are given below in Figures 5.27, 5.28, and 5.29.

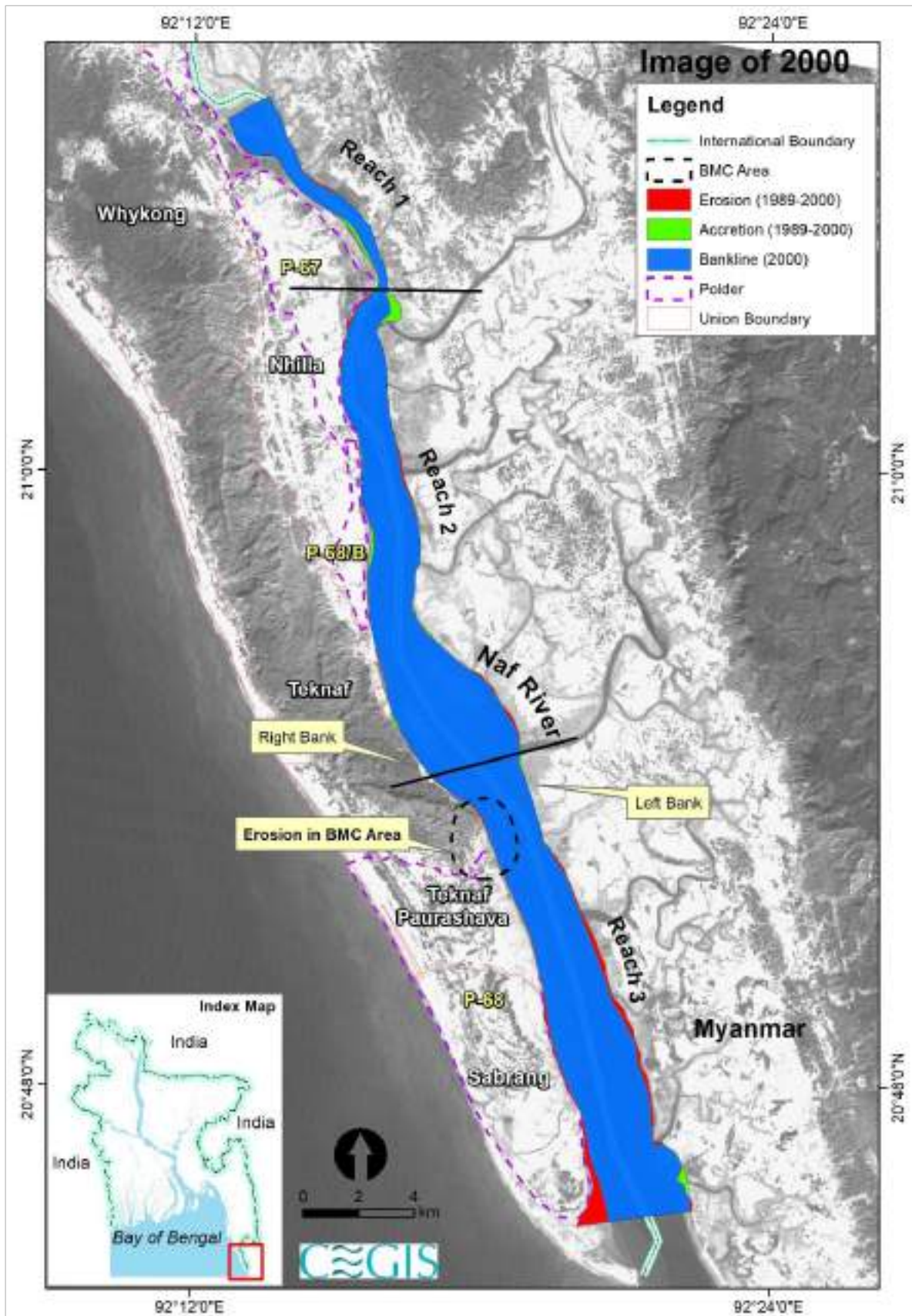


Figure 5.27: Erosion and Accretion in the Naf River from 1989 to 2000

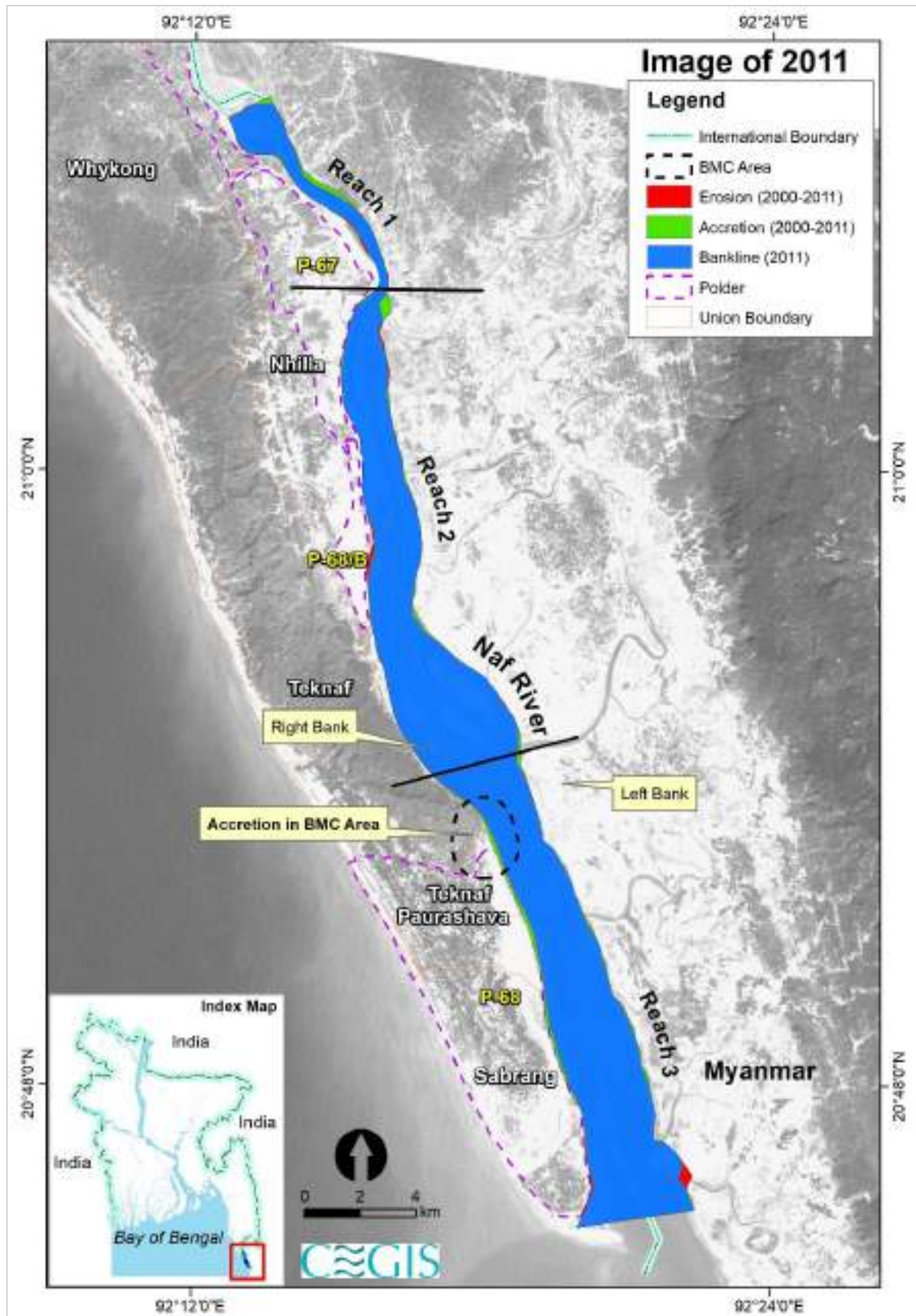


Figure 5.28: Erosion and Accretion in the Naf River from 2000 to 2011

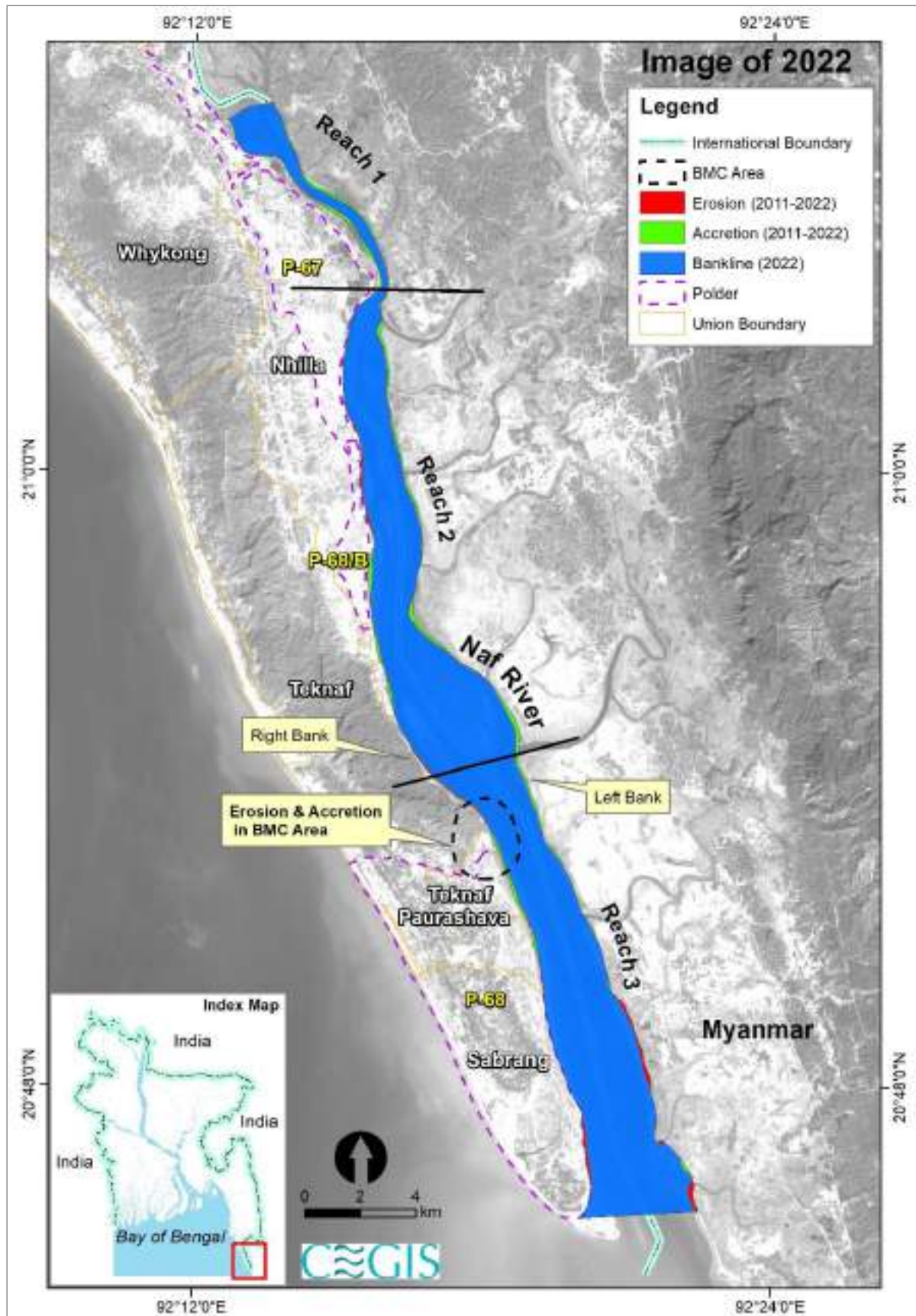


Figure 5.29: Erosion and Accretion in the Naf River from 2011 to 2022

Key Findings and Conclusions

- The sinuosity of the Naf River has not changed much over the years in all the three reaches (**Figure 5.21**) with slight change only being observed in Reach 2 between 1989 and 2000 where the sinuosity seems to have decreased. The constant values of sinuosity indicate the stable characteristics of the river and that the river has not changed its course within the time period considered (1989 to 2022).
- The average width of the river shows a noticeable trend in the various reaches (**Figure 5.21**). In Reach 1, the avg. width shows a decreasing trend. In Reach 2, the avg. width seems to have decreased between 2011 and 2022. In Reach 3, however, the average width seems to have decreased between 2000 and 2011 whilst almost remaining constant between 2011 and 2022.
- It is evident that during the study period, in Reach 3 (where the study area is located), both erosion and accretion took place from 1989 to 2022. However, accretion seems to be the dominant process the along the Right Bank of the Naf River located in the Teknaf Paurashava (where BMC area is located) in the recent years. However, in the Lower part of the river, erosion is the dominant process the along the Right Bank located in the Sabrang Union (**Figures 5.27 and 5.29**).

5.1.3 Geomorphological Settings for BFDC

The study area comprises of the estuary of the Karnaphuli River. The river flows through Patiya, Double Mooring, Patenga, Anowara, Kotwali, Chittagong Port, Bakalia, Rangunia, Raozan, Boalkhali Upazila under Chittagong district and meets the Bay of Bengal near Patenga Upazila. This study estimates the erosion-accretion in the study area.

The erosion and accretion rates within the study area are low, indicating minimal changes to the landform over time. This suggests a stable environment with limited erosion and deposition processes, likely influenced by factors such as low sediment transport rates or effective land management practices. The **Figure 5.30** shows the study area.

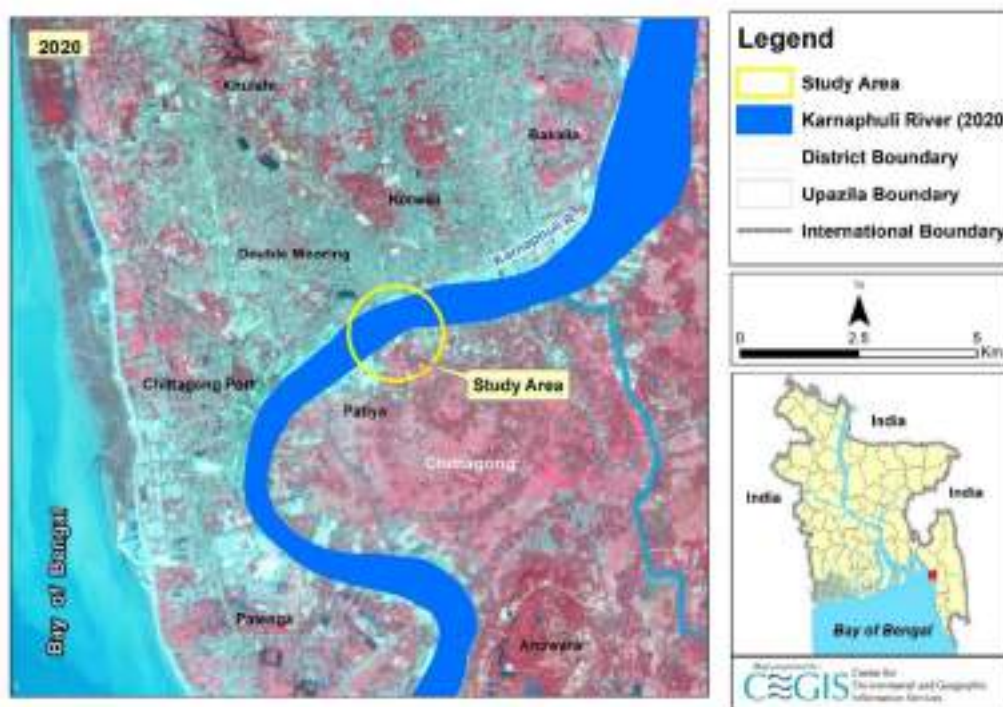


Figure 5.30: Map Showing the Study Area

Historical Development

Karnaphuli River, which is the major river of Chittagong, originates from Lushai hills in Mizoram state and flows about 270 km south and southwest through the south-eastern part of Bangladesh to reach the Bay of Bengal.

To observe the changes in its course from Rangunia to Anowara, historical maps and satellite images have been used. Comparing the scenarios between Rennel's map (1776) and Tassin's map (1840), the river seems to be more straightened in 1840 than in 1776 (specially at the upstream in Rangunia). Moreover, the river course shifted towards south in those decades. Afterwards, satellite image of 1989 and 2020 have also been observed (**Figure 5.31**). From the image of 1989, it can be said that the river has shifted towards north again and has turned into meandering which has continued till 2020. From **Figure 5.31**, it is evaluated that, average width of the river may vary a little, but the river has not changed its course in any significant manner in almost last 30 years.

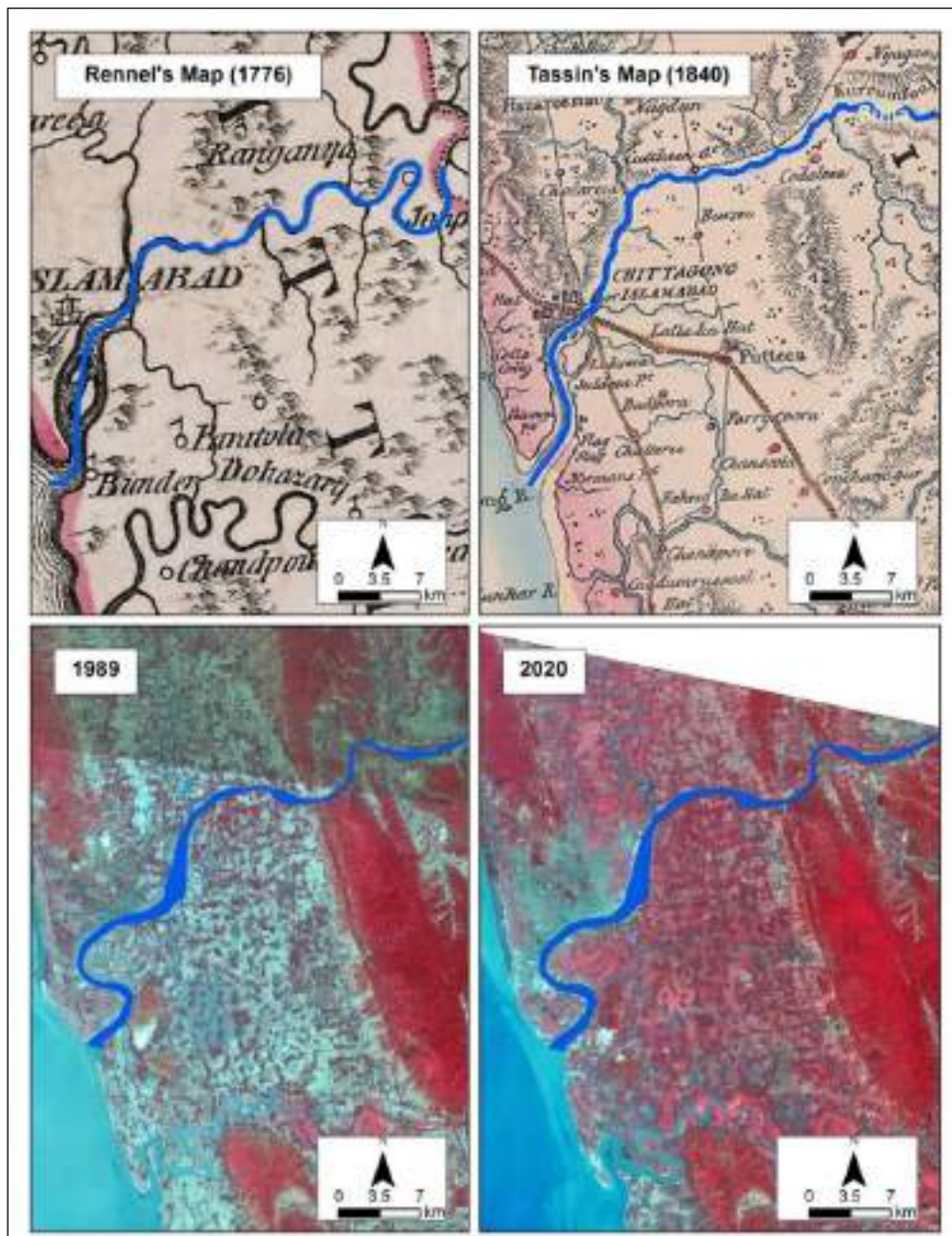


Figure 5.31: Historical Development of Karnaphuli River

Erosion and Accretion of the Study Reach

Erosion and accretion in the area of concern have been assessed during different time periods from 1989 to 2020 and shown in **Table 5.11**. It is evident from the figures that the river channel within the study area did not experience much dynamicity in last 30 years. The erosion and accretion rates within the study site are notably low, underscoring its stable nature.

From 1989 to 2000, erosion had been dominant over accretion. This area experienced erosion of about 52 ha of area and accretion of 36 ha. Eroded and accreted areas from 2000 to 2010 are also calculated using ArcMap Tools. In this decade, this area experienced highest amount of accretion of about 56 ha, while less amount of erosion of 36 ha of area has been observed. In the decade of 2010 and 2020, Accretion has been dominant for this area with approximately 50 ha of area over eroded area of about 39 ha.

Overall, the whole scenario indicates that though erosion has been higher than accretion in this area from 1989 to 2000, accretion has become dominant process for the last 20 years (2000-2020).

Table 5.11: Erosion-Accretion in the Karnaphuli River

Year	Duration	Erosion (Ha)	Erosion Rate (Ha/yr)	Accretion (Ha)	Accretion Rate (Ha/yr)
1989-2000	11	52	4.8	36	3.3
2000-2010	10	36	3.7	56	5.6
2010-2020	11	39	3.9	50	5.1

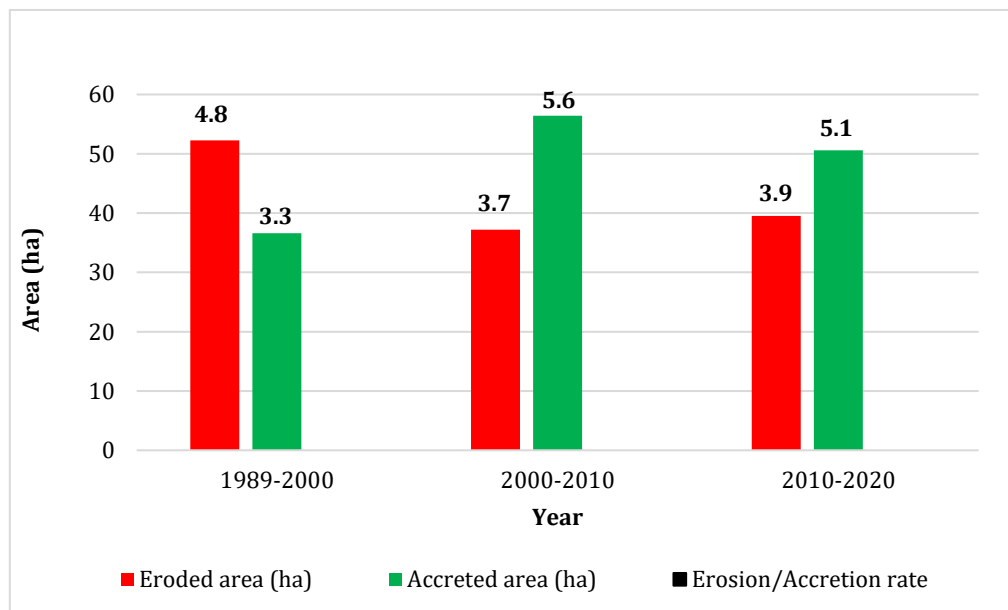


Figure 5.32: Eroded and Accreted Area (1989-2020)

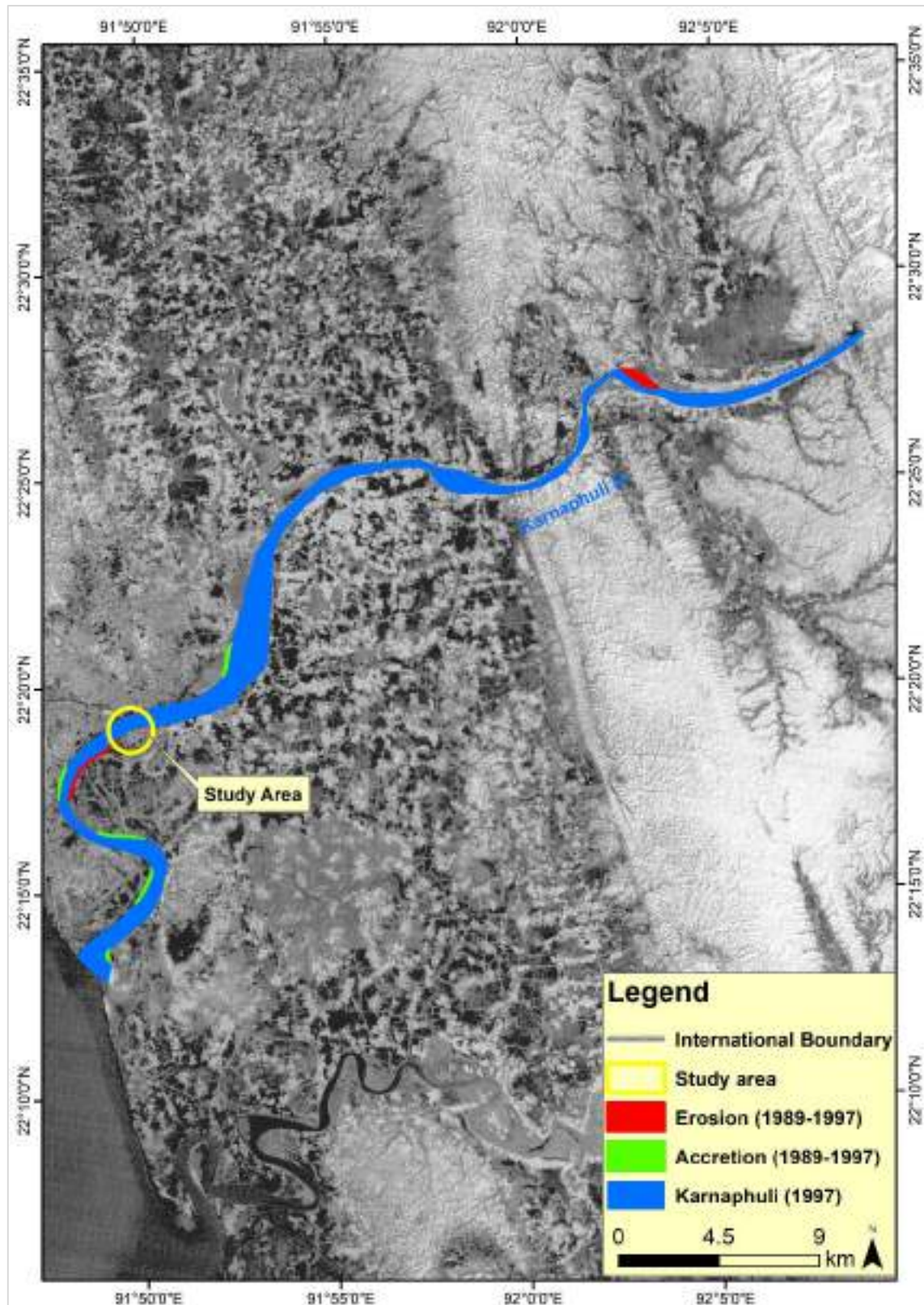


Figure 5.33: Erosion and Accretion in the Karnaphuli River from 1989 to 1997

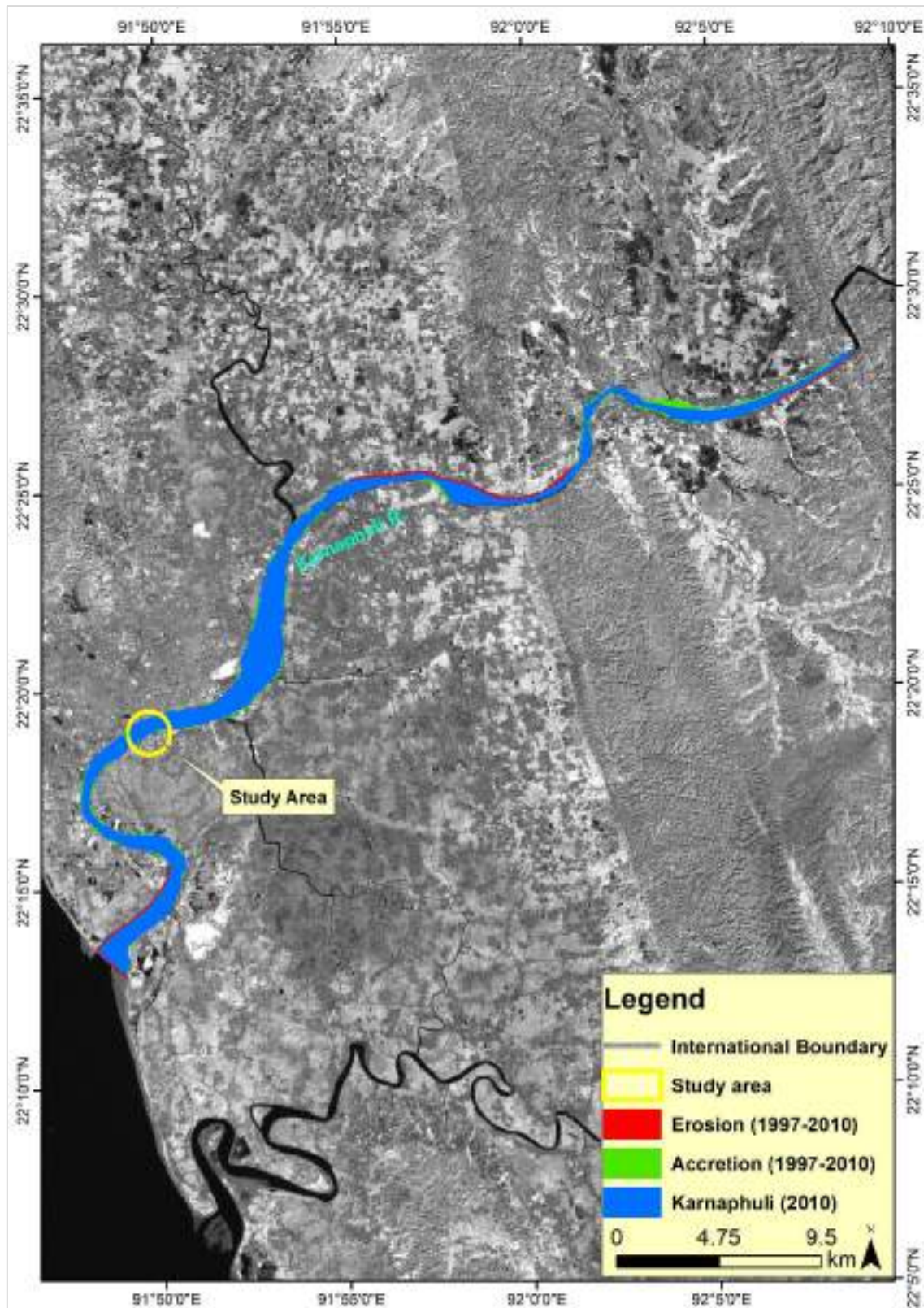


Figure 5.34: Erosion and Accretion in the Karnaphuli River from 1997 to 2010

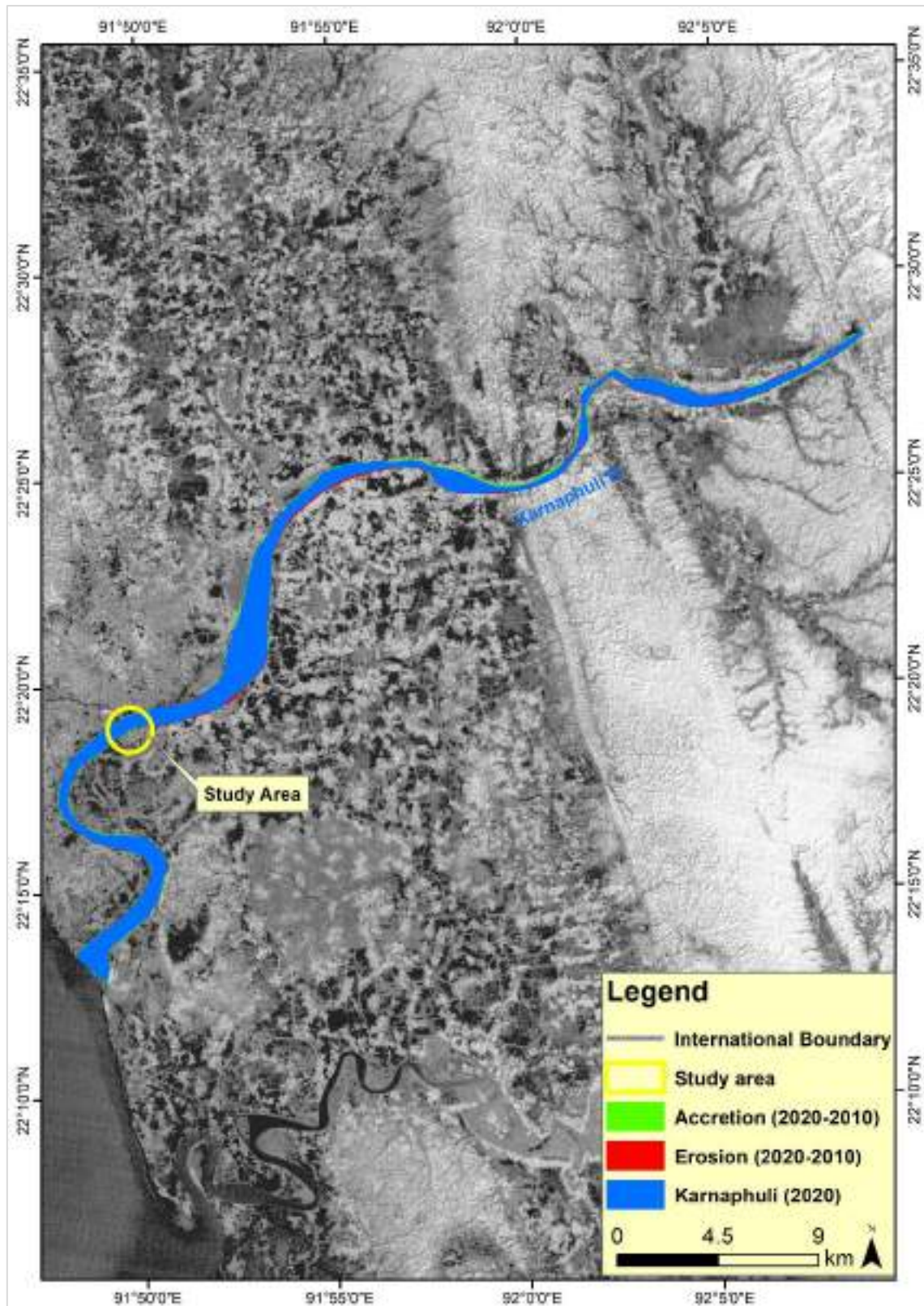


Figure 5.35: Erosion and Accretion in the Karnaphuli River from 2010 to 2020

Sinuosity

Sinuosity is the ratio of the meandering length of a river to its straight chord length. Sinuosity of the river has been measured for 1989 to 2020. Lower values of sinuosity mean that the river course has not changed significantly and indicates stable characteristics of the river. From the analysis, it is evident that the sinuosity of the river has mostly remained unchanged during this time. The **Table 5.12** shows the graphical representation of the sinuosities.

Table 5.12: Variation in sinuosity of the Karnaphuli River

Year	Sinuosity
1989	1.34
2000	1.35
2010	1.35
2020	1.35

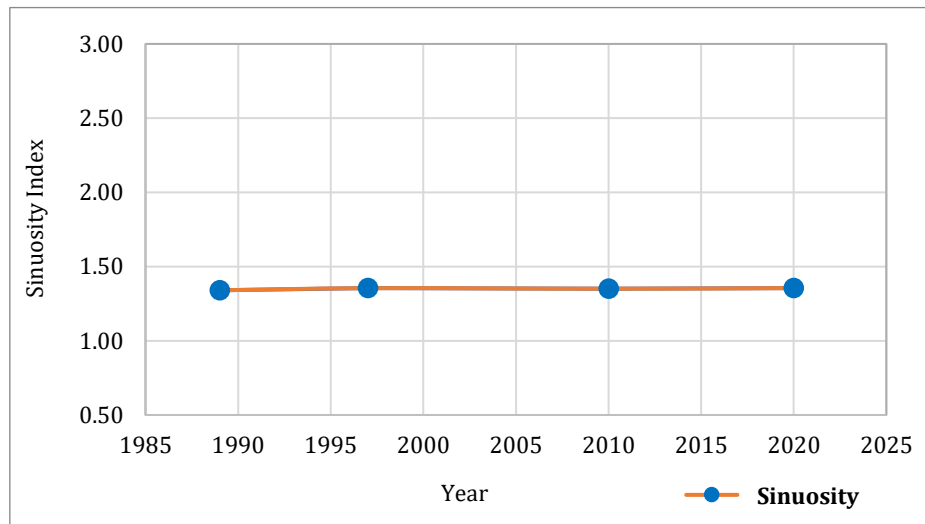


Figure 5.36: Comparison among the Sinuosities

Changes in Width

Average widths for this area have been analyzed for 1989 to 2020 which is represented in **Table 5.13**. From **Table 5.13**, it has been found that the average width of the river has not changed in any significant manner in last 30 years. The width ranges from 790m to 805m on average.

Table 5.13: Average Width

Year	Average Width (m)
1989	790
2000	815
2010	805
2020	805

Source: CEGIS Estimation from Analysis of Satellite Images

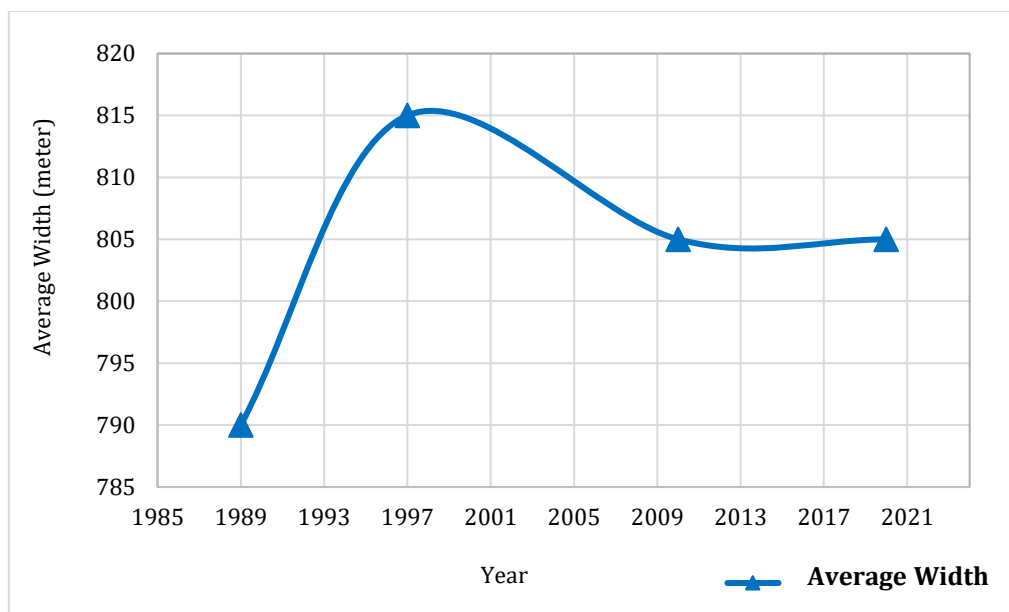


Figure 5.37: Changes in Width

5.1.4 Topography of the Sub-Projects

The study areas of the CSE, BFDC Harbor at Chattogram, and BMC at DFTC Teknaf are mainly located under the coastal region of Chattogram coastal plains. The topography of these areas is highly affected by tidal effects and tectonic activities of the geologic history. However, locally, it seems that these areas are mostly flat. The drainage system is mainly governed by tidal effect of the adjacent rivers which are closely connected by the Bay of Bengal. The seasonal flood of the study areas is mainly shallow and temporal.

For the study area of CSE as shown in the **Figure A16.1** under **Annex 16** under the **Volume II: Annexures of Main Report**, is most flat and lowly elevated within the three study areas of the south eastern part of the study area. The elevation of the area varies mainly from 0mPWD to 6mPWD.

However, from the digital elevation model (DEM) map of the BFDC (**Figure A16.2** under **Annex 16** under the **Volume II: Annexures of Main Report**), it is evident that elevation of the study area ranges 0 to more than 14mPWD. The 0mPWD mainly covers the Karnaphuli River within the study area. A major part of the BFDC study area belongs to the 3mPWD to 8mPWD.

On the other hand, the DEM shows that the elevation of the BMC (**Figure A16.3** under **Annex 16** under the **Volume II: Annexures of Main Report**), varies from 0mPWD to more than 21mPWD. The project area of BMC belongs to the 0mPWD to 12mPWD elevation.

For the south western part of the study area and its vicinity show flat and smooth topography influenced by seasonal flood, erosion and deposition along the river sides and floodplains. The tidal landscape has a low ridge and a basin relief crossed by innumerable tidal rivers and creeks. Local differences in elevation of Ganges Tidal Floodplain are generally less than 1m compared with 2-3m on the Ganges River floodplain. From the Digital Elevation Model (DEM), it is evident that the elevation of the study area of the Khals under Khulna (**Figure A16.4** under **Annex 16** under the **Volume II: Annexures of Main Report**) district varies below mean sea level (-0.39 mPWD) to 5.19mPWD. It also shows that the northern part of the Khulna portion has higher elevation than the southern. Generally, water slopes to the south in the study area of the Khulna District, the area varies from 0.44mPWD to 2.7 mPWD (**Figure A16.4** under **Annex 16** under the **Volume II: Annexures of Main Report**). For Bagerhat District (**Figure A16.5** under **Annex 16** under the **Volume II: Annexures of Main Report**),

it shows more or less same topographic features like that of Khulna. The DEM map shows, the elevation ranges -0.16mPWD to 3.52mPWD. Finally, the Satkhira (**Figure A16.6** under **Annex 16** under the **Volume II: Annexures of Main Report**) has an elevation range as like as (-0.39 mPWD to 5.19mPWD) of Khulna but in the Bagerhat the higher elevated area is more than that of Khulna.

5.2 Geological Settings

5.2.1 Tectonic Setting of the Study Areas

Bangladesh is the part of Bengal Basin. The frequent tectonic activities among the Indian, Tibetan (Eurasian) and Burmese (West Burma Block) Plates have made the Bengal Basin dynamic in nature. A major collision of the Indian plate with South Tibet and Burma plates took place in the Early Miocene, and rapid uplift occurred in the Himalayas and Tibet. At the same time, a major upthrust movement occurred along the Dauki Fault resulting in separation of the Sylhet Trough from the stable shelf, and the Trough formed an important sediment deposition hub. However, subsurface geophysical characteristics of Bangladesh has divided the country into nine major tectonic units- the Himalayan Fore Deep, Rangpur Platform, Bogura Shelf, Calcutta-Mymensingh Hinge zone, Faridpur Trough, Sylhet Trough, Barisal Gravity High, Hatiya Trough and Indo-Burman Ranges.

The study areas of CSE, BFDC Harbor at Chattogram, and BMC at DFTC, Teknaf fall under the Indo-Burman Range as shown in the Figure in **Annex 17** under the **Volume II: Annexures of Main Report** which has a complicated and relatively recent tectonic history and also lies within the folded hills of the Chittagong-Chittagong Hill Tracts Region. Geological point of view, structurally, this area is represented by the north south stretching hills of sedimentary rocks and also directly related to the development of the Himalayan Mountain in the north and Arakan Yoma Mountain in the east. In general, the axis of this folded region is running in NNW-SSE direction, parallel to the general trend of regional strike. Both the flanks of the anticline merge into the alluvial plain of the Feni River in the north and the Karnaphuli in the south due to its doubly plunging nature. The structure has a gently dipping eastern flank and steeper western flank, which is suddenly truncated by the alluvial plain. This truncation is a result of a major faulting that runs parallel to the general strike of the anticline. A general lithological succession of the study area is given in the **Table 5.14**.

Table 5.14: A Generalized Stratigraphic Succession (Tectonic Province-3) of the Study Areas

Age (Appx)		Group	Formation	Lithology	Max Thick. (m)	Depositional Envt.	Tectonic Events
Holocene			Alluvium			Fluvial	
Plio-Pleistocene		Tipam	Dupi Tila	Coarse ferruginous sandstone with layers of quartz pebbles and siltstone with lignitic fragments and petrified wood.	1,600	Fluvial	Folding in the eastern Bengal Basin
			Girujan Clay	Clay and Siltstone			
			Tipam Sandstone	Coarse-grained, pebbly, cross bedded sandstone.		Alluvial	Dauki Fault
Miocene	Late Mio.	Surma	Boka Bil	Dark grey pyrite-bearing shale, sandy shale and sandstone.	1600	Fluvial tidal-deltaic estuarine	Uplift of the Himalayas
	Middle Mio.		Bhuban	Sandstone and pebbly sandstone at the top and sandy shale at the bottom	1500	Shallow marine	

Source: Modified after Evans (1964), Khan (1991a, b), Reimann (1993), Gani and Alam (1999, 2003), Alam et al. (2003)

The study areas of Khulna, Bagerhat and Satkhira fall under Faridpur Trough as shown in the Figure in **Annex 17** under the **Volume II: Annexures of Main Report** which is filled up by enormous volume of Tertiary sediments and can broadly be said, Carboniferous to Recent sediments of about 15 to 20 km pile of deposits. It is an active deltaic Trough with a subsidence rate of 2.2 cm/year or higher. In this area three types of subsidence are recognized which are tectonic subsidence, compaction of peat layers and human induced subsidence. This area is geologically one of the least explored areas in Bangladesh. A general lithological succession of the south western part of the study area is given in the **Table 5.15**.

Table 5.15: Stratigraphic Units of the Cenozoic and Quaternary Sediments within the Bengal

Stage	Group	Formation	Lithology
Holocene		Alluvium	Silt, sand, gravel and clay
Pleistocene/Pliocene (up to 6375 m)	Madhupur	Dihing Formation/ Madhupur Clay	Yellow to yellowish grey, massive, fine to medium sandstone and clay stone/sticky clay
		Dupi Tila Formation	Yellow to ochre, pink, light brown, light grey to greyish-white sandstone, siltstone and conglomerate. Several oxidized, iron-rich, clayey palaeosols. Petrified wood Grey to greenish grey, red mottled, silty shale, shale and clay stone
Pleistocene/ Neogene	Tipam Group Girujan Clay (U. Jamalganj in NW)	Girujan Clay	Grey to greenish grey, red mottled, silty shale, shale and clay stone
Neogene		Tipam Sandstone	Light yellow to yellowish grey, grey, brownish grey and orange fine to medium grained pebbly sandstone, siltstone and shale
	Surma Group (L. Jamalganj in NW)	Boka Bil formation	Greenish to bluish grey and yellowish grey marine pyritic shale, silt-stone and very fine to medium grained sandstone, marine fossils
Miocene(3100m)		Bhuban Formation	Grey to bluish grey fine to medium sandstone, siltstone, clay stone
Oligocene (800-1000 m)		Barail Formation Bogra Formation in the NW	Brown, yellow-brown, pink and grey sandstone, siltstone and carbonaceous shale
Late Eocene (Eocene 600-800 m) Middle to Early Eocene	Jaintia Group	Kopili Formation	Grey, greenish grey to black silty clay stone, fossiliferous shale, thin beds of glauconitic sandstone and limestone
		Sylhet Limestone	Grey to greyish brown massive nummulitic limestone
Eocene and Paleocene		Tura Formation	Grey, brown, pink and greyish-white ferruginous sandstone, coal and shale
Late-Middle Cretaceous	Upper Gondwana	Sibganj Trapwash	Coarse yellow brown sandstone; white clay; volcanic ash

Stage	Group	Formation	Lithology
Early Cretaceous - Jurassic		Rajmahal Traps	Amygdaloidal basalt; serpentinised andesite; shale; agglomerate
Late Permian	Lower Gondwana	Paharpur Formation	Sandstone; feldspathic greywacke; coal, shale; coarse sandstone
Early Permian	Lower Gondwana	Kuchma Formation	Coarse grained sandstone, shale; thick coal seams
Precambrian		Basement Complex	Gneiss and schist

Source: Alam et al. (1990)

5.2.2 Physiography of the Study Area

In the context of physiography, Bangladesh may be classified into three distinct physiographic regions- (a) floodplain areas, (b) terraces, and (c) hills. Each of the units has particular distinguishing characteristics that make each unit identical from others. Almost all the study areas of CSE, BFDC Harbor at Chattogram, and BMC at DFTC, Teknaf belong to Chattogram Coastal plain (**Figure A18.1 – A18.3 under Annex 18 under the Volume II: Annexures of Main Report**). The study area comprises almost-level land crossed by numerous tidal creeks. Adjoining areas of young tidal mud and beach sand along the coast have been included. Small areas near the coast are affected by salinity. Presently the study area is highly interrupted by anthropogenic activities. A very minor area of BMC falls under north-eastern hills physiographic unit which is mainly influenced by hills topography and weathering.

Rajapur Khal of Khulna (**Figure A18.4 under Annex 18 under the Volume II: Annexures of Main Report**) and part of Andigram khal of Bagerhat District (**Figure A18.5 under Annex 18 under the Volume II: Annexures of Main Report**) fall under Gopalganj Khulna Beel Physiographic Unit. The Gopalganj-Khulna Beel occupies a number of low-lying areas which have thick deposits of peat. The Gopalganj-Khulna Beel is the largest peat stock basin of Bangladesh. The basins are deeply flooded by clear rainwater during the monsoon. Subsidence is still going on in this physiographic unit area. Dohar Khal of Khulna District (**Figure A18.4 under Annex 18 under the Volume II: Annexures of Main Report**) falls within two units namely Ganges River Floodplain and Ganges Tidal Floodplain.

Kalmeghar Khal, Atshotobigha and Mahandi Khal of Satkhira District (**Figure A18.6 under Annex 18 under the Volume II: Annexures of Main Report**); Soiludubir Khal of Bagerhat District (**Figure A18.5 under Annex 18 under the Volume II: Annexures of Main Report**) fall under High Ganges River Floodplain. *High Ganges River Floodplain* includes the western part of the Ganges River floodplain which is predominantly highland and medium highland. Most areas have a complex relief of broad and narrow ridges and inter-ridge depressions. The upper parts of high ridges stand above normal flood level. Lower parts of ridges and basin margins are seasonally shallowly flooded. General soil types predominantly include calcareous dark grey floodplain soils and calcareous brown floodplain soils. Organic matter content in the brown ridge soils is low but higher in the dark grey soils. Soils are slightly alkaline in reaction. General fertility level is low.

Char Dakatia and Burir Khal of Bagerhat District (**Figure A18.5 under Annex 18 under the Volume II: Annexures of Main Report**) fall under Low Ganges River Floodplain physiographic unit. *Lower Ganges River Floodplain* holds the eastern half of the Ganges River floodplain which is low-lying. It has a typical meander floodplain landscape of broad ridges and basins. Soils of this region are silt loams and silty clay loams on the ridges and silty clay loam to heavy clays on lower sites. General soil types predominantly include calcareous dark grey and calcareous brown floodplain soils. Organic matter content is low in ridges and moderate in the basins. General fertility level is medium.

Dakatia Khal and Madhobkhali Khal of Satkhira (**Figure A18.6** under **Annex 18** under the **Volume II: Annexures of Main Report**) District fall within two units namely High Ganges River Floodplain and Ganges Tidal Floodplain. Andigram Khal of Bagerhat (**Figure A18.5** under **Annex 18** under the **Volume II: Annexures of Main Report**) District also falls within two physiographic units namely Low Ganges River Floodplain and Gopalganj Khulna Beel.

Mora Jopojopia Nodi and Bollobi Khal of Khulna District (**Figure A18.4** under **Annex 18** under the **Volume II: Annexures of Main Report**); Magra Khal of Satkhira District (**Figure A18.6** under **Annex 18** under the **Volume II: Annexures of Main Report**); and Jibon Nodir Khal, Kumbkhali Khal and Gajdurer Khal of Bagerhat District (**Figure A18.5** under **Annex 18** under the **Volume II: Annexures of Main Report**) fall under Ganges Tidal Floodplain Physiographic unit. The boundary between Ganges Tidal Floodplain unit and the Ganges River Floodplain is traditional. The landscape of Ganges Tidal Floodplain has a low ridge and a basin relief crossed by innumerable tidal rivers and creeks. Local differences in elevation generally are less than 1m compared with 2-3m on the Ganges floodplain. The sediments are mainly non-calcareous clays, but they are silty and slightly calcareous on riverbanks and in a transitional zone in the east adjoining the lower Meghna. This unit covers most of Satkhira, Khulna, Bagerhat, Pirojpur, Barisal, Patuakhali, Bhola and the entire Jhalokati and Barguna districts but excludes the Sundarbans in the southwest. The river carries fresh water throughout the year in the northeast and east, but saltwater penetrates increasingly further inland towards the west, mainly in the dry season, but for most or all of the monsoon in the southwest. In the northeast, there is moderately deep flooding in the monsoon season, mainly by rainwater ponded on the land when the Ganges distributaries and the lower Meghna are at high flood levels. Elsewhere, there is mainly shallow flooding at high tides, either throughout the year, or only in the monsoon, except in the extensive areas where tidal flooding is prevented by embankments. Within embankments, there is seasonal flooding with accumulated rainwater. The soils are non-saline throughout the year over substantial areas in the north and the east, but they become saline to varying degrees in the dry season in the southwest.

5.2.3 Seismicity of the Study Area

Analysis of earthquake hazard is more regional concern than that of local. For example, an earthquake occurred in Nepal may cause damage to Bangladesh. So, regional earthquake analysis is necessary to predict any earthquake hazard in Bangladesh. According to Bangladesh National Building Code (BNBC), 2015; whole land area of Bangladesh has been divided into four seismic zones as shown in the Figure under **Annex 19** under the **Volume II: Annexures of Main Report**. The zone coefficients (Z) for four zones respectively are: Z= 0.12 (Zone-I), Z= 0.20 (Zone-II), Z=0.28 (Zone-III) and Z= 0.36 (Zone-IV). However, the study areas of BFDC, BMC and Chakaria are located under Earthquake Zone III Figure under **Annex 19** under the **Volume II: Annexures of Main Report**, which is third in position with respect to vulnerability level in the context of Bangladesh. It is known that seismic zone co-efficient is considered to provide adequate earthquake resistance for the structure. If any civil structure is designed in the study area taking seismic coefficient, Z=0.28; then according to the relationship between Z values and Richter Scale; the structure can withstand a maximum earthquake of 07 on the Richter Scale. On the other hand, the study areas of Khulna, Bagerhat and Satkhira are located under Earthquake Zone-I Figure under **Annex 19** under the **Volume II: Annexures of Main Report**, which is the lowest in position with respect to vulnerability level in the context of Bangladesh. In this area, if any civil structure is designed in the study area taking seismic coefficient, Z=0.12; then according to the relationship between Z values and Richter Scale; the structure can withstand a maximum earthquake of 05-06 on the Richter Scale. Only, Kalmeghar Khal under Satkhira district falls under Seismic Zone-II. In this area, if any civil structure is designed in the study area taking seismic coefficient, Z=0.20; then according to the relationship between Z values and Richter Scale; the

structure can withstand a maximum earthquake of 06-07 on the Richter Scale. A summary table of seismic intensity and the historical records of earthquake in and around the Bangladesh that occurred during last 475 years is presented in the in **Table 5.16** as ready reference for future planning and designing purposes for this project.

Table 5.16: The Regional Earthquake History of Bangladesh for Last 475 Year

SL	Year	Source Area	Magnitude (Richter Scale)	Depth (Km)
1	1548	Sylhet	-	-
2	1664	Shillong-Plateau	-	-
3	1762	Chittagong-Arakan	≤8.8	-
4	1858	Sandway, Myanmar	6.5	-
5	1869	Cachar, India	7.5	48
6	1885	Sirajganj, Bangladesh	7	72
7	1897	Assam, India	8.1	60
8	1906	Calcutta, India	5.5	-
9	1912	Mandalay, Myanmar	7.9	25
10	1918	Srimangal, Bangladesh	7.6	14
11	1930	Dhubri, India	7.1	60
12	1934	Bihar, India-Nepal	8.3	33
13	1943	Numaligarh, Assam, India	7.2	13
14	1938	Mawlaik, Myanmar	7.2	60
15	1950	Assam, Himalaya	8.6	25
16	1950	Chittagong, Bangladesh	6	-
17	1954	Manipur, India	7.4	180
18	1975	Assam, India	6.7	112
19	1981	Sundarbans, Bangladesh	4.9	-
20	1984	Cachar, India	5.7	4
21	1988	Bihar, India-Nepal	6.6	65
22	1988	Phek, Manipur, India	7.3	90
23	1995	Monipur, India	6.4	-
24	1997	Sylhet, Bangladesh	5.6	35
25	1997	Bangladesh-Myanmar	5.3	56
26	1999	Maheshkhali, Bangladesh	4.2	10
27	2003	Rangamati, Bangladesh	5.6	-
28	2011	Sikim, India	6.9	-
29	2015	Gorkha, Nepal	7.8	8.2
30	2016	Imphal, India	6.7	-
31	2016	Baniachang, Sylhet, Bangladesh	4.4	30
32	2023	14 km ESE of Dohar upazila,Dhaka	4.3	10
33	2023	Ramganj Upazila in Lakshmipur	5.5	10

Source: US Geological Survey

5.3 Soil and Land Resources

The Soil and Land Resources section provides information on the Agro-ecological Zone (AEZ), land type, soil texture, soil salinity, and land use. According to the current definition, AEZ, land type, soil texture, and soil salinity will only be considered for agricultural lands. Therefore, this section will not include discussions on the project area of Chakaria Shrimp Estate and BFDC, both project and study areas of the BMC of Teknaf, catchment areas of Atshobigha Khal, and Kalmegher Khal in Satkhira, Rajapur Khal in Khulna, and Kumbkhali Khal in the Bagerhat district.

5.3.1 Agro-Ecological Zone

Bangladesh's diverse environment presents difficulties because of its variable moisture, temperature, and flooding patterns. To manage this and adequately plan the agricultural sector of Bangladesh, the entire country has been divided into thirty agro-ecological zones and 88 sub-zones. These zones have been identified by adding successive layers of information on the physical environment (physiography, soils, depth and duration of seasonal flooding, and agro-climatology).

According to the analysis, the majority part of the study area of CSE falls under Chittagong Coastal Plain (AEZ-23) and a small part under Northern and Eastern Hills (AEZ-29) (**Figure A20.1** under **Annex 20** under the **Volume II: Annexures of Main Report**). The whole study areas of the BFDC Harbor at Chattogram and BMC area under DFTC, Teknaf fall under Chittagong Coastal Plain (AEZ-23) (**Figure A20.2** and **Figure A20.3** under **Annex 20** under the **Volume II: Annexures of Main Report** respectively).

On the other hand, the study areas of the canals under Satkhira District fall under Ganges Tidal Floodplain, and High Ganges River Floodplain Zones. The Study areas of Atshotobigha Khal and Kalmegher Khal fall under Ganges Tidal Floodplain; Magra Khal falls under High Ganges River Floodplain. However, the majority parts of the Mahandi Khal, Dakshkathi Khal, and Madhabkhali Khal fall under Ganges Tidal Floodplain and rest of the study areas fall under High Ganges River Floodplain. The AEZ Maps of the Study Areas under Satkhira District is shown in **Figure A20.4** under **Annex 20** under the **Volume II: Annexures of Main Report**.

The study areas of the canals under Khulna District fall under Ganges Tidal Floodplain, High Ganges River Floodplain, and Gopalganj- Khulna Beels Zones. Among the five (05) canals under this District, three (03) canals: the Nagkati Khal, Dohar Khal, and Bollobi Khal fall under High Ganges River Floodplain; Mora Jopjopia Nodi falls under Ganges Tidal Floodplain; and the Rajapur Khal falls under Gopalganj- Khulna Beels Zones. The AEZ Maps of the Study Areas under Khulna District is shown in **Figure A20.5** under **Annex 20** under the **Volume II: Annexures of Main Report**.

The study areas of the Bagerhat District cover four (04) AEZs: Ganges Tidal Floodplain, Gopalganj- Khulna Beels, High Ganges River Floodplain, and Low Ganges River Floodplain at different locations. Under this district, Kubkhali Khal falls under Ganges Tidal Floodplain; Jibonkhalir Khal, and Shoilodubir Khal fall under Ganges Tidal Floodplain, and High Ganges River Floodplain; Burir Khal Falls under Low Ganges River Floodplain; Andigram Khal, and Dakatia Khal Fall under Gopalganj- Khulna Beels, and Low Ganges River Floodplain. The AEZ Maps of the Study Areas under Bagerhat District is shown in **Figure A20.6** under **Annex 20** under the **Volume II: Annexures of Main Report**.

The coverage of the AEZ within the study areas is given in the following **Table 5.17**.

Table 5.17: The Coverage of AEZ within the Study Areas of the Sub-Project Sites

List of Intervention Area	Name of AEZ					
	Chittagong Coastal Plain (AEZ-23)	Northern and Eastern Hills (AEZ-29)	Gopalganj-Khulna Bils (AEZ-14)	Ganges Tidal Floodplain (AEZ-13)	High Ganges River Floodplain (AEZ-11)	Low Ganges River Floodplain (AEZ-12)
<i>Chakaria Shrimp Estate</i>						
Project Area	-	-	-	-	-	-
Study Area	444.49	18.52	-	-	-	-
<i>BFDC Harbor at Chattogram</i>						
Project Area	-	-	-	-	-	-
Study Area	15.61	-	-	-	-	-
<i>BMC Area at DFTC, Teknaf</i>						
Project Area	-	-	-	-	-	-
Study Area	-	-	-	-	-	-
<i>Catchments of the Canals for Cluster Farming under Satkhira, Khulna, and Bagerhat Districts</i>						
Atshobigha Khal	-	-	-	-	-	-
Kalmegher Khal	-	-	-	310.66	-	-
Magra Khal	-	-	-	-	655.51	-
Dakatia Khal and Gajdurer Khal	-	-	-	664.36	-	-
Mahandi Khal, Daskathi Khal and Madhobkhali Khal	-	-	-	228.38	-	-
Bollobi Khal	-	-	-	-	289.16	-
Rajapur Khal	-	-	259.38	-	-	-
Dohar Khal	-	-	-	-	186.04	-
Mora Jopjopia Nodi	-	-	-	1,394.61	-	-
Kumbkhali Khal	-	-	-	5.32	-	-
Shoilodubir Khal and Jibon Khalir Khal	-	-	-	951.67	-	-
Burir Khal	-	-	-	-	-	373.76
Andigram khal	-	-	344.75	-	-	-
Nagkati Khal	-	-	-	-	199.46	-

Source: NWRD 2012

The general characteristics of the AEZs those covers the study areas of the sub-project sites are given below:

High Ganges River Floodplain (AEZ-11): This region includes the western part of the Ganges River floodplain which is predominantly highland and medium highland. Most areas have a complex relief

of broad and narrow ridges and inter-ridge depressions. The upper parts of high ridges stand above normal flood level. Lower parts of ridges and basin margins are seasonally shallowly flooded. General soil types predominantly include calcareous dark grey floodplain soils and calcareous brown floodplain soils. Organic matter content in the brown ridge soils is low but higher in the dark grey soils. Soils are slightly alkaline in reaction. General fertility level is low.

Low Ganges River Floodplain (AEZ-12): The region comprises the eastern half of the Ganges River floodplain which is low-lying. The area has a typical meander floodplain landscape of broad ridges and basins. Soils of this region are silt loams and silty clay loams on the ridges and silty clay loam to heavy clays on lower sites. General soil types predominantly include calcareous dark grey and calcareous brown floodplain soils. Organic matter content is low in ridges and moderate in the basins. General fertility level is medium.

Ganges Tidal Floodplain (AEZ-13): The Ganges Tidal Floodplain constitutes about half of the southern region (48%) which is a low-lying area and is crisscrossed by innumerable tidal rivers and creeks whose banks generally stand less than a meter above the adjoining basins. The greater part of this region has smooth relief having large areas of salinity. Riverbanks generally stand about a meter or less above the level of adjoining basins. Non-calcareous grey floodplain soil is the major component of general soil types. Acid sulphate soil also occupies a significant part of the area, where it is extremely acidic during the dry season. Most of the topsoil are acidic and subsoils are neutral to mildly alkaline. General fertility level is high, with medium to high organic matter content.

Gopalganj- Khulna Beels (AEZ-14): The region occupies extensive low-lying areas between the Ganges River floodplain and the Ganges tidal floodplain. Soils of the area are grey, and dark grey, acidic, heavy clays overlay peat or muck at 25-100 cm. Such soils predominate in subregion- Bill margin. Soft peat and muck occupy perennially wet basin centers. Calcareous brown and dark grey loams to clay occupy a generally narrow strip on river banks, but creeks in peat areas do not have mineral soils on their banks. The basin soils stay wet for most or all of the dry season. Fertility level is medium.

Chittagong Coastal Plain (AEZ-23): The soils under this zone are grey silt loams and silty clay loam soils, which are predominant. Acid Sulphate soils, potentially strongly acidic, occur in mangrove tidal floodplains. Non-calcareous grey floodplain soils, non-calcareous alluvium, and acid sulphate soils are the major components of the area's general soil types. The general fertility level of the soils is medium, and N and K are limiting. The status of S is low to optimum. Organic matter content is low to medium. The status of Zn and B is low to medium, and that of N and P is very low to low.

Northern and Eastern Hills (AEZ-29): Northern and Eastern Hills are major hill soils that are yellow-brown to strong brown, permeable, friable, and loamy; they are very strongly acidic and low in moisture-holding capacity. However, soil patterns are generally complex due to local differences in the underlying sedimentary rocks' sand, silt, and clay content and the amount of erosion that has occurred. Brown Hill soils are the predominant general soil type in the area. Organic matter content and general fertility level are low to medium with very low to low status of N and P.

5.3.2 Land Type

Land type is a system of classifying cultivated/agricultural land based on the seasonal inundation depth of normal flooding. In terms of depth of flooding on agriculture land, five classes of land types: High land (F₀), Medium Highland (F₁), Medium Lowland (F₂), Lowland (F₃) and Very Low Land (F₄) are recognized.

The entire study area of the CSE falls under the Medium-high land. Almost one-third of BFDC falls under highland. The catchment areas of the canals are also fallen under highland and medium highland. The land type of Atshobigha canal is excluded from consideration due to the absence of any agricultural

land. The coverage of land type in the study area is presented in **Table 5.18**. The Land Type of the study areas under the sub-projects are given in **Annex 21** under the **Volume II: Annexures of Main Report**.

Table 5.18: The Coverage of Land Type of the Study Areas of the Sub-Project Sites

List of Intervention Area	Land Type	
	Highland	Medium Highland
<i>Chakaria Shrimp Estate</i>		
Project Area	-	-
Study Area	-	463.01
<i>BFDC Harbor at Chattogram</i>		
Project Area	-	-
Study Area	5.15	10.46
<i>BMC Area at DFTC, Teknaf</i>		
Project Area	-	-
Study Area	-	-
<i>Catchment Areas of the Canals for Cluster Farming under Satkhira, Khulna, and Bagerhat Districts</i>		
Atshobigha Khal	-	-
Kalmegher Khal	-	310.66
Magra Khal	655.51	0.00
Dakatia Khal and Gajdurer Khal	-	664.36
Mahandi Khal, Daskathi Khal and Madhobkhali Khal	228.38	-
Bollobi Khal	289.16	-
Rajapur Khal	-	259.38
Dohar Khal	-	186.04
Mora Jopjopia Nodi	-	1394.61
Kumbkhali Khal	5.32	-
Shoilodubir Khal and Jibon Khalir Khal	951.67	-
Burir Khal	-	373.76
Andigram khal	344.75	-
Nagkati Khal	199.46	-

Source: SRDI, 2006

5.3.3 Soil Texture

Soil texture is the relative proportions of sand, silt, and clay, and is an important soil characteristic that determines crop selection, crop production and field management. It influences many other properties of great significance to land use and management.

In the Chakaria Shrimp Estate, the entire study area exhibits a clay texture. Conversely, in the study area of BFDC, soil texture is distributed approximately equally between clay and clay loam. The catchment of the khal areas are also fallen under 2 (two) types of soil texture in the study area. Atshobigha Khal's soil texture is excluded from consideration due to the absence of any agricultural land. The coverage of soil texture in the study area is presented in **Table 5.19**. The soil texture of the

study areas under the sub-projects are given in **Annex 22** under the **Volume II: Annexures of Main Report**.

Table 5.19: Information of Soil Texture within the Study Areas of the Sub-Project Sites

List of Intervention Area	Soil Texture	
	Clay	Clay Loam
<i>Chakaria Shrimp Estate</i>		
Project Area	-	-
Study Area	463.01	-
<i>BFDC Harbor at Chattogram</i>		
Project Area	-	-
Study Area	8.27	7.34
<i>BMC Area at DFTC, Teknaf</i>		
Project Area	-	-
Study Area	-	-
<i>Catchment Areas of the Canals for Cluster Farming under Satkhira, Khulna, and Bagerhat Districts</i>		
Atshobigha Khal	-	-
Kalmegher Khal	-	310.66
Magra Khal	655.51	-
Dakatia Khal and Gajdurer Khal	664.36	-
Mahandi Khal, Daskathi Khal and Madhobkhali Khal	228.38	-
Bollobi Khal	289.16	-
Rajapur Khal	259.38	-
Dohar Khal	186.04	-
Mora Jopjopia Nodi	1394.61	-
Kumbkhali Khal	5.32	-
Shoilodubir Khal and Jibon Khalir Khal	951.67	-
Burir Khal	373.76	-
Andigram khal	-	344.75
Nagkati Khal	199.46	-

Source: SRDI 2006

5.3.4 Land Use

Land use data derived from the satellite image. For this project, multispectral WorldView3 satellite images of 2022-2023, with the spatial a resolution of 0.3m was used for classifying the land use and land cover areas of the study areas of the sub-projects.

In Chakaria, the primary land use of the project area is aquaculture and shrimp farm cum salt pan, whereas significant land use in the study area is also similar. In BFDC, the major land use of the project area is the build-up area, followed by fallow land, whereas, in the study area, the major land use is river and khals, followed by the build-up area. In BMC, the entire land use of the project area is aquaculture, whereas in the study area, the primary land use is river and khals, followed by a built-up area. However, no agricultural land is found in the Chakaria, BFDC, and BMC project areas.

For the analysis of khals catchment areas, certain land-use classes are being combined. Rural settlements, roads, industrial zones, railroads, and other similar areas are merged into built-up non-linear areas. Ditches, ponds, water bodies, oxbow lakes, rivers, and khals are merged into river khals and other water bodies. Orchards, agroforestry areas, betel leaf trellises, and forested areas are combined into orchard and other plantation areas.

In the catchment area of khals, rice cum fish cultivation stands out as a major land use (about 16%). Consequently, these areas are considered for both crop cultivation and fish farming during production calculations. The detailed land use of the study area is presented in **Table 5.20** and **Figure A23.1 to A23.17** in **Annex 23** under the **Volume II: Annexures of Main Report**.

The definition of the land use classes is given in **Annex 24** under the **Volume II: Annexures of Main Report**.

Table 5.20: Land Use and Land Cover Information of the Study Areas of the Sub-Project Sites

Intervention Area		Land use												Total
		Shrimp Farm-cum-Salt Pan	Built-Up Non-Linear	Crop Land	Rice cum Fish Culture	Net cropped area	Fallow Land	Aquaculture	River-Khals and other water bodies	Mangrove Area	Orchard and Other Plantation	Hill	Mudflat or Inter-tidal Area	
CSE	Project Area (ha)	1517.30	5.65	10.04	-	-	70.75	1515.03	495.64	17.75	-	-	36.62	3668.79
	Project Area (in %)	41.36	0.15	0.27	-	-	1.93	41.30	13.51	0.48	-	-	1.00	100.00
	Study Area (ha)	2694.11	244.16	594.01	-	463.01	104.37	2784.11	1479.81	108.97	20.79	-	118.47	8148.80
	Study Area (in %)	33.06	3.00	7.29	-	7.49	1.28	34.17	18.16	1.34	0.26	-	1.45	100.00
BFDC Harbor at Chattogram	Project Area (ha)	-	33.94	-	-	-	8.07	-	6.88	0.51	3.70	-	-	53.09
	Project Area (in %)	-	63.92	-	-	-	15.19	-	12.97	0.96	6.96	-	-	100.00
	Study Area (ha)	-	48.62	15.61	-	15.61	23.69	7.88	122.07	41.76	1.32	-	-	260.95
	Study Area (in %)	-	18.63	5.98	0.00		9.08	3.02	46.78	16.00	0.51	-	-	100.00
BMC Area at DFTC, Teknaf	Project Area (ha)	-	-	-	-	-	-	20.98	-	-	-	-	-	20.98
	Project Area (in %)	-	-	-	-	-	-	100.00	-	-	-	-	-	100.00
	Study Area (ha)	19.31	117.48			0.00	19.83	7.33	219.14	46.23	-	106.69	-	536.02
	Study Area (in %)	3.60	21.92	-	-	-	3.70	1.37	40.88	8.63	-	19.90	-	100.00
Atshobigha Khal	Catchment Area (ha)	-	434.76	-	-	-	-	2654.26	87.78	-	17.08	-	-	3193.88
	Catchment Area (%)	-	13.61	-	-	-	-	83.10	2.75	-	0.53	-	-	100.00
Kalmegher Khal	Catchment Area (ha)	-	171.16	310.66	-	310.66	-	460.90	54.40	-	0.08	-	0.09	997.30
	Catchment Area (%)	-	17.16	31.15	-	-	-	46.21	5.45	-	0.01	-	0.01	100.00
Magra Khal	Catchment Area (ha)	-	92.55	349.09	306.42	655.51	-	-	18.85	-	-	-	-	766.90
	Catchment Area (%)	-	12.07	45.52	39.95	-	-	-	2.46	-	-	-	-	100.00
	Catchment Area (ha)	-	256.24	66.36	598.01	664.36	-	-	31.07	-	-	-	-	951.67

Intervention Area		Land use												Total
		Shrimp Farm-cum-Salt Pan	Built-Up Non-Linear	Crop Land	Rice cum Fish Culture	Net cropped area	Fallow Land	Aquaculture	River-Khals and other water bodies	Mangrove Area	Orchard and Other Plantation	Hill	Mudflat or Inter-tidal Area	
Dakatia Khal and Gajdurer Khal	Catchment Area (%)	-	26.93	6.97	62.84	-	-	-	3.26	-	-	-	-	100.00
Mahandi Khal, Dakskathi Khal and Mahdhobkhali Khal	Catchment Area (ha)	-	171.90	182.07	46.32	228.38	-	479.76	27.94	-	5.35	-	-	913.33
	Catchment Area (%)	-	18.82	19.93	5.07	-	-	52.53	3.06	-	0.59	-	-	100.00
Bollobi Khal	Catchment Area (ha)	-	79.86	35.10	254.06	289.16	0.95	1.74	30.71	-	25.06	-	-	427.48
	Catchment Area (%)	-	18.68	8.21	59.43	-	0.22	0.41	7.18	-	5.86	-	-	100.00
Rajapur Khal	Catchment Area (ha)	-	16.93	0.12	259.26	259.38	0.78	-	12.52	-	2.99	-	-	292.59
	Catchment Area (%)	-	5.79	0.04	88.61	-	0.27	-	4.28	-	1.02	-	-	100.00
Dohar Khal	Catchment Area (ha)	-	144.36	119.95	66.09	186.04	1.35	8.25	45.57	-	1.68	-	0.24	387.50
	Catchment Area (%)	-	37.25	30.96	17.06	-	0.35	2.13	11.76	-	0.43	-	0.06	100.00
Mora Jopjopia Nodi	Catchment Area (ha)	-	464.35	1394.61	-	1394.61	-	358.72	262.67	-	-	-	-	2480.36
	Catchment Area (%)	-	18.72	56.23	0.00	-	-	14.46	10.59	-	-	-	-	100.00
Kumbkhali Khal	Catchment Area (ha)	-	72.93	-	5.32	5.32	-	193.53	21.74	-	-	-	-	293.52
	Catchment Area (%)	-	24.85	-	1.81	-	-	65.93	7.41	-	-	-	-	100.00
Shoildubir Khal and Jibon Khalir Khal	Catchment Area (ha)	-	966.17	930.86	20.81	951.67	-	12.27	93.18	-	2.18	-	-	2025.45
	Catchment Area (%)	-	47.70	45.96	1.03	-	-	0.61	4.60	-	0.11	-	-	100.00

Intervention Area		Land use												Total
		Shrimp Farm-cum-Salt Pan	Built-Up Non-Linear	Crop Land	Rice cum Fish Culture	Net cropped area	Fallow Land	Aquaculture	River-Khals and other water bodies	Mangrove Area	Orchard and Other Plantation	Hill	Mudflat or Inter-tidal Area	
Burir Khal	Catchment Area (ha)	-	88.54	-	373.76	373.76	-	-	14.18	-	-	-	-	476.49
	Catchment Area (%)	-	18.58	-	78.44	-	-	-	2.98	-	-	-	-	100.00
Andigram khal	Catchment Area (ha)	-	182.41	-	344.75	344.75	-	-	14.07	-	-	-	-	541.23
	Catchment Area (%)	-	33.70	-	63.70	-	-	-	2.60	-	-	-	-	100.00
Nagkati Khal	Catchment Area (ha)	-	346.62	198.44	1.02	199.46	-	-	12.99	-	10.38	-	-	569.44
	Catchment Area (%)	-	60.87	34.85	0.18	-	-	-	2.28	-	1.82	-	-	100.00
Total Khal Area	Catchment Area (ha)	-	3488.77	3587.25	2275.82	5863.07	3.08	4169.44	727.68	-	64.80	-	0.33	14317.16
	Catchment Area (%)	-	24.37	25.06	15.90	-	0.02	29.12	5.08	-	0.45	-	0.00	100.00

Source: Worldview 3, 2022-2023 and CEGIS field visit in 2024

Note:

For CSE:

Built up area includes: Ashrayon Project, Jetty, Road and Rural Settlement with Homestead Vegetation

Fallow Land includes: Dyke and fallow land

Aquaculture includes: shrimp farm/ gher

River-Khals and other water bodies include: River, canal, pond, oxbow lake and ditch

Mangrove Area includes Parabon

Orchard and Other Plantation includes Agroforestry, betel leaf trellis, orchard

5.4 Climate and Meteorology

Relevant meteorological data such as rainfall, temperature, Relative humidity, wind speed and sunshine hour were collected from the nearest Bangladesh Meteorological Department (BMD) stations of the respective Sub-Projects to analyze the overall micro-climatic conditions of the study areas. The stations are: Cox's Bazar (Station ID: 11925) at Kutubdia, Chattogram (Station ID:11921), Satkhira (Station ID:11610), and Khulna (Station ID:11604). For Bagerhat District, the nearest BMD station is Khulna, hence, necessary analysis on meteorological condition for Bagerhat District has been considered based on the Khulna Station.

5.4.1 Chakaria Shrimp Estate (Station ID: 11925 at Kutubdia, Cox's Bazar)

Rainfall: The analysis of historical (1993-2022) average monthly rainfall data for the Station ID 11925 at Kutubdia shows that it varies from 217 mm to 842 mm in the monsoon, and the area received a maximum of 1805 mm rainfall in July 1998. The historical maximum annual rainfall of this station was recorded as 4,587 mm in 1998, the minimum was 901 mm in 2022, and average annual rainfall (**Figure 5.38**) is 3099 mm. The pre-monsoon and monsoon periods undergo significant rainfall whereas the dry period (December to March) experiences scarcity of rain. A graphical representation of annual rainfall is shown in **Figure 5.39**.

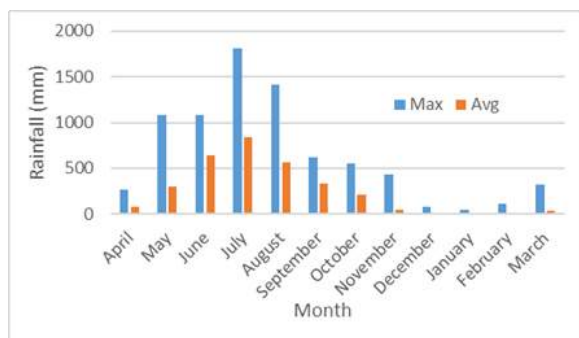


Figure 5.38: Monthly Average Rainfall

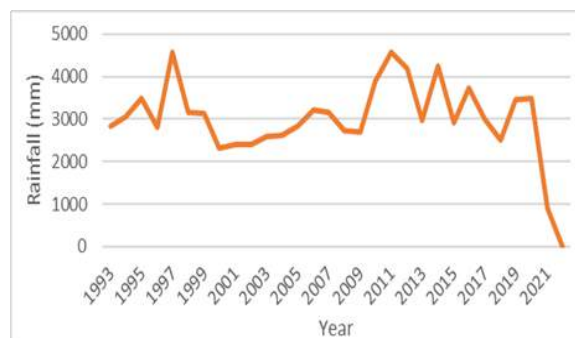


Figure 5.39: Annual Rainfall

Temperature: The analysis of historical (1993-2022) monthly maximum and minimum temperature data of the Station ID 11925 at Kutubdia reveals that the warmest month is May (about 34°C) whereas January is the coldest month (about 13°C). The minimum temperature remains close to 23°C during monsoon season (June to October). The analysis result of monthly average maximum and minimum temperature is shown in **Figure 5.40**.

Relative Humidity: The analysis of historical (1993-2022) average humidity data of the Station ID 11925 at Kutubdia shows that it varies between 74% and 87%. The highest humidity observed during June through September is greater than 85% (**Figure 5.41**).

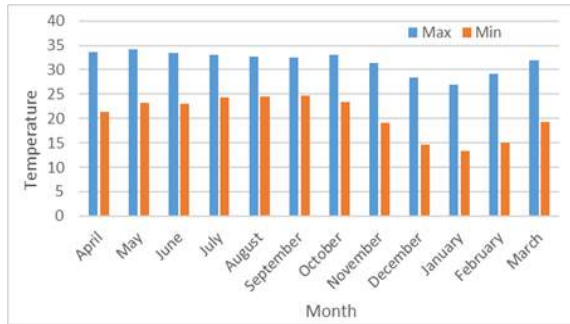


Figure 5.40: Monthly Averaged Maximum and Minimum Temperature

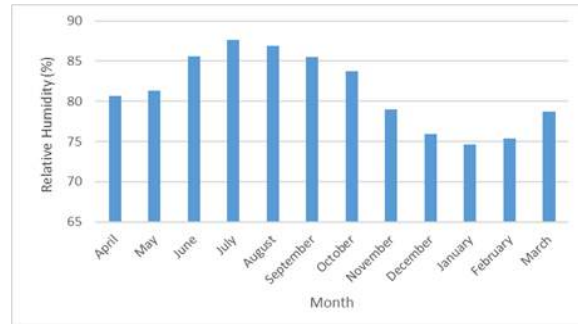


Figure 5.41: Monthly average Relative Humidity

Wind Speed: The analysis of historical (1993-2022) monthly average wind speed data (**Figure 5.42**) of the Station ID 11925 at Kutubdia shows that higher wind speeds are observed during the pre-monsoon and monsoon months. A comparatively lower wind speed prevails during the post-monsoon and dry periods. The monthly average wind speed varies between 9 and 40 km/h. **Table 5.21** shows the wind speed and duration considering various return period.

Table 5.21: Wind Speed and Duration Time for 20, 30, 50 and 100 Years Return Period

	20 Years	30 Years	50 Years	100 Years
Wind Speed (knots)	68.0	77.0	84.6	97.6
Wind Speed (km/hr)	125.9	142.6	156.7	180.8
Duration Time (hours)	15.5	17.5	21.1	25.5

Source: BMD and Feasibility Study Report on Deep Sea Port (PCI, 2009)

Sunshine Hour: The analysis of historical (1993-2022) monthly average sunshine hours' data of the Station ID 11925 at Kutubdia indicates a variation between 4 to 8.5 hours/day (**Figure 5.43**). The figure also shows that the daily average sunshine hours are higher from the end of monsoon and extends up to the dry months (November to April). However, the values are considerably low during monsoon and drops close to 4 hours/day in July due to an increased extent of cloud cover.

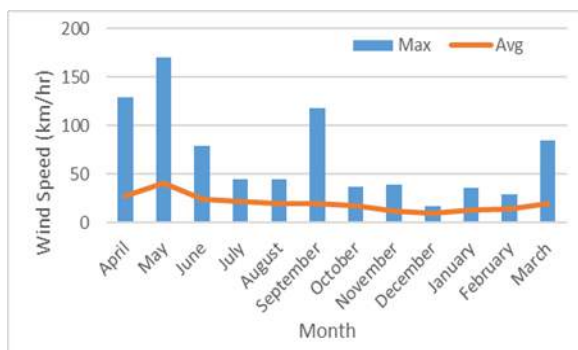


Figure 5.42: Monthly Variation of Average Wind Speed at Kutubdia

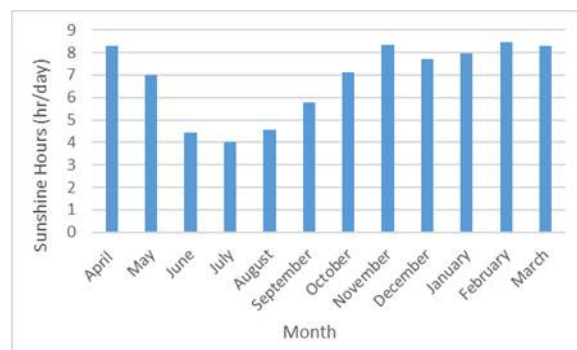


Figure 5.43: Monthly Average Sunshine Hours Per Day at Kutubdia

5.4.2 BFDC (Station ID:11921 at Chattogram)

Rainfall: The analysis of historical (1988-2021) monthly maximum and average rainfall data (**Figure 5.44**) of the Station ID 11921 at Chattogram shows that the monthly average rainfall varies from 307 mm to 745 mm in monsoon and the area received the maximum of 1555 mm rainfall in July, 2015. The

historical maximum annual rainfall (**Figure 5.45**) of this station was recorded as 4340 mm in 2007 and minimum was 2208 mm in 2016.

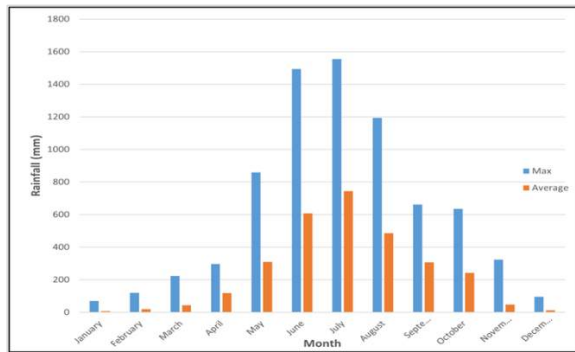


Figure 5.44: Monthly Maximum and Average Rainfall

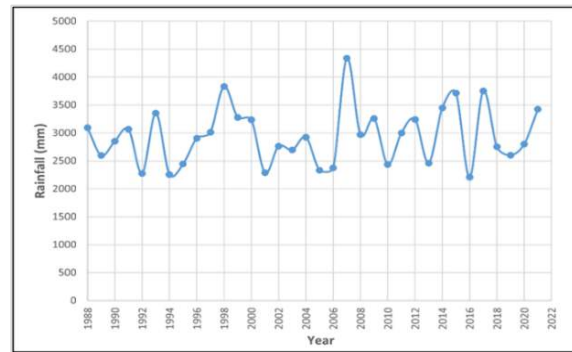


Figure 5.45: Annual Rainfall

Temperature: The analysis of historical (1988-2021) monthly average temperature data of the Station ID 11921 at Chattogram shows that the maximum temperature varies from 26.6°C to 32.9°C and May is the warmest month while the minimum temperature varies from 13.9°C to 25.2°C and January is the coldest month in the study area (**Figure 5.46**).

Relative Humidity: The analysis of historical (1988-2021) Relative Humidity (RH) data of the Station ID 11921 at Chattogram indicates that the average RH varies seasonally from minimum of 67% in February to maximum of 86.4% in July (**Figure 5.47**).

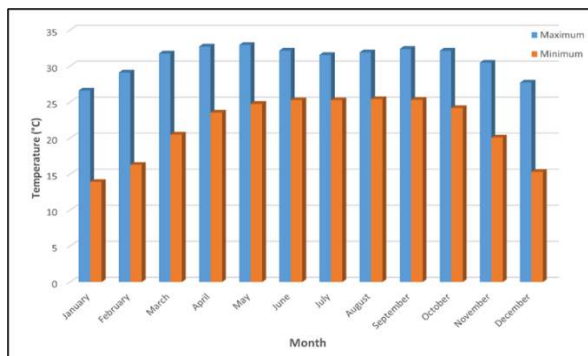


Figure 5.46: Monthly Average of Maximum and Minimum Temperature of Chattogram

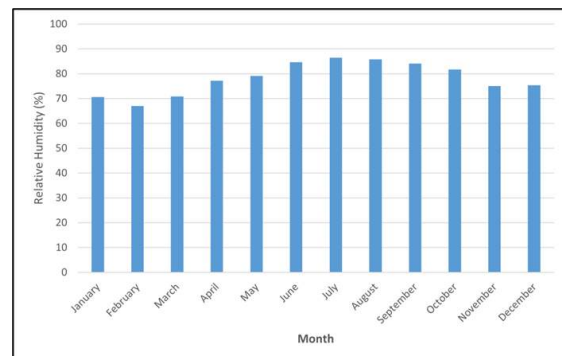


Figure 5.47: Monthly Relative Humidity

Wind Speed: Wind in the area is mostly characterized by a Southerly wind from the Bay of Bengal during monsoon and North-westerly wind from the Himalaya during winter. The analysis of historical (1988-2021) maximum wind speed data of the Station ID 11921 at Chattogram for the last 34 years shows that the monthly maximum wind speed of 166.68 km/hour occurred in May, 1997. On the other hand, the average of maximum wind speed was analyzed and found that it varies from 22.98 km/hour in December to 53.1 km/hour in May (**Figure 5.48**).

Sunshine Hour: The analysis of historical (1988-2021) sunshine hours data of the Station ID 11921 at Chattogram for the last 34 years reveals that the monthly average sunshine hour varies from minimum of 4.04 hours/day in July to maximum of 8.05 hours/day in April (**Figure 5.49**).

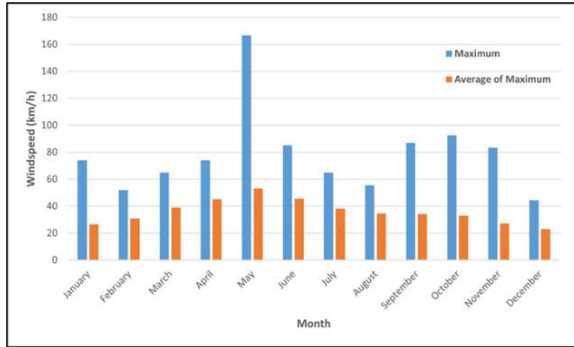


Figure 5.48: Monthly Maximum and Average of Maximum of Wind Speed

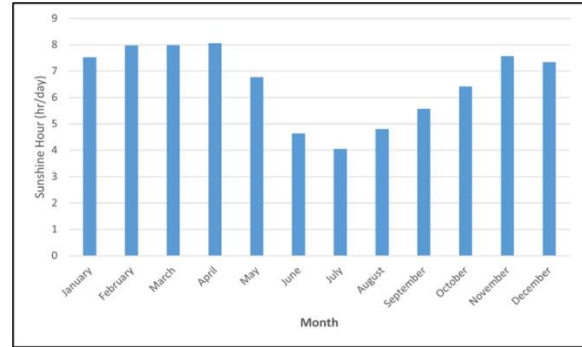


Figure 5.49: Monthly Variation of Sunshine Hours

5.4.3 Canals under Satkhira District (Station ID:11610 at Satkhira)

Rainfall: The monthly maximum and average rainfall data for the last 30 years (1993-2022) was collected and analyzed. The result shows that the monthly average rainfall varies from 151 mm to 344 mm in the monsoon and the area received the maximum of 681 mm rainfall in July in 2015 (**Figure 5.50**). The historical maximum annual rainfall of this station was recorded as 2107 mm in 1997 and minimum was 542.6 mm in 2022 (**Figure 5.51**).

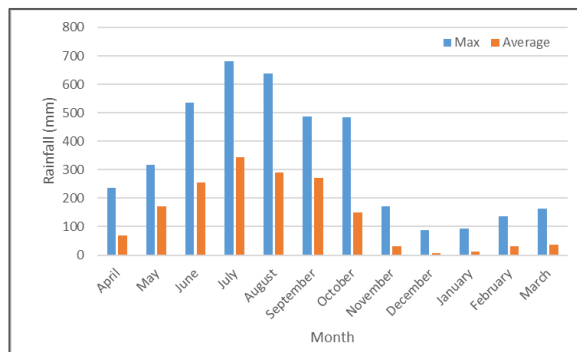


Figure 5.50: Monthly Maximum and Average Rainfall

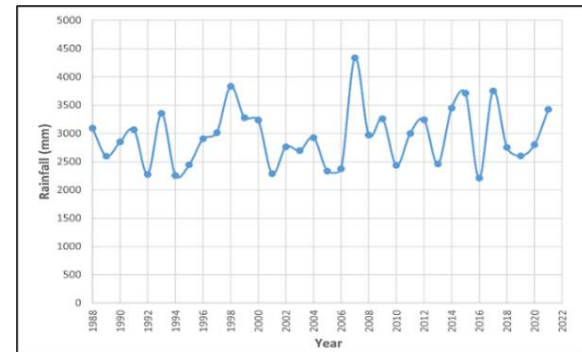


Figure 5.51: Annual Rainfall

Temperature: The monthly average temperature data of last 30 years (1993-2022) shows that the maximum temperature varies from 25.03°C to 35.2°C and May is the warmest month while the minimum temperature varies from 12°C to 25.7°C and January is the coldest month in the study area (**Figure 5.52**).

Relative Humidity: The analysis of the Relative Humidity (RH) data for the period from 1993-2022 indicates that the average RH varies seasonally from minimum of 71.7 % in March to maximum of 85.9% in August (**Figure 5.53**).

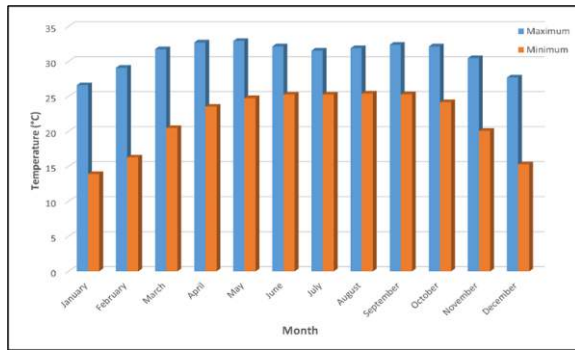


Figure 5.52: Monthly Average of Maximum and Minimum Temperature of Chattogram

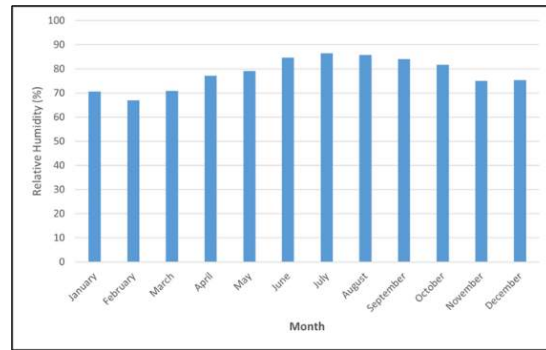


Figure 5.53: Monthly Relative Humidity

Wind Speed: Wind in the area is mostly characterized by Southerly wind from the Bay of Bengal during monsoon and North-westerly wind from Himalaya during winter. The data of maximum wind speed of the last 30 years (1993-2022) shows that the monthly maximum wind speed of 148.8 km/hour occurred in May, 2020. On the other hand, the average of maximum wind speed was analyzed and found that it varies from 10.1 km/hour in December to 29 km/hour in May (**Figure 5.54**).

Sunshine Hour: The data of sunshine hours for the last 30 years' period (1993-2022) was collected and analyzed. It reveals from the analysis that the monthly average sunshine hour varies from minimum of 4.01 hours/day in July to maximum of 8.3 hours/day in April (**Figure 5.55**).

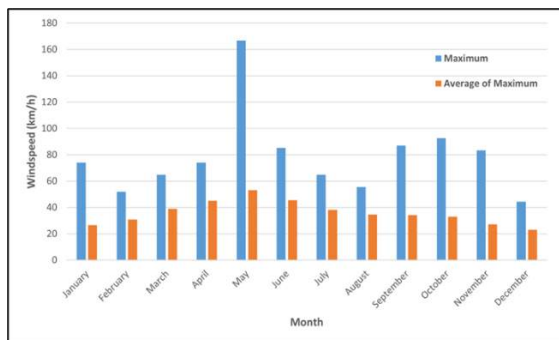


Figure 5.54: Monthly Maximum and Average of Maximum of Wind Speed

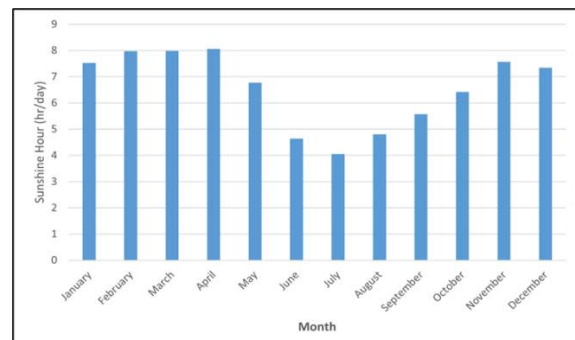


Figure 5.55: Monthly Variation of Sunshine Hours

5.4.4 Canals under Khulna and Bagerhat Districts (Station ID: 11604 at Khulna)

Rainfall: The rainfall data for Khulna stations and 30 years (from 1993 to 2022) data are analysed. The monthly maximum rainfall 922 mm was recorded in the month of October in 2015 and monthly average rainfall varies between 6.8 mm to 371.7 mm (**Figure 5.56**). The maximum annual rainfall of 2594 mm was recorded in the year 2002 and the minimum annual rainfall of 467.8 mm was recorded at Khulna in the year 2022 (**Figure 5.57**).

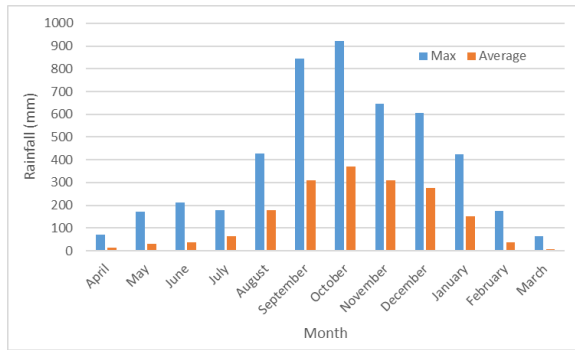


Figure 5.56: Monthly Maximum and Average Rainfall

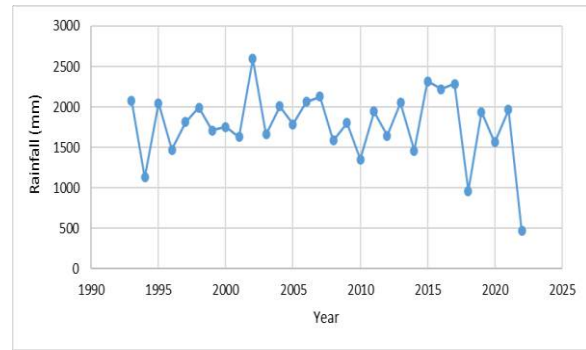


Figure 5.57: Annual Rainfall

Temperature: The monthly average temperature data in Khulna for the last 30 years (1993-2022) shows that May denote as the warmest month and the maximum temperature varies from 29.2°C to 37.9°C. On the other hand, the minimum temperature varies from 9.04°C to 24.5°C and January is the coldest month (**Figure 5.58**).

Relative humidity: Relative humidity data from Khulna weather stations during 1993-2022 has been collected and analyzed. The atmosphere of coastal zone is always enriching with humidity because of high evaporation over the sea surface. The monthly average RH varies seasonally from minimum of 72.1% in February to maximum of 87.1% in July (**Figure 5.59**).

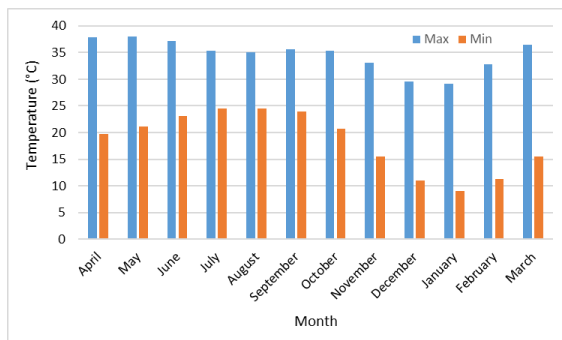


Figure 5.58: Monthly Temperature (°C) at Khulna

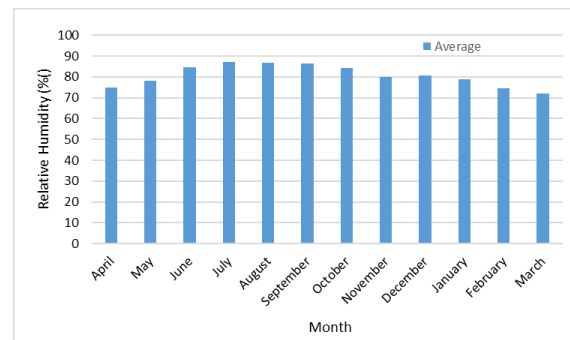


Figure 5.59: Monthly Relative Humidity

Wind Speed: Wind in the area is mostly characterized by Southerly wind from the Bay of Bengal during monsoon and North-westerly wind from the Himalayas during winter. The data of maximum wind speed of the last 30 years (1993 to 2022) shows that the monthly maximum wind speed of 121.3 km/hour occurred in September 1997 and November 2007 at the time of Sidr (**Figure 5.60**).

Sunshine Hour: The data of sunshine hours for the last 30 years' period (1993-2022) was collected and analyzed. The monthly average sunshine hour varies from 3.8 to 8.1 hours/day in July and April, respectfully (**Figure 5.61**).

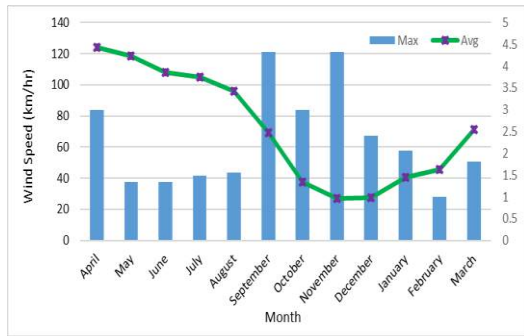


Figure 5.60: Monthly Maximum and Average of Maximum Wind Speed

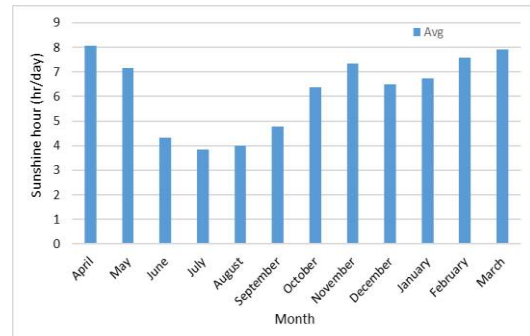


Figure 5.61: Monthly Variation of Sunshine Hours

5.5 Historical Change of the Project Site

5.5.1 Rehabilitation of 10- and 11-acre Chakaria Shrimp Estate, Chakaria, Cox's Bazar

Initially, the Cox's Bazar Coast was occupied by the low-lying saline swamp/mangrove forest at the mouth of the Matamuhuri Delta (Hossain *et al.* 2006). The then Government formed the Chakaria Sundarban Range in 1903 with an area of about 8,276 ha in which around 7,284 ha of area was gazetted as Reserve Mangrove Forest and around 992 ha as the Protected Mangrove Forest. In 1929, an area of about 1,540 ha was leased to 262 land-less families for settlement who were dependent on the mangrove for firewood and housing materials as well as their daily common needs. However, a comparison between the topographic map of 1952 and the black and white aerial photographs of 1974-1975 using remote sensing technique (Alam *et al.* 1990) reveals that the overall mangrove coverage remained unchanged within this tenure of 1952- 1975. Afterwards, this mangrove coverage gradually decreased especially for shrimp farming and a few for salt cultivation (Hossain *et al.* 2006).

Considering the growing demand of shrimp globally, the Government of Bangladesh (GoB) in 1978 started leasing and in 1986, a total of 5000 acres of landmass has been divided into 468 plots of 10 acres each to lease to the interested shrimp farmers through the International Development Agency (IDA)-supported "Shrimp Farming Project" to expand shrimp farming activities with an effort to improve the economic status. Similarly, with the help of Asian Development Bank (ADB), 2000 acres of landmass has been divided into plots of 11 acres and leased to 119 shrimp farmers through the "Fisheries Development Project". Technical assistance is provided through technology demonstration and training programs to shrimp farmers and entrepreneurs by covering an area of a 48-acre shrimp demonstration farm with the support of the Asian Development Bank (ADB) assisted Fisheries Development Project.

The changes of the landmass from mangrove forest to shrimp estate over time are shown in the following **Table 5.22**.

Table 5.22: Changes of CSE over the Time Period

Measuring Parameters	Purely Mangrove Forest	Invasion of Settlement	Shrinkage of Forest	Exhaustion of Forest	Plant Species only on Dyke
Time	1903	1929	1952-1975	1977-1988	2001
Activity	Reserve Forest	Allowed Human Settlement	Human Settlement Expanded	Shrimp and Salt Pan Encroachment	The entire mangrove forest altered into shrimp farms with minor salt pan and human settlement

Source: Hossain et. al. 2006

5.6 Hazard, Risk and Vulnerability

5.6.1 Natural Hazards

Bangladesh is a natural hazard prone country due to its deltaic geographical location. The hazards like tidal flooding, cyclone with storm surge etc. are very common in this area. According to the portal⁴ of UN Environment Programme (UNEP), more than 90% of natural hazards are depending on the weather condition and these are the consequences of the climate change impacts such as: change in hydrological cycle, its frequency, intensity of storms etc. These lead to adverse impacts on food security due to loss of crop and fish production; damage to the property; injury or even casualty; shifting and loss of livelihood, which eventually may have detrimental effects on country's economy as well.

In addition, a natural event occurring two opposite phenomena of periodic warming or colder than the average of sea surface named as El Niño and La Niña respectively, significantly affect the weather patterns of the earth. This event occurs in every two to seven years and last for nine to twelve months period.

Although this recurring climate pattern happens across the tropical Pacific Ocean (the El Niño-Southern Oscillation⁵, or “ENSO”), brings a predictable shift in ocean surface temperature and disrupts the wind and rainfall patterns across the tropics, and results drier and warmer conditions than usual mostly in United States of America (USA) and Canada; these changes are also responsible for global side effects. El Niño can trigger adverse effects on the monsoon season. It also causes warm weather during winter, leading to dry and inadequate summer monsoons with huge temperature rise. These effects encompass alterations in precipitation patterns, droughts, floods and shifts in storm tracks. On the other hand, during La Niña, the sea surface temperatures in the same region become cooler than average, and can also result in distinct weather patterns across different regions.

Figure 5.62 shows the occurrence of “El Niño and La Niña”.

⁴ <https://www.unep.org/topics/fresh-water/disasters-and-climate-change/climate-change-and-water-related-disasters>

⁵ <https://www.climate.gov/enso>

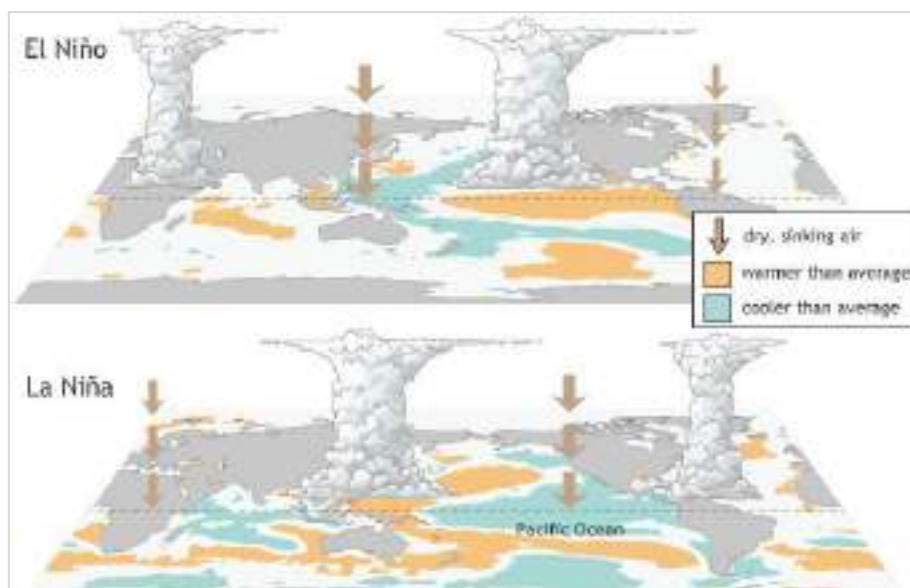


Figure 5.62: El Niño and La Niña Patterns across the Tropical Pacific Ocean

Marine populations are directly affected by El Niño through upwelling of cold nutrient-rich water weakens or ceases entirely, resulting in reduced phytoplankton. This leads to a scarcity of food for the fish populations that rely on phytoplankton as a primary food source and consequently, impacts on other organisms those are dependent on fish such as seabirds and marine mammals.

In this Project, all the sub-project sites are located in the coastal region of the country. Hence, the sub-project sites are susceptible to Cyclone with storm surge, flood event, and salinity. The detailed description of the baseline scenario of the sub-projects are given as follows:

Cyclone and Storm Surge

Cyclone is a natural phenomenon which is unpredictable in terms of timing, intensity and the actual track. Obviously, no measure of design consideration can influence any of the three factors. The only option is to try to predict, as early as possible, the track and intensity of the cyclone storm. During last 125 years more than 42 cyclones have hit the coastal areas and 16 cyclones (**Table 5.23**) have occurred in the last 25 years.

Table 5.23: Major Cyclones Hitting the Bangladesh Coast

Date		Maximum Wind speed (km/hr)	Storm Surge height (Meter)
30 October	1960	211	4.6-6.1
30 May	1961	160	6.1-8.8
28 May	1963	203	4.2-5.2
11 May	1965	160	6.1-7.6
15 December	1965	211	4.6-6.1
1 November	1966	146	4.6-9.1
23 October	1970	163	3.0-4.9
12 November	1970	224	6.1-9.1
25 May	1985	154	3.0-4.9
29 November	1988	160	3.0-4.0

Date		Maximum Wind speed (km/hr)	Storm Surge height (Meter)
29 April	1991	235	6.0-7.5
2 May	1994	210	2.0-3.0
25 November	1995	140	2.0-3.0
19 May	1997	220	3.1-4.2
15 November (Sidr)	2007	240	up to 10
25 May (Aila)	2009	120	3.0
2 August (Komen)	2015	75	1.0 to 2.0
19 May (Roanu)	2016	111	2.0
31 May (Mora)	2017	120	1.2 to 1.5
24 October (Sitrang)	2022	85	1.5 to 2.4

Source: MCSP, 1993, Bangladesh Meteorological Department and Wikipedia (Tropical Cyclones in Bangladesh)

The coastal areas of Bangladesh are one of the most vulnerable areas that experience very high cyclonic storm surge attack. The intensity of the coastal surge largely depends on the pressure fall in the sea level. The most severe pressure fall was recorded in the cyclone of 1991 which was 74 mb with a radius strength of 74 km. The cyclone hit the eastern coast of the Bay of Bengal around Chittagong. The consequent maximum surge was 4.73 m MSL which was a result of combination of astronomical tide and the storm surge.

Flooding

Bangladesh is situated between India, Myanmar and the Bay of Bengal. This country is one of the most vulnerable countries in the world regarding extreme climatic events. The entirety of coastal Bangladesh is under 10 meters' elevation and is highly populated, which increases its exposure to coastal floods. Though people of the deltas have learnt how to live with periodic coastal submersion, they face numerous constraints like ground instability because of fluvial alluvium and subsidence, insalubrity of swamps, and ground salinity, which compelled the population to adapt its cultural activities like planting new rice varieties or shifting from rice cultivation to shrimp farming.

In addition to these, lots of places are exposed to extreme flooding, the population is aggregated around the main cities of the Southeast, Southcentral and Southwest Regions: Khulna, Barisal, Chittagong and Cox's Bazar. In Khulna, despite water level is lower but becomes significantly impactful when crosses the area of higher population density. In Satkhira and Khulna, the west coastal districts, population density is lower but as the people of this area is highly dependent on natural resources, the flooding of the Sundarbans increases the vulnerability to the community.

Three devastating floods struck Bangladesh in 1987, 1988, and 1998, leaving a path of destruction and suffering behind them. In Bangladesh, severe floods that occurred in 1987, 1988, and 1998 submerged up to 70% of the country. According to the annual Report of Flood Forecasting and Warning Center (FFWC), 2021, multiple short-duration floods occurred in Chittagong and Cox's Bazar during the monsoon of 2021 and the highest water level was recorded as 3.48 mPWD at these areas. In addition, the Karnaphuli River flowed below the danger level (4.60 m), peaking on May 27 at 3.60 mPWD, 38 cm below the danger level (4.60 m). It should be noted that the maximum water level previously recorded was 4.98 mPWD.

On the other hand, in Teknaf, during flooding, water overflows on the Golar char land in some of the extent which is beyond the study area. However, most of the areas don't face flooding as it is protected by embankment. According to Annual Flood Report 2021, highest one day maximum rainfall at Teknaf station on July 2021 was recorded 328 mm. Moreover, according to the same Report, the Pasur River

in Khulna reached a peak flow of 3.36 mPWD, which was 32 cm above the corresponding DL (3.04 m) on August 26, 2020.

An analysis of flood considering various return period are given below:

a) Chakaria Shrimp Estate

Flood frequency analysis for Maheshkhali Channel

Historical water level of Maheshkhali Channel was collected from BWDB station at Saflapur (Station ID-200) for the period of 1990 – 2023. Frequency analysis of maximum water level for various return periods using Gumbel Distribution was carried out to assess the corresponding probable flood level, shown in **Table 5.24**. The analysis shows that the flood levels for 20-, 50- and 100-year return periods are 4.33m, 4.82m and 5.2 mPWD respectively.

Table 5.24: Flood frequency analysis of BWDB Station (Saflapur) at Maheshkhali Channel

Return Period (T)	River Water level (mPWD)
2	2.96
5	3.56
10	3.95
20	4.33
50	4.82
75	5.04
100	5.2

Flood Frequency Analysis of Matamuhuri River

Historical yearly maximum water level of Matamuhuri River was collected from BWDB station at Chiringa (Station ID-204) for the period of 1990 – 2023. Frequency analysis of maximum water level for various return periods using Gumbel Distribution was carried out to assess the corresponding probable flood level, shown in **Table 5.25**. The analysis shows that the flood levels for 20-, 50- and 100-year return periods are 8.44m, 9.23m and 9.81 mPWD respectively.

Table 5.25: Flood frequency analysis of annual maximum water level at Matamuhuri River BWDB Station (Chiringa)

Return Period (T)	River Water level (mPWD)
2	6.25
5	7.20
10	7.83
20	8.44
50	9.23
75	9.57
100	9.81

Risk Assessment

Risk assessments for the study area encompass two main categories: 1) Monsoon Flood Risk Assessment, and 2) Storm Surge Risk Assessment. Subsequent sections of the report delve into the specifics of these assessments.

1. Monsoon Flood Risk Assessment

The objective of the Monsoon Flood Risk Assessment model is to assess flood hazards in the study area, focusing on scenarios including the baseline situation and projections for 2030, 2050, and 2080 under different climate change scenarios (RCP4.5 and RCP8.5) for various return periods (RP10, RP20, RP50, RP100).

Modeling Software: For the flood modeling process, the sophisticated Sobek modeling suite, developed by Deltares in The Netherlands, was selected as the primary software tool. This suite offers a comprehensive set of features, including rainfall-runoff (RR), 1D, and 2D hydrodynamic modules, which are essential for simulating complex flood scenarios. By leveraging the capabilities of Sobek, the study ensures a robust and integrated approach to flood modeling, enabling the dynamic linkage and transfer of flow between different modules.

Model Schematization: The model schematization process involves the refinement and enhancement of the existing Eastern Hill regional model, which was previously developed for specific parts of the region. Through the incorporation of updated cross-section data, additional river reaches, and boundary conditions, the model's spatial representation is improved, thereby ensuring a more precise simulation of flood events within the study area.

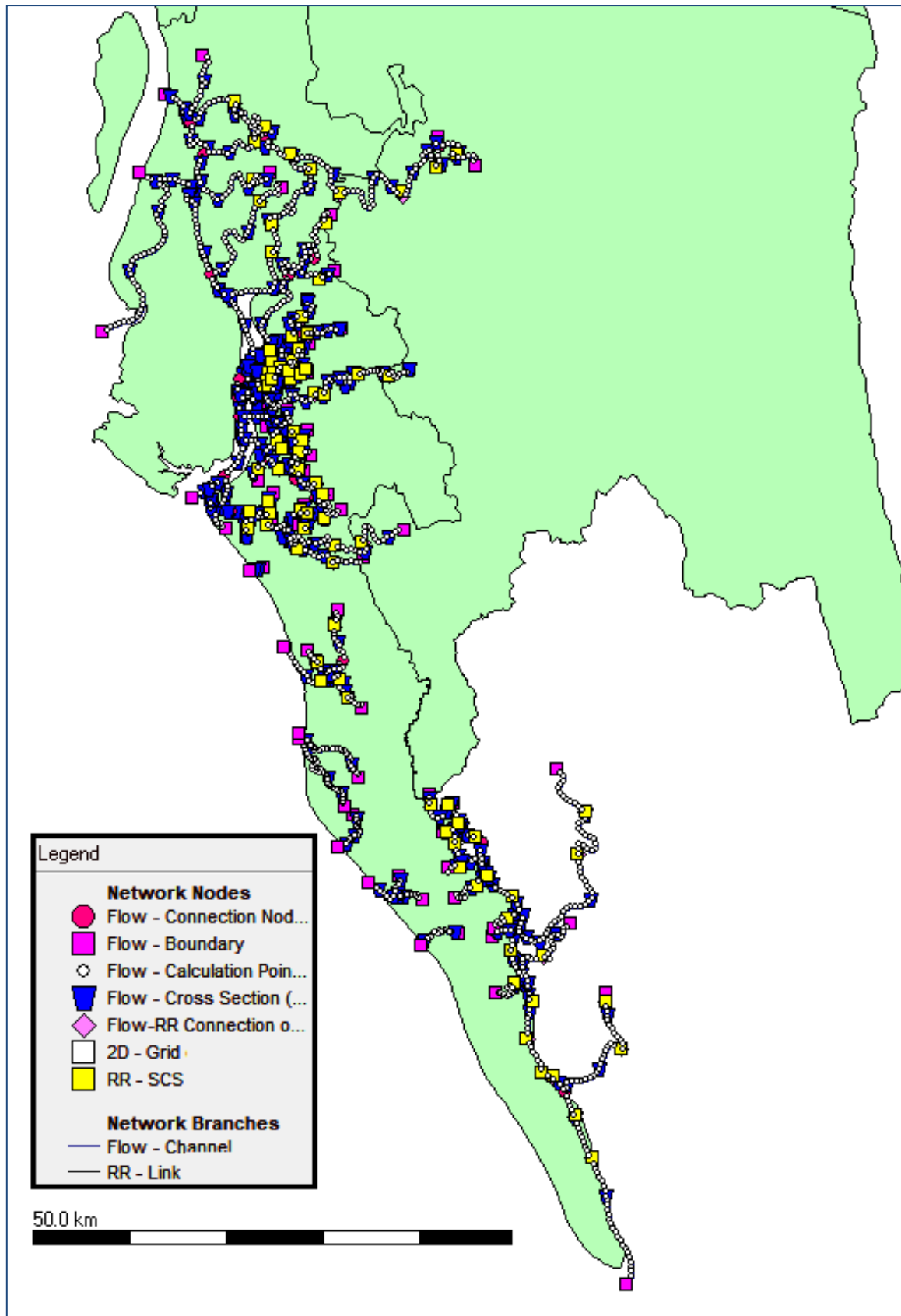


Figure 5.63: Computational Domain of Eastern Hill Regional Model

Input Data: A diverse range of input data is utilized to inform the hydrologic and hydrodynamic models, including observational data for water level and discharge, river cross-section measurements, meteorological data (e.g., rainfall), Digital Elevation Models (DEMs), soil type information, land cover datasets, and future climate projections. By integrating these datasets, the models can accurately represent the complex interactions between various environmental factors that influence flood dynamics within the study area.

Table 5.26: Summary of Input Data of the Hydrologic/ Hydrodynamic Models

Data Layer	Type	Spatial resolution	Source
Water level, Discharge	Station Observation, time series		BWDB
River cross section	BWDB measurement		BWDB
Meteorology (Rainfall)	Station Observation, time series		BMD
Digital Elevation Model	Grid	30 m	Copernicus, ESA

Result: Visual representations of the total flooded area across different return periods are provided in **Figure 5.64** to **Figure 5.66**. The analysis reveals that under existing conditions, the study area faces significant inundation, with the entire area susceptible to flooding. This is particularly concerning given the current dyke height of 1 meter and inadequate drainage sluices, which fail to adequately mitigate the effects of tidal inundation.

These findings underscore the urgent need for proactive measures to enhance flood resilience and mitigate the adverse impacts of inundation events. By addressing critical infrastructure gaps and implementing robust flood management strategies, stakeholders can work towards minimizing the risk posed by recurrent flooding and safeguarding the well-being of communities within the study area.

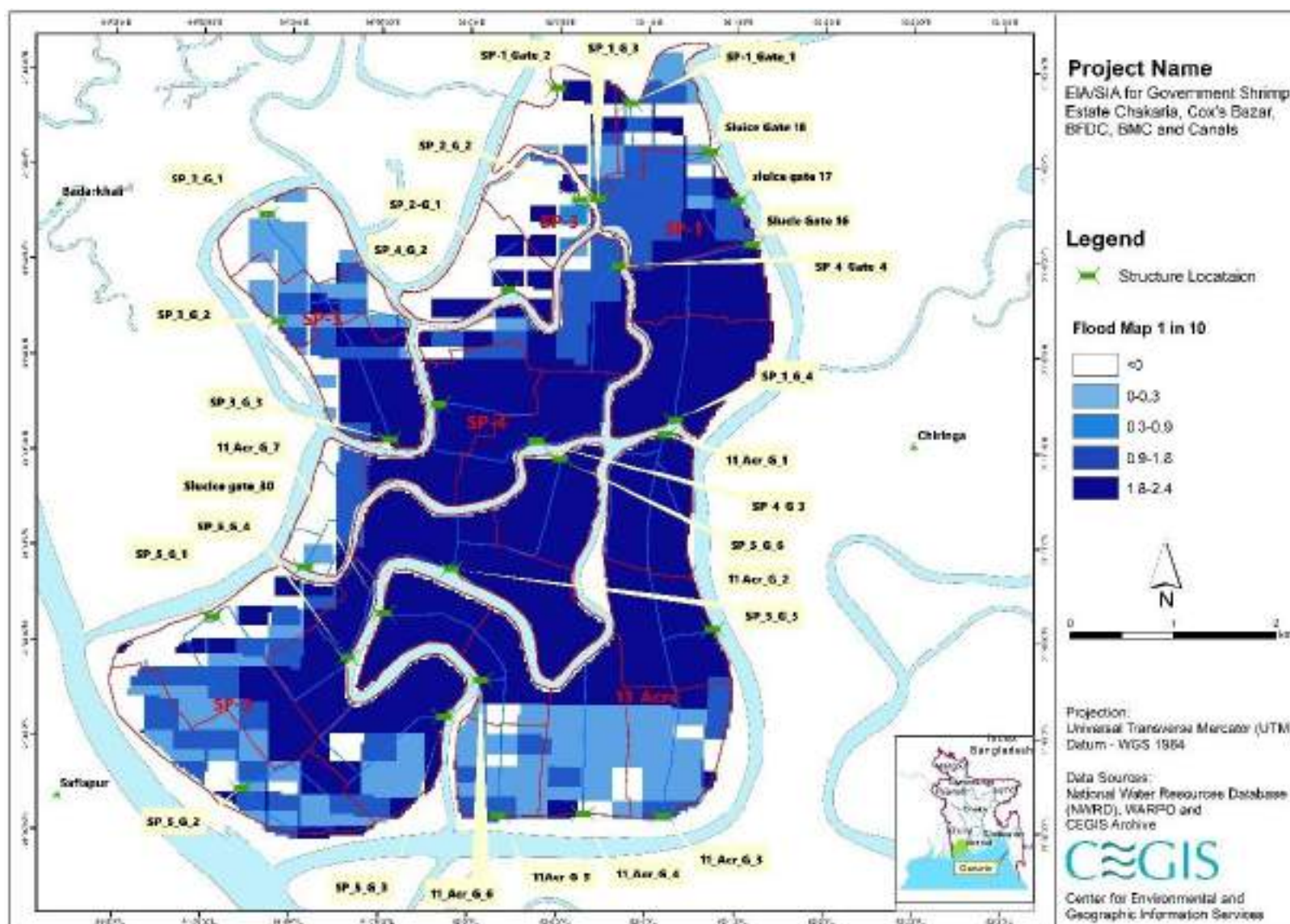


Figure 5.64: The Maximum Flood Inundation for 1 in 10 Return Period in Chakaria Upazila

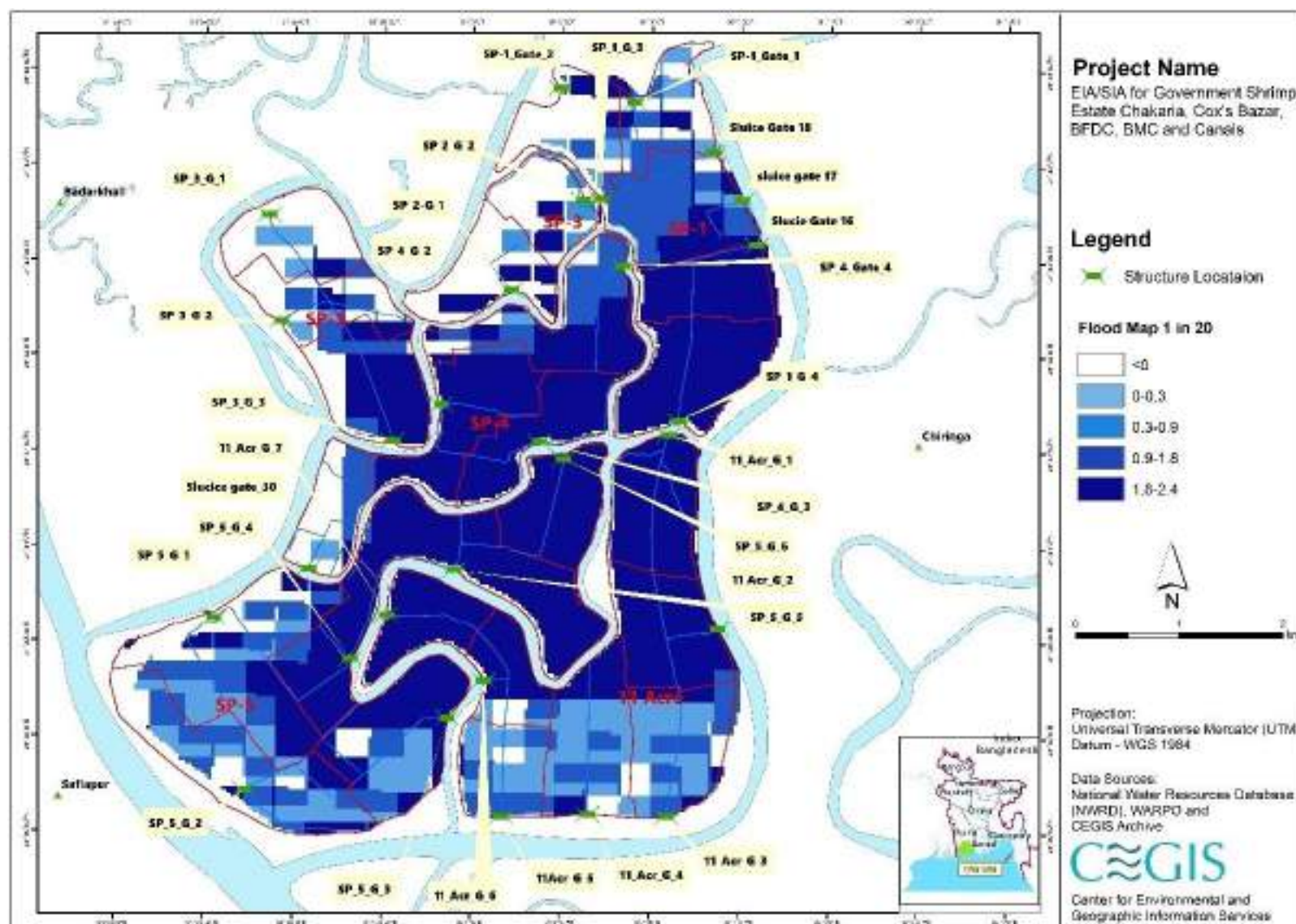


Figure 5.65: The Maximum Flood Inundation for 1 in 20 Return Periods in Chakaria Upazila

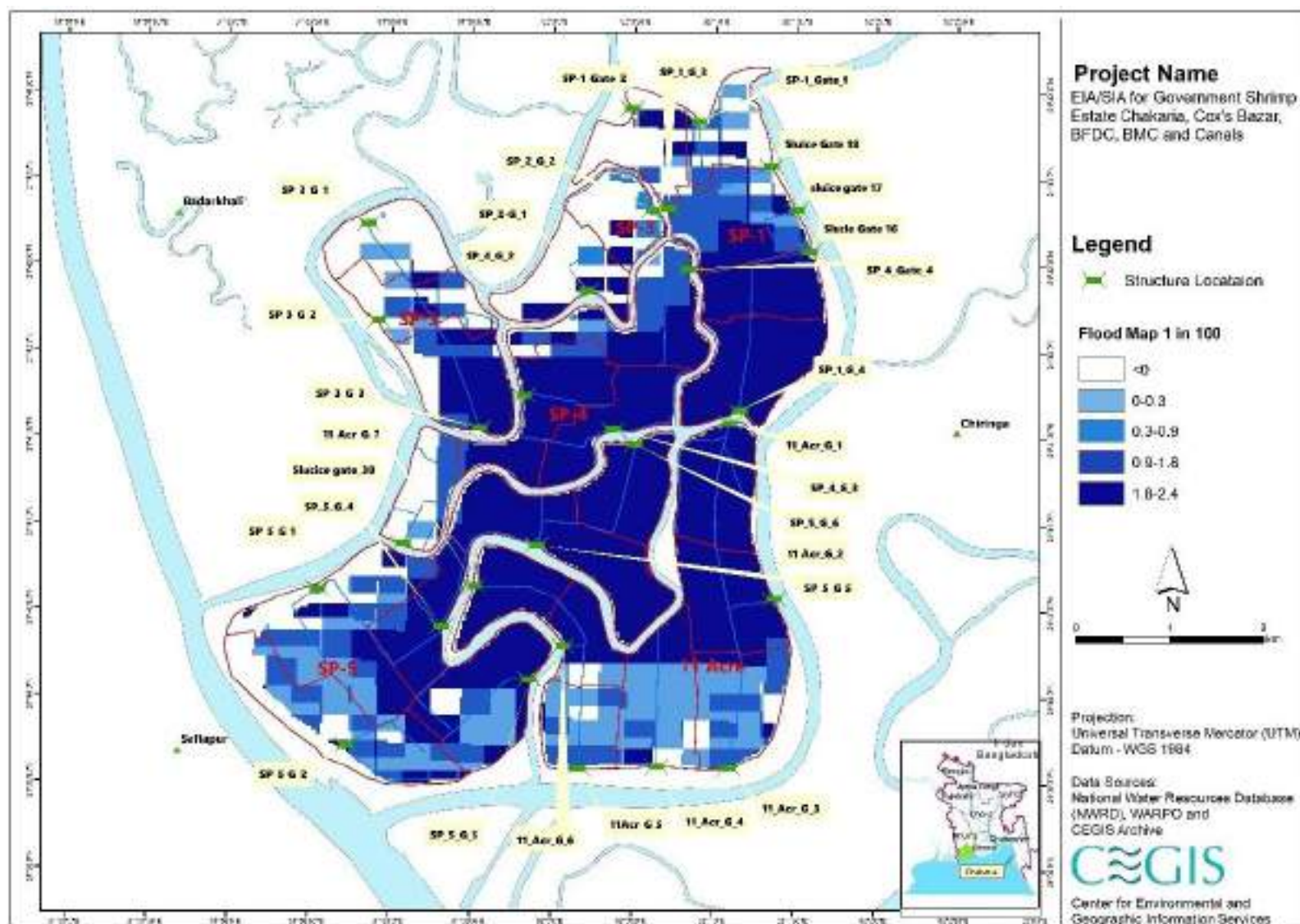


Figure 5.66: The Maximum Flood Inundation for 1 in 100 Return Periods in Chakaria Upazila

2. Storm Surge Risk Assessment

The storm surge risk assessment utilized a simulation approach employing the Storm Surge model developed by CEGIS, powered by Delft3D. This model was specifically tailored to simulate the impacts of storm surges within the study area. CEGIS's Storm Surge model, integrated with Delft3D, offers advanced capabilities for simulating storm surge events. By leveraging this model, the assessment aimed to accurately replicate the behavior of storm surges, considering various factors such as cyclone intensity, wind patterns, and topographical features of the coastal region.

Historical Storm Surge Data Collection: There are many agencies that provide the historical data for cyclone induced storm surges occurred in the different parts in the world. Among them, tracks provided by the Joint Typhoon Warning Centre (JTWC) and IBTrACS (International Best Track Archive for Climate Stewardship) are by far the highly used ones for storm surges. JTWC provides the storm surge track data for the past 70 years with wind speed, pressure drop, cyclone locations, track, radius of maximum wind speed, eye diameter etc. IBTrACS track is also freely available for storm surges. On the other hand, Indian Meteorological Department (IMD) has been providing the best track data for the Bay of Bengal for last 30 years. This study used JTWC, IBTrACS and IMD track data of eastern coast only for generating representative storm surge. **Figures 5.67** presents the cyclone tracks during the last 50 years in Chittagong coastal zones of Bangladesh.

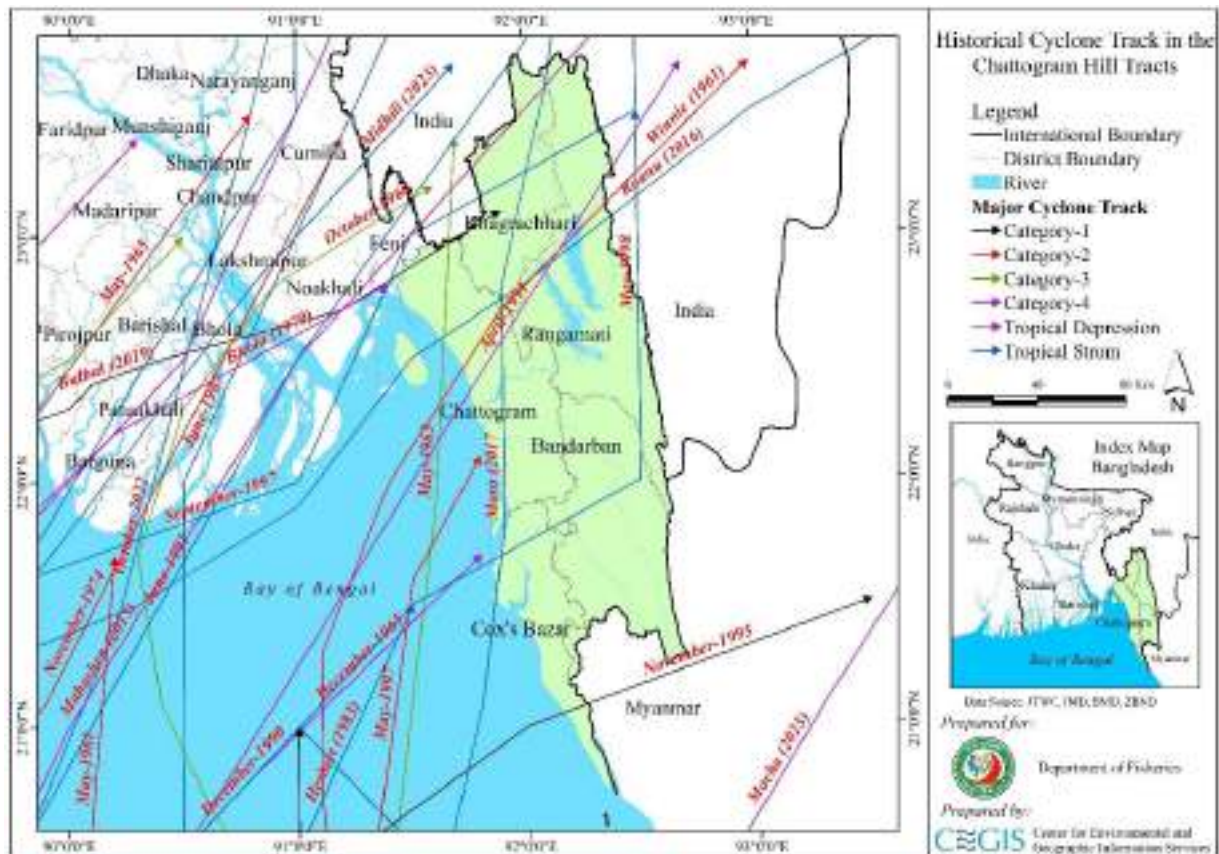


Figure 5.67: Storm Surge Tracks of Last 50 Years Over Chittagong Coastal Zone

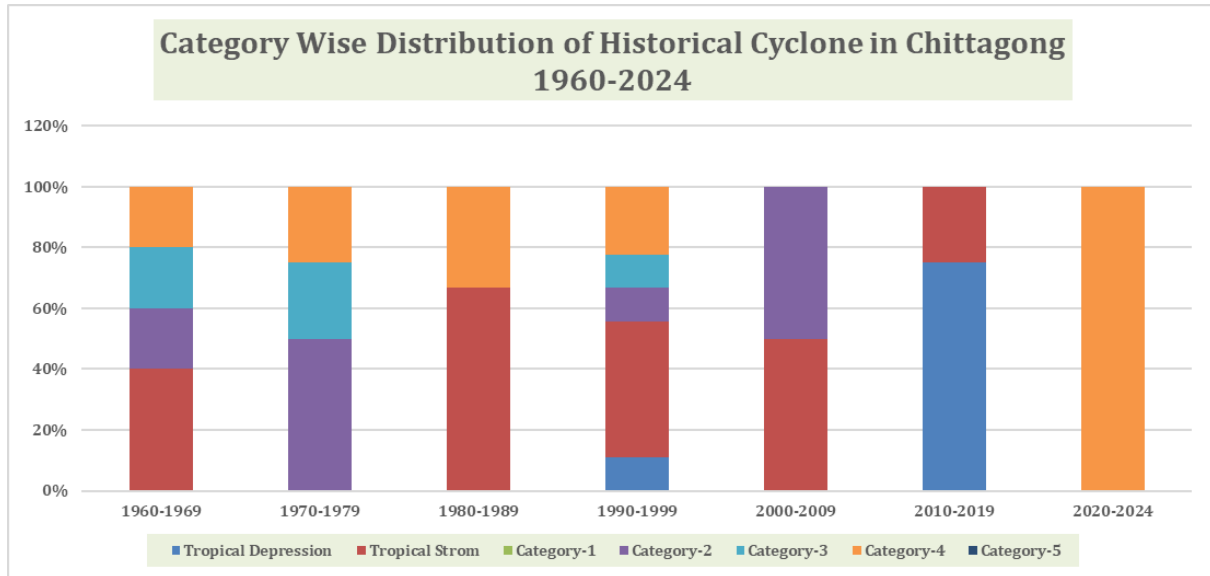


Figure 5.68: Category Wise Distribution of Historical Cyclone in CHT Region

It is observed that cyclonic activity has persistently affected the Chittagong coast over the last six decades, with 27 cyclones recorded in the past 64 years. The historical pattern reveals significant shifts in cyclone categories over time. 27 tropical cyclones (wind speed >220 km/hr) and Extremely Severe Cyclonic Storm (wind speed between 166 to 220 km/hr) struck the Chittagong-Cox's Bazar coast between 1960 and 2024. Of these, 33% happened in the pre-monsoon season, while the remaining 67% occurred in the post-monsoon season. Chittagong has faced numerous catastrophic severe cyclone events, especially in the last two decades, including Mocha, Mora, Mahasen, Komen and others. In the past two decades, a shift toward higher-intensity cyclones is evident, as supported by the category-wise distribution chart. While earlier decades featured a mix of Tropical Depressions, Tropical Storms, and lower-category cyclones, recent years particularly 2010 to 2024 have been dominated by Category-4 cyclones. Notably, Cyclone Mocha (2023) reached an extremely severe category with wind speeds of 212 km/hr, ranking among the strongest in recent memory. The most frequently occurring type over the last 27 years has been Severe Cyclonic Storms, but the trend indicates a rising proportion of Category-4 events compared to weaker storms. This intensification pattern aligns with broader climate change projections, which anticipate stronger tropical cyclones under warming ocean conditions. The growing severity poses an escalating threat to life, infrastructure, and livelihoods particularly for fishing and agriculture in coastal Chittagong necessitating robust early warning systems, resilient infrastructure planning, and adaptive community preparedness.

Table 5.27: Major Cyclone Storms List with its Nature of Phenomenon and Landfall Area

SL no.	Date of Occurrence	Name	Nature of Phenomenon	Landfall Area	Maximum wind speed in km/hr	Direction of the Max. Wind Speed	Tidal Surge Height in ft	Central Pressure (mbs)
1	11.10.60		Severe Cyclonic Storm	Chittagong	160	South-East	6	-
2	31.10.60		Severe Cyclonic Storm	Chittagong	193	South-East	15	-
3	09.05.61		Severe Cyclonic Storm	Chittagong	160	South-East	20	-
4	30.05.61		Severe Cyclonic Storm	Chittagong (Near Feni)	160	South-South-East	8-10	-
5	28.05.63		Severe Cyclonic Storm	Chittagong- Cox's Bazar	209	South-East	6-15	-
6	11.05.65		Severe Cyclonic Storm	Chittagong-Barisal Coast	160	South-South-East	8-12	-
7	05.11.65		Severe Cyclonic Storm	Chittagong	160	South-East	12	-
8	15.12.65		Severe Cyclonic Storm	Cox's Bazar	210	South-East	8-12	-
9	01.11.66		Severe Cyclonic Storm	Chittagong	120	South-East	8-10	-
10	12.11.70		Severe Cyclonic Storm with a core of hurricane wind	Chittagong	224	South-East	-	-
11	28.11.74		Severe Cyclonic Storm	Cox's Bazar	163	South-East	10-33	-
12	15.10.83		Cyclonic Storm	Chittagong	93	South-East	7-15	995
13	09.11.83		Severe Cyclonic Storm	Cox's Bazar	136	South-East	-	986
14	24.05.85		Severe Cyclonic Storm	Chittagong	154	South-East	5	982
15	18.12.90		Cyclonic Storm (crossed as a depression)	Cox's Bazar Coast	115	South-East	2-14.5	995
16	29.04.91		Severe Cyclonic Storm with a core of hurricane wind	Chittagong	225	South-East	5-7	940
17	02.05.94		Severe Cyclonic Storm with a core of hurricane wind	Cox's Bazar-Teknaf Coast	220	South-East	12-22	948
18	25.11.95		Severe Cyclonic Storm	Cox's Bazar	140	South-East	5-6	998

SL no.	Date of Occurrence	Name	Nature of Phenomenon	Landfall Area	Maximum wind speed in km/hr	Direction of the Max. Wind Speed	Tidal Surge Height in ft	Central Pressure (mbs)
19	19.05.97		Severe Cyclonic Storm with a core of hurricane wind	Sitakundu	232	South-East	10	965
20	27.09.97		Severe Cyclonic Storm with a core of hurricane wind	Sitakundu	150	South-South-East	15	-
21	20.05.98		Severe Cyclonic Storm with core of hurricane winds	Chittagong Coast near Sitakunda	173	South-South-East	10-15	
22	19.05.04		Cyclonic Storm	Teknaf-Akyab Coast	65-90	South-East	5-7	990
23	16.05.13	MAHSEN	Cyclonic Storm (MAHASEN)	Noakhali-Chittagong Coast	100	South-South-East	-	-
24	30.07.15	KOMEN	Cyclonic Storm (KOMEN)	Chittagong-Cox's Bazar Coast	65	South-East	7	988
25	30.05.17	MORA	Severe Cyclonic Storm (MORA)	Chittagong-Cox's Bazar Coast near Kutubdia	146	South-East	-	-
26	29.05.18		Deep Depression	Chittagong-Cox's Bazar Coast	55	South-East	-	994
27	09.05.23	MOCHA	Extremely Severe Cyclonic Storm (MOCHA)	Chittagong-Cox's Bazar Coast	212	South-East	-	938

It has been seen that in the Chittagong zone most severe cycle occurred during 1991 which surge height was almost 6 ft. It is observed that the Chittagong coast has been repeatedly struck by cyclonic events over the past six decades, with **27 recorded cyclones** between 1960 and 2023. These events range from deep depressions to extremely severe cyclonic storms, with maximum recorded wind speeds reaching up to **232 km/hr**.

Simulation Scenarios: The assessment focused on the cyclone that occurred in 1991, chosen as a representative event for modeling storm surge impacts. Additionally, different sea level rise scenarios were considered, aligning with the predictions outlined in the IPCC AR6 report for the Bay of Bengal region. These scenarios included sea level rise projections of 50cm, 65cm, and 95cm, reflecting potential future changes in sea level due to climate change.

Outcome: The simulation results provide valuable insights into the potential risks posed by storm surges under different scenarios. By analyzing the inundation extents, flood depths, and affected areas, stakeholders can gain a comprehensive understanding of the vulnerabilities and risks associated with storm surge events.

The analysis revealed alarming findings regarding the vulnerability of the study area to storm surge events. Approximately 90% of the area was projected to be submerged under water across all simulation scenarios, highlighting the widespread risk posed by storm surges.

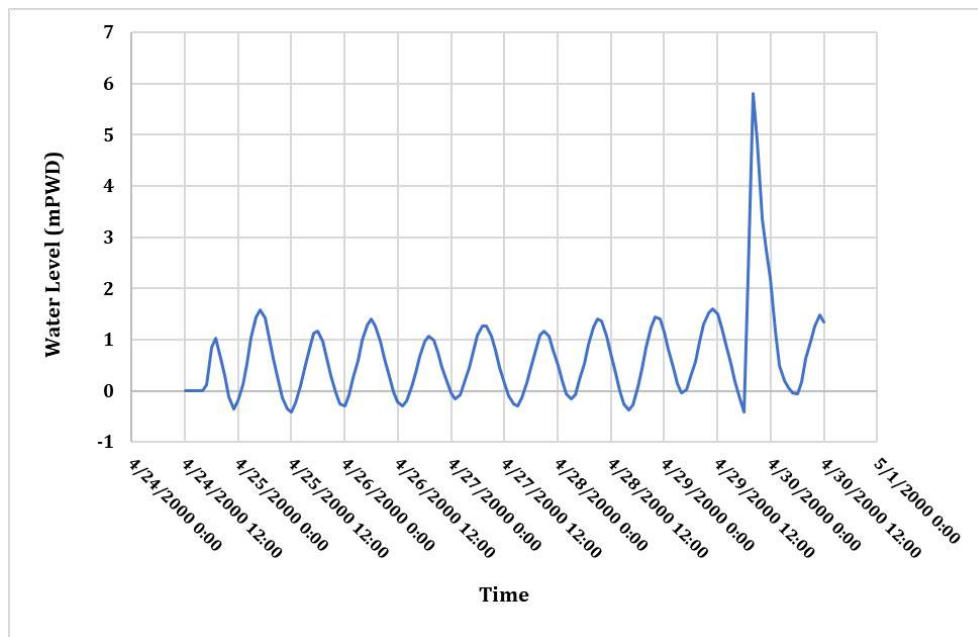


Figure 5.69: Water Level of 1991 Cyclone Event in Chittagong

From the figure it is seen that except the cyclonic event the regular water level is lower than 2, but at the time of the 1991's cyclone this raised up to 6 m.

Moreover, the height of the storm surge observed in the area during the 1991 cyclone was recorded at 6 meters above the present water datum (mPWD), surpassing the elevation of the polders which stood at 3 meters above the present water datum. This significant disparity between the storm surge height and polder elevation underscores the imminent threat of inundation during flood events, with the entire study area at risk of being submerged.

These findings emphasize the urgent need for proactive measures to address the heightened risk of flooding and storm surges within the study area. Implementation of robust flood management strategies, investment in resilient infrastructure, and community-based adaptation initiatives are essential to mitigate the adverse impacts of future flood events and safeguard the well-being of the population residing in vulnerable coastal areas.

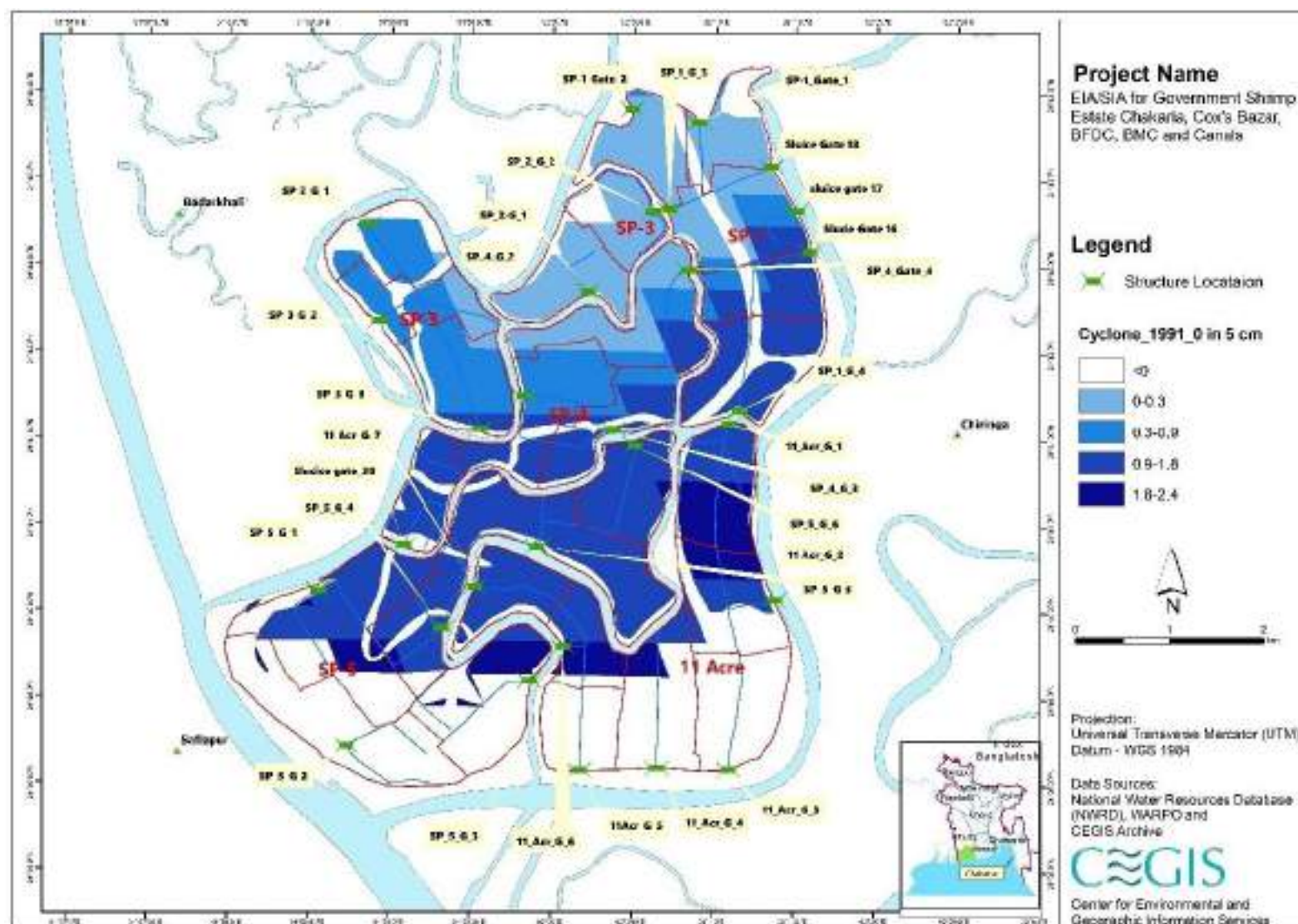


Figure 5.70: The Maximum Flood Inundation for 50cm Sea Level Rise in Chakaria Upazila

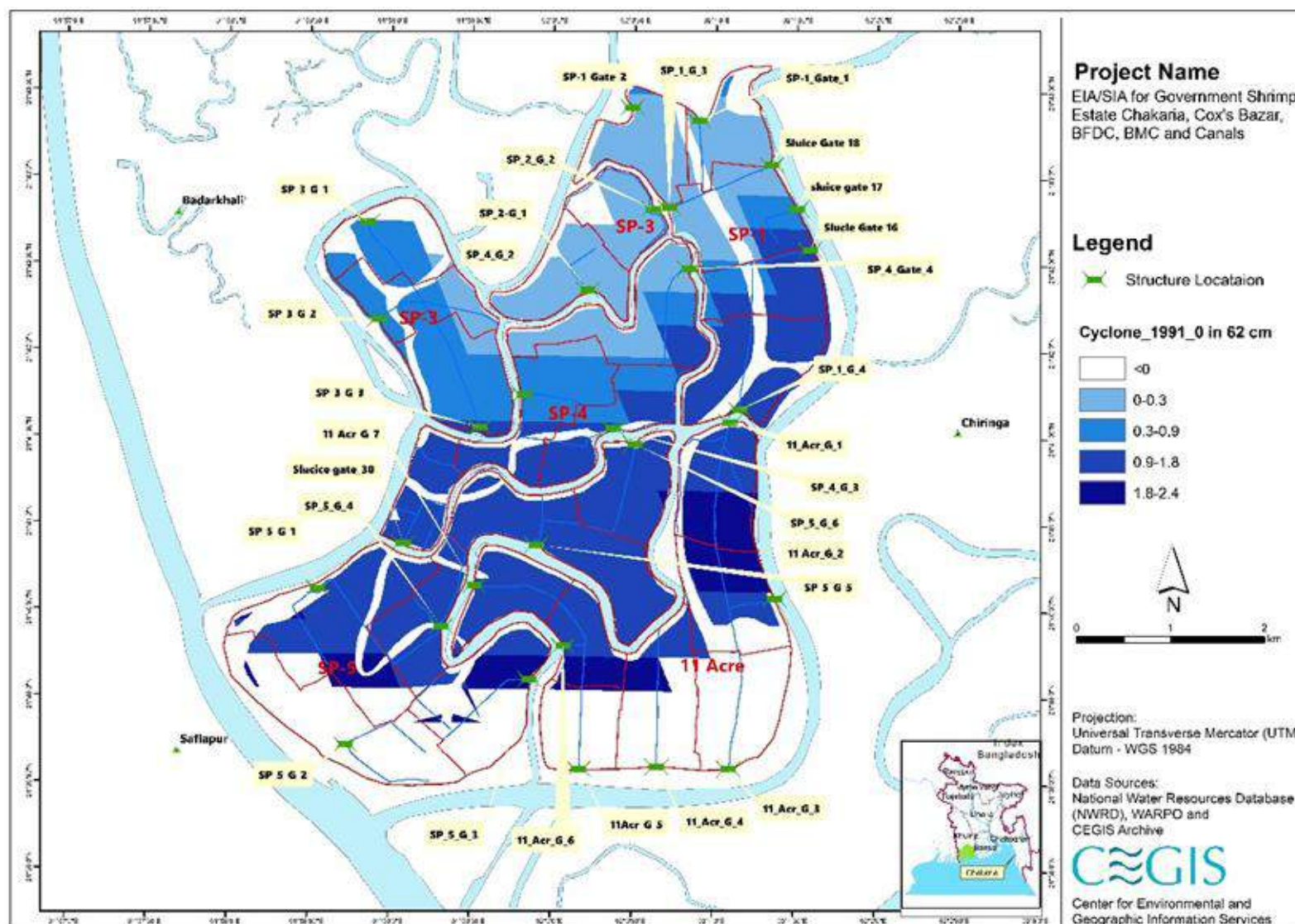


Figure 5.71: The Maximum Flood Inundation for 65 cm Sea Level Rise in Chakaria Upazila

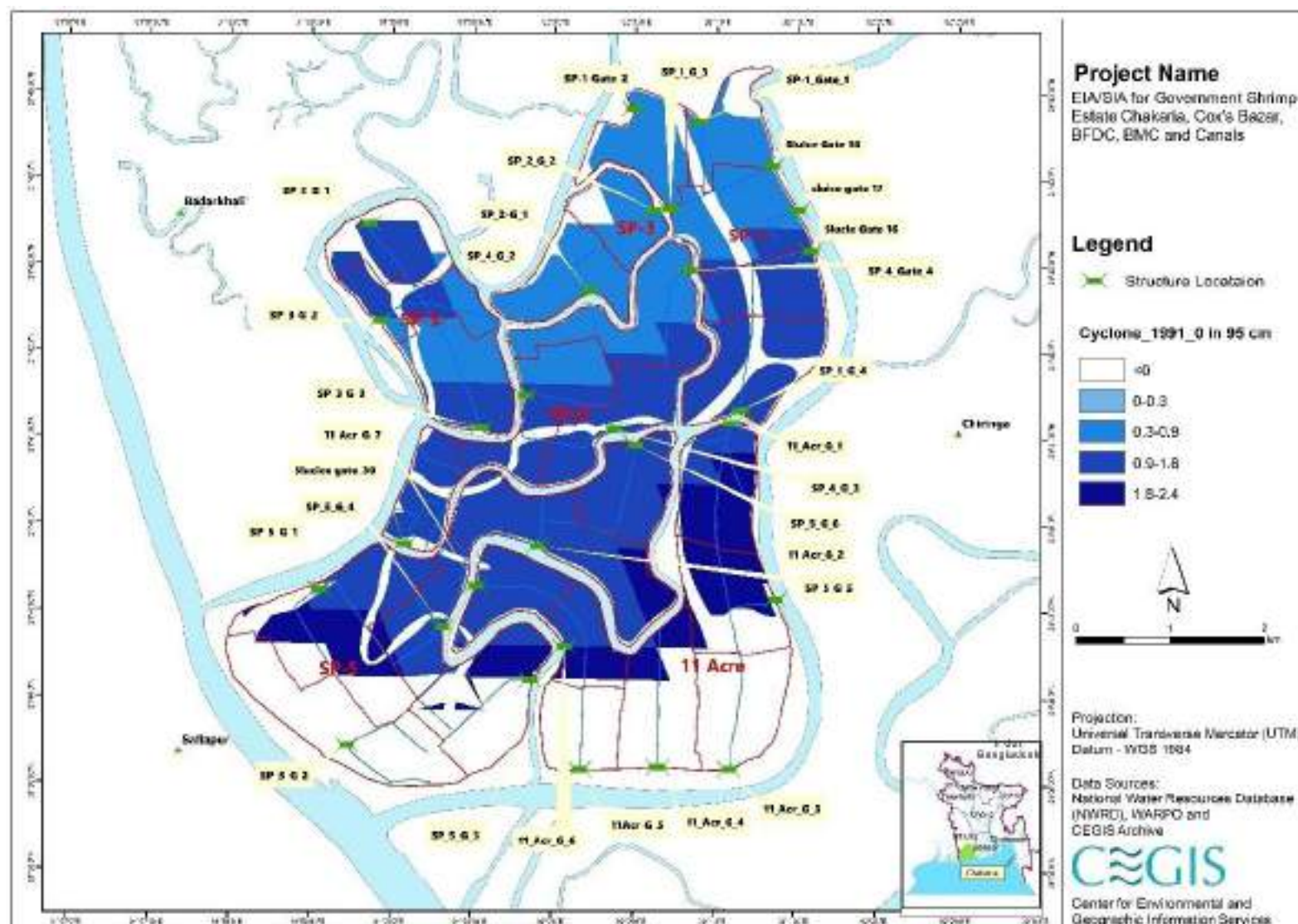


Figure 5.72: The Maximum Flood Inundation for 95 cm Sea Level Rise in Chakaria Upazila

3. Drainage Risk Assessment

The Drainage Risk Assessment was conducted utilizing a desk analysis approach due to the unavailability of measured data, such as inside khal cross-sections and detailed dyke/polder elevation data. While limitations prevented the development of a comprehensive drainage model, efforts were made to understand the overall hydrological situation within the polder through catchment delineation and catchment-wise flow calculations.

Methodology

- Catchment Delineation

Catchments within the study area were delineated to identify distinct drainage areas. This process involved defining boundaries based on natural topographical features and land characteristics.

- Flow Calculation

Catchment-wise flow calculations were performed using the Soil Conservation Service Curve Number (SCS-CN) method. This method estimates runoff based on factors such as land use, soil type, and antecedent moisture conditions, providing insights into the hydrological processes within the polder.

Outcome: While the assessment lacked detailed data necessary for a comprehensive drainage model, the desk analysis approach provided valuable insights into the overall hydrological dynamics within the study area. By delineating catchments and calculating flow patterns, stakeholders gained a better understanding of the drainage characteristics and potential risks associated with inundation events.

The assessment was constrained by the absence of measured data, such as inside khal cross-sections and detailed dyke/polder elevation information. These limitations restricted the ability to develop a more sophisticated drainage model, hindering the accuracy and comprehensiveness of the assessment.

- Catchment Delineation

Catchment delineation is crucial for assessing drainage patterns and estimating discharge within a given area. In this study, the process of delineating catchments was conducted using ArcSWAT, focusing on the position of the project area near the river to calculate discharge.

- Single Catchment Approach

Initially, the entire study area was treated as a single catchment. Subsequently, the catchment was divided into 27 sub-catchments using ArcSWAT, allowing for a more detailed analysis of drainage characteristics.

- i. DEM Generation: Survey data was utilized to generate a Digital Elevation Model (DEM) of the study area with a resolution of 5 meters. All layers of Geographic Information System (GIS) were projected in the WGS 1984 coordinate system to ensure consistency and accuracy in spatial analysis.
- ii. Model Setup: DEM-based model setup was performed to facilitate catchment delineation. This involved generating automatic flow direction, flow accumulation, and stream network using ArcSWAT. Streams and outlets were identified, with particular focus on outlets near the river and the project area.
- iii. Catchment Delineation: Automatic catchment delineation was executed based on the generated stream network and outlets. This process enabled the identification of catchment boundaries and sub-catchments within the study area.

The delineation of catchments and sub-catchments provides valuable insights into the drainage characteristics of the study area. By identifying distinct catchment boundaries and sub-divisions, stakeholders can better understand the flow patterns and discharge dynamics within the watershed.

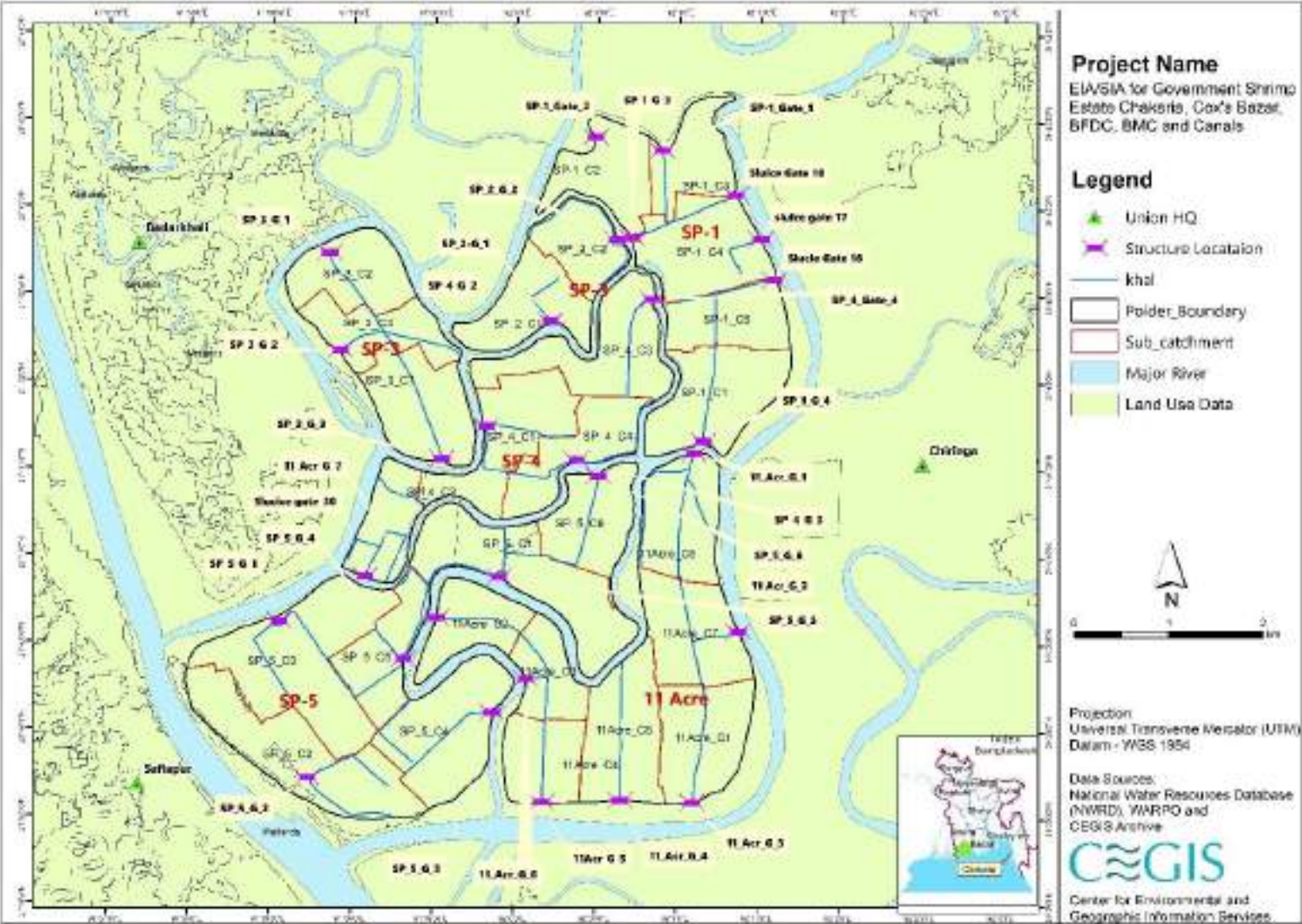


Figure 5.73: Six Selected Polders for Chakaria in the Southeastern Zone

Table 5.28: Sub-Catchment Area of 6 Polders in Hectare

Polder Id	Sub Catchment ID	Catchment Area (Ha)	Polder Id	Sub Catchment ID	Catchment Area (Ha)
11Acre	11Acre_C1	107.77	SP_3	SP_3_C1	107.82
	11Acre_C2	69.72		SP_3_C2	85.77
	11Acre_C3	60.60		SP_3_C3	74.88
	11Acre_C4	73.63	SP_4	SP_4_C1	113.81
	11Acre_C5	116.71		SP_4_C2	66.57
	11Acre_C6	100.39		SP_4_C3	126.07
	11Acre_C7	106.85		SP_4_C4	86.03
SP-1	SP-1_C1	121.13	SP_5	SP_5_C1	153.19
	SP-1_C2	82.30		SP_5_C2	159.75
	SP-1_C3	72.24		SP_5_C3	196.61
	SP-1_C4	118.87		SP_5_C4	133.76
	SP-1_C5	78.80		SP_5_C5	80.85
SP_2	SP_2_C1	87.24		SP_5_C6	86.76
	SP_2_C2	66.27			

Rainfall Analysis: Different rainfall event has been analyzed from the daily rainfall data to determine the consecutive rainfall effects of BMD rainfall stations Kutubdia. This station has been selected by analyzing the influence of each rainfall station on the selected polder through the Thiessen Polygon Technique. Yearly maximum rainfall data for 32 years (1990-2022) has been calculated for determining 1-day, 2-day, 3-day, 5-day and 10-day cumulative rainfall events.

These 32 years of yearly maximum rainfall data have been taken into consideration and CEGIS has used them to determine the different return period rainfall information for all rainfall events. Four statistical distribution methods have been considered for determining the rainfall for different return period. Gumbel (Gum), Log Pearson (LP) and Long Normal (LN) Distribution, Normal Distribution (ND) methods have been tested to fit the raw rainfall data. Goodness of fit has been tested with Chi-Square method, Kolmogorov Smirnov and Anderson Darling method. Seven different return periods (1 in 2.33, 1 in 5, 1 in 10, 1 in 25, 1 in 50 and 1 in 100 year) have been considered to estimate the design rainfall. Among them, 1 in 25-year rainfall is considered as design rainfall for designing any structure according to BWDB design manual. However, in this study, a 5-day storm with 10-year rainfall intensity has been considered for planning and designing the polder water management system for the future.

- Determination of design flood event

The Kutubdia rainfall station is influencing the study area. Therefore, design rainfall event has been calculated using the rainfall information of Kutubdia. Different rainfall event has been analysed from the daily rainfall data to determine the consecutive rainfall effects in the study area. Analysis indicates that yearly maximum rainfall data for 32 years (1990-2022) has been calculated for determining 1-, 2-, 3-, 5- and 10-day cumulative rainfall events. The table below shows the yearly maximum rainfall event for the last 32 years.

Table 5.29: Yearly Maximum Rainfall of Kutubdia for Different Rainfall Event

Year	1-day	2-day	3-day	5-day	10-day
1990	187	260	357	515	885
1991	225	356	363	482	745
1992	230	428	601	822	898
1993	152	233	361	475	562
1994	153	210	233	360	421
1995	197	326	377	397	453
1996	205	297	329	365	512
1997	130	225	315	335	413
1998	422	673	765	820	1084
1999	165	219	257	341	524
2000	223	257	306	332	602
2001	161	230	244	379	584
2002	153	205	239	343	353
2003	136	206	309	320	538
2004	156	273	319	377	457
2005	246	335	371	434	579
2006	154	266	311	453	656
2007	124	204	221	282	432
2008	179	318	420	635	907
2009	198	330	422	550	595
2010	120	210	264	355	447
2011	239	376	448	571	683
2012	279	327	496	688	808
2013	240	431	609	814	901
2014	211	350	388	639	800
2015	253	432	671	828	1101
2016	200	295	449	561	620
2017	188	306	354	437	642
2018	142	234	315	370	509
2019	202	240	377	532	821
2020	271	415	444	473	539
2021	116	212	299	456	778
2022	122	180	272	366	466

It has been observed by the Goodness-of-fit test that Normal method gives the best result for 1-day rainfall compared to other methods. It means normal method fitted well with the yearly maximum rainfall for the daily rainfall information. However, when we consider 2 and 5-days cumulative rainfall, Log Normal (LN) method gives the lower values compared to the rest of the two other methods. Different scenario has been observed during calculation of design rainfall for 10-days cumulative rainfall. It has been observed that Normal Method provides the best results. It is already determined that the polder water management system will be designed for 5-days cumulative rainfall event and 1 in 10-year return periods rainfall considered as design rainfall.

Different statistical distribution methods have been tested for fitting the hydrological conditions which has been described in the earlier section. The following tables presents the suitable statistical distribution method contains the design rainfall. The design rainfall (1 in 10 year) for 1-day hydrological rainfall event has been estimated 279 mm which is the nearest rainfall 279 mm happened in 2012. Similarly, the design rainfall for 5-days cumulative rainfall has been estimated 689 mm and nearest rainfall is 688 mm already happened in 2012. It indicates that the computed design rainfall is almost than the yearly maximum rainfall of 2012. This statistic confirms that during generation of design runoff for the design rainfall events, 1% additional rainfall should be added with the daily rainfall data of 2012 for getting the expected design runoff.

Table 5.30: Rainfall for Different Return Periods in Kutubdia (in mm)

	1 Day Rain fall(mm)				2 Day Rain Fall(mm)				3 Day Rain Fall(mm)				5 Day Rain fall (mm)				10 Day Rain fall (mm)			
RP	Gumble	LP	LN	Normal	Gumbles	LP	LN	Normal	Gumble	LP	LN	Normal	Gumble	LP	LN	Normal	Gumble	LP	LN	Normal
2.3	193	262	195	191	282	262	301	289	368	372	381	384	467	480	491	363	622	659	652	643
5	249	326	236	249	347	326	366	353	454	458	467	470	551	564	602	451	709	803	793	784
10	295	370	269	279	398	370	417	397	522	526	535	538	620	633	689	496	764	911	904	895
25	353	420	309	312	460	420	479	447	605	609	618	621	707	720	797	545	825	1054	1041	1024
50	396	455	338	333	506	455	525	482	666	670	679	682	771	784	876	576	866	1153	1140	1123
100	439	487	366	352	550	487	569	514	725	729	738	741	835	848	953	604	903	1250	1237	1220

Table 5.31: Goodness of Fit Test (1-day Rainfall)

SL	Distribution	Kolmogorov	Anderson	Chi-Squared	Rank
		Smirnov	Darling		
1	Gumbel Max	0.13	1.01	6.05	4
2	Log-Pearson	0.1	0.39	4.69	3
3	Lognormal	0.14	0.76	3.45	2
4	Normal	0.1	0.28	0.73	1

Table 5.32: Goodness of Fit Test (2-day Cumulative Rainfall)

SL	Distribution	Kolmogorov	Anderson	Chi-Squared	Rank
		Smirnov	Darling		
1	Gumbel Max	0.12	0.88	3.26	4
2	Log-Pearson	0.08	0.37	0.86	2
3	Lognormal	0.11	0.51	0.23	1
4	Normal	0.1	0.44	3.21	3

Table 5.33: Goodness of Fit Test (3-day Cumulative Rainfall)

SL	Distribution	Kolmogorov	Anderson	Chi-Squared	Rank
		Smirnov	Darling		
1	Gumbel Max	0.11	0.53	2.51	4
2	Log-Pearson	0.09	0.26	2.34	3
3	Lognormal	0.09	0.32	1.81	2
4	Normal	0.09	0.25	0.33	1

Table 5.34: Goodness of Fit Test (5-day Cumulative Rainfall)

SL	Distribution	Kolmogorov	Anderson	Chi-Squared	Rank
		Smirnov	Darling		
2	Gumbel Max	0.1	0.26	1.46	3
3	Log-Pearson	0.09	0.22	1.27	2
4	Lognormal	0.09	0.24	1.04	1
6	Normal	0.14	0.6	2.67	4

Table 5.35: Goodness of Fit Test (10-day Cumulative Rainfall)

SL	Distribution	Kolmogorov	Anderson	Chi-Squared	Rank
		Smirnov	Darling		
1	Gumbel Max	0.14	1.17	3.25	4
2	Log-Pearson	0.09	0.3	0.91	2
3	Lognormal	0.12	0.53	2.17	3
4	Normal	0.08	0.24	0.55	1

Table 5.36: Summary of Goodness of Fit Test

Hydrological Events	1day rain fall (mm)	2 days cumulative rainfall	3 days cumulative rain fall	5 days cumulative rainfall	10 days cumulative rainfall
Return period	Normal	LN	Normal	LN	Normal
2.33	191	301	384	491	643
5	249	366	470	602	784
10	279	417	538	689	895
25	312	479	621	797	1024
50	333	525	682	876	1123
100	352	569	741	953	1220

Runoff Calculation: To evaluate the discharge of a catchments SCS-CN method is used. In this approach a simple empirical formula and readily available tables and curves is used. The CN is a crucial factor to consider for runoff estimation. A high curve number means high runoff and low infiltration; whereas a low curve number means little runoff and high infiltration. The curve number is a function of land use and Hydrologic Soil Group (HSG). It can incorporate the land use for the computation of runoff from rainfall. The SCS-CN method provides a rapid way to estimate runoff change due to land use change.

Table 5.37: Maximum Runoff Calculation for existing land use for each sub catchments

Polder Id	Sub Catchment ID	Soil Group	Catchment Area (Ha)	Maximum Runoff (m ³ /s)			
				10YP_B	25YP_B	10YP_CC	25YP_CC
11Acre	11Acre_C1	D	107.77	3.40	3.41	8.28	8.86
	11Acre_C2	D	69.72	2.20	2.20	5.35	5.73
	11Acre_C3	D	60.60	1.91	1.91	4.65	4.98
	11Acre_C4	D	73.63	2.32	2.33	5.65	6.05
	11Acre_C5	D	116.71	3.68	3.69	8.96	9.59
	11Acre_C6	D	100.39	3.16	3.17	7.70	8.24
	11Acre_C7	D	106.85	3.37	3.38	8.20	8.78
SP-1	SP-1_C1	D	121.13	3.66	3.67	9.13	9.79
	SP-1_C2	D	82.30	2.51	2.51	6.22	6.67
	SP-1_C3	D	72.24	2.20	2.21	5.46	5.86
	SP-1_C4	D	118.87	3.59	3.59	8.95	9.60
	SP-1_C5	D	78.80	2.38	2.38	5.94	6.36
SP_2	SP_2_C1	D	87.24	2.68	2.68	6.62	7.09
	SP_2_C2	D	66.27	2.01	2.02	5.01	5.36
SP_3	SP_3_C1	D	107.82	3.40	3.41	8.27	8.86
	SP_3_C2	D	85.77	2.61	2.62	6.49	6.95
	SP_3_C3	D	74.88	2.36	2.37	5.75	6.15
SP_4	SP_4_C1	D	113.81	3.49	3.50	8.63	9.25
	SP_4_C2	D	66.57	2.10	2.10	5.10	5.47
	SP_4_C3	D	126.07	3.83	3.83	9.52	10.20
	SP_4_C4	D	86.03	2.59	2.60	6.48	6.94
SP_5	SP_5_C1	D	153.19	4.79	4.80	11.71	12.54
	SP_5_C2	D	159.75	5.02	5.03	12.24	13.10

Polder Id	Sub Catchment ID	Soil Group	Catchment Area (Ha)	Maximum Runoff (m ³ /s)			
				10YP_B	25YP_B	10YP_CC	25YP_CC
	SP_5_C3	D	196.61	6.18	6.20	15.07	16.14
	SP_5_C4	D	133.76	4.22	4.23	10.27	10.99
	SP_5_C5	D	80.85	2.55	2.56	6.21	6.65
	SP_5_C6	D	86.76	2.70	2.71	6.63	7.10

Overall, the table provides valuable insights into the relationship between flow rates and vent sizes within the drainage system of the polder. It highlights the importance of adequately sizing vents to accommodate the expected flow rates, especially considering potential increases in flow due to climate change. However, it is important to note that the relatively insufficient dyke height could impact the internal drainage of the polder, exacerbating existing drainage issues.

Furthermore, while the table focuses on comparing flows with vent sizes, it is crucial to also consider the functionality of regulators within the drainage system. Ensuring that regulators function properly is essential for effective drainage management. Any malfunctioning regulators could significantly impede drainage, exacerbating existing challenges.

Although the calculated flow rates can be used to estimate required vent sizes, the lack of internal water level data and the inability to develop a comprehensive drainage model limit the accuracy of these estimations. However, field observations suggest that the area is already experiencing drainage issues, and the calculated increase in flow due to climate change indicates that these problems may worsen in the future.

In summary, while the table provides a starting point for understanding flow rates and vent sizes, it is crucial to address the broader drainage infrastructure challenges, including dyke height adequacy and regulator functionality, to effectively manage drainage issues within the polder, particularly in the context of anticipated climate change impacts.

b) Canal Rehabilitation for Cluster Farming- Satkhira District

Flood Frequency Analysis of Betna-Kholpetua River

Historical water level of Betna-Kholpetua River was collected from BWDB station at Kalaroa (Station ID-23) for the period of 1990 – 2023. Frequency analysis of maximum water level for various return periods using Gumbel Distribution was carried out to assess the corresponding probable flood level, shown in **Table 5.38**. The analysis shows that the flood levels for 20-, 50- and 100-year return periods are 5.21m, 5.8m and 6.24 mPWD respectively.

Table 5.38: Flood frequency analysis of annual maximum water level at Betna-Kholpetua River BWDB Station (Kalaroa)

Return Period (T)	River Water level (mPWD)
2	3.56
5	4.28
10	4.75
20	5.21
50	5.8
75	6.06
100	6.24

Flood Frequency Analysis of Betna-Kholpetua River:

Historical water level of Betna-Kholpetua River was collected from BWDB station at Benarpota (Station ID-24) for the period of 1990 – 2023. Frequency analysis of maximum water level for various return periods using Gumbel Distribution was carried out to assess the corresponding probable flood level, shown in **Table 5.39**. The analysis shows that the flood levels for 20-, 50- and 100-year return periods are 4.58m, 5.19m and 5.65 mPWD respectively.

Table 5.39: Flood frequency analysis of annual maximum water level at Betna-Kholpetua River BWDB Station (Benarpota)

Return Period (T)	River Water level (mPWD)
2	2.88
5	3.62
10	4.11
20	4.58
50	5.19
75	5.46
100	5.65

Flood Frequency Analysis of Ichamati (Western Border) River:

Historical water level of Ichamati (Western Border) River was collected from BWDB station at Basantapur (Station ID-129) for the period of 1990 – 2023. Frequency analysis of maximum water level for various return periods using Gumbel Distribution was carried out to assess the corresponding probable flood level, shown in **Table 5.40**. The analysis shows that the flood levels for 20-, 50- and 100-year return periods are 4.27m, 4.55m and 4.77mPWD respectively.

Table 5.40: Flood frequency analysis of annual maximum water level at Ichamati (Western Border) River BWDB Station (Basantapur)

Return Period (T)	River Water level (mPWD)
2	3.48
5	3.83
10	4.05
20	4.27
50	4.55
75	4.67
100	4.75

Flood Frequency Analysis of Ichamati (Western Border) River:

Historical water level of Ichamati (Western Border) River was collected from BWDB station at Kaikhali (Station ID-130) for the period of 1990 – 2023. Frequency analysis of maximum water level for various return periods using Gumbel Distribution was carried out to assess the corresponding probable flood level, shown in **Table 5.41**. The analysis shows that the flood levels for 20-, 50- and 100-year return periods are 4.02m, 4.19m and 4.32 mPWD respectively.

Table 5.41: Flood frequency analysis of annual maximum water level at Ichamati (Western Border) River BWDB Station (Kaikhali)

Return Period (T)	River Water level (mPWD)
2	3.54
5	3.75
10	3.88
20	4.02
50	4.19
75	4.27
100	4.32

Flood Frequency Analysis of Kobadak River

Historical water level of Kobadak River was collected from BWDB station at Tala Magura (Station ID-163) for the period of 1994 – 2023. Frequency analysis of maximum water level for various return periods using Gumbel Distribution was carried out to assess the corresponding probable flood level, shown in **Table 5.42**. The analysis shows that the flood levels for 20-, 50- and 100-year return periods are 3.90m, 4.55m and 5.04 mPWD respectively.

Table 5.42: Flood frequency analysis of annual maximum water level at Kobadak River BWDB Station (Tala Magura)

Return Period (T)	River Water level (mPWD)
2	2.08
5	2.87
10	3.40
20	3.90
50	4.55
75	4.84
100	5.04

*c) Canal Rehabilitation for Cluster Farming- Khulna District**Flood Frequency Analysis of Bhadra River:*

Historical water level of Bhadra River was collected from BWDB station at Dumuria (Station ID-28) for the period of 1990 – 2023. Frequency analysis of maximum water level for various return periods using Gumbel Distribution was carried out to assess the corresponding probable flood level, shown in **Table 5.43**. The analysis shows that the flood levels for 20-, 50- and 100-year return periods are:

Table 5.43: Flood frequency analysis of annual maximum water level at Bhadra River BWDB Station (Dumuria)

Return Period (T)	River Water level (mPWD)
2	2.92
5	3.36
10	3.66
20	2.94
50	4.30
75	4.46
100	4.57

Flood Frequency Analysis of Off take at Atharobanka River:

Historical water level of Off take at Atharobanka River was collected from BWDB station at Dumuria (Station ID-105) for the period of 1990 – 2023. Frequency analysis of maximum water level for various return periods using Gumbel Distribution was carried out to assess the corresponding probable flood level, shown in **Table 5.44**. The analysis shows that the flood levels for 20-, 50- and 100-year return periods are 3.90m, 4.32m and 4.64 mPWD respectively.

Table 5.44: Flood frequency analysis of annual maximum water level at Gorai-Madumati-Haringhata-Baleswar River BWDB Station (Off take at Atharobanka)

Return Period (T)	River Water level (mPWD)
2	2.73
5	3.24
10	3.58
20	3.90
50	4.32
75	4.51
100	4.64

d) Canal Rehabilitation for Cluster Farming- Bagerhat District

Flood Frequency Analysis of Aliapur Khal Daratona River

Historical water level of Aliapur Khal Daratona River was collected from BWDB station at Bagerhat (Station ID-1) for the period of 1990 – 2023. Frequency analysis of maximum water level for various return periods using Gumbel Distribution was carried out to assess the corresponding probable flood level, shown in **Table 5.45**. The analysis shows that the flood levels for 20-, 50- and 100-year return periods are 2.96m, 3.16m and 3.30 mPWD respectively.

Table 5.45: Flood frequency analysis of annual maximum water level at at Aliapur Khal Daratona River BWDB Station (Bagerhat)

Return Period (T)	River Water level (mPWD)
2	2.42
5	2.65
10	2.81
20	2.96
50	3.16
75	3.24
100	3.30

El Niño and La Niña Effects

Bangladesh is one of the worst victim regions of this effect due to its geophysical settings. Bangladesh has low-lying plain land areas criss- cross with large number of rivers which fall into the Bay of Bengal. This makes the country like a basin. The country is an agro-based country and the production system mainly depends on climatic phenomena. Similarly, having a large number of rivers including other surface water bodies such as haor, ox-bow lakes, lakes, beel, ponds etc. make the country enrich in fisheries resources with captured and cultured fisheries.

Sea level rise and induced changes to the river estuary might trigger the changes in fish habitats and breeding grounds. On the other hand, shrimp aquaculture is threatened by changes in climate signature parameters like temperature and precipitation, which induce climatic events i.e., drought and other climatic phenomena such as: cyclones, storm surge, floods. Rising temperature as well as sea level including rainfall intensity may cause degrading the quality of surface water consequently leads to viral and bacterial diseases to shrimp.

In consequence of increasing trend of temperature of earth surface, decadal warming rate has been increased by more than 0.1 °C (*Hansen et. al., 2010*) and leading to more frequent heat waves (*Hartmann et. al., 2013*). The increasing temperature of surface water sources results in more pronounced stratification of the water column, with more dramatic consequences for freshwater systems than for oceans due to their shallowness and lower buffering capacity. On the other hand, DO levels decreases with increased temperature in the waterbodies.

According to a published Report of TeOra, shrimps are sensitive to changes in temperature, salinity, and water quality, and any disturbance to these factors can cause stress and weaken their immune system. When shrimps are stressed and their immune system is compromised, they are more vulnerable to disease outbreaks.

According to a published Report of TeOra⁶ The shrimp are sensitive to changes in temperature, salinity, and water quality, and any disturbance to these factors can cause stress and weaken their immune system. When shrimp are stressed and their immune system is compromised, they are more vulnerable to disease outbreaks.

M. Yuniartik *et. al., 2022*, explains in the research note that increase in water temperature, low dissolved oxygen concentrations and pH fluctuation may cause shrimp mortality and affect its production. The research also reveals that fluctuation in water quality especially the values of the parameters: temperature, DO, salinity, phosphate, and nitrate continuously cause the condition of phytoplankton in water bodies to change drastically; and lead to several shrimp diseases such as Early Mortality Syndrome (EMS), White feces disease (WFD), White spot disease (WSD), and Myobacterium etc.

White Spot Syndrome Virus (WSSV) turns more virulent in water temperatures between 25-28 °C. When the water temperature in a shrimp farm rises above a certain threshold, it can trigger an outbreak of disease that can rapidly spread throughout the population. On the other hand, Extreme weather events such as hurricanes, cyclones, and heavy rains can cause flooding in shrimp farms, which can wash away shrimp and disrupt the delicate balance of the water environment. These events can also cause changes in water temperature, salinity, and nutrient levels, which can create ideal conditions for disease outbreaks (TeOra, 2023). The Management Plan for Shrimp farming is given in **Section 2.16: Fisheries Management Plan**, and **Section 2.10: Environmental Quality Management-** (Water Quality Management and Water Quality Maintenance) under **Chapter 2 of Annex A: ESMP Report**.

5.6.2 Anthropogenic Hazards

Security issues in this case are considered as the major concerning anthropogenic hazards associated with shrimp farming practices in this area. Fish theft is a recurring problem in the shrimp estate, and as per the field information, CSE faces frequent incidents of fish robberies, with local perpetrators

⁶ <https://www.linkedin.com/pulse/underwater-troubles-impact-climate-change-shrimp-farming-teora-life>

demanding monthly payments. This estate also faces encroachment by the people living around it. An investigation with limited access in collecting field information reveals that there is a good number of cottage type houses, which are seemingly resided by the encroachers or people who have no legal rights located in and around the 48- acres of Shrimp Demonstration Pond area. This issue has been raising serious concerns about the security and integrity of the shrimp farming community over the time.

5.7 Water Resources

5.7.1 Hydrological Condition of the Sub-Project Sites

Bangladesh is highly vulnerable to floods due to its geographical location at the deltas of the Ganges, Brahmaputra and Meghna (GBM) rivers. About 93 per cent of the area of three basins lies outside the boundaries of the country. More than 80 per cent of the annual precipitation of Bangladesh occurs in the monsoon period between June and September. The hydro-meteorological characteristics of the three river basins are unique and they often cause large to extremely large floods in Bangladesh. It is possible that these floods could inundate 70 percent of the country and the physical damage could be very serious for the economy of Bangladesh with its low gross domestic product (GDP).

Water related impacts of climate change will likely be the most critical for Bangladesh – largely related to coastal and riverine flooding, but also enhanced possibility of winter (dry season) drought in certain areas. The effects of increased flooding resulting from climate change will be the greatest problem faced by Bangladesh. Both coastal flooding (from sea and river water), and inland flooding (river/rain water) are expected to increase. One-fifth of the country is flooded every year, and in extreme years, two-thirds of the country can be inundated. This vulnerability to flooding is exacerbated by the fact that Bangladesh is also a low-lying deltaic nation exposed to storm surges from the Bay of Bengal.

The coast of Bangladesh consists of 19 Districts, covers 32% of the country and accommodates more than 35 million people. Increasing salinity is a crucial issue to the people of the coastal region of Bangladesh. Due to increasing salinity in the water and soil, the people of the region are suffering from scarcity of safe drinking water, irrigation, agriculture and other uses. Ecology of the coastal region especially in the southwest region is greatly concerned with salinity.

Bangladesh faces semi diurnal tide i.e., two flood tide and two ebb tides in a day in a 6hour consecutive time interval. Coincidence of heavy rainfall and flood tide occurred during monsoon urban area located in the coastal part of our country faces flooding due to water logging. During the monsoon period it make high tide and overflow saline water surrounding the coastal region. However, a total of 123 flood control polders involving 5,107 km of embankment have been constructed covering approximating 1.5 million ha of the coastal area under the Coastal Embankment Project (CEP). These polders prevent inundation of floodplain agricultural land by saline water during high tide. Because of reduced tidal prism, peak tidal velocity has reduced and siltation in the channels has aggravated. The polders have caused rise in channel bed, which in turn has resulted drainage congestion. The rise in riverbed has resulted serious water logging in the adjacent area, which has become a major environmental concern in the region. The continued water logging has caused serious damage to agriculture, forestry, fisheries, livestock and physical infrastructures and generated widespread discontent among the coastal people. Many people had to leave their ancestral homestead by abandoning traditional livelihood activities.

Hydrological Network for CSE

The major surface water sources of the CSE are the Matamuhuri River, Bura Matamuhuri River and Maheshkhali Channel. The hydrological network of the study area is shown in **Figure 5.74**.

Matamuhuri River: Matamuhuri is a trans-boundary river. The river originates from the Lusai hill situated in the boundary of Bangladesh and Myanmar at Alikadam Upazila of Bandarban district. The river has been named after the famous Muhuri family. The tributary Bamu Khal originated from hilly areas of Saria union and meets the Matamuhuri River near Lama Bazar. Lama Chhara and Popa Chhara meet near Dardari and the joint course falls in to the Matamuhuri River. Two hydrometric stations of Bangladesh Water Development Board (BWDB) are situated on this river. The river has tidal effects. A 20-vent regulator has been built on this river to prevent saline water intrusion. The riverside lands near the sea are used for salt cultivation. Some artificial khals in Chakaria are used to bring saline water from the river into the salt cultivation lands. The danger level of flood for Ciringa station on this river is 5.75 m (PWD), whereas for Lama Station, the danger level is 12.25 m (PWD).

Bura Matamuhuri River: Originating from west Boroveula of Chakaria Upazila, the river falls in the Maheshkhali channel. The river once had a connection with the Matamuhuri River but at present there is no existence of in East Borovela and Lakhaier Char. Saline water intrudes into the salt cultivation lands beside the rivers through numerous artificial khals during high tide. The river is perennial in nature. The width of the river is 290 meters near the sea and the average width is about 87 meters. The river has no tributary and distributary.

Maheshkhali Channel: It lies between the mainland of Bangladesh (Cox's Bazar District) and Maheshkhali Island. The Channel carries the combined flow of the Matamuhuri and its tributaries and of other rivers such as Bharuakhali khal, Bura Matamuhuri, Mangla Khal, Manikchhari khal, etc. The length of the channel is 35 km. The channel is connected to the Bay of Bengal.

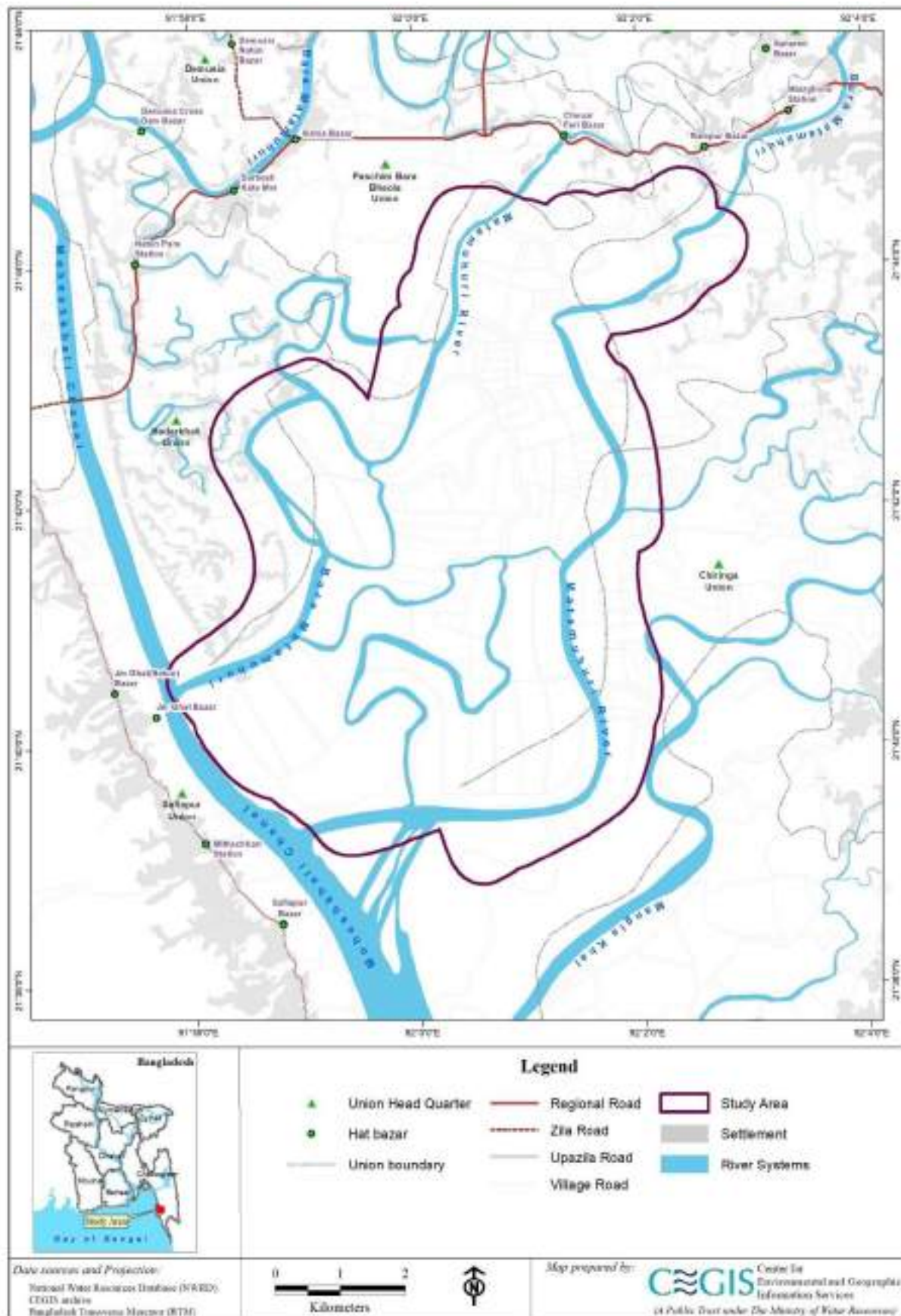


Figure 5.74: Hydrological Network of the CSE

Hydrological Network for BFDC Harbor at Chattogram

The Karnaphuli River and the Shahbazpur Channel, are the main surface water sources situated around the Bangladesh Fisheries Development Corporation (BFDC). Besides, some other small canals such as: Murari Khal (aerial distance around 3.5 km on the east from the study area), Karnaphuli canal (aerial distance around 1.2 km on the west from the study area). The Shahbazpur Channel is on the west side of the study area with an aerial distance of around 5.5 km. The hydrological network of the study area is shown in the **Figure 5.75**.

Karnaphuli River: The Karnaphuli River originates from Shaita village (Lusai Pahar) in Mamit District, Mizoram Province, India and flows through Chattogram Hill Tracks and Chattogram to join the Bay of Bengal near Patenga, Chattogram. At the mouth of this river, the main seaport of Bangladesh, the Chattogram Seaport is situated.

Shahbazpur Channel: The Shahbazpur Channel and the Bay of Bengal are on the West side of the BFDC area. Shahbazpur channel is connected to the Meghna River at Monpura Upazila in Bhola District.

Hydrological Network for BMC

The study area of BMC is mainly governed by Naf River. Apart from that, there are two significant khals such as Hachkar Khal and Kaikhali Khal. The hydrological network of the study area is shown in the **Figure 5.76**.

Naf River: This is an international river marking the border of southeastern Bangladesh and northwestern Myanmar. It flows through Ukhiya and Teknaf Upazila into the Bay of Bengal in the Indian Ocean, between the Bangladeshi Cox's Bazar District of the Chittagong Division, and the Burmese Rakhine State. This river has tidal effect. The length of the river is about 63 km and the average width is 1364 m. The river is perennial.

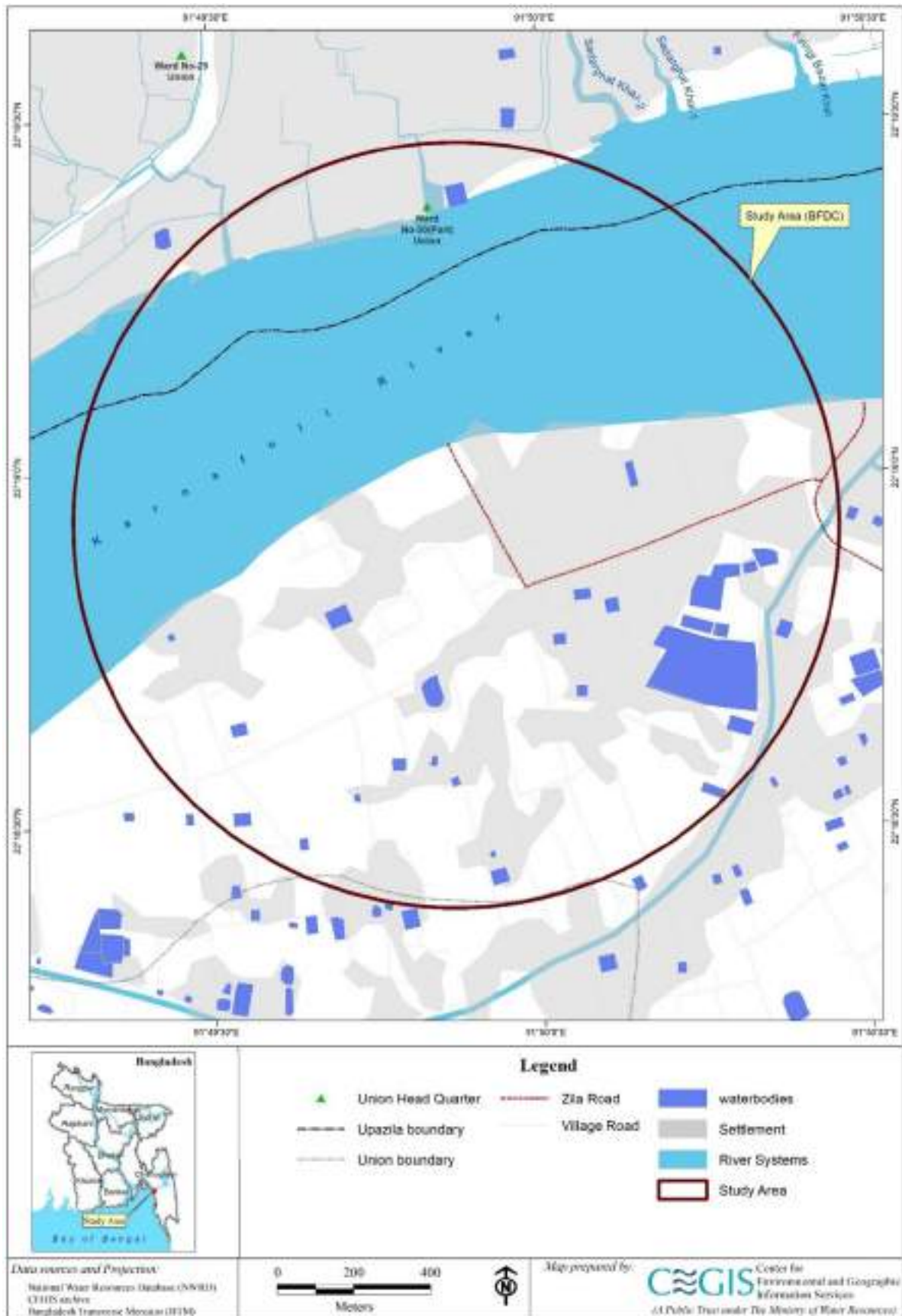


Figure 5.75: Hydrological Network around the BFDC Harbor at Chattogram

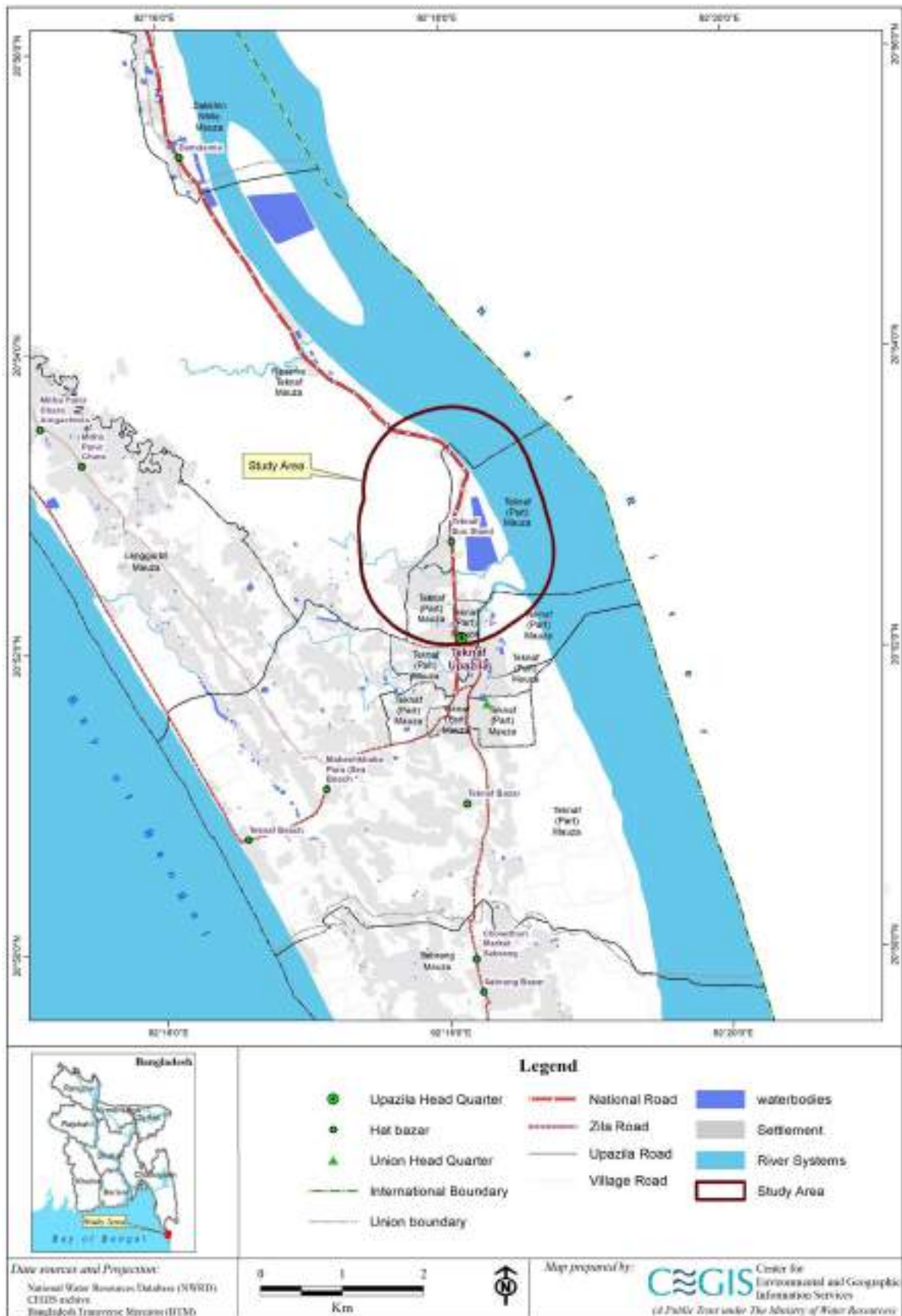


Figure 5.76: Hydrological Network around the BMC Area at DFTC, Teknaf

Hydrological Network for Canals under Three (03) Coastal Districts

There are six (06) canals, five (05) canals, and seven (07) canals under Khulna, Satkhira and Bagerhat Districts respectively for rehabilitation for cluster farming. It is observed that seven (07) out of eighteen canals are originated from the flood plain and fall into various rivers. The detail description of each canal is given in **Annex 11** under the **Volume II: Annexures of Main Report**. The district-wise hydrological network around these canals is shown in **Figure 5.75**, **Figure 5.76**, and **Figure 5.77**.

Canal-wise hydrological condition is given below:

Satkhira District

Mahandi Canal: Mohanondi canal is located at Tala Upazilas in Satkhira District. This canal starts from a part of Dhaskathi canal, and ending portion is connected with pitch road. According to existing data, this canal was 1500m long, and its width is 11.5m. After visiting this canal from start to finish, it will be 3750m long and 17m wide.

Dhakshkathi Canal: Dhaskathi canal is located at Tala Upazilas in Satkhira District. This canal starts from a river between Satkhira and Khulna District. This canal has three parts, all of which are connected from one location to another. According to existing data, this canal was 6300m long, and its width is variable. After visiting this canal from start to finish, it will be 6300m long and 16m wide.

Madhobkhali Canal: Madhobkhali canal is located at Tala Upazilas in Satkhira District. This canal is a part of Dhaskathi canal, The starting point is a culvert which is connected with soiling roads and ending portion is connected with Dhaskathi canal. According to existing data, this canal was 2100m long, and its width was 30m. After visiting this canal from start to finish, it will be 1075m long and 15m wide.

Magra Canal: Magra canal is located at Kolaroa Upazilas in Satkhira District. The starting point is a culvert which is connected with soiling roads and ending portion is connected with another RCC bridge beside of cluster. According to existing data, this canal was 1800m long, and its width was 13.5m. After visiting this canal from start to finish, it will be 2025m long and 11m wide.

Asthobigha Canal: The Debhata Upazilas in the Satkhira District is home to the Asthobigha canal. Pitcher roads connect the beginning point, a culvert, and another RCC bridge connects the finishing section. The information currently available indicates that the canal was 2700 meters long and 15 meters wide. This canal will be 20 m wide and 5225 m long after you have visited it from end to end.

Kalmeghar Canal: The Kalmeghar Canal is situated in the Satkhira District's Shyamnagar Upazilas. Two additional RCCC culverts connect the finishing section to the bridge, which serves as the starting point. Based on available data, the canal measured 1800 meters in length and 22 meters in width. Following a thorough inspection, this canal will measure 3780 meters in length and 22 meters in width.

Khulna District

Bollobi Khal: Bollobi khal is located at Rupsha Upazila in Khulna District. The starting point of the canal is E-770633.883 N-2520550.122 & the ending point of the canal is E-771771.425 N-2518496.621. The canal is 3900 m long in total with a variable width of 5m~25m. At the dead-end Bangladesh Water Development Board has excavated 800m canal with a width of 25 m and the on the other side at the starting point Department of fisheries has excavated 1700 m with a width of 12 m. So now in the middle of the canal there is 1400 m long area unexcavated. This area has to excavate with a width of 12 m. But the local people demand the excavation work has to be done the rest of 3100

m with 25 m width. As per local people's information, the canal has enough land to excavate it with 25 m width.

Nagkati Canal: Nagkati canal is located at Digholia Upazila in Khulna District. The canal starts from Bhoirob river near Mondol Jute mills. From there it flows through Dighalia Upazila and ends at Dighalia Shrimp Farmers Cluster-01. The starting point of the canal is E-759748.844 N-2531399.713 & the ending point of the canal is N-22°54'12" E-89°32'12". At first the canal was about to excavate 1500 m till sugandhi but for the beneficiary of the cluster farmers, it was decided to excavate 5000 m to Brakkhogati Union. If the excavation work will be done less than 5000 m, the cluster farmers won't be beneficiary through the excavation work. So, for the beneficiary of the cluster farmers and according to the advisory of Senior Upazila Fisheries Officer, it was decided to excavate 5000 m long with a width of 10 m. Even then the canal won't find a continuous flow by merging with another canal or river. The ending point of the canal is a dead end.

Dohar Canal: Dohar canal is also located at Digholia Upazila in Khulna District. The canal can serve 3 shrimp clusters in its way. The canal starts from Panigati Shrimp farming cluster-01 to Panigati Shrimp farming cluster-03. The starting point of the canal is N-22°54'11" E- 89°33'11" & the ending point of the canal is N-22°53'37" E-89°33' 30". The canal is 1500 m long and 13 m wide. After excavating this canal, three cluster farmers along with other a lot of shrimp and agricultural farmers will be beneficiary by the water flow of the Dohar canal.

Mora Jopjopia Nodi: The canal is located at Batiaghata Upazila in Khulna District. The starting point of the canal is E-753512.681 N-252512919.223 & the ending point of the canal is E-754358.132 N-2510222.867. The canal starts from Titukhali bridge and merges with the Bhanga River at a 10 km distance. But the clusters are situated within 1 km to 3 km from the starting point of the canal. So, though the canal is 10 km long, excavating a length of 3.3 km would be enough for the clusters to get water from the canal. The top width of the canal should be 22 m and with a slope of 1:1.25, the bottom width should be 15 m. The canal will maintain a depth of 3 m.

Bagerhat District

Kumbkhali Canal: Kumbkhali canal is situated at Rampal Upazila, Bagerhat District. The starting point of the canal is N-2500291.851 E-770748.652 & the ending point of the canal is N-22°35' 00" E-89°38' 31". The canal originates from the river Bogura and flows through the open field which contains both paddy field and shrimp hatchery. We heard from the local people how carrying out the excavation would benefit the farmers the best and according to their guideline we got an estimate of 1400 m need to be excavated & another 150 m branch canal need to be excavated to facilities natural canal water to the shrimp hatchery. So, total 1550 m land with a width of 13.7 m need to be excavated. The depth will be 3 m.

Char Dakatia Canal: The canal is located at Chitalmari Upazila in Bagerhat District. The starting point of the canal is E-797836.586 N-2522743.77 & the ending point of the canal is E- 89°54'58" N-22°47'39". The char dakatia canal starts from the ending of another canal which has already been excavated under "Sofol" project and it merges with the Baleshwar River at the end. The canal is very narrow, has only width of 5.79 m. But the canal has a long length of 2000 m. Excavating this portion will allow a smooth water flow from the other canal and will be very helpful for farming. For excavating the canal, there will be needed to extermination some infrastructure.

Gajdurer Canal: The canal named "Gajdurer Khal" is also located at Chitalmari Upazila at Bagerhat District. The starting point of the canal is E-797246.36 N-2522048.704 & the ending point of the canal is E- 89°54'16" N-22°46'36". The canal's starting point is adjacent with another canal and it merges with river. So, there is very good chance to flow water freely if the canal is excavated properly. There is a lot of shrimp hatchery and vegetable field on both side of the canal that can be beneficiary from

the canal water. The canal is 1500 m long and 10 m wide. The depth of the canal will be 3 m as same as the other canals.

Burir Canal: The canal is locally known as “Burir Khal”. It is the third one of our visits at Chitalmari Upazila in Bagerhat District. The starting point of the canal is N-22°49’ 25” E-89°55’ 18” & the ending point of the canal is -Two end point: including Branch N-2526625.826 E-796963.581 N-22°49’ 41” E-89°54’ 03”. This canal is longer than the other two canals and it has two branch canals. Excavation work needs to be done 5000 m long including 02 branches. The main canal is 3500 m long. Between 2 branches one branch is 1000 m long and the other branch is 500 m long. The width of the canal is 11 m and after excavation the depth will be 3 m.

Jibonkhalir Canal: The canal is locally known as “Jibonkhalir Khal”. It is located at Kachua Upazila in Bagerhat District. The canal starts from Padmanagar, Bhandarkhali. The starting point location is N-22°37’ 47” E-89°52’ 35” and the ending point location is N-2502704.507 E-793623.298. The canal goes through Goribpur and Signboard Bazar and ends near Bagerhat - Pirojpur highway. The canal length is 5500 m and the wide of the canal is 15 m. The depth of the canal will be 3 m as well.

Shoilodubir Canal: Shoilodubir canal or locally known as “Shoilodubir Khal” is also located at Kachua Upazila in Bagerhat District. Shoilodubir khal starts from the ending point of Jibonkhalir Khal near Bagerhat – Pirojpur Highway. So, the starting point of Shoilodubir Khal and the ending of Jibonkhalir Khal is same (N-2502704.507 E-793623.298). And the ending point of Shoilodubir Khal is N-22°36’05” E-89°50’08”. The canal is 2700 m long, 16 m in wide and the depth is same as others 3 m.

Andigram Canal: Andigram canal is located at Mollahat Upazila in Bagerhat District. The canal starts from Atharobanki river and flows straight. It has covered up 2 nos. clusters in its way. The starting point of the canal is E- 89°43’30” N-22°53’40” and the canal has ended at paddy field. The ending point of the canal is E-779769.621 N-2532330.693. The canal is 2300 long from the starting point to ending point and the width of the canal is 10 m. As all other canals the depth of the canal is 3 m.

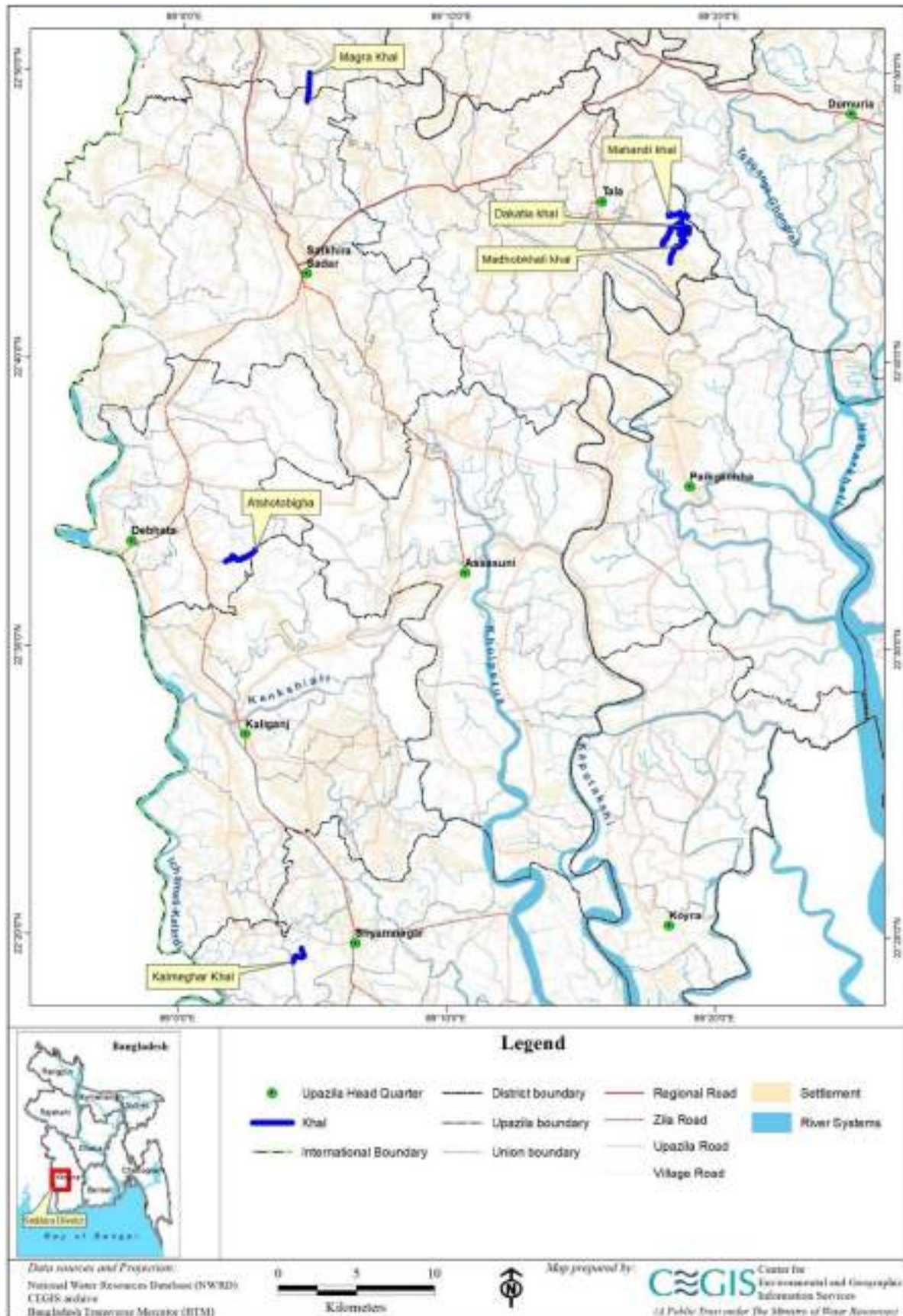


Figure 5.77: Hydrological Network around the Canals under Satkhira District

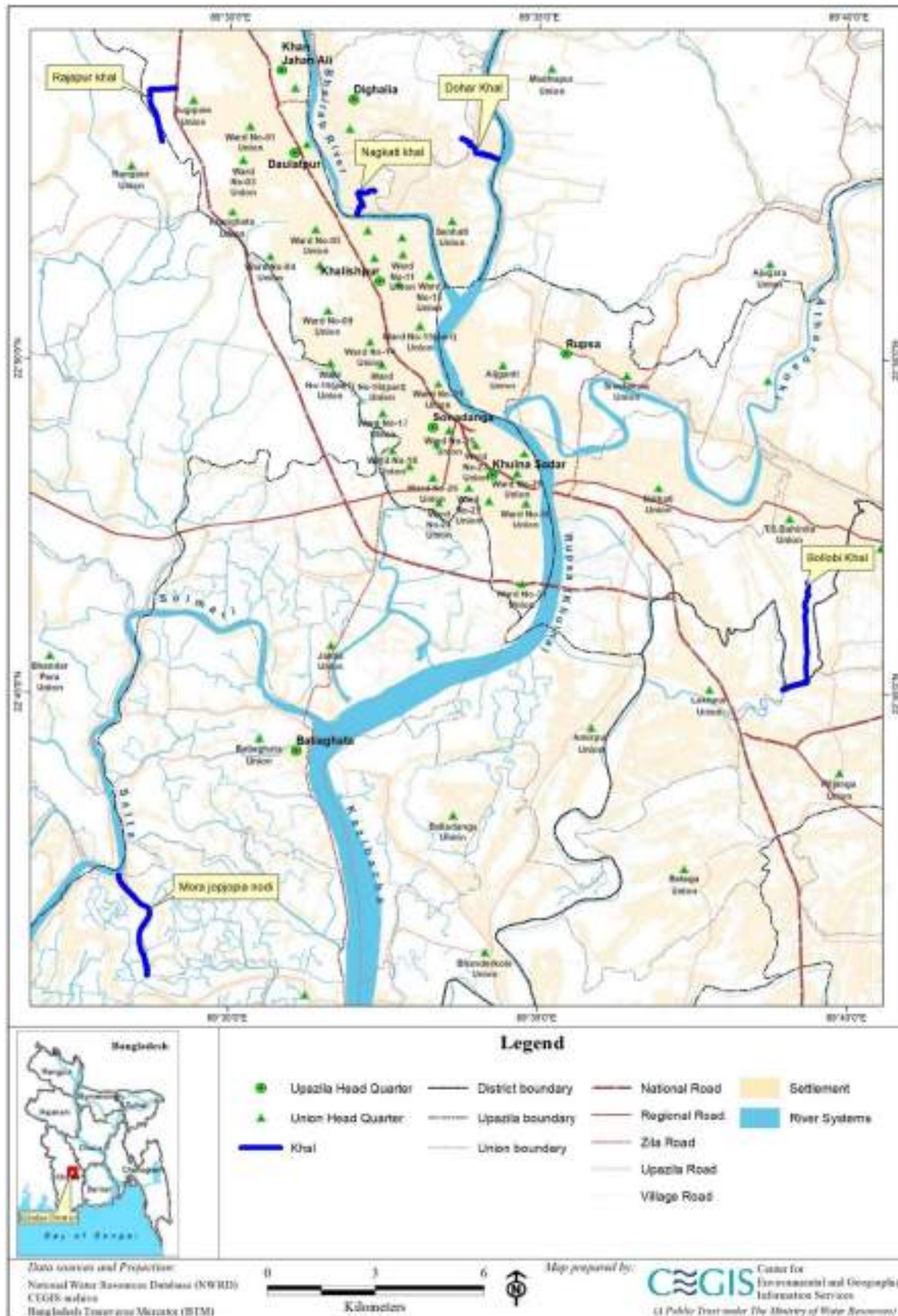


Figure 5.78: Hydrological Network around the Canals under Khulna District

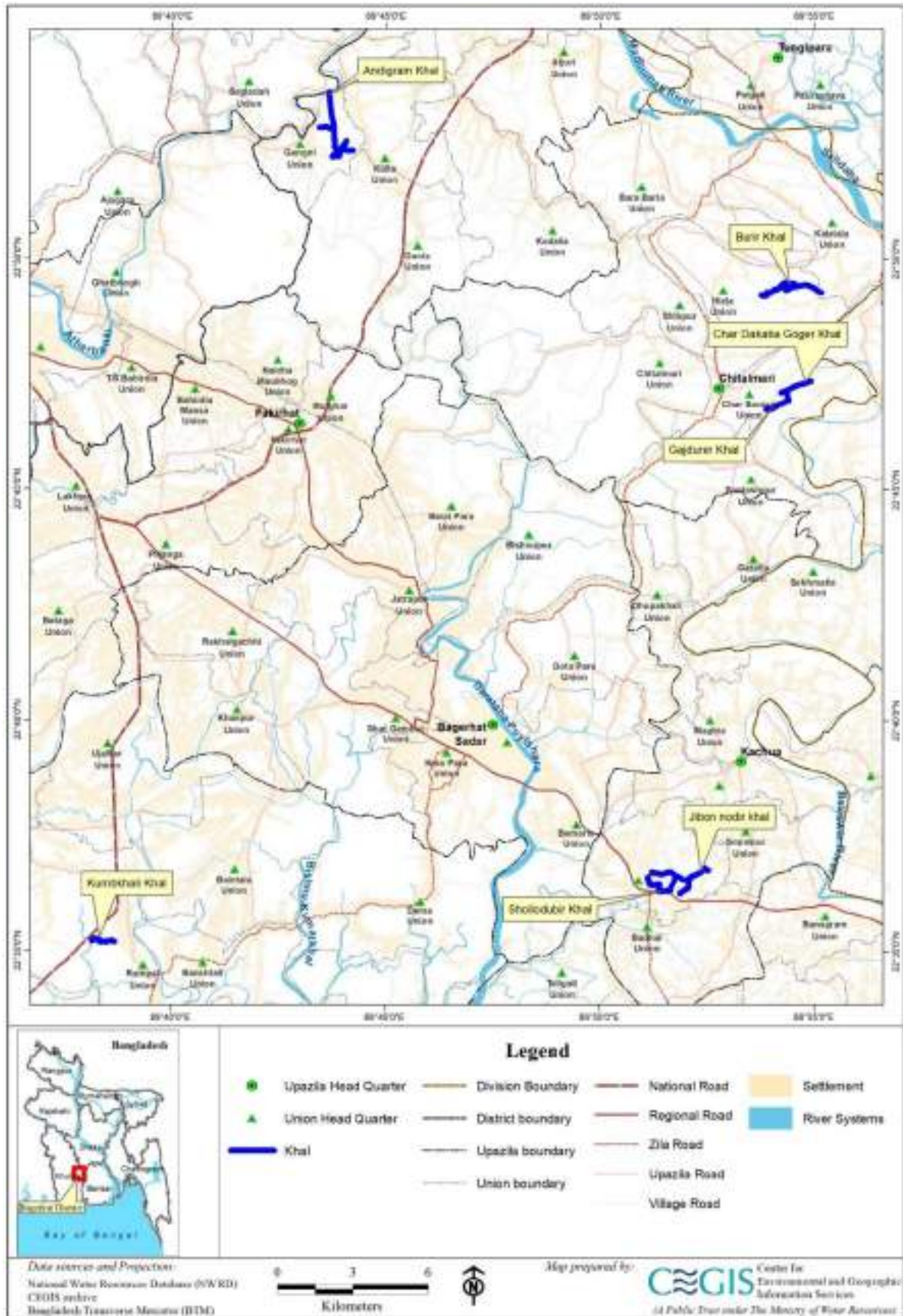


Figure 5.79: Hydrological Network around the Canals under Bagerhat District

5.7.2 Surface Water Level

Chakaria Shrimp Estate

To assess the surface water characteristics of the study area, water level data were collected from tidal gauge stations of BWDB: Saflapur (Moheskhali) (ID: 200) and Chiringa (ID: 204) for Chakaria Study area and analyzed, which are given below.

Saflapur (Moheskhali): Historical water level of Maheshkhali Channel was collected from BWDB station at Saflapur (Station ID-200) for the period of 1994 – 2023. Maheshkhali Channel receives tidal flow and so, the water level fluctuates in a cyclic order and the peaks occur twice a day. **Figure 5.80** shows the monthly variation of high and low tide water levels. It reveals that the maximum high tide ranges between 4.17 mPWD and 3.04 mPWD and low tide varies from – 1.77 mPWD to – 1.92 mPWD.

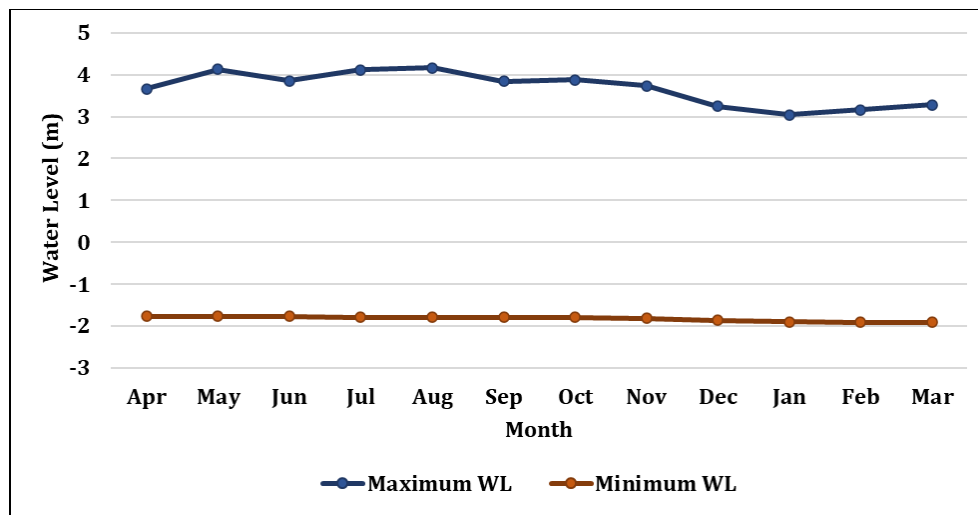


Figure 5.80: Monthly Variation of Water Level of BWDB Station (Saflapur) at Maheshkhali Channel

Chiringa (Matamuhuri River): Historical water level of Matamuhuri River was collected from BWDB station at Chiringa (Station ID-204) for the period of 1994 – 2023. **Figure 5.81** shows the monthly variation of high and low tide levels. The maximum high tide ranges between 2.68mPWD and 7.62 mPWD and low tide varies from 0.26 mPWD to 1.24 mPWD.

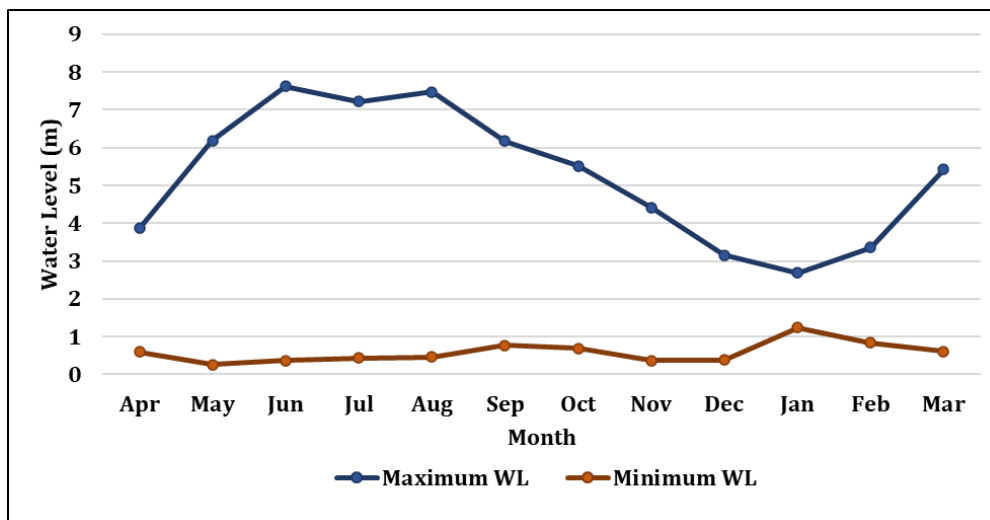


Figure 5.81: Monthly Variation of Water Level at Matamuhuri River BWDB Station (Chiringa)

BFDC

To assess the surface water characteristics of the study area, water level data were collected from tidal gauge stations of BWDB: Chattogram (ID: 153) on the Karnaphuli River and analyzed accordingly.

Historical water level of Karnaphuli River was collected from BWDB station at Chattogram (**Station ID-153**) for the period⁷ of **1959 – 1988**. **Figure 5.82** shows the monthly variation of high and low tide levels. The maximum high tide ranges between 3.14 mPWD and 4.39 mPWD and low tide varies from -1.59 mPWD to -0.98 mPWD.

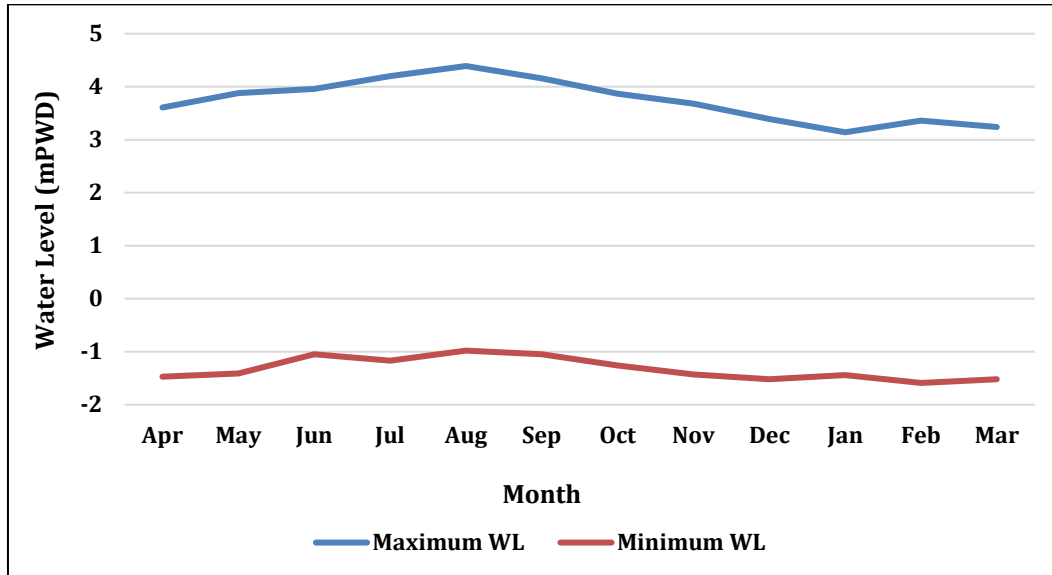


Figure 5.82: Monthly Variation of Water Level at Karnaphuli River BWDB Station (Chattogram)

BMC Area at DFTC, Teknaf

To assess the surface water characteristics of the study area, water level data were collected from tidal gauge stations of BWDB: Teknaf (ID: SW316) on the Naf River and analyzed accordingly. The historical data period⁸ as available in BWDB under this station is from 1968 to 1988.

Historical water level of Naf River was collected from BWDB station at Teknaf (Station ID-316) for the period of 1968 – 1988. **Figure 5.83** shows the monthly variation of high and low tide levels. The maximum high tide ranges between 1.1 mPWD and 2.23 mPWD and low tide varies from -3.42 mPWD to -1.9 mPWD.

⁷ Surface water level data is scarce for the project area. Even though there is a BWDB station situated in Chattogram, on the Kanafuli called "Chittagong" (SW153); data available in that station is from 1968 to 1988. Besides, data for this station is available from 03 February 2016 to 14 March 2016 in the Processing and Flood Forecasting Circle (PFFC) database of BWDB. That's why surface water level analysis is not possible to be done in such a way as the historical analysis needs to be considered for at least 30 years data.

⁸ A new station has recently been installed on Naf River and the station ID is "Rongikhali" (BWDB SW358). Data for this station is available from 01 September 2020 to 31 December 2022. That is why surface water level analysis is not possible to be done in such a way as the historical analysis needs to be considered for at least 30 years data.

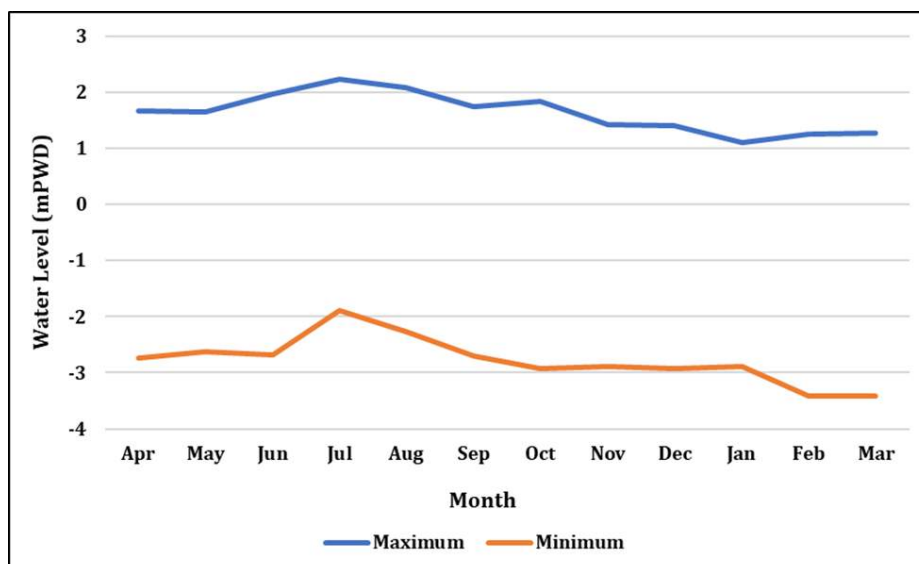


Figure 5.83: Monthly Variation of Water Level at Naf River BWDB Station (Teknaf)

Canal Rehabilitation for Cluster Farming

Bagerhat (Aliapur Khal Daratona River): Historical water level of Aliapur Khal Daratona River was collected from BWDB station at Bagerhat (Station ID-1) for the period of 1994 – 2023. **Figure 5.84** shows the monthly variation of high and low tide levels. The maximum high tide ranges between 2.25mPWD and 3.00 mPWD and low tide varies from -1.38 mPWD to -1.70 mPWD.

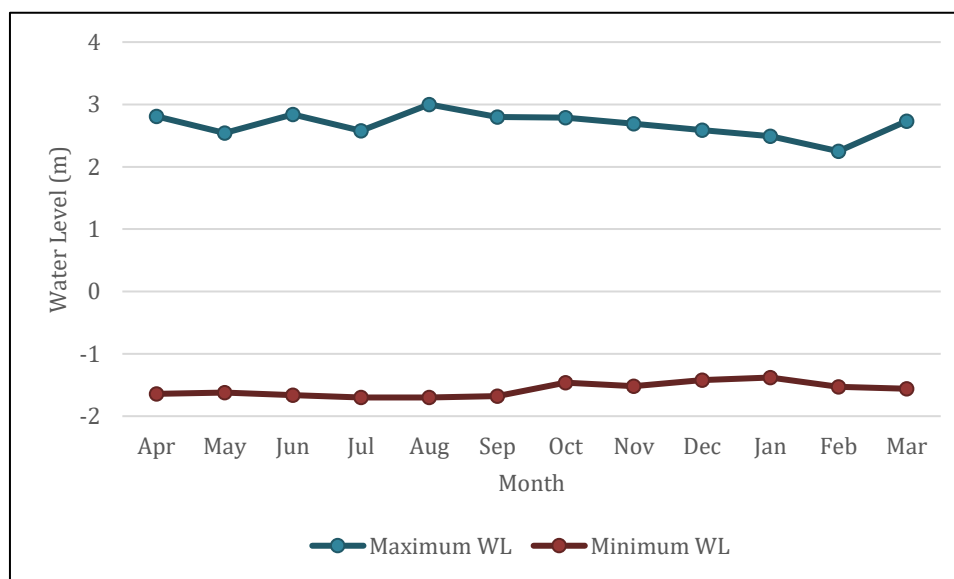


Figure 5.84: Monthly Variation of Water Level at Aliapur Khal Daratona River BWDB Station (Bagerhat)

Kalaroa (Betna-Kholpetua River): Historical water level of Betna-Kholpetua River was collected from BWDB station at Kalaroa (Station ID-23) for the period of 1994 – 2023. **Figure 5.85** shows the monthly variation of high and low tide levels. The maximum high tide ranges between 3.33mPWD and 5.64 mPWD and low tide varies from 1.27 mPWD to -0.21 mPWD.

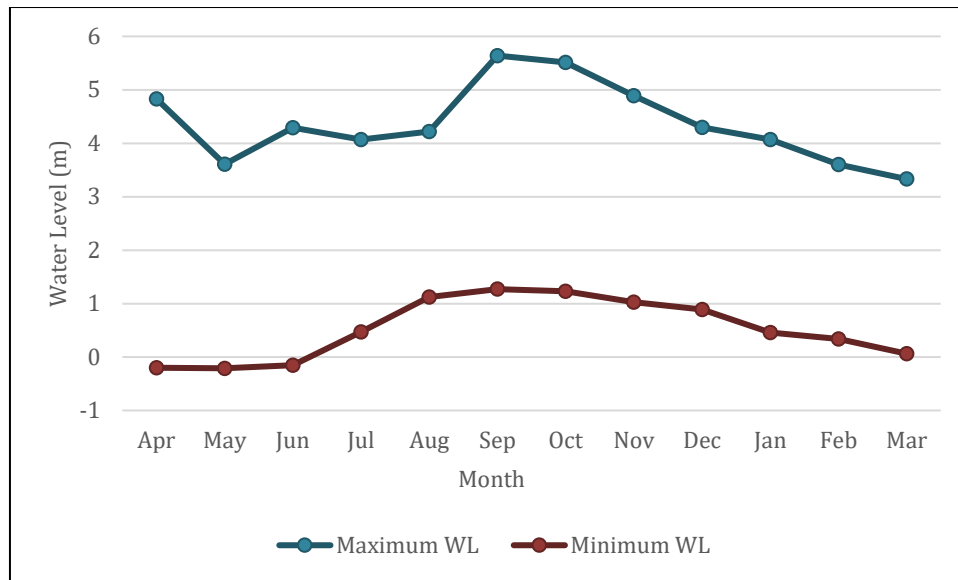


Figure 5.85: Monthly Variation of Water Level at Betna-Kholpetua River BWDB Station (Kalaroa)

Benarpota (Betna-Kholpetua River): Historical water level of Betna-Kholpetua River was collected from BWDB station at Benarpota (Station ID-24) for the period of 1994 – 2023. **Figure 5.86** shows the monthly variation of high and low tide levels. The maximum high tide ranges between 3.1mPWD and 4.97 mPWD and low tide varies from -1.04 mPWD to -2.14 mPWD.

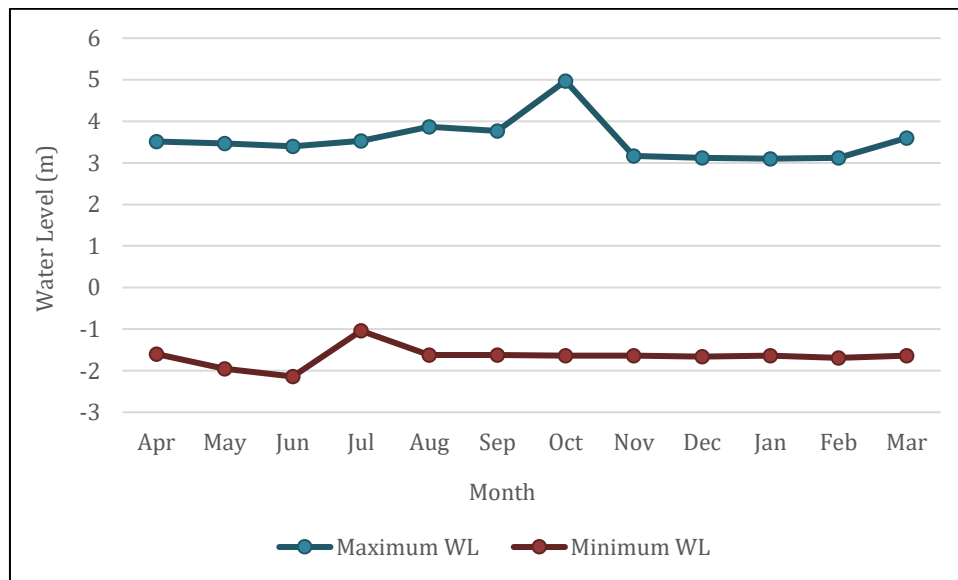


Figure 5.86: Monthly Variation of Water Level at Betna-Kholpetua River BWDB Station (Benarpota)

Dumuria (Bhadra River): Historical water level of Bhadra River was collected from BWDB station at Dumuria (Station ID-28) for the period of 1994 – 2023. **Figure 5.87** shows the monthly variation of high and low tide levels. The maximum high tide ranges between 3.1mPWD and 3.58 mPWD and low tide varies from -2.28mPWD to -2.75 mPWD.

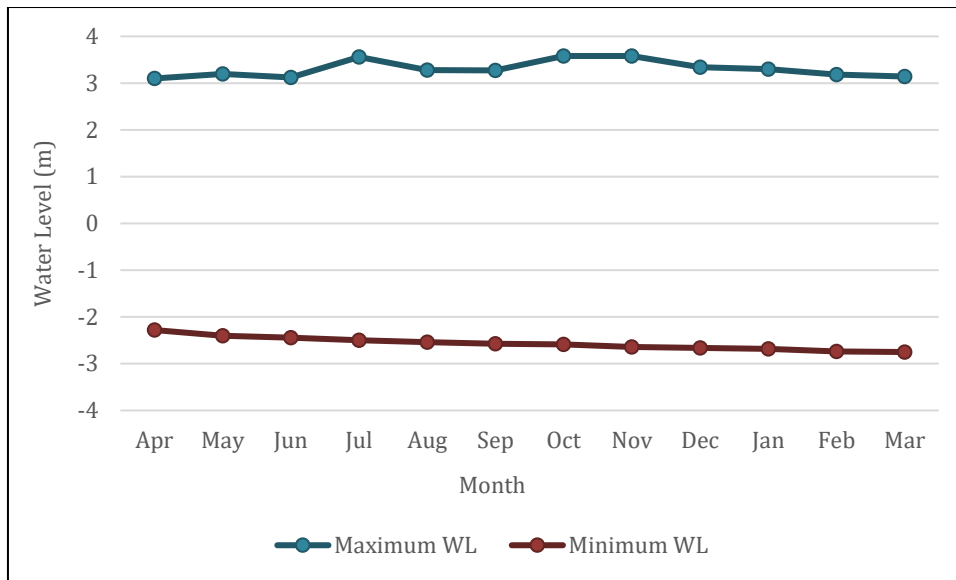


Figure 5.87: Monthly Variation of Water Level at Bhadra River BWDB Station (Dumuria)

Atharobanki (Gorai-Madhumati-Haringhata-Baleswar River): Historical water level of Off take at Atharobanki River was collected from BWDB station at Dumuria (Station ID-105) for the period of 1994 – 2023. **Figure 5.88** shows the monthly variation of high and low tide levels. The maximum high tide ranges between 3.1mPWD and 3.58 mPWD and low tide varies from -2.28mPWD to -2.75 mPWD.

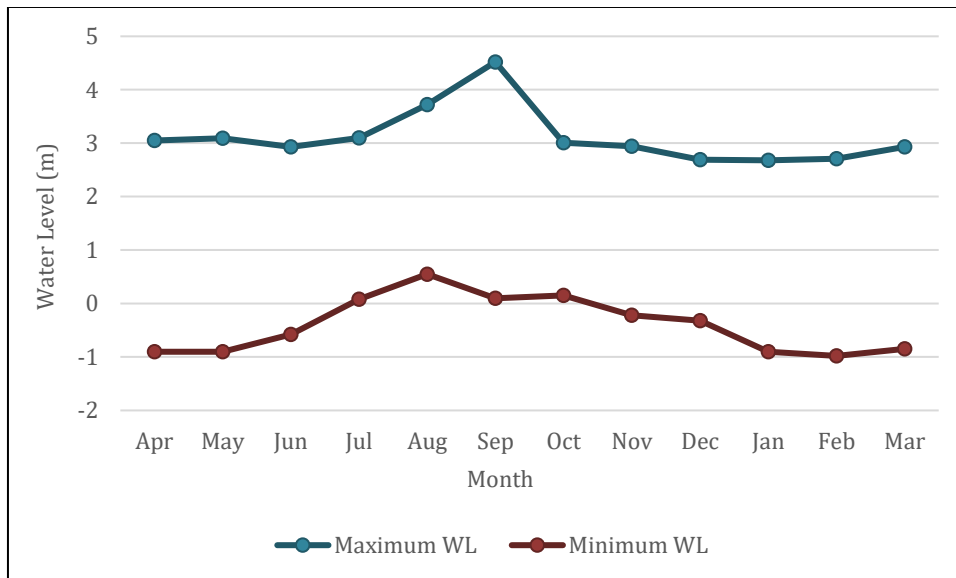


Figure 5.88: Monthly Variation of Water Level at Gorai-Madumati-Haringhata-Baleswar River BWDB Station (Off take at Atharobanki)

Nazirpur (Gorai-Madumati-Haringhata-Baleswar River): Historical water level of Gorai-Madumati-Haringhata-Baleswar River was collected from BWDB station at Nazirpur (Station ID-107A) for the period of 1994 – 2023. **Figure 5.89** shows the monthly variation of high and low tide levels. The maximum high tide ranges between 1.68mPWD and 2.77 mPWD and low tide varies from -0.52mPWD to -1.05 mPWD.

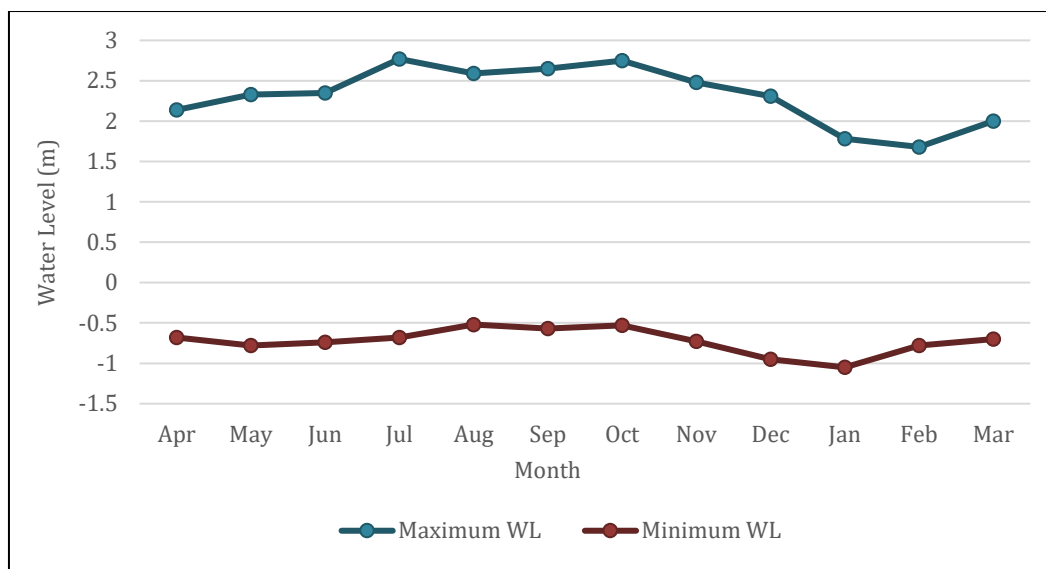


Figure 5.89: Monthly Variation of Water Level at Gorai-Madumati-Haringhata-Baleswar River BWDB Station (Nazirpur)

Basantapur (Ichamati {Western Border} River): Historical water level of Ichamati (Western Border) River was collected from BWDB station at Basantapur (Station ID-129) for the period of 1994 – 2023. **Figure 5.90** shows the monthly variation of high and low tide levels. The maximum high tide ranges between 3.31mPWD and 4.25 mPWD and low tide varies from -2.39mPWD to -3.31 mPWD.

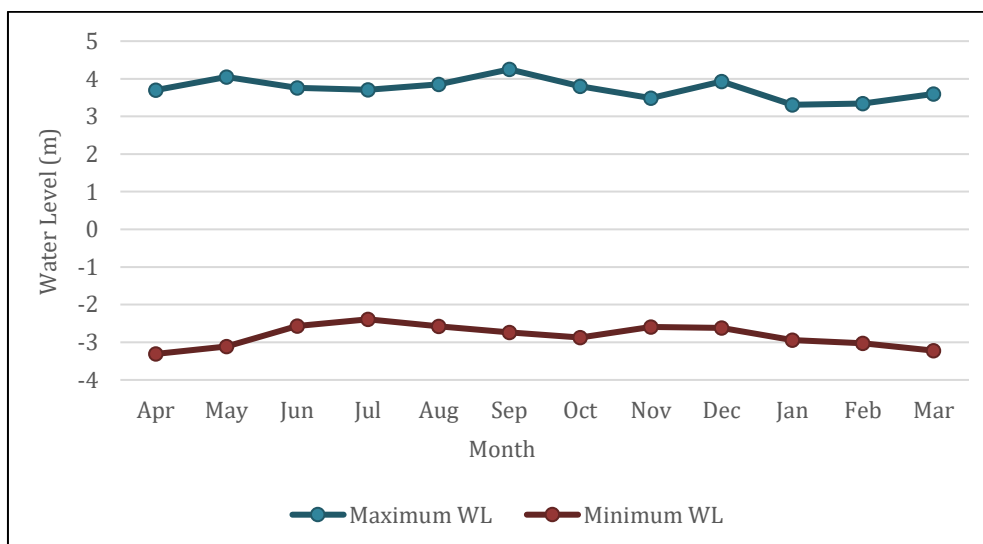


Figure 5.90: Monthly Variation of Water Level at Ichamati (Western Border) River BWDB Station (Basantapur)

Kaikhali (Ichamati {Western Border} River): Historical water level of Ichamati (Western Border) River was collected from BWDB station at Kaikhali (Station ID-130) for the period of 1994 – 2023. **Figure 5.91** shows the monthly variation of high and low tide levels. The maximum high tide ranges between 3.05mPWD and 3.9 mPWD and low tide varies from -1.68mPWD to -2.85 mPWD.

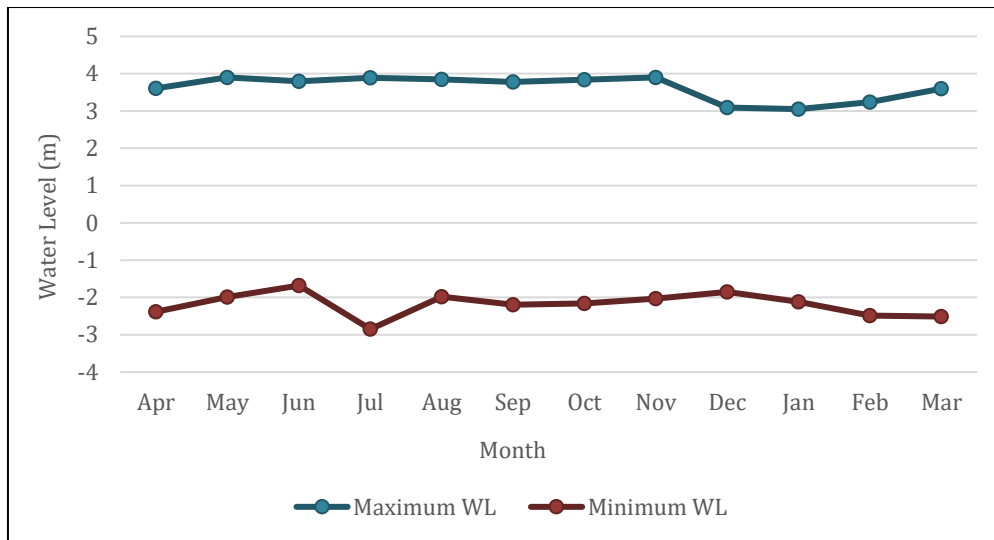


Figure 5.91: Monthly Variation of Water Level at Ichamati (Western Border) River BWDB Station (Kaikhali)

Tala Magura (Kobadak River): Historical water level of Kobadak River was collected from BWDB station at Tala Magura (Station ID-163) for the period of 1994 – 2023. **Figure 5.92** shows the monthly variation of high and low tide levels. The maximum high tide ranges between 2.57mPWD and 3.35 mPWD and low tide varies from -0.92mPWD to -2.29 mPWD.

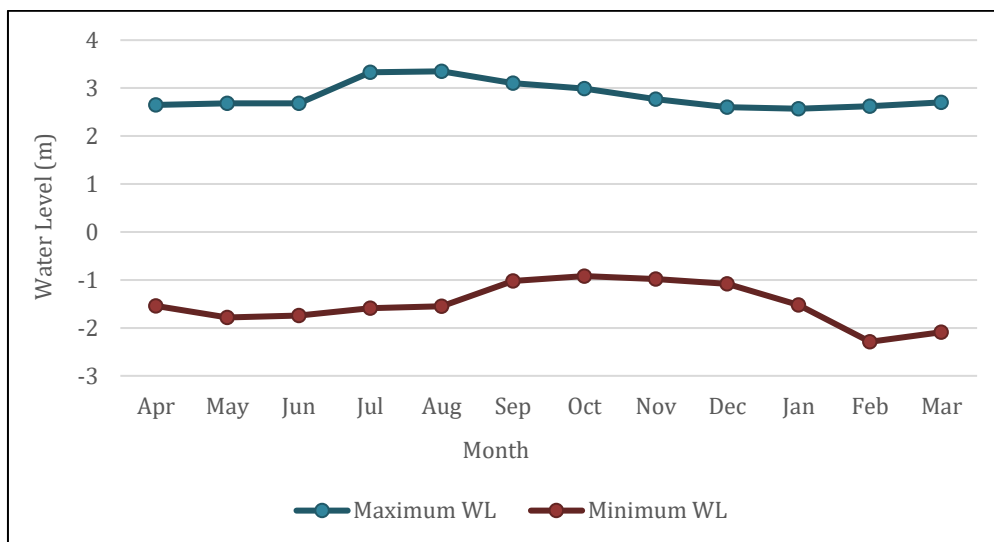


Figure 5.92: Monthly Variation of Water Level at Kobadak River BWDB Station (Tala Magura)

Discharge

Chakaria Shrimp Estate

The Matamuhuri River has a discharge station (ID:203, Station name: Lama) which is located approximately 18 km upstream from the CSE study area and presumed that has an influence on the study area. Surface water availability assessment of this station has been given below:

Surface Water Availability Assessment

The hydrological data has been analyzed for the last 30 years (1987 – 2017) for the existing flow condition. The average, 75% ,80% and 90% dependable flows at Lama station of Matamuhuri River is given in **Table 5.46**.

Table 5.46: Average, 75%, 80% and 90% dependable flow at Lama on the Matamuhuri River

Month	Decade	Flow at Lama (m ³ /s)			
		Average	75% Dependable	80% Dependable	90% Dependable
Jan	1	14.02854	12.612	11.2752	3.46868
	2	13.5361	12.21	10.9172	3.14104
	3	13.10012	11.84818	10.59231	2.787236
Feb	1	12.20358	11.312	10.29916	2.47336
	2	12.07134	10.948	10.0472	2.26074
	3	11.87704	10.6325	9.877133	2.1613
Mar	1	11.58373	10.0444	9.59708	3.013
	2	11.33572	9.6975	9.29928	2.54182
	3	10.84626	9.374909	8.958527	2.463145
Apr	1	10.5937	9.1785	8.64974	2.59822
	2	10.34613	8.8945	8.40442	2.49658
	3	10.46817	8.5594	8.29338	2.76296
May	1	10.98778	8.2498	7.9846	3.08992
	2	12.18004	9.4282	7.79404	3.57238
	3	16.90889	10.41118	8.056982	3.721945
Jun	1	18.33613	10.896	9.09296	7.8509
	2	44.65876	14.867	12.65274	11.34856
	3	73.25015	32.331	27.5036	20.7488
Jul	1	77.71426	48.163	45.9354	37.153
	2	69.28997	41.623	39.0392	36.0306
	3	76.47191	48.54273	44.64327	34.45527
Aug	1	62.62894	37.44	34.4708	26.6006
	2	59.11894	37.571	35.1976	20.8436
	3	53.01205	34.57273	31.87655	24.532
Sep	1	44.99646	26.651	25.6264	20.5338
	2	37.9663	24.924	22.2544	19.1464
	3	33.1821	22.283	20.322	16.003
Oct	1	29.9746	19.364	18.643	16.6188
	2	27.57429	19.729	18.248	16.7346
	3	23.28059	17.20364	15.87709	14.84964
Nov	1	21.02117	16.864	16.4104	14.2218
	2	20.29186	15.661	15.203	11.30488
	3	17.70106	14.791	14.3542	9.52292
Dec	1	16.54265	14.263	13.556	7.86004
	2	15.81563	13.834	13.1718	6.668
	3	15.12325	13.43727	12.82564	5.765491

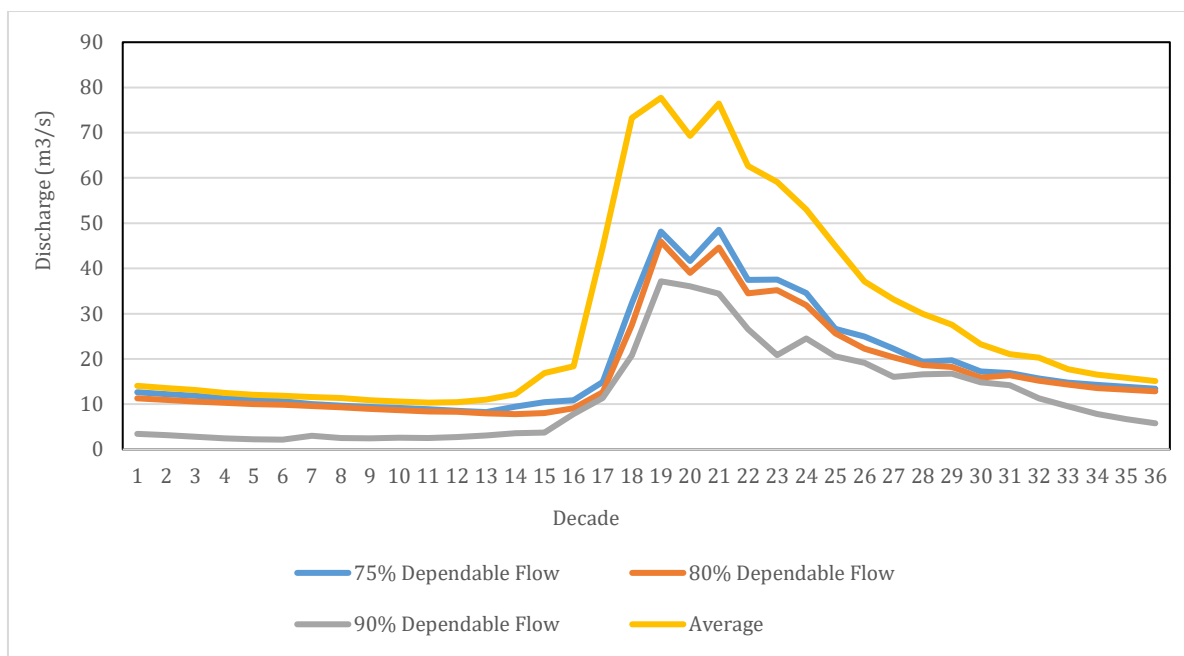


Figure 5.93: Dependable flow for Lama Station on the Matamuhuri River

5.7.3 Groundwater Level

Chakaria Shrimp Estate

Station ID- COX002: The groundwater data of BWDB observation Station COX002 for the period⁹ from **1984 to 2013** were analyzed. It is observed that the average depth of groundwater level from the ground surface in dry season goes downward and depth is highest in April. On the other hand, the water table rises in monsoon and the lowest depth of groundwater level from the ground surface is observed in July due to recharging by rainwater and peripheral river water. Average depths vary between 0.88 m and 2.51 m. The monthly maximum and minimum depth of groundwater from the ground surface during this period are also shown in **Figure 5.94**.

⁹ The groundwater data of BWDB observation Station COX002 for the period from 1984 to 2013 has been analyzed. But the recent data from 2014 to till now is not possible to be obtained from BWDB as digital well establishment is going on by groundwater circle of BWDB. As such, the groundwater level analysis has been carried out for the period from 1984 to 2013.

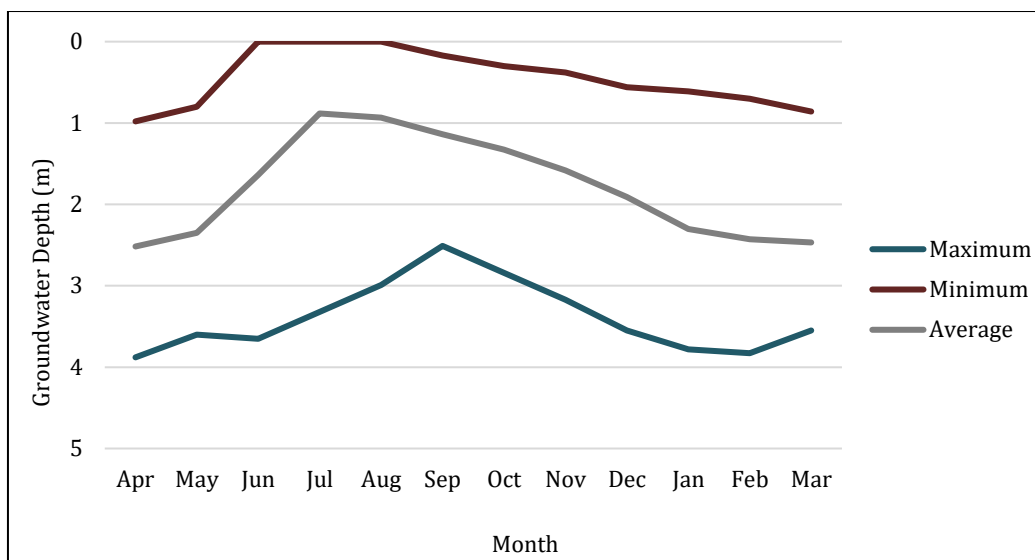


Figure 5.94: Depth of Groundwater from the Station ID-COX002 (1984-2013) near the Matamuhuri River

Station ID- COX004: The groundwater data of BWDB observation Station COX004 for the period¹⁰ from 1984 to 2013 were analyzed. It is observed that the average depth of groundwater level from the ground surface in dry season goes downward and depth is highest in May. On the other hand, the water table rises in monsoon and the lowest depth of groundwater level from the ground surface is observed in August due to recharge by rainwater and peripheral river water (Figure 5.95). The monthly maximum and minimum depth of groundwater from the ground surface during this period are also shown in Figure 5.95.

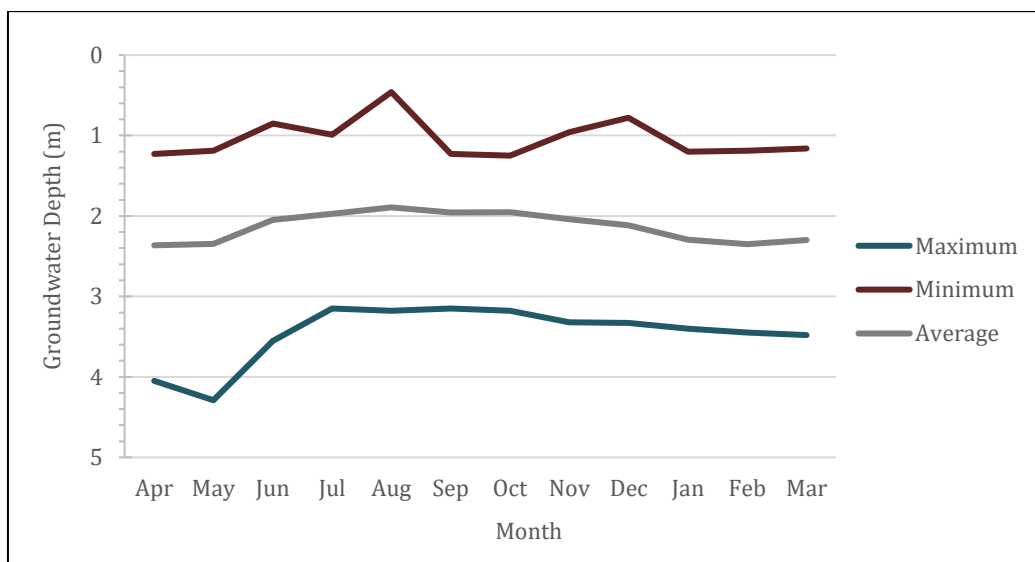


Figure 5.95: Depth of Groundwater from the Station ID- COX004 (1984-2013) near Matamuhuri River

¹⁰ The groundwater data of BWDB observation Station COX004 for the period from 1984 to 2013 has been analyzed. But the recent data from 2014 to till now is not possible to be obtained from BWDB as digital well establishment is going on by groundwater circle of BWDB. As such, the groundwater level analysis has been carried out for the period from 1984 to 2013.

BFDC

Station ID- THA001: The groundwater data of BWDB observation Station THA001 for the period¹¹ from **1984 to 2013** were analyzed. It is observed from **Figure 5.96** that the average depth of groundwater level from the ground surface in dry season goes downward and depth is highest in April. On the other hand, the water table rises in monsoon and the lowest depth of groundwater level from the ground surface is observed in September due to recharge by rainwater and peripheral river water. Average depths range between 1.39 m and 3.01 m. The monthly maximum and minimum depth of groundwater from the ground surface during this period are also shown in **Figure 5.96**.

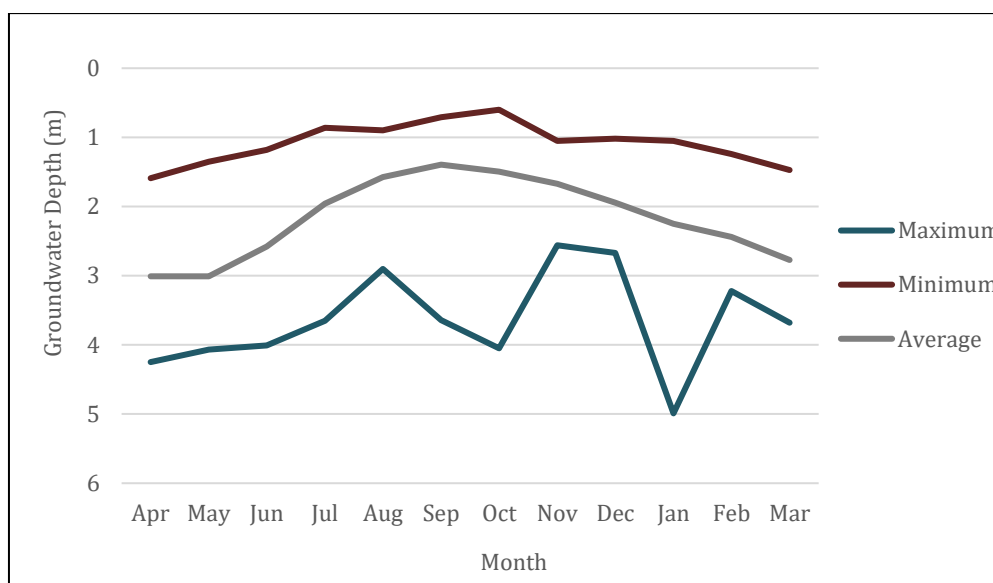


Figure 5.96: Depth of Groundwater from the Station ID- THA001 (1984-2013) near the Karnaphuli River

Station ID- THA002: The groundwater data of BWDB observation Station THA002 for the period¹² from **1984 to 2013** were analyzed. It is observed from **Figure 5.97** that the average depth of groundwater level from the ground surface in dry season goes downward and depth is highest in April. On the other hand, the water table rises in monsoon and the lowest depth of groundwater level from the ground surface is observed in September due to recharge by rainwater and peripheral river water. Average depths range between 2.56 m and 5.07 m. The monthly maximum and minimum depth of groundwater from the ground surface during this period are also shown in **Figure 5.97**.

¹¹ The groundwater data of BWDB observation Station THA001 for the period from 1984 to 2013 has been analyzed. But the recent data from 2014 to till now is not possible to be obtained from BWDB as digital well establishment is going on by groundwater circle of BWDB. As such, the groundwater level analysis has been carried out for the period from 1984 to 2013.

¹² The groundwater data of BWDB observation Station THA002 for the period from 1984 to 2013 has been analyzed. But the recent data from 2014 to till now is not possible to be obtained from BWDB as digital well establishment is going on by groundwater circle of BWDB. As such, the groundwater level analysis has been carried out for the period from 1984 to 2013.

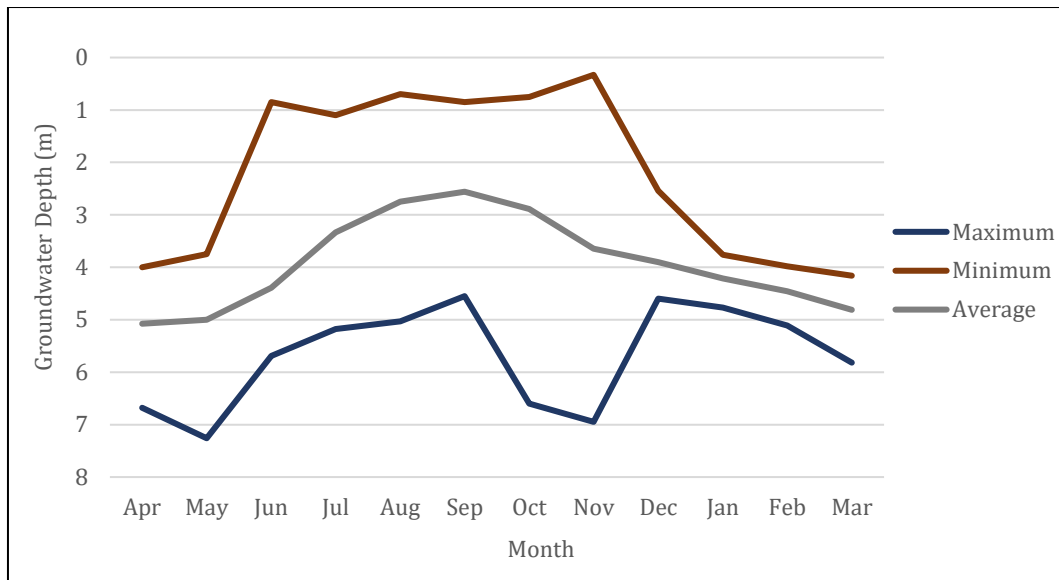


Figure 5.97: Depth of groundwater from the ground surface of Station THA002 (1984-2013) near the Karnaphuli River

Ground Water Availability Assessment

$$\text{Potential Recharge (PR)} = A + B \cdot \log_{10} AR$$

Here,

A & B are empirical constant:

$$A = -4548.9$$

(source: MPO study, CEGIS)

$$B = 1566.1$$

(source: MPO study, CEGIS)

$$AR = \text{Annual Rainfall} = 3099.92 \text{ mm}$$

(source: NWRD Data base)

Recharge Availability = 75% of Potential Recharge (PR)

$$\text{Potential Recharge of Kutubdia station} = A + B \cdot \log_{10} AR$$

$$= 918.904 \text{ mm}$$

$$= 0.918 \text{ m}$$

Recharge Availability = 75% of 0.918 m

$$= 0.6885 \text{ m}$$

The radius of influence for a 1.5 cusec pump is considered 1900 feet or 579.12 m (based on the thumb rule for the South-East coastal zone). The GW availability within an area of 1900 ft radius is given below.

The radius of influence is 579.12 m (1900 ft) (for deep tube well)

(Source: Groundwater Management Act 1985)

The volume of recharged water (available water) within the radius of influence

$$= \pi (\text{radius of influence})^2 \times \text{recharge availability}$$

$$= 725424.07 \text{ m}^3/\text{year}$$

$$= 1987.46 \text{ m}^3/\text{day}$$

$$= 82.811 \text{ m}^3/\text{hr}$$

$$\sim 83 \text{ m}^3/\text{hr}$$

For Cox's Bazar and Patenga, same procedure follows according to the above formula for ground water availability assessment.

For Cox's Bazar,

AR = Annual Rainfall = 3625.33 mm

$$\begin{aligned}\text{Potential Recharge of Cox's Bazar station} &= A+B*\log_{10}AR \\ &= 1025.39\text{mm} \\ &= 1.025\text{m}\end{aligned}$$

$$\begin{aligned}\text{Recharge Availability} &= 75\% \text{ of } 1.025 \text{ m} \\ &= 0.768 \text{ m}\end{aligned}$$

The radius of influence for a 1.5 cusec pump is considered as 1900 feet or 579.12 m (based on the thumb rule for the South-East coastal zone). The GW availability within an area of 1900 ft radius is given below.

The radius of influence is 579.12 m (1900 ft) (for deep tube well)

(Source: Groundwater Management Act 1985)

The volume of recharged water (available water) within the radius of influence

$$\begin{aligned}&= \pi * (\text{radius of influence})^2 * \text{recharge availability} \\ &= 809187.63 \text{ m}^3/\text{year} \\ &= 2216.95 \text{ m}^3/\text{day} \\ &= 92.37 \text{ m}^3/\text{hr} \\ &\sim 92 \text{ m}^3/\text{hr}\end{aligned}$$

For Chattogram (Patenga)

AR = Annual Rainfall = 2905.07mm

$$\begin{aligned}\text{Potential Recharge of Cox's Bazar station} &= A+B*\log_{10}AR \\ &= 874.75\text{mm} \\ &= 0.874\text{m}\end{aligned}$$

$$\begin{aligned}\text{Recharge Availability} &= 75\% \text{ of } 0.874 \text{ m} \\ &= 0.655\text{m}\end{aligned}$$

The radius of influence for a 1.5 cusec pump is considered as 1900 feet or 579.12 m (based on the thumb rule for the South-East coastal zone). The GW availability within an area of 1900 ft radius is given below.

The radius of influence is 579.12 m (1900 ft) (for deep tube well)

(Source: Groundwater Management Act 1985)

The volume of recharged water (available water) within the radius of influence

$$\begin{aligned}&= \pi * (\text{radius of influence})^2 * \text{recharge availability} \\ &= 690127.47 \text{ m}^3/\text{year} \\ &= 1890.76 \text{ m}^3/\text{day} \\ &= 78.78 \text{ m}^3/\text{hr} \\ &\sim 79 \text{ m}^3/\text{hr}\end{aligned}$$

The water demand for the project area is about 1000 metric ton/year or 41.67 m³/hr~ 42 m³/hr. This means the volume of available water within the radius of influence is about 83 m³/hr for Kutubdia station, 92 m³/hr for Cox's Bazar and 79 m³/hr for Chittagong (Patenga). It reveals that safe extraction of such quantity of water is really a constraint. Besides, it is essential to conduct Pump Test for understanding the drawdown effect and groundwater availability assessment in detail.

Canals Rehabilitation for Cluster Farming

Station ID- GT1519900: The groundwater data of BWDB observation Station GT1519900 for the period from 1996 to 2018 were analyzed. It is observed that the average depth of groundwater level from the ground surface in dry season goes downward and depth is highest in January. On the other hand, the water table rises in monsoon and the lowest depth of groundwater level from the ground surface is observed in May due to recharging by rainwater and peripheral river water. Average depths vary between -3.62 m and 0.65 m. The monthly maximum and minimum depth of groundwater from the ground surface during this period are also shown in **Figure 5.98**.

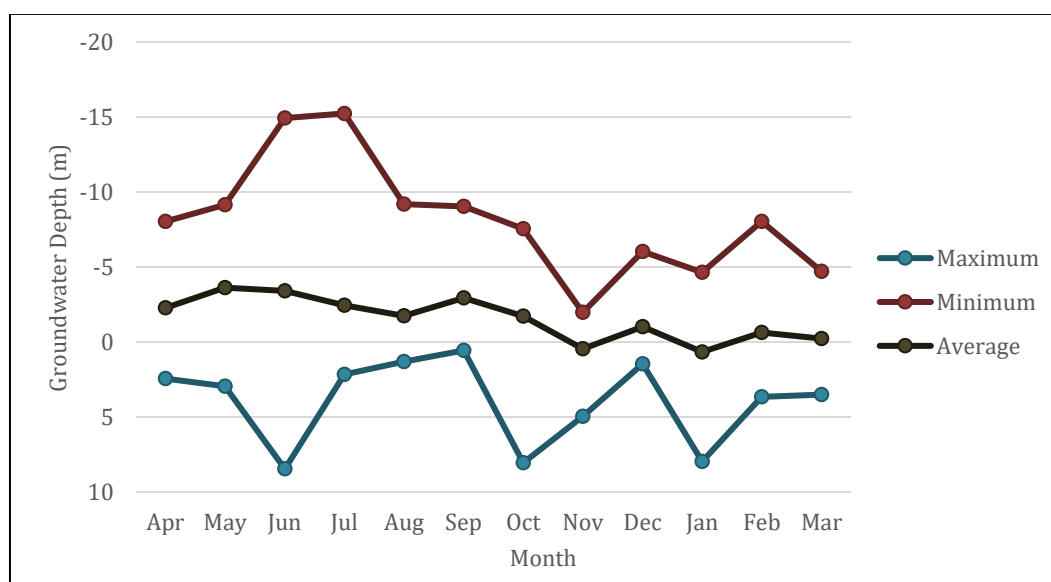


Figure 5.98: Depth of Groundwater from the Station ID- GT1519900 (1996-2018)

Station ID- GT4751900: The groundwater data of BWDB observation Station GT4751900 for the period from 1996 to 2018 were analyzed. It is observed that the average depth of groundwater level from the ground surface in dry season goes downward and depth is highest in October. On the other hand, the water table rises in monsoon and the lowest depth of groundwater level from the ground surface is observed in May due to recharging by rainwater and peripheral river water. Average depths vary between 0.14 m and 0.79 m. The monthly maximum and minimum depth of groundwater from the ground surface during this period are also shown in **Figure 5.99**.

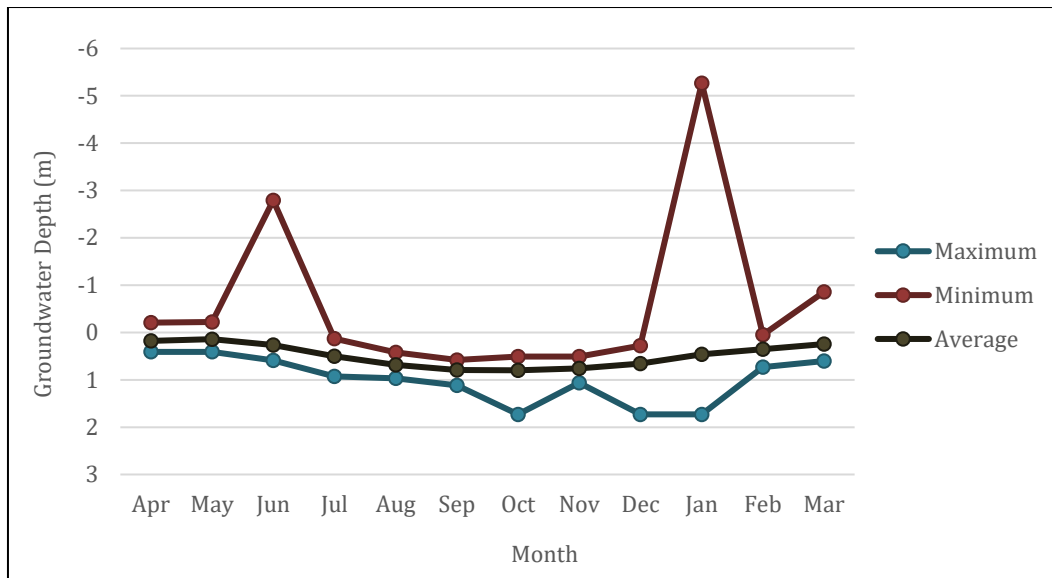


Figure 5.99: Depth of Groundwater from the Station ID- GT4751900 (1994-2021)

5.8 Environmental Quality

Environmental quality issues have been monitored in dual modes; in-situ and ex-situ. To understand the environmental quality for the both seasons (wet/ monsoon and dry) environmental parameter for ambient air, surface & ground water, acoustic noise and soil samples were collected during the field visit to analyse the environmental quality during wet period. The same would be collected during the dry period.

5.8.1 Air Quality

The sampling locations for testing the air quality in and around the sub-project sites, were selected considering the wind direction before visiting the sites. To compare the results of air quality parameters, air quality samples were collected for both monsoon and dry periods for 24 hours periods for each location. However, the study team did not visit to the BMC area at DFTC, Teknaf as the location was not fixed at earlier, hence, air quality was measured for this location only for the dry period.

Considering the sub-project activities for all the canals for cluster farming under Satkhira, Khulna, and Bagerhat Districts, and the physical condition of the catchment areas of the canals, three random samples were taken for three Districts near the Mahandi Khal at Tala, Satkhira; Nagkati Khal at Digholia, Khulna; and Dakatia Khal at Chitalmari Bagerhat.

Table 5.47 shows the locations of the ambient air quality monitoring within the study areas of the sub-project sites, and **Table 5.48** shows the measured values of the air quality parameters during monsoon and dry periods.

Table 5.47: Air Quality Monitoring Locations

Sl. No.	Monitoring ID	Period/ Season with Date	Geographic Location	Location Name	Testing Parameters
1.	AQ 1	Monsoon (03 October, 2023)	21°41'0.8"N 91°58'46.7"E	48- acres of Shrimp Demonstration Area at CSE	SPM, PM ₁₀ , PM _{2.5} , CO, SO _x , NO _x
2.		Dry (13 February, 2024)			
3.	AQ 2	Monsoon (04 October, 2023)	21°43'25.76"N 91°58'37.47"E	Settlement area on the embankment near Chakaria Shrimp Farm at Badarkhali.	
4.		Dry (15 February, 2024)			
5.	AQ 3	Monsoon (05 October, 2023)	22°18'56.43"N 91°49'35.01"E	BGB Road, Bangladesh Coast Guard, East Zone, Motshya Bondor Ichanagar; BFDC Harbor at Chattogram	
6.		Dry (17 February, 2024)			
7.	AQ 4	Dry (12 February, 2024)	20° 52' 25.5"N 92° 18' 2.5"E	Training Dormitory, DFTC, Teknaf	
8.	AQ 5	Monsoon (17 October, 2024)	22° 44' 41.5"N 89° 19' 46.4"E	Mahandi Khal, Tala, Satkhira	
9.		Dry (02 March, 2024)			
10.	AQ 6	Monsoon (16 October, 2023)	22° 52' 17.5"N 89° 31' 51.9"E	Nagkati Khal, Digholia, Khulna	
11.		Dry (05 March, 2024)			
12.	AQ 7	Monsoon (18 October, 2023)	22° 47' 10.7"N 89° 54' 2.6"E	Dakatia khal, Chitalmari, Bagerhat	
13.		Dry (07 March, 2024)			

Table 5.48: Air Quality Monitoring Result

Sampling period	Criteria Pollutant		Particulate Matter (PM ₁₀)	Particulate Matter (PM _{2.5})	Carbon Monoxide (CO)	Sulphur Dioxide (SO ₂)	Nitrogen Dioxide (NO _x)	Ozone (O ₃)
	Test Duration		24 hrs.					
	Unit		µg/m ³	µg/m ³	mg/m ³	µg/m ³	µg/m ³	µg/m ³
Oct-23	Concentration Present at locations during the measuring period	AQ 1	4.9	4.43	0.386	29.92	38.99	20.28
Feb-24			44.68	36.12	0.264	5.73	27.18	18.37
Oct-23		AQ 2	13.57	12.22	0.207	30.47	33.77	20
Feb-24			46.94	38.55	0.195	11.4	30.04	22.30
Oct-23		AQ 3	44.54	38.27	0.245	29.62	34.14	16.72
Feb-24			125.4	112.13	0.551	21.59	28.64	22.3
Feb-24		AQ 4	89.78	81.97	0.573	20.96	26.45	26.06
Oct-23		AQ 5	68.03	62.02	1.898	12.98	12.74	11.59
Mar-24			68.4	59.58	0.249	20.39	57.96	27.13
Oct-23		AQ 6	28.95	23.97	0.378	9.64	20.17	10.26
Mar-24			54.35	44.21	0.222	20.7	48.52	23
Oct-23		AQ 7	31.97	23.65	0.265	11.51	21.44	15
Mar-24			46.94	38.55	0.195	11.4	30.04	22.3
DoE Standard			150	65	5	80	80	100
IFC/ World Bank Standard			150 (IT-1), 24 hrs	75 (IT-1), 24 hrs	-	125 (IT-1), 24 hrs	200 (G), 1 hr	160 (IT-1), 8 hrs

Source: Lab Report, CEGIS

5.8.2 Water Quality

In total twenty-six (26) surface water quality samples were collected from the various surface water sources in and around the sub-project sites, in which five (05) samples were from CSE; one (01) from jetty area of the BFDC Harbor at Chattogram; two (02) from BMC areas at DFTC, Teknaf; eighteen (18) from each canal for cluster farming (**Table 5.49**).

On the other hand, ground water samples were collected from the tube wells from various locations within the study areas of the sub-project sites in which one (01) sample from Satdalia, Badarkhali settlement area close to CSE; one (01) sample from BFDC Harbor (existing tube well); one (01) sample from DFTC Training dormitory tube well; and five (05) from the tube wells of the settlement areas close to the canals for cluster farming under Khulna, Satkhira, and Bagerhat Districts.

The samples were analysed to determine the status of physico-chemical parameters which has been compared with the National standard (ECR 2023) inland surface water and drinking water standards and details of the analysis methods are presented in **Table 5.50**. The samples were taken both for monsoon and dry period to make a comparison of the results for seasonal variations, except for the BMC area. The water samples from BMC area were collected only for the dry period.

Table 5.49: Surface and Ground Water Quality Sampling Locations

Sampling Code	Sampling Location	GPS	Date	Type of Source
Chakaria Shrimp Estate				
SW 1	Matamuhuri River	21°39'30.05"N	03-10-23	Matamuhuri River
		91°59'56.19"E	13-02-24	
SW 2	Canal connected with the Matamuhuri River near Plot No. 135, Polder 1, CSE	21°41'41.17"N	03-10-23	Internal Canal
		92° 0'59.64"E	13-02-24	
SW 3	Bura Matamuhuri River close to existing 48- acres of Shrimp Demonstration Area	21°41'0.58"N	04-10-23	Internal Canal
		91°58'45.46"E	13-02-24	
SW 4	Canal under Plot No. 222, Polder 1, CSE	21°43'25.39"N	04-10-23	Internal Canal
		92° 0'6.18"E	15-02-24	
SW 5	Canal under Plot No. 163, Polder 2, CSE	21°42'23.86"N	04-10-23	Internal Canal
		91°59'24.19"E	15-02-24	
GW 1	Tube well from the settlement area at Satdalia, Badarkhali near CSE	21°43'23.92"N	04-10-23	Tube Well
		91°58'36.65"E	14-02-24	
BFDC Harbor at Chattogram				
SW 6	BFDC Jetty, Chattogram	22°19'6.77"N	05-10-23	Karnaphuli River
		91°49'40.47"E	17-02-24	
GW 2	Tube Well at BFDC Harbor at Chattogram	22° 18' 50. 5"N	05-10-23	Tube Well
		91° 49' 43.1"E	17-02-24	
Canal Rehabilitation for Cluster Farming				
Khulna				
SW 7	Mora Jopjopia Nodi, Botiaghata, Khulna	22°42'13.23"N	16-10-23	Canal
		89°28'5.49"E	03-03-24	
SW 8	Dohar Khal, Digholia, Khulna	22°54'5.66"N	16-10-23	Canal
		89°28'56.62"E	04-03-24	

Sampling Code	Sampling Location	GPS	Date	Type of Source
SW 9	Nagkati Khal, Digholia, Khulna	22°52'17.87"N	16-10-23	Canal
		89°31'54.59"E	05-03-24	
SW 10	Rajapur Khal, Digholia, Khulna	22°53'21.64"N	17-10-23	Canal
		89°33'34.90"E	04-03-24	
SW 11	Bollobi Khal, Rupsha, Khulna	22°46'14.01"N	17-10-23	Canal
		89°38'27.12"E	04-03-24	
GW 3	Tube well from the settlement area within the catchment area of Dohar Khal, Digholia, Khulna	22°52'18.17"N	16-10-23	Tube Well
		89°31'53.84"E	04-03-24	
Satkhira				
SW 12	Atshotobigha Khal, Debhata, Satkhira	22°33'4.18"N	18-10-23	Canal
		89° 1'41.72"E	29-02-24	
SW 13	Magra Khal, Kolaroa, Satkhira	22°49'0.92"N	18-10-23	Canal
		89° 4'27.39"E	01-03-24	
SW 14	Mahandi Khal, Tala, Satkhira	22°44'5.48"N	18-10-23	Canal
		89°17'45.14"E	01-03-24	
SW 15	Madhobkhali Khal, Tala, Satkhira	22°44'17.76"N	18-10-23	Canal
		89°18'28.95"E	02-03-24	
SW 16	Dakshkathi Khal, Tala, Satkhira	22° 45' 4.20"N		Canal
		89° 18' 35.00"N	02-03-24	
SW 17	Kalmeghar Khal, Shaymnagar, Satkhira	22°19'29.64"N	18-10-23	Canal
		89° 4'26.82"E	29-02-24	
GW 4	Kolaroa, Satkhira	22°49'0.92"N	18-10-23	Tube Well
		89° 4'27.39"E	29-02-24	
GW 5	Shaymnagar, Satkhira	22°19'29.64"N	18-10-23	Tube Well
		89° 4'26.82"E		
Bagerhat				
SW 18	Andigram Khal, Mollahat Bazar, Bagerhat	22°40'17.22"N	19-10-23	Canal
		89°41'40.52"E	07-03-24	
SW 19	Gajdurer Khal, Chitalmari, Bagerhat	22°36'43.29"N	19-10-23	Canal
		89°51'16.35"E	07-03-24	
SW 20	Dakatia Khal, Chitalmari, Bagerhat	22°36'23.06"N	19-10-23	Canal
		89°51'12.82"E	07-03-24	
SW 21	Burir Khal, Chitalmari, Bagerhat	22°36'18.83"N	19-10-23	Canal
		89°51'43.19"E	06-03-24	
SW 22	Kumbkhali Khal, Rampal, Bagerhat	22°35'18.86"N	19-10-23	Canal
		89°38'2.38"E	04-03-24	
SW 23	Jibon Khalir Khal, Kachua, Bagerhat	22°36'57.78"N	19-10-23	Canal
		89°51'15.35"N	06-03-24	
SW 24	Shoilodubir Khal, Kachua, Bagerhat	22°52'50.86"N	20-10-23	Canal

Sampling Code	Sampling Location	GPS	Date	Type of Source
		89°43'36.60"E	06-03-24	
GW 6	Kachua, Bagerhat	22°49'29.60"N	19-10-23	Tube Well
		22°49'29.60"N		
GW 7	Tube well at the settlement area of Char Dakatia, Chitalmari, Bagerhat	22°47'13.17"N		Tube Well
		89°54'14.22"E	07-03-24	
BMC Area at DFTC, Teknaf				
SW 25	Confluence of Kaikhali Khal and Hochkar Khal near BGB Check Post Teknaf Ghat	20°52'31.56"N		Canal
		92°18'8.49"E	12-02-24	
SW 26	BMC Jetty Site, Kaikhali Khal, Teknaf Bazar Boat Line	20°52'22.7"N		Canal
		92°18'6.03"E	12-02-24	
GW 8	Tube Well at DFTC, Teknaf	20°52'25.59"N		Tube Well
		92°18'2.51"E	12-02-24	

Source: Field Survey by CEGIS Team, August 2023 and February-March, 2024

Surface Water Quality

After collecting the water samples from pre-selected surface water sources, some parameters of water quality were checked through In-Situ test. The parameters were: pH, temperature, EC, TDS, Turbidity, Salinity, and DO. The method for testing water quality is mentioned in the **Annex 1** under **Volume II: Annexures of Main Report**. The In-Situ test results are given in **Table 5.50** along with the National standard (ECR, 2023) and International Standard (IFC, 2007).

pH concentrations were found to be within the standard limit as compared with the standards. On the other hand, Water temperature was found to be ranged in between 28.13-32.58. Salinity, EC and TDS values were found to be more in the Chakaria area than Khulna, Bagerhat and Satkhira area as the location receives more sea water than the other sites. Moreover, DO values were found to be within the standard at most of the area but some canals got low DO values as these receive much waste load than the other canals. The values indicate that the water quality of most of the canals are quite suitable for aquaculture practice but some of the canals need to be excavated and increased water flows and taken care of in terms of the water quality.

Table 5.50: In-situ Test Results of Surface Water Quality

Sampling period	Sampling ID	Parameters						
		pH	Temperature	EC	TDS	Turbidity	Salinity	DO
		Unit						
			°C	µS/cm	mg/L	NTU	ppt	mg/L
Oct-23	SW-1	7.1	28.96	6400	3030	111	3.5	7.3
Feb-24		7.57	25.63	21600	12200	69.9	12.9	5.53
Oct-23	SW-2	7.3	29.02	6590	3800	192	3.6	7.8
Feb-24		7.57	25.63	21600	12200	69.9	12.9	5.53
Oct-23	SW-3	7.31	29.39	6240	3390	175	3.4	8.04
Feb-24		7	25.6	20700	11000	25.7	12.4	4.64
Oct-23	SW-4	7.17	28.7	4210	2300	153	2.2	7.1
Feb-24		7.5	29	18900	10700	37.8	11.2	7.8
Oct-23	SW-5	7.31	28.6	5660	3370	219	3.1	6.57

Sampling period	Sampling ID	Parameters						
		pH	Temperature	EC	TDS	Turbidity	Salinity	DO
		Unit						
			°C	µS/cm	mg/L	NTU	ppt	mg/L
Feb-24	SW-6	7.5	25.4	20900	12000	87.7	12.5	5
Oct-23		7.8	28.13	194	100	372	0.1	6.7
Feb-24		7.18	23.74	6870	4000	140	3.8	8.6
Oct-23	SW-7	7.1	32.58	838	450	Out of Range	0.4	8
Mar-24		7.9	31.95	3770	2300	293	2	8.5
Oct-23	SW-8	7.34	31.98	786	420	7.01	0.4	6.41
Mar-24		7.65	28.57	1670	900	33	0.8	7.7
Oct-23	SW-9	7.78	31.33	164	100	309	0.1	6.96
Mar-24		7.75	28.9	1390	750	89.7	0.7	5.85
Oct-23	SW-10	7.44	31.34	798	410	50.5	0.4	4.61
Mar-24		7.36	29.26	1470	800	28.2	0.7	8.2
Oct-23	SW-11	7.6	29.94	567	300	42.3	0.3	5.91
Mar-24		8.2	28.17	1330	700	72.5	0.7	5.21
Oct-23	SW-12	7.6	29.18	3150	1950	0	1.6	5.6
Mar-24		7.46	26.16	5730	3000	88	3.1	7
Oct-23	SW-13	7.8	31.2	238	140	9	0.1	4.85
Mar-24		8.37	24.33	683	400	39.3	0.3	4.82
Oct-23	SW-14	7.7	32.23	1200	800	96	0.7	8.5
Mar-24		8.54	29.8	2830	1700	270	1.5	8.2
Oct-23	SW-15	7.8	32.31	3370	2000	103	1.8	6.02
Mar-24		8.48	30.68	3850	2250	126	2	6.85
Mar-24	SW-16	8.19	30.67	7380	4000	316	4.1	7.6
Oct-23	SW-17	7.98	32.24	2480	1300	170	1.3	6.1
Mar-24		8.1	31	14000	7500	70.6	8.1	7.5
Oct-23	SW-18	7.2	29.8	1200	610	58	0.9	5.2
Mar-24		7.69	24.19	2600	1350	114	0.1	2.8
Oct-23	SW-19	7.5	30	1450	700	45	0.7	4.5
Mar-24		7.48	25.86	1740	1050	8.53	0.9	3.21
Oct-23	SW-20	7.8	30.1	1500	770	200	0.85	4
Mar-24		7.66	24.7	1960	1050	71.8	1	4.16
Oct-23	SW-21	8	30.2	1160	600	69	0.67	4.8
Mar-24		7.17	26.39	650	350	15	0.3	3.39
Oct-23	SW-22	7.91	30.95	1350	866	350	0.7	5.9
Mar-24		7.52	28.19	1660	850	35.9	0.8	8.64
Oct-23	SW-23	7.65	30	1360	660	65	0.6	5.2
Mar-24		8.1	30.13	3870	2100	133	2	8.6
Oct-23	SW-24	8	30.5	1210	620	300	0.6	5.1
Mar-24		8.02	27.73	6470	3700	627	3.5	6.45
Feb-24	SW-25	7.8	26.3	18100	10000	56.5	10.7	8.7
Feb-24	SW-26	7.8	25.5	19800	10300	92.3	11.8	5.01

Sampling period	Sampling ID	Parameters						
		pH	Temperature	EC	TDS	Turbidity	Salinity	DO
		Unit						
			°C	µS/cm	mg/L	NTU	ppt	mg/L
Standards								
ECR' 23		6.5-8.5	-	-	1000	-	-	≥5
IFC		06-09	-	-	-	-	-	-
DPHE		-	20-30	-	1000	10	-%0	6
WHO Guideline		6.5-8.5	-	-	-	-	-	-

Water samples as collected from three locations (Matamuhuri River on the east side of the CSE; Jetty site of the BFDC Harbor at Chattogram; and Nagkati Khal near Senhati Jute Mills, Digholia, Khulna) for two seasons and were sent to BCSIR Lab for testing the parameters: Oil and Grease, Arsenic, Mercury, Lead, and Cadmium. Large numbers of activities are present at these locations such as vessel movement, fishing, transporting goods, etc. at Matamuhuri River and Maheshkhali Channel; Karnaphuli River; Bhairab River as connected to the Nagkati Khal by which water may be contaminated. This may eventually have impacts on water quality of CSE, BFDC, and Canals for cluster farming.

Afterwards, the study team collected water samples from some other areas to check the water quality of same parameters during dry period only. The test results from the BCSIR Lab are provided in the following **Table 5.51** which indicate the results comply the standard limit.

Table 5.51: Surface Water Quality Analysis Results Tested by the BCSIR Lab

Sample ID	Sampling Location	Sampling Period	Name of Water Quality Parameters				
			Oil and Grease (mg/L)	Arsenic (mg/L)	Mercury (mg/L)	Lead (mg/L)	Cadmium (mg/L)
Seasonal Variation							
SW 1	Matamuhuri River	Oct- 23	<2.0		<0.001	<0.01	<0.001
		Feb- 24	<2.0	<0.005	<0.001	<0.01	
SW 6	BFDC Jetty, Chattogram	Oct- 23	<2.0		<0.001	<0.01	<0.001
		Feb- 24	<2.0	<0.005	<0.001	<0.01	
SW 9	Nagkati Khal, Digholia, Khulna	Oct- 23	<2.0		<0.001	<0.01	<0.001
		Mar- 24	<2.0	<0.005	<0.001	<0.01	
Dry Period Data Only							
SW 25	Confluence of Kaikhali Khal and Hochkar Khal near BGB Check Post Teknaf Ghat	Feb- 24	<2.0	<0.005	<0.001	<0.01	
SW 26	BMC Jetty Site, Kaikhali Khal, Teknaf Bazar Boat Line	Feb- 24	<2.0	<0.005	<0.001	<0.01	
SW 2	Canal connected with the Matamuhuri River near Plot No. 135, Polder 1, CSE	Feb- 24	<2.0	<0.005	<0.001	<0.01	
SW 3	Bura Matamuhuri River close to existing 48-	Feb- 24	<2.0	<0.005	<0.001	<0.01	

Sample ID	Sampling Location	Sampling Period	Name of Water Quality Parameters				
			Oil and Grease (mg/L)	Arsenic (mg/L)	Mercury (mg/L)	Lead (mg/L)	Cadmium (mg/L)
	acres of Shrimp Demonstration Area						
SW 4	Canal under Plot No. 222, Polder 1, CSE	Feb- 24	<2.0	<0.005	<0.001	<0.01	
SW 5	Canal under Plot No. 163, Polder 2, CSE	Feb- 24	<2.0	<0.005	<0.001	<0.01	
SW 7	Mora Jopjopia Nodi, Botiaghata, Khulna	Mar- 24	<2.0	<0.005	<0.001	<0.01	
SW 8	Dohar Khal, Digholia, Khulna	Mar- 24	<2.0	<0.005	<0.001	<0.01	
SW 10	Rajapur Khal, Digholia, Khulna	Mar- 24	<2.0	<0.005	<0.001	<0.01	
SW 11	Bollobi Khal, Rupsha, Khulna	Mar- 24	<2.0	<0.005	<0.001	<0.01	
SW 12	Atshotobigha Khal, Debhata, Satkhira	Feb- 24	<2.0	<0.005	<0.001	<0.01	
SW 13	Magra Khal, Kolaroa, Satkhira	Mar- 24	<2.0	<0.005	<0.001	<0.01	
SW 14	Mahandi Khal, Tala, Satkhira	Mar- 24	<2.0	<0.005	<0.001	<0.01	
SW 15	Madhobkhali Khal, Tala, Satkhira	Mar- 24	<2.0	<0.005	<0.001	<0.01	
SW 17	Kalmeghar Khal, Shaymnagar, Satkhira	Mar- 24	<2.0	<0.005	<0.001	<0.01	
SW 18	Andigram Khal, Mollahat Bazar, Bagerhat	Mar- 24	<2.0	<0.005	<0.001	<0.01	
SW 19	Gajdurer Khal, Chitalmari, Bagerhat	Mar- 24	<2.0	<0.005	<0.001	<0.01	
SW 20	Dakatia Khal, Chitalmari, Bagerhat	Mar- 24	<2.0	<0.005	<0.001	<0.01	
SW 21	Burir Khal, Chitalmari, Bagerhat	Mar- 24	<2.0	<0.005	<0.001	<0.01	
SW 22	Kumbkhali Khal, Rampal, Bagerhat	Mar- 24	<2.0	<0.005	<0.001	<0.01	
SW 23	Jibon Khalir Khal, Kachua, Bagerhat	Mar- 24	<2.0	<0.005	<0.001	<0.01	
SW 24	Shoilodubir Khal, Kachua, Bagerhat	Mar- 24	<2.0	<0.005	<0.001	<0.01	
Standards							
Bangladesh Standards, ECR 2023			-	-	0.004	0.1	-
DPHE			0.01	0.05	0.001	0.05	0.005
WHO Guideline			-	0.01	0.001	0.01	0.003
Test Method (APHA)			5520.B	3114.C	3112.B	3111.B	3111.B

The surface water samples were also submitted to the Department of Public Health Engineering (DPHE) Lab and CEGIS Lab for testing some other parameters. From DPHE, Ammonia, Arsenic (As), Chemical Oxygen Demand (COD), Chloride, Hardness, and Total Suspended Solid (TSS); and from CEGIS Lab, Nitrate (NO_3^-), Phosphate (PO_4^-), Sulphate (SO_4^{2-}), Iron (Fe), Silica (SiO_2), Ammonium

(NH₄⁺), and Fluoride (F⁻) water quality parameters have been tested. Following **Table 5.52** and **5.53** shows the analysis results of the water quality samples tested by the DPHE, and CEGIS Lab respectively. The table indicates that the concentrations COD exceed the standard limit during the dry period. This is because, usually during dry period, the surface water dries up and might have relatively low flow in rivers and canals, hence, waste material becomes more intense in this period of time.

Table 5.52: Surface Water Quality Analysis Results Tested by the DPHE Lab

Sample ID	Sampling Period	Water Quality Parameters					
		Ammonia	Arsenic	COD	Chloride	Hardness	TSS
		Unit					
		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
SW 1	Oct- 23	0.30	0.001	196	4100	2200	8
	Feb- 24	0.15	0.003	416	16500	6800	8
SW 2	Oct- 23	0.24	0.002	96	3500	2100	11
	Feb- 24	0.24	0.002	400	15100	7500	7
SW 3	Oct- 23	0.34	0.002	180	4200	2000	12
	Feb- 24	0.19	0.001	332	15000	6560	3
SW 4	Oct- 23	0.24	0.002	120	2550	2300	7
	Feb- 24	0.20	0.005	212	14100	5850	4
SW 5	Oct- 23	0.30	0.002	192	4050	2000	12
	Feb- 24	0.24	0.002	324	15300	6000	6
SW 6	Oct- 23	0.25	0.002	16	50	300	11
	Feb- 24	0.21	0.002	208	14600	5900	7
SW 7	Oct- 23	0.20	0.014	88	370	282	21
	Mar- 24	0.24	0.003	172	2650	2300	6
SW 8	Oct- 23	0.15	0.003	48	325	242	2
	Mar- 24	0.19	0.002	96	920	1900	3
SW 9	Oct- 23	0.20	0.004	60	40	160	8
	Mar- 24	0.20	0.004	88	740	2100	5
SW 10	Oct- 23	0.19	0.006	60	340	310	3
	Mar- 24	0.24	0.006	112	770	1700	7
SW 11	Oct- 23	0.24	0.013	36	250	290	4
	Mar- 24	0.30	0.007	64	700	2000	4
SW 12	Oct- 23	0.30	0.008	168	1900	1300	3
	Feb- 24	0.26	0.004	280	3000	2500	5
SW 13	Oct- 23	0.15	0.019	16	30	170	2
	Mar- 24	0.22	0.035	80	170	310	3
SW 14	Oct- 23	0.16	0.010	36	720	900	2
	Mar- 24	0.20	0.004	180	1600	2700	5
SW 15	Oct- 23	0.14	0.007	400	2130	780	4
	Mar- 24	0.24	0.002	368	5600	4750	6
SW 16	Oct- 23	-	-	-	-	-	-
	Mar- 24	0.32	0.010	72	1750	550	8
SW 17	Oct- 23	0.21	0.004	112	1500	800	5
	Feb- 24	0.19	0.008	120	110	340	4

Sample ID	Sampling Period	Water Quality Parameters					
		Ammonia	Arsenic	COD	Chloride	Hardness	TSS
		Unit					
		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
SW 18	Oct- 23	0.15	0.008	16	60	175	3
	Mar- 24	0.43	0.008	4	870	1950	3
SW 19	Oct- 23	0.18	0.004	64	250	310	3
	Mar- 24	0.17	0.007	92	1220	1700	4
SW 20	Oct- 23	0.17	0.004	48	240	315	4
	Mar- 24	0.19	0.002	56	280	525	4
SW 21	Oct- 23	0.14	0.023	4	20	200	3
	Mar- 24	0.29	0.006	88	4600	1200	13
SW 22	Oct- 23	0.15	0.012	36	700	800	18
	Mar- 24	0.27	0.004	104	810	2000	5
SW 23	Oct- 23	0.17	0.004	120	650	2400	6
	Mar- 24	0.20	0.004	72	2400	2200	8
SW 24	Oct- 23	0.32	0.004	40	460	200	5
	Mar- 24	0.17	0.005	372	5100	2900	6
SW 25	Feb- 24	0.14	0.002	248	11500	4800	4
SW 26	Feb- 24	0.16	0.003	136	4700	2800	8
Standards							
Bangladesh Standard, ECR 2023		-	-	50	-	-	-
DPHE		0.5	0.05	4	150-600	200-500	10
WHO Guideline		-	0.01	-	-	-	-
Analysis Method		UVS	AAS	CRM	Titrimetic	Titrimetic	Gravimetric
LOQ		0.10	0.001	4.0	-	-	-

According to above Table, the analysis report reveals that the concentration of nitrate complies with the standard for SW25 and phosphate comply with irrigation standard except for SW10 during the dry period. The Ammonium concentrations were observed comparatively higher for SW 1- SW 5, SW 7, SW 22, and SW 25- SW 26) than the standard limit mainly dry period within the study area. The largest source of ammonium emissions might be from agriculture, including animal husbandry and NH_3 -based fertilizer applications, excretion of nitrogenous wastes from animals.

Table 5.53: Surface Water Quality Analysis Results Tested by the CEGIS Lab

Sample ID	Sampling Period	Water Quality Parameters						
		Nitrate (NO ₃ ⁻)	Phosphate (PO ₄ ⁻)	Sulphate (SO ₄ ²⁻)	Iron (Fe)	Silica (SiO ₂)	Ammonium (NH ₄ ⁺)	Fluoride (F ⁻)
		Unit						
		ppm	ppm	ppm	ppm	ppm	ppm	ppm
SW 1	Oct- 23	0.9700	0.0295	206.75	1.2513	21.810	0.2581	Undetectable
	Feb- 24	2.3998	0.0822	246.08	Undetectable	1.3747	3.7639	1.6100
SW 2	Oct- 23	1.2433	0.0768	205.24	1.1434	37.428	0.3226	Undetectable
	Feb- 24	2.3788	0.0916	236.80	Undetectable	0.7943	4.2599	1.5497
SW 3	Oct- 23	0.9700	0.0752	215.35	2.3545	26.427	0.8080	Undetectable
	Feb- 24	3.2829	0.0948	239.95	Undetectable	5.5250	3.9755	1.6005
SW 4	Oct- 23	0.5705	0.0692	184.91	0.9347	56.012	0.1360	Undetectable
	Feb- 24	4.7128	0.1109	243.40	Undetectable	3.0415	3.7866	1.4866
SW 5	Oct- 23	0.5705	0.1380	210.02	0.9529	28.360	0.1288	0.1434
	Feb- 24	3.0516	0.0916	243.63	Undetectable	14.259	4.4260	1.5842
SW 6	Oct- 23	5.3226	0.1753	202.29	1.3118	40.044	0.3394	Undetectable
	Feb- 24	2.3578	0.2671	215.95	0.0352	7.1418	Undetectable	0.5639
SW 7	Oct- 23	1.4115	0.7462	166.61	12.957	346.87	5.5185	Undetectable
	Mar- 24	4.5235	0.6273	143.23	0.8298	1.6581	Undetectable	Undetectable
SW 8	Oct- 23	1.2013	0.4978	12.178	0.2969	7.2585	Undetectable	0.0763
	Mar- 24	2.3998	1.8356	41.641	Undetectable	Undetectable	Undetectable	Undetectable
SW 9	Oct- 23	3.3250	0.2358	4.9130	2.0974	66.347	0.9223	Undetectable
	Mar- 24	11.547	1.2453	11.444	0.4305	4.7583	0.1854	Undetectable
SW 10	Oct- 23	2.0844	0.6877	0.5930	0.11366	12.392	Undetectable	0.675
	Mar- 24	13.166	2.4006	1.2427	0.2445	11.442	1.1640	Undetectable
SW 11	Oct- 23	1.5587	0.0689	6.2545	0.1376	9.8587	0.0128	Undetectable
	Feb- 24	0.9910	0.1213	58.921	Undetectable	6.1751	Undetectable	Undetectable
SW 12	Oct- 23	1.9162	0.1842	98.593	0.0841	8.6920	0.0112	0.4745

Sample ID	Sampling Period	Water Quality Parameters						
		Nitrate (NO ₃ ⁻)	Phosphate (PO ₄ ⁻)	Sulphate (SO ₄ ²⁻)	Iron (Fe)	Silica (SiO ₂)	Ammonium (NH ₄ ⁺)	Fluoride (F ⁻)
		Unit						
		ppm	ppm	ppm	ppm	ppm	ppm	ppm
	Mar- 24	0.8018	0.0831	181.90	0.0246	5.2917	Undetectable	0.0635
SW 13	Oct- 23	1.2433	0.2387	1.1668	0.1330	13.442	Undetectable	0.4135
	Mar- 24	4.4184	1.1301	1.1668	0.0443	13.826	Undetectable	Undetectable
SW 14	Oct- 23	1.8741	0.3097	61.494	0.2172	9.1253	0.0663	0.0438
	Mar- 24	11.210	0.5395	84.233	1.0865	8.3753	0.3337	Undetectable
SW 15	Oct- 23	1.8952	0.1052	141.43	0.2626	11.792	0.1292	0.0736
	Mar- 24	14.511	0.1766	142.43	0.6498	6.3418	0.3294	Undetectable
SW 16	Oct- 23	-	-	-	-	-	-	-
	Mar- 24	1.6008	0.2457	193.85	1.6552	3.1582	Undetectable	0.3770
SW 17	Oct- 23	5.3646	0.0360	93.388	0.9337	21.193	0.4663	Undetectable
	Feb- 24	3.3690	0.1027	229.63	0.1502	2.1414	1.0031	0.5855
SW 18	Oct- 23	3.4932	0.0188	4.3899	0.9443	11.309	0.0961	0.0323
	Mar- 24	3.0306	0.2075	21.535	0.3972	6.1251	Undetectable	Undetectable
SW 19	Oct- 23	1.9793	0.1853	5.2252	0.0700	8.2586	Undetectable	Undetectable
	Mar- 24	Undetectable	0.2880	63.207	0.0488	4.9750	Undetectable	Undetectable
SW 20	Oct- 23	3.2409	0.1718	8.0770	0.1885	9.0586	Undetectable	0.3526
	Mar- 24	4.4605	0.8605	39.726	0.5616	9.3920	Undetectable	Undetectable
SW 21	Oct- 23	1.9582	0.0864	5.5627	0.2646	8.4253	Undetectable	0.4332
	Mar- 24	Undetectable	0.0869	26.951	0.0715	6.3251	Undetectable	Undetectable
SW 22	Oct- 23	0.7387	0.0236	134.96	11.855	13.276	4.6243	Undetectable
	Mar- 24	0.6335	0.0588	82.28	3.1088	3.0082	Undetectable	0.1758
SW 23	Oct- 23	1.5798	0.0679	50.078	0.1053	6.3418	Undetectable	0.0757
	Mar- 24	1.1172	0.2776	70.404	Undetectable	1.9081	Undetectable	Undetectable
SW 24	Oct- 23	1.4536	0.2037	37.464	0.0811	3.2749	Undetectable	Undetectable

Sample ID	Sampling Period		Water Quality Parameters						
			Nitrate (NO ₃ ⁻)	Phosphate (PO ₄ ⁻)	Sulphate (SO ₄ ²⁻)	Iron (Fe)	Silica (SiO ₂)	Ammonium (NH ₄ ⁺)	Fluoride (F ⁻)
			Unit						
			ppm	ppm	ppm	ppm	ppm	ppm	ppm
	Mar- 24		4.5656	0.2984	145.10	0.7310	10.875	Undetectable	Undetectable
SW 25	Feb- 24		11.715	0.4723	239.95	Undetectable	2.4748	3.1100	1.34318
SW 26	Feb- 24		2.9255	0.3290	233.11	Undetectable	Undetectable	3.0123	1.5280
Standards									
Bangladesh Standard (ECR 2023)	Drinking	After Conventional Treatment	7.0	0.5	-	-	-	0.3	-
		After Disinfecting Process	7.0	0.1	-	-	-	0.1	-
	Fisheries		7.0	0.5	-	-	-	0.3	-
	Irrigation		5.0	2.0	-	-	-	1.5	-
	Recreational		7.0	0.5	-	-	-	0.3	-
	By Various Process and Cooling Industries		-	-	-	-	-	2.7	-
DPHE			<1	6	400	0.3-1	-	-	1
WHO Guideline			3.0 (0.2)	-	-	-	-	-	1.5
Analysis Method			UV- VIS	UV- VIS	UV- VIS	UV- VIS	UV- VIS	UV- VIS	UV- VIS
Minimum Detection Limit (MDL)			0.05008	0.0003	0.02	0.0003	0.04957	0.01037	0.00328

Ground Water Quality

In total eight (08) groundwater quality samples were collected within the study areas of the sub-project sites, in which one (01) sample from each of the sub-projects: CSE, BFDC Harbor at Chattogram, and BMC Area at DFTC, Teknaf was collected during field visit. On the other hand, one (01) sample was collected from the tube well at the settlement area close to Senhati Jute Mills at Digholia, Khulna just beside the Nagkati Khal. One (01) sample from the catchment area of the Atshtobigha Khal at Debhata; and one (01) sample from the catchment area of Kalmegher khal at Shyamnagar under Satkhira District were collected. Two (02) ground water samples were collected from the deep tube well under Bagerhat District, one (01) from the catchment area of Shoilodubir khal at Kachua, and one (01) from the catchment area of Dakatia Khal at Char Dakatia, Chitalmari. The locations of the Ground Water sampling are shown in the **Table 5.49**.

The in-situ test results are given in **Table 5.54** along with the National standard (ECR, 2023) and International Standard (WHO, 2022). pH concentrations were found to be within the standard limit as compared with the standards. On the other hand, Water temperature was found to be ranged in between 28.13-32.58. Total Dissolve Solid (TDS) values were also found to be within the standard except GW-2 and GW-3. Turbidity was found to be exceeded at all sites. However, all the other parameters for all sites were found suitable for dinking purposes.

Similarly, the testing results of selected parameters, those were analyzed by the BCSIR, DPHE, and CEGIS Lab are given in the **Table 5.55, 5.56, and 5.57**.

Table 5.54: In-Situ Test Results of Ground Water Monitoring

Sampling period	Sampling ID	Parameters						
		pH	Temperature	EC	TDS	Turbidity	Salinity	DO
		Unit						
			°C	µS/cm	mg/L	NTU	ppt	mg/L
Oct-23	GW 1	6.9	28.7	293	161	3.5	0.1	2.7
Feb-24		7.7	27.88	212	120	0.03	0.1	7.7
Oct-23	GW 2	7.8	26.73	514	395	3.25	0.3	4.88
Feb-24		8	24.04	400	200	2.69	0.2	5.38
Oct-23	GW 3							
Mar-24		7.6	30	3000	1600	20.3	1.3	3
Oct-23	GW 4	7.7	29.8	2000	1050	22	0.8	2
Feb-24		6.68	26.64	668	350	0	0.3	3.84
Oct-23	GW 5							
Mar-24		7.6	30	3000	1600	20.3	1.3	3
Oct-23	GW 6							
Mar-24		7.8	30.1	1600	800	19	1	2.2
Oct-23	GW 7							
Mar-24		7.19	25.98	764	400	13.5	0.4	2.53
Oct-23	GW 8							
Mar-24		8.6	27.6	1740	1100	3.6	0.9	4
Standards								
ECR' 23		6.5-8.5	-	-	-	-	-	≥5
IFC		06-Sep	-	-	-	-	-	-
DPHE		-	20-30	-	1000	10	-%0	6
WHO Guideline		6.5-8.5	-	-	-	-	-	-

Table 5.55: Ground Water Quality Analysis Results Tested by the BCSIR Lab

Sample ID	Sampling Location	Sampling Period	Name of Water Quality Parameters		
			Arsenic (mg/L)	Mercury (mg/L)	Lead (mg/L)
GW 1	Tube well from the settlement area at Satdalia, Badarkhali near CSE	Feb- 24	<0.005	<0.001	<0.01
GW 2	Tube Well at BFDC Harbor at Chattogram	Feb- 24	<0.005	<0.001	<0.01
GW 3	Tube well from the settlement area within the catchment area of Dohar Khal, Digholia, Khulna	Mar- 24	<0.005	<0.001	<0.01
GW 4	Debhata, Satkhira	Feb- 24	<0.005	<0.001	<0.01
GW 7	Tube well at the settlement area of Char Dakatia, Chitalmari, Bagerhat	Mar- 24	<0.005	<0.001	<0.01
GW 8	Tube Well at DFTC, Teknaf	Feb- 24	<0.005	<0.001	<0.01
Standards					
Bangladesh Standards, ECR 2023			-	0.004	0.1
DPHE			0.05	0.001	0.05
WHO Guideline			0.01	0.001	0.01
Test Method (APHA)			3114.C	3112.B	3111.B

Table 5.56: Ground Water Quality Analysis Results Tested by the DPHE Lab

Sample ID	Sampling Period	Water Quality Parameters					
		Ammonia	Arsenic	COD	Chloride	Hardness	TSS
		Unit					
		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
GW 1	Oct- 23	0.10	0.001	4	20	180	1
	Feb- 24	0.12	0.001	8	80	500	1
GW 2	Oct- 23	-	-	-	-	-	-
	Feb- 24	0.10	0.001	4	20	165	1
GW 4	Oct- 23	0.43	0.101	8	1700	1300	1
	Feb- 24	0.18	0.013	48	200	1200	1
GW 5	Oct- 23	0.40	0.009	12	1160	1000	1
	Mar- 24	-	-	-	-	-	-
GW 6	Oct- 23	0.24	0.013	12	130	190	2
	Mar- 24	-	-	-	-	-	-
GW 7	Oct- 23	-	-	-	-	-	-
	Mar- 24	0.35	0.486	36	120	1800	1
GW 8	Oct- 23	-	-	-	-	-	-
	Feb- 24	0.13	0.001	60	560	1600	1
Standards							
Bangladesh Standard, ECR 2023		-	-	50	-	-	-
DPHE		0.5	0.05	4	150-600	200-500	10
WHO Guideline		-	0.01	-	-	-	-
Analysis Method		UVS	AAS	CRM	Titrimetic	Titrimetic	Gravimetric
LOQ		0.10	0.001	4.0	-	-	-

Table 5.57: Ground Water Quality Analysis Results Tested by the CEGIS Lab

Sample ID	Sampling Period		Water Quality Parameters						
			Nitrate (NO ₃ ⁻)	Phosphate (PO ₄ ⁻)	Sulphate (SO ₄ ²⁻)	Iron (Fe)	Silica (SiO ₂)	Ammonium (NH ₄ ⁺)	Fluoride (F ⁻)
			Unit						
			ppm	ppm	ppm	ppm	ppm	ppm	ppm
GW 1	Oct- 23		2.6311	1.0452	1.7321	0.0428	20.893	Undetectable	0.0750
	Feb- 24		2.3157	0.8915	Undetectable	Undetectable	16.609	Undetectable	Undetectable
GW 2	Oct- 23		-	-	-	-	-	-	-
	Feb- 24		0.4863	0.2293	0.1543	Undetectable	3.110	Undetectable	0.1772
GW 4	Oct- 23		17.203	0.3151	4.4320	0.0534	33.627	Undetectable	0.1352
	Feb- 24		0.5284	1.9804	Undetectable	Undetectable	25.560	Undetectable	Undetectable
GW 5	Oct- 23		3.0516	0.4976	178.66	0.4850	15.042	Undetectable	0.0384
	Mar- 24		-	-	-	-	-	-	-
GW 6	Oct- 23		1.5167	0.3325	116.94	1.4233	20.743	Undetectable	0.0777
	Mar- 24		-	-	-	-	-	-	-
GW 7	Oct- 23		-	-	-	-	-	-	-
	Mar- 24		1.0331	1.7513	7.8154	2.5597	23.610	1.0706	Undetectable
GW 8	Oct- 23		-	-	-	-	-	-	-
	Feb- 24		1.3064	0.1706	0.2808	Undetectable	10.592	0.3398	2.4665
Standards									
Bangladesh Standard (ECR 2023)	Drinking	After Conventional Treatment	7.0	0.5	-	-	-	0.3	-
		After Disinfecting Process	7.0	0.1	-	-	-	0.1	-
	Fisheries		7.0	0.5	-	-	-	0.3	-
	Irrigation		5.0	2.0	-	-	-	1.5	-
	Recreational		7.0	0.5	-	-	-	0.3	-
	By Various Process and Cooling Industries		-	-	-	-	-	2.7	-

Sample ID	Sampling Period	Water Quality Parameters						
		Nitrate (NO ₃ ⁻)	Phosphate (PO ₄ ⁻)	Sulphate (SO ₄ ²⁻)	Iron (Fe)	Silica (SiO ₂)	Ammonium (NH ₄ ⁺)	Fluoride (F ⁻)
		Unit						
		ppm	ppm	ppm	ppm	ppm	ppm	ppm
DPHE		<1	6	400	0.3-1	-	-	1
WHO Guideline		3.0 (0.2)	-	-	-	-	-	1.5
Analysis Method		UV- VIS	UV- VIS	UV- VIS	UV- VIS	UV- VIS	UV- VIS	UV- VIS
Minimum Detection Limit (MDL)		0.05008	0.0003	0.02	0.0003	0.04957	0.01037	0.00328

5.8.3 Acoustic Noise

Acoustic noise level was monitored at seven (07) pre-selected locations in and around the CSE; one (01) location at BFDC Harbor, Chattogram near jetty site; one (01) location at BMC at DFTC, Teknaf near the Training Dormitory; and eighteen (18) locations near each canal (**Table 5.58**). Considering the locations area types have been determined. Noise level was measured for 15 minutes at with time intervals of 5 min during day-time only. From the obtained data the LAeq value which is defined by a weighted equivalent of continuous sound level was computed.

During field visit, although the CSE was found very calm and quiet, the noise levels of some locations exceeded the standard value. The selected locations were close to the internal canals where water vessels like speed boat, trawlers etc. moves through this canals which eventually might expedite the noise level. Moreover, the noise level (NL 6) was measured near a settlement area where there is a tea shop and many human activities were also observed there. This is why, the noise level was observed slightly high in this location.

The acoustic noise level was within the standard level both for the sub-project sites: BFDC Harbor at Chattogram, and BMC at DFTC, Teknaf.

However, within some catchment areas of the canals for cluster farming under Khulna, Satkhira and Bagerhat District were observed noisy. Most of the places could be recognized as lightly dense residential areas, and mixed areas. Along with the residential settlements, few commercial activities like bazar and shops were also observed which was considered as the commercial areas.

Among the monitoring sites: Atshotobigha Khal (55.8 dBA and 61.30 dBA), Rajapur Khal (58.9 dBA and 58.95 dBA), Andigram Khal (51.9 dBA and 51.85 dBA), and Shoilodubir Khal (63 dBA and 62.99) were subjected to numerous types of Noise generation activities e.g. Vehicle running, commercial activities, certain industrial, agricultural and construction processes. Hence, the interventions of canal rehabilitation through re-excavation during the construction stage may increase the noise level at the surrounding areas of the canals. However, it is expected that this situation might not continue for a long period of time.

Table 5.58: Acoustic Noise Level Monitoring Result

ID	Sampling Location	Noise Level (dBA) October, 2023	Noise Level (dBA) February-March, 2024	Area Type	Standards (dBA)
Chakaria Shrimp Estate					
NL 1	11- acre Shrimp Estate area near internal canal connected to the Matamuhuri River	56.7	50.75	Mixed Area	60
NL 2	Plot No. 113, Polder 4, CSE	50.3	42.65	Silent Area	50
NL 3	Plot No. 163, Polder 2, CSE	51.5	47.88	Silent Area	50
NL 4	Near Plot No. 135, Polder 1, CSE	53.1	48.99	Silent Area	50
NL 5	Existing 48- acres of Shrimp Demonstration Area	50.6	40.55	Mixed Area	60
NL 6	Settlement area at Badarkhali near CSE	55.5	53.86	Residential Area	55
NL 7	Plot No. 222, Polder 1, CSE	56.4	55.51	Silent Area	50

ID	Sampling Location	Noise Level (dBA) October, 2023	Noise Level (dBA) February-March, 2024	Area Type	Standards (dBA)
BFDC Harbor at Chattogram					
NL 8	BFDC jetty, Chattogram	64.8	61.09	Industrial Area	75
BMC at DFTC, Teknaf					
NL 9	Training Dormitory, DFTC, Teknaf	-	41.75	Mixed Area	60
Canals for Cluster Farming					
Satkhira District					
NL 10	Atshotobigha Khal Debhata, Satkhira	55.8	61.30	Silent Area	50
NL 11	Magra Khal, Kolaroa, Satkhira	49.8	58.62	Silent Area	50
NL 12	Kalmeghar Khal, Shaymnagar, Satkhira	44.7	44.08	Silent Area	50
NL 13	Mahandi Khal, Tala, Satkhira	57.9	52.59	Mixed Area	60
NL 14	Dakshkathi Khal, Tala, Satkhira	45.8	42.15	Silent Area	50
NL 15	Madhobkhali Khal, Tala, Satkhira	49.2	49.2	Residential Area	55
Khulna District					
NL 16	Dohar Khal, Digholia, khulna	44.5	44.52	Silent Area	50
NL 17	Mora Jopjopia Nodi, Botiaghata, Khulna	45.8	45.81	Silent Area	50
NL 18	Nagkati Khal, Digholia, khulna	60.7	60.68	Mixed Area	60
NL 19	Rajapur Khal, Digholia, khulna	58.9	58.95	Silent Area	50
NL 20	Bollobi Khal, Rupsha, khulna	52.0	52.02	Residential Area	55
Bagerhat District					
NL 21	Andigram Khal, Mollahat, Bagerhat	51.9	51.85	Silent Area	50
NL 22	Gajdurer Khal, Chitalmari, Bagerhat	57.9	57.92	Commercial Area	70
NL 23	Dakatia Khal, Chitalmari, Bagerhat	63.0	62.97	Commercial Area	70
NL 24	Burir Khal, Chitalmari, Bagerhat	45.3	45.29	Residential Area	55
NL 25	Kumbkhali Khal, Rampal, Bagerhat	55.8	55.83	Mixed Area	60
NL 26	Jibon Khalir Khal, Kachua, Bagerhat	48.6	48.59	Commercial Area	70
NL 27	Shoilodubir Khal, Kachua, Bagerhat	63.0	62.99	Silent Area	50

5.8.4 Soil Quality

Soil Salinity

Soil Salinity data for the study area was collected from the SRDI SFSDP program. Salts in the soil have an important effect on the functions and management. According to the report, the country has been divided into five salinity classes. These are- S1 (Non-Saline with some Very Slightly Saline, EC: 2.0-4.0), S2 (Very Slightly Saline with some Slightly Saline, EC: 4.1-8.0), S3 (Slightly Saline with some Moderately Saline, EC: 8.1-12.0), S4 (Moderately Saline with some Strongly Saline, EC: 12.1-16.0) and S5 (Strongly Saline with some Very Strongly Saline, EC: >16.0). The study area of the Chakaria Shrimp Estate is equally distributed into salinity classes S4 and S5, whereas the entire study area of BFDC has fallen under the S1 salinity class. Atshobigha Khal's salinity class is excluded from consideration due to the absence of any agricultural land while catchment area of Nagkati khal doesn't show any soil salinity. Among the remaining 16 khals, 9 are in S1, 1 in S2, 3 in S3, 2 in S4 and 1 in S5. The coverage of soil salinity in the study area is presented in **Table 5.59**.

Table 5.59: Soil Salinity Information of the Study Areas of the Sub-Project Sites

List of Intervention Area	Soil Salinity				
	Non-Saline with some Very Slightly Saline (S1_EC_2.0-4.0)	Very Slightly Saline with some Slightly Saline (S2_EC_4.1-8.0)	Slightly Saline with some Moderately Saline (S3_EC_8.1-12.0)	Moderately Saline with some Strongly Saline (S4_EC_12.1-16.0)	Strongly Saline with some Very Strongly Saline (S5_EC_>16.0)
<i>Chakaria Shrimp Estate</i>					
Project Area	-	-	-	-	-
Study Area	-	-	0.09	233.08	229.84
<i>BFDC Harbor at Chattogram</i>					
Project Area	-	-	-	-	-
Study Area	15.61	-	-	-	-
<i>BMC Area at DFTC, Teknaf</i>					
Project Area	-	-	-	-	-
Study Area	-	-	-	-	-
<i>Catchment of the Canals for Cluster Farming under Satkhira, Khulna, and Bagerhat Districts</i>					
Atshobigha Khal	-	-	-	-	-
Kalmegher Khal	-	-	-	-	310.66
Magra Khal	655.51	-	-	-	-
Dakatia Khal and Gajdurer Khal	664.36	-	-	-	-
Mahandi Khal, Daskathi Khal and Madhobkhali Khal	228.38	-	-	-	-
Bollobi Khal	-	-	289.16	-	-
Rajapur Khal	-	259.38	-	-	-
Dohar Khal	186.04	-	-	-	-
Mora Jopjopia Nodi	-	-	-	1394.61	-

List of Intervention Area	Soil Salinity				
	Non-Saline with some Very Slightly Saline (S1_EC_2.0-4.0)	Very Slightly Saline with some Slightly Saline (S2_EC_4.1-8.0)	Slightly Saline with some Moderately Saline (S3_EC_8.1-12.0)	Moderately Saline with some Strongly Saline (S4_EC_12.1-16.0)	Strongly Saline with some Very Strongly Saline (S5_EC_>16.0)
Kumbkhali Khal	-	-	-	5.32	-
Shoilodubir Khal and Jibon Khalir Khal	-	-	951.67	-	-
Burir Khal	373.76	-	-	-	-
Andigram khal	344.75	-	-	-	-
Nagkati Khal	199.46	-	-	-	-

Source: BARC: 2012, 1 ds/m=640ppm (approximate.)

Soil Quality

Soil quality is one of the significant criteria and indicators which might be vulnerable due to project activity. Surge (both tidal and storm) has affected soil quality, ultimately hindering crop production. Therefore, soil quality measurement is an important issue. During this project, soil quality data were collected from Soil Resource Development Institute (SRDI). The analysis is compared for loamy to clayey soil for wetland rice crops. The concentration of different parameters in soil is presented in **Table 5.60**, **Table 5.61**, and **Table 5.62**.

Table 5.60: Concentration of Different Parameters in Soil within the Study Areas

Nutrient Element	Concentration	CSE		BFDC Harbor at Chattogram		BMC Area at DFTC, Teknaf	
		Project Area (ha)	Study Area (ha)	Project Area (ha)	Study Area (ha)	Project Area (ha)	Study Area (ha)
Organic Matter (in %)	Very High (>5.5)	-	-	-	-	-	-
	High (3.5-5.5)	-	14	-	-	-	-
	Medium (1.8-3.4)	-	325	-	16	-	-
	Low (1.0-1.7)	-	124	-	-	-	-
	Very Low (<1.0) pH:	-	-	-	-	-	-
Total		-	463	-	16	-	-
pH	Strongly Acidic (4.6-5.5)	-	160	-	9	-	-
	Slightly Acidic (5.6-6.5)	-	292	-	-	-	-
	Neutral (6.6-7.3)	-	0	-	-	-	-
	Slightly Alkaline (7.4-8.4)	-	11	-	6	-	-
	Strongly Alkaline (8.4-9.0)	-	-	-	-	-	-
Total		-	463	-	16	-	-
Phosphorus (in ppm)	Very High (>30.0)	-	-	-	-	-	-
	High (24.1-30.0)	-	8	-	-	-	-
	Optimum (18.1-24.0)	-	-	-	-	-	-
	Medium (12.1-18.0)	-	276	-	-	-	-
	Low (6.1-12.0)	-	173	-	1	-	-
	Very Low (<6.0)	-	7	-	15	-	-
Total		-	463	-	16	-	-
Potassium (meq/100 g soil)	Very High (>0.375)	-	-	-	-	-	-
	High (0.31-0.375)	-	28	-	2	-	-
	Optimum (0.226-0.30)	-	36	-	1	-	-

Nutrient Element	Concentration	CSE		BFDC Harbor at Chattogram		BMC Area at DFTC, Teknaf	
		Project Area (ha)	Study Area (ha)	Project Area (ha)	Study Area (ha)	Project Area (ha)	Study Area (ha)
	Medium (0.151-0.225)	-	65	-	2	-	-
	Low (0.076-0.15)	-	334	-	10	-	-
	Very Low (<0.075)	-	-	-	-	-	-
Total		-	463	-	16	-	-
Sulphur (in ppm)	Very High (>45.0)	-	39	-	1	-	-
	High (36.1-45.0)	-	277	-	15	-	-
	Optimum (27.1-36.0)	-	117	-	-	-	-
	Medium (18.1-27.0)	-	30	-	-	-	-
	Low (9.1-18.0)	-	-	-	-	-	-
	Very Low (<9.0)	-	-	-	-	-	-
Total		-	463	-	16	-	-

Source: SRDI, 2020

Table 5.61: Concentration of Organic Matter, pH, and Phosphorus in Soil within the Catchment Areas of the Canals for Cluster Farming

Name of Canals	Organic Matter (in %)					Total	pH					Total	Phosphorus (in ppm)						Total
	VH	H	M	L	VL		St. A	Sl. A	N	Sl. Al	St. Al		VH	H	O	M	L	VL	
Atshobigha Khal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kalmegher Khal	0	0	311	0	0	311	273	37	0	0	0	311	0	0	6	221	84	0	311
Magra Khal	0	0	288	367	0	656	0	0	0	656	0	656	125	118	92	269	46	7	656
Dakatia Khal and Gajdurer Khal	120	438	106	0	0	664	0	47	445	173	0	664	0	0	0	0	545	120	664
Mahandi Khal, Daskathi Khal and Madhobkhali Khal	0	0	21	208	0	228	0	0	11	217	0	228	25	55	57	62	30	0	228
Bollobi Khal	0	9	280	0	0	289	0	0	0	289	0	289	0	6	9	61	200	14	289
Rajapur Khal	220	39	0	0	0	259	52	208	0	0	0	259	0	0	0	0	88	171	259

Name of Canals	Organic Matter (in %)					Total	pH					Total	Phosphorus (in ppm)						Total
	VH	H	M	L	VL		St. A	Sl. A	N	Sl. Al	St. Al		VH	H	O	M	L	VL	
Dohar Khal	19	71	97	0	0	186	2	76	73	35	0	186	0	7	13	97	32	37	186
Mora Jopjopia Nodi	0	42	1269	84	0	1395	0	56	934	404	0	1395	0	0	0	0	153	1241	1395
Kumbkhali Khal	0	0	4	1	0	5	0	0	0	5	0	5	0	4	1	0	0	0	5
Shoilodubir Khal and Jibon Khalir Khal	29	581	343	0	0	952	10	171	495	276	0	952	0	0	0	57	895	0	952
Burir Khal	0	146	34	194	0	374	0	120	232	22	0	374	0	0	0	0	303	71	374
Andigram khal	0	186	159	0	0	345	0	0	241	103	0	345	0	10	0	183	152	0	345
Nagkati Khal	36	52	112	0	0	199	4	180	16	0	0	199	0	0	0	8	30	162	199

Source: SRDI, 2020

Table 5.62: Concentration of Potassium, and Sulphur in Soil within the Catchment Areas of the Canals for Cluster Farming

Name of Canals	Potassium (meq/100 g soil)						Total	Sulphur (in ppm)						Total
	VH	H	O	M	L	VL		VH	H	O	M	L	VL	
Atshobigha Khal	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kalmegher Khal	0	183	37	90	0	0	311	0	301	9	0	0	0	311
Magra Khal	92	256	308	0	0	0	656	0	0	0	164	492	0	656
Dakatia Khal and Gajdurer Khal	0	0	0	512	153	0	664	0	259	365	40	0	0	664
Mahandi Khal, Daskathi Khal and Madhobkhali Khal	187	41	0	0	0	0	228	87	73	57	11	0	0	228
Bollobi Khal	40	90	159	0	0	0	289	283	6	0	0	0	0	289
Rajapur Khal	236	21	0	0	0	0	257	202	57	0	0	0	0	259
Dohar Khal	186	0	0	0	0	0	186	182	4	0	0	0	0	186
Mora Jopjopia Nodi	1395	0	0	0	0	0	1395	1395	0	0	0	0	0	1395
Kumbkhali Khal	2	4	0	0	0	0	5	0	5	0	0	0	0	5
Shoilodubir Khal and Jibon Khalir Khal	0	0	0	952	0	0	952	19	371	485	57	19	0	952

Name of Canals	Potassium (meq/100 g soil)						Total	Sulphur (in ppm)						Total
	VH	H	O	M	L	VL		VH	H	O	M	L	VL	
Burir Khal	0	0	0	179	194	0	374	30	75	269	0	0	0	374
Andigram khal	345	0	0	0	0	0	345	310	7	28	0	0	0	345
Nagkati Khal	199	0	0	0	0	0	199	195	4	0	0	0	0	199

Source: SRDI, 2020

Organic Matter (in %): VH- Very High (>5.5), H- High (3.5-5.5), M- Medium (1.8-3.4), L- Low (1.0-1.7), VL- Very Low (<1.0);

pH: St. A- Strongly Acidic (4.6-5.5), Sl. A- Slightly Acidic (5.6-6.5), N- Neutral (6.6-7.3), Sl. Al- Slightly Alkaline (7.4-8.4), St. Al- Strongly Alkaline (8.4-9.0);

Phosphorus (in ppm): V.H- Very High (>30.0), H- High (24.1-30.0), O- Optimum (18.1-24.0), M- Medium (12.1-18.0), L- Low (6.1-12.0), VL- Very Low (<6.0);

Potassium (meq/100g soil): VH- Very High (>0.375), H- High (0.31-0.375), O- Optimum (0.226-0.30), M- Medium (0.151-0.225), L- Low (0.076-0.15), VL- Very Low (<0.075);

Sulphur (in ppm): VH- Very High (>45.0), H- High (36.1-45.0), O- Optimum (27.1-36.0), M- Medium (18.1-27.0), L- Low (9.1-18.0), VL- Very Low (<9.0).

T: Total

6. Description of Baseline Scenario of Biological Environment

This Chapter focuses on the biological environment, which covers ecological, fisheries and agricultural resources of the Project and Study Areas.

6.1 Ecological Resources

Biological environment typically refers to the surroundings or conditions in which living organisms exist and interact. The biological environment is a dynamic and complex system that includes both biotic (living) and abiotic (non-living) components. The study has considered both biotic and abiotic components but this chapter has emphatically discussed the biotic components such as Flora and Fauna while abiotic components (i.e., environmental quality, climate, geomorphology, topography etc.) are discussed in **Chapter 5**.

6.1.1 Bio-Ecological Zone

The study areas of the sub-projects fall under various Bio-Ecological Zones (BEZs). Chakaria Sub-Project falls under Chakaria Sundarban (7b), and Chittagong Hills and the CHTs (9a); BFDC Habor at Chattogram and Brood Management Center at DFTC, Teknaf fall under the same BEZ, Chittagong Hills and the CHTs (9a); the canals under Satkhira District fall under Saline Tidal Floodplain (10), and Ganges Floodplain (4b); the canals under Khulna and Bagerhat Districts fall under three BEZs, Saline Tidal Floodplain (10), Ganges Floodplain (4b), and Gopalganj/ Khulna Peat Lands (6). The detailed descriptions of these BEZs with maps are explained in **Annex 25** under the **Volume II: Annexures of Main Report**.

6.1.2 Ecosystem and Biodiversity

Ecosystems and biodiversity are intricately connected, with each relying on the other for stability, resilience, and overall functionality. The loss of biodiversity can disrupt ecosystems, leading to negative consequences for both the environment and human societies. Conservation efforts often focus on maintaining and restoring biodiversity to ensure the health of ecosystems.

Chakaria is under Cox's Bazar District in the Southeastern Hydrological Region of Bangladesh known for its diverse landscapes, including hills, forests, and agricultural areas. The region has a mix of terrestrial ecosystems, including mangrove forests, salt pans, and shrimp cultivation. The biodiversity of this area includes a variety of plant species, insects, birds, and small mammals.

The BFDC Harbor area falls within the urban areas of Chattogram City under Chattogram District having lower expanses of planted vegetation.

BMC area at DFTC, Teknaf is under Cox's Bazar District located in the Southeastern Hydrological Region of Bangladesh, near the border with Myanmar. It is known for its coastal areas and is a gateway to the Bay of Bengal. The region has coastal ecosystems, including beaches and mangrove areas. Coastal biodiversity includes various marine species, shorebirds, and other organisms adapted to the dynamic conditions of the coastline.

The study area of the canals for cluster farming are under Khulna, Bagerhat and Satkhira Districts in the Southwestern Hydrological Region of Bangladesh. The region has a diversity of natural resources, including coastal fisheries and shrimp, forest, salt and minerals. The study area and its surroundings possess different landforms with vegetation patterns that create a separate ecosystem that supports various flora and fauna. Flora and fauna, both are significant for human existence as they are responsible for the regulation of oxygen and carbon dioxide in the air. Also, they one hand function as

a provisioning ecosystem and benefit us with a variety of food, water, and medicines. On the other hand, they function as regulating ecosystem and support us in providing safety from disastrous events like cyclone, river/Bay bank erosion, etc.

Ecosystem Types

CSE and BMC

In the study areas, the major ecosystems can be categorized into terrestrial and aquatic ecosystems. The terrestrial ecosystem incorporates various habitats such as mangrove forests, mudflats, offshore regions, salt pans, croplands, and settlements, while the aquatic ecosystem includes freshwater aquaculture ponds and rivers among others. These existing ecosystems are vital for maintaining the delicate balance of nature through processes such as cycling nutrients, regulating climate, and offering shelter for a diverse range of species. The interconnectedness of these ecosystems highlights their importance in sustaining the environment and supporting biodiversity, illustrating the intricate web of life on our planet that relies on their stability for survival and growth.

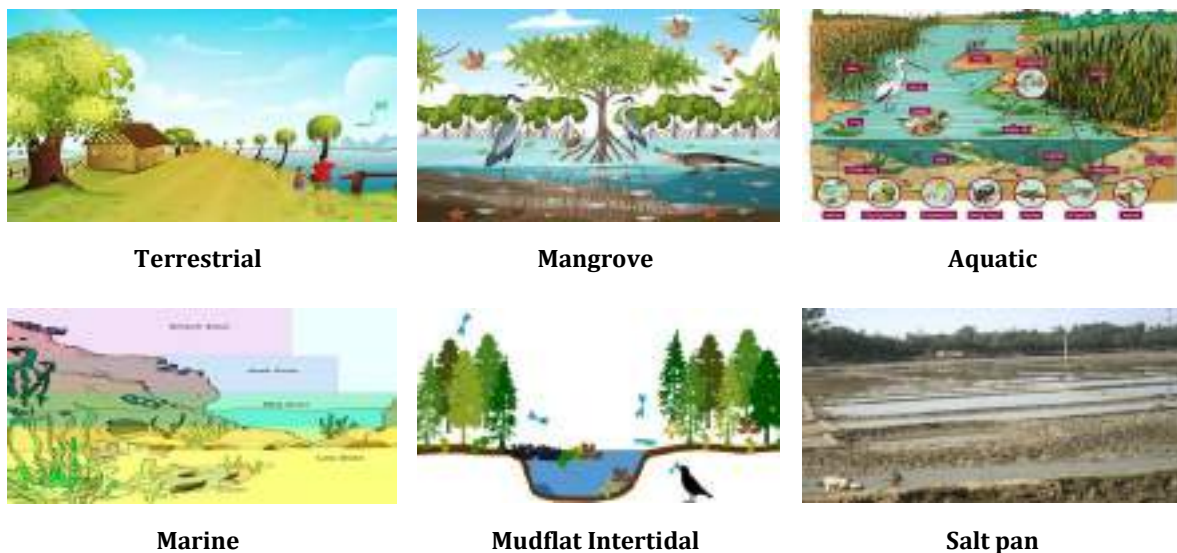


Figure 6.1: The Schematic Portrays Reflect the Major Ecosystems of the Study Area

BFDC Habor at Chattogram

The study area is dominated with terrestrial ecosystem having more ecosystem subclasses including afforested or planted forest, herbs and shrubs land, fruit garden. In addition, the Karnaphuli River contain aquatic ecosystem of the project sites.

Canals Rehabilitation for Cluster Farming

The study area has both aquatic body and terrestrial land area, therefore, the whole study area can be categorized into two broad categories i.e. terrestrial ecosystem and aquatic ecosystem. The terrestrial ecosystem is classified according to its habitat. Each habitat supports a unique collection of plant species. The major terrestrial vegetation types in the study area are: homestead vegetation, roadside vegetation, crop field vegetation and bank side vegetation.



Figure 6.2: Major Ecosystem of the Canals under Khulna, Bagerhat, and Satkhira Districts

UNEP defines an ecosystem is a dynamic complex of plant, animal, and microorganism communities and the non-living environment, interacting as a functional unit. Humans are an integral part of the ecosystems. Ecosystem services are the tangible and intangible benefits people obtain from the ecosystems. These include provisioning services such as food and water; regulating services such as flood and disease control, cultural services such as spiritual, recreational, and cultural benefits, and supporting services, such as nutrient cycling, that maintain the conditions for life on earth.

Ecosystem Services

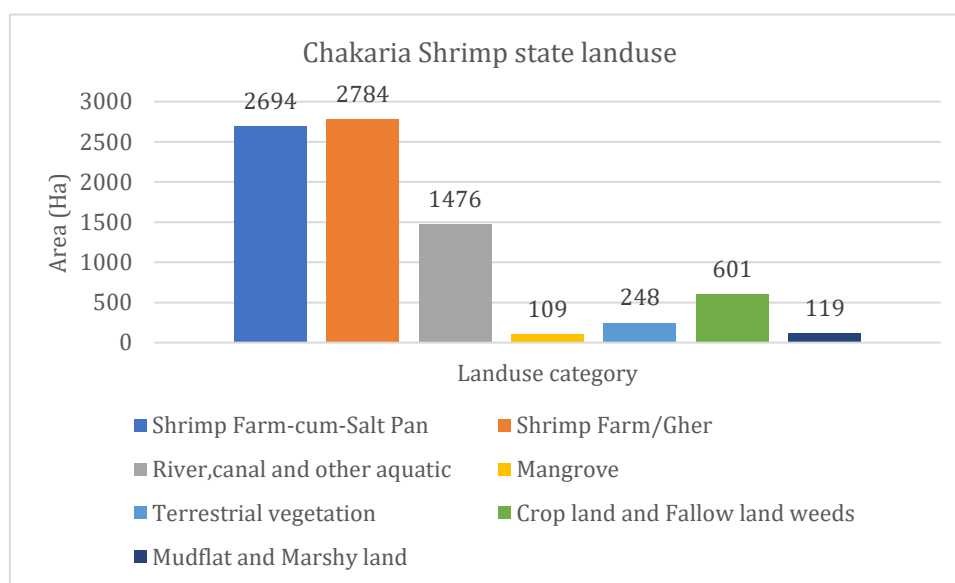
Chakaria Shrimp Estate

Land use is closely connected to ecosystem services, as the way we utilize and manage land directly influences the services that ecosystems can provide. Ecosystem services are the benefits that humans obtain from ecosystems, including provisioning services (such as food and water), regulating services (such as climate and disease control), supporting services (such as nutrient cycling), and cultural services (such as recreational and aesthetic benefits). The land use of a study area in general indicates the status of ecosystem service of that area. The following table relate the ecosystem services of the discussed areas.

Land Use: Different land use classes contribute to various ecosystem services. Here's an expression of potential ecosystem services based on the provided land use **Table 6.1** and shown in the bar chart in **Figure 6.3**.

Table 6.1: Ecosystem Services with Subclass of the Study Area of CSE

Sl. No.	CSE Land Use Class	Ecosystem services	
		Provisioning Services	Regulating Services
1	Shrimp Farm-cum-Salt Pan (2694 Ha)	Shrimp production, salt production	Water purification, flood control
2	Shrimp Farm/Gher (2784 Ha)	Shrimp production	Water purification, habitat for aquatic species
3	River, canal, and another aquatic (1476 Ha)	Fish production	Water purification, flood control, erosion control, habitat for aquatic species
4	Mangrove (109 Ha)	Fuelwood, traditional medicine, etc.	Bank protection, carbon sequestration, habitat for various species
5	Terrestrial vegetation (248 Ha)	Timber, non-timber forest products	Carbon sequestration, air quality improvement
6	Crop land and Fallow land weeds (601 Ha)	Crop production	Soil erosion prevention, nutrient cycling
7	Mudflat and Marshy land (119 Ha)	Wetland plants, some fisheries,	Water filtration, flood control, habitat for diverse species specially wetland and migratory bird

**Figure 6.3: Land Use of the Study Area of CSE**

Unmanaged or poorly managed activities can have negative impacts on the services provided by ecosystems. Additionally, there may be cultural and supporting services that are not explicitly mentioned in this brief overview.

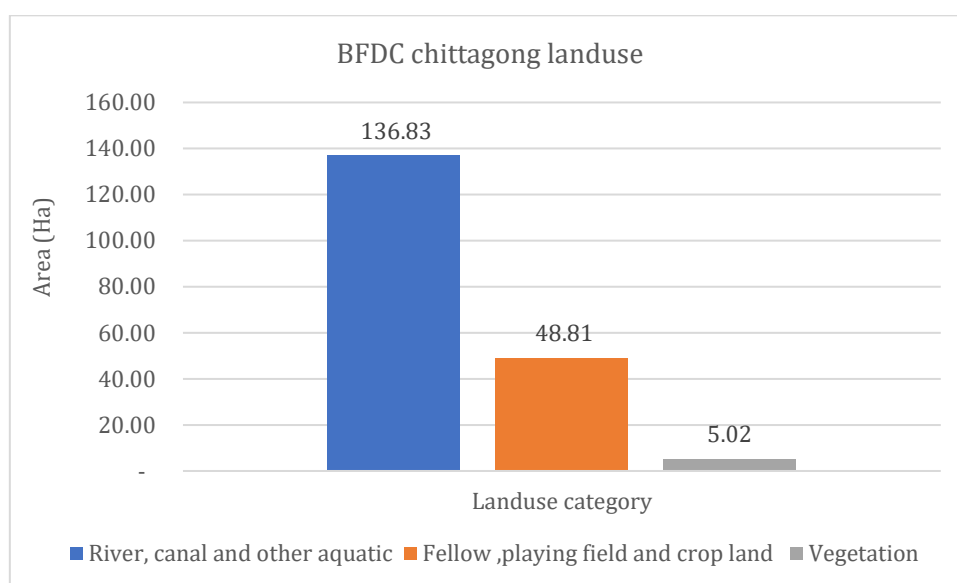
BFDC Harbor at Chattogram

An expression of potential ecosystem services of the land use of the study area under this sub-project is given as follows:

Table 6.2: Ecosystem Services with Subclass of the Study Area of BFDC Harbor at Chattogram

Sl. No.	BFDC Land class	Ecosystem services	
		Provisioning Services	Regulating Services
1	River, canal, and other water bodies (136.83 Ha)	Fish production	Water purification. Flood regulation. Erosion control. habitat for various species
2	Fallow, playing field, and crop land (48.81 Ha)	Crop production	Soil stabilization, Nutrient cycling, Cultural support, Recharge potential
3	Vegetation (5.02 Ha):	Timber and non-timber forest products	Carbon sequestration. Air quality improvement. habitat for various species

It's important to note that the specific types of ecosystem services provided can vary based on the specific characteristics of each land use class and how it is managed. The Land Use information is given in the following **Figure 6.4**.

**Figure 6.4: Land Use of the Study Area of BFDC Harbor at Chattogram**

Brood Management Center

An expression of potential ecosystem services of the land use of the study area under this sub-project is given in following **Table 6.3** and through bar chart as shown in the **Figure 6.5**.

Table 6.3: Ecosystem Services with Subclass of the Study Area of BMC

Sl. No.	Land Use Class of BMC Area at DFTC, Teknaf	Ecosystem services	
		Provisioning Services	Regulating /cultural Services
1	Rural Settlement with Homestead Vegetation (102 Ha):	Food production (from home gardens). Wood and non-timber forest products.	Aesthetic and recreational value.
2	Mangrove (46 Ha):	Fuelwood, Traditional medicine, Fish and shellfish production.	Coastal protection. Carbon sequestration., Habitat for various species.
3	Shrimp Farm-cum-Salt Pan (19 Ha):	Shrimp production. Salt production.	Water purification, flood control,
4	Shrimp Farm/Gher (28 Ha):	Shrimp production,	Water purification, flood control, habitat for aquatic species

Sl. No.	Land Use Class of BMC Area at DFTC, Teknaf	Ecosystem services	
		Provisioning Services	Regulating /cultural Services
5	Crop Land and Fallow Land (19 Ha):	Timber, non-timber forest products	Carbon sequestration, air quality improvement
6	River, Canal, and Other Aquatic (219 Ha):	Wetland plants, fish production,	Water filtration, flood control, habitat for diverse species specially wetland and migratory bird

Sustainable management is crucial for maximizing the benefits while minimizing negative impacts on ecosystems.

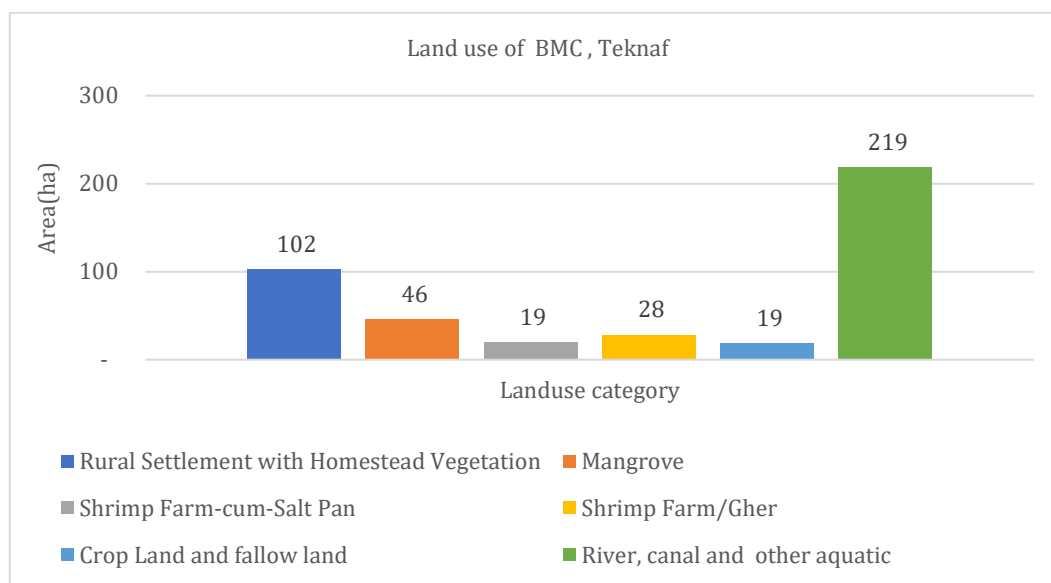


Figure 6.5: Land Use of the Study Area of Brood Management Center

Canals Rehabilitation for Cluster Farming

Ecosystem "services" of this sub-project includes maintaining hydrological cycles, regulating climate, shelterbelt, cleansing water and air, maintaining the gaseous composition of the atmosphere, pollinating crops and other important plants, generating and maintaining soils, storing and cycling essential nutrients, absorbing and detoxifying pollutants; providing aesthetic beauty and recreation.

Table 6.4: Ecosystem Services with Subclass of the Study Area of the Canals

Ecosystem Service Category	Ecosystem Services Provided	Significance
Provisioning Services	Water for Irrigation	Canals serve as channels for water distribution, supplying irrigation water to agricultural lands. This ensures continuous crop production and sustains agricultural livelihoods in the region.
	Fisheries	The canals support diverse fish species particularly shrimp and prawn culture activities, contributing to the livelihoods of local communities. It is a significant source of protein and income for many households.
	Timber and Non-timber Forest Products	Bank side vegetation of different canals provide timber, firewood, medicinal plants, and other non-timber products, supporting local economies and traditional practices.

Ecosystem Service Category	Ecosystem Services Provided	Significance
Regulating Services	Flood Regulation	Canals help regulate water flow during heavy rainfall and flood events by providing a pathway for excess water to drain. This helps mitigate the risk of flooding in low-lying areas (like Mahandi khal), protecting lives and property.
	Water Purification	Wetlands vegetation along the bank side act as natural filters, improving water quality by trapping sediments, nutrients, and pollutants, thus maintaining the ecological balance of the canal's ecosystem.
Cultural Services	Spiritual and Religious Value	The canals are often used for religious ceremonies and rituals. Hindus use them for immersion of ashes after cremation, a practice believed to help the soul attain salvation. Locals also use the canals for holy baths and offerings, reflecting the deep connection between the waterways and their spiritual beliefs.
Supporting Services	Biodiversity Conservation	Both bank side of the canals supports diverse flora and fauna, including local and migratory species. It serves as a habitat for wildlife and maintains genetic diversity, essential for ecosystem resilience.
	Soil formation	Canals contribute to soil formation and fertility through sediment deposition and nutrient enrichment. The deposition of organic matter and minerals carried by water helps replenish soil nutrients, supporting agricultural productivity and livelihoods in the region.

Biodiversity

A. Flora

Chakaria Shrimp Estate

Floral Diversity of the Aquatic Ecosystem within the Study Area

About seven different species of mangrove trees are typically found in the bank zone of shrimp estate, creating a diverse and unique ecosystem for numerous marine creatures. A large number of areas are covered by *Parabon*, with the dominant species being three. These mangroves play a crucial role as natural barriers, serving as effective wave protectors that safeguard the fragile shrimp banks from erosion and other environmental threats, sustaining the delicate balance of this coastal habitats. Wetlands support a variety of aquatic plant species, including free-floating, submerged, sedges and meadows, and marginal plants. There are several aquatic plants in Chakaria, particularly around the pond and Matamuhori River. Nine (09) major species of aquatic vegetation have been identified in Chakaria. However, in shrimp estate sites, it is a common sight to find a variety of herbs and shrubs flourishing near crop fields and river banks. These plants not only enhance the landscape but also contribute to the overall biodiversity and ecosystem health of these areas. The below **Table 6.5** shows the major mangrove, aquatic and herbs and shrubs of CSE area.

Table 6.5: Existing Mangrove, and Aquatic Species in CSE Area

Sl. No.	Local name	Common Name	Scientific Name	Type
Mangrove				
1.	Sada baen	White Mangrove	<i>Avicennia alba</i>	Tree
2.	Keora	Mangrove Apple	<i>Sonneratia apetala</i>	Tree
3.	Ora	Crabapple Mangrove	<i>Sonneratia caseolaris</i>	Tree
4.	Gewa	Milky Mangrove	<i>Excoecaria agallocha</i>	Tree

Sl. No.	Local name	Common Name	Scientific Name	Type
Mangrove				
5.	Koronja	Pongam Tree	<i>Pongamia pinnata</i>	Tree
6.	Nona joba	Beach Hibiscus	<i>Talipariti tiliaceum</i>	Shrubs
7.	Hargoja	Sea Holly	<i>Acanthus ilicifolius</i>	Herbs
Aquatic Vegetation				
1	Jol kolmi	Pink morning glor	<i>Ipomoea aquatic</i>	Amphibian
2	Kochu	Taro	<i>Colocasia spp.</i>	Amphibian
3	Helencha	Alligator weed	<i>Alternanthera philoxiroides</i>	Amphibian
4	Ghechu	Floating lace plant	<i>Aponogeton natans</i>	Submerged
5	Jhangi	water thyme	<i>Hydrilla verticillata</i>	Submerged
6	Khudipana	Duck weed	<i>Lemna perpusilla</i>	Free floating
7	Kutipana	Water velvet	<i>Azolla pinnata</i>	Free floating
8	Shapla	Water lily	<i>Nymphaea rubra</i>	Free floating
9	Kochuripana	Water hyacinth	<i>Eichhornia crassipes</i>	Free floating

Source: Field Survey, February 2024

Floral Diversity of the Terrestrial Ecosystem within the Study Area

The settlement area has terrestrial vegetation around their small living area, which is mainly fruit trees. About 22 terrestrial species are commonly seen in the study area (**Table 6.6**). The Gher(farm) boundary has no vegetation because litter fall may impact shrimp cultivation, but exceptionally, there is a project named Grameen with boundary vegetation. They used mainly coconut trees for the boundary of the vegetation, and the litter is used to control the temperature of the water. The following table shows the vegetation types in the study area.

Table 6.6: Existing major terrestrial Species

Sl. No.	Local Name	Common name	Scientific name	Family	Abundance*	Use
Tree						
1	Aam	Mango	<i>Mangifera indica</i>	Anacardiaceae	C	Fruit
2	Mahogany	Mahogany	<i>Swietenia mahagoni</i>	Meliaceae	VC	Timber
3	Narikel	Coconut tree	<i>Cocos nucifera</i>	Arecaceae	VC	Fruit
4	Peyara	Guava	<i>Psidium guajava</i>	Myrtaceae	C	Fruit
5	Raintry koray	Rain tree	<i>Samanea saman</i>	Fabaceae	VC	Timber
6	Sada Koroi	Indian Siris	<i>Albizia procera</i>	Fabaceae	VC	Timber
7	Akashmoni	Acacia	<i>Acacia auriculiformis</i>	Fabaceae	VC	Timber
8	Amra	Hog pulm	<i>Spondias mombin</i>	Anacardiaceae	C	Fruit
9	Boroi	Indian jujube	<i>Ziziphus mauritiana</i>	Rhamnaceae	VC	Medicinal
10	Eucalyptus	Eucalyptus	<i>Eucalyptus citriodora</i>	Myrtaceae	VC	Timber
11	Jam	Malabar plum	<i>Syzygium cumini</i>	Myrtaceae	C	Fruit, Timber
12	Kala Koroi	Lebbek tree	<i>Albizia lebbek</i>	Fabaceae	VC	Timber

Sl. No.	Local Name	Common name	Scientific name	Family	Abundance*	Use
13	Kath Badam	Almond	<i>Terminalia catappa</i>	Combretaceae	C	Fruit
14	Kathal	Jackfruit	<i>Artocarpus heterophyllus</i>	Moraceae	C	Fruit
15	Kodom	Burlflower	<i>Neolamarckia cadamba</i>	Rubiaceae	C	Aesthetic
16	Krishnochura	Gulmohar	<i>Delonix regia</i>	Fabaceae	C	Aesthetic
17	Tetul	Tamarind	<i>Tamarindus indica</i>	Fabaceae	C	Fruit
18	Supari	Betelnut pulm	<i>Areca catechu</i>	Arecaceae	VC	Fruit
19	Amloki	Indian gooseberry	<i>Phyllanthus emblica</i>	Phyllanthaceae	C	Fruit
20	Khejur	Date palm	<i>Phoenix sylvestris</i>	Arecaceae	VC	Fruit
21	Shimul	Redsilk cotton	<i>Bombax ceiba</i>	Malvaceae	R	Timber
22	Minjiri	Cassod	<i>Cassia siamea</i>	Fabaceae	R	Medicinal
Herbs and shrubs						
1	Bansh	Bamboo	<i>Bambusa sp.</i>	Poaceae		Thatch material
2	Mutha	Java Grass	<i>Cyperus rotundus</i>	Poaceae		Medicine
3	Nisinda	Chinese chaste tree	<i>Vitex negundo</i>	Lamiaceae		Medicine
4	Durba	Bermuda Grass	<i>Cynodon dactylon</i>	Poaceae		Fodder
5	Berela	Cuban jute	<i>Sida rhombifolia</i>	Malvaceae		Medicine
6	Bon chakunda	Sickle Senna	<i>Senna tora</i>	Fabaceae		Medicine
7	Keyakata	Screw pine	<i>Pandanus foetidus</i>	Pandanaceae		Medicine
8	Chagol kuri	Beach morning glory	<i>Ipomoea pes-caprae</i>	Convolvulaceae		-
9	Chorakata	lesser spear grass	<i>Andropogon aciculatus</i>	Poaceae		-
10	Nol khagra	Tall Reed	<i>Phragmites karka</i>	Poaceae		Thatch material
11	Holud hurhuria	Yellow spider flower	<i>Cleome viscosa</i>	Solanaceae		Spice
12	Kochu	Taro	<i>Colocasia esculenta</i>	Araceae		Vegetable
13	Jadupalang	shoreline purslane	<i>Sesuvium portulacastrum</i>	Portulacaceae		Medicine
14	Joba	China Rose	<i>Hibiscus Rosa Sinensis</i>	Malvaceae		Aesthetic
15	Khurakata	spiny amaranth	<i>Amaranthus spinosus</i>	Amaranthaceae		Vegetable
16	Thankuni	Indian pennywort	<i>Centella asiatica</i>	Apiaceae		Medicine Vegetable
17	Pepe	Papaya	<i>Carica papaya</i>	Caricaceae		Food
18	Kolkesunda	Coffee weed	<i>Cassia occidentalis</i>	Rubiaceae		Medicine
19	Venna	castor oil plant	<i>Ricinus communis</i>	Euphorbiaceae		Oil

Sl. No.	Local Name	Common name	Scientific name	Family	Abundance*	Use
20	Lonthon ful	Sage	<i>Lantana camara</i>	Lamiaceae		-
21	Mati Konduri	Sessile Joy weed	<i>Alternanthera sessilis</i>	Asteraceae		Fodder
22	Mukta Juri	Indian Nettle	<i>Acalypha indica</i>	Urticaceae		Medicine
23	Opango ful	Prickly Chaff Flower	<i>Achyranthes aspera</i>	Amaranthaceae		Medicine

Source: Field Survey, February 2024 * VC = Very Common, C= Common, R= R

BFDC Harbor at Chattogram

Floral Diversity of the Terrestrial Ecosystem within the Study Area

According to the information as collected from the BFDC, a number of 192 trees will be fallen under a wood stand, primarily Arjun and Akashmoni for the proposed interventions. Besides the scattered terrestrial vegetation at the study site, which consists of fruit and timber trees, there are also various shrubs and bushes contributing to the plant diversity in the area. A total of 18 different species, encompassing 13 different families of flora, are evenly spread throughout the location, creating a diverse ecosystem. Major terrestrial flora is listed in following **Table 6.7**.

Table 6.7: Major Terrestrial Species in BFDC harbor, Chittagong

Sl. No.	Local Name	Scientific name	Family	Abundance*	Use
Tree					
1.	Aam	<i>Mangifera indica</i>	Anacardiaceae	VC	Fruit
2.	Mahogany	<i>Swietenia mahagoni</i>	Meliaceae	C	Timber
3.	Debdaru	<i>Monoon longifolium</i>	Annonaceae	C	Timber
4.	Narikel	<i>Cocos nucifera</i>	Arecaceae	C	Fruit
5.	Peyara	<i>Psidium guajava</i>	Myrtaceae	C	Fruit
6.	Raintree	<i>Samanea saman</i>	Fabaceae	VC	Timber
7.	Sada Koro	<i>Albizia procera</i>	Fabaceae	R	Timber
8.	Akashmoni	<i>Acacia auriculiformis</i>	Fabaceae	VC	Timber
9.	Arjun	<i>Terminalia arjuna</i>	Combretaceae	C	Medicine
10.	Amra	<i>Spondias mombin</i>	Anacardiaceae	R	Fruit
11.	Boroi	<i>Ziziphus mauritiana</i>	Rhamnaceae	VC	Medicinal
12.	Jam	<i>Syzygium cumini</i>	Myrtaceae	C	Fruit, Timber
13.	Kath Badam	<i>Terminalia catappa</i>	Combretaceae	C	Fruit
14.	Kathal	<i>Artocarpus heterophyllus</i>	Moraceae	C	Fruit
15.	Krishnochura	<i>Delonix regia</i>	Fabaceae	C	Aesthetic
16.	Segun	<i>Tectona grandis</i>	Verbenaceae	VC	Timber
17.	Supari	<i>Areca catechu</i>	Arecaceae	VC	Fruit
18.	Amloki	<i>Phyllanthus emblica</i>	Phyllanthaceae	C	Fruit

Sl. No.	Local Name	Scientific name	Family	Abundance*	Use
Herbs and Shrubs					
19	Bon tepari	<i>Physalis angulata</i>	Solanaceae	R	Herb
20	Kanchira	<i>commelina benghalensis</i>	commelinaceae	C	Herb
21	Durba	<i>Cynodon dactylon</i>	Poaceae	C	Herb
22	Mushokdana	<i>Abelmoschus moschatus</i>	Malvaceae	R	Shrub
23	Pepe	<i>Carica papaya</i>	Caricaceae	C	Shrub
24	Cinderella weed	<i>Synedrella nodiflora</i>	Compositae	C	Herb

Source: Field Survey, February 2024 *VC = Very Common, C= Common, R= R

Floral Diversity of the Aquatic Ecosystem within the project Area

There is no aquatic or mangrove vegetation observed on the proposed side of BFDC harbor; only a single species of crabapple mangrove and a little hargoja bushy area are observed on the jetty area.

Brood Management Center

Floral Diversity of the Terrestrial Ecosystem within the Study Area

There are 44 number of trees of terrestrial vegetation in the proposed BMC intervention area at DFTC. The species composition in this area includes mangrove herbs and shrubs along with Narikel, Boroi, Jarul, Aam, and Kanthal.

The terrestrial species those were observed during field visits in the BMC, Teknaf are given in the **Table 6.8** below:

Table 6.8: Existing terrestrial Species in BMC

Sl. No.	Local name	Common Name	Scientific Name	Type
Terrestrial vegetation				
1	Narikel	Coconut tree	<i>Cocos nucifera</i>	Tree
2	Aam	Mango	<i>Mangifera indica</i>	Tree
3	Kanthal	Jack fruit	<i>Artocarpus heterophyllus</i>	Tree
4	Jarul	Giant crepe-myrtle	<i>Lagerstroemia speciosa</i>	Tree
5	Boroi	Indian jujube	<i>Ziziphus mauritiana</i>	Tree
6	Jhau	Jhao	<i>Tamarix dioica</i>	Tree
7	Raintry korai	Rain tree	<i>Samanea saman</i>	Tree
8.	Tentul	Tamarind	<i>Tamarindus indica</i>	Tree

Source: Field Survey, February 2024

Floral Diversity of the Aquatic Ecosystem within the project Area

Three species predominate among the roughly six mangrove species that are found in the BMC area. Those are Hargoja, Ora, and Baen. However, 13 number of baen plants are found in the Jetty area. Nonetheless, that location is home to about 500 Hargoja species. The mangrove species those were observed during field visits in the BMC, Teknaf are given in the **Table 6.9**.

Table 6.9: Existing mangrove Species in BMC

Sl. No.	Local name	Common Name	Scientific Name	Type
Mangrove				
1.	Sada baen	White Mangrove	<i>Avicennia alba</i>	Tree
2.	Keora	Mangrove Apple	<i>Sonneratia apetala</i>	Tree
3.	Ora	Crabapple Mangrove	<i>Sonneratia caseolaris</i>	Tree
4.	Koronja	Pongam Tree	<i>Pongamia pinnata</i>	Tree
5.	Nona joba	Beach Hibiscus	<i>Talipariti tiliaceum</i>	Shrubs
6.	Hargoja	Sea Holly	<i>Acanthus ilicifolius</i>	Herbs

Source: Field Survey, February 2024

A view of major terrestrial vegetation in CSE, BFDC Harbor, and Brood Management Center area are given in following **Figure 6.6**.

**Different Types of Vegetation in and around CSE****Vegetation Pattern at BFDC Harbor, Chattogram****Various types of vegetation BMC Area at DFTC, Teknaf**

Source: Field Survey, February 2024

Figure 6.6: A View of Major Terrestrial Vegetation in CSE, BFDC Harbor, and BMC Areas

Canals Rehabilitation for Cluster Farming

Floral Diversity of the Terrestrial Ecosystem within the Study Area:

Homestead vegetation is one of the most important plant communities in the study area. The homesteads far from the project site show a comparatively high density and diversity of vegetation. Most of the homestead cover consists of timber plant species, a few medicinal plants, and some

vegetables and fruit trees. According to the vegetation survey, the most common plants that are now being planted by local people are Mango, Jackfruit, Guava, Banana, Betel Nut, Papaya, Palmyra Palm, Coconut, Tamarind, and Bamboo, which are also commonly found in each homestead in the study area. Most of the roadside vegetation in the study area is settled species that are timber and fuel-yielding. Major species found along the village road are Sirish, Babla, Palmyra palm, Coconut, and Betel nut and Date palm etc. The roads that have passed between two homesteads mostly have Kocha and Date palm as these have been planted for fencing. Additionally, crop field vegetation plays a crucial role in maintaining a functioning ecosystem. The study area observed three distinct types of crop field vegetation: shrimp culture pond dyke vegetation's, primarily comprising year-round vegetable cultivation on the pond dykes, along with some fruit species; rice crop vegetations, where the main crop cultivated is Boro rice; and fallow land vegetations, characterized by the presence of grass-like herb species and some shrub species. All these types of crop field vegetation support grazing for cattle and provide feeding and breeding habitats for numerous arthropods, reptiles, and avifauna in the study area. Bank side Vegetation of the proposed study area is exclusively dominated by Babla, Sirish, Banana, Palmyra palm, and Date palm which have good adaptation in low saline. Some naturally regenerated mangrove species like Gewa, Keora, Golpata, Noil, Hargoza, Ora and Bain also observed in the study area. Vegetation of this type supports good habitats for local avifauna. Different types of marginal herbs like Dholekolmi, Bishkatali, Mutha gash, etc. are dominant in the inner portion of the river and canal.

A list of terrestrial floral species within the study and project area is given in **Annex 27** under the **Volume II: Annexures of Main Report**.

Floral diversity of the Aquatic Ecosystem within the Study area

Diversity of aquatic floral species like different submerged, free-floating and attached floating vegetation, amphibian vegetation like sedges and meadows are also higher in number within the study area. The major wetland types of the study area are rivers, ponds, canals and other temporary water bodies. The study area representing mainly as well as brackish water ecosystems. Numerous canals have crisscrossed through all over the study area and some of which are connected with surrounding rivers. Most of the canals are narrow and silted up since long back. List of plant species observed in the wetlands of the study and project area is given in **Annex 28** under the **Volume II: Annexures of Main Report**.

B. Fauna

Chakaria Shrimp Estate

CSE is situated near about important bird area of Bangladesh name Sonadia Island and existing Chakaria Mangroves Forest area (Chakaria Sundarban) allow numerous wetland and shore bird. The homestead vegetation, which is adjacent to the marsh and mangrove passage, provides roosting and breeding grounds for approximately 22 different bird species. Shrimp culture, settlement vegetation and mangrove vegetation allow birds that are the most common major terrestrial faunal groups in this area, with the biggest density. All avifaunal populations have mynas, pied starlings, sparrows, bulbuls, cuckoos, herons, and egrets. Kites, eagles, and other birds of prey can be seen near open areas of grain fields. Along mudflats and canal systems where migratory birds like such as the northern solver duck can be found. **Table 6.10** shows the avifaunal composition in CSE.

Table 6.10: Common avifaunal species of the project area of CSE

Common Name	Scientific Name	Migration Status	IUCN Status – Bangladesh, 2015
Common myna	<i>Acridotheres tristis</i>	Resident	LC
Red vented bulbul	<i>Pycnonotus cafer</i>	Resident	LC
Pied starling	<i>Sturnus vulgaris</i>	Resident	LC
Sparrow	<i>Passer domesticus</i>	Resident	LC
Green Bee eater	<i>Merops orientalis</i>	Resident	LC
Indian Cuckoo	<i>Cuculus micropterus</i>	Resident	LC
Black kite	<i>Milvus migrans</i>	Resident	LC
Brahminy kite	<i>Haliastur indus</i>	Resident	LC
Little Egret	<i>Egretta garzetta</i>	Resident	LC
Great Egret	<i>Casmerodius albus</i>	Resident	LC
Common Kingfisher	<i>Alcedo atthis</i>	Resident	LC
White Throated Kingfisher	<i>Halcyon smyrnensis</i>	Resident	LC
Brown winged kingfisher	<i>Pelargopsis amauroptera</i>	Resident	VU
Collared kingfisher	<i>Todiramphus chloris</i>	Resident	LC
White breasted hen	<i>Amaurornis phoenicurus</i>	Resident	LC
Collared Kingfisher	<i>Todiramphus chloris</i>	Resident	LC
Little Cormorant	<i>Microcarbo(Phalarocorax) niger</i>	Resident	LC
Indian Pond Heron	<i>Ardeola grayii</i>	Resident	LC
Common green shank	<i>Tringa nebularia</i>	Resident	LC
Eurasian crew	<i>Numenius arquata</i>	Resident	LC
Black headed Ibis	<i>Threskiornis melanocephalus</i>	Migratory	LC
Northern slover	<i>Spatula clypeata</i>	Migratory	LC
Eurasian Curlew	<i>Numenius arquata</i>	Migratory	NT

Source: Field investigation & Local people interviewed, 2024;

IUCN red list 2015 Note: NE= Not Evaluated; NT= Near Threatened, VU= Vulnerable, EN= Endangered, LS= Least concern, DD= Data deficient CE=Critically Endangered

During the field visit, spot observation and KII interviews were taken for the wildlife survey. It is very difficult to census wild life in a particular part of a region. They are constantly moving, searching for pasture, drinking water, preying, or running away from predators, and sometimes they undergo seasonal migration for a more conducive environment. (Vanlevienen, 1979). There are no larger mammals in this area. In addition, fishing cats were found in the shaplapur sites of the Chakaria study area. However, Indian jackal is commonly found near village grooves. Out of all the aquatic faunal groups, fish have the greatest number of higher vertebrates. There are different kinds of crabs that shelter in the mangroves and canals. In this region, common amphibian species include the Indian Bull Frog, Skipper Frog, and Common Toad. Since there are numerous wetlands where snakes like the checkered keelback and common water snake are found. No dolphin site was observed during the field investigation. Below **Table 6.11** provides a list of existing wildlife in CSE area.

Table 6.11: List of Amphibians, Chordata, Reptiles, Arthropods and Mollusca

Types of species	English Name	Scientific name	Family	Habitat	IUCN Status – Bangladesh, 2015
Mammals	Common House Rat	<i>Rattus rattus</i>	Muridae	Mostly in Mangrove grooves, bushy areas	LC
	Fishing cat	<i>Prionailurus viverrinus</i>	Felidae		EN
	Field Mouse	<i>Mus booduga</i>	Muridae		LC
	Grey Musk Shrew	<i>Suncus murinus</i>	Soricidae		LC
	Flying Fox	<i>Pteropus giganteus</i>	Pteropodidae		LC
	Indian Jackal	<i>Canis aureus indicus</i>	Canidae		LC
	Common House Gecko	<i>Hemidactylus frenatus</i>	Gekkonidae		LC
Amphibians	Common Toad	<i>Bufo melanosticus</i>	Bufonidae	Wetland areas and the dried areas	-
	Bull Frog	<i>Hoplobatrachus tigerinus</i>	Dicroglossidae		LC
	skipper frog	<i>Euphlyctis cyanophlyctis</i>			LC
	Sona Bang	<i>Asian bullfrog</i>	Microhylidae		LC
Chordata	Indian Turtle	<i>Lissemys punctata</i>	Trionychidae		LC
Reptiles	Common Garden Lizard	<i>Calotes versicolor</i>	Agamidae	Both wet land and dry areas	LC
	Common skink	<i>Eutropis carinata</i>	Scincidae		LC
Reptile (snake)	Bengal Monitor	<i>Varanus bengalensis</i>	Varanidae		NT
	Striped Keelback	<i>Xenochrophis vittatus</i>	Colubridae		LC
	Indian Rat Snake	<i>Ptyas mucosa</i>	Colubridae		LC
	Monocled Cobra	<i>Naja kaouthia</i>	Elapidae		LC
Arthropod	Lal kakra	<i>Perisesarma guttatum</i>	Sesarmidae		Not evaluated
	Boro kakra	<i>Scylla tranquebarica</i>	Portunidae	wetland	Do
Mollusca	Apple snail	<i>Ampullariidae</i>	Ampullariidae	Wetland	LC

Source: Field investigation & Local people interviewed, 2024;

IUCN red list 2015 Note: NE= Not Evaluated; NT= Near Threatened, VU= Vulnerable, EN= Endangered, LS= Least concern, DD= Data deficient CE= Critically Endangered

BFDC Harbor at Chattogram

BFDC harbor is an industrial commercial area with little plantation area support habitat of urban bird. About 10 species of birds are commonly observed during field observation. Among them house crow is found a large number which roaming the jetty sides of the project area. Moreover, a little cormorant browsing in jetty side. The common avifaunal species are given in following **Table 6.12**.

Table 6.12: Common Avifaunal Species of the Project Area

Common Name	Scientific Name	Migration Status	IUCN Status –Bangladesh, 2015
Common myna	<i>Acridotheres tristis</i>	Resident	LC
House crow	<i>Corvus splendens</i>	Resident	LC
Common starling	<i>Sturnus vulgaris</i>	Resident	LC
Sparrow	<i>Passer domesticus</i>	Resident	LC
Green Bee eater	<i>Merops orientalis</i>	Resident	LC
Robin	<i>Cuculus micropterus</i>	Resident	LC
Brahminy kite	<i>Haliastur indus</i>	Resident	LC
Common Kingfisher	<i>Alcedo atthis</i>	Resident	LC
Little Cormorant	<i>Microcarbo (Phalacrocorax) niger</i>	Resident	LC
Indian Pond Heron	<i>Ardeola grayii</i>	Resident	LC

Source: Field investigation & Local people interviewed, 2024;

IUCN red list 2015 Note: NE= Not Evaluated; NT= Near Threatened, VU= Vulnerable, EN= Endangered, LS= Least concern, DD= Data deficient CE=Critically Endangered

In the study area, no endangered or vulnerable species are present due to the high level of human interference. Consequently, the restricted movement of wildlife is a direct result of commercial land use, leading to a limited biodiversity within the region. The common wild fauna is given in the following **Table 6.13**.

Table 6.13: List of Major Amphibians, Reptiles and Mollusca

Types of species	English Name	Scientific name	Family	Habitat	IUCN Status – Bangladesh, 2015
Mammals	Common House Rat	<i>Rattus rattus</i>	Muridae	bushy areas	LC
	Field Mouse	<i>Mus booduga</i>	Muridae		LC
	Common House Gecko	<i>Hemidactylus frenatus</i>	Gekkonidae		LC
Amphibians	Common Toad	<i>Bufo melanostictus</i>	Bufonidae	Wetland and dried areas	-
Reptiles	Common Garden Lizard	<i>Calotes versicolor</i>	Agamidae	Both wetland and dry areas	LC
	Indian Rat Snake	<i>Ptyas mucosa</i>	Colubridae		LC
Mollusca	Apple snail	<i>Ampullariidae</i>	Ampullariidae	Wetland	LC

Source: Field investigation & Local people interviewed, 2024;

IUCN red list 2015 Note: NE= Not Evaluated; NT= Near Threatened, VU= Vulnerable, EN= Endangered, LS= Least concern, DD= Data deficient CE=Critically Endangered

Brood Management Center (BMC)

In BMC area, different wetland birds like little egrets, white-breasted kingfishers, Indian pond herons, Common kingfishers, little cormorants, grey herons are frequently seen. Some common aquatic avifaunal species of the study area are listed in the **Table 6.14**.

Table 6.14: Common Avifaunal Species of the Project Area

Common Name	Scientific Name	Migration Status	IUCN Status –Bangladesh, 2015
Jungle myna	<i>Acridotheres fuscus</i>	Resident	LC
Common starling	<i>Sturnus vulgaris</i>	Resident	LC
Sparrow	<i>Passer domesticus</i>	Resident	LC
Green Bee eater	<i>Merops orientalis</i>	Resident	LC
Brahminy kite	<i>Haliastur indus</i>	Resident	LC
Little Egret	<i>Egretta garzetta</i>	Resident	LC
Great Egret	<i>Casmerodius albus</i>	Resident	LC
Common Kingfisher	<i>Alcedo atthis</i>	Resident	LC
White Throated Kingfisher	<i>Halcyon smyrnensis</i>	Resident	LC
Collared kingfisher	<i>Todiramphus chloris</i>	Resident	LC
Little Cormorant	<i>Microcarbo (Phalarocorax) niger</i>	Resident	LC
Indian Pond Heron	<i>Ardeola grayii</i>	Resident	LC
Common green shank	<i>Tringa nebularia</i>	Resident	LC

Source: Field investigation & Local people interviewed, 2024;

IUCN red list 2015 Note: NE= Not Evaluated; NT= Near Threatened, VU= Vulnerable, EN= Endangered, LS= Least concern, DD= Data deficient CE=Critically Endangered

A mangrove forest on the project site contains a diverse variety of wild fauna. Though there is a large area covered by shrimp culture, a hilly portion and mangrove passage allow for a temporary visit of wildlife in the project area. Moreover, fishing cats are an endangered species (IUCN Red List, 2015) and are rarely visited at project sites. In addition, different pond sites in the study sites contain some aquatic wild fauna.

Table 6.15: List of Major Amphibians, Reptiles, Arthropod and Mollusca

Types of species	English Name	Scientific name	Family	Habitat	IUCN Status – Bangladesh, 2015
Mammals	Common House Rat	<i>Rattus rattus</i>	Muridae	Mostly in Mangrove grooves, bushy areas	LC
	Fishing cat	<i>Prionailurus viverrinus</i>	Felidae		EN
	Field Mouse	<i>Mus booduga</i>	Muridae		LC
	Grey Musk Shrew	<i>Suncus murinus</i>	Soricidae		LC
	Bengal Fox	<i>Pteropus giganteus</i>	Pteropodidae		LC
	Common House Gecko	<i>Hemidactylus frenatus</i>	Gekkonidae		LC
Amphibians	Common Toad	<i>Bufo melanostictus</i>	Bufonidae	Wetland areas and the dried areas	-
	Bull Frog	<i>Hoplobatrachus tigerinus</i>	Dicroglossidae		LC
	skipper frog	<i>Euphlyctis cyanophlyctis</i>			LC
	Sona Bang	<i>Asian bullfrog</i>	Microhylidae		LC
Chordata	Koscop	<i>Lissemys punctata</i>	Trionychidae		LC

Types of species	English Name	Scientific name	Family	Habitat	IUCN Status – Bangladesh, 2015
Reptiles	Common Garden Lizard	<i>Calotes versicolor</i>	Agamidae	Both wet land and dry areas	LC
	Common skink	<i>Eutropis carinata</i>	Scincidae		LC
Reptile (snake)	Bengal Monitor	<i>Varanus bengalensis</i>	Varanidae		NT
	Striped Keelback	<i>Xenochrophis vittatus</i>	Colubridae		LC
	Indian Rat Snake	<i>Ptyas mucosa</i>	Colubridae		LC
	Monocled Cobra	<i>Naja kaouthia</i>	Elapidae		LC
Arthropod	Lal kakra	<i>Perisesarma guttatum</i>	Sesarmidae		Not evaluated
	Boro kakra	<i>Scylla tranquebarica</i>	Portunidae	wetland	Do
Mollusca	Apple snail	<i>Ampullariidae</i>	Ampullariidae	Wetland	LC

Source: Field investigation & Local people interviewed, 2024;

IUCN red list 2015 Note: NE= Not Evaluated; NT= Near Threatened, VU= Vulnerable, EN= Endangered, LS= Least concern, DD= Data deficient CE= Critically Endangered

The following **Figure 6.7** are representing the wildlife in the project area of three sites.



Source: Field Survey, February 2024

Figure 6.7: Wild Fauna within the Study Areas of the Sub-Projects

Canals Rehabilitation for Cluster Farming*Faunal diversity of the study area*

The roadside, bankside, homestead vegetation, crop field vegetation area provide habitat for various wildlife species, including shelter and foraging options for insect in the study area. Terrestrial fauna of the study area can be categorized into following categories amphibian, reptiles, mammals and avifauna. The study area appears to be rich in biodiversity, supporting a variety of amphibians, reptiles, mammals, and birds. Common Toad, Bullfrog, and Cricket Frog thrive in the small ditches, homestead ponds, and canal edges. The House Lizard, Rat Snake, and Common Kukri Snake find suitable habitat near homestead vegetation, gardens, crop fields, roadsides, and riverside vegetation. Mammals like Jackals, Foxes, Squirrels, Flying Foxes, and Fishing Cats inhabit specific areas, while small Indian Civets, Rats, Mice, and Shrews can be found in homesteads, crop fields, orchards, and bamboo bushes. Finally, the diverse avian community includes Common Mynas, Red-vented Bulbul, Oriental Magpie Robin, Brahminy Kite, Black Drongo, and Swallow-tailed bee-eater dwelling in various patches near homesteads, fields, riverbanks, and wetlands. The names of the terrestrial fauna that have been frequently seen during field visits and noted by local people are shown in **Table 6.16** along with their IUCN-Bangladesh (2015) status and dependencies on the river, canals.

A diverse range of water dependent faunal species is observed and reported by the local inhabitants during the field visits. According to the local knowledgeable persons, a limited number of aquatic birds are frequently found along river, canal systems and seasonal wetlands throughout the year. During winter, moderate number of migratory birds roams along the canal side, riverside of the study area. The name of aquatic fauna that were frequently seen during the field visits and noted by the local peoples are shown in **Table 6.16** below along with their IUCN- Bangladesh (2015) status.

Table 6.16: Faunal Distribution of the Study Area

English Name	Scientific Name	Terrestrial/Aquatic	IUCN 2015 status- Bangladesh
Amphibians			
Cricket Frog	<i>Rana cyanophlyctis</i>	Terrestrial/Aquatic	LC
Common toad	<i>Bufo melanostictus</i>	Terrestrial	-
Bull Frog	<i>Hoplobatrachus Crassus</i>		LC
Indian Bull Frog	<i>Hoplobatrachus tigerinus</i>	Aquatic	LC
Skipper frog	<i>Euphlyctis cyanophlyctis</i>		LC
Reptiles			
Common skink	<i>Eutropis carinata</i>	Terrestrial	LC
Bengal Monitor	<i>Varanus bengalensis</i>		NT
Garden Lizard	<i>Calotes versicolor</i>		LC
Rat Snake	<i>Ptyas mucosa</i>		LC
Common Kukri Snake	<i>Oligodon arnensis</i>		
Smooth Water Snake	<i>Enhydryis enhydryis</i>	Aquatic	LC
Checkered Keelback Snake	<i>Xenochrophis piscator</i>		LC
Mammals			
Common Mongoose	<i>Herpestes edwardsii</i>	Terrestrial	LC
Bengal Bandicot Rat	<i>Bandicota bengalensis</i>		LC

English Name	Scientific Name	Terrestrial/Aquatic	IUCN 2015 status-Bangladesh
Common House Rat	<i>Rattus rattus</i>		LC
Flying Fox	<i>Pteropus giganteus</i>		LC
Golden Jackal	<i>Canis aureus</i>		LC
Grey Musk Shrew	<i>Suncus murinus</i>		LC
Common House Gecko	<i>Hemidactylus frenatus</i>		LC
Fishing Cat	<i>Prionailurus viverrinus</i>		EN
Avifauna			
Common Myna	<i>Acridotheres tristis</i>	Terrestrial	LC
House Crow	<i>Corvus splendens</i>		LC
Black Drongo	<i>Dicrurus macrocercus</i>		LC
Oriental Magpie Robin	<i>Copsychus saularis</i>		LC
Asian Palm Swift	<i>Cypsiurus balasensis</i>		LC
White wagtail	<i>Motacilla alba</i>		LC
Swallow-tailed bee-eater	<i>Merops hirundineus</i>		LC
Little egret	<i>Egretta garzetta</i>	Aquatic	LC
Great egret	<i>Casmerodious albus</i>		LC
Indian pond heron	<i>Ardeola grayii</i>		LC
Common kingfisher	<i>Alcedo atthis</i>		LC
White-throated kingfisher	<i>Halcyon smyrnensis</i>		LC
Collared kingfisher	<i>Todiramphus chloris</i>		LC
Little cormorant	<i>Phalarocorax niger</i>		LC
Asian Openbill Stork	<i>Anastomus oscitans</i>		LC
Black headed Ibis	<i>Threskiornis melanocephalus</i>		LC
Arthropod			
Lal kakra	<i>Perisesarma guttatum</i>	Aquatic	Not evaluated
Boro kakra	<i>Scylla tranquebarica</i>		Not evaluated
Mollusca			
Apple snail	<i>Ampullariidae</i>	Aquatic	LC

Note: LC= Least Concern, VU= Vulnerable, NT= Near Threatened, NE= Not Evaluated

Flora and Fauna within the Project Area

There are 18 pre-selected canals by DoF under three (03) coastal districts: Khulna, Bagerhat and Satkhira, to be re-excavated for the shrimp farming purposes. Some canals, mostly in the Southern Part of Satkhira and Khulna have tidal effects and carry saline water during dry period and sweet water during monsoon. However, the canals located on the Northern Part of the mentioned districts especially in Bagerhat carry fresh water round the year. Most of the canals are already silted.

During field visits, consulting with local people, eye observation, FGD, and KII, the baseline situation of the project area on the basis of ecology like flora and fauna, including rare or endangered species; sensitive natural habitats, exotics and aquatic weeds, etc. including pictures of Flora and Fauna are given in details in **Annex 26** under the **Volume II: Annexures of Main Report**.

6.1.3 Limnological Aspects

Limnology is a multidisciplinary field that examines various aspects of freshwater ecosystems and their interactions with the surrounding environment. Here are considered key components of limnological aspects biological characteristics and ecological process.

Biological Characteristics

Limnological studies examine the diverse communities of organisms living in freshwater ecosystems, including phytoplankton, zooplankton, macroinvertebrates, fish, amphibians.

Methodology

For the Plankton survey, 100 liters of water were filtered successively through 64µm mesh nylon nets (Millipore corp., Bedford, USA), and 70 ml of the concentrate was collected initially as a crude measure of plankton. For the qualitative and quantitative study, samples were observed under a compound microscope in a S-R (Sedgewick-Rafter cell, U.K.) cell (Photoplate 12.1) following published methods (Welch, 1948). Briefly, 1 ml samples of 5% buffer formalin-fixed plankton were pipetted on to a clean S-R (Sedgewick-Rafter cell) cell and observed at 10 X 10 magnification, using a (KRUS, MBL 2100, Germany) compound microscope (Photoplate 12.2).

On the other hand, the Benthic faunal communities were sampled by taking sediments from each sampling point. Containers were labelled indicating the site code, the sample code, the sampling date etc. They are sieved in a net and preserved in Lugol's iodine in a plastic container until use.

The number of plankton estimated per ml was calculated by adopting the following formula (Welch, 1948):

$$N = \frac{A \times C}{L}$$

Here,

N = Number of Zooplankton/L

A = Total concentrate number of Zooplankton (ml).

C = Number of Zooplankton counted in 1 ml sample

L = Amount of water (In litre) passed through plankton net (minimum 100 litre).

Sampling Process

Plankton samples were collected from the surface layer by plankton net and sediment and benthic samples were collected from the bottom soil samples of the project site (**Table 6.17** and **Table 6.18**) during the period of February 2024; and March 2024 respectively. Collected samples were taken in plastic containers. The collected samples were immediately preserved with Lugol's iodine solution for phytoplanktonic analysis and transferred to the laboratory for analysis. A total of 10 samples of Plankton and Benthos were collected from the study areas of three (03) sub-project sites: CSE; BFDC Harbor at Chattogram; and BMC area at DFTC, Teknaf as shown in **Table 6.17** and 15 samples of Plankton and Benthos were collected from 18th canal area **Table 6.18**. Most Common Micro-fauna within the study areas of CSE, BFDC Harbor, and BMC are given in the **Table 6.19**.

Table 6.17: Plankton and Benthos Sampling Locations from CSE, BFDC, and BMC

Sl. No.	Name of Canal	Sample Id	GPS Location	Union	Upazila	District
1	Charfari khal	CSL-1P	21°44'56"N 92°01'01"E	Choarfari	Chakaria	Coxsbazar
2	Koralkhali canal	CSL-2P	21°40'34"N 91°57'41"E	Koralkhali		
3	Satdalia canal	CSL-3P	21°42'59"N 91°58'58"E	Satdalia		
4	Minishundarban khal	CSL-4P	21°42'26"N, 92°01'36"E	Choarfari		
5	Baramatamuhuri river	CSL-5P	21°40'34"N, 91°57'41"	Badarkhali		
6	Baramatamuhuri river	CSL-6P	21°40'34"N, 91°57'41"E	Saflapur		
7	Hockar Khal	CSL-7P	20°52'21"N, 92°18'06"E	Teknaf Sadar	Teknaf	
8	Kaikkhali Khal	CSL-8P	20°19'02"N 92°18'05"E	Teknaf Sadar		
9	Karnaphuli River	CSL-9P	22°19'02"N, 91°49'32"E	Ichanagar	Anowara	Chottagram
10	Karnaphuli River	CSL-10P	22°19'00"N 91°49'37"E	Ichanagar		

Table 6.18: Plankton and Benthos Sampling Locations from Canals for Cluster Farming

Sl. No.	Name of Canal	Sample Id	GPS Location	Union	Upazila	District
1	Mora Jopjopia Nodi	BSL-9	22°41'42.14"N 89°28'34.42"E	Gangarampur, Surkhali	Botiaghata	Khulna
2	Dohar Khal	BSL-8	22°53'51.65"N 89°33'17.93"E	Dighalia, Senhati	Digholia	
3	Nagkati Khal	BSL-7	22°52'45.71"N 89°32'5.05"E	Dighalia		
4	Atshotobigha Khal (Starting from Tepukhali Cyclone Center to Daiburir Gher)	BSL-5	22°33'16.9"N, 89°02'29.3"E	Noapara	Debhata	Satkhira
5	Magra Khal	BSL-4	22°49'15.7"N, 89°04'30.7"E	Balli, Kolaroa	Satkhira Sadar, Kolaroa	
6	Dhaskhathi Khal Shishutala	BSL-2	22°45'03.7"N, 89°18'34.6"E	Khalil Nagar	Tala	
7	Mahandi Khal	BSL-1	22°44'41.9"N, 89°17'21.9"E	Khalil Nagar		
8	Madhobkhali Khal (From Shalta River to Masranga Mauza/ Doani Khal)	BSL-3	22°44'12.7"N, 89°18'37.0"E	Khalil Nagar		

Sl. No.	Name of Canal	Sample Id	GPS Location	Union	Upazila	District
9	Kalmeghar Khal (Kallanpur Sluice gate to shoaliya Bridge)	BSL-6	22°19'34.2"N, 89°04'24.7"E	Shaymnagar	Shaymnagar	
10	Andigram khal	BSL-10	22°52'47.57"N 89°43'36.03"E	Gangni	Mollahat	Bagerhat
11	Gajdurer Khal	BSL-14	22°46'37.97"N 89°54'15.76"E	Char Baniari	Chitalmari	
12	Burir Khal	BSL-11	22°49'28.27"N 89°54'42.89"E	Hizla, Kalatala		
13	Kumbkhali Khal	BSL-17	22°35'18.52"N, 89°38'1.57"E	Rampal	Rampal	
14	Jibon Khalir khal	BSL-15	22°36'2.14"N 89°50'43.19"E	Raripara	Kachua	
15	Shoilodubir Khal	BSL-16	22°36'58.60"N 89°51'11.00"E	Raripara		

Some pictures of sample collection are given in the following **Figure 6.8**.





Figure 6.8: Some Pictures of Collecting Samples from the Study Areas

Results

Zooplankton

Freshwater zooplankton is an important component in aquatic ecosystems as primary and secondary links in the food chain (Hutchinson, 1967; Lind 1985; Wetzel 1975). Within the study areas of CSE, BFDC Harbor, and BMC Area eight (08) species were encountered from the Zooplankton Group. Among which two (02) species belong to Crustacea followed by Arthropoda and Rotifera as identified from the samples (**Table 6.19**). In addition, Cyclops & Nauplius were identified which are under the group Crustacea, and followed by the Crab zoea, and Acetes were under the Arthropoda respectively (**Table 6.19**).

On the other hand, from the catchment areas (Study areas) of the canals for cluster farming, three (03) species were encountered. Among which two (02) species belong to Crustacea followed by 1 species of Arthropoda were identified (**Table 6.20**). Cyclops & Nauplius under the group Crustacea followed by Cypris under the Arthropoda were found, respectively (**Table 6.20**).

According the analysis results, under the CSE, BFDC Harbor, and BMC Area, the dominating species are Nauplius (28%), followed by Cyclops (21%) and Crab zoea (13%) (**Figure 6.9**); and under the canals for cluster farming among 15 sampling point, the dominating species are cyclops (38%) followed by Cypris (35%) and Nauplius (27%) (**Figure 6.10**). The canals with stagnant water and low oxygen levels might possess a less quantity of zooplankton.

Table 6.19: Qualitative Assessment of Zooplankton of the CSE, BFDC, and BMC

Zooplankton	Family	Groups	CSLP 1	CSLP 2	CSLP 3	CSLP 4	CSLP 5	CSLP 6	CSLP 7	CSLP 8	CSLP 9	CSLP 10	Total	Percentage
<i>Nauplius</i>	<i>Arthropod</i>	<i>Crustacea</i>	2	1	0	2	0	1	2	0	2	1	11	28
<i>Cyclops</i>	<i>Cyclopidae</i>	<i>Crustacea</i>	1	0	1	1	2	1	1	0	0	1	8	21
<i>Brachionus angularis</i>	<i>Brachionidae</i>	<i>Rotifera</i>	1	1	0	1	0	0	0	1	1	0	5	13
<i>Trichocerca</i>	<i>Trichocercidae</i>	<i>Rotifera</i>	0	0	0	0	1	0	0	0	0	1	2	5
<i>Polychaete larvae</i>	<i>Polychaete</i>	<i>Annelida</i>	1	0	1	0	0	0	1	0	0	0	3	8
<i>Crab zoea</i>	<i>Brachyura</i>	<i>Arthropoda</i>	0	1	1	1	0	0	0	2	0	0	5	13
<i>Sagitta sp.</i>	<i>Sagittidae</i>	<i>Chaetogtha</i>	0	0	1	0	0	0	1	1	0	0	3	8
<i>Acetes sp</i>	<i>Sergestidae</i>	<i>Arthropoda</i>	0	0	0	1	0	0	1	0	0	0	2	5
Total			5	3	4	6	3	2	6	4	3	3	39	100

Table 6.20: Qualitative Assessment of Zooplankton of the Canals for Cluster Farming

Zooplankton	Family	Groups	BSL 1	BSL 2	BSL 3	BSL 4	BSL 5	BSL 6	BSL 7	BSL 8	BSL 9	BSL 10	BSL 11	BSL 12	BSL 13	BSL 14	BSL 15	Total	Percentage
<i>Cyclops</i>	<i>Cyclopidae</i>	<i>Crustacea</i>	1	1	0	0	1	0	0	1	0	1	1	1	0	0	3	10	38
<i>Cyprus</i>	<i>Cyprididae</i>	<i>Arthropoda</i>	0	0	2	1	0	1	1	0	1	1	1	0	0	1	0	9	35
<i>Nauplius</i>	<i>Arthropod</i>	<i>Crustacea</i>	2	0	0	0	1	0	0	1	0	2	0	0	0	0	1	7	27
Total			3	1	2	1	2	1	1	2	1	4	2	1	0	1	4	26	100

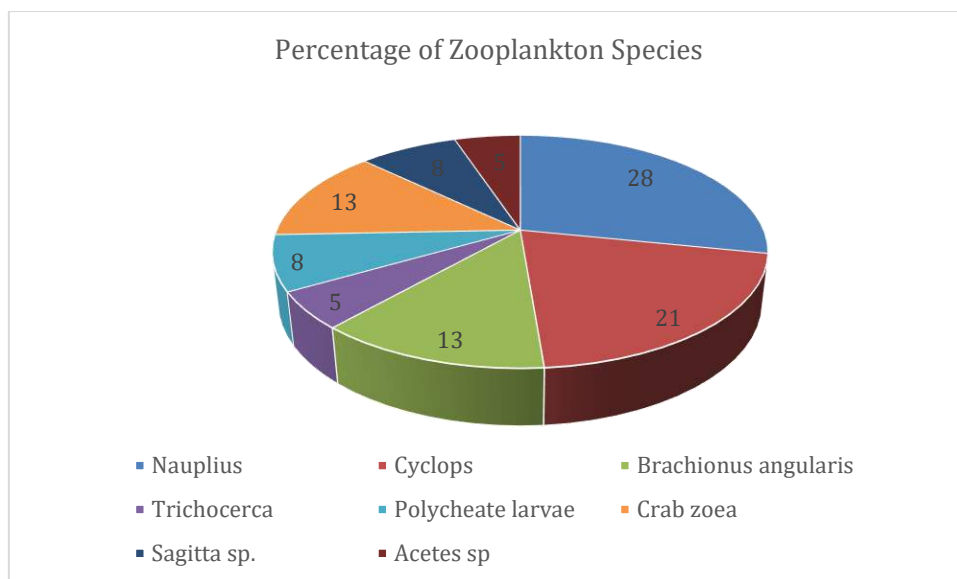


Figure 6.9: Species Based Zooplankton (%) for CSE, BFDC, and BMC

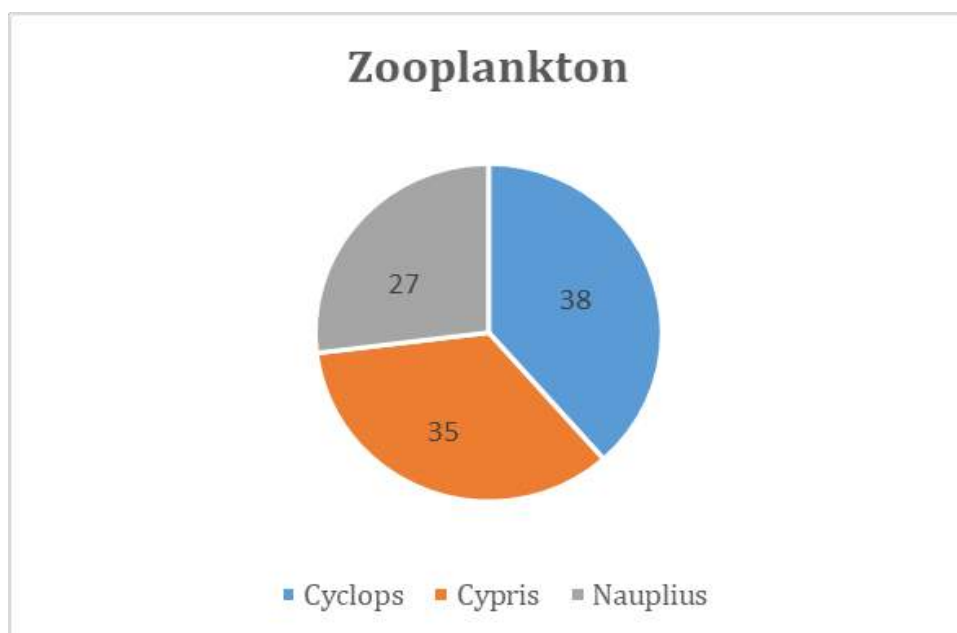


Figure 6.10: Species Based Zooplankton (%) for Canals for cluster Farming

Phytoplankton

The number of phytoplankton species identified was a medium in CSE, BFDC Harbor, and BMC study areas. Six (06) species were encountered in ten (10) sampling plots. Among them navicular from Gyrsta group is found 38% respectively 19% are *Thalassiothrix spp.* and 16% of *Ditylum spp.* was found in sampling sites (**Table 6.21**). As the growth and proliferation of phytoplankton merely depend on sunlight penetration in any waterbody. The translucency of the river and canal water surrounding the sampling station may be adversely affected temporally by dredging in the vicinity of the sampling locations.

Table 6.21: Qualitative Assessment of Phytoplankton of the CSE, BFDC, and BMC

Phytoplankton	Family	Groups	CSLP 1	CSLP 2	CSLP 3	CSLP 4	CSLP 5	CSLP 6	CSLP 7	CSLP 8	CSLP 9	CSLP 10	Total	Percentage
<i>Navicula</i>	<i>Naviculaceae</i>	<i>Gyrista</i>	2	0	1	2	1	1	2	2	1	0	12	38
<i>Ditylum</i>	<i>Lithodesmiaceae</i>	<i>Gyrista</i>	1	1	0	1	0	0	1	0	0	1	5	16
<i>Ceratium</i>	<i>Ceratiaceae</i>	<i>Myzozoa</i>	0	0	0	0	1	0	0	1	0	0	2	6
<i>Skeletonema</i>	<i>Skeletonemataceae</i>	<i>Gyrista</i>	0	1	0	1	0	0	0	1	1	1	5	16
<i>Cyclotella</i>	<i>Stephanodiscaceae</i>	<i>Gyrista</i>	0	1	0	0	0	1	0	0	0	1	3	9
<i>Thalassiothrix</i>	<i>Thalassionemataceae</i>	<i>Heterokonta</i>	1	0	2	0	1	1	1	0	0	0	6	19
Total			4	3	3	4	3	3	4	4	2	3	33	100

On the other hand, the number of phytoplankton species identified was a little low in quantity at the catchments of the canals for cluster farming. Only a single specie was encountered in the sample. *Diatom* species belongs to Gyrista group. The low occurrence of phytoplankton may be due to the opaqueness of the water. As the growth and proliferation of phytoplankton merely depend on sunlight penetration in any waterbody. High levels of sedimentation or suspended solids in canals can increase turbidity, stagnant or slow-flowing water in canals may limit the dispersal of phytoplankton. Dredging in and around the sampling sites might have bad impact in the transparency of the rivers and canals.

Benthos

Benthos is a community of organisms which live on, in, or near the seabed (known as benthic zone). This community lives in or near marine sedimentary environments from tidal pools along foreshore, out to the continental shelf, and down to the abyssal depths. Many organisms adapted to deep water pressure cannot survive in the upper parts of the water column. Benthic habitats constitute the largest single ecosystem on earth in spatial coverage and support the provision of important and valuable ecosystem services (i.e., nutrient cycling, primary production, air quality, and climate regulation). 10 species under 5 Phylum were identified (**Table 6.22**) under CSE, BFDC, and BMC. Among the 10 species observed at 10 sampling points, the dominating species found Annelida and Arthropoda (27%) followed by Nematoda (18%) and Mollusca (15%) (**Figure 6.11**). The lowest percentage was found platyhelmenthis (12%). In the project site water deficiency significantly decrease benthic communities. The species distribution is: Annelida (60%); Platyhelminthes (20%); Arthropoda (70%); Nematoda (50%); and Mollusca (30%).

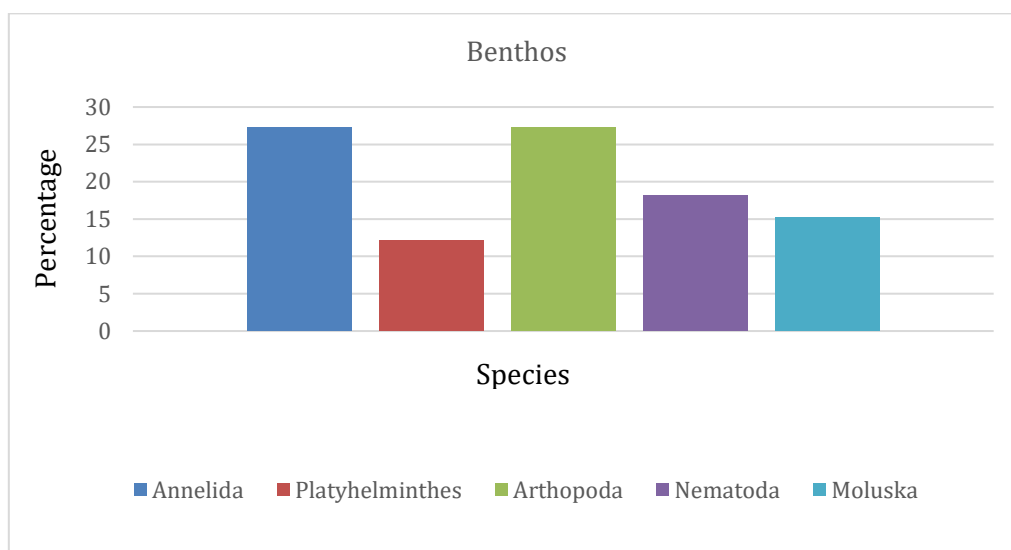


Figure 6.11: Species Based Benthic (%) for CSE, BFDC, and BMC

On the other hand, eight (08) species under 5 Phylum were identified (**Table 6.23**). These belong to Arachnida, Bivalvia, Gastropoda, Insecta, Oligochaeta, Ostracoda, Planaria, Polychaeta. Among the 8 species observed at 15 sampling points, the dominating species found Annelida (36%) followed by Arthropoda (24%) and Mollusca (20%) (**Figure 6.12**). The lowest percentage was found Nematoda (4%). In the project site water deficiency significantly decrease benthic communities. Reduced water levels can lead to decreased dissolved oxygen levels, making harder for aquatic organisms to survive. Additionally, decreased water flow can impact nutrient availability and sediment deposition, affecting the food source and shelter in benthic organisms. Dredging and re-excavation efforts frequently disturb sediments, which reduces visibility and raises the turbidity of water to the point where it limits the amount of photosynthesis that can take place in the water, impairing the ecosystem's ability to

operate as a whole. The population of all benthos may be negatively impacted by this. Benthic invertebrates are crucial in transitional ecosystems because they filter phytoplankton and then serve as a food source for larger animals like fish, connecting primary production with higher trophic levels. They play a crucial part in destroying organic matter prior to bacterial demineralization. They also shape and oxygenate the bottom by reworking sediments. Therefore, care should be made to prevent disturbing their habitat.

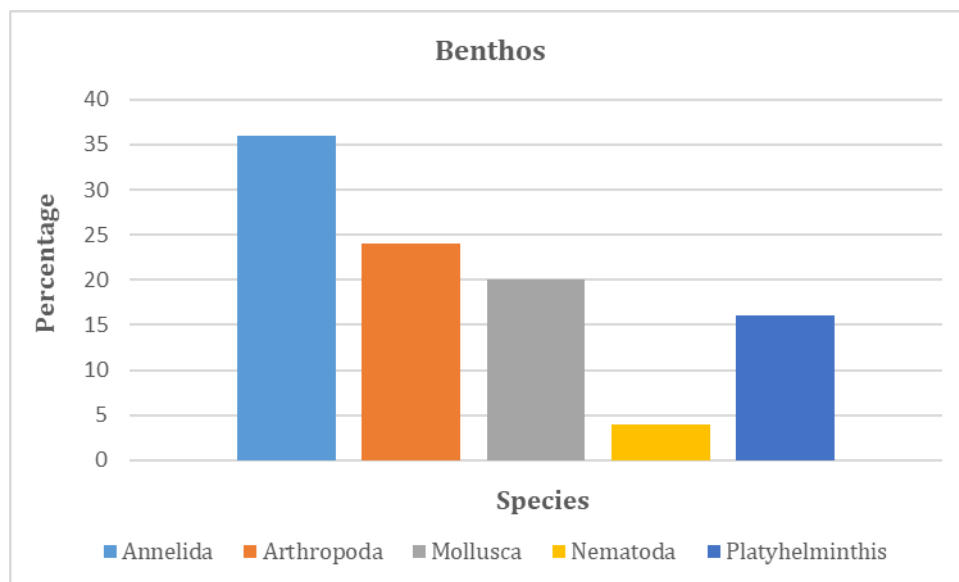


Figure 6.12: Species Based Benthic (%) for Canals for Cluster Farming

Table 6.22: Qualitative Assessment of Benthos Group of the CSE, BFDC, and BMC

Benthos (Group)	CSL-1B	CSL-2B	CSL-3B	CSL-4B	CSL-5B	CSL-6B	CSL-7B	CSL-8B	CSL-9B	CSL-10B	Total	Percentage
<i>Annelida</i>	1	0	2	0	0	2	2	1	0	1	9	27
<i>Platyhelminthes</i>	2	0	2	0	0	0	0	0	0	0	4	12
<i>Arthropoda</i>	1	2	0	1	1	1	0	1	1	0	8	24
<i>Nematoda</i>	0	1	0	1	0	0	0	1	1	1	5	15
<i>Moluska</i>	0	0	2	2	0	0	1	0	0	0	5	15
Total	4	3	6	4	1	3	3	3	2	2	31	100

Table 6.23: Qualitative Assessment of Benthos Group of the Canals for Cluster Farming

Benthos (Group)	BSL 1B	BSL 2B	BSL 3B	BSL 4B	BSL 5B	BSL 6B	BSL 7B	BSL 8B	BSL 9B	BSL 10B	BSL 11B	BSL 12B	BSL 13B	BSL 14B	BSL 15B	Total	Percentage
<i>Annelida</i>	0	0	2	0	0	1	1	0	0	1	1	1	1	1	0	9	36
<i>Arthropoda</i>	1	0	0	0	1	0	0	1	1	0	1	0	0	0	1	6	24
<i>Mollusca</i>	0	2	0	2	0	0	0	0	0	0	0	0	0	1	0	5	20
<i>Nematoda</i>	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	4
<i>Platyhelminthis</i>	0	1	0	0	0	0	0	1	1	1	0	0	0	0	0	4	16
Total	1	3	2	3	1	1	1	2	2	2	2	1	1	2	1	25	100

Ecological Process

Limnology investigates ecological processes occurring within freshwater ecosystems, such as nutrient cycling, primary production, decomposition, energy flow, and nutrient uptake. A healthy ecosystem is frequently indicated by a greater diversity of plankton and benthic species in the river. Biological characteristics of the study area is healthy that makes an overall idea about the ecological process of that area is also good.

6.1.4 Potential Vector for Diseases

CSE, BFDC Harbor at Chattogram, and BMC at DFTC, Teknaf

Most of the study area are covered by shrimp production, in shrimp cultivation, there are several potential vectors for diseases associated with vegetation and wildlife. The situation is common in both chakaria and BMC, Teknaf study area but BFDC is exceptional as it is situated in Urban developed area. Here's a breakdown of how these vectors can contribute to disease transmission:

Vegetation

Aquatic Plants: Aquatic plants can harbor various pathogens, including bacteria, viruses, and fungi. These pathogens may infect shrimp directly or indirectly through waterborne transmission. Aquatic plants can also create favorable conditions for pathogen proliferation by providing shelter and nutrients. From the KII interview, local people know that the excess of katashewla (*Najas indica*) aquatic plant causes pathogens in the shrimp culture.

Organic Debris: Decomposing organic matter such as dead leaves, twigs, and other plant debris can degrade water quality and create breeding grounds for pathogens. Shrimp may come into contact with these pathogens while foraging for food in the substrate or water column. Gewa and other existing specie's litterfall expect coconut tree cases damage the water quality of shrimp cultivation and other aquatic landform, as they said. (Hai, Tran & Yakupitiyage, Amaratne. (2005).



Figure 6.13: Jaleshwar Aquatic Plant at Ramgar Shrimp Gher



Figure 6.14: Gewa Plant Beside the Shrimp Gher at Badarkhali

Wildlife

Birds: Birds such as egrets, herons, and other waterfowl are natural reservoirs for various pathogens, including avian influenza viruses and bacteria like Salmonella. Bird droppings can introduce pathogens into shrimp ponds or water sources, leading to disease outbreaks among shrimp

populations. The study area is randomly roaming ground of wetland and migratory bird. Field visit in February, 2024 confirmed the flying activities.



Source: CEGIS field visit, 2024

Figure 6.15: A Folk of Black Headed Ibis in Chakaria

Figure 6.16: Little Heron at Teknaf BMC

Crustaceans and Mollusks: Wild crustaceans (e.g., crabs) and mollusks (e.g., snails) can carry diseases that are transmissible to shrimp. These organisms enter shrimp ponds through water exchange, tidal influx, or accidental introduction. Close proximity between wild and farmed species increases the risk of disease transmission. Adjacent mangrove and near sea area allows a good number of crustacean and Mollusks.

Insects: Insects such as mosquitoes and flies can act as mechanical vectors for faunal pathogens (Wang, J., Gao, L. & Aksoy 2023). They transfer infectious agents from contaminated sources to shrimp ponds or shrimp themselves. Additionally, insect infestations can stress shrimp and make them more susceptible to diseases. Different fishing zone and mangrove passage favor to allow various insect that may act as a potential vector of disease.

Canals Rehabilitation for Cluster Farming

The majority of the study area is covered by shrimp farming; shrimp aquaculture contains multiple possible vectors for diseases related with flora and fauna. The condition is common in Khulna, Bagerhat and Satkhira region. Here's an overview of how these vectors can contribute to disease transmission, given as follows:

Flora

Aquatic plants: Bacteria, viruses, and fungi are all possible diseases found in aquatic plants. These viruses can affect shrimp directly or indirectly via watery transfer. Aquatic plants can also promote pathogen growth by providing protection and nutrition.

Organic Debris: Decomposing organic materials, such as leaves, fallen branches, and other plant debris, can deteriorate the quality of water and serve as a habitat for viruses. These diseases may come into touch with shrimp when they are searching the substrate or water column for food. According to the local information they mentioned, gewa and other extant species "litterfall" expects coconut tree cases that harm the water quality of shrimp farming and other aquatic landforms.

Fauna

Birds: Waterfowl, especially egrets and herons, are natural hosts to a variety of infections, including bacteria like Salmonella and avian influenza viruses. In shrimp ponds or water sources, bird droppings can carry infections that cause illness outbreaks in shrimp populations. The study region is a wetland and migratory bird migration area that is randomly roamed. A field visit in February 2024 verified the avian operations.

Crustaceans and Mollusks: Wild crustaceans (e.g., crabs) and mollusks (e.g., snails) can carry diseases that are transmissible to shrimp. These organisms may enter shrimp ponds through water exchange, tidal influx, or accidental introduction. Close proximity between wild and farmed species increases the risk of disease transmission.

6.1.5 Forest and Wildlife

Chakaria Shrimp Estate

The presence of a 109-hectare mangrove forest within the Chakaria Mangrove Forest area signifies a crucial sanctuary for biodiversity and ecosystem stability in the region. In Chakaria, these mangroves likely harbor a diverse array of flora and fauna, providing essential habitats for numerous species of fish, crustaceans, birds, and mammals. Furthermore, these mangroves play a vital role in carbon sequestration, contributing to climate change mitigation efforts. wildlife of this section is already discussing at **Section 6.1.2**.

Representation of Geographically Change in Mangrove Areas

The following graph shows that the study area losses almost half (137 ha) mangrove forest in 23 years

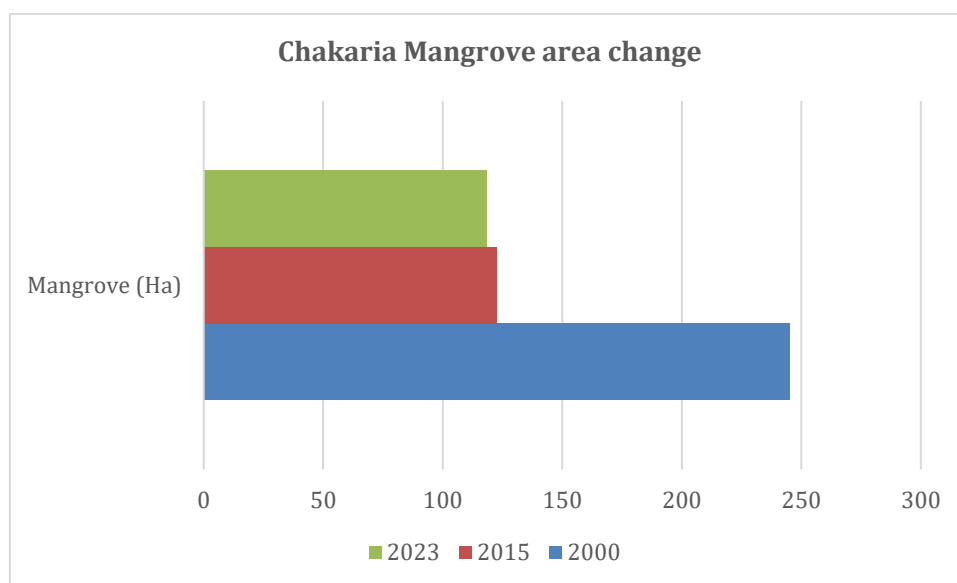


Figure 6.17: Area Changes in Mangrove in CSE

Meanwhile, Sonadia Island, located around 11 km from the Chakaria site and already designated as an important bird area, is the closest ecologically critical region. Furthermore, recognized forests such as Medakacchapia and Dulhazra are only 4.66 km and 1.73 km away, respectively. The Cox's Bazar-Teknaf Peninsula, with an area of 14.66 km, is another location of great ecological importance. The protected area surrounding the Shrimp Estate at Chakaria is shown **Figure 6.18** on the map below.



Figure 6.18: Distance of Protected Sites from the Study Area of CSE

BFDC Harbor at Chattogram

The study area has no designated forest area and is situated in an industrial urban zone. There are only plantations and scattered, distributed terrestrial vegetation along the Karnaphuli River. Urban birds and small mammals are present in that zone. The nearest protected area is about 36 km from the study area.

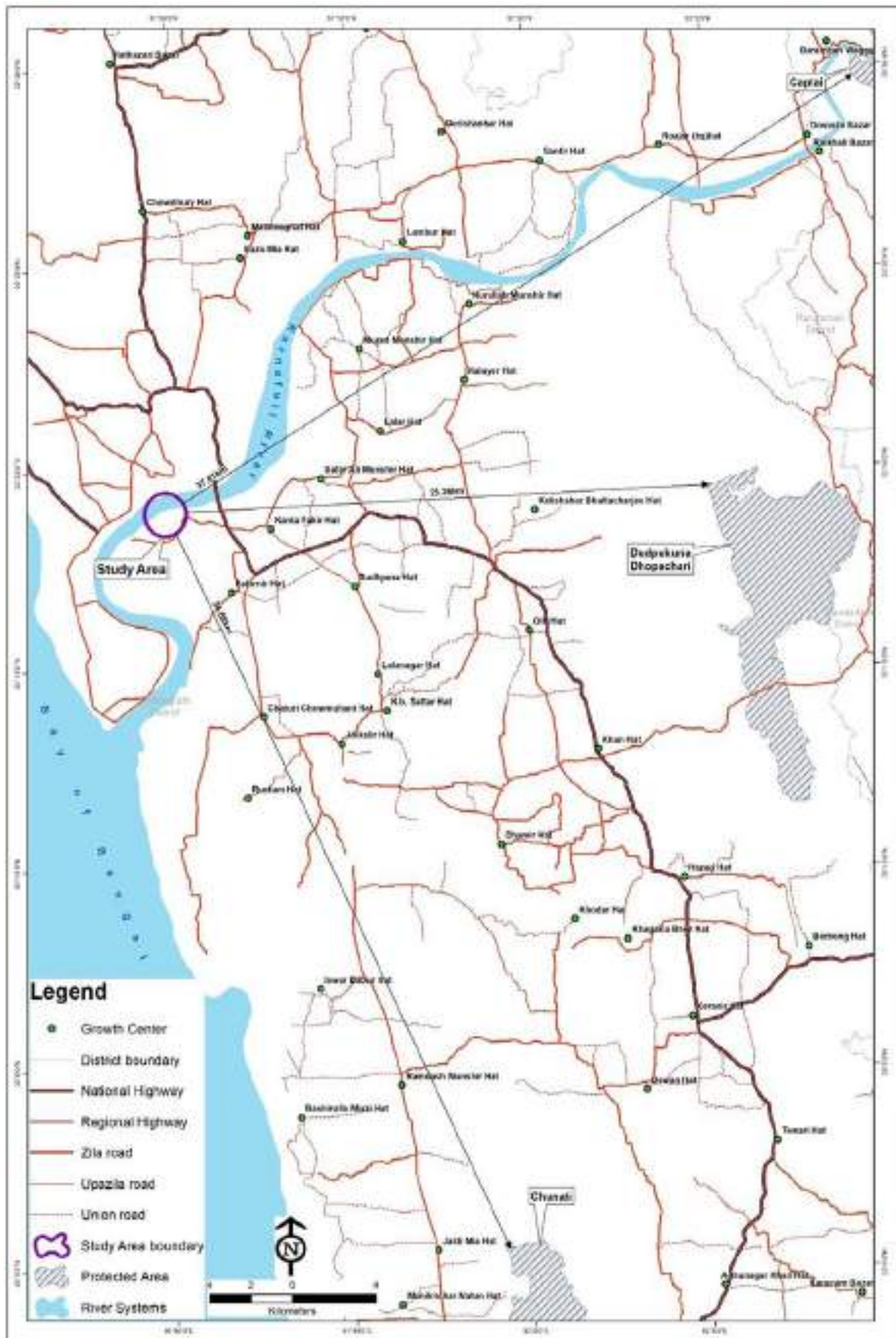


Figure 6.19: Distance of Protected Sites from the Study Area of BFDC Harbor at Chattogram

BMC at DFTC, Teknaf

The study area is in a protected area and adjacent Cox's Bazar Teknaf peninsula Ecologically Critical Area (ECA) area. A mangrove passage is situated near the project sites. The distance between the protected and ECA areas from the project site shows in following maps. As previously discussed in **Section 6.1.2**, the area supports a diverse range of wildlife.

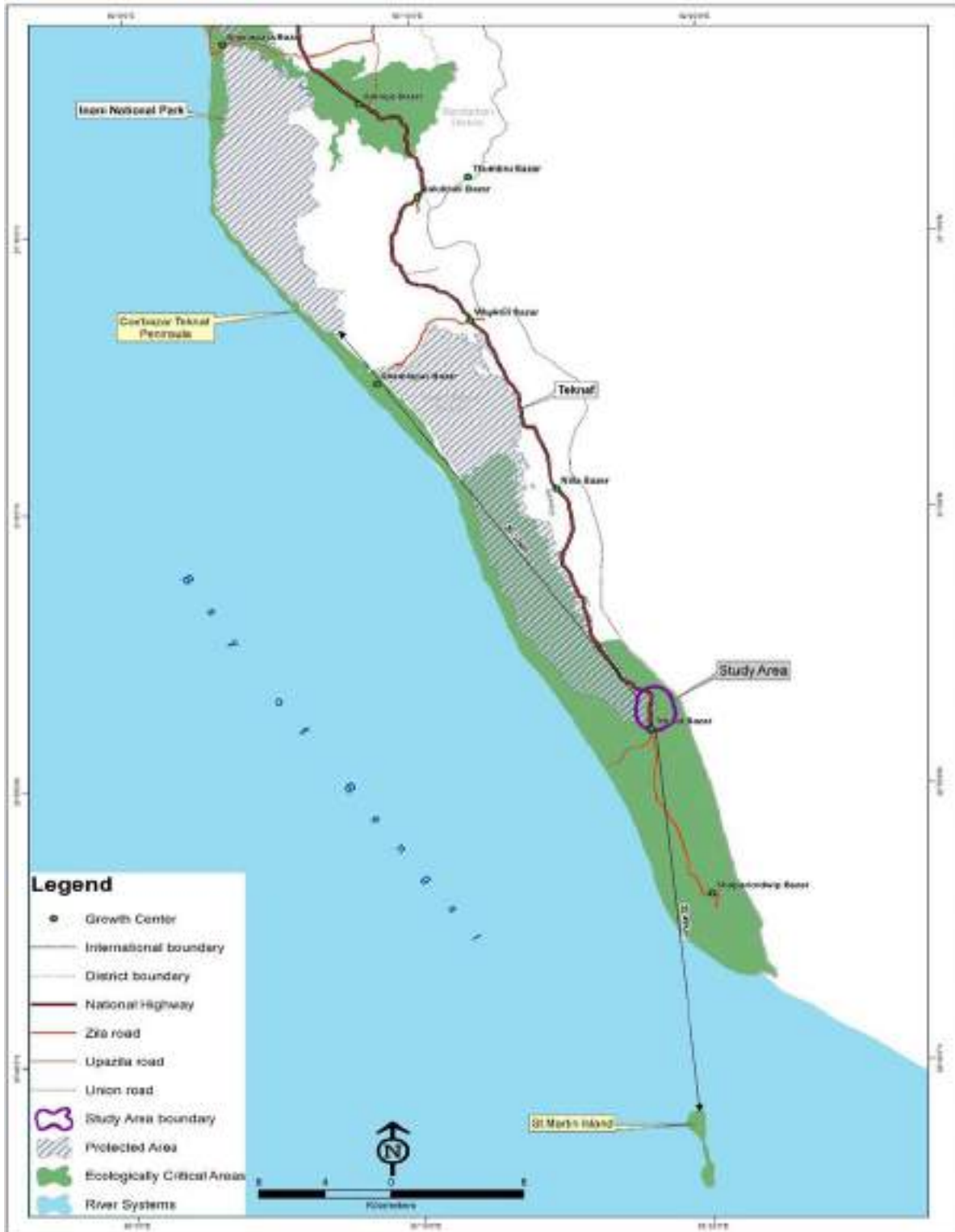


Figure 6.20: Distance of Protected Sites from the Study Area of BMC at DFTC, Teknaf

Canals Rehabilitation for Cluster Farming

There are no ecologically critical areas (ECA) or protected areas in the study and project area. The Nearest ECA area, “Sundarbans Reserve Forest” is approximately 43 km, 30 km, and 45 km away from Khulna, Bagerhat, and Satkhira study areas respectively. The biodiversity of these protected areas is not anticipated to be impacted by the proposed project activities.

6.2 Fisheries Resources

6.2.1 Chakaria Shrimp Estate

Nestled along the scenic coastline of Cox's Bazar, Shrimp Estate in Chakaria emerges as a key hub for fisheries resources, with a primary focus on the cultivation of shrimp. The study area characterized by its estuarine waters and mangrove-lined landscapes, supports a thriving aquaculture industry. In Rampura mouza, the shrimp estate spans across about 7022 acres. This extensive area is subdivided into plots of ten and eleven acres each. Specifically, there are 468 plots measuring ten acres, 119 plots measuring eleven acres, and an additional 18 plots of 48-acre shrimp demonstration farm. There are 846 shrimp farmers and 427 shrimp gher, 10,683 registered fishers in Chakaria, making the most of the region's natural resources which contributing to a robust total fish production of 9,216 metric tons per year (DoF, 2023-24).

Habitat Characterization and Assessment

Habitat Description: The study area comprises of different types of fish habitats i.e., River and canals (Khals), shrimp farm/gher, shrimp farm-cum salt pan and pond. Notably, the Chakaria study area includes the Matamuhuri River, Bura Matamuhuri River, and Maheshkhali Channel. The rivers and canals are perennial in nature and play an important role for shrimp farming by feeding saline water accompanied by different fish species. Presently, most of the canals are experiencing siltation issues, resulting less water depth. Local people reported that siltation rate in the internal canal is 2-4 inch per year. Shrimp farmers are greatly dependent on canal water because it is the main source of wild shrimp and other fish species. The Canals (Khals) functions as breeding and grazing ground along with nutrition influxes and used as migration route for fishes.





Figure 6.21: Fish Habitat in the Study Area

The study area possesses mud flat area having water during high tide and freed water during low tide. The mud flat holds water only few hours in a day. So, the area has not considered in fish habitat estimation. However, the mud flat area is very important for fisheries as it is used for nursing and grazing ground for juveniles of many riverine or marine fishes.

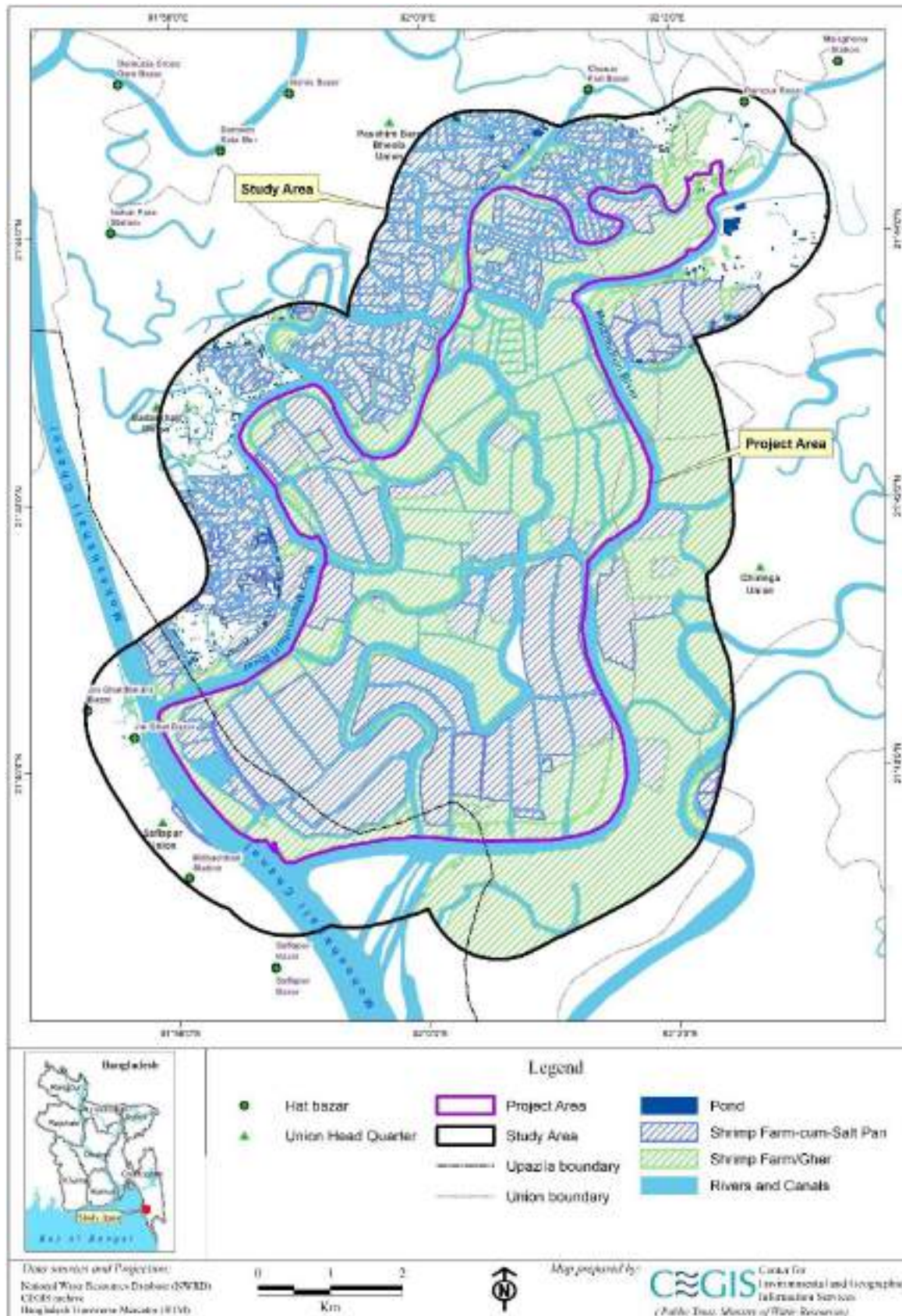


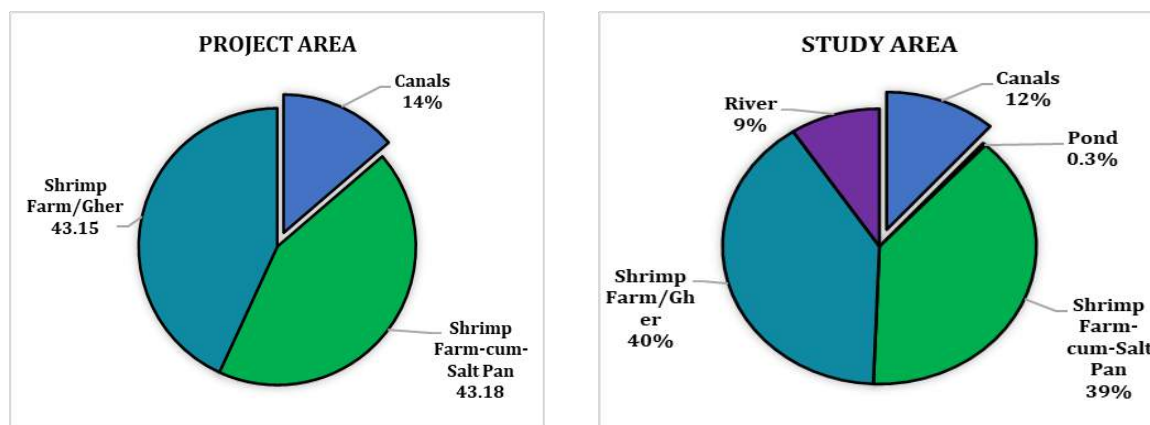
Figure 6.22: Fish Habitat in the Study Area

The canal in Chakaria holds immense significance for shrimp culture, acting as a lifeline for the thriving aquaculture industry in the region. This canal serves as a vital artery, supplying the necessary saline water for shrimp farming while also aiding in the disposal of wastewater. The brackish water environment created by the canals provides optimal conditions for shrimp growth and reproduction, contributing to high yields and quality harvests. Additionally, the canal facilitates transportation of shrimp fry and feed. Moreover, it plays a crucial role in sustaining the local economy by generating employment opportunities and supporting the livelihoods of numerous families engaged in shrimp farming.

Habitat Assessment: The project area comprises of about 3,514 Ha and study area is about 6,943 Ha. The overall habitat status in the study area is shown in the following **Figure 6.23**.

Table 6.24: Fish Habitat Area within the Study Area

Habitat Category	Habitat Name	Habitat Area (Ha)	
		Project Area	Study Area
Fisheries (Capture)	River	-	644
	Canals	481	797
	Sub-Total	481	1,441
	Shrimp Farm/Gher	1516	2784
Aquaculture	Shrimp Farm-cum-Salt Pan	1517	2694
	Pond	-	24
	Sub-Total	3,033	5,502
	Total	3,514	6,943



Source: Landuse data extracted from satellite image by CEGIS and field visit, 2024

Figure 6.23: Percentage of Fish Habitat within the Project and Study Area

Habitat Quality

Primary Productivity of Canal: The main aim of productivity measurement was to get a better understanding of the food chain relationships and of the functioning of the ecosystem. In ecological studies, understanding primary productivity and respiration rates is crucial as they reflect the energy dynamics within ecosystems. Data was collected from four distinct sampling locations namely, Rampura, Badarkhali, Chuarfari, and Pokkhali to gain insights into their productivity and respiration patterns.

Rampura exhibits moderate levels of primary productivity among the sampled locations, with a higher GPP than NPP, indicating substantial energy loss through respiration. However, the NPP: CR ratio suggests efficient utilization of resources, with NPP exceeding CR, indicating a net gain in biomass.

Badarkhali demonstrates the highest primary productivity among the sampled locations, with both NPP and GPP significantly higher than in Rampura. The low CR: GPP ratio indicates efficient energy conversion, with a large proportion of the generated biomass being retained.

Choarhari displays relatively lower productivity compared to Badarkhali but higher than Rampura. The NPP: GPP ratio suggests considerable energy loss, with a substantial portion being respired. The NPP: CR ratio indicates a balance between primary productivity and respiration.

Pokkhali exhibits the lowest productivity levels among the sampled locations, with both NPP and GPP significantly lower than in Badarkhali and Choarhari. The NPP: CR ratio indicates a slight deficit in biomass production compared to respiration, suggesting potential resource limitations.

Overall, these findings highlight the variability in primary productivity and respiration rates across different sampling locations. Badarkhali emerges as the most productive site, followed by Choarhari, Rampura, and Pokkhali. Understanding such variations is essential for effective ecosystem management and conservation efforts. Further investigations into the environmental factors influencing these dynamics are warranted for a comprehensive understanding of ecosystem health and functioning.

Table 6.25: Different Primary Productivity within the Study Area

Sampling Location	NPP (mgL/m ³ /h)	GPP (mgL/m ³ /h)	CR (mgL/m ³ /h)	NPP: GPP	NPP:CR	CR: GPP
Rampura	26.25	45	18.75	0.58	1.40	0.42
Badarkhali	52.5	67.5	15	0.78	3.50	0.22
Chuarhari	22.5	52.5	30	0.43	0.75	0.57
Pokkhali	15	37.5	22.5	0.40	0.67	0.60

Source: CEGIS field survey, 2024

Gross Primary Production -GPP, Net Primary Production -NPP and Community Respiration -CR

Importance of snails in shrimp gher/pond: Snails are molluscs that play important ecological roles in aquatic and terrestrial ecosystems, providing food for other organisms and improving water quality (Srivastava, 2020). In the study area, snails serve important roles in the shrimp gher/pond ecosystem, offering multifaceted benefits to the aquaculture ecosystem. They help in natural pest control by preying on harmful parasites and algae that can afflict shrimp populations, thus bolstering the overall health of the aquatic environment. Additionally, snails contribute to nutrient recycling, efficiently converting organic matter into valuable nutrients that promote the growth of essential microorganisms and plankton, forming the foundation of the food web. By grazing on algae and organic debris, they help maintain optimal water quality, crucial for supporting thriving shrimp populations. Furthermore, their bioturbation activities oxygenate the sediment, mitigating the risk of toxic gas buildup and creating a healthier habitat for shrimp and other aquatic organisms. Embracing the role of snails in shrimp ghers not only fosters sustainable aquaculture practices but also underscores the intricate balance of nature within these aquatic systems, ultimately benefiting both farmers and the environment.

Species Diversity and Composition

During field visit, it was observed that different types of crustaceans in the rivers and canals of the study area, includes *Macrobrachium spp.*, *Penaeus spp.*, *Metapenaeus spp.*, *Fenneropenaeus indicus* and *Scylla serrata*. The most available canal fish species are *Lates calcarifer*, *Mystus spp.*, *Datniodes polota*, *Glossogobius giuris*, *Scatophagus argus*, *Hilsa sp* etc.

A total of **29 species** of fish belonging to 19 families and 10 shellfish species were recorded during field survey. In the past, few studies were carried out in the Chakaria study area. Among the studies, Akter **et al.**, (2017) identified 54 finfish and 10 shellfish species. According to the statement of local people, fish diversity is declining gradually due to sedimentation, use of illegal fishing gears, catching of shrimp PL etc.

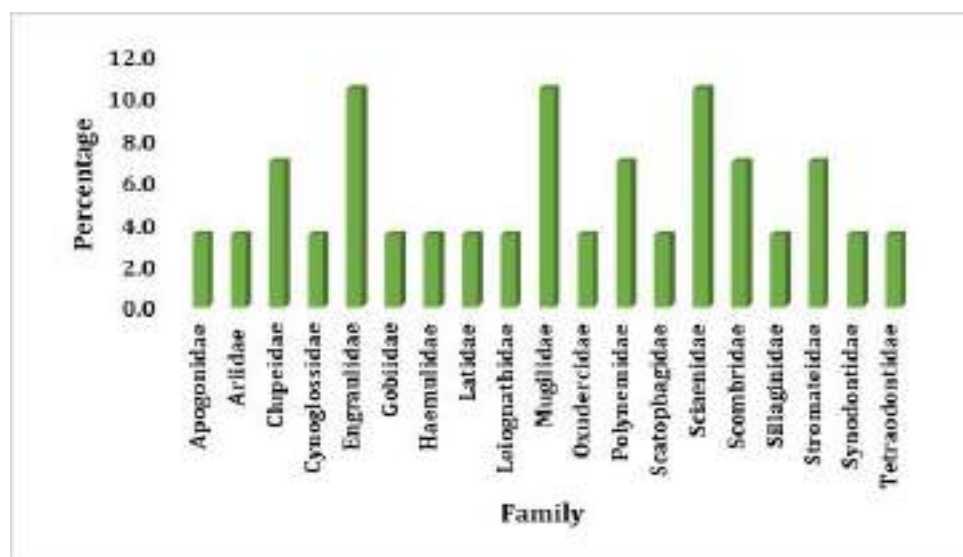


Figure 6.24: Percentage of Family-Wise Species Composition in the Study Area

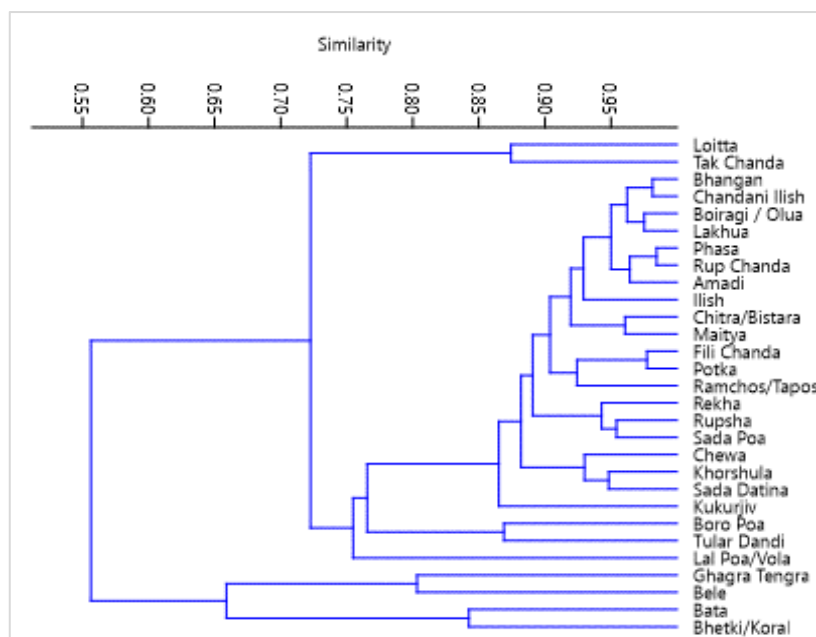
The Shannon-Weiner diversity index and Simpson index values, suggest varying degrees of fish species diversity across the study area. The sites with higher Shannon and Simpson indices in Badarkhali, likely harbor more diverse and evenly distributed populations. Conversely, lower indices in Chuarfari indicates lower species diversity. Additionally, evenness values emphasize the distributional patterns of species within the study area. Higher evenness values in Badarkhali suggest a more balanced distribution of species abundance.

Table 6.26: Different Species Diversity Index at Sampling Site of the Study Area

Diversity Index	Rampura	Chuarfari	Badarkhali	Pokkhali
Simpson	0.9317	0.9119	0.941	0.9289
Shannon-Weiner	2.973	2.825	3.034	2.961
Evenness	0.6983	0.5813	0.7695	0.6896

Source: CEGIS field survey, 2024

The Cluster analysis showed that fish assemblages were clearly separated into two groups at a Bray-Curtis similarity index value of 0.55 (**Figure 6.25**): the first branching representing the assemblages of Bele, Bata and Bhetki/Koral, and the second branching consisting of the remaining fish species. It means these species have same habitat preferences. Subsequent groupings within the second branching were slightly more difficult to identify except Loitta and Tak Chanda, but a further split was observed at a Bray-Curtis similarity index value of 0.73% (**Figure 6.25**). Loitta and Tak Chanda prefer similar habitats but differing from other species in the second branching.

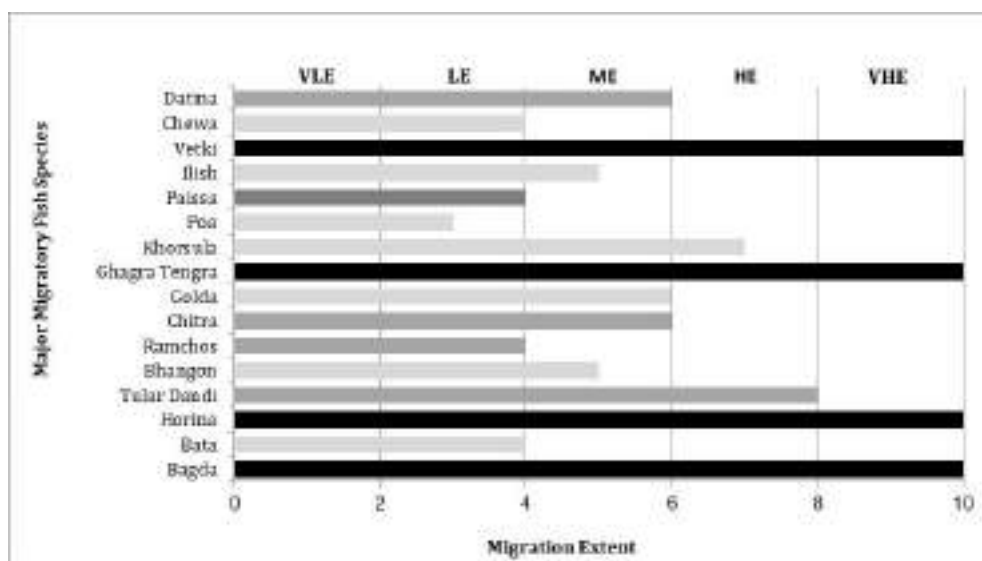


Source: CEGIS field survey, 2024

Figure 6.25: Spatial and Temporal Cluster of Fish Assemblage Based on Bray-Curtis Similarity Matrix

Fish Migration and Breeding

The rivers of the study area provide necessary ecological demand for feeding, breeding/spawning and nursing of fries and juvenile fishes of different migratory fish species. According to the local fishers and Upazila Fisheries Officials, major longitudinal migratory fishes in the rivers are Koral (*Lates calcarifer*), Ramchos (*Polynemous paradiseus*), Poma (*Otolithoides pama*) and Tular Dandi (*Sillaginopsis panijus*). The lateral migration occurs mostly for small fishes like Tengra (*Mystus bleekeri*), Gulia (*Mystus gulio*), Faisha (*Liza Persia*), and small shrimp/prawns are mostly limited between the rivers and khal.



Source: On spot Catch Survey, CEGIS (2024)

VLE: Very Low Extent; LE: Low Extent; ME: Moderate Extent; HE: High Extent and VHE: Very High Extent

Figure 6.26: Migration Extent of Major Migratory Fish Species within the Study Area

Fish Breeding/ Spawning: Most of the species use rivers and canals as breeding and spawning grounds. On the other hand, the breeding and spawning ground of Bagda and Galda is estuary. The following table (**Table 6.28**) shows breeding seasons of different species in the study area.

Table 6.27: Breeding Season of the Important Fish and Shell Fish Species within the Study Area

Species	Locality	Breeding season
Tular Dandi	River	November-February and August-September
Ilish	River	Peak breeding season is late October to early November
Datina	River	December-April
Bhangon	River	January-February
Khorshula	River	May-September
Ramchos	River	May to October
Ghagra Tengra	Canal	June-September
Bele	River	▪ March-April ▪ September- October
Bagda	Estuary	January
Galda	Estuary	January
Horina	River	Peaked in winter (December) and in early spring (March), but with a minor peak in autumn (October)

Source: Literature review and CEGIS Field Survey, 2024

Aquaculture Technology

Shrimp Farming: Shrimp farming in the study area involves a traditional practice where farmers cultivate shrimp for seven months, reserving the remaining five months for salt culture activities. Shrimp are typically grown from May to November, with the land repurposed for salt production for the rest of the year. All investigated farms are situated in the inter-tidal range, employing an open system without treatment ponds. The average water depth in the gher ranges from 3 to 5 feet, while in the canals, it ranges from 5 to 6 feet.



Figure 6.27: Culture Pattern of Shrimp and Salt Culture in Chakaria

Shrimp farm/Gher Preparation: The farmers of the study area predominantly practice shrimp farm/gher preparation, a process involving washing out old shrimp farm water by the end of November, leaving it to dry for 20-30 days before salt culture preparation begins. During this period, farmers also undertake maintenance tasks such as repairing dykes, water intake gates, and guard sheds. The construction of pond dykes, typically ranging from 1.5 to 4 feet in height and 0.5 to 2.5 feet in width, is done manually by excavating adjacent topsoil. Shallow canals are created along the dykes to retain water, serving as shrimp nursing grounds and fish refuges, with a diameter of 5-6 feet. After drying and filling the farms with tidal water, agricultural limestone (CaCO_3) is applied at an average

rate of 7-10 kg/ha. The limestone is soaked in water overnight and then sprayed across the farm the following day. Fertilization is done with water introduced after a week of fertilizing. Notably, no chemicals or antibiotics are used in the surveyed farms.



Figure 6.28: Shrimp Farm/Gher Preparation within the Study Area

Fry Collection: Shrimp farmers primarily rely on two sources for fry such as wild and hatchery-bred. Initially, farmers prefer wild fry due to their natural strength and adaptation to local water conditions. However, when wild fry become scarce and prices rise, farmers are forced to purchase hatchery post-larvae (PL) regardless of cost. The shift towards hatchery PL has been gradual since the prohibition on wild fry collection in 2000. Farmers procure PL from fry dealers, emphasizing the significant impact of PL quality on farm productivity and revenue. Concerns are raised regarding the quality of hatchery PL, with farmers noting increased susceptibility to disease compared to wild fry, as well as higher mortality rates due to chemical use and the presence of underage PL (below PL15). Despite these concerns, the collection of single wild shrimp fry leads to the loss of various fish species, as mentioned in focus group discussions (FGDs) where respondents highlighted the rarity of certain white fish species.

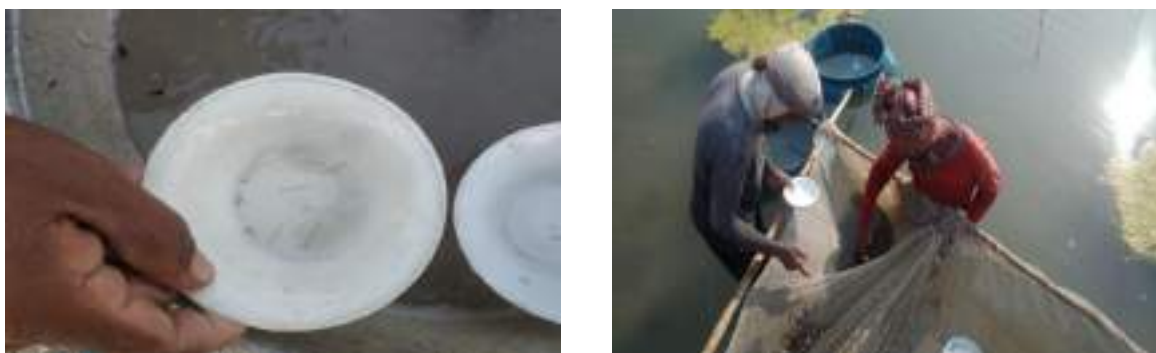


Figure 6.29: Shrimp PL Collection

Stocking: Majority of the farmers stocked shrimp PL directly to grow out ponds, while a few of them nursed fry in nursery pond before transferring to grow out ponds. In some cases, the shrimp PL is put into a nursing pond for 1-2 months for increasing PL size and survivability. Many of the farmers start stocking little by little from the wild source and hatchery. After mid-February, Shrimp farmers usually stocked little amount into the canal of the gher for their shrimp farming. According to the statement of local farmers, about 80% of Bagda PL from hatcheries and 20% is derived from wild source. The price of wild fry and hatchery fry is 1 tk/piece and 0.5 tk/piece respectively. Stocking density varies from about 15,000 to 25,000 PL per ha. They stocked in every new and full moon. Farmers stocked shrimp PL for more than five times in a year. Shrimp farmers completed stocking between February to July (Falgun-Ashar mash). By this time, they also stock different species of white fish species.

Table 6.28: List of Culture Species Investigated in the Gher within the Study Area

Sl. No.	Scientific Name	Sl. No.	Scientific Name
1.	<i>Penaeus monodon</i>	11	<i>Fenneropenaeus indicus</i>
2.	<i>Metapenaeus monoceros</i>	12	<i>Mystus spp</i>
3.	<i>Oreochromis mossambicus</i>	13	<i>Hypophthalmichthys molitrix</i>
4.	<i>Oreochromis niloticus</i>	14	<i>Labeo calbasu</i>
5.	<i>Lates calcarifer</i>	15	<i>Cyprinus carpio</i>
6.	<i>Chelon parsia</i>	16	<i>Gibelion catla</i>
7.	<i>Scatophagus argus</i>	17	<i>Cirrhinus mrigala</i>
8.	<i>Glossogobius giuris</i>	18	<i>Labeo rohita</i>
9.	<i>Mugil cephalus</i>	19	<i>Ctenopharyngodon idella</i>
10.	<i>Datniodes polota</i>		

Water Exchange: Water for the farms is typically sourced from adjacent rivers or canals and discharged back into the same water source without treatment. The surveyed farms utilize sluice gates, predominantly made of wood or concrete, to exchange water. Smaller farms typically employ wooden gates, whereas larger farms use both wooden and concrete gates. These gates are regulated by a wooden shutter. Most farms utilize the same gate for drainage and flushing, although a few have separate gates for these purposes. Water exchange occurs every 4-6 days during each lunar cycle, with farmers conducting exchanges at other times if necessary. During water exchange, certain predator fish species, including *Lates calcarifer*, *Scatophagus argus*, *Glossogobius giuris*, and *Mystus spp.*, may enter the farms due to the unplanned development of inlet and outlet canals, effluent water from one shrimp farm often flows into another.

**Figure 6.30: Water Exchange Gate of Shrimp Farm/Gher**

Shrimp Harvest: Shrimp typically take 2-3 months to reach harvest maturity. Harvesting occurs between 60 to 120 days of growth, usually during the full and new moons of a lunar cycle, which lasts 5 to 7 days. During this time, farm water is drained into adjacent canals, and fresh tidal water is introduced to attract shrimp. Shrimp are attracted to tidal water due to their preference for swimming against the current, and harvesting is done using traps and nets in a catchment area. Bamboo traps, cast nets, and seine nets are commonly used harvesting tools. The process involves gravity or pumping the enclosure, hand-picking, and trapping, lasting around 10 to 12 hours. After harvesting, shrimp are stored in bamboo or plastic crates or coops, sometimes with the use of ice, before being cleaned and arranged in heaps for sale at the farm entrance.

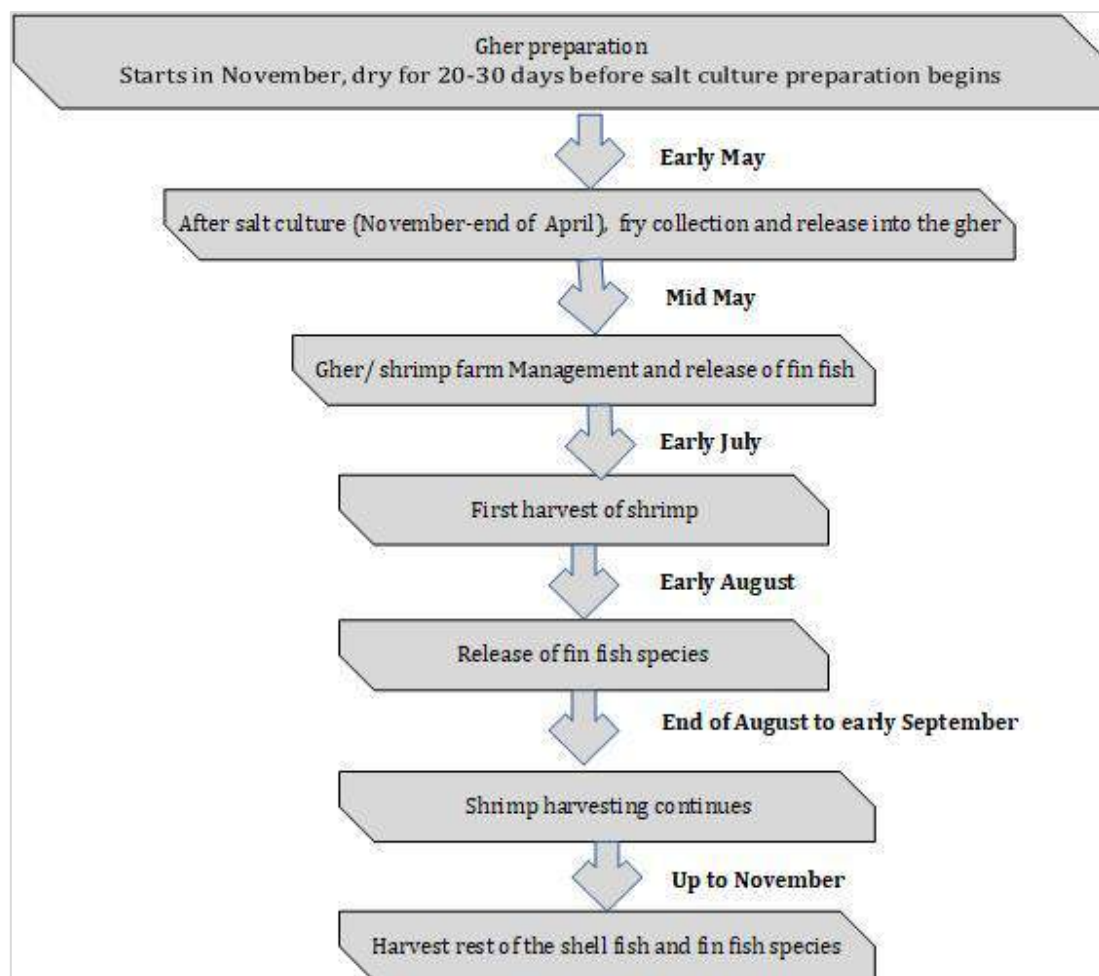


Figure 6.31: Shrimp Production Flow Chart in Chakaria

Disease outbreaks and Management: Shrimp culture in Chakaria is facing severe disease outbreaks. They do not use pesticides or antibiotics during disease outbreaks. When disease struck on their farms or those of their neighbors, the farmers harvested early as well. Farmers reported that they are facing different types of disease among them white spot syndrome (WSS) is most dangerous to shrimp. A list of shrimp disease found in the study area is given below:

Table 6.29: Different types of disease is found in the shrimp farm of Chakaria

Disease Name	Types	Clinical symptoms	Sources of disease outbreaks
White Spot Syndrome	Viral	- White spot inside surface of carapace and appendages - Aggregation at the gher edges - Sluggish movement - Less appetite and reddish discoloration.	- Poor pond management - Water quality management - Overstocking - Broodstock health - Pathogen introduction - Poor health management practice - Lack of disease monitoring and early detection - Climate and environmental factor
Yellow Head Disease	Viral	- Yellowish discoloration under carapace or hepatopancrease - Aggregation at the pond edge - Erratic swimming near the surface	

Disease Name	Types	Clinical symptoms	Sources of disease outbreaks
Vibriosis	Bacterial	- Black spot in different parts of the shell - abnormal swimming behavior at the edge or surface of gher - Lethargic and loss of appetite	- Feeding practices - Bird droppings into the pond water
Black Gill Disease	Environmental	- Black spot in gill under carapace - Sluggish movement - Damage gill	
Soft Shell Disease	Nutritional	- The shell become thick and soft - Shell is rough and wrinkled	

Source: CEGIS field visit, 2024

Climatic hazards and adaptive capacity: The present study found that the local aquaculture farm owners have very limited adaptive capacity against the extreme climate induced events. According to the statement of local fishers, 70% took no adaptive measures for heavy rainfall, cyclone, erratic rainfall, and wet days.

Table 6.30: Adaptive Measures for Farm Management

Hazard	Adaptive Measures
Extreme Hot Days	- Pumping water - Use of water hyacinth to make shade - Use coconut leaves over pond to make shade
Tidal Flood	- Fish farmers fenced by Nylon net or bamboo made mat (Bana) around the fish farm to prevent fish from escaping - The farmers heighten the pond dyke to prevent fish from escaping - The farmers harvest fish at an early stage before flooding to some extent.
Heavy Rainfall	Fish farmers usually do not take any measure
Cyclone	
Erratic Rainfall	

CEGIS Field Survey, 2024

Aquaculture Inputs

The present study results that 75% of the farmers use pre-stocking inputs while only 25% of them use some post-stocking input. A list of aquaculture inputs is given below:

Table 6.31: Aquaculture Inputs for Different Farming System in the Study Area

Name of Inputs	Farming System			
	Traditional	Extensive	Semi-intensive	Intensive
Gher Size (ha)	5-10 or >	5-10 or >	1-10	<1
Stocking type	Natural	Natural + Artificial	Artificial	Artificial
Stocking density (Seed/m ²)	1-1.5	2-10	20-40	40-60

Name of Inputs	Farming System			
	Traditional	Extensive	Semi-intensive	Intensive
Seed source	Wild	Wild+ hatchery	Wild+ hatchery	Hatchery
Feed used	Natural	Natural and little low-cost feed	Natural and pelleted feed	Formulated complete feed
Water exchange	Tidal	Tidal, minimal pumping	Tidal, pumping	Pumping, reservoir, filter
Aeration	No	Little or no	Yes	Yes
Culture type	Polyculture	Polyculture	Monoculture	Monoculture
Lime used (kg/ha/yr)	Little or no	<100	250-400	500+
Fertilizer used (kg/ha/yr)	Little or no	Cowdung-500, little or no Urea/TSP	Cowdung-2000, Urea-300, TSP-100+	Cowdung-4000, Urea-500, TSP-200+
Chemicals used	No	Little or no	Used	Widely used
Yield (MT/ha)	0.1-0.5	0.6-1.5	2-6	7-15
Production cost (Tk/kg)	No data	100-300	200-600	400-800

Source: CEGIS field visit, 2024

Production

In Chakaria Upazila, fish production is robust at 9,216 metric tons, exceeding local demand of 8,382 metric tons, resulting in a surplus of 833 metric tons. Additionally, the estimated total fish production in the project and study areas stands at 2,401 MT and 4,600 MT, respectively. The overall fish production status in the study area is shown in the following **Table 6.32** and **Figure 6.32**.

Table 6.32: Aquaculture Inputs for Different Farming System in the Study Area

Habitat Category	Habitat Name	Fish Production (MT)	
		Project area	Study area
Fisheries (Capture)	River	-	258
	Canals	212	352
	Sub-Total	212	610
	Shrimp Farm/Gher	1,124	2,064
Aquaculture	Shrimp Farm-cum-Salt Pan	1,065	1,891
	Pond	-	35
	Sub-Total	2189	3990
	Total	2401	4600

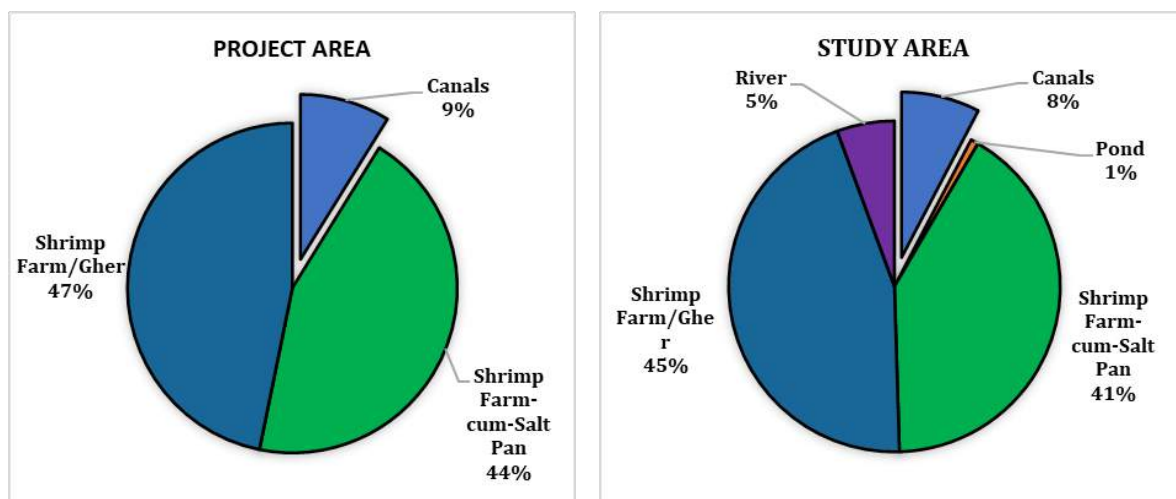


Figure 6.32: Percentage of Fish Production within the Study Area

Aquaculture Production Barrier

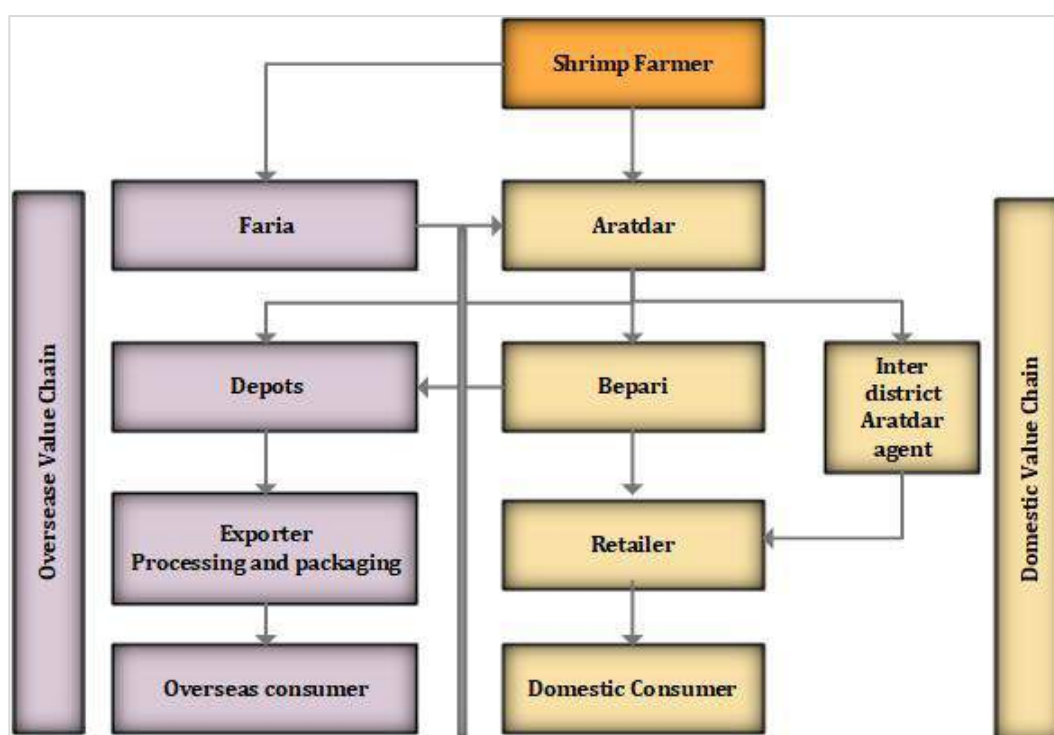
- Shrimp farms are susceptible to diseases that can quickly spread and devastate the entire crop.
- Poor water connectivity, pollution, and inadequate oxygen levels affect production.
- Market fluctuations and competition pose challenges for producers.
- Changes in climatic patterns, extreme weather events, and environmental concerns is affecting aquaculture production.
- Lack of access to modern aquaculture technologies training and inadequate infrastructure.
- Limited access to capital and financial resources can be a significant barrier for small-scale shrimp farmers.
- Diseases can spread from bird droppings, and when a diseased fish falls into the pond water during carrying fish in bird's mouth, the disease can also spread from this.



Figure 6.33: Shrimp Production Impacting Variables

Fish Landing Center and Trading

Value chain of shrimp: The main fish landing center in the study area is Choarfari Bazar of Shahar Beel Union. Fish and shellfish come from the Sea, River, Canal, and Aquaculture. Culture fish originates from Poschim Borobi, Badarkhali, Purba Boro Bula, and Shahar Beel area. Additionally, fish also comes from Maheshkhali, Sonadia, and Kutubdia. Fish is landed in full swing for seven months, from Jaistha to Agrahan Mash, with the monsoon being the peak landing period for shrimp, averaging 2500-3000 Kg/day. Despite there being 30 Aratdar and 12 cold storage facilities, there is no ice factory, requiring them to bring ice from Cox's Bazar or Badar Khali. According to the local Aratdar, the average capacity of this landing center is 1500-3000 kg/day. The percentage of landed fish and shellfish is 30% and 70% respectively. The main fish species landed here include bata, Tengra, Vetki, Tilapia, Pangas, Nilotica, Parshe, Kachki, Poa, Ilish, Rui, Catla, etc. The value chain becomes longer with various activities in each step and connections between different chains. Below is the shrimp value chain in the study area.



Source: CEGIS field visit, 2024

Figure 6.34: Value Chains of Shrimp within the Study Area

Backward and Forward Linkages

In Chakaria, Cox's Bazar, the shrimp culture industry demonstrates both backward and forward linkages that play crucial roles in its economic ecosystem. The backward linkages involve the supply chain elements such as hatcheries providing shrimp larvae, feed manufacturers supplying shrimp feed, and technology providers offering equipment and expertise. These inputs are essential for the cultivation process, ensuring optimal growth and productivity. On the other hand, forward linkages encompass processing plants, exporters, and market channels that facilitate the distribution and sale of the harvested shrimp. These linkages contribute to the region's economic development by generating employment opportunities, boosting local businesses, and fostering trade networks. Furthermore, the interconnectivity between backward and forward linkages forms a symbiotic relationship, driving efficiency and sustainability within the shrimp culture industry of Chakaria, Cox's Bazar.

Fisheries and Aquaculture Management

There is no fish sanctuary in the study area. Field investigation revealed the following existing fisheries management in CSE:

- Regular monitoring and evaluation
- Conducting regular campaign for implementation of Shrimp policy 2013
- Regular inspection of shrimp plots and advice to farmers
- Vannamei shrimp farming pilot project
- Fisheries management of 48-acre plot.

6.2.2 BMC Area at DFTC, Teknaf

Introduction

The study area is important for fisheries resources due to close proximity to Naf River. Moreover, good numbers of fishermen comprising both male, female as well as children, engage in fishing activities/ fish related as subsistence fishers in the nearer water bodies. In addition to this, a considerable number of people are involved in Bay of Bengal fishing, trading, fish drying related activities. The Upazila has 10,683 registered fishermen who engage in open water fishing in various way. There are 84 shrimp farmers, 20 fish landing sites, 11 Fish arot, 4 ice factory, Mechanized fishing Boat is 1424 nos. and non-mechanized 30 nos. in Teknaf Upazila. (Source: Upazila fisheries office, Teknaf).

Habitat Characterization and Assessment

Habitat Description: There are some ponds in the project area which is filled by tidal water. This pond holds water round the year with the depth of 2-3.5 ft. Some fish species use the sub-project site as grazing ground. In the project area existing aquaculture is very limited on the other hand, study area has some aquaculture pond e.g. Shrimp Farm-cum-Salt Pan, Shrimp Farm/Gher etc. and this area is also connected with the Naf River. Hence, the study area is rich and diversified with mainly brackish water of the river. This area has mangrove forest which support a wide variety of fish species.



Figure 6.35: Picture of Fish Pond within the Study Area

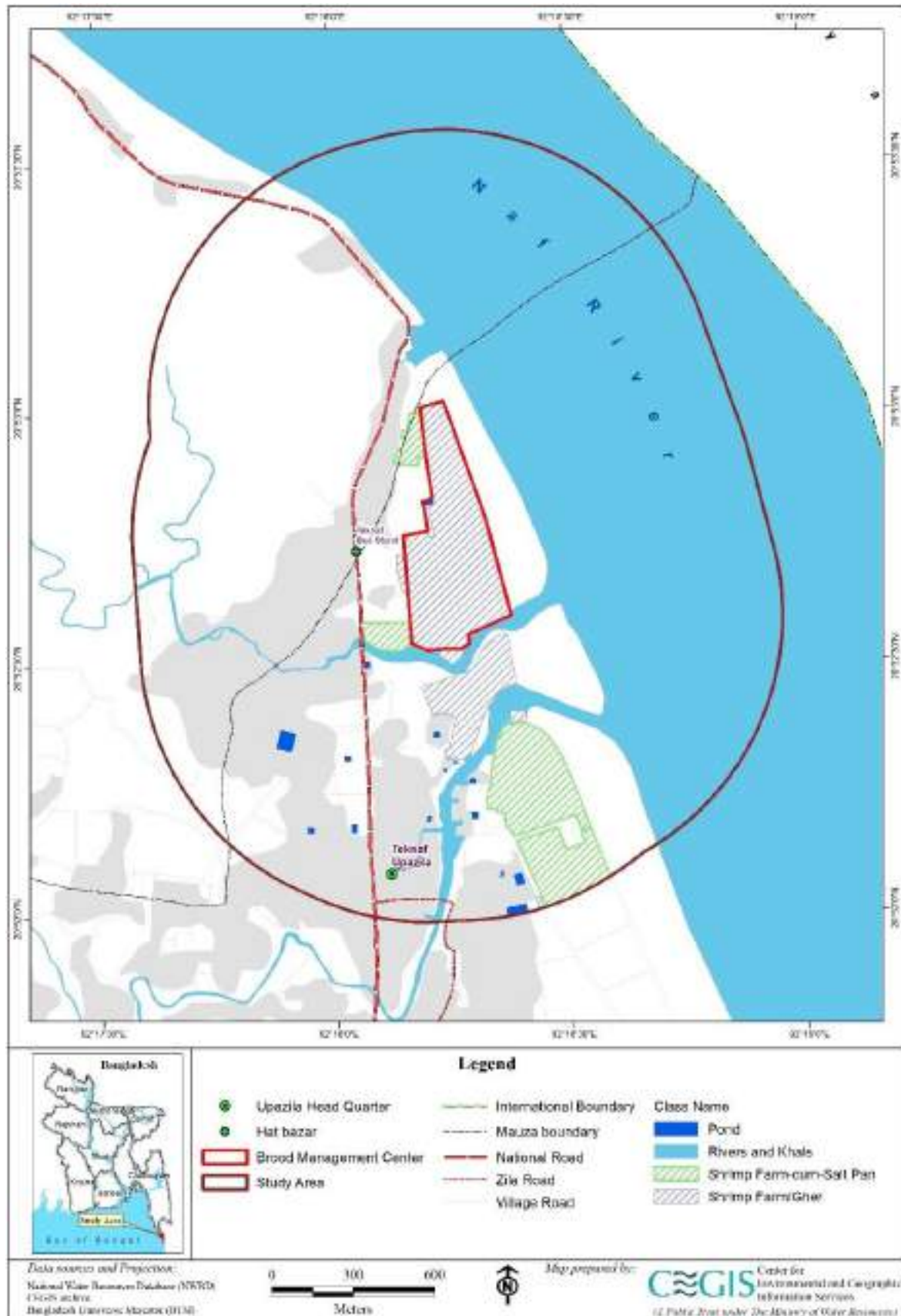


Figure 6.36: Fish Habitat within the Study Area

Habitat Assessment: Estimated area of total fish habitats is about 267 hectares (ha) in the study area and 21 hectares (ha) in the project area, with the share of Rivers and Khals by 81.6% followed by Shrimp Farm-cum-Salt Pan 7.1% and Shrimp Farm/Gher is about 10.5%. Detailed habitat fragmentation is being done through land use data by remote sensing (RS) division, CEGIS. Fish habitat area in the study area is shown in **Table 6.33**.

Table 6.33: Fish habitat Area within the Study Area

Habitat Category	Fish Habitat	Study Area (Ha)	Project Area (Ha)
Fisheries (Capture)	Rivers and Khals	218	-
Aquaculture	Pond	1	21
	Shrimp Farm-cum-Salt Pan	19	-
	Shrimp Farm/Gher	28	-
Grand-total		267	21

Source: Landuse data extracted from satellite image by CEGIS and field visit, 2024

Fish Species Diversity: The dominating fish species of the open water bodies around the proposed Project site are *Lates calcarifer*, *Tenualosa ilisha*, *Mugil cephalus*, *Chanos chanos*, *Harpadon nehereus*, *Mystus gulio*, *Epinephelus* sp., *Gerres filamentosus*, *Polydactylus sextarius*, etc. Available fish species with their local name, English names are given in **Table 6.34**.

Table 6.34: A list of Fish Species Observed within the Study Area

Sl. No.	Scientific name	Local name	Common English name	IUCN Status in Bangladesh	IUCN Status
1	<i>Tenualosa ilisha</i>	Hilsa shad	Ilish	LC	Least Concern (LC) ; Date assessed: 23 January 2013
4	<i>Chanos chanos</i>	Akharul/ Chela	Milk fish	-	Least Concern (LC) ; Date assessed: 23 June 2016
5	<i>Harpadon nehereus</i>	Loitya	Bombay duck	-	Near Threatened (NT) ; Date assessed: 28 June 2018
6	<i>Mystus gulio</i>	Guilla	Long whiskers catfish	NT	Least Concern (LC) ; Date assessed: 11 August 2019
7	<i>Mugil cephalus</i>	Kharul bata	Flathead mullet	LC	Least Concern (LC) ; Date assessed: 21 December 2018
9	<i>Leiognathus brevirostris</i>	Tek chanda	Short nose pony fish	-	Not Evaluated
11	<i>Acanthopagrus latus</i>	Sada Datina	Yellow fin sea bream	-	Data deficient (DD) ; Date assessed: 03 December 2009
12	<i>Acanthopagrus berda</i>	Kala Datina	Picnic sea bream	-	Least Concern (LC) ; Date assessed: 28 June 2016
13	<i>Arius spp.</i>	Kata Machh	Threadfin sea catfish	-	DD
15	<i>Ilisha filigera</i>	Choukka	Big eye ilisha	LC	Data deficient (DD) ; Date assessed: 28 February 2017
16	<i>Scomberomorus guttatus</i>	Maitya/Surma	King Mackerel	-	Data deficient (DD); Date assessed: 04 December 2009
17	<i>Polydactylus sexfilis</i>	Lakkha	Sixfinger threadfin	-	Not Evaluated
18	<i>Johnius amblycephalus</i>	Puka/Poa	Bearded craoker	-	Least Concern (LC); Date assessed: 26 September 2018
19	<i>Scartelaos histophorus</i>	Chiring	Walking goby	LC	Least Concern (LC); Date assessed: 20 June 2017
20	<i>Lepturacanthus savala</i>	Chhuri	Savalani hairtail	-	Not Evaluated
22	<i>Pampus argenteus</i>	Foli chanda	Silver pomfret	-	Not Evaluated
23	<i>Pampus chinensis</i>	Rup Chanda	Chinese silver pomfret	-	Not Evaluated
24	<i>Acentrogobius caninus</i>	Bailla	Tropical Sand Goby	-	Least Concern (LC); Date assessed: 11 March 2015
25	<i>Polynemus paradiseus</i>	Topse	Paradise threadfin	-	Least Concern (LC); Date assessed: 21 June 2018
27	<i>Setipinna taty</i>	Teilla phasa	Scaly hairfin anchovy	LC	Least Concern (LC); Date assessed: 28 February 2017
29	<i>Coilia dussumieri</i>	Olua	Pointed tail anchovy	LC	Least Concern (LC); Date assessed: 09 February 2018
30	<i>Protonibea diacanthus</i>	Kala poa	Black spotted croaker	-	Near Threatened (NT); Date assessed: 30 July 2018
32	<i>Penaeus monodon</i>	Bagda	Giant tiger prawn	-	-
33	<i>Penaeus indicus</i>	Chaca/Sada Chingri	White shrimp	-	-

Source: CEGIS field visit, 2024

6.2.3 BFDC Harbor at Chattogram

Introduction

The Bangladesh Fisheries Development Corporation (BFDC) in Chattogram stands as a cornerstone in the country's fisheries sector, wielding immense importance in its development and sustenance. Serving as a central hub for coordination and management, BFDC facilitates the entire fisheries value chain, from the landing of fish to their processing, distribution, and export. Through its robust infrastructure, stringent quality control measures, and adoption of modern technology, BFDC ensures the maintenance of high standards in fishery operations, bolstering consumer confidence in Bangladeshi seafood products both locally and internationally. Moreover, BFDC plays a pivotal role in market expansion, employment generation, and revenue generation, thereby contributing significantly to economic growth, food security, and livelihood enhancement for millions of individuals reliant on the fisheries industry in Chattogram and beyond.

Description of the Fish Processing Plant

The Fish Processing Center of the Bangladesh Fisheries Development Corporation (BFDC) in Chattogram has been a pivotal player in the food industry since its establishment in 1966, with production commencing in 1973. Primarily geared towards export, it also caters to the national market. Key export destinations include China, Thailand, Korea, and the Middle East. Utilizing airblast and plate freezing techniques, the facility handles a diverse array of fish species, including Tongue Sole, Ribbon Fish, Cattle Fish, Squid, Octopus, Stingray, Yellow Croaker, Silver Pomfret, Red Zoes, and Indian Salmon. Additionally, it processes selected Haor fish species, such as Shoal, Boal, Catla, Taki, Tengra, Rui, other carp, and Kachki sourced from Kaptai Lake, primarily for the domestic market. With a focus on efficiency, the center minimizes waste by not gutting fish, thereby producing no byproducts. These plants annually produced around 3,360 tons, allowing for processing of 16 tons per day. An average of 30-50 contract workers, both men and women, are employed in the processing plant during the peak season. Women are usually engaged in cleaning, while men work more closely with machinery, freezing, and packaging. Additionally, there is a mini laboratory capable of quality testing.

Habitat Characterization and Assessment

Habitat Description: The trans boundary River Karnaphuli is known as the gate way of hill tracts of South Eastern Bangladesh. It holds immense importance from a fisheries perspective for several compelling reasons. Its rich biodiversity sustains a diverse array of fish species, fostering a thriving ecosystem that supports robust fisheries. The Karnaphuli River facilitates the migration of major carps during breeding season and also movement of other migratory fishes and estuarine fishes. This abundance of fish serves as a vital source of livelihood for countless communities, who rely on fishing as their primary occupation. Moreover, the economic impact of Karnaphuli's fisheries cannot be overstated, as the sale and trade of its fish contribute substantially to the local economy. Beyond mere economic value, the river's fish also play a critical role in ensuring food security, providing a significant source of protein. Additionally, the river attracts tourists and recreational anglers, further highlighting its importance beyond mere sustenance.

The study area possesses some aquaculture pond in the study area practicing extensive and semi-intensive method. some fast-growing fish species like Indian major carp, minor carp, Tilapia etc. are released in these ponds.



Figure 6.37: Fish Habitat within the Study Area

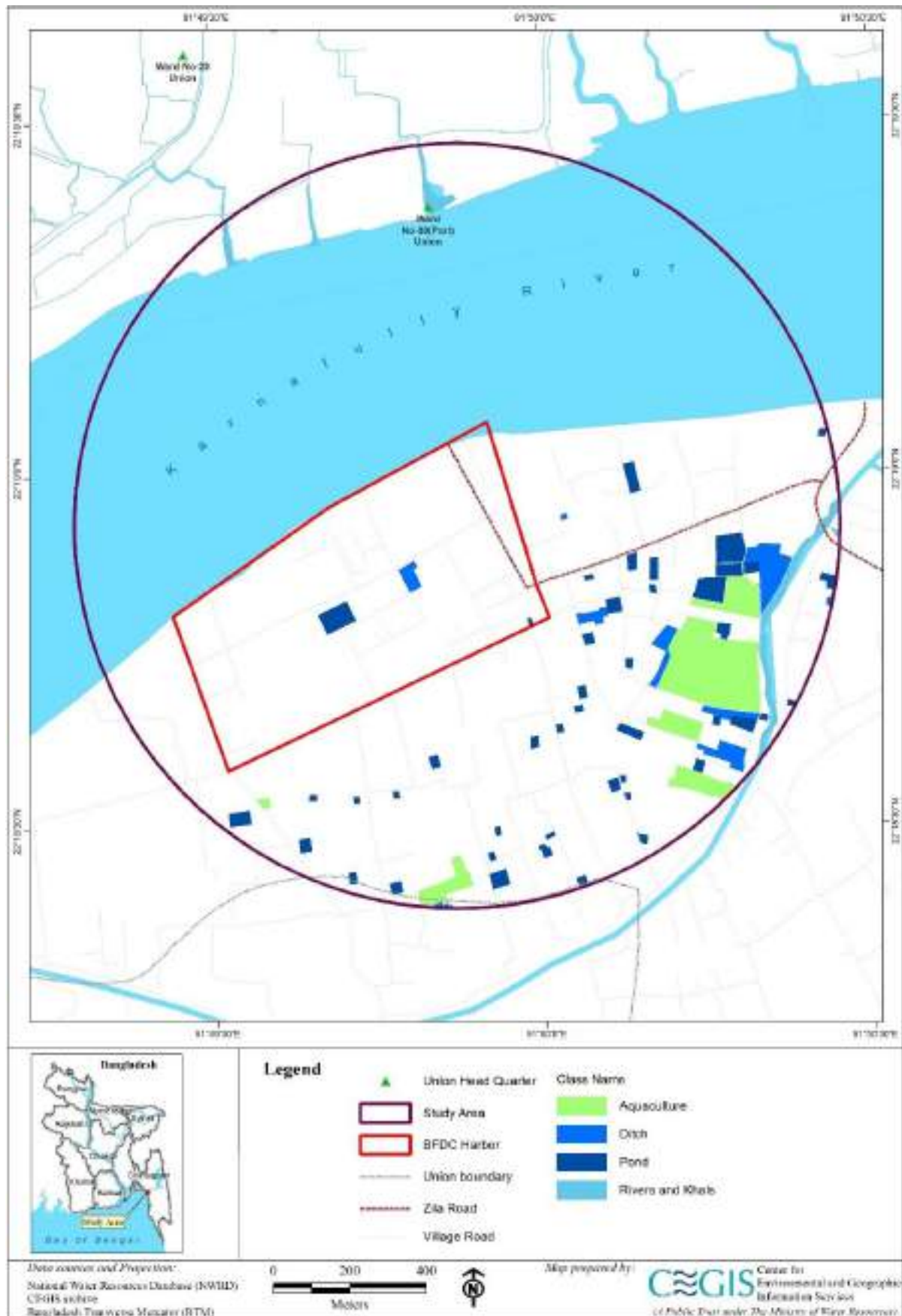


Figure 6.38: Fish Habitat in the Study Area

Habitat Assessment: Open water or Capture fishery leads the bulk of fisheries which is 88% of the study area. The estimated total fish habitat area is about 137 Ha in the study area and only one (01) Ha in the project area. Detailed habitat fragmentation is being done through land use data by remote sensing division, CEGIS. Fish habitat area in the study area is shown in **Table 6.35**.

Table 6.35: Fish Habitat Area within the Study Area

Habitat Category	Fish Habitat	Study Area (Ha)	Project Area (Ha)
Fisheries (Capture)	Karnaphuli River	121	-
Aquaculture	Semi-intensive	8	-
	Extensive	8	1.00
Grand Total		137	1.00

Source: Landuse data extracted from satellite image by CEGIS and field visit, 2024

Fish Species Diversity: The study area is rich in fish species. However, the fish species diversity appears declining trend over the years. The main reasons of declining fish species diversity are degradation of open water habitats due to siltation mostly causes by flash flood, fishing by destructive gear like gill net (Current Jal), seine net (Ber/Kona Jal) and set bag net (Bin Jal), brood fish and juvenile harvest, pollution etc. Some fish species which are found very common in the study area habitats and their conservation status is shown in **Table 6.36**.

Table 6.36: A list of Fish Species Observed within the Study Area

Sl. No.	Scientific Name	Common Name	Local Name	IUCN Status in Bangladesh	Global IUCN Status
1.	<i>Lates calcarifer</i>	White Sea bass/ Asian sea Bass/ Barramundi	Coral/Vetki	-	Least Concern (LC) ; Date assessed: 15 February 2019
2.	<i>Tenualosa ilisha</i>	Hilsa shad, Hilsa	Ilisha	LC	Least Concern (LC) ; Date assessed: 23 January 2013
3.	<i>Raconda russeliana</i>	Smooth back herring	Fatra	-	Least Concern (LC) ; Date assessed: 14 October 2019
4.	<i>Cynoglossus macrostomus</i>	Bengal tongue sole/tonguefish	Kukurjeeb	-	Vulnerable (VU); Date assessed: 16 August 2019
5.	<i>Dasyatis zugei</i>	Pale-edged Stingray /sharp-nose stingray	Saplapata	-	Vulnerable (VU); Date assessed: 28 August 2019
6.	<i>Drepane ngimana</i>	Sickle fish	Bishtara	-	-
7.	<i>Dussumieri aacuta</i>	Rainbow sardine/Common sprat	Goru mash	-	-
8.	<i>Coilia dussumieri</i>	Gold spotted grenadier anchovy	Boiragi / Olua	LC	Least Concern (LC) ; Date assessed: 09 February 2018
9.	<i>Setipinna phasa</i>	Scaly hairfin anchovy	Phasa/Mod uphasa	LC	Least Concern (LC) ; Date assessed: 04 December 2019

Sl. No.	Scientific Name	Common Name	Local Name	IUCN Status in Bangladesh	Global IUCN Status
10.	<i>Stolephorus indicus</i>	Indian/ Hardenberg's anchovy	Sea mola	-	Least Concern (LC) ; Date assessed: 02 March 2017
11.	<i>Acentrogobius cyanomos</i>	Gobi	Nunabaila	-	Least Concern (LC) ; Date assessed: 19 July 2017
12.	<i>Apocryptes bato</i>	Gobi mudskipper	Baila, Chewabele	LC	Least Concern (LC) ; Date assessed: 19 July 2017
13.	<i>Trypauchen vagina</i>	Burrowing goby	Chewa	LC	Least Concern (LC) ; Date assessed: 28 June 2018
14.	<i>Lutjanus johnii</i>	John's snapper	Ranga Choukka	-	Least Concern (LC) ; Date assessed: 05 March 2015
15.	<i>Leptomelanosoma indicum</i>	Indian threadfin	Lakkha	-	Not Evaluated
16.	<i>Polynemus paradiseus</i>	Paradise threadfin	Taposi	-	Least Concern (LC) ; Date assessed: 21 June 2018
17.	<i>Rastrelliger kanagurta</i>	Indian Mackerel	Champa	-	Least Concern (LC) ; Date assessed: 01 March 2022
18.	<i>Thunnus albacares</i>	Yellow fin tuna, Yellow finned albacore	Surma	-	Least Concern (LC) ; Date assessed: 15 January 2021
19.	<i>Johnius belangerii</i>	Belanger's croaker/Jewfish	Poa	LC	Least Concern (LC) ; Date assessed: 30 July 2019
20.	<i>Pennahia argentata</i>	Silver jaw fish	Lalpoa/ Vola fish	-	Least Concern (LC) ; Date assessed: 01 July 2016
21.	<i>Sillaginopsis domina</i>	Gangetic Sillago	Tulardanti	-	Not Evaluated
22.	<i>Pampus argenteus</i>	Silver or white pomfret	Folichanda	-	Not Evaluated
23.	<i>Pampus chinensis</i>	Chinese silver pomfret	Rupchanda	-	Not Evaluated
24.	<i>Harpadon nehereus</i>	Bombay-duck	Loitta	-	Near Threatened (NT); Date assessed: 28 June 2018
25.	<i>Lepturacanthus savala</i>	Savala hairtail	Churi	-	Not Evaluated

Source: CEGIS field visit, 2024

6.2.4 Canal Rehabilitation for Cluster Farming

Introduction

The study area presents a rich fisheries resource, offering a diverse array of habitats catering to both freshwater and saline water fish species. Vital to this ecosystem are the open water fish habitats, comprising the encompassing canals and rivers, which serve as vital route for fish migration into the study area. Amidst this thriving aquatic landscape, expansive shrimp and prawn culture farms contribute significantly to the local economy. However, these farms grapple with formidable challenges, particularly stemming from water scarcity. Issues such as morphological changes, canal siltation, and the loss of connectivity with rivers have been identified as pressing concerns. As a consequence, the impediment of water flow into the canals poses a significant disruption to fish culture activities within the region.

Problems and Issues

The problems and issues in the study area related to fisheries are mentioned below:

- Fish habitats in the dry season become critical for fish habitation.
- Canals get dried up in dry season.
- Siltation causes degradation of the canal habitats and reduce fish migration rate.
- Deterioration of water quality due to the pollutants coming from the different point and non-point sources.
- Crop cultivation is extending over across the canals.

Habitat Characterization and Assessment

Habitat Assessment: The Study area falls in the Khulna, Satkhira and Bagerhat Districts, characterized by a network of perennial and seasonal canals. The presence of both types of canals highlights the dynamic nature of the water resources in the project area, impacting both the natural environment and the livelihoods of the local communities.

In the study area, about 89% of the fish habitat area is devoted to aquaculture, while fisheries (capture) occupy only 11% of the area. The breakdown of fish habitats in the study area is provided in **Table 6.37**.

Table 6.37: Habitat Assessment within the Study Area

Habitat Category	Habitat Type	Fish Habitat Area (Ha)													
		Khulna					Satkhira				Bagerhat				
		Mora Japjopia Khal	Dohar Khal	nagkati Khal	Rajapur Khal	Bollobi Khal	Atshotobigha Khal	Magra Khal	Mahandi, Dakshkathi, and Madhobkhali Khal	Kalmeghar Khal	Andigram Khal	Dakatia and Gajdurer	Burir Khal	Kumbkhali Khal	Shoilodubi and Jibonkhalir Khal
Fisheries (Capture)	River/Canal	207	31	4	10	13	44	7	18	28	11	20	7	9	35
Sub Total		207	31	4	10	13	44	7	18	28	11	20	7	9	35
Aquaculture	Shrimp/Prawn Gher	359	74	1	259	256	969	306	526	461	38	1	0	198	33
	Homestead Pond	56	15	9	3	18	43	12	10	25	3	11	7	13	59
Sub Total		415	89	10	262	273	1,013	319	536	486	41	12	7	211	92
Grand Total		621	120	14	272	287	1057	325	554	514	52	32	14	220	126

Source: Landuse data extracted from satellite image by CEGIS and field visit, 2024

Note: The land use class, "Ditch, waterbody, and pond" are categorized as Homestead Ponds; and "Rice-cum-fish culture and Aquaculture" are categorized as Shrimp/Prawn Ghers.

Fish Habitat Description: The canals in the study area are mostly ephemeral in nature and support a medium to low variety of fish species. The major problems encountering in this area include shortage of canal water, shrinkage of water retention period and overfishing. A brief description of the canals as fish habitat is given in the following **Table 6.38**.

Table 6.38: Fish Habitat and Biodiversity of the Canals for Cluster Farming

Sl. No.	Name of the Canal	Seasonality	Data Collection Location	Fish Habitat	Fish Biodiversity
1.	Mora Jopjopia Nodi	Perennial	22°41'42.14"N 89°28'34.42"E	The Canal is perennial in nature and water flows in the canal throughout the year. During the high tide, water retains about 10-12 ft and 3 ft in low tide. This canal is connected with the Salta River. According to the statement of the local people, the canal is already silted hence water cannot enter into the canal. According to the statement of local farmers, if the canal is not re-excavated quickly, fish culture will gradually cease. There is no fisherman along with the canal.	As per local fishers' statement, fish species diversity is comparatively good. Important fish species are present in the Canal is Bagda, Horina, Galda, Parshe, Patari, Datina, Bele, Tengra. Bata, Parshe, khorshula etc.
2.	Dohar Khal	Perennial	22°53'51.65"N 89°33'17.93"E	The Dohar Khal retains water at the depth range of 4-5 ft in the monsoon whereas 1-2 ft in the dry season. Some parts of the canal are dried up. Considering the hydrological condition, the canal become unsuitable for fish during dry season due to lack of water.	During field visit, as per statement of local people, near about 10 fish species are available in the canal. Major fish species are Shing (<i>Heteropneustes fossilis</i>), Bele (<i>Glossogobius giuris</i>), Kholisha (<i>Colisa fasciatus</i>), Koi (<i>Anabas testudineus</i>), Punti (<i>Puntius sp</i>), Taki (<i>Channa punctata</i>), Bata (<i>Liza parsia</i>) etc.
3.	Nagkati Khal	Seasonal	22°52'45.71"N 89°32'5.05"E	The Canal is poor in respect of fish habitation. It is seasonal in nature even in monsoon season this canal holds minimal water (1-2ft). There is no fisherman along with the canal. Water pollution present.	The field investigation and consultation with local people the study reveals number of fish species in the canal is very minimum.
4.	Atshotobigha Khal	Perennial	22°33'16.9"N, 89°02'29.3"E	The Atshoto Bigha Khal retains water at the depth range of 4-5 ft in the monsoon whereas 0.5-1.5 ft in the dry season. Some parts of the canal are totally dried up. Considering the hydrological condition, dry season is not suitable for fish.	During field visit, as per statement of local people, very minimum fish species are available in the canal. Major fish species are Bele (<i>Glossogobius giuris</i>), Punti (<i>Puntius sp</i>) and some shell fish species
5.	Magra Khal	Perennial	22°49'15.7"N, 89°04'30.7"E	The Megra Khal retains water at the depth range of 5-6 ft in the monsoon whereas 0.5-1.5 ft in the dry season. Some parts of the canal are dried up. Most of the canal is covered with water hyacinth. Local farmers reported that, they use	During field visit, as per statement of local people, some species are available in the canal. Major fish species are Shing (<i>Heteropneustes fossilis</i>), Bele (<i>Glossogobius giuris</i>), Kholisha (<i>Colisa fasciatus</i>),

Sl. No.	Name of the Canal	Seasonality	Data Collection Location	Fish Habitat	Fish Biodiversity
				the water of this canal for aquaculture during monsoon period.	Koi (<i>Anabas testudineus</i>), Punti (<i>Puntius sp</i>), Bata (<i>Liza parsia</i>) etc.
6.	Dhaskhathi Khal	Perennial	22°45'03.7"N, 89°18'34.6"E	The Doshkathi Khal retains water at the depth range of 3-4 ft in the low tide whereas 6-7 ft in the high tide. Considering the hydrological condition, the canal can be termed as good type of fish habitat.	Spot catch was surveyed during field visit and investigated only Tengra fish is available. But the fishers reported that the name of other fish species is Bele, Chota Bele, Bagda, Horina, Chali chingri, bata etc.
7.	Mahandi Khal	Seasonal	22°44'41.9"N, 89°17'21.9"E	The origin point of the canal is in the Salta River. Half of the canal retains no water from Magh to Baishak mash and rest of the canal holds water for round the year. the lower part of the canal is remained dry for 5-6 months. During dry period, farmers do not use canal water for their gher.	Local people reported that some fish species are found in the upper and lower part of the canal. In the dry season fish richness goes down. Some important fish species of this canal is Tengra, Parshe, khorshula, Bele, Horina, chali, Kakra, Chela etc.
8.	Madhobkhali Khal (From Shalta River to Masranga Mauza/ Doani Khal)	Perennial	22°44'12.7"N, 89°18'37.0"E	Water is available in good quantities during the monsoon but it becomes very shallow during the dry season, making it a poor environment for fish to live in.	The field investigation, reveals about some important species of fish in the Canal. Such as Tengra, Parshe, Horina, khorshula, Rui, Catla, bata, Chali, Mrigal, Chota Bele, Nondi bele and some species of crab.
9.	Kalmeghar Khal	Perennial	22°19'34.2"N, 89°04'24.7"E	The Kalo Megher canal retains water at the depth range of 3-4 ft in the low tide whereas 6-7 ft in the high tide. Considering the hydrological condition, the canal can be termed as good type of fish habitat. Many farmers use this canal water for their gher.	This canal is very good source of shrimp PL. During field visit, as per statement of local fishers, available species in the canal is shell fish species (Horina, Chali chingri, Chaka, Roshni chingri, Bagda, galda) and fish species (Vetki, Datina, paira, Chela, Chota Bele, Tengra, Tilapia, Gulia, bele, Jak Bele, Parshe, Vangon, Khorshula etc.) Horina and Bagda found in large quantity from Chotro to Ashwin mash.
10.	Andigram khal	Seasonal	22°52'47.57"N 89°43'36.03"E	It is a fresh water canal. This canal become dry from Choitro Mash -Joishtho Mash. During the monsoon, water depth is about 4-5 ft. and stays around 7-8 months in the	Some small fish species are available in this canal. Such as Puti (<i>Puntius sp.</i>), Tengra (<i>Mystus vittatus</i>), Koi (<i>Anabas testudineus</i>), Taki (<i>Channa punctatus</i>), Bele (<i>Glossogobius giuris</i>) etc.

Sl. No.	Name of the Canal	Seasonality	Data Collection Location	Fish Habitat	Fish Biodiversity
				Canal. It became fully dry and covered with water hyacinth in dry season.	
11.	Gajdurer Khal	Seasonal	22°46'37.97"N 89°54'15.76"E	The Canal is poor in respect of fish habitation. Siltation present and it is seasonal in nature even in monsoon season this canal holds minimal water ranging from 2-4ft. On the other hand, this canal holds no water for 3-4 months. There is no fisherman along with the canal. Water pollution present.	The field investigation and consultation with local people the study reveals very minimum fish species in the Canal. Some fish species such as Taki, Puti, Tengra, Koi etc.
12.	Burir Khal	Seasonal	22°49'28.27"N 89°54'42.89"E	The Canal is seasonal in nature. During the monsoon, water depth is about 3-4 ft. and stays around (4-5) months from Ashar to Kartik. In dry season the canal is totally dried up.	The water quality is not so good due to different types of household waste. Very minimum fishes are available in wet season like Taki, Puti.
13.	Kumbkhali Khal	Perennial	22°35'18.52"N, 89°38'1.57"E	The canal retains water at the depth range of 1-2 ft in the low tide whereas 5-7 ft in the high tide. Some small canal is connected with this canal.	During monsoon, as per statement of local people, available species in the canal is shell fish species (Horina, Chali chingri, Chaka, Bagda, galda) and Fish species (Tengra, Chela, Chota Bele, Tilapia, Gulia, Jak Bele, Khorshula etc.).
14.	Jibon Khalir khal	Seasonal	22°36'2.14"N 89°50'43.19"E	The Canal is poor in respect of fish habitation. It is seasonal in nature even in monsoon season this canal holds only 3-5ft water. The canal is silted hence water can not enter into the canal. It holds saline water only for two months. According to the statement of local farmers, if the canal is not re-excavated quickly, fish culture will gradually cease. There is no fisherman along with the canal.	The field investigation and consultation with local people the study reveals number of fish species in the Canal is very minimum eg. Taki, shol, Puti etc.
15.	Shoilodubir Khal	Perineal	22°36'58.60"N 89°51'11.00"E	The Canal is perineal in nature and water is 7-10ft in monsoon. On the other hand, in dry season depth of the canal goes 4-5ft. This canal holds saline water from Falgun Mash to Ashar Mash. Some subsistence fisherman found near the canal. Considering the hydrological condition, the canal can be termed as good type of fish habitat.	This canal is very good source of shrimp PL. During field visit, as per statement of local people, available species in the canal is shell fish species (Horina, Chali chingri, Chaka, Roshni chingri, Bagda, galda) and fish species (Bata, Vetki, Datina, paira, Chela, Chota Bele, Tengra, Tilapia, Gulia, bele, Jak Bele, Parshe, Vangon, Khorshula etc.). Horina and Bagda found in large quantity.

Sl. No.	Name of the Canal	Seasonality	Data Collection Location	Fish Habitat	Fish Biodiversity
16.	Bollobi Khal	Perennial	22°46'14.01"N 89°38'27.12"E	This canal is Perennial in nature, holds water round the year. Average water depth is 6-8 ft in the monsoon. In dry season the canal water depth is 2-4 ft.	Some important fishes are present as reported by the local fishers and adjacent community. The available fish species in is Puti, Tengra, Koi, Guchi baim, Taki, Bata, khorshola, Tilapia etc.
17.	Char Dakatia Khal	Seasonal	22°36'23.06"N 89°51'12.82"E	The Canal is seasonal in nature. During the monsoon, water depth is about 3-4 ft. and stays around (2-3) month in the Canal. In dry season the canal is totally dried up.	The water quality is not so good due to different types of household waste. Local people stated that there is no fish during field survey.
18.	Rajapur Khal	Perinial	22°53'21.64"N 89°33'34.90"E	The canal retains water at the depth range of 1-1.5 ft in dry season whereas 3-5 ft in the monsoon period. Most of the canal is covered with water hyacinth hence, the water quality is not so good for fish.	The field investigation and consultation with local people the study reveals that, some fish species is present in this canal namely Taki, Shol, Shing, Magur, Koi, Taki, Tilapia etc.



Andigram Khal



Atshotobigha Khal



Bollobi Khal



Burir Khal



Char Dakatia Khal



Dhashkathi Khal



Dohra Khal



Shoilodubir Khal



Gajduarer Khal



Jhopjhopia Khal



Jibonkhalir Khal



Kalomegher Khal



Kumbokhalir Khal



Madhobkhali Khal



Magra Khal



Mahandi Khal



Nagkati Khal



Rajapur Khal

Figure 6.39: Partial Pictures of the Canals for Cluster Farming

Fish species biodiversity: The biodiversity of fishes is declining trend over the years. High siltation on river and canal habitat, obstruction of fish migration routes, squeezing of spawning, breeding and feeding ground, etc. are responsible for gradually declining of fish abundance and fish biodiversity.

During field visit, a total of 25 fish species has been observed through consultation with fishers and market visit. The available fish species are given below:

Table 6.39: A List of Fish Species Observed within the Study Area

SL. No.	Scientific Name	Local name	SL. No.	Scientific Name	Local name
1.	<i>Heteropneustes fossilis</i>	Shingh	14.	<i>Mugil corsula</i>	Khorsula
2.	<i>Puntius spp.</i>	Punti	15.	<i>Anabas testudineus</i>	Koi
3.	<i>Colisha fasciatus</i>	Kholisha	16.	<i>Glossogobius guiris</i>	Baila
4.	<i>Leander styliferus</i>	Icha	17.	<i>Channa punctatus</i>	Taki
5.	<i>Mystus cavasius</i>	Gulsha	18.	<i>Mastacembelus pancalus</i>	Guchi Baim
6.	<i>Penaeus monodon</i>	Bagda	19.	<i>Cyprinus carpio</i>	Karfu/Japanese
7.	<i>Metapenaeus monoceros</i>	Harina	20.	<i>Telapia mosambica</i>	Telapia
8.	<i>Penaeus indicus</i>	Chaka	21.	<i>Labeo rohita</i>	Rui
9.	<i>M. rosesbergii</i>	Golda	22.	<i>Ctenopharyngodon idella</i>	Grass carp
10.	<i>Hypophthalmichthys molitrix</i>	Silver carp	23.	<i>Pangasius hypophthalmus</i>	Pangas
11.	<i>Lates calcarifer</i>	Bhetki/Coral	24.	<i>Catla catla</i>	Catal
12.	<i>Liza parsia</i>	Bata	25.	<i>Cirrhinus mrigala</i>	Mrigel
13.	<i>Mystus spp.</i>	Tengra			

Source: Field observation

Fish Migration and Movement: Fish use internal rivers and canals as migratory pathways both longitudinally and laterally during their life cycle. Deteriorating river and canal beds significantly limit fish movement in the study area. Limited migration of fresh water fish species and other riverine brackish water fish species usually occur only in monsoon period.

Aquaculture: The project area is very important for aquaculture sector. Different types of aquaculture practices in the study area. Polyculture and monoculture both are practicing here. Most of the fish farmers in the study area uses polyculture as their main culture pattern which is very popular in this area because of its high economic significance. There are two culture type, one is for year-round fish

culture and another is for 6 months fish culture than rice culture. Fish culture is done from May-December and rice is done from January- May. During the field visit, in most of the case, shrimp culture found near the river side. Average depth of the gher/pond is 1.5ft-6ft. Although wild shrimp post-larvae (PL) are better in quality than hatchery produced PL, farmers collected PL from both sources as per availability and price. Farmers usually used inorganic fertilizers like Urea and TSP instead of organic one. The farmers mostly preferred natural feeds for cost efficiency and management purposes. During field visit, it was found that some fish farmers used floating and submerged feed for higher production.

Water availability is the main problem in the study area. Name of species culturing here is Bagda, Galda, Horina, Vetki, Tengra, Khorshola, Vangon, Rui, Catla, Tilapia, Silver carp, Grass Carp, Common carp, Bighead carp, Mrigal etc.

Fish Production: About 96% fish production comes from aquaculture and only 6% comes from fisheries (capture). The overall fish production status in the study area is shown in the following **Table 6.40**.

Table 6.40: Fish Production within the Study Area

Habitat Category	Habitat Type	Fish Production (MT)													
		Khulna					Satkhira				Bagerhat				
		Mora Japjopia Khal	Dohar Khal	nagkati Khal	Rajapur Khal	Bollobi Khal	Atshotobigha Khal	Magra Khal	Mahandi, Dakshathi, and Madhobkhali Khal	Kalmeghar Khal	Andigram Khal	Dakatia and Gajdurer	Burir Khal	Kumbkhali Khal	Shoilodubir and jibonkhalir Khal
Fisheries (Capture)	River/Canal	85	13	2	4	5	18	3	7	11	5	8	3	4	14
Sub Total		85	13	2	4	5	18	3	7	11	5	8	3	4	14
Aquaculture	Shrimp/ Prawn Gher	391	81	1	282	279	1095	346	594	521	38	1	0	196	33
	Homestead Pond	82	22	13	4	26	54	15	13	31	4	16	10	19	86
Sub Total		473	103	14	287	305	1149	361	607	552	42	17	10	215	118
Grand Total		558	115	16	291	311	1167	364	614	564	46	25	13	219	133

Fisheries Management

There is no management system in the study area. There is no fish sanctuary in the study area. Most of the catchment area have no Fishermen Community Based Organizations (FCBOs). Moreover, existing FCBOs have very limited opportunity to bring positive changes in the traditional fisheries management system. Some NGOs are working, but they are very much limited in extension services and aquaculture training.

6.3 Agricultural Resources

Agriculture is still Bangladesh's primary livelihood. The sector has a significant impact on the national economy. The baseline condition of agricultural resources has been established by collecting primary and secondary data from the study area. During the field visit, several FGDs were conducted and discussion was cropping season, farming practices, cropping patterns, crop production, crop production loss, and agricultural inputs used in different locations. These were Chakaria, Teknaf, Chattogram, and catchment area of khals. The study areas have been considered for baseline evaluation on various agriculture parameters for the ESIA study of the proposed project.

6.3.1 Farming Practices

Farming practices in the study area are largely controlled by physical, biological, climatological and socio-economic factors. There are two distinct cropping seasons in a year. They are Kharif and Rabi seasons. The Kharif season is from March to October, while the Rabi season is from November to February. Based on crop adaptability and crop culture, the Kharif season is further sub-divided into the Kharif-I (March-June) and the Kharif-II (July-October) seasons.

The Kharif-I season is characterized by high temperatures, low humidity, high evaporation, high solar radiation and uncertainty of rainfall with alternating dry and wet spells. In this season crops are not grown in the study area.

The Kharif-II season is characterized by high rainfall, lower temperatures, high humidity, low solar radiation and high floods that recede towards the end of the season. Rice is the predominant crop grown during this season due to the submergence of soil. Excessive soil moisture also restricts other crops suitable for a high temperature regime. In this season, local Aman and HYV Aman crops are grown in the study area. HYV Aman is only grown in catchment areas of Mora Jopjopia Nodi, Nagkati khal, Shoilodubir Khal and Jibon Khalir khal.

The Rabi/Boro season is favored with high solar radiation, low humidity and temperature, but lack of adequate soil moisture depresses the crop yield because of very low or even no rainfall throughout the season. In the Rabi season, HYV Boro, pulses, grass and mustard crops are grown in the study area. In khal catchment areas Boro is the major crop. Mustard is only grown in catchment areas of Nagkati khal. Pulse is grown in catchment areas of Shoilodubir Khal and Jibon Khalir Khal.

Glimpse of agricultural practice is presented in **Annex 30** under the **Volume II: Annexures of Main Report**.

6.3.2 Cropping Pattern and Intensity

The cropping patterns in the Chakaria Shrimp Estate comprises Fallow-HYV Aman-HYV Boro, followed by Fallow-HYV Aman-Fallow. BFDC's study area mainly features Fallow-HYV Aman-Pulse, followed by Fallow-HYV Aman-Fallow. In BMC's study area, no crops are cultivated. Major cropping pattern of the khal catchment areas is Fallow-Fallow-Boro. Farmers of those area used to cultivate fish during the fallow period.

Salt production stands as a significant practice in both project and study area of Chakaria Shrimp Estate and study area of BMC. The salt production areas cover around 1,517 and 2672 ha in the project and study areas of Chakaria Shrimp State, respectively, while BMC's study area comprises 19 ha allocated for salt cultivation.

The cropping intensity of the Chakaria Shrimp Estate study area and BFDC is 170% and 165%, respectively. Although cropping intensity of khal catchment areas is mostly 100% except Nagkati khal, Shoilodubir Khal and Jibon Khalir Khal where cropping intensity is 279%, 120% and 120%.

Table 6.41: Cropping Pattern and Intensity of the Study Area

Intervention Area	Fallow-Local Aman-HYV Boro	Follow-HYV Aman-HYV Boro	Follow-HYV Aman-Fallow	Follow-HYV Aman-Pulse	Follow-HYV Aman-Grass	Follow-HYV Aman-Mustard-HYV Boro	Follow-HYV Aman-Mustard	Fish-HYV Boro	Net Cropped Area	Total Cropped Area	Cropping Intensity
Chakaria Shrimp Estate											
Project Area	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
Study Area	92.60	231.51	138.90	0.00	0.00	0.00	0.00	0.00	463.01	787.12	170
BFDC											
Project Area	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0.00	0
Study Area	0.00	0.00	5.46	9.37	0.78	0.00	0.00	0.00	15.61	25.76	165
BMC											
Project Area	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0.00	0
Study Area	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0.00	0
Khals											
Atshobigha Khal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
Kalmegher Khal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	310.66	310.66	310.66	100
Magra Khal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	655.51	655.51	655.51	100
Mahandi Khal, Daskathi Khal, and Madhobkhali Khal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	228.38	228.38	228.38	100
Mora Jopjopia Nodi	0.00	0.00	1394.61	0.00	0.00	0.00	0.00	0.00	1394.61	1394.61	100
Bollobi Khal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	289.16	289.16	289.16	100
Rajapur Khal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	259.38	259.38	259.38	100
Dohar Khal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	186.04	186.04	186.04	100
Nagkati Khal	0.00	19.84	0.00	0.00	0.00	158.75	19.84	1.02	199.46	556.64	279

Intervention Area	Fallow-Local Aman-HYV Boro	Follow-HYV Aman-HYV Boro	Follow-HYV Aman-Fallow	Follow-HYV Aman-Pulse	Follow-HYV Aman-Grass	Follow-HYV Aman-Mustard-HYV Boro	Follow-HYV Aman-Mustard	Fish-HYV Boro	Net Cropped Area	Total Cropped Area	Cropping Intensity
Kumbkhali Khal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.32	5.32	5.32	100
Shoilodubir Khal, and Jibon Khalir Khal	0.00	0.00	744.69	186.17	0.00	0.00	0.00	20.81	951.67	1137.84	120
Burir Khal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	373.76	373.76	373.76	100
Andigram khal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	344.75	344.75	344.75	100
Dakatia khal, and Gajdurer Khal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	664.36	664.36	664.36	100

Source: CEGIS field visit in 2024

6.3.3 Crop Yield and Production

The total crop production was estimated using the formula: Total crop production = damage free area × normal yield + damaged area x damaged yield. Total crop production in the study area of the Chakaria Shrimp Estate is 3,019 metric tons (clean rice). In the study area of BFDC total crop production is 91.63 metric tons of which 54.79 metric tons (60%) is clean rice and non-rice is 36.84 metric tons (40%). In the khal areas total production is 1714.1 metric tons of which 1571.2 metric tons (92%) is clean rice and non-rice is 142.9 metric tons (8%). The crop yield across the study area is nearly uniform. Yields for local Aman, HYV Aman, HYV Boro, Pulse, Mustard, and Grass are approximately 1.52, 3.51, 4.87, 1.25, 0.8, and 32.2 tons/ha, respectively. Salt production in the Chakaria Shrimp Estate's project and study areas amounts to 182,076 and 140,070 metric tons, respectively, while BMC's study area yields 2,317 metric tons of salt.

Table 6.42: Crop Production of the Study Area

Intervention Area	Crop Area (ha)						Total Production (Tons)					
	Local Aman	HYV Aman	HYV Boro	Pulse	Mustard	Grass	Local Aman	HYV Aman	HYV Boro	Pulse	Mustard	Grass
Chakaria Shrimp Estate												
Project Area	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Study Area	92.60	370.41	324.11	0.00	0.00	0.00	140.76	1300.13	1578.40	0.00	0.00	0.00
BFDC												
Project Area	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Study Area	0.00	15.61	0.00	9.37	0.00	0.78	0.00	54.79	0.00	11.71	0.00	25.13
BMC												
Project Area	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Study Area	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Khals												
Atshobigha Khal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Kalmegher Khal	0.00	0.00	310.66	0.00	0.00	0.00	0.00	0.00	1512.94	0.00	0.00	0.00
Magra Khal	0.00	0.00	655.51	0.00	0.00	0.00	0.00	0.00	3192.33	0.00	0.00	0.00
Mahandi Khal, Daskathi Khal and Madhobkhali Khal	-	-	-	-	-	-	-	-	-	-	-	-
Mora Jopjopia Nodi	0.00	1394.61	0.00	0.00	0.00	0.00	0.00	4895.10	0.00	0.00	0.00	0.00
Bollobi Khal	0.00	0.00	289.16	0.00	0.00	0.00	0.00	0.00	1408.21	0.00	0.00	0.00
Rajapur Khal	0.00	0.00	259.38	0.00	0.00	0.00	0.00	0.00	1263.17	0.00	0.00	0.00
Dohar Khal	0.00	0.00	186.04	0.00	0.00	0.00	0.00	0.00	906.02	0.00	0.00	0.00
Nagkati Khal	0.00	198.44	179.61	0.00	178.59	0.00	0.00	696.51	874.72	0.00	142.87	0.00
Kumbkhali Khal	0.00	0.00	5.32	0.00	0.00	0.00	0.00	0.00	25.92	0.00	0.00	0.00

Intervention Area	Crop Area (ha)						Total Production (Tons)					
	Local Aman	HYV Aman	HYV Boro	Pulse	Mustard	Grass	Local Aman	HYV Aman	HYV Boro	Pulse	Mustard	Grass
Shoilodubir Khal, and Jibon Khalir Khal	0.00	930.86	20.81	186.17	0.00	0.00	0.00	3267.31	101.35	232.71	0.00	0.00
Burir Khal	0.00	0.00	373.76	0.00	0.00	0.00	0.00	0.00	1820.23	0.00	0.00	0.00
Andigram khal	0.00	0.00	344.75	0.00	0.00	0.00	0.00	0.00	1678.92	0.00	0.00	0.00
Dakatia khal, and Gajdurer Khal	0.00	0.00	664.36	0.00	0.00	0.00	0.00	0.00	3235.44	0.00	0.00	0.00

Source: CEGIS field visit in 2024

6.3.4 Irrigation Status

Irrigation coverage of the study area of Chakaria Shrimp Estate is about 70% of the total NCA during the dry season whereas in BFDC study area no irrigated crop is grow. Mostly surface water are the sources of irrigation in the study area. Surface water is mainly used for HYV Boro cultivation. The sources of surface water irrigation are pond, Khals, small rivers and ditches in the study area. Mainly Shallow Tube Wells (STWs) are being used for lifting groundwater for irrigation purposes. T. Aman crops are grown fully under rain-fed conditions whereas pulse, mustard and grass required no external irrigation. In the khal areas the irrigation is mainly carried out from surface water.

6.3.5 Crop Production Constraint

The main constraints of crop production in the study area are scarcity of irrigation water during the dry season, heavy rainfall, and drainage congestion. Pest and disease infestation etc. also affect normal crop production to some extent.

6.4 Livestock Resources

The livestock resources were prepared based on primary information. Data on Livestock and poultry resources including fodder and diseases were collected from local people during field visit through several FGDs in different locations. These were Chakaria, Teknaf, Chattogram, and catchment areas of khals.

6.4.1 Population and Fodder

According to the locals, cattle, buffalo, goats, chickens and ducks are reared in the study area. Moreover, livestock owners of the study area are facing problems regarding the availability of feed and fodder during the monsoon season due to the non-availability of grazing land. During the monsoon season (July-October), most of the area remains underwater, and Aman rice remains in the field, where rice straw/rice hay is the only source of fodder. The poultry and duck population at the family level survive by scavenging; generally, no feed supplements are provided. However, the livestock and poultry farmers use readymade feed from the union/village level market. Some glimpse of livestock population in the overall study area is presented in **Figure 5.40**.



Figure 6.40: Glimpse of Livestock within the Study Area

6.4.2 Livestock and Poultry Diseases

Productions of livestock and poultry are mainly constrained due to diseases and the population's death. The outbreak of disease is causing a considerable economic loss in livestock farming. The most vulnerable period is between July and October (rainy season) for spreading diseases to livestock and poultry populations. The duck plague generally occurs in summer. However, some diseases are found around the year. During monsoon season, the soggy condition of the animal shelter promotes various kinds of diseases to the bullocks and cows. Moreover, the unhygienic condition of the courtyards during this season may increase the number of diseases in poultry birds (**Table 6.43**).

Table 6.43: Livestock Diseases in the Study Area

Name of Livestock and poultry	Name of Diseases	Disease (Timing)	Causes
Cow/Bullock	FMD	May to July	Viral
	Mastitis	June to September	Indigestion
Buffalo	Parasitic Disease	All year round	Bacterial
Goat	PPR	June to September	Helminth
	Pneumonia	All year round	Viral
Sheep	PPR	May to September	Bacterial
Duck	Plague	September to December	Viral
	Cholera	All year round	Viral
Chicken	New castle	All year round	Viral
	Foul Pox	March to July	Viral

Source: CEGIS field visit in 2024

7. Description of Baseline Scenario of Socio-Economic Environment

This Chapter takes into account the socio-economic baseline conditions of four different areas which are part of the "Sustainable Coastal and Marine Fisheries Project (SCMFP)". Social and economic data have been extracted from both primary and secondary sources. Secondary sources. For secondary sources, union wise data was used from Population and Housing Census, 2022. However, some of the data were unavailable up to union level, hence, upazila level data were used in such cases. BBS 2011 was also used for few sectors for instance, enrollment and gender wise attendance in school as it was not available in Population and Housing Census, 2022. For poverty data, Poverty Maps of Bangladesh 2016 was used. Primary data were collected using Focus Group Discussions (FGDs), Rapid Rural Appraisals (RRA), and Key Informant Interviews (KIIs).

7.1 Administrative Area and Location

The project is divided into 4 Sub-Projects, such as (a) Rehabilitation of 10 and 11-acre CSE which is administratively located in Chakaria and Maheshkhali upazilas (b) Implementation of a Brood Management Center (BMC) at DFTC under Teknaf paurashava and Teknaf upazila (c) Development Works for Sustainable Management of BFDC Harbor at Chattogram, under Chattogram City Corporation area and Karnaphuli upazila and (d) Rehabilitation of Canals for cluster farming under Khulna, Bagerhat and Satkhira Districts. The total study area of 4 subprojects covered 32 unions of different districts, 5 wards under Chattogram City Corporation and 5 wards under Teknaf paurashava. The study has been conducted within the study areas which have been considered the Project influenced areas under each sub-project (Ref. to the **Table 4.5** under **Section 4.12**). The total study area of the project is about 198.4 Square km. Details of the study area is presented in the **Table 7.1** below:

Table 7.1: Administrative Area of the Sub-Projects

Districts	Upazila	Unions/paurashava	Union Coverage (%)
CSE			
Cox's Bazar	Chakaria	Badarkhali	13.71
		Chiringa	20.83
		Pashchim Bara Bheola	3.56
		Saharbil	75.64
	Maheshkhali	Saflapur	3.63
BMC Area at DFTC, Teknaf			
Cox's Bazar	Teknaf	Teknaf	1.61
	Teknaf Pourashava	Ward No. 01	74.63
		Ward No. 02	91.79
		Ward No. 03	77.10
		Ward No. 04	1.04
		Ward No. 07	46.82
BFDC Harbor at Chattagram			
Chattogram	Karnaphuli	Char Patharghata	31.25
	Sadarghat	Ward No. 28	19.17
		Ward No. 29	35.00
		Ward No. 30	41.97

Districts	Upazila	Unions/paurashava	Union Coverage (%)
		Ward No. 31	35.66
		Ward No. 33	27.89
Canals Rehabilitation for Cluster Farming			
Bagerhat	Chitalmari	Char Baniari	40.96
		Hizla	15.07
		Kalatala	5.47
	Kachua	Badhal	20.37
		Gopalpur	35.02
		Kachua	12.76
		Raripara	50.89
	Mollahat	Gangni	29.49
	Rampal	Rampal	8.11
Khulna	Batiaghata	Batiaghata	12.00
		Gangarampur	23.88
		Surkhali	14.80
	Dighalia	Dighalia	41.99
		Senhati	7.74
Satkhira	Debhata	Naoapara	40.24
		Parulia	26.91
		Sakhipur	21.46
	Kalaroa	Jallabad	8.42
		Kalia	23.82
	Kaliganj	Nalta	5.44
	Satkhira Sadar	Balli	19.95
	Shyamnagar	Bhurulia	20.51
		Shyamnagar	15.41
	Tala	Dhandia	4.44
		Khalilnagar	18.52

Source: CEGIS

7.2 Demographic Profile of the Study Area

According to Population and Housing Census 2022 data, population within the Study areas of the sub-project sites are around 29,430; 12,859; 52,253; and 41,51,24 under the CSE at Chakaria, Cox's Bazar; BMC area at DFTC, Teknaf; BFDC Harbor at Chattogram; and within the catchment of the selected canals under canal rehabilitation for cluster farming under Khulna, Satkhira, and Bagerhat Districts. The sex ratio of the overall study area is 97.7. In the study area, the average household size is 4.5 and the projected total number of households is 12,01,93. **Table 7.2** presents the demographic characteristics of the study area, including the total number of households, population by gender, male-to-female ratio and household size.

During the field visit, no households were observed in the BMC and BFDC project areas, as these Sub-project sites are owned by the Proponent. However, according to the field observation and findings of the various formal and informal consultation, around 150 numbers of households were currently present within the CSE. On the other hand, around 25 households were observed on the banks of the

selected eighteen (18) canals, those are selected for rehabilitation for cluster farming under Khulna, Satkhira, and Bagerhat Districts.

Table 7.2 shows the demographic characteristics of the study areas of the sub-projects.

Table 7.2: Demographic Characteristics of the Study Area of the Sub-Projects

Study area	Households (nos.)	Population			Household size	Sex ratio
		Total	Male	Female		
Chakaria Shrimp Estate	5,973	29,430	50.4	49.6	4.8	99.2
Brood Management Center	2,631	12,859	50.3	49.7	4.9	97.4
BFDC Harbor at Chattogram	12,499	52,253	52.0	48.0	4.2	92.1
Canal Rehabilitation for Cluster Farming	99,090	4,15,124	49.9	50.1	3.9	102.1
Total/average	1,20,193	5,09,666	50.7	49.3	4.5	97.7

Source: Population and Housing Census, 2022

7.2.1 Age Composition

Union wise data for age group was not found in Population & Housing Census 2022 which is why Upazila data has been used for this section. According to Population & Housing Census 2022 (Upazila), 63.3% of the total population in the study area belongs to the working group aged 15-65 years old. 32.3% and 4.4% of the population belongs to the 0-14 years and 65 years and above years old group respectively. These two groups are considered as the dependent group. The average dependency ratio is 58.7%.

Table 7.3: Percentage of Population in the Age Group

Study area	0-14	15-65	65 years and above
Chakaria Shrimp Estate	35.7	60.4	3.9
Brood Management Center	38.3	58.9	2.8
BFDC Harbor at Chattogram	30.0	66.1	3.9
Canal Rehabilitation for Cluster Farming	25.0	68.0	7.0
Average	32.3	63.3	4.4

Source: Population and Housing Census, 2022

7.3 Livelihoods

7.3.1 Employment Status

According to Population and Housing Census 2022 data, the employment status of the study areas of CSE, Brood Management Center, BFDC Harbor in Chattogram and canal rehabilitation project in Khulna, Bagerhat and Satkhira are 31.1%, 31.1%, 39.6% and 34.3 of the population, respectively. 26.7% population on average are involved in household work and 1.3% on average are looking for work. 41.1% population in CSE, 41.9% in BMC, 36.9% in BFDC and 31.9% in Canal rehabilitation do not work which indicates a large portion are not involved in income generating activities.

During field visit it has been observed that, the locals are unable to get lease from DoF or launch an own business in shrimp estate area due to a lack of financial resources. As a result, the locals labor as cultivators and the outsiders gets the chance to obtain leases. The locals are mostly working as labor and contractual workers.

Table 7.4: Employment Status of the Study Area

Study area	Employed	Household work	Looking for work	Do not work
Chakaria Shrimp Estate	31.1	26.5	1.3	41.1
Brood Management Center	31.1	26.0	1.1	41.9
BFDC Harbor at Chattogram	39.6	22.5	1.0	36.9
Canal Rehabilitation for Cluster Farming	34.3	32.0	1.8	31.9

Source: Population and Housing Census, 2022

7.3.2 Field of Activity

The primary source of income for the households in the study area is agriculture and service. According to the Population and Housing Census, 2022, about 55.5% of households in the study area of CSE are involved in the agricultural sector and 37.5% involved in service sector, while 66.2% of households in the study area of BFDC harbor at Chattogram are involved in the service sector and only 4.7% in agriculture.

During field visit it was found that the majority of the CSE's residents work in the fishery sectors. The majority of labors are employed in agriculture and fishery, salt production, and shrimp farming. According to locals, almost 95% of the population works in salt pans and fisheries. The production of salt is a seasonal activity that usually takes place in the dry months when there is sufficient sunshine for evaporation. Salt is cultivated for three months. Subsequently, the proprietor and cultivators split the product equally. It provides people in the area employment opportunities, especially during the salt harvesting season and it supports the local economy. The producers of salt believe that their industry is more lucrative than that of shrimp. In shrimp and salt pan, males are the main working force and the local people are employed as labor in this estate. They are appointed as a sentry for shrimp cultivation and gets Tk. 10,000 monthly as salary. However, majority of the population in the BMC and BFDC study areas are now involved in service sector. In the canal rehabilitation area under Khulna, Bagerhat and Satkhira districts most of the people are involved in Shrimp cultivation and agriculture. There are lot of gher in the Bagerhat and Satkhira areas.

Table 7.5: Major Field of Activity in the Study Area

Study area	Agriculture	Industry	Service
Chakaria Shrimp Estate	70.9	3.1	26.0
Brood Management Center	14.8	18.0	67.2
BFDC Harbor at Chattogram	3.7	27.6	68.8
Canal rehabilitation	69.1	9.5	21.5

Source: Population and Housing Census, 2022

Availability of Labor and Wage Rate

Male agricultural labors are more readily available than female labors in the project region because female work is not much appreciated in the study area. The agricultural labors in the study area are paid between BDT 700 and 800 per day while workers for non-farm labors are paid BDT 1,000 per day.

7.4 Land Holding and Tenure

7.4.1 Land Holding and Tenure Procedures of CSE

Ref. to **Section 4.6.1** under **Chapter 4** of this Report, currently, the lease system status is on the third stage. The Department of Fisheries has granted the lessee a lease on the land as per the government lease rule. Generally, rich people lease property from the fisheries department and hire local labor. The issue is that these people frequently come from different areas, which might lead to an imbalance in the outsider-insider dynamic. The agreement contains no clause stating that only residents of this area will be eligible to apply for a lease. During the field visit, it was found that the primary landowner had handed the lands to locals in exchange of cash. The local tenants use the land by sharing it with others. In similar way it has also been found in secondary and tertiary levels. The historical background of the land holding issues under this sub-project is given in **Section 4.6.1**.

On the other hand, the activities under the BFDC harbor at Chattogram, and Brood Management Center sub-projects would be implemented within their own premises. Hence, no land-related issues were observed for these sub-projects.

7.5 Education

7.5.1 Literacy

The following table represents the literacy status of the study area. According to Population and Housing Census 2022, the average literacy rate of the study area is 76.2 which is higher than the national rate 74.66%. The average male literacy rate is 78.3% and female is 74.1% showcasing more male literates compared to female. Highest literacy rate was found in FBDC Harbor and lowest in BMC.

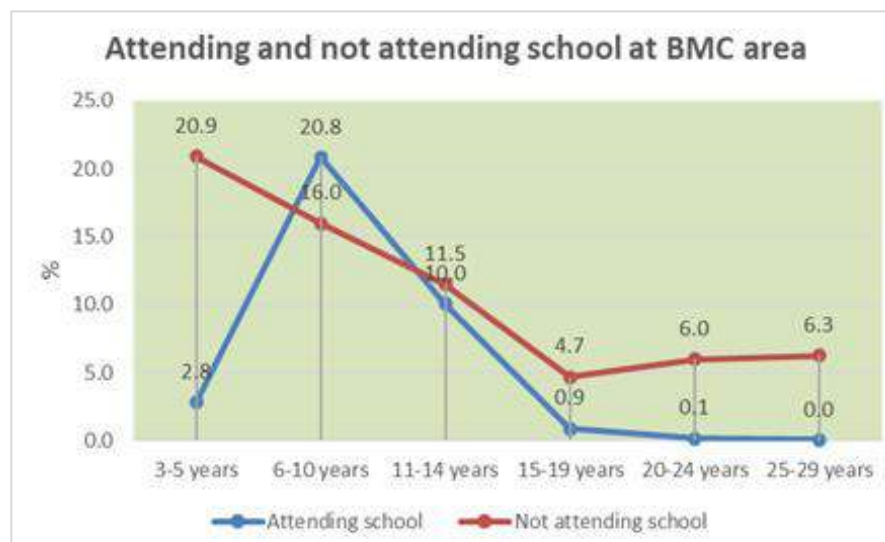
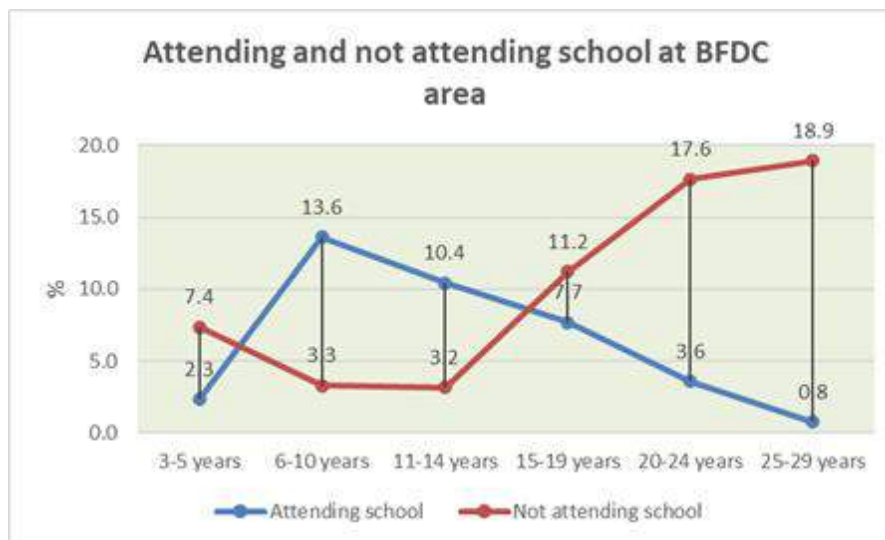
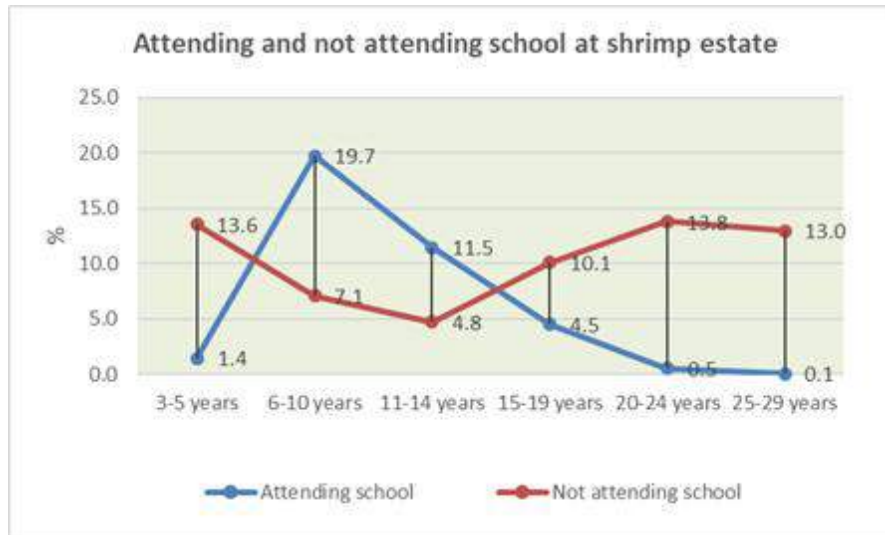
Table 7.6: Literacy Rate within the Study Area

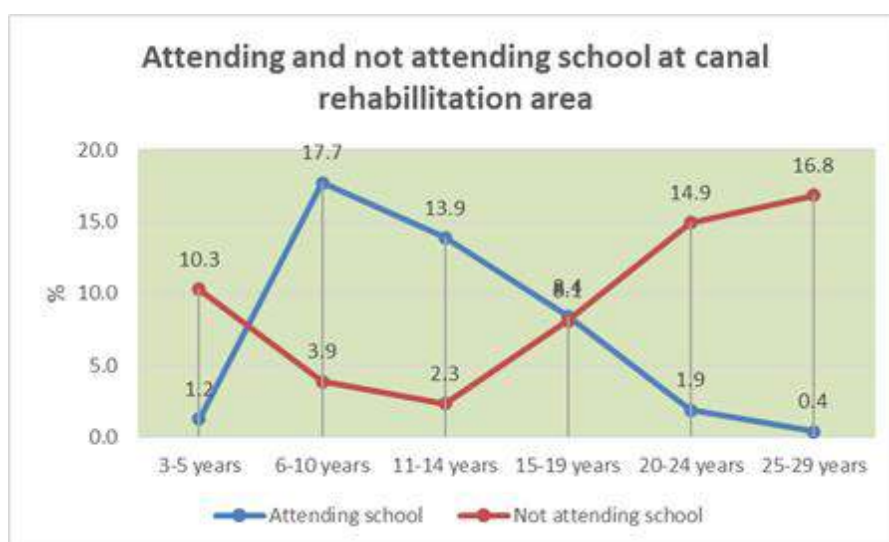
Study area	Male	Female	Total
Chakaria Shrimp Estate	70.3	72.3	71.3
Brood Management Center	74.1	63.7	69.0
BFDC Harbor at Chattogram	87.4	84.3	85.9
Canal Rehabilitation for Cluster Farming	81.2	76.0	78.6
Average	78.3	74.1	76.2

Source: Population and Housing Census, 2022

Enrolment

For enrollment related data, BBS 2011 was used. **Figure 7.1** shows the attending and non-attending status of the study area. The percentage of students in the study area who are enrolled in school at the age range of 6 to 10 is high. The percentage of students who are attending in school in the 15-to-19-year age group is very low in the BMC study area, and has decreased more rapidly than in the other study areas. This indicates that the BMC study area has a higher percentage of dropouts starting at the age of 15. They have the lack of capacity to pursue further education, thus they work in a variety of industries and service sectors throughout that period. The overall data indicates that while most of the students in the study area complete their high school/SSC level, but do not complete their college level or higher education. Since Chattogram City Corporation, an urban area, comprises the majority of the BFDC study area, the category of attending school is relatively high. They are willing and have the chance to pursue higher education.





Source: BBS, 2011

Figure 7.1: Portrayal of School Attending and Not Attending Rate in terms of Age Groups

7.6 Living Standards

7.6.1 Housing Condition

According to Population and Housing Census 2022, housing condition of the study area is mostly Kancha (39.6%), followed by Pucca (31.1%). Highest number of Kancha house can be observed across CSE which 61.6% and highest number of Jhupri (16.9%) in BMC. BFDC Harbor has the highest number of Pucca houses which is 72%.

During the field visit, no households were found within the BMC and BFDC sub-Project area, as the land is entirely owned by the government and are being operated by DoF. Rampur's 48-acre shrimp estate contains few sheds and some residential buildings, as stated by the locals. The majority of houses have bamboo fences, mud floors, and tin roofs. The primary uses of these buildings are as guard sheds and homes. These buildings are not particularly strong and are highly vulnerable to weather-related risks. **Table 7.7** shows the household structure within the study area.

Table 7.7: Housing condition within the Study Area

Study area	Type of Structure			
	Pucca	Semi-pucca	Kancha	Jhupri
Chakaria Shrimp Estate	13.3	13.6	61.6	11.5
Brood Management Center	19.0	33.0	31.1	16.9
BFDC Harbor at Chattogram	72.0	20.6	6.8	0.7
Canal Rehabilitation for Cluster Farming	20.2	19.3	59.0	1.5
Average	31.1	21.6	39.6	7.7

Source: Population and Housing Census, 2022

7.6.2 Drinking Water

According to Population and Housing Census 2022, all the study areas (except BFDC heavily depends on tube well. The households in BFDC are highly dependent on Tap/pipe supply water which is 87.1%. 99.4% of the households depends on tube well as source of drinking water. 11.2% of the households

in BMC are dependent on Well showcasing that still some households are reliant on old tradition source. 18.4% of the households in Canal Rehabilitation project area are dependent on Pond/ River/ Canal/ Lake.

According to the residents of the study area, the average depth at which groundwater is suitable for drinking is between 750 and 800 feet. However, there aren't sufficient for them.

Table 7.8: Drinking Water Facility within the Study Area

Study area	Source of Drinking Water							
	Tap/ Pipe (Supply)	Tube-well (Deep/ Shallow)	Bottled/ Jar Water	Well	Pond/ River/ Canal/ Lake	Spring	Rain Water	Others
Chakaria Shrimp Estate	0.0	99.4	0.5	0.0	0.1	0.0	0.0	0.4
Brood Management Center	1.0	81.0	7.1	11.2	0.3	2.2	0.0	0.1
BFDC Harbor at Chattogram	87.1	11.9	0.9	0.0	0.8	0.0	0.0	0.0
Canal Rehabilitation for Cluster Farming	7.4	69.5	10.4	0.8	18.4	0.0	4.2	0.2

Source: Population and Housing Census, 2022

7.6.3 Sanitation Facility

Table 7.9 shows the sanitation facilities available to the study families in the project. According to Population and Housing Census 2022, toilet facility has been divided into six different categories and majority of the households across all study areas can be seen using Safe Disposal with Flushing/Pouring Water.

During a field visit, it was discovered that the BFDC and Brood Management Center's overall sanitation facilities are moderate and while that in the CSE area are not satisfactory.

Table 7.9: Sanitation Facility within the Study Area

Study area	Toilet Facilities					
	Safe Disposal with Flushing/ Pouring Water	Unsafe Disposal with Flushing/ Pouring Water	Pit Latrine with Slab/ Ventilated Improved Latrine/ Composting Latrine	Pit Latrine without Slab/ Open Pit	Raw/Open/ Hanging Latrine (Permanent/ Temporary)	Open Defecation/ No Latrine Available
Chakaria Shrimp Estate	37.9	22.0	16.0	9.7	12.3	2.1
Brood Management Center	63.4	14.2	8.6	5.8	12.0	1.6
BFDC Harbor at Chattogram	88.3	6.8	3.8	0.8	0.7	0.1
Canal Rehabilitation for Cluster Farming	52.7	12.9	28.1	3.3	2.7	0.4

Source: Population and Housing Census, 2022

7.6.4 Electricity Coverage

The electricity connection status in each of the subproject locations is displayed in the figure below. According to Population and Housing Census 2022, all the study areas have very decent electricity coverage. At most all the households (99.9%) in BFDC study area have access to electricity. 1.1% of the households in CSE relies on solar power and 2.6% of the households do not have any source of electricity.

Table 7.10: Sources of Electricity Coverage in the Study Area

Study area	Main Source of Electricity				No Electricity
	Total	National Grid	Solar Power	Others	
Chakaria Shrimp Estate	97.4	95.8	1.1	0.5	2.6
Brood Management Center	98.6	97.9	0.4	0.7	1.6
BFDC Harbor at Chattogram	99.9	99.8	0.1	0.2	0.1
Canal Rehabilitation for Cluster Farming	99.3	98.8	0.4	0.2	0.7

Source: Population and Housing Census, 2022

7.6.5 Health Condition

The primary healthcare facility for the residents of the CSE study area is the Upazila Sadar Hospital. The healthcare facility of Teknaf Upazila Sadar Hospital and Brood Management Center and canal rehabilitation areas shares the same. The people are mostly dependent on upazila hospital and medical/family welfare center. However, the BFDC region is very close to Chattogram city, as such the individuals may easily obtain the medical care provided by trained doctors. The health facility can be reached through an effective communication system. Because of which, this area is better in having health care than those in Chakaria and Teknaf. According to data obtained from the upazila office, it is found that, there are 15 family planning centers and 43 health subcenters in the Chakaria upazila.

7.7 Poverty

7.7.1 Poverty Rate Index

Union wise poverty data was not available in Poverty Map of Bangladesh 2016 which is why Upazila data was used for this assessment. Based on the data, it can be seen that the BMC has the highest Head Count Ratio which is 30% and Canal Rehabilitation has the lowest which is 19.7%.

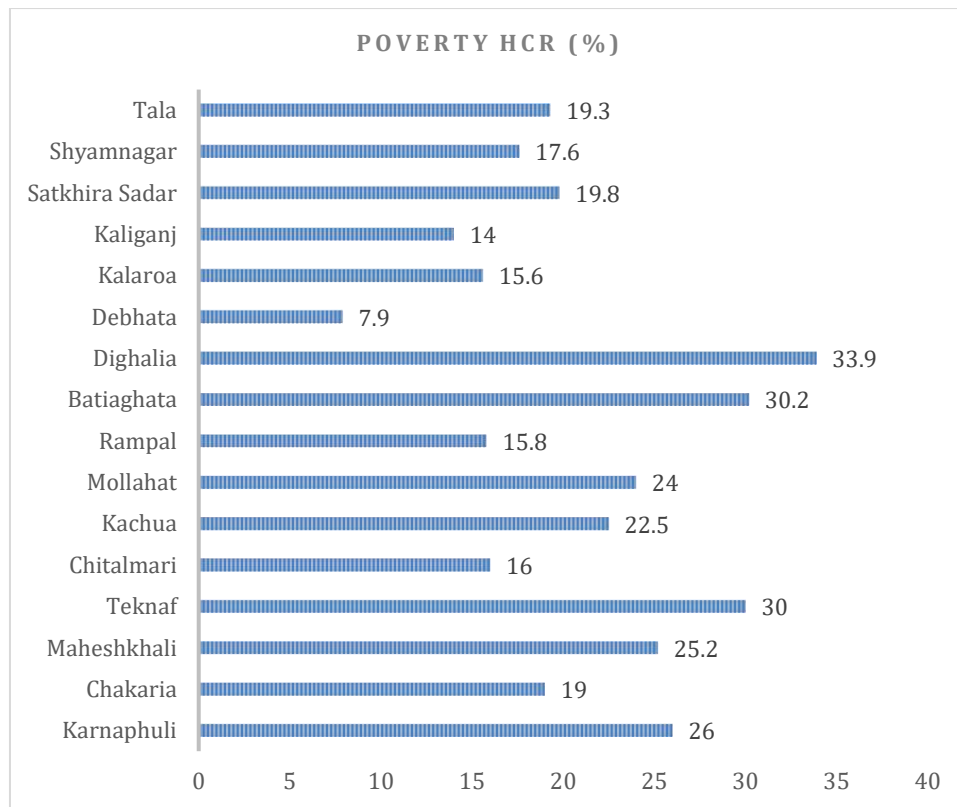
Table 7.11: Poverty Status in the Study Area

Study area	HCR (%)
Chakaria Shrimp Estate	22.1
Brood Management Center	30
BFDC Harbor at Chattogram	26
Canal Rehabilitation for Cluster Farming	19.7

Source: Poverty Map of Bangladesh, 2016

Following graph represent the poverty scenario of the upazilas that are under the study area. According to Poverty Map of Bangladesh, 2016, Dighalia Upazila has the highest poverty HCR which is 33.9% which is higher than the national (24.3%) and Debhata Upazila has the lowest which is 7.9%. Other than Dighalia, Batiaghata, Teknaf, Maheshkhali and Karnaphuli Upazila also has higher poverty HCR compared to the national. During field visit it has been found that, in CSE, fishing and shrimp

farming are the two main forms of employment. Wealthy entrepreneurs lease land for shrimp farming, with locals working as essential labor. There aren't much occupational career options available to them. Additionally, the primary occupations in the BFDC Harbor region and the Brood Management facility were in service. As a result, service groups have higher income levels than labor groups.



Source: Poverty Map of Bangladesh, 2016

Figure 7.2: Poverty Status in Study Area

7.8 Social Safety Nets

The concerned government organizations (GOs) and the local and national non-government organizations (NGOs) are working mainly to alleviate poverty in the study area. In order to ensure the social safety nets for the poor, the upazila-based various departments e.g. Project Implementation Office (PIO), Social Services Office (SSO), Women Affairs Office (WAO), Bangladesh Rural Development Board (BRDB), Secondary Education Office (SEO) etc. are serving their national programs as well as different disaster management programs considering the local needs. These programs are implemented through respective Union Parishads under the guidance of the concerned upazila offices. The major programs are the Food for Education/Cash for Education, Integrated Poverty Reduction Program, Old Age Allowance (Boyoska Bhata), Food/Taka for Work (F/TFW) etc. These programs created food security as well as social safety nets among the targeted poor households/vulnerable communities. Various NGOs are also active in this area. The respondents stated that, 80% of the population receives loans from BRAC, ASA, BURO Bangladesh, Coast, Prottashi, and Grameen Bank, among other NGOs those operate in this area.

7.9 Social Facilities/ Amenities

7.9.1 Road Network

The CSE project location is not accessible by road. Products from the project area are first dumped at the bazaars in Badarkhali or Choarfari. After that, a truck or other vehicle are used to transport them to different other places. On the other hand, the BMC and BFDC Harbor can be easily reached by roadway. The Cox's Bazar marine drive route makes it easy to reach BMC in Teknaf, and from which a variety of vehicles are found available to travel. Due to BFDC Harbor's close proximity to Chittagong City Corporation, access to the road network is easy.

7.9.2 Navigation Route

The waterway is the only access point to the CSE project region. The Matamuhuri River's channel and the Badarkhali area provide access to this area. After crossing a river, the site becomes easy accessible from Badarkhail Bazar. BMC is close to the Naf River and access from this location is not crucial. Also, the BFDC campus is directly next to the Karnaphuli River. Therefore, the Karnaphuli River could be used for transportation at any situation.

The only way to go to the CSE project area is waterway. This area is accessible from the channel of Matamuhuri River and Badarkhali area. It is easily accessible from the Badarkhail Bazar after crossing a river. The BMC is adjacent to the Naf River but it is not important to get access from here. Again, Karnaphuli River is just beside the BFDC campus. As such, Karnaphuli River could be a way of transportation and for any other purpose.

7.9.3 Markets

The nearby main market of the CSE project area is Badarkhali Bazar. This market has significance for the people of this area. There is a fish landing center in this area namely Choarfari Bazar. Fish captured from the nearby areas is dumped in this market. For BMC Teknaf sadar is the main market. There are also some small markets in this area. Upazila data indicates that, there are 13 nos. markets in this upazila. And for BFDC area the local big fish market is Fishery ghat which is just opposite to the BFDC harbor.

7.9.4 Cyclone Shelters and Others

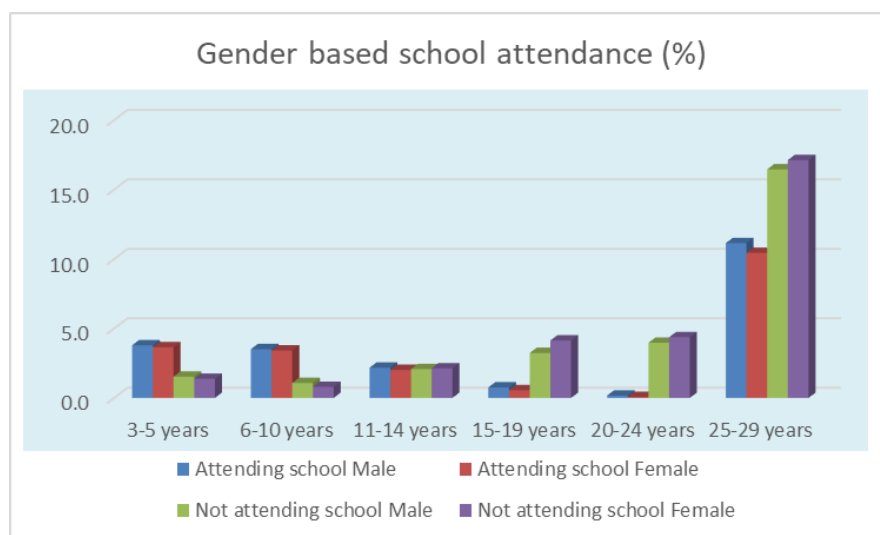
Upazila data shows that, there are 51 nos. of cyclone centers in Teknaf upazila and 84 nos. in the Chakaria upazila. But the local people opined that, the overall condition of the cyclone centers are not satisfactory. Moreover, the number of the cyclone centers is insufficient. There are two Mujib Killas in the Saharbil union which are used as shelters for the cattle during natural hazards.

7.10 Gender Issues

The demography of women population including the girl children; the restriction on women mobility; male-female discrimination which includes the right to live free from violence; to get the highest attainable standard of physical and mental health; to earn an equal wage; to be educated; to own property; to vote etc., mortality, health & nutrition, and girl education etc. are the main gender issues and concerns in the study area. Overall, 2,53,961 nos. of females are living in the study area. This indicates about 49.3% of the population as a whole. The sex ratio is 97.7. The literacy rate for women is 74.08%, but the literacy rate for men is 78.27%. A higher percentage of girls (17.1%) compared to boys (16.5%) stop attending school by age 19 due to financial constraints or early marriage [BBS, 2019]. Women's employment rate is 4.8%, significantly lower than men's 29.3% (Population and Housing Census 2022). However, among household workers, women cover 25.8% and men cover

0.9% (Population and Housing Census 2022). The women in the Cox's Bazar and Chattogram region do not feel comfortable to work outside of their homes. Women have limited access to financial resources, relying mostly on microfinance, which is often insufficient for larger entrepreneurial ventures. Most credit facilities are utilized by men. As a result, they mainly remain at home and work there (rearing of livestock, child care, household chores activities, fish net woven etc.). In comparison to other parts of Cox's Bazar, the women's group in Chakaria reported less occurrences of gender-based violence. Within the family, women usually make primary family decisions. The male members share especially the family related issues with women. Household head usually consult with other family members before taking any decision. Now a day, early marriage and the dower system are somewhat rare. They can obtain medical facilities from the adjacent health centers. The women in the districts of Bagerhat, Khulna, and Satkhira in southwest Bangladesh, work in a variety of income-generating occupations, have expressed willing to work harder.

The following figure shows the total school attendance status throughout the four subproject areas. Male and female enrollment in schools is almost equal between the ages of three & five and six & ten. Between the ages of 15 & 19, the percentage of people not attending school is higher (4.1%). It is due to the family's financial hardship and especially for girl's the percentage drops due to early marriage. At this age, they start helping in domestic chores. Women make up a somewhat higher percentage of those who do not attend (17.1%) than do men (16.5%). The government's numbers of education initiatives, women's awareness, and family desire had supported the spread of female education in those areas.



Source: BBS, 2011

Figure 7.3: Gender based School Attendance

The women mobility for various socio-economic activities is moderately restricted either by religious or social point of view. Talking with women reveals that, at present they do not experience male-female discrimination in areas such as marriage, healthcare, or education. Mortality rate of the pregnant mother during delivery period is declining in the area. The rising consciousness among the local people as well as the health services provided by the public and other health centers including the programmes of NGOs decreased the mortality rate. Maternal mortality rates are declining, but access to healthcare remains limited, especially in remote areas. Only 12% of households in CSE use hygienic latrines [WorldFish, 2020]. Women in coastal communities are 14 times more likely than men to die during natural disasters [UNDP, 2016]. The healthcare center is far away from the project area which is risky for the pregnant women. Although maternal mortality rates are declining, access to healthcare is limited, particularly in remote areas. This poses a significant risk for pregnant women,

especially in emergencies and with poor sanitation and water quality issues. Only 12% of households in CSE use hygienic latrines, posing serious health risks, particularly for women and children. Increasing temperatures and deteriorating water quality due to climate change threaten shrimp farming, with women, heavily involved in cluster farming, being particularly vulnerable. The overall condition in these aspects is moderate in the BFDC Harbor study area.

Women make up approximately 50-80% of the workforce in the post-harvest fisheries sector, including processing, drying, and marketing fish products, yet their contributions are often undervalued and underreported [WorldFish, 2018; FAO, 2017]. The fisheries sector in Bangladesh employs around 1.4 million people, with about 10% being women, although this likely underestimates their involvement due to informal and unrecognized work [FAO, 2020]

Women in the fisheries sector typically earn 20-30% less than men, primarily due to their concentration in lower-paying roles, such as fish processing and marketing [FAO, 2018; WorldFish, 2018]. Additionally, only 5-10% of women in coastal fishing communities have access to formal credit facilities, compared to 15-20% of men [IFPRI, 2019].

More than 50% of women and girls in Cox's Bazar have experienced some form of GBV, including domestic violence, sexual assault, and early marriage. Among Rohingya refugee women, the rates are even higher, with 73% reporting experiences of GBV since their arrival in Bangladesh [UN Women in 2020]. GBV is significantly underreported in Cox's Bazar due to stigma, fear of retaliation, and lack of access to safe reporting mechanisms. It is estimated that only 20-30% of GBV cases are reported to authorities or humanitarian organizations. Furthermore, 60% of GBV survivors in Cox's Bazar do not have access to adequate support services, including legal aid, psychosocial support, and healthcare. Women have the limited access to income generating activities. Local women opined that, if tourism is developed in the shrimp estate, women might get involved in hospitality in running guesthouses, restaurants, or selling local crafts. In shrimp farms, both men and women work together, especially in cluster farms where women play a significant role in pond preparation, stocking shrimp post-larvae, feeding, and harvesting. Despite their crucial contributions, women face challenges like limited resource access, land ownership issues, and gender-based discrimination. The communication and access to health facility is very limited for the people especially the women in the study area.

7.11 Small Ethnic Community

According to Population & Housing Census 2022, the upazila(s) under CSE study area contains 3,239 (majority Rakhain and Marma); BMC study area contains 4,010 (majority Chakma, Rakhain and Tonchonga); BFDC study area contains 216 (majority Marma, Chakma and Tripura); and Cluster Shrimp Farming Canals study area contains 5,097 (Majority Chakma, Marma, Garo and few others) ethnic people (**Table 7.12**).

However, the social surveys including FGDs, KIIs and RRAs reveal that there is no ethnic community within the sub-project sites and its adjoining areas. Despite the presence of the ethnic community within the study area, their settlements are far away from the sub-project sites, hence, their livelihoods are not dependent primarily on any of the sub-projects. Therefore, this community would not likely to be impacted for the sub-project implementation.

Table 7.12: Ethnic Population in Study Area

Study area	Male	Female	Total
Chakaria Shrimp Estate	1613	1626	3,239
Brood Management Center	2061	1949	4010
BFDC Harbor at Chattogram	173	43	216
Canal rehabilitation	2705	2392	5097
Total	6552	6010	12562

Source: Population and Housing Census, 2022

7.12 Cultural/ Historical Sites and Heritage

The significant cultural heritage in the Chakaria upazila are Dulhazra Safari Park, Choarfari Mangrove Forest, Sat-Gambuj Masjid of Fazle Quke at Manikpur (1873). There are no significant cultural heritages in the study area but there are Buddhist temple (Naitong Hill), Mathiner Kup (well of Mathin, 1854) in the Teknaf upazila. Over the years, shrimp estate and the surrounding area have attracted the tourists, especially those seeking a quieter and less crowded alternative to Cox's Bazar's main beach.

7.13 Security Concern

Security issue is the major concern associated with shrimp farming. Fish theft is a recurring problem in the shrimp estate, and this area faces frequent incidents of fish robberies, with local perpetrators demanding monthly payments. The shrimp estates also face encroachment, with individuals from various locations settling within the estate. Initial investigations reveal the presence of a hundred and fifty households residing inside the 48-acre shrimp estate, raising serious concerns about the security and integrity of the shrimp farming community. This location is far from the Chakaria thana (police station), and the communication infrastructure connecting to the shrimp estate is inadequate. The only means of communication with this location is by river or canals. The majority of the criminals reside in the vicinity of the Shrimp estate and are locals. The people suggested setting up a police camp in this area, close to the shrimp estate.

The Department of Fisheries (DoF) owns the area in Teknaf that is being considered for the brood management center. During field visit at BMC, no issues were found regarding land acquisition and requisition. But there is no boundary wall around the area therefore, Outsiders often trespasses into the area and use drugs as well. Again, no security issues have been found in the BFDC area.

8. Stakeholder Consultation and Disclosure

8.1 Introduction

The ESIA Study has been conducted by engaging the stakeholders who are directly or indirectly associated with the sub-projects through formal and informal consultation meetings. The informal meetings were conducted using a set of social tools like Rapid Rural Appraisal (RRA), Key Informant Interview (KII), consulting with local people (various working group including women group) through random selection etc. and the formal meetings were conducted through Focus Group Discussion (FGD), Public Consultation Meeting (PCM) and Public Disclosure Meeting (PDM). The key purposes of the consultation meetings were to assist the Proponent (DoF) in achieving their acceptance and to understand how the local people can be involved at different stages for their perceptions, opinions, suggestions during planning and designing of the Project. The consultations are also important to maintain the norms, practice and guidelines of DoE and World Bank in conducting ESIA Study. In this study, stakeholder consultations were conducted at different tiers of stakeholders: various occupational groups, local Government authority and Government Department.

8.2 Regulatory Regime

8.2.1 DoE Guidelines

The ESIA Guideline for Industries (Chapter 9, DoE 2021) meant that since the public is the ultimate recipient of the economic benefit and environmental damages, an ESIA study should involve the public as part of the decision-making process and it is an important step of the ESIA process in any industrial development. In addition, according to the Clause 16 of ECR 2023, to achieve effective and meaningful consultation, it is necessary to communicate with people as much as possible in the different possible ways of communication. The formal consultation requires pre-planning, resources, identification of target groups and several of techniques for effective communication.

8.2.2 Lender's Guidelines

This Project will follow the World Bank's (WB) Operational Policy and Bank Procedure. For this Project, OP 4.12 for Involuntary resettlement, OP 4.01 for Environmental assessment and others as mentioned in Section 2.2 under Chapter 2 are triggered by the Project. Effective stakeholder engagement can improve the environmental and social sustainability of projects, enhance project acceptance, and make a significant contribution to successful project design and implementation.

8.3 Stakeholder Identification and Mapping

While conducting several field visits to the sub-project sites, potential stakeholders were identified and they were grouped into various sub-groups. From this flow's stakeholder analysis, a more in-depth investigation was made at stakeholder group interests, how they will be affected and to what extent, and what influence they could have on the project. On the basis of necessary adaptation of mentioned above stakeholder consultation guideline of IFC, World Bank Group, the study team identified the project stakeholders in the following ways:

- Selection of directly and indirectly affected project stakeholders;
- Prioritization of stakeholders;
- Referring to past stakeholder information and consultation;
- Develop socio-economic fact sheets with a focus on vulnerable groups;

- Verification of stakeholder representatives;
- Engaging with stakeholders in their own communities;
- Determining government as the key stakeholder
- Ensuring representation of NGOs;
- Recognizing local power structure as a good channel of communication

Therefore, the participants of consultations belong to different occupational groups as farmer, fisher, day labor, school teacher etc. Moreover, to grasp the women's perception consultation sessions were also facilitated among a group of women to know the existing occupational status, future possibilities for employment due to the implementation of this project.

8.3.1 Primary Stakeholder

People those who would be in the project are selected as primary stakeholders. These people would be directly benefited or impacted by this project intervention. The primary stakeholders of the Project include the shrimp cultivators, aratdar (wholesale stockholder), customers, farmers, fishermen and fisheries dependent families, small business community, women groups, and wage labors Primary stakeholders were identified and consulted during the field visits.

8.3.2 Secondary Stakeholder

This category of stakeholders pertains to those who may not be directly affected but have interests that could contribute to the study, play a role in implementation at some stage, or affect decision making on Project aspects. In this Project concerned government departments (DoF), Upazila offices, BWDB, DoE and line agencies fall under this category. Secondary stakeholders for the Project include local government institutions (LGI), other government agencies, NGOs, entrepreneur's doing business in the Chattogram port, firms engaged in the processing and export of shrimp, and general public at large.

8.3.3 Disadvantaged and Vulnerable Individuals or Groups

Groups that are more likely than the general population to face poverty, discrimination, and violence were also present during the field visit and were discussed separately. These groups included, ethnic minorities, women headed household, migrants, people with disabilities, and isolated elderly people.

8.4 Stakeholder Engagement Plan

On the basis of Stakeholder engagement guideline of Department of Environment, World Bank OP 4.01, OP 4.04, OP 4.09, OP 4.10, OP 4.12, the periodic steps of consultation process have been prepared. Before consultation process, the study team prepared an overall stakeholder consultation plan including purpose, requirements, stakeholders, scoping, techniques etc.

8.5 Summary of the Feedback from the Stakeholders

8.5.1 Key Issues Discussed During the Consultations, FGDs and KIIs

- Existing land distribution arrangement, control, disputes
- Existing management of shrimp estate, community participation, limitations, conflicts (if any)
- Safety and security: crime rates, law enforcement, and community safety initiatives
- Livelihood strategies, dependency on shrimp estate, challenges, alternative options of shrimp cultivators, workers and other dependent communities

- Education, training status of the people
- Employment generation, drawbacks and potentiality in future
- Existing trading, value/supply chain, market linkages (local, regional, national, cross border), access, limitations (policy and practice), remedial measures, etc.
- Infrastructural facilities (road, communication, health, storage, other structures), service providers, limitations and challenges.
- Engagement of women in the project activities/SEA/SH/GBV/challenges
- Steps to be taken in future for improvement of livelihood, face the challenges etc.

8.5.2 Knowledge about the Project

The participants of the public consultation sessions of the sub-project areas had shallow and not so clear idea about the project. A few among the people, heard about the project from the local leaders, the elected public representatives or from the government officials etc. More so than the BMC and BFDC activities, they are mostly known for the CSE and canal rehabilitation of the cluster shrimp areas.



Discussion with the Local People at CSE at Rampur



Discussion with one of the Lease Holders at Badarkhali Bazar



Consultation with the local people at Mohandi khal



Consultation with the local people at Kumbkhali khal



Consultation with the local people at
Atshotobigha khal



Consultation with the local people at Bollobi khal

Figure 8.1: Consulting with Local People within the Study Area of the Sub-Projects

8.5.3 People's Perception

People adjacent to the each of the subproject areas are known about the project. But people of the study area had not much knowledge about the project. The project area's population of the BMC and BFDC is not clear as about the project because the interventions of the BMC and BFDC area are entirely contained within the campuses of these organizations. From the miscellaneous perception of participants regarding the project site the study team perceived that people had no clear idea as the they were not informed earlier about the project.

8.5.4 People's Attitude regarding Project Implementation

People's attitude varies (whether it is positive or negative) depending on the loss of their properties owing to the project implementation. The local people opined that they have been deprived from the benefit of such a big shrimp estate due to the open leasing system of the government as the lease holders were coming from the outside of the area. They urge to consider the local people in rendering shrimp farming in the estate through a suitable mechanism so that local people can own the farming activities and play important role in the local as well as national economy. They also want implementation of this project because they believe that the employment opportunity, income generation, communication infrastructure and other utility facilities of the study area would be improved for implementation of the sub-project. The people of the cluster shrimp farming area also appreciate the implementation of the project as they will be benefitted from the drainage related problems. People showed their positive attitude towards the project and they are ready to provide their assistance during implementation of the project.

8.5.5 Occupation Pattern of the Local People within the Study Area

According to the local people of the CSE, Bagerhat, Satkhira and Khulna canal rehabilitation areas most of the people in the study area is engaged with fishery and shrimp cultivation as means of livelihood. People have limited access to the agriculture or other crop farming due to the soil and water salinity. People engaged with shrimp cultivation are divided into two groups: owners of gher and day labor in the gher. The gher owners belong to the outside of the study area while the labors are from the study area. Other common occupations in the study area were: boat ply, van/motorcycle pulling, construction works, petty business, porter in the adjacent areas. The people in the BFDC and BMC areas are involved in the service also. BFDC area is very adjacent to the Chattogram City Corporation area. As a result, they get the opportunity to work in different industries.

In the districts of Bagerhat, Khulna, and Satkhira, 17 canals have been visited. It is polder area and the majority of the population in this region is mostly reliant on fishing and agriculture. Shrimp farming is the main occupation. Shrimp farming is significant in the southwestern regions Bangladesh including Khulna, Satkhira, and Bagerhat districts. Shrimp farms are typically concentrated in these areas due to the suitable brackish water conditions.

8.5.6 Potential Positive Impacts for the Project Implementation

The participants of PCMs identified several possible positive impacts of this project, such as; the national development would be accelerated with a huge pace for the increased production of shrimp. Local People will be engaged in the project activities and that is how employment and income will be generated for them. More female employees will be involved in the BFDC fish processing center. The safety and security of the shrimp estate will be increased. Production of fish preferably and rice to some extent will be increased due the rehabilitation of the canals. The participants feel that because of the implementation of this project their bad communication infrastructure will be structured in the shrimp estate areas. The development of communication infrastructure will connect the areas with the centre more rigorously. This connection will ensure financial blessing. The participants think that their present unemployment, low literacy rate, low wage, less economic productivity will be changed and improved. They think that the project will have to recruit huge number of labors and they expect that contractor will recruit the jobless farmers in non-technical works of the project.

8.5.7 Potential Adverse Impacts from the Project Interventions

The participants said that the project's negative impact will be an increase in occupational hazards. The Rampur area residents fear that they would be forced out as a result of the project's implementation. It should be resolved before implementation of the project. The present lease system is not supportive for the locals to be able to obtain a lease from DoF due to the lack of wealth. People from different areas and districts take this opportunity to obtain a lease based solely on their ability to pay. Thus, they think that after the project is implemented, more external parties will seek to do business with them.

8.5.8 Suggestions for Mitigation

No land needs to be acquired for this project, according to the project document. However, the locals recommended that any land issues should be settled before the project is implemented. According to the local people, due to land acquisition not only the landowners will be affected but also all the people those were dependent on this land will be affected equally. The locals recommended changing the lease system's agreement rules so that residents would have preference in receiving a lease. They believe that the jobless workers will get job, especially non-technical/non-hazardous jobs in this project. They demanded that if the government finalizes the project to be implemented the government should improve the road communication infrastructure which will reduce the pressure on the waterways. The contractors should manage water-sanitation facilities on their own for the labors of the project. The project authority should manage extra health care system for the workers and surrounding villagers in case of any accident for the proposed project activities.



FGD with Lease Holders, Fish/ Shrimp Farmers, and Salt Cultivators at Badarkhali Bazar, Chakaria



FGD with Local Aratdar at Choarhari Bazar, Chakaria



FGD with Cluster Farmers at Barmagati, Dighalia, Khulna



FGD with Cluster Farmers at Dakatia Village, close to Char Dakatia- Gajdurer Khal, Chitalmari, Bagerhat

Figure 8.2: Conducting FGDs at Various Locations within the Study Areas

8.5.9 Consultation with Women

Due to cultural, religious and social norms in the CSE and BMC areas, many women prefer to prioritize roles within the home or local community rather than pursuing employment outside. This choice reflects their personal values and the societal expectations that shape their work-life balance, rather than any inherent limitation on their capabilities. In contrast, naturally, they are deprived of their rights and other opportunities because of traditional social structure, religious fanaticism, superstition, vicious circle of poverty. Lack of educational opportunities, early marriage, dowry, wage discrimination is also notable. Despite the obstacles mentioned above, in the study area the rate of female literacy is not so much less than of their male counterpart. Employment opportunity for women is not significant. At present women are mostly engaged in household chores. The literate has limited employment opportunities and thus they remain unemployed.

According to the **Table 6.4**, at CSE, people involved in household works mostly females are about 26.5%; in BMC it is 26%; in BFDC 22.5% and Canal Rehabilitation for Cluster Farming is 32%. However, a very limited size of women population of the project sites is involved in outside works in different sectors. The major constraints in less involvement of women in outside work are the cultural, religious and social norms and also have an inadequacy of civic structures for women at their respective work places. Moreover, despite a low level of risk from SEA/SH, but still, it becomes a deterrent factor for involving women themselves in the outside work. Therefore, rest of the percentage of the females under the influence areas of four sub-Projects might be trained up through various vocational training programs such as: sustainable resource management, shrimp farming

techniques, aquaculture practices, and quality control so that they could involve in fish and fish products-based ventures.

Specific recommendations for women employment have been suggested in **Chapter 12: Section 12.2** of this Report.



Figure 8.3: FGD with women at Koralkhali village, Chakaria

The women participants of public consultation sessions ensured that if the government can make any employment opportunities for them through the implementation of this project, then they are very much eager to contribute their family financially. They opined that due to the implementation of this project they can find miscellaneous jobs, such as, earthwork, plantation, road construction, day labor, petty business in project site, etc. They opined that if available training facilities could be ensured then they also can contribute in technical jobs. Finally, if possible, they demanded some reserved employment options for them in the proposed sub projects.

8.5.10 Consultation with Local Government Authorities and Government Departments

The consulted different stakeholders of local government authority and government departments and their concerned issues are summarized in the following **Table 8.1**.

Table 8.1: Inventory and Summary of the Key Informant Interviews (KII)

Sl. No.	Stakeholder	Name and designation	Issues	Reflection of Consultation Result
1.	Fisheries Officers, Cox's Bazar	Md. Badruzzaman, District Fisheries Officer, Cox's Bazar	Initiation of the land reclamation procedure at the CSE in Rampur area. There are 587 plots available for lease. The encroachers will be evicted from the DoF owned area at Rampur, not the lease holders.	Regarding the land reclamation of the shrimp estate at Rampur, the ESIA report makes a recommendation for coordination amongst all departments. They should be compensated if they are evicted in compliance with World Bank criteria.
			PL selection for Brood Management Center	SPF-Black Tiger Shrimp (<i>Penaeus monodon</i>) will be managed in the Brood Management Center (BMC). Considering sensitivity of this PL specie, study area has been

Sl. No.	Stakeholder	Name and designation	Issues	Reflection of Consultation Result
				delineated for the sub-project: BMC Area at DFTC, Teknaf.
		Senior Upazila Fisheries Officer, Chakaria	This area lacks the necessary infrastructure for the year-round farming of shrimp. There is no provision in the present leasing agreement for the prioritization of local residents. They do not feel that the project is their own as a result. The lease system should be updated, giving locals preference when applying for a lease.	The lease agreement policy should be revised while maintaining provisions giving locals preference when applying for a lease on the shrimp estate. It is referenced in the ESIA report's EMP section.
			Shrimp productivity loss	Gher/Farms water depth have reduced hence dry season shrimp culture is becoming difficult. This issue has been detailed out in Section 5.2.1 under Chapter 5 .
2.	Police Officer, Cox's Bazar	Officer in Charge, Chakaria Police Station	The present security management system is not adequate for the project area. The project would require more assistance to be implemented. The project authority for carrying out the project will be co-operated by local police.	The ESIA report recommends that the police station or camp be situated in the nearest area to the shrimp estate area. referenced in the EMP and mitigation section
3.	Upazila Administration	Upazila Nirbahi Officer, Chakaria, Cox's Bazar	The upazila administration will provide support to the implementing authority in every steps. Let the people know about the project and its impacts The project is expected to impact positively on the local economy.	During the consultation process, the local community was informed about the project's operations. Information will also be distributed at the upazila level consultation meeting
4.	Other Stakeholders	Md. Helal Uddin, Lease owner, Chakaria	The DoF office did not provide them with the original copy of the leasing agreement. They therefore desire to hold the original copy. Locals ought to participate in the project's activities.	The leasing agreement process must to be transparent. The DoF office have been suggested to provide the original copy of the contract agreement in the mitigation section of the ESIA

Sl. No.	Stakeholder	Name and designation	Issues	Reflection of Consultation Result
			Before starting project construction, encroachers should be removed. This project will greatly benefit the community.	Participation from locals is necessary for construction activities, which will boost their income and it has been reflected in the ESIA report.

Some pictures were taken while interviewing the Key Informants, are shown in the following **Figure 8.4**.



KII with DFO, Cox's Bazar



KII with RFO, Cox's Bazar



KII with SUFO, Chakaria Upazila, Cox's Bazar



KII with UNO, Chakaria Upazila, Cox's Bazar

Figure 8.4: KII with Various Government Officials

8.5.11 Public Consultation and Disclosure Meetings on the Implementation of Rehabilitation of 10- and 11-acre Chakaria Shrimp Estate

Findings of Local/Upazila Level Public Consultation Meeting

A formal Public Consultation Meeting has been organized by CEGIS at Chakaria Upazila Parishad with the presence of AC Land, and SUFO, Chakaria on 12 June 2024. The participants of different levels include but not limited to local public representatives, government officials, salt and shrimp cultivators, local elites, political figures, traders and other relevant stakeholders. In addition, other local people, those are related to CSE were invited in the meeting through postering and giving advertisement in the local newspaper (**Annex 32 of Volume II: Annexures of Main Report**).

After disclosing the findings of the ESIA study of CSE through a ppt. presentation, the participants shared their opinions and suggested recommendations as well. The findings from the meeting are given in the **Table 8.2** below:

Table 8.2: People's Opinions at Public Consultation Meeting

Sl. No.	Name of Participant	Designation	Opinion/ Recommendation for implementing CSE	Response of Implementation Agency
1.	Jafar Alom (Rampur Mouza)	Businessman	The shrimp farmers of the estate are mostly annoyed with the weak enforcement of laws by the local competent authority. Robbery, hooliganism and ransom demanding are the regular practices of the area. The safety and security system of Kanpur Saharbil area of CSE needs to be guaranteed.	The local representative (SUFO, Chakaria) of the Project Authority, spells out that respective initiatives would be undertaken to overcome this situation which has been mentioned below this Table 8.2 .
2.			The management of sluice gate should be freed from the encroachers.	Necessary actions would be undertaken by the Project Authority during implementing the rehabilitation work within the CSE. This issue has been recommended in the Section 12.2: Recommendation under Chapter 12 .
3.			The dyke along with the bridge should be repaired to improve communication.	As per the activities as mentioned under the Section 4.10.2 , a peripheral dyke would be reconstructed and herring bone road would be also constructed on the dyke to facilitate the communication system of the CSE.
4.	Belal Uddin (Saharbil Area)	Fish Trader	The implementing authority should consult with the shrimp farmers before implementing the project.	This issue has been addressed in Stakeholder Engagement Plan under Section 3.3 under Chapter 3 of Annex A: ESMP Report .
5.			Safety and security issues in the shrimp estate become a havoc for the farmers and workers.	Please see the above response in Sl. No. 1 .
6.	Akkas Ahmed Saudagar (Ward No. 3)	Fish Trader	The project will not be successful if robbery and hooliganism with ransom demand are continued.	Please see the above response in Sl. No. 1 .
7.			Roadway communication system should be developed.	Please see the above response in Sl. No. 3 .
8.			Culverts should be constructed at the 11-acre and 10-acre clusters of CSE to make the road communication congenial.	This issue might be undertaken by the Project authority as per requirement where and when necessary. However, currently, the authority does not have this provision.

Sl. No.	Name of Participant	Designation	Opinion/ Recommendation for implementing CSE	Response of Implementation Agency
9.	Abdur Rouf (Badarkhali)	Salt Cultivator	Cultivations of the items (i.e., shrimp, salt, buffalo, etc.) should be given value severally as these are interlinked and same person may be involved for all items. So, the government should think how an integrated cultivation system can be promoted in the CSE.	This issue has been already recommended and mentioned in Chapter 12 of this Report under Section 12.2 .
10.	Khabiruddin Md. Jahangir	Panel Chairman, Badarkhali Union Parishad	It is requested to implement measures that forbid robbery and fish theft. It has been a problem for the last couple of decades.	Please see the above response in Sl. No. 1 .
11.			The electricity facilities should be onboarded to the CSE area to facilitate concerning issues spelled out above.	As per the activities as mentioned under the Section 4.10.2 , there is a provision to installation of on-grid solar panels on the peripheral dyke. Hence, electricity facilities would be onboarded within the CSE.
12.	K. M. Salauddin, Former Chairman, Chiringa UP	Representative of freedom fighter and a pioneer fish farmer	The development of an internal transportation and communication system of the CSE is necessary.	Please see the above response in Sl. No. 3 .
13			The electricity facilities should be onboarded to the CSE area to facilitate concerning issues spelled out above.	Please see the above response in Sl. No. 11 .
14.			The state of Security Issue is getting worse day by day. It needs due care to ensure safety and security to the people involved in the CSE for performing different activities including patrolling.	Please see the above response in Sl. No. 1 .
15. 16.			Encroachment and natural phenomena have been causing shrinkage of canal and reduce water room and flow. Canal's conveyance wide dredging should be done to resolve the problem.	Please see the above response in Sl. No. 2 .
17.			To protect the fish fry and post larvae of shrimp, illegal fishing nets should be prohibited.	Please see the above response in Sl. No. 1 .
18.			Fish landing centers should be renovated and modernized.	There is a designated fish landing center at Chaorfari, which is also known as Choarfari Bazar which is around 1.3km away from the CSE

Sl. No.	Name of Participant	Designation	Opinion/ Recommendation for implementing CSE	Response of Implementation Agency
				on its North. Shrimp and other fisheries from CSE are usually brought here from the surrounding farms including CSE for further processing and selling. However, the Choarfari Landing Center worth renovation and modernization, currently which is shabby and traditional in nature, as finfish and shrimps harvested around it are onboarded to this center due to its good accessibility. This is to be noted here that the landing center is beyond the project site.

In response to the participant's comments, the representative of the Project Authority informed in the meeting that priority has been given in addressing the concerning issues of the area. Among them, ensuring security at CSE is the foremost issue. In this regard, a police furrey (security camp) would be constructed within the CSE to ensure the security of shrimp farming activities and people involved in it. Firstly, this task would be assigned officially to the Ansar. A police station will be built afterwards at the 48-acres of Shrimp Demonstration area. The communication facilities from the Upazila and necessary structures would be developed gradually.

Findings of National/District Level Public Consultation and Disclosure Meeting

Under SCMFP, a Public Consultation and Disclosure Meeting was held on January 13th in Cox's Bazar on the Environmental and Social Impact Assessment (ESIA) Report of the Government Chakaria Shrimp Estate. Potential stakeholders from all levels were invited at the meeting. Around 40 participants were presented in the meeting. The participant List and some pictures are given in **Appendix 2**. At the outset of the meeting, Mr. Borun Chandra Biswas, Deputy Project Director (DPD), Sustainable Coastal and Marine Fisheries Project (SCMFP) gave a welcome address before the participants. Mr. Monish Kumar Mondal, DPD, SCMMFP Project presented the overview and progress of the Project. Subsequently, Mr. Mohammed Mukteruzzaman, Deputy Team Leader and Coastal Aquaculture Expert, ESIA Study of SCMFP and Principal Specialist of CEGIS presented the findings of the study through a PowerPoint Presentation. With due permission of the moderator, the participants spontaneously participated in the open discussion and expressed their valued opinions in this regard. Understanding the proposed Project and study findings, the participants expressed their positive attitude and interest in the proposed Project with an expectation that it will significantly contribute to the local and national economy and offset the local livelihood crisis.

The findings of the meeting are attributed in details in **Table 8.3**.

Table 8.3: Meeting Outcomes

Sl. No.	Participants	Comments/Suggestions/ Concerns	Remarks
1.	Mr. Mohammad Salahuddin, Deputy Commissioner &	He expressed his gratitude for choosing Cox's Bazar particularly the Chakaria Shrimp Estate (CSE) among the 16 districts considered under the project as a potential area for the improvement of shrimp	Acknowledged with thanks.

Sl. No.	Participants	Comments/Suggestions/ Concerns	Remarks
	District Magistrate, Cox's Bazar.	farming. The Project seems to be in line with the concept of 'Blue Economy'.	
		The Project could be thought as a derivative sector, meaning linking with other sectors like 'Tourism'. For example, in Australia, whale watching is a tourist attraction which is included in fisheries activities.	Afforestation considered under this project in the long run would create scenic beauty with touristic view.
		Avoid any kind of protected area including the Ecologically Critical Areas (ECAs) and other ecologically sensitive areas during project implementation and operation stages.	The CSE Sub-project site is about 8 km from the Sonadia ECA and 8 km from the nearest protected area (Medha Kachapia National Park)
		Cobweb theory is the idea that price fluctuations can lead to fluctuations in supply which cause a cycle of rising and falling prices. This theory represents the cycle of less benefit and less production loop. Necessary actions should be taken so that shrimp farmers get the right price of their product.	It is a very timely idea and DoF will communicate DC Office, Cox's Bazar in this regard.
		The DoF is requested to fix strategy communicating with the concerned office of the Deputy Commissioner to ensure access of the CSE to the following aspects: 1. Market 2. Finance 3. Skill 4. Government to Business Services. - o Access of shrimp farmers to national and international markets should be ensured. - o Access of shrimp farmers to easy bank loan should be ensured as the primary beneficiaries they do not get the loan easily. - o Ensure skill development program for all the actors of the value chain. - o Government documents related to the G2B services should be reviewed and relevant outcomes should be applied in this Project.	Agreed and DoF will communicate DC Office, Cox's Bazar in this regard.
2.	Firoz Ahmed, shrimp farmer (a 10 acre- allottee)	He expressed his appreciation for arranging the meeting in the presence of DoF high officials. He also thanked the authority to take initiative for the improvement of shrimp production in the CSE.	Acknowledged with thanks.
		The shrimp estate was highly affected by 1991 cyclone, which caused breaching of embankment largely and damaging of sluice gates devastatingly. The ongoing development work of the sluice gates and peripheral dyke under this project would be beneficial to prevent this kind of damages and might increase the resilience.	Acknowledged with thanks.
		This is a bandit prone area and safety and security is a huge concern in this area. Previously, some of the infrastructure development projects were ruined due to security issues. Hence, security guard should be appointed for each newly constructed 27 sluice gates to ensure regular patrolling. This will also help	Agreed.

Sl. No.	Participants	Comments/Suggestions/ Concerns	Remarks
		proper functioning of the hydraulic structures and support the regular exchange of water in the gher.	
		He also drew the attention of the DC and DG, DoF regarding the illegal occupancy in the Rampur Mouza, which is under judiciary.	Local administration and DoF will work jointly to resolve the issue.
		He expresses some requirements, such as i) uninterrupted electricity supply; ii) road and communication development; iii) enforcement of law and order; and iv) solution of the illegal possession.	The ongoing CSE Master Plan is expected to cover the issues and DoF will implement these accordingly.
3.	Dr. Akhter Hossain Chowdhury, Team Leader, Chakariar Master Plan Study, Sheltech	Afforestation done by Grameen Foundation replaces the indigenous plant species supporting native biodiversity caused the imbalance in the local ecosystem. It is recommended that plantation under this project should be abstained from such kind of activities.	Native plant species are recommended for the afforestation on the peripheral dyke.
		Ensure social and political safety for smooth shrimp production and marketing.	DoF will try to build an enabling environment.
		He suggested to consider bio-safety in the ESIA Report.	The ESIA has covered
		According to him, two roads planned under Matarbari Integrated Infrastructure Development Initiative (MIDI) crosses the CSE area. So, the impacts to be exerted on the environment should be considered in the ESIA Study.	It is expected that the CSE Master Plan would cover this issue with the alignment and road dimensions. Implementation of the Master Plan might require an ESIA Study, which will consider the cumulative impacts of the roads.
		ESIA study should consider the findings of the Master Plan.	There is a time gap. The ESIA should precede the Master Plan.
4.	Gias Uddin, President, Shrimp Hatchery Association	The Specific Pathogen Free (SPF) shrimp should be promoted for better production.	Agreed and DoF has already taken initiative.
5.	Dr. Shafiqur Rahman, Principal Scientific Officer, Bangladesh Fisheries Research Institute (BFRI), Cox's Bazar	Cox's Bazar is behind in compare to Khulna in terms of SPF quality shrimp and its production. NGOs like World Fish could be involved to improve the situation.	Acknowledged.
		Anarchy done by few people of the area could be prevented by the joint effort of local people and Government.	Acknowledged.
		Easy loan should be sanctioned to the farmers by the GoB with the endorsement of DoF.	DoF is expected to facilitate the issue.
6.	Dr. Prantosh Roy, Assistant Conservator of	Expressed concern about the feed quality used in aquaculture and shrimp farming, and whether they pose any threat to human health and forest	DoF has already followed the National Residue Control Plan (NRCP) to

Sl. No.	Participants	Comments/Suggestions/ Concerns	Remarks
	Forest, Chakaria Forest Department	conservation. Quality of the feeds must be maintained.	identify the source of contaminants and prevent them from entering the supply chain.
		Expressed concern regarding the consecutive shrinkage of the forest.	DoF under the SCMFP, afforestation program has been taken on the peripheral dyke of the CSE.
7.	AC Land, Chakaria	- A recent survey held in 2018 by the DC Office revealed that about 12,000 acres of land are under shrimp cultivation in addition to the CSE. The size of CSE is about 7,000-acres, fallen mostly under Rampur Mauza. However, the shrimp estate under this Mauza is currently facing encroachment problems and security issues. - Illegal occupancy is found as a critical problem and several cases filed regarding this issue are under judiciary. This problem could be minimized by leasing the land among the local people.	With the cooperation of the local administration, DoF will take initiative to resolve the encroachment problems and security issues.
		Incentives could be introduced to the local lease holders.	
		Deployment of Ansar at the initial level to ensure the security of CSE.	
8.	Office in Charge (OC), Chakaria	The problems related to illegal occupancy have been prevailing in this area due to the sublease system. This kind of practice should be prohibited.	This issue will be inflicted through the CSE Master Plan and DoF will take necessary action accordingly.
		Before implementing any infrastructure or actions in this area, the local police station should be informed to prevent theft and robbery.	Agreed.
9.	Fisheries Officer	If laws and order situation could be maintained properly, Cox's Bazar will regain its lost glory in shrimp farming.	Agreed.
10.	Abdus Sattar, Director, Marine Fisheries	Self-defense of lease holders should be ensured and maintained with the support of government.	Agreed.
		- Biological factor: - Maintain Bio-safety issues - Shrimp production should be eco-friendly	Agreed.
11.	DG, DoF	Welcomed the suggestions of the stakeholders i.e., marine tourism, quality SPF production, avoidance of ECA etc. and committed to discuss all the issues with the concerned Authority.	N/A
		Suggested to review and update the ESIA study after finalization of the Master Plan.	
		International investment could be strengthened the Project.	

Sl. No.	Participants	Comments/Suggestions/ Concerns	Remarks
		The increased local consumption could be met if the project is properly maintained.	
		A UK-based organization BCCI has been on boarded to invest in SPF hatchery.	
		Skill development for all the actors involved in the value chain will be ensured.	
		The quality of the exported shrimp is checked regularly and the whole exporting process is being audited by the qualified foreign organizations.	
		A Brood Management Center (BMC) would be implemented under SCMFP.	
		In response to Mr. Dr. Prantosh Roy, DoF follows the National Residue Control Plan (NRCP) to identify the source of contaminants and prevent them from entering the supply chain.	
		Fisheries sector should be given priority during the loan allocation in agricultural sector.	
12.	PD, SCMFP, DoF	Although the ESIA Report revealed that the Project does not have much adverse impacts, the ESIA Team should check once again whether all the issues have been addressed or not, especially the social impacts.	The CEGIS Team revisited the thing and addressed accordingly.
		Report should be finalized by incorporating the comments of the participants of the PDM.	The findings of the PDM have been addressed in this report and the outcomes of the local and national stakeholders' consultations have been addressed in the following sub-sections.
		The feed quality is safe which is provided to the fish farmer, he mentioned.	N/A

Findings of Public Disclosure Meeting

According to the ECR 2023, a Public Disclosure Meeting (PDM) was held at Upazila Parishad Hall Room, Chakaria, Cox's Bazar to disclose the ESIA study findings to the stakeholders on May 20th 2025. Around 52 participants including government officials; representatives from the local people, women group, relevant organizations etc.; journalist; businessmen; salt and shrimp farmers; fishers; teacher and student representative attended the meeting. The participants were invited to attend the meeting through the invitation letters and giving advertisements in the local daily newspaper, "Chakaria News" (চকরিয়া নিউজ) and a national daily newspaper, "Daily Manabjamin" (দৈনিক মানবজমিন). The advertisement for the PDM, the attendance list and the meeting minutes of the program signed by the Director, DoE, Cox's Bazar are attached in **Appendix 4**. Mr. Md. Anwarul Amin, Senior Upazila Fisheries Officer (SUFO), Chakaria presided over the meeting and started the program with his welcome speech and presented a power point on the overview of the SCMFP. This is to be noted here that Mr. Atikur Rahman, Upazila Nirbahi Officer, Chakaria graced the meeting as the Chief Guest. Subsequently, Mr. Mohammed Mukteruzzaman, Deputy Team Leader and Coastal Aquaculture Expert, ESIA Study of SCMFP and Principal Specialist of CEGIS disclosed the findings of the study through a

Power Point Presentation. With due permission of the Moderator, the participants spontaneously participated in the open discussion and expressed their valued and prudent opinions in this regard. On behalf of DoF and ESIA Study Team of CEGIS, SUFO of Chakaria and Deputy Team Leader respectively answered all the issues raised during the open discussion. The participants expressed their positive attitude for the Project implementation provided taken care of their issues. They believe that this Project will contribute to the local economy which will eventually significantly contribute to the national economy as well. The findings of the PDM and accordingly the response of the raised issues are given in detail below:

Table 8.4: PDM Findings

Sl. No.	Participants and their Designation	Comments/ Suggestions/ Concerns	Response of Implementation Agency	Remarks
1.	Mr. M. R Mahmud, Senior Journalist, Daily Samakal (দৈনিক সমকাল)	He expressed his gratitude for inviting the participants and briefing them about the Project in details. In addition, he raised some issues and gave his suggestions regarding the implementation of Project.	N/A	Acknowledged with thanks.
2.		Shrimp farming started in this area in 1980 and destroyed the Chakaria mangrove forest.	This issue has already been considered by the Project authority through planning an afforestation program with plant species adapted to this area on the outer side of the peripheral dyke to reinstate the greenery and dependent wildlife and biodiversity which had before in this area.	A detailed green belt development plan has been given in Section 11.6 under Chapter 11 of this Report.
3.		Deforestation in the Chakaria Sundarbans (Mangrove Forest), development of unplanned shrimp gher and salt farms leading to loss of biodiversity of this area along with the Sundari tree.	Stated as above.	Stated as above.
4.		Peripheral dyke and the hydraulic structures have made the Chakaria Shrimp Estate safe and secured from the natural hazards.	Acknowledged with thanks.	N/A
5.		Currently, the flowing Matamuhuri and Bura Matamuhuri Rivers on the	This issue might be addressed by the Project authority	this issue is cited in the recommendation

Sl. No.	Participants and their Designation	Comments/ Suggestions/ Concerns	Response of Implementation Agency	Remarks
		East and the West side of the Chakaria Shrimp Estate respectively and the connecting canals are silted up. As a result, fish habitat suitability of this area has been hampered and fish abundance has been decreased.	and re-excavation or rehabilitation program for the drainage canals would be undertaken where required.	(Section 12.2 under Chapter 12).
6.		To ensure safety and security of this shrimp estate, an active and functional police station is strongly required.	Active and functional police station(s)/furry(ies) have already been provisioned under this Project.	The issue has been mentioned in this Report in Section 8.5.11 below the Table 8.2 .
7.	Abdur Shukkur, Shrimp Farmer, Badarkhali	Majority of the existing sluice gates/water regulatory structures within the Chakaria Shrimp Estate are currently in no use and most of them are malfunctioning and leading to siltation of internal canals. In consequence, it is hampering the controlled exchange of water of the shrimp gher. The Regional Fisheries Officer (RFO) should monitor the operation of the water regulatory structures actively once it is retrofitted.	Acknowledged with thanks.	Rehabilitation or retrofitting or construction of new sluice gates/water regulatory structures are being materialized.
8.	Abul Kashem, Shrimp Farmer	Robbery, hooliganism and ransom demanding are the regular practices in this area. These phenomena have been critically hampering the shrimp farming activities. The safety and security measures should be strengthened and ensured.	Please see the above response in Sl. No. 6 .	Ref. the remark in Sl. No. 6 .
9.		The electricity facilities should be arranged to the CSE area to ensure safety and security during night time.	There is a provision of installing grid-tied solar panels on the peripheral dyke under this Sub-Project.	This issue has been covered in Section 4.10.2 of this Report.
10.		The primary allottees of the CSE give sub-lease to the	Acknowledged with thanks.	Ref. to Section 4.6.1 of this Report, currently,

Sl. No.	Participants and their Designation	Comments/ Suggestions/ Concerns	Response of Implementation Agency	Remarks
		small farmers for a year. They increase the rate of sub-lease each year, hence, small farmers are deprived of equitable lease value.	Ref. to Sl. No. 1 of the Table 8.1 under Section 8.5.10 , SUFO, Chakaria stated that lease system should be updated giving preferences to the local communities when applying for a lease.	the 3 rd phase lease period is ongoing which will be ended in 2032. In the meantime, Master Plan for the CSE is being conducted. Once the Master Plan of CSE is completed, this system is expected to be resolved. It is referenced in the ESIA Report's ESMP section.
11.	Mobarak Hossain Jihan, Student representative, Boishammya Birodhi Chhatra Andolon	A functional and well-equipped Police Station is required to ensure the safety and security of the Chakaria Shrimp Estate.	Please see the above response in Sl. No. 6 .	Please see the above response in Sl. No. 6 .
12.	Shahnaj Ferdousi, Upazila Agriculture Officer (In-Charge)	Security system should be strong in Chakaria shrimp Estate	Please see the above response in Sl. No. 6 .	Please see the above response in Sl. No. 6 .
13.		Active involvement of the people engaged in implementing the sub-Project should be ensured.	Acknowledged with thanks.	N/A
14.		Production of improved quality shrimp should be ensured to promote export and earn foreign currency which would in turn contribute to the national economy.	Agreed.	Indirect Project benefits have been discussed in Section 11.2 of this Report.
15.	Md. Abdus Salam, Senior Chemist, DoE, Cox's Bazar	He suggested DoF to take necessary initiatives to implement the findings of the ESIA Report.	Agreed.	N/A
16.	Dr. Mohammad Moktakim Billah, Veterinary Surgeon, Upazila Livestock Office, Chakaria	The Specific Pathogen Free (SPF) shrimp should be promoted for better quality production to earn more foreign currency through exporting shrimp. In addition, quality of hatchery PL should be ensured.	Agreed and DoF has already taken initiative through this Project.	N/A
17.		Breeding and spawning period should be avoided during construction activities of this sub-Project. Authority should take care of this issue.	Acknowledged with thanks.	Please see the above response in Chapter 9 .

Sl. No.	Participants and their Designation	Comments/ Suggestions/ Concerns	Response of Implementation Agency	Remarks
18.		To reinstate Chakaria Sundarbans, native mangrove species, especially those were existed before aquaculture had been started in this area should be included in the afforestation plan.	Please see the above response in Sl. No. 2.	Please see the above response in Sl. No. 2.
19.	Mohammad Atikur Rahman, UNO, Chakaria Upazila, Cox's Bazar	To keep active and usable the 70 km long peripheral dyke and 27 sluice gates at various locations within the Chakaria Shrimp Estate, DoF should work proactively. In addition, as the activities under the shrimp estate is being implemented in Upazila level, monitoring works of including safety and security of this area should be under the responsibility of SUFO, Chakaria.	Acknowledged with thanks.	N/A
20.		Although the main goal of this sub-Project is the development works of Chakaria Shrimp Estate, it is also essential to renovate the existing landing center at Choarfari. This issue should be considered under this sub-Project.	This has already been considered under Chakaria Shrimp Estate sub-Project.	Fish Landing Center related activities are addressed in Section 4.10.2 under Chapter 4. The connection of value chains of fish/ Shrimp with the Choarfari Bazar has been explained in Section 6.2.1 under Chapter 6 of this Report.
21.		One of the positive sides of this sub-Project is employment generation of the local people those are living in and around the Shrimp Estate. Women should be encouraged to involve in the various works of this Project especially in processing, packaging and selling of fish and shrimp. In this regard, security for the women should be ensured.	Acknowledged with thanks.	Consultation with women has been done under this Project and elaborated in Section 8.5.9 under Chapter 8 of this Report. Considering their response, necessary suggestions are recommended for women under this Project in Section 12.2 of Chapter 12 in this Report.

Sl. No.	Participants and their Designation	Comments/ Suggestions/ Concerns	Response of Implementation Agency	Remarks
22.		To ensure safety and security of Chakaria Shrimp Estate, CCTV camera should be installed in each guard shed.	Agreed.	This issue has been addressed in Section 12.2 of Chapter 12 .
23.		Adequate number of night guards should be deployed to ensure the security of the Chakaria Shrimp Estate.	Agreed.	N/A
24.		Salinity tolerant vegetables might be planted as an integrated farming concept in the Chakaria Shrimp Estate. This kind of farming is being practiced in the southwest region of Bangladesh.	Acknowledged with thanks.	N/A
25.		For the development of the Chakaria Shrimp Estate, the Department of Fisheries (DoF), Department of Agriculture Extension (DAE) and Department of Livestock Services (DLS) should work together in an integrated fashion from the planning stage to boost up the local economy.	Acknowledged with thanks.	N/A
26.		Internal canals of the Chakaria Shrimp Estate should be re-excavated or rehabilitated periodically to overcome the siltation problem due to natural hazards like cyclone, storm surge, tidal flood, etc.	Acknowledged with thanks.	This issue has been addressed as a recommendation in Section 12.2 of Chapter 12 of this report. Monitoring program for canal re-excavation has been discussed in the Table 2.7 under Chapter 2 and the mitigation plan has been discussed in Table 6.1 under Chapter 6 of the Annex A: ESMP Report .
27.		Local people should be employed in this Project in various activities based on their expertise and skill which would contribute to the local economy as well as to the country's GDP.	Acknowledged with thanks.	The issue of 'Employment Generation' has been addressed in the following sections: Section 9.3.2 under Chapter 9;

Sl. No.	Participants and their Designation	Comments/ Suggestions/ Concerns	Response of Implementation Agency	Remarks
				- Section 11.2.1 and Section 11.2.2 under Chapter 11, and - Section 12.2 under Chapter 12 of this Report.
28.		Social awareness should be built to the local people in and around the Estate in developing works of Chakaria Shrimp Estate. The Project Authority should take necessary actions in this regard.	Acknowledged with thanks.	N/A

8.5.12 Documentation of the Process and Results of Consultation

Date and location of consultation meeting are mentioned in the following **Table 8.4** and the names of the consulted persons are given in the **Table 8.5**. The list of consulting persons during field visits and people attended in various FGDs and PCM are Given in **Annex 31** under **Volume II: Annexures of Main Report**. The Photographs of field works including collecting field information, samples, consulting with local people, Poster and Baner of PCM, Invitation process of respective persons in the PCM, and some pictures of PCM are given in the **Annex 32** under **Volume II: Annexures of Main Report**.

Table 8.5: Formal Consultation Meetings by Location and Date

Type of Consultation	District	Upazila	Union	Village	Date
Focus Group Discussion	Cox's Bazar	Chakaria	Badarkhali	Badarkhali	14/02/2024
	Cox's Bazar	Chakaria	Chaorfari	Saharbil	15/02/2024
	Cox's Bazar	Chakaria	Koralkhali	Saharbil	15/02/2024
	Satkhira	Tala	Khailil Nagar	Khailil Nagar	02/03/2024
	Khulna	Dighalia	Barmagati	Dighalia	05/03/2024
	Bagerhat	Chitalmari	Charbaniari	Dakatia	07/03/2024
Key Informant Interview (KII)	All over the sub project/study area with Local administration, LGI representatives, different occupational groups, women etc.				During study period
Upazila level consultation meeting	Cox's Bazar	Chakaria	-	-	12/06/2024
District level consultation meeting	Cox's Bazar	Cox's Bazar Sadar	-	-	13/01/2025

Table 8.6: Personal Details of the Interviewees

Name	Age	Occupation	Address/Phone No.
Md. Badruzzaman	40	DFO, Cox's Bazar	01712999278
Md. Toufiqul Islam	42	RFO, Cox's Bazar	01712514870

Name	Age	Occupation	Address/Phone No.
Md. Fakhurul Islam	34	UNO, Chakaria Upazila	01733373215
Md. Farhan Tajim	32	SUFO, Chakaria Upazila	01718927656
Md. Jashim	56	Employee, Fisheries office	01813734076
Md. Shaohidul Alam	38	FA, Upazila office	Teknaf, 01879314602
Md. Habibullah	20	Fisherman	Teknaf
Md. Jahedul Islam	56	Fisherman	Saharbil, Chakaria, 01823970320
Md. Helaluddin	75	Lease Holder	Chakaria, 01740618681
Shoaibul Islam	42	Fisherman	Chakaria, 01818565237
Maruf Islam	38	Fisherman	Chakaria, 01892032325
Md. Zakir Hossain Sardar	42	Ex president, Charkathi clustar	Kachua, Bagerhat, 01747788196
Md. Zakaria	45	Treasurer, Sarkarpara cluster	Mollahat, 01642689090
Md. Nur Islam	53	Secretary, Sarkarpara cluster	Mollahat, 01710859646
Rina Rani Hira	55	President, Chardakatia cluster	Chardakatia, 01956549879
Abinash	65	Member, Gajduari cluster	Burirkhal, 01323368133
Md. Jihadul	52	President, Gajduari cluster	01724040689
Krishnadas Biswas	50	Member, Charbaniari cluster	Chitalmari, Bagerhat, 01715211795
Ranidas Gharami	42	Member, Charbaniari cluster	Chitalmari, Bagerhat
Nikhil Mondal	45	Member, Charbaniari cluster	Chitalmari, Bagerhat, 01991616405
Gouro Basu	53	Member, Charbaniari cluster	Chitalmari, Bagerhat
Liton Poddar	48	Member, Charbaniari cluster	Chitalmari, Bagerhat, 01984147050

8.5.13 Concluding Remarks

The local people are very much concerned about the possible impacts of the subprojects. The local people have no major objection about the goals and objectives of the project. They are very much interested about the implementation of the subprojects. They suggested that project planning would take into account their growth and well-being for a brighter future.

However, most of the local / Upazila level stakeholders raised the security issue within the CSE in the public consultation meeting at Chakaria. To them, security issue is getting worse day by day because of the poor mode of communication system and weak enforcement of laws by the local competent authority. Robbery, hooliganism and ransom demanding are the regular practices of the area. Therefore, this issue should be properly taken care of. In addition, utility service like electricity and communication system are the major requirements for the project site and surroundings.

In the district level public consultation and disclosure meeting, the stakeholders also raised the issue of safety and security of the CSE which is hampering the usual farming practices and compelling the actors to harness less yield and commerce than that of the potential. Patrolling might be a solution of this issue and guards should be recruited in each of the 27 sluice gates. According to them, local people might be given priority during allocation of shrimp estate by DoF to avoid social conflicts. Uninterrupted electricity supply and improved road communication system should be ensured. In addition, plantation around the Project site should be conducted in such way, so that native biodiversity does not hamper. A "Tourism" Project may also be implemented here if properly managed.

8.6 Grievance Redress

Usually, rich people take lease land from the Department of Fisheries and engage local people to work as day laborer or guard at CSE. Since majority of the leaseholders are from other districts and hire workers of their own choice, sometimes even from other districts, who are unable to understand the local social issues and norms. The study reveals that the people living around the CSE are mostly depend on fishing, salt and fish/ shrimp farming etc. Therefore, engaging people from from other areas at CSE by the leaseholders, local people get deprived which eventually creates grievance to the locals. As a result, social conflicts, robberies, fish theft etc. have been increased at CSE.

The formal and informal consultations reveal that grievance might be reduced and more employment opportunity would be generated for the local people if the local people would grant lease the land. They also suggested to review the lease agreement and adding additional opportunities for the local people. Therefore, after the lease period (as given up to the year 2032) the DoF through the administrative authority is recommended to solve this issue.

9. Potential Risks, Impacts, and Mitigation Measures

9.1 Preamble

The development work, based on the type and nature of its interventions, might have diversified adverse and beneficial impacts on the intervened environment and society. The discussed project has multiple and diverse sub-project/interventions mentioned in **Section 4.10** under **Chapter 4** were considered for assessing the impacts and evaluating them in terms of persistence of the impacts for temporary, reversible or permanent and in terms of implementation stages e.g., pre-construction, construction and operation). In this Chapter, potential risks, and impacts with corresponding mitigation measures are provided for each sub-project considering the sub-project activities. In the process of impact assessment, primarily a long list of the Valued Environmental and Social Components (VESC) were identified based on the information collected for Physical, Biological, and Socio-economic environment and screened down the list based on the findings of the consultations and brainstorming session of relevant experts. The selected VESCs and rationale for the selection have been mentioned in **Annex 33 of Volume II: Annexures of Main Report**.

The adverse impacts were then assessed against each VESC using multiple layers of information including spatiotemporal data of the study area and the proposed project activities. Project benefits and other positive benefits were excluded from the impact assessment. Once an impact is identified, it was further evaluated based on its degree of significance. The degree of significance of an impact or risk is defined by a five-point Likert Scale and evaluated by its sensitivity and magnitude. The details of the methodology for assessing sensitivity, magnitude and finally the significance are presented in **Annex 3 of Volume II: Annexures of Main Report**.

9.2 Potential Risks, and Impact Assessment and Corresponding Mitigation Measures

The project includes four sub-projects with multiple activities each, as mentioned in the **Section 4.10** for various stages of the sub-project implementation; such as: Pre-construction, construction, and operation stages. Potential risk and impacts on Physical, Biological, and Socio-economic environment for individual sub-project are identified and assessed, and based on the significance of the impacts, specific mitigation measures are discussed in the following sections.

9.2.1 Pre-construction Stage

Refer to the **Section 4.10.1**- Sub-project activities for pre-construction stage, under **Chapter 4**, no ground activities would be conducted within the sub-project sites. Only desk-based work would be done in this stage. However, raw materials including associated items would be procured, and carried to the sub-project sites. The required manpower at different levels would be sorted out and necessary arrangement like contract/agreement would be completed with the compliant manpower/labor supply agencies in this stage. Hence, other than social issues, no risks and impacts have not been considered in this stage.

9.2.2 Construction and Operation Stage

Before starting the sub-project implementation works at this stage, labor shed would be constructed at the CSE, BFDC Harbor at Chattogram, and BMC at DFTC, Teknaf. In addition, land development would be done by filling the puddles and pools of the shrimp demonstration area at CSE, BFDC harbor at Chattogram, and BMC area at DFTC, Teknaf.

Referring to the sub-project activities mentioned in **Section 4.10** under **Chapter 4**, it is comprehensible that during construction stage, the physical (water resources and environmental

quality, such as water, air, noise and soil quality), biological (biodiversity, fisheries and agriculture), and socio-economic (demographic indicators, livelihood, cultural, etc.) resources of the study areas/sub-project influenced areas might face diverse environmental risks, and impacts.

Similarly, during operation/ post-construction stage there would be some impacts at each sub-project sites. The summary of impacts to be exerted, their evaluation including magnitude of various environmental parameters under physical, biological, and socio-economic environment for each sub-project during construction and operation stages are given in the following Sections.

Physical Environment

a) Drainage Congestion

Unauthorized dumping of the generated debris due to rehabilitation of structures within the sub-project areas, drainage congestion might be occurred to the internal drainage system at the sub-project sites during heavy rainfall at monsoon and cyclonic storm surge. On the other hand, during re-excavation of internal canals at the CSE, drainage flow might be hampered in the river and other canals if the re-excavated soil is not managed properly.

A summary of the impact on drainage congestion for each sub-project site are presented in the following **Table 9.1** and corresponding mitigation measures are presented in the **Table 9.2**.

Table 9.1: Summary of Impact Evaluation on Drainage Congestion during Construction and Operation Stages

Sub-Project Name	Sub-Project Activities	Potential Impacts	Temporal Aspects	Spatial Aspects	Reversibility	Compliance	Likelihood	Magnitude	Sensitivity	Significance without mitigation	Residual Impact after mitigation
Construction Stage											
Rehabilitation of 10, and 11-acre shrimp estate including associated canals and 48-acre Shrimp demonstration Farm, Chakaria, Cox's Bazar	Unauthorized dumping of loose soil during land leveling at 48-acre of Shrimp demonstration area	Sliding of loose soil into the drain due to non-methodical soil dumping in the sub-project site may result in drainage congestion in the internal drainage system.	2	1	2	2	2	M	L	L	L
	Unplanned and unorganized dumping of waste materials	Unauthorized dumping of various wastes such as: concrete wastes, wooden debris, and kitchen wastes may cause wash out to the nearby river (the Bura Matamuhuri and the Matamuhuri River) and internal canals by heavy rain. This eventually would cause drainage congestion	2	2	3	2	2	S	M	M	L
	Improper management of re-excavated soil	Sliding of loose soil into the canal may result in drainage congestion in the internal drainage system of CSE and malfunctioning the rehabilitation work	2	1	3	2	2	M	M	M	L
BFDC Harbor at Chattogram	Unplanned and unorganized dumping of waste materials	Unauthorized dumping of various wastes such as: concrete wastes, wooden debris, and kitchen wastes may cause wash out to the nearby the Karnaphuli River and the internal drainage system by heavy rain and may cause drainage congestion.	2	1	2	2	2	M	L	L	L
BMC at DFTC, Teknaf	Unplanned and unorganized dumping of waste materials	Unauthorized dumping of various wastes such as: concrete wastes, wooden debris, and	2	1	2	2	2	M	L	L	L

Sub-Project Name	Sub-Project Activities	Potential Impacts	Temporal Aspects	Spatial Aspects	Reversibility	Compliance	Likelihood	Magnitude	Sensitivity	Significance without mitigation	Residual Impact after mitigation
		kitchen wastes may cause wash out to the nearby canals and the internal drainage system by heavy rain and may cause drainage congestion.									
Canal Rehabilitation for Cluster Farming	Improper management of re-excavated soil	Sliding of loose soil into the canal may result in malfunctioning the rehabilitation work.	2	1	3	2	2	M	M	M	L

Necessary measures on drainage congestion are given in the following **Table 9.2**.

Table 9.2: Necessary Measures for Drainage Congestion

Mitigation Hierarchy	Measures
Avoid	N/A
Minimize	Waste should be disposed in the designated site(s), so that no construction or kitchen wastes fall in the drain, which may hamper the storm water drainage.
Mitigate	- A good housekeeping of kitchen waste collection and disposal system should be adopted. - There should be a designated site for waste disposal and managed with proper care. - Unregulated scattering /throwing of waste should be prohibited. - Discharge from construction sites as mentioned in the ESCOP 3: Water Resources Management; ESCOP 4: Drainage Management should be followed during construction stage.
Compensate/Offset	N/A

b) Waste Generation

Kitchen Waste Generation: Ref. to **Table 4.8** in **Section 4.22.1- perishable waste**, around 32 kg, 18 kg, and 19 kg of kitchen waste would be generated from the labor camp/shed at the CSE, BFDC Harbor at Chattogram, and BMC sub-project sites respectively. Unauthorized dumping of this waste might cause hamper to the scenic beauty, and washing out by heavy rain into the nearby surface water sources. In addition, haphazard management of these waste may create nuisance and cause for the bad smell at the site. These phenomena in turn would contaminate the waters of the receiving waterbodies and reason of threat to the human being and aquatic animals.

Concrete Waste and Wooden Debris generation: Ref. to **Table 4.9** in **Section 4.22.1- non perishable waste**, a huge volume of concrete waste would be generated during the construction stage due to rehabilitation of abandoned civil structures at CSE (about 20,123.5 Ton), BFDC Harbor (about 363.33 Ton), and BMC area (about 21,772.83 Ton) sub-project sites, and rehabilitation of hydraulic structures (about 19,783 Ton) from the internal canals at CSE. In addition, a number of trees including grassy vegetation and some herbs and shrubs would also be cleared from all the sub-project sites from which wooden debris would be generated. Moreover, unauthorized dumping of re-excavated soil may create problem for the pedestrians those use the canal dyke as road or walkway.

Organic Solid Waste Generation: Ref. to **Section 4.22.1- organic solid waste**, around 8m³, 4.6m³, and 5m³ sewage¹³ would be generated from the labor colony and officers' residence during construction stage from the CSE, BFDC Harbor, and BMC area sub-project sites respectively. These would cause bad smell around the labor camp/shed area and sometimes it would cause contamination to the nearby surface waterbodies if not properly managed. Waterborne diseases may outbreak within the labor camp/shed area and nearby community people.

A summary of the impact on waste generation for each sub-project site are presented in the following **Table 9.3**. and corresponding mitigation measures are presented in the **Table 9.4**.

¹³ Considering 0.29 wt.(kg)/ person/ day for 26 working days for Lower Income Group and 0.6 wt.(kg)/ person/ day for 22 working days for Medium and Higher Income Group.

Table 9.3: Summary of Impact Evaluation on Waste Generation during Construction and Operation Stages

Sub-Project Name	Sub-Project Activities	Potential Impacts	Temporal Aspects	Spatial Aspects	Reversibility	Compliance	Likelihood	Magnitude	Sensitivity	Significance without mitigation	Residual Impact after mitigation
Construction Stage											
Rehabilitation of 10, and 11-acre shrimp estate including associated canals and 48-acre Shrimp demonstration Farm, Chakaria, Cox's Bazar	Operation of labor camp/shed	Generation of around 32 kg of kitchen waste (Ref. to Table 4.8) from the labor camp/shed.	2	2	2	2	3	S	M	L	L
		Around 8 m ³ of sewage waste (Ref. to Section 4.22.1- organic solid waste/ sewage waste) would be generated from the labor camp/shed.	2	2	2	2	3	S	M	M	L
	Disposal of kitchen waste generated at labor camp	Create nuisance, and bad smell.	2	3	2	1	2	S	L	L	L
	Wash out to the nearby surface waterbodies by heavy rain	Contamination of water of the internal canals, and rivers.	2	3	2	3	2	S	M	M	L
	Tree felling and vegetation clearance	Ref. to Section 4.22.1- other solid wastes around 3.4 m ³ (3 ton) of wooden debris (Table 4.9) and leaves would be generated due to clearing vegetation.	2	1	2	2	4	S	L	L	L
	Rehabilitation of canals through re-excavation and disposal of excavated earth on the dykes	Unauthorized dumping/ disposal of re-excavated soil on the dykes of the internal canals may cause slide back to the canal. This may cause re-siltation of the canals and increase of turbidity of the waters of that area.	2	1	2	2	2	M	L	L	L
	Rehabilitation of abandoned civil structures	Around 3,06,628 kg of concrete debris (Ref. to Table 4.9) would be generated.	2	2	2	2	3	S	M	M	L

Sub-Project Name	Sub-Project Activities	Potential Impacts	Temporal Aspects	Spatial Aspects	Reversibility	Compliance	Likelihood	Magnitude	Sensitivity	Significance without mitigation	Residual Impact after mitigation
	Construction activities	Generation of other non-perishable solid wastes as scrap like iron pieces, plastic etc. may cause injury to the workers if not properly handle.	2	2	2	2	3	S	M	M	L
BFDC Harbor at Chattogram	Operation of labor camp/shed	Generation of around 18 kg of kitchen waste (Ref. to Table 4.8).	2	2	2	3	3	S	M	M	L
		Around 4.6 m ³ of sewage waste (Ref. to Section 4.22.1- organic solid waste/ sewage waste) would be generated from the labor camp/shed.	2	2	2	3	3	S	M	M	L
	Rehabilitation of abandoned civil structures	Ref. to Table 4.9 , 300 kg iron from 224 CI sheets, and around 3,04,814 kg of concrete materials would be generated.	2	3	2	3	3	S	M	M	L
	Tree felling and vegetation clearance	About 192 nos. of timber trees (Ref. to Section 4.16) would be felled down; hence, wooden log and leaves would be generated as waste materials.	2	3	2	2	2	S	M	M	L
	Construction activities	Generation of other non-perishable solid wastes as scrap like iron pieces, plastic etc. may cause injury to the workers if not properly handle.	2	2	2	2	2	M	L	L	L
BMC area at DFEC, Teknaf	Operation of labor camp/shed	Generation of around 19 kg of kitchen waste (Ref. to Table 4.8).	2	1	2	3	3	S	M	M	L
		Around 5 m ³ of sewage waste (Ref. to Section 4.22.1- organic solid waste/ sewage waste) would be generated from the labor shed.	2	1	2	3	3	S	M	M	L
	Rehabilitation of abandoned civil structures	About 9,57,987 kg of concrete materials (Ref. to Table 4.9) would be generated.	2	3	2	2	2	S	M	M	L

Sub-Project Name	Sub-Project Activities	Potential Impacts	Temporal Aspects	Spatial Aspects	Reversibility	Compliance	Likelihood	Magnitude	Sensitivity	Significance without mitigation	Residual Impact after mitigation
	Tree felling and vegetation clearance	About 44 nos. of trees (Ref. to Section 11.6) would be felled down; hence, wooden log and leaves would be generated as waste materials.	2	2	2	2	3	S	L	L	L
	Construction activities	Generation of other non-perishable solid wastes as scrap like iron pieces, plastic etc. may cause injury to the workers if not properly handle.	2	2	2	3	3	S	M	M	L
Canal Rehabilitation for Cluster Farming	Tree felling and vegetation clearance	Ref. to Annex A: ESMP Report clearance of fruit trees (as existing on the both side dykes) would generate wooden debris and leaves.	2	2	2	2	3	S	L	L	L
	Rehabilitation of canals through re-excavation and disposal of excavated earth on the dykes	Unauthorized dumping/ disposal of re-excavated soil on the dykes of the internal canals may cause slide back to the canal. This may cause re-siltation of the canals and increase turbidity of the waters of that area.	2	3	2	2	2	S	M	M	L
Operation Stage											
BFDC Harbor at Chattogram	Cleaning of Fish processing Plant, Chiller and other facilities	Generation of waste water	2	1	2	4	2	S	L	L	L

Necessary measures on waste generation are given in the following **Table 9.4**.

Table 9.4: Necessary Measures for Generating Wastes

Mitigation Hierarchy	Measures
Avoid	N/A
Minimize	- The project should consider the septic tank with soak well for the treatment of sanitary (organic) waste generated in the labor shed and staff room. - The size of the septic tank for connected with the toilets of the labor shed and the staff dorm should be about 4.5m³, 2.5m³, and 3m³ including a soak well may be constructed in the construction sites of the CSE, BFDC Harbor at Chattogram, and BMC Area at DTFC, Teknaf sub-project sites respectively.
Mitigate	- A good housekeeping of kitchen waste collection and disposal system should be adopted. - There should be a designated site for kitchen waste disposal with an adequate number of waste bins with different colors indicating disposal of degradable and non-degradable wastes. Unregulated scattering /throwing and burning of waste should be prohibited. - Perishable wastes and non-perishable waste such as glasses, plastics, recyclable and reusable wastes etc. may be segregated at source and manage separately. - Wastes should be disposed in adequate number of waste bins with different colors indicating disposal of degradable and non-degradable wastes kept in a designated place and afterwards those would be carried outside the Project site by waste carrying vehicles/dump truck through proper authority. - ESCOP 1: Waste Management, ESCOP 2: Fuels and Hazardous Goods Management should be followed. In addition, following rules should be followed: ✓ National National 3R Strategy for Waste Management, 2015 ✓ Bangladesh Standards and Guidelines for Sludge Management (BSGSM) 2015 ✓ Solid Waste Management - Discharging of sanitary waste water, the waste water should be treated properly through ETP which should meet the national standard (Schedule 3 of ECR 2023) for sanitary wastewater discharges or the indicative guideline values applicable to sanitary wastewater discharges of IFC EHS Guidelines 2007 (Wastewater and Ambient Water Quality) (Appendix 1). - The treated water may be re-used in gardening, car wash, cleaning etc.
Compensate/Offset	N/A

c) Impacts on Environmental Quality

Air Quality

According to the sub-project activities as mentioned in the **Section 4.10**, rehabilitation and construction of new civil structures at the CSE; BFDC Harbor at Chattogram; Teknaf would require vegetation clearance and tree felling. Moreover, underground cable installation at BFDC through open cut method would require trench cutting, cable laying and site restoration. Vehicular and vessel movement would be increased during transporting logs and debris (waste materials) to be generated from the construction sites to the vendors and construction materials to the sub-project sites. In addition, land leveling and preparation would be conducted at the sub-project sites; and re-excavation would be conducted at the internal canals under CSE, and the canals for cluster farming under

Satkhira, Khulna, and Bagerhat Districts. Beside this, underground distribution line would be installed at BFDC. These activities might have impacts on ambient air quality at the sub-project sites and surroundings. The nature of impacts is mentioned in the following sections:

Generation of Dust particles: The above-mentioned activities might increase dust particles such as: SPM, PM₁₀, and PM_{2.5} in the local airshed especially during demolition of civil structures, vehicular movement on the connecting roads to the sub-project sites, tree felling on the ground, land leveling and land preparation, construction activities (such as: carrying sand, gravel, rock, cement; rock and brick crushing; and mixing construction materials etc.), and re-excavation of canals including excavated soil management. However, the magnitude of generating dust particles in the ambient air varies depending on sources. Therefore, the evaluated impacts on ambient air quality including its magnitude and significance are mentioned in the following **Table 9.5** and corresponding mitigation measures are given in the following section accordingly.

Exhaust Emission: Excavator, construction site generator, project vehicles, construction materials carrying vessels are the main source of exhaust emission. Vehicular movement at the sub-project sites, vessel movement at the internal canals, rivers and the Maheshkhali Channel might increase criteria pollutants such as: e.g., Nitrogen Oxides (NO_x), Sulfur Oxides (SO_x) and Carbon Monoxide (CO) in the local air shed in and around the sub-project sites. The evaluated impacts on ambient air quality including its magnitude and significance are mentioned in the following **Table 9.5** and corresponding mitigation measures are given in the following section accordingly.

Table 9.5: Summary of Impact Evaluation on Air Quality during Construction and Operation Stages

Sub-Project Name	Sub-Project Activities	Potential Impacts	Temporal Aspects	Spatial Aspects	Reversibility	Compliance	Likelihood	Magnitude	Sensitivity	Significance without mitigation	Residual Impact after mitigation
Construction Stage											
Rehabilitation of 10, and 11-acre shrimp estate including associated canals and 48-acre Shrimp demonstration Farm, Chakaria, Cox's Bazar	Tree felling and vegetation clearance	Generation of fugitive dust particles	2	1	2	2	3	M	L	L	L
	Rehabilitation of civil structures and associated demolition activities		2	2	2	2	2	M	L	L	L
	Land filling, cutting and leveling		2	3	2	2	2	S	L	L	L
	Carrying construction materials and other construction activities such as crushing rocks and bricks, mixing sand, brick chips, cement, etc.		2	3	2	2	2	S	L	L	L
	Re-excavation of internal canals		2	1	1	2	2	M	L	L	L
	Running of fuel based heavy machineries and equipment	Exhaust emission and increased criteria pollutants in the local airshed	4	4	3	2	4	H	M	S	L
	Vehicular and vessel movement		2	2	2	2	2	M	L	L	L
BFDC Harbor at Chattogram	Tree felling and vegetation clearance	Generation of fugitive dust particulate matters	2	1	2	2	3	M	L	L	L
	Rehabilitation of civil structures and associated demolition activities		2	1	2	3	3	M	M	M	L
	Land filling, cutting and leveling		1	1	2	3	3	M	M	M	L
	Running of fuel based heavy machineries and equipment		2	1	2	2	3	M	M	M	L
	Running of fuel based heavy machineries and equipment		2	1	2	2	3	M	M	M	L

Sub-Project Name	Sub-Project Activities	Potential Impacts	Temporal Aspects	Spatial Aspects	Reversibility	Compliance	Likelihood	Magnitude	Sensitivity	Significance without mitigation	Residual Impact after mitigation
	Vehicular movement	Exhaust emission and increased criteria pollutants in the local airshed	2	4	2	2	3	S	M	M	L
BMC Area at DFTC, Teknaf	Tree felling and vegetation clearance	Generation of fugitive dust particles	2	1	2	2	3	M	L	L	L
	Land filling, cutting, and leveling		2	1	1	2	2	M	L	L	L
	Running of fuel based heavy machineries and equipment		2	1	2	2	3	M	M	M	L
	Running of fuel based heavy machineries and equipment	Exhaust emission and increased criteria pollutants in the local airshed	4	4	3	2	4	H	M	S	L
	Vehicular movement		2	4	2	2	3	S	M	M	L
Canal Rehabilitation for Cluster Farming	Excavators for re-excavation, land leveling and compacting re-excavated soil by roller or hammer	Generation of fugitive dust particulate matters	2	1	2	2	2	M	L	L	L
	Vessel movement	Exhaust emission and increased criteria pollutants in the local airshed	2	4	2	2	3	S	M	M	L
Operation Stage											
Rehabilitation of 10, and 11-acre shrimp estate including associated canals and 48-acre Shrimp demonstration Farm, Chakaria, Cox's Bazar	Increased volume of riverine traffic	Exhaust emission and increased criteria pollutants in the local airshed	3	2	4	2	3	S	M	M	L

Acoustic Noise

Noise might be generated during tree felling, and demolition of abandoned civil structures at 48- acres of shrimp demonstration area under CSE, BFDC Harbor at Chattogram, and BMC area at DFTC, Teknaf. On the other hand, civil construction and vehicular movement are also major sources of noise. The sources of noise are given in the following **Table 9.6**.

Table 9.6: Sources of Noise and Activities

Sl. No.	Sources of Noise	Activities Responsible for Generating Noise
1	Construction sites	• Site clearing and preparation; • Excavation, piling and concrete placement; • Erection of structures; • Concrete mixing and aggregate production systems; • Construction Camps / Ancillary Facilities; • Drilling activities; and • Haulage and general vehicle movements.
2	Mobile sources (Mostly vehicles involved in construction activities)	• Engine running; • Hydraulic horns; • Loading and unloading activities.

The potential impacts have been evaluated based on the activities under each sub-project separately. The magnitude and significance of these impacts on acoustic noise were evaluated with different scores. **Table 9.7** shows the evaluated impacts on the acoustic noise for each sub-project sites and corresponding mitigation measures are given in the **Table 9.10**.

Table 9.7: Summary of Impact Evaluation on Acoustic Noise during Construction and Operation Stages

Sub-Project Name	Sub-Project Activities	Potential Impacts	Temporal Aspects	Spatial Aspects	Reversibility	Compliance	Likelihood	Magnitude	Sensitivity	Significance without mitigation	Residual Impact after mitigation
Construction Stage											
Rehabilitation of 10, and 11-acre shrimp estate including associated canals and 48-acre Shrimp demonstration Farm, Chakaria, Cox's Bazar	Tree felling and vegetation clearance	Increase in acoustic noise level	2	2	2	2	3	S	L	L	L
	Rehabilitation of civil structures after demolition of those by drilling, hammering, etc.		2	2	2	2	4	S	L	L	L
	Land filling and levelling		1	1	2	2	2	M	L	L	L
	Civil Constructions		2	1	2	2	4	S	L	L	L
	Re-excavation of internal canals		1	2	1	2	1	M	L	L	L
	Rehabilitation of hydraulic structures (sluice gates)		2	2	2	2	4	S	L	L	L
	Construction of labor camp/shed and other facilities for the labors		1	2	1	2	3	M	L	L	L
	Vehicular and vessel movements		3	4	2	2	3	S	L	L	L
BFDC Harbor at Chattogram	Tree felling and vegetation clearance		2	2	2	2	2	M	M	M	L
	Rehabilitation of civil structures after demolition of those by drilling, hammering, etc.		2	3	2	2	4	S	M	M	L
	Land levelling		2	2	1	2	3	M	L	L	L
	Civil Constructions		2	3	2	2	4	S	M	M	L
	Laying of underground distribution line		1	1	1	2	1	M	L	L	L
	Construction of labor camp/shed and other facilities for the labors		1	2	1	2	1	M	L	L	L
	Transporting generated wastes through dump truck to nearby landfill site		2	4	2	2	2	S	M	M	L

Sub-Project Name	Sub-Project Activities	Potential Impacts	Temporal Aspects	Spatial Aspects	Reversibility	Compliance	Likelihood	Magnitude	Sensitivity	Significance without mitigation	Residual Impact after mitigation
BMC Area at DFTC, Teknaf	Tree felling and vegetation clearance		1	1	1	2	2	M	L	L	L
	Rehabilitation of civil structures after demolition of those by drilling, hammering, etc.		2	2	2	2	3	S	L	L	L
	Land filling and levelling		1	2	1	2	2	M	L	L	L
	Construction of labor camp/shed and other facilities for the labor		1	2	1	2	1	M	L	L	L
	Transporting generated wastes and construction materials through dump trucks to the landfill site		2	2	2	2	2	M	L	L	L
Canal Rehabilitation for Cluster Farming	Re-excavation of the canals		1	1	1	2	1	M	L	L	L
	Compacting the excavated soil on the dykes		2	1	2	2	1	M	L	L	L
	Transporting excavated materials to other places through mechanized van		2	3	1	2	2	M	L	L	L
Operation Stage											
Rehabilitation of 10, and 11-acre shrimp estate including associated canals and 48-acre Shrimp demonstration Farm, Chakaria, Cox’s Bazar	Vessel movements	Increase in acoustic noise level	3	2	2	2	2	S	L	L	L
BFC Harbor at Chattogram	Fish cleaning, processing and packaging		4	2	4	2	2	S	L	L	L
	Loading and unloading activities		4	1	1	2	2	M	L	L	L
	Vehicular movement and vessel movement		4	4	4	2	3	H	M	S	L
	Lifting activities through fork lifter at the jetty site		4	2	1	2	2	S	L	L	L
	Operation of fish landing center		4	4	2	2	3	S	M	M	L
BMC area at DFTC, Teknaf	Vehicular movement		4	4	4	2	3	H	L	M	L

Water Quality

Potential impacts on the water quality of river and groundwater are mostly related with the construction related interventions of the project. If proper approaches based on available best practices are not taken, the water quality might be contaminated as listed below:

Contamination of water bodies by construction waste: Waste from construction sites e.g., cement, sand, bricks, etc., and other waste e.g., trash materials, scrap wood, paper, kitchen waste from construction camp, spilled-oils from oil containment/storage area/equipment/vehicles/vessels, etc. might fall into river if not properly managed. Also, open discharge of solid and liquid wastes from the labor shed and houseboat can contaminate the surface water with excessive nutrients, heavy metals, organic pollutants, etc.

Increase of turbidity in river-water column: The bank protection works at sites will involve dumping of soil and compaction, piling, preparing slope for bank protection work, etc. might increase turbidity in the river-water column nearby. Besides, the canal will be re-excavated which will contribute to change in water quality in place of bank protection and re-excavation.

Risk of oil spillage from the vessel: There is a risk of spillage of oil, lubricant and bilge water during excavation, hydrographic surveys, refueling, lose or broken hydraulic fittings and transport/storage, if not properly maintained.

A summary of the impact on water quality for each sub-project site are presented in the following **Table 9.8.** and corresponding mitigation measures are presented in the **Table 9.11.**

Table 9.8: Summary of Impact Evaluation on Water Quality during Construction and Operation Stages

Sub-Project Name	Sub-Project Activities	Potential Impacts	Temporal Aspects	Spatial Aspects	Reversibility	Compliance	Likelihood	Magnitude	Sensitivity	Significance without mitigation	Residual Impact after mitigation
Construction Stage											
Rehabilitation of 10, and 11-acre shrimp estate including associated canals and 48-acre Shrimp demonstration Farm, Chakaria, Cox's Bazar	Disposal of construction waste	Contamination to surface water bodies.	2	3	2	2	2	S	L	L	L
	Disposal of kitchen waste generated at labor camp	- Unauthorized dumping of construction waste on the peripheral or internal dyke may cause slide down the wastes into the river or internal canals or shrimp gher. - Similarly, unauthorized dumping of kitchen wastes may cause wash out to the nearby water bodies by rain.	1	2	2	2	3	M	L	L	L
	Re-excavation of internal canals	Increased turbidity of water column of the intervened canals and connected flowing waterbodies may cause respiratory problems and susceptible to predation temporarily	2	2	2	2	3	S	L	L	L
	Vessel movement for transporting construction materials and equipment	Oil spillage and discharge of bilge water into the internal canals may deteriorate water quality	2	2	2	2	3	S	L	L	L
	Civil construction and hydraulic structure rehabilitation	Risk of spilling concrete or concrete slurry into the nearby waterbodies	2	2	2	2	3	S	L	L	L
BFDC at Chattogram	Disposal of construction waste	Contamination of surface water bodies	2	3	2	3	2	S	M	M	L
	Disposal of kitchen waste generated at labor camp	Unauthorized dumping of construction waste nearby waterbodies may cause slide down the wastes into it.	2	2	2	2	2	M	L	L	L
BMC Area at DFTC, Teknaf	Disposal of construction waste		2	3	2	2	2	S	L	L	L

Sub-Project Name	Sub-Project Activities	Potential Impacts	Temporal Aspects	Spatial Aspects	Reversibility	Compliance	Likelihood	Magnitude	Sensitivity	Significance without mitigation	Residual Impact after mitigation
	Disposal of kitchen waste generated at labor camp	Similarly, unauthorized dumping of kitchen wastes may cause wash out to the nearby water bodies by rain.	2	2	2	2	2	M	L	L	L
Operation Stage											
BFDC Harbor at Chattogram	- Treatment of effluent or waste water in ETP generated in the fish processing plant. - Waste water from fish processing plant transferring to ETP for treatment	Contamination of surface water bodies - Leakage of waste water before entering the ETP and mixing with nearby waterbodies. - Accidental chemical oil leaks, spills on land/ water from equipment/ parts of the treatment plants e.g., WTP and ETP. - Unauthorized management of sludge generated in the WTP and ETP may cause contamination to nearby waterbody.	3	2	3	4	2	S	M	M	L

Description of Mitigation Measures

Necessary mitigation measures for air quality are given in the following **Table 9.9**.

Table 9.9: Mitigation Measures for Air Quality

Mitigation Hierarchy	Measures
Avoid	▪ Avoid transporting the construction materials through the earthen roads to the extent possible ▪ Avoid water bodies and community area/locations for rock/ brick crushing, concrete batching yards ▪ Avoid storing the construction materials nearby waterbodies and community area ▪ Avoid storing of trash materials along the bank/slope of a water body. ▪ Avoid queuing of vehicles in areas adjacent to site, particularly near sensitive receptors including housing
Minimize	▪ Fencing/railing of construction area by drum sheet or mesh nets or GI wire/tarija ▪ Limiting site clearance and base stripping activities within the project boundary ▪ Stocking and covering (if needed) of construction materials and machinery must be within a limited area ▪ Stock piles of construction materials be required to cover in order to protect them from wind and weathering action ▪ Burning of waste material will be restricted ▪ Limiting activities for producing fugitive dust particle e.g., excavating earth, handling of the construction materials etc. ▪ Vegetation clearance and base stripping at riverside and country side slopes of the bank protection work will be minimized ▪ Regular maintenance of water vessels, vehicles, generator and construction machinery in accordance with manufacturer's specifications and ensuring the good operating condition. ▪ Switch off / throttle down all site vehicles, water vessels, generator and machinery when not in use. ▪ Concrete batching and mixing plant ought to be located downwind of and minimum 500m away from residential areas as well as sensitive receptors and be fitted with high stack (30m) to allow adequate dispersion of emissions; ▪ Construction wastes must be reused or recycled as and where possible.
Mitigate	▪ Vehicle speed restriction (e.g., 10-20 km/h) must be enforced to control dust generation ▪ Construction materials must be covered to protect from wind action ▪ Spray water regularly for suppressing fugitive dust ▪ dump trucks carrying sand or other fines containing materials have their loads covered when under way to mitigate dust generation from the loads ▪ An appropriate freeboard must be maintained in trucks hauling construction materials ▪ Introducing pollution free/new technology in construction activities ▪ Approved pollution control devices to be fitted in equipment and machinery ▪ Establish grass carpeting in the unpaved area where possible ▪ Regular air monitoring will be carried out near the sensitive receptors to ensure ambient air quality remains within the limits defined by national standards
Compensate/Offset	N/A

Mitigation measures on ambient noise are given in the following **Table 9.10**.

Table 9.10: Mitigation Measures on Ambient Noise Level

Mitigation Hierarchy	Measures
Avoid	▪ No construction activities at night. ▪ No positioning of stationary noise sources such as generators and compressors as far away as possible from noise sensitive areas. ▪ Forbidding horns in populated areas. ▪ No operations during monsoon seasons ▪ No time periods when effective impact mitigation is not possible, ▪ No night time pile driving activities to eliminate vibration in nearby homes during the nighttime hours
Minimize	▪ Minimize the duration over which the sound-producing activity is intended to take place; ▪ No pile driving during high water level to avoid impact on aquatic species. ▪ Minimize the individual and cumulative sound pressure and exposure levels delivered into the environment by the activity. If necessary, the use of alternative, lower impact equipment and methods could be explored (e.g., vibratory hammer, gravity base piles). ▪ Use muffler systems to control engine noise ▪ Use shields that are physically attached to the particular piece of equipment, particularly for stationary equipment and where considerable noise reduction is required. ▪ Movable noise attenuation measures would be erected around pumps, trucks, and other noisy equipment when operating in close proximity to residential areas. ▪ Use a smaller hammer to reduce the sound pressure. The sound produced in pile driving has a direct relationship to the force used to drive the pile ▪ For minimizing vibrations, route heavily loaded trucks away from the residential streets, if possible, select streets with fewest homes, if no alternatives are available. ▪ Operating of earth moving equipment on the construction lot as far away from vibration sensitive sites as possible
Mitigate	▪ Source control requirements may have the added benefits of promoting technological advances in the development of quieter equipment. ▪ Equipment modifications, such as dampening of metal surfaces, are effective in reducing noise due to vibration. ▪ Enclosures for stationary work may be constructed of wood or any other suitable material and typically surround the specific operation area and equipment. ▪ The use of electric powered equipment is typically quieter than diesel, and hydraulic powered equipment is quieter than pneumatic power. ▪ Using vehicles and equipment in good conditions ▪ Monitor sound levels during pile driving at various distances within the mitigation zone to ensure that noise levels do not exceed the DoE, WB or any other international recognized criteria. ▪ Implement measures to attenuate the sound when sound pressure levels exceed the DoE, WB or any other internationally recognized criteria. ▪ Incorporate the use of fully enclosing or confined bubble curtains, encircling absorptive barriers (e.g., isolation casings, cofferdams) or other demonstrably effective noise reduction methods at the immediate works site
Compensate/Offset	N/A

Mitigation measures on water quality are given in the following **Table 9.11**.

Table 9.11: Mitigation Measures on Water Quality

Mitigation Hierarchy	Measures
Construction Stage	
Avoiding	No mixing concrete onsite and use concrete premix.
Minimizing	- Maximize the use of construction materials and hence, minimize the disposal and runoff of construction waste. - Hire unskilled local labor to minimize the size of construction cam
Mitigation	- ESCOP 1: Waste Management - ESCOP 3: Water Resources Management; - ESCOP 6: Erosion and Sediment Control
Compensate/Offset	N/A
Operation Stage	
Avoiding	- No dumping of any type of solid waste and wastewater into open water - Restrict fishers from throwing any sort of waste material into the water by communication, awareness building, and legal enforcement.
Minimizing	Install waste disposal containers within trollers and vessels and then organize a collection and disposal system to an approved landfill location
Mitigation	- Monitoring of implementation of environmental management plan will be done by responsible agencies - Introducing penalty/fine for littering or non-observance of waste management procedure would help enforcement of law.
Compensate/Offset	N/A

d) Accidental Event

Road Traffic Management

According to the sub-project activities as mentioned in the **Section 4.10**, some demolition works and underground distribution line installation work would be conducted. According to the **Table 4.9** under **Section 4.22.1** of **Chapter 4** the debris to be generated from demolition of abandoned civil structures and wooden debris. Hence, considering the road width and accessibility to the sub-project site, around 2013, and 37 dump trucks with capacity of 10 Ton and 257 dump trucks with capacity of 5 Ton would be required for CSE, BFDC, and BMC for transporting the wastes. Road traffic would be increased during construction stage and accidental events might also be occurred.

As the underground lines will be constructed at BFDC within roadways, road or lane closures will be required and traffic control signage would be installed. The construction area will need to be barricaded off to keep the public away from the works. Building construction will be prohibited above the underground cables, since they would interfere with maintenance and repair work. The temporary road closure may disturb/limited the public movement and accidental events might also be occurred.

Vessel Traffic Management

According to the information of generated concrete wastes from civil and hydraulic structures and wooden debris would be generated at CSE (Ref. to **Table 4.9** in **Section 4.22.1**), hence, to transport these debris from CSE to Cox's Bazar Boat Ghat a number of vessels would be required as CSE is not accessible directly through roadways. This might be done using trawlers as the internal canals are not

wide enough to carry a large volume of debris at a time. In addition, tidal effect is also to be considered in this case. Hence, vessel traffic would be increase during the construction stage in CSE.

Underground Utility Managment

Public utilities including electricity and telephone lines, gas pipes, water pipelines or sewers may be affected during the installation works of underground cables.

A summary of the impact on accidental event for the sub-project sites are presented in the following **Table 9.12** and corresponding mitigation measures are presented in the **Table 9.13**.

Table 9.12: Summary of Impact Evaluation on Accidental Event during Construction and Operation Stages

Sub-Project Name	Sub-Project Activities	Potential Impacts	Temporal Aspects	Spatial Aspects	Reversibility	Compliance	Likelihood	Magnitude	Sensitivity	Significance without mitigation	Residual Impact after mitigation
Construction Stage											
Rehabilitation of 10, and 11-acre shrimp estate including associated canals and 48-acre Shrimp demonstration Farm, Chakaria, Cox's Bazar	Transporting generated debris (Ref. to Section 4.22.1) from the construction site to the boat ghat through trawlers	Vessel movement in the internal canals and surrounding rivers would be increased.	2	2	2	3	2	S	M	M	L
	Transporting generated debris (Ref. to Section 4.22.1) from the boat ghat to the vendors through dump trucks	Road traffic would be increased and accidental events may also be happened.	2	4	4	3	3	H	H	H	M
BFDC Harbor at Chattogram	Transporting generated debris (Ref. to Section 4.22.1) from the construction site to the vendors through dump trucks;	Road traffic would be increased and accidental events may also be happened.	2	4	4	3	3	H	H	H	M
	Underground cable installation	Underground utilities may be affected	2	2	2	2	2	M	H	S	L
BMC area at DFTC, Teknaf	Transporting generated debris (Ref. to Section 4.22.1) from the construction site to the vendors through dump trucks	Road traffic would be increased and accidental events may also be happened.	2	4	4	3	3	H	H	H	M

Necessary measures on accidental event are given in the following **Table 9.13**.

Table 9.13: Necessary Measures for Accidental Event

Mitigation Hierarchy	Measures
Avoid	N/A
Minimize	▪ Dump trucks should be covered properly and maintain limited speed. ▪ Underground utility survey should be conducted before finalization the distribution line route.
Mitigate	▪ Access to project site should be restricted for the local community. ▪ Adequate number of danger signs, symbols are placed properly at the loading and unloading locations. ▪ No unfit vehicles such as dump trucks, construction material trucks/lorries, etc. and other machines should be allowed to be in use. ▪ Slabs (concrete, bamboo or wooden) should be placed across the cable trench in front of residential or official building to act as bridges for people near to the cable route trench. ▪ Trenching activities along the road should be done in the dry season. ESCOP 14: Road Transport and Road Traffic Management, and ESCOP 15: River Transport Management should be followed properly.
Compensate/Offset	N/A

Biological Environment

Ecological Resources

Potential impacts and corresponding mitigation measures on the selected VESCs are mentioned as follows:

Vegetation: During the construction stage encompassing the establishment of the site office, work shed, and stock yard, along with the transportation and organization of construction materials, it is crucial to acknowledge the minimal impact on the surrounding vegetation at specific points. Specifically, the vegetation most at risk of disturbance includes the plants near the designated areas for the site office, labor shed, stock yard, and material storage areas.

In addition, a number of vegetation would be felled down. Ref to the **Section 4.22.1 (iii)**, five (05) trees from the 48- acres of Shrimp Demonstration Area of CSE, and 192 trees from BFDC Harbor at Chattogram would be felled down. In addition, Ref. to **Section 11.6**, around 44 trees would be felled down from the BMC Area at DFTC, Teknaf. A number of plants and trees including date tree, banana plant, palm tree etc. exists on both sides of canal dykes of cluster farming area would be cleared.

Therefore, vegetation including trees and some mangroves would be cleared for canal re-excavation and disposal of re-excavated materials alongside canals (on the banks) would cause loss of several native plants, herbs, shrubs, and epiphytes within the vicinity.

Wildlife Habitat: Removal of riparian and mangrove vegetation in the project site would hamper the habitat for wildlife species like birds, amphibians, and aquatic mammals in that area. Disturbance from construction noise, equipment operations, and human interference would displace wildlife habitat. Disposal of excavated materials alongside rivers and canals could damage or clear existing vegetation and also could contaminate water quality if not done properly. This could indirectly impact both aquatic and terrestrial fauna. Excavation of soil from river bed will cause casualties invertebrates and crustaceans. Increasing turbidity would deteriorate habitat quality and relocation of fishes, snakes etc. from the excavated locations. Mollusks crabs and benthic fauna will be evicted with the excavated soils and cast away at the soil placement sites. As the perennial portion of a river support last shelter for

the fishes and other aquatic biota in driest period of the year, so excavation of river bed would cause the death or extinction of that aquatic biota. Temporary disturbed on local fauna like wetland bird, Water snakes, Rat, Mongoose, Garden lizard, Frogs, local and migratory birds etc. due to habitat loss. Risk/death of invertebrate's mollusks and crustaceans in river beds will happen during excavation. Temporarily impacted due to Withdrawn of bed materials from river beds and earthen placement hampering the wildlife movement.

Table 8.14: Summary of Impact Evaluation on Vegetation during Construction and Operation Stages

Sub-Project Name	Sub-Project Activities	Potential Impacts	Temporal Aspects	Spatial Aspects	Reversibility	Compliance	Likelihood	Magnitude	Sensitivity	Significance without mitigation	Residual Impact after mitigation
Construction Stage											
Rehabilitation of 10, and 11-acre shrimp estate including associated canals and 48-acre Shrimp demonstration Farm, Chakaria, Cox's Bazar	Tree felling and vegetation clearance	Loss of vegetation	2	3	2	2	2	S	L	L	L
	Vehicular movement	Damage to seedling caused by movement of vehicle.	1	2	1	1	2	M	L	L	L
	Storage of construction materials on the yard	Damage to existing yard vegetation	2	2	1	2	1	M	L	L	L
	Re-excavation of internal canals	Movement of excavator may cause smash down the mangrove and marginal vegetation	4	4	3	2	4	H	M	S	L
	Quarrying of re-excavated soil from canal bed	The aquatic vegetation will be uprooted/ demolished	1	2	2	2	2	M	L	L	L
	Re-excavated soil management	All the grasses, herbs and shrubs will be buried at the sites where re-excavated earthen materials would be placed	4	4	2	2	2	S	M	M	L
BFDC Harbor at Chattogram	Tree felling and vegetation clear	Existing vegetation loss	4	4	3	2	4	H	M	S	L
BMC Area at DFTC, Teknaf	Tree felling and vegetation clear	Existing vegetation loss	4	3	3	2	4	H	M	S	L
		Removal of mangrove vegetation	4	3	3	2	4	H	M	S	L
Canal Rehabilitation for Cluster Farming	Re-excavation of canals and dumping of excavated earth	Disposal of excavated earth along the both banks of the canals might cause draping small vegetation including native plants, herbs, shrubs, and epiphytes within the vicinity	2	2	3	2	4	S	L	L	L

Table 9.15: Summary of Impact Evaluation on Wildlife Habitat during Construction and Operation Stages

Sub-Project Name	Sub-Project Activities	Potential Impacts	Temporal Aspects	Spatial Aspects	Reversibility	Compliance	Likelihood	Magnitude	Sensitivity	Significance without mitigation	Residual Impact after mitigation
Construction Stage											
Rehabilitation of 10, and 11-acre shrimp estate including associated canals and 48-acre Shrimp demonstration Farm, Chakaria, Cox's Bazar	Tree felling and vegetation clearance	Damage to the habitats of small mammals, reptiles, amphibian, urban and other wetland birds.	2	2	2	2	2	M	L	L	L
	Re-excavation of internal canals	Risk/death to invertebrates/shell fish like mollusks and crustaceans in canal beds.	4	3	3	2	2	S	L	L	L
		Disturbance to wetland bird movement, roaming grounds.	2	2	2	2	2	M	L	L	L
BFDC Harbor at Chattogram	Tree felling and vegetation clearance	Damage to the existing habitats of small mammals, reptiles, amphibians, urban and other wetland birds at the excavation and civil works area.	2	2	2	2	2	M	L	L	L
BMC Area at DFTC, Teknaf	Tree felling and vegetation clear	Damage to the existing habitats of small mammals, reptiles, amphibians, urban and other wetland birds at the excavation and civil works area.	2	2	2	2	2	M	L	L	L
	Land preparation and construction activities	Disturbance to wetland bird movement, roaming grounds.	2	2	2	2	2	M	L	L	L
Canal Rehabilitation for cluster farming	Tree felling and vegetation clearance	Damage to the existing habitats of small mammals, reptiles, amphibians, urban and other wetland birds at the excavation and civil works area.	2	2	2	2	2	M	L	L	L
	Land filling and cutting and levelling	Risk/death to invertebrates/shell fish like mollusks and crustaceans in canal beds.	4	3	3	2	2	S	M	M	L
	Land preparation, abandoned structure demolition, and other construction activities	Disturbance to wetland bird movement, roaming grounds.	2	2	2	2	2	M	L	L	L

Necessary measures for vegetation and wildlife habitat are given in the following **Table 9.16**.

Table 9.16: Necessary Measures for the Damages of Vegetation and Wildlife Habitat

Mitigation Hierarchy	Measures
Measures for Vegetation	
Avoid	• Avoid vegetative parts as much as possible for labor shed and stock yard • Avoid mangrove vegetation for excavator movement • Avoid aquatic vegetation as much as possible for dumping of excavated earth • Avoid queuing of vehicles in areas adjacent to site, particularly near sensitive vegetation areas.
Minimize	• Choose barren land for site office, labor shed and stock yard and piling the construction materials area for labor shed and material stock yard • Limit the movement of excavator at the same alignment for forwarding and back-warding • Untouched the aquatic vegetation at the deepest portions of the river to give chance to propagate by natural process • Earthen materials ought to be set at desolate territory and step down at plantation region and minimum disturb of herbs and shrubs area be restricted • Vegetation clearance and base stripping at riverside and country side slopes of the bank protection work will be minimized
Mitigate	• Implement marginal and amphibian plantation including local floral species within the river levees to enhance vegetation of the development area • Execute awareness program on plant, fish and wild life preservation among the nearby individuals to limit over investigation of assets from river, canal and natural product garden regions • Chosen suitable location for mangrove plantation • Consider suitable native species for success • Implement plantation plan with indigenous floral species at the arms of proposed water control structures
Compensate/Offset	• N/A
Measures for Wildlife Habitat	
Avoid	• No construction activities at night. • Avoid clearing of the important faunal habitat. • Forbidding horns in mangrove areas. • No operations during monsoon period when activities of aquatic biota are high • Avoid forest area for heavy activities
Minimize	• No pile driving during high water level to avoid impact on aquatic species. • Re-excavated materials should be placed in the barren habitat area; • Schedule excavation activities during monsoon seasons of low wildlife activity (e.g., avoid nesting seasons for birds or breeding seasons for aquatic species). • Use specialized equipment and techniques to minimize noise, vibrations, and sedimentation that can disturb wildlife. • Use buffer systems to control disturbed of wildlife
Mitigate	• Restore disturbed habitats by replanting native vegetation, creating new wetlands, or installing artificial structures to provide nesting sites or shelter for wildlife. • Install temporary wildlife fencing and barriers to prevent animals from accessing construction sites and becoming injured or displaced.

Mitigation Hierarchy	Measures
	- Ensure that fencing is wildlife-friendly, with escape routes for smaller animals and periodic openings for larger species. - Monitor sound levels during pile driving at various distances within the mitigation zone to ensure that no damage of important habitat.
Compensate/ Offset	N/A

Fisheries Resources

Potential impacts and corresponding mitigation measures on the selected VESCs are mentioned as follows:

Chakaria Shrimp Estate

Impact on Fish Habitat: Rehabilitation of water supply and drainage canals, including re-excavation of canals, repairing of sluice gates, and reconstruction of embankments, may potentially disturb the condition of aquatic habitats by increasing water turbidity. Increased turbidity in the water column due to re-excavation activities can temporarily hamper fish respiration and the propagation of primary producers. This disturbance can harm fish and other aquatic life by reducing food supplies and excavating spawning beds. Increased turbidity could also affect the gill function of fish, potentially causing suffocation and starvation. The underwater noise and disturbance from re-excavation activities can scare fish, causing them to shift away from the site. Additionally, removal of silt from the canal bed through re-excavation can temporarily disrupt the habitations of demersal fish species. These habitats are expected to be reinstated over the course of three to five years.

Sensitive and important habitats in the canals, which serve as wintering sites for fish, may also be disrupted due to the re-excavation of bed sediments. Furthermore, any accidental leakage, spillage of contaminants, or dumping of solid waste or debris into water bodies can potentially affect canal habitats.

On the other hand, waste from fish processing plant of BFDC, including organic waste and chemicals, can pollute nearby water bodies. If the polluted water falls into the Karnaphuli River, the river water will be polluted. This pollution can lead to eutrophication, habitat degradation, and harm to life of different fishes. Traditional waste management methods may be insufficient to handle the volume and scale of waste will produce by processing plant.

For the canal rehabilitation for cluster farming sub-project, re-excavation of canals, may potentially disturb the condition of aquatic habitats by increasing water turbidity. Increased turbidity in the water column due to re-excavation activities can temporarily hamper fish respiration and the propagation of primary producers. This disturbance can harm fish and other aquatic life by reducing food supplies and excavating spawning beds. Increased turbidity could also affect the gill function of fish, potentially causing suffocation and starvation. The underwater noise and disturbance from re-excavation activities can scare fish, causing them to shift away from the site. Additionally, removal of silt from the canal bed through re-excavation can temporarily disrupt the habitations of demersal fish species. These habitats are expected to be reinstated over the course of three to five years. Sensitive and important habitats in the canals, which serve as wintering sites for fish, may also be disrupted due to the re-excavation of bed sediments. Furthermore, any accidental leakage, spillage of contaminants, or dumping of solid waste or debris into water bodies can potentially affect canal habitats.

Impacts on fish migration: Among the proposed interventions, repair & renovation of existing sluice gate might alter the natural flow of water, which may impede the passage or lateral migration of the

low velocity (0.5m/s–0.6m/s) tolerant fishes (i.e., SIS, small carps, gobids, etc.). On the other hand, canal re-excavation though temporarily may hamper longitudinal migration of fishes.

Sluice gates can affect snail movements and habitats, delaying migration and causing bed scouring due to various designs (Barton et al., 1992; Rasoul et al., 2022; Salah et al., 2021; Janusz et al., 2020; Shahidul et al., 2014). Additionally, snails can damage sluice gate structures by attaching to them.

Under the sub-project, “Canal Rehabilitation for Cluster Farming”, Fish migration generally occurs for different biological purposes (i.e., distribution, growth, reproduction, shelter, protection from predators) of fish. Temporary blockage or alteration of fish migratory routes due to excavation work may hamper fish migration. The canal re-excavation activities would have very limited impact on the fish migration but in the long run it may facilitate such migration. This in-turn would support the balance in species composition, which are dealt later.

Impacts on Fish Species Composition: Alteration in the natural flow of water may change the distribution pattern of fish species and reduce the availability of some important fish species. During the construction period particularly re-excavation, the fishes may shift from the area because of excessive suspended sediment, increased water turbidity and underwater noise, etc. Moreover, fish eggs, fry, larvae and juveniles may be damaged at the dredging/re-excavation in the construction area. These impacts mostly may be marked as temporary while damage to fish eggs and fries may be marked as a big loss to next progeny.

On the other hand, alteration in the natural flow of water may change the distribution pattern of fish species and reduce the availability of some important fish species in the canals those would be rehabilitated for cluster farming purposes. During the construction period, the fishes may shift from the area because of excessive suspended sediment, increased water turbidity and underwater noise, etc. Moreover, fish eggs, fry, larvae and juveniles may be damaged at the dredging/re-excavation in the construction area. These impacts mostly may be marked as temporary while damage to fish eggs and fries may be marked as a big loss to next progeny

Impacts on Fish Production: Fish production will be temporarily reduced due to impacts on fish habitat, species composition and migration.

Impacts on grazing ground: Grazing ground will be destroyed due to establishment of shrimp hatchery in the project area of Brood Management Center (BMC). The project area has some mudflat area which provide critical feeding and breeding grounds for fish, crustaceans, and mollusks. Destruction of these habitats can displace these species, reducing their populations.

Potential Impacts and their significance in construction and operation stages for each sub-projects are mentioned in the following **Table 9.17**:

Table 9.17: Summary of Impact Evaluation on Fish Habitat during Construction and Operation Stages

Sub-Project Name	Sub-Project Activities	Potential Impacts	Temporal Aspects	Spatial Aspects	Reversibility	Compliance	Likelihood	Magnitude	Sensitivity	Significance without mitigation	Residual Impact after mitigation
Construction Stage											
Rehabilitation of 10, and 11-acre shrimp estate including associated canals and 48-acre Shrimp demonstration Farm, Chakaria, Cox's Bazar	- Reconstruction of Embankment/ Peripheral Dyke; - Rehabilitation of water supply and drainage canals; - Repair & renovation of existing sluice gate.	Habitat disturbance due to canal re-excavation leads to higher turbidity levels in the water column. Suspended sediments can clog fish gills, affecting their respiration.	2	2	2	4	4	S	H	H	M
		Re-excavation activities may disturb benthic fish habitats, as well as their spawning and feeding grounds.	2	2	2	4	4	S	H	H	M
		Habitat quality may degrade because turbidity reduces light penetration and decreases primary production.	2	1	2	2	3	M	M	M	L
		Underwater noise from excavation machinery disturbing aquatic life and fish can move away from the disturbance area.	1	1	1	1	2	M	L	L	L
		Destruction or alteration of fish habitats adjacent to the embankment.	1	2	1	1	2	M	L	L	L
Canal Rehabilitation for Cluster Farming	Re-excavation of Canal	Habitat disturbance due to canal re-excavation leads to higher turbidity levels in the water column. Suspended sediments can clog fish gills, affecting their respiration.	2	2	2	4	4	S	H	H	M

Sub-Project Name	Sub-Project Activities	Potential Impacts	Temporal Aspects	Spatial Aspects	Reversibility	Compliance	Likelihood	Magnitude	Sensitivity	Significance without mitigation	Residual Impact after mitigation
		Excavation activities may disturb benthic fish habitats, as well as their spawning and feeding grounds.	2	2	2	4	4	S	H	H	M
		Habitat quality may degrade because turbidity reduces light penetration and decreases primary production.	2	1	2	2	3	M	M	M	L
		Underwater noise from excavation machinery disturbing aquatic life and fish can move away from the disturbance area.	1	1	1	1	2	M	L	L	L
Operation Stage											
BFDC Harbor at Chattogram	- Construction of pre-processing zone with ICE Plant and chilled storage facilities - Construction of modern processing factory 500 MT capacity with 4-6 chambers including storage and associate other facilities;	Waste from the BFDC fish processing plant, including organic waste and chemicals, can pollute nearby water bodies and the Karnaphuli River, causing eutrophication, habitat degradation, and harm to fish if the ETP does not function well.	4	2	4	2	3	S	M	M	L

Table 9.18: Summary of Impact Evaluation on Fish Migration during Construction and Operation Stages

Sub-Project Name	Sub-Project Activities	Potential Impacts	Temporal Aspects	Spatial Aspects	Reversibility	Compliance	Likelihood	Magnitude	Sensitivity	Significance without mitigation	Residual Impact after mitigation
Construction Stage											
Rehabilitation of 10, and 11-acre shrimp estate including associated canals and 48-acre Shrimp demonstration Farm, Chakaria, Cox's Bazar	- Rehabilitation of water supply and drainage canals; - Repair & renovation of existing sluice gate;	Temporary blockage or alteration of fish migratory routes due to canal excavation and sluice gate rehabilitation.	2	2	1	1	4	M	L	L	L
	Repair & renovation of existing sluice gate;	Sluice gates can affect snail movements and habitats, delaying migration and causing bed scouring due to various designs. Additionally, snails can damage sluice gate structures by attaching to them.	2	2	1	2	3	M	M	M	L
Canal Rehabilitation for Cluster Farming	Re-excavation of Canals	Temporary blockage or alteration of fish migratory routes due to excavation work.	2	2	1	1	4	M	M	M	L

Table 9.19: Summary of Impact Evaluation on Fish Species Composition during Construction and Operation Stages

Sub-Project Name	Sub-Project Activities	Potential Impacts	Temporal Aspects	Spatial Aspects	Reversibility	Compliance	Likelihood	Magnitude	Sensitivity	Significance without mitigation	Residual Impact after mitigation
Construction Stage											
Rehabilitation of 10, and 11-acre shrimp estate including associated canals and 48-acre Shrimp demonstration Farm, Chakaria, Cox's Bazar	Rehabilitation of water supply and drainage canals;	Fish eggs, fry, larvae, and juveniles may be damaged due to re-excavation in the construction area. This damage could result in a significant loss to the next progeny. Hence, fish species richness at the construction site would be decreased temporarily.	2	2	2	2	3	S	M	M	L
Canals Rehabilitation for Cluster Farming	Re-excavation of canals	Fish eggs, fry, larvae, and juveniles may be damaged due to re-excavation in the construction area. This damage could result in a significant loss to the next progeny. Hence, fish species richness at the construction site would be decreased temporarily.	2	2	2	2	3	S	M	M	L

Table 9.20: Summary of Impact Evaluation on Grazing Ground during Construction and Operation Stages

Sub-Project Name	Sub-Project Activities	Potential Impacts	Temporal Aspects	Spatial Aspects	Reversibility	Compliance	Likelihood	Magnitude	Sensitivity	Significance without mitigation	Residual Impact after mitigation
Construction Stage											
BMC Area at DFTC, Teknaf	Establishment of shrimp hatchery in the project area will destroy grazing ground;	Grazing ground will be destroyed due to establishment of shrimp hatchery in the project area.	4	2	4	4	4	H	L	M	L

Corresponding measures might be undertaken for the potential impacts on various VESCs under Fisheries Resources. The measures are given in the following **Table 9.21** below:

Table 9.21: Necessary Measures for the Impacts on the VESCs under Fisheries Resources

Mitigation Hierarchy	Measures
Measures for Fish Habitat	
Avoid	▪ N/A
Minimize	▪ N/A
Mitigate	▪ Implement sedimentation control measures during construction to minimize sedimentation in water bodies. ▪ Schedule re-excavation avoiding the critical periods such as fish spawning seasons. Re-excavation of canals should be done in the dry season, i.e. November to March; ▪ Excavated materials should be placed at safe distance so the disposing materials do not come back into the canals. ▪ To reduce noise impacts, use quieter machinery and limit working hours. Additionally, ensure the excavator is properly maintained to prevent oil and lubricant leaks, which can deteriorate water quality. ▪ Create a variety of habitats within the canals, such as deep pools, shallow areas, and vegetated zones, to support different life stages and species of fish. ▪ Design embankments with gentle slopes and vegetation to mimic natural riverbanks, enhancing habitat complexity.
Compensate/Offset	▪ N/A
Fish Habitat Condition at BFDC Harbor at Chattogram During Operation Stage	
Avoid	▪ N/A
Minimize	▪ N/A
Mitigate	▪ Proper functioning of ETP to manage and treat liquid organic and chemical waste before discharging into the open waterbodies. ▪ Monitoring and regulating the use of harmful chemicals in processing to prevent environmental contamination. ▪ Regularly monitoring water quality and habitat health to detect and address pollution early. ▪ Using bioremediation techniques to treat organic waste naturally and reduce environmental impact. ▪ Developing systems to recycle and reuse fish processing by-products, such as converting fish waste into fishmeal or fertilizers.
Compensate/Offset	▪ N/A
Measures for Fish Migration	
Avoid	▪ N/A
Minimize	▪ N/A
Mitigate	▪ Engineering design for sluice gate should consider the migratory fish species, their velocity tolerances and swimming speeds. Since majorly small fishes perform lateral migration, so the velocity in a range of 0.5 m/s to 1.5 m/s should be maintained through the structures; ▪ Ensure alternative routes for fish migration during excavation activities. Facilitate fish passage through the canal by-pass while rehabilitating the sluice gates to allow fish migration and minimize barriers to fish movement;

Mitigation Hierarchy	Measures
	Adjusting the design of energy dissipation devices and sills to create more snail-friendly hydraulic conditions. Ensuring that flow velocities and turbulence levels are within ranges that do not hinder snail movement or cause excessive local bed scouring. Enhancing riparian and aquatic vegetation around sluice gates to provide refuges and stable substrates for snails.
Compensate/Offset	N/A
Measures for Fish Species Composition	
Avoid	N/A
Minimize	N/A
Mitigate	- Make protection from waste of construction materials. - A confinement area should be built by very minute mesh size (0.5 cm) net so that small fish and juvenile do not enter into construction site. - Indiscriminate fishing of brood and fry fishes should be prohibited along the canal.
Compensate/Offset	N/A
Measures for Grazing Ground	
Avoid	N/A
Minimize	N/A
Mitigate	- Create or restore alternative habitats to compensate for the loss of mudflats. This can include the construction of artificial reefs, restoration of degraded wetlands, or creation of new mudflat areas. - Implement regular environmental monitoring programs to track water quality, sedimentation, and biodiversity. This data will help to adapt management practices as needed.
Compensate/Offset	N/A

Socio-Economic Environment

Shifting of temporary settlements: In the project area, there are some people who are employed as guards and laborers, working at the CSE, who would be required to be shifted to some other places during sub-Project implementation. For this, they may face financial crisis for shifting their structures and belongings to other places.

Income Generation: Procuring the raw materials and associated items to the construction site, contractors' engagement and man power loading may act for the income generation of the poor household's group of the study area. Therefore, income generation has been identified as an VSC.

Security Issue: Fish theft is a recurring problem in the shrimp estate, and this area faces frequent incidents of fish robberies, with local perpetrators demanding monthly payments. The shrimp estates also face encroachment, with individuals from various locations settling within the estate.

Labor influx & community health and safety: The project involves labor engagement for land preparation and other related activities. Eventually, there will a labor influx from different areas. The labor influx may have impacts on community health and safety through intermixing. Furthermore, if local labors are not preferred for recruitment, there will have a chance of social conflicts.

Occupational health and safety: As labors will be involved in various types of project activities, their occupational health and safety will be a big concern. If a proper arrangement is not taken, labors health and safety will be affected.

On the other hand, Labors' occupational health and safety might be another concern during the post-construction period because of various types of activities, such as: stage-wise plantation on the embankment/peripheral dyke. The labors might be involved for implementing various types of activities in each sub-project site.

Land holding (Social conflicts regarding dumping of excavated soil): Most of the cases, land has been given lease to the lease holders of outside of Cox's Bazar District. Local people work under those land lease owners as laborers, guards etc. with monthly wages. As a result, local people have grievance on these issues at CSE.

In the case of canal re-excavation, dumping of soil will be a crucial issue if local people do not welcome. Usually, land surrounding the khals are private. Therefore, an agreement with landholder and a proper method of dumping will be required. The random and/or unplanned dumping may cause social conflicts.

Gender issue: Gender issues are crucial for the subprojects' during implementation. Women may become marginalized if they choose not to participate in project activities or if their distinctive viewpoints are not taken into account. There is no opportunity to provide training for women especially, and they are not capable of performing all the activities involved in construction like males are. It might upset the balance of power in the workplace between men and women. Accidental and health risks may be taken into consideration if women are working in development or construction. Women working in construction may experience sexual harassment, gender-based violence, and other forms of workplace abuse. The CSE region has serious security concerns, and women feel insecure there as well. Outside workers will enter this region to do construction-related activities. As a result, both external and internal criminals may be able to breach the security system.

Potential Impacts and their significance in construction and operation stages for each sub-projects are mentioned in the following **Table 9.22**:

Table 9.22: Summary of Impact Evaluation on Socio-Economic Issues during Construction and Operation Stages

Sub-Project Name	VSC	Sub-Project Activities	Potential Impacts	Temporal Aspects	Spatial Aspects	Reversibility	Compliance	Likelihood	Magnitude	Sensitivity	Significance without mitigation	Residual Impact after mitigation
Construction Stage												
Rehabilitation of 10, and 11-acre shrimp estate including associated canals and 48-acre Shrimp demonstration Farm, Chakaria, Cox's Bazar	Shifting of temporary settlements	- Land development, levelling and land preparation; - Re-excavation of canals and dumping of soils on the dyke; - Construction of temporary labor shed and sanitation facilities; - Reconstruction of embankment/peripheral dyke - Construction of guard shed with sanitary and electrical facilities; - Installation of on grid solar panels on embankment (peripheral dyke)	The laborers and guards working in the CSE would be affected as they might have to be shifted to some other place for which they might face financial crisis for shifting their structures and belongings.	2	1	3	3	3	S	M	M	L
	Security Issue	- Construction of Guard Shed with sanitary and electrical facilities - Construction of Police Fari	Fish theft is a recurring problem in the shrimp estate, and this area faces frequent incidents of fish robberies, with local perpetrators demanding monthly payments.	2	2	3	1	3	S	M	M	L
		- Land development, levelling and land preparation - Construction of Police Fari	Disputed land leasing system may cause social conflict among the local people.	3	2	2	2	1	M	L	M	L
			The shrimp estates has encroachment, with individuals from various locations settling within the estate	3	2	2	2	1	M	L	M	L

Sub-Project Name	VSC	Sub-Project Activities	Potential Impacts	Temporal Aspects	Spatial Aspects	Reversibility	Compliance	Likelihood	Magnitude	Sensitivity	Significance without mitigation	Residual Impact after mitigation
	Occupational health and safety	All the mentioned subproject activities during construction stage	The labor influx may have impacts on occupational health and safety will be a big concern.	2	2	3	3	3	S	M	M	L
	Gender issues	- Land development, levelling and land preparation. - Construction of temporary labor shed and sanitation facilities; - Reconstruction of Embankment/ Peripheral Dyke	Women labor influx may have impacts on their occupational health and safety Women working in construction may experience sexual harassment, gender-based violence, and other forms of workplace abuse	2	2	3	3	3	S	M	M	L
BFDC Harbor at Chattogram	Occupational health and safety	All the mentioned subproject activities during construction stage	The labor influx may have impacts on occupational health and safety will be a big concern.	2	2	3	3	3	S	M	M	L
	Gender issues	All the mentioned subproject activities during construction stage	Additional women labor influx may have impacts on their occupational health and safety Women working in construction may experience sexual harassment, gender-based violence, and other forms of workplace abuse.	2	2	3	3	3	S	M	M	L
BMC Area at DFTC, Teknaf	Occupational health and safety	Establishment of shrimp hatchery	The labor influx may have impacts on occupational health and safety will be a concern.	2	2	3	3	3	S	M	M	L
Canals Rehabilitation	Land holding	Desilting and rehabilitation of existing canals of cluster shrimp	Usually, land surrounding the khals are private. In the case of canal re-excavation, dumping of soil will be a	2	3	2	3	3	S	M	M	L

Sub-Project Name	VSC	Sub-Project Activities	Potential Impacts	Temporal Aspects	Spatial Aspects	Reversibility	Compliance	Likelihood	Magnitude	Sensitivity	Significance without mitigation	Residual Impact after mitigation
for Cluster Farming		farms at different locations of Khulna, Bagerhat, and Satkhira; ▪ Repairing and construction (as per suggestion of the Feasibility and ESIA Team) of hydraulic structures on the selected Canals	crucial issue if local people do not welcome.									
	Occupational Health and Safety	▪ Desilting and rehabilitation of existing canals of cluster shrimp farms at different locations of Khulna, Bagerhat, and Satkhira; ▪ Repairing and construction (as per suggestion of the Feasibility and ESIA Team) of hydraulic structures on the selected Canals.	The labors will be involved in different activities of canal rehabilitation. It may have impacts on occupational health and safety which will be a big concern.	2	2	3	3	3	S	M	M	L
	Gender issues	▪ Desilting and rehabilitation of existing canals of cluster shrimp farms at different locations of Khulna, Bagerhat, and Satkhira; ▪ Repairing and construction (as per suggestion of the Feasibility and ESIA Team) of hydraulic structures on the selected Canals.	Additional women labor influx may have impacts on their occupational health and safety Women working in construction may experience sexual harassment, gender-based violence, and other forms of workplace abuse	2	2	3	3	3	S	M	M	L
Operation Stage												
Rehabilitation of 10, and 11-acre shrimp estate	Occupational health and safety	▪ Stage -wise plantation on the embankment/ peripheral dyke;	Tree plantation activities and monitoring of the project may have	3	2	2	2	1	M	L	M	L

Sub-Project Name	VSC	Sub-Project Activities	Potential Impacts	Temporal Aspects	Spatial Aspects	Reversibility	Compliance	Likelihood	Magnitude	Sensitivity	Significance without mitigation	Residual Impact after mitigation
including associated canals and 48-acre Shrimp demonstration Farm, Chakaria, Cox's Bazar		- Environmental and social monitoring including implementation of the ESMP; and - Proper maintenance of the sub-projects.	impacts on occupational health and safety.									
BFDC Harbor at Chattogram	Occupational health and safety	- Stage -wise plantation on the embankment/ peripheral dyke; - Environmental and social monitoring including implementation of the ESMP; and - Proper maintenance of the sub-projects.	Occupational health and safety both for men and women at fish processing center.	1	2	2	2	1	M	M	M	L
	Gender issues	Women working in the fish processing factory and associated activities	Additional women labor influx may have impacts on their occupational health and safety Women working in construction may experience sexual harassment, gender-based violence, and other forms of workplace abuse	2	2	3	3	3	S	M	M	L

The mitigation measures are given in the **Table 9.23** below:

Table 9.23: Mitigation Measures on Socio-Economic Issues

Measures for Shifting of temporary settlements issues	
Mitigation Hierarchy	Measures
Avoiding	Shifting of temporary settlements.
Minimizing	- Informing the people of CSE about the project activities and impacts earlier and take suggestions from them; - Designing the area of the implementation in such a way so that a minimum number of settlements are required to be shifted.
Mitigation	Engage the affected people in the sub-Project activities (for both male and female) based on their skills.
Compensate/Offset	Providing shifting charge to the affected people.
Measures for Land holding issues	
Avoiding	Unauthorized dumping of re-excavated soil on the dyke or homestead (if any) of the canals.
Minimizing	- Particularly in the Rampur area, before proceeding with the implementation of this project, it is advisable to address the land-related difficulties. - Engage local stakeholders (political, cultural, religious, health teams, local councils, social workers) in awareness rising activities.
Mitigation	- When it comes to leasing, locals should be given priority, and the lease contract should contain a clause indicating this with the support of the local authority; - The selection process of dredged materials dumping locations land should be selected by discussing with the field level stakeholders and LGIs; - Training in poultry, fish farming and new skill development training will be provided.
Compensate/Offset	Take enhancement measures through livelihood program.
Measures for Security Issue	
Avoiding	Avoiding the unauthorized person in the project area.
Minimizing	Minimize the number of external labors.
Mitigation	The site of the police station or camp should be nearest to the area where the shrimp estate is located.
Compensate/Offset	N/A.
Measures for Occupational Health and Safety	
Avoiding	- Use of all forms of forced labor and child labor; - Employing unskilled person in the activities
Minimizing	- Minimize the hazard through design of safe work systems and administrative or institutional control measures like job rotation, training safe work procedures, lock-out and tag-out, workplace monitoring, limiting exposure or work duration, etc. - Training on the zero tolerance of SEA/SH and other forms of GBV under the project.
Mitigation	- Provide sufficient treatment, non-discrimination, and equal opportunity for project workers - The health and safety officer, entrusted with worker's safety, must ensure that the equipment and safety control mechanisms are working properly before the workers start their work, each day.

	• protect project workers, including vulnerable workers such as women, persons with disabilities, children (of working age, per National law and, World Bank ESF) • Building awareness to mitigate the risks of Sexual Exploitation and Abuse and Sexual Harassment (SEA/SH) in the workplace • The assigned contractor will be responsible to implement the LMP that will be monitored by IA/Consultant.
Compensate/Offset	• Apply GRM in case of safety issues • Take enhancement measures through livelihood program. • Female headed HH will receive additional compensation and training on income generation activities
Measures for Gender Issue	
Avoiding	• Remove the temporary structure as less as possible both from CSE and cluster shrimp farming canal areas; • Employing unskilled women laborers in the activities.
Minimizing	• Minimizing the occupational discrimination between men and women • Minimize the hazard through design of safe work systems and administrative or institutional control measures like job rotation, training safe work procedures, lock-out and tag-out, workplace monitoring, limiting exposure or work duration for women etc. • Training in poultry, fish farming and new skill development training will be provided. Fishery related training should be prioritized •
Mitigation	• Training on the zero tolerance of SEA/SH and other forms of GBV under the project • Providing separate facilities for women at workstation • Arrangement of baby care at workstation for the working women • A complaint box ought to be maintained so that women can voice their concerns and be shielded from sexual harassment and GVM.
Compensate/Offset	• Apply GRM in case of safety issues for women • Alternative livelihood arrangement for the project affected women. • Female headed HH will receive additional compensation and training on income generation activities

9.3 Beneficial Impacts and Enhancement Measures

9.3.1 Biological Impacts and Enhancement Measures

Ecological Resources

A large-scale afforestation and green belt development will enable creation of new habitat around the CSE. In addition, Ref. to the **Section 11.6**, afforestation plan has been given for all the sub-projects and designs and layout for CSE and the canals for cluster farming.

Fisheries Resources

Due to implementing sub-project interventions, some beneficiary impacts are assumed to be on fisheries resources sector. The beneficial impacts are given as follows:

Impacts

Chakaria Shrimp Estate

- Rehabilitating canals ensures a consistent and controlled flow of water, which is essential for maintaining optimal water levels in fish habitats. This is particularly important for species that are sensitive to changes in water conditions.
- Functional canals will improve connectivity between different water bodies, allowing fish to migrate and access various habitats for breeding, feeding, and shelter.
- Reconstructed embankments and properly working sluice gates can prevent flooding, which protects fish habitats from being damaged by excessive water flow. This stability is crucial for the spawning and nursery grounds of many fish species. It will reduce the risk of flooding of aquaculture habitats (Gher/fish farm).
- Reconstructed embankments and properly working sluice gates can prevent flooding, reduce the risk of flooding in aquaculture habitats (Gher/fish farm) and protecting fish habitats from being damaged by excessive water flow. Effective drainage systems prevent stagnation and reduce the accumulation of pollutants. This leads to better water quality, which is beneficial for fish health and productivity.
- In saline water areas, functional sluice gates can prevent saltwater from intruding into freshwater habitats, thereby protecting species that are intolerant to salinity changes.

The corresponding enhancement measures would be as follows:

- Conduct regular inspections and maintenance of canals to remove debris, repair damages, and ensure unobstructed water flow.
- Implement a water quality monitoring program to detect and address pollutants or changes in water parameters that could affect fish health.
- Maintenance re-excavation work should be conducted properly.
- Migration route should be maintained properly.
- Manage regular fry release program and create fish sanctuary or protected area for enhancing sustainability.
- Aware the local community to dig fish pond. Provide fish culture training to the pond owner to use scientific fish culture method in their pond for incremental production.

Canal Rehabilitation for Cluster Farming under Satkhira, Khulna, and Bagerhat Districts

- Rehabilitating canals ensures a consistent and controlled flow of water, which is essential for maintaining optimal water levels in fish habitats. This is particularly important for species that are sensitive to changes in water conditions.
- Functional canals will improve connectivity between different water bodies, allowing fish to migrate and access various habitats for breeding, feeding, and shelter.
- Reconstructed canals will store more water and this may reduce the risk of flooding of aquaculture habitats (Gher/fish farm). Cluster farmers can use canal water continuously.

The enhancement measures would be as follows:

- Conduct regular inspections and maintenance of canals to remove debris, repair damages, and ensure unobstructed water flow.
- Implement a water quality monitoring program to detect and address pollutants or changes in water parameters that could affect fish health.
- Maintenance re-excavation work should be conducted properly.
- Migration route should be maintained properly.

- Manage regular fry release program and create fish sanctuary or protected area for enhancing sustainability.
- Aware the local community to dig fish pond. Provide fish culture training to the pond owner to use scientific fish culture method in their pond for incremental production.

9.3.2 Socio-Economic Impacts

Impacts

- Income would be generated for local people during implementing of all the sub-projects. In this regard, local unskilled, semi-skilled and skilled workers would be engaged in different activities under various sub-Projects, which would create temporary to permanent employment for the local people;
- According to the **Table 4.7**, under **Section 4.21** of **Chapter 4**, on an average around 254 labors would be involved in various types of civil construction and erection works during construction stage of the sub-project sites;
- Implementation of the CSE and canals for cluster farming sub-projects may have the provision for additional communication facilities such as road network, bridge culvert and other infrastructural facilities. These may improve the communication system and people could move their designated place very easily;

Enhancement Measures:

- Procuring the raw materials and associated items to the construction site, contractors' engagement and man power loading may act for the income generation of the poor household's group of the study area. Here are some measures to be taken to enhance the scope of income: skill development programs, promotion of small and medium enterprises, promotion of tourism, social safety nets etc.;
- To enhance the occupational diversity there should be create a good market system for shrimp cultivation. Besides that, some steps could be taken as vocational training programs, promotion of entrepreneurship, gender equality initiatives, diversification of industrial sectors such as technology and renewable energy etc.
- For women the project could provide vocational training programs for women in sustainable resource management, shrimp farming techniques, aquaculture practices, and quality control, facilitate access to credit and financial resources for women, helping them invest in businesses or adopt sustainable fishing practices. This could involve partnering with microfinance institutions to create larger credit facilities tailored to women entrepreneurs in the fisheries sector, support initiatives that provide scholarships or stipends for girls to continue their education, particularly in technical and vocational training related to fisheries, improve access to basic healthcare services, particularly for pregnant women and young mothers, prioritize constructing gender-sensitive sanitation facilities, especially in public areas like markets and processing plants, introduce climate-resilient farming practices and technologies, focusing on training women in their use, Ensure women's active participation in community-based resource management and decision-making processes, the project could establish gender-sensitive governance structures within fisheries management bodies, support livelihood diversification programs that offer women alternative income-generating activities, such as small-scale aquaculture, fish processing businesses, or handicrafts related to the fisheries sector, integrate GBV prevention and response measures specific to the fisheries and shrimp sector, including establishing safe spaces for women working in these industries, improving access to support services (legal, medical, and psychosocial) at processing plants, and conducting training programs to raise awareness about GBV in local fishing communities.

10. Environmental and Social Management Plan

10.1 Introduction

The Environmental and Social Management Plan (ESMP) includes several plans for implementing mitigation and enhancement measures, emergency response, occupational health and safety, and Environmental Code of Practices. Generally, the impacts, which are minor or moderate, are to be mitigated by adopting Environmental and Social Code of Practices (ESCOPs: as detailed out in the **Annex 34** under the **Volume II: Annexures of Main Report**) and EPC contractor's good practices during project implementation. On the other hand, impacts and risks which are critical or major would be mitigated or prevented by adopting mitigation measures discussed in **Chapter 9** and specific plans discussed in this Chapter. The detailed description and explanation of ESMP budget is given in the **Annex A: ESMP Report**.

10.2 Objective

The basic objective of the ESMP is to manage adverse impacts of proposed project interventions in a way that minimizes the adverse impact on the environment and people in the project area. The specific objectives of the ESMP are to:

- Facilitate the implementation of the mitigation measures identified during the present ESIA to comply with regulatory requirements that discussed earlier in the document;
- Maximize potential project benefits and control adverse impacts;
- Draw responsibilities for Project Proponent (in this case, PMU of the DoF), contractors, consultants, and other stakeholders of the project team for the environmental and social management of the Project;
- Maintain essential ecological process, preserving biodiversity, and where possible restoring degraded natural resources;
- Make stakeholders aware about implications of the project activities, satiate their concerns and roles and responsibilities of respective quarters; and
- Foster and facilitate informed decision-making process and ensure sustainable development.

10.3 Environmental and Social Management Plan

The ESMP includes different types of mitigation and control measures and management plans for addressing and managing significant impacts and risks, including: (i) general and non-site-specific measures in the form of ESCOPs to address general construction and operation matters identified as medium and minor/low significance prior to mitigation and prevention; (ii) project specific and, to the extent possible, site-specific mitigation measures; (iii) CESAP with site-specific and contract-specific management plans to be prepared by the Contractors that will be submitted within 90-days of a contractor's mobilization and be approved by the Engineer; (iv) OHS Management System Processes and SOPs to be prepared by the Contractors; and (v) proposed ESMP sub-plans to address direct and indirect impacts on biodiversity, environment project workers and community.

The ESMP includes several sub-plans, including: (i) Occupational Health and Safety Plan; (ii) Demolition plan (iii) Community Health and Safety Plan; (iv) Sexual Exploitation and Abuse/Sexual Harassment (SEA/SH) plan (v) Labor Management Procedure; (vi) Flood Management Plan; (vii)

Stakeholder Engagement Plan (SEP); (viii) Fisheries Management Plan; (ix) Biodiversity management Plan; (x) No net loss/Net Gain Strategy; and (xi) Social management Plan.

10.4 Mitigation Plan

A mitigation plan for each sub-Project has been given in the following **Table 10.1**. The Table also mentions the responsible authorities (Implementation/ supervision) for individual issue.

Table 10.1: Mitigation Plan

Issues	Environmental Impacts	Mitigation Measures	Institutional Responsibilities	
			Implementation	Supervision
Construction Stage				
Biodiversity and Ecosystem	Impact on aquatic habitats, including benthic habitat, due to sliding of re-excavated soil into the canal again and re-excavation of canals for creating proper drainage	▪ Due care should be paid during managing re-excavated soil. ▪ There should be a well-fenced/marked designated site for waste disposal with proper monitoring facilities. ▪ Re-excavation operation should be carried out with proper care.	Contractor	Design Consultant/ PMU/ EHSU
Fish Habitat	Temporarily disruption of canal ecosystem due to re-excavation work.	▪ Implement sedimentation control measures during construction to minimize sedimentation in water bodies. ▪ Schedule re-excavation avoiding the critical periods such as fish spawning seasons. Re-excavation of canals should be done in the dry season, i.e. November to March; ▪ Excavated materials should be placed at safe distance so the disposing materials do not come back into the canals. ▪ To reduce noise impacts, use quieter machinery and limit working hours. Additionally, ensure the excavator is properly maintained to prevent oil and lubricant leaks, which can deteriorate water quality. ▪ Create a variety of habitats within the canals, such as deep pools, shallow areas, and vegetated zones, to support different life stages and species of fish. ▪ Design embankments with gentle slopes and vegetation to mimic natural riverbanks, enhancing habitat complexity.	Contractor	SE/ PMU

Issues	Environmental Impacts	Mitigation Measures	Institutional Responsibilities	
			Implementation	Supervision
Fish migration	Fish migration may be hampered due to repairing of sluice gates	- Engineering design for sluice gate should consider the migratory fish species, their velocity tolerances and swimming speeds. Since majorly small fishes perform lateral migration, so the velocity in a range of 0.5 m/s to 1.5 m/s should be maintained through the structures; - Ensure alternative routes for fish migration during excavation activities. Incorporate fish passage structures in sluice gates to facilitate fish migration and minimize barriers to fish movement.	Contractor	SE/ PMU
Fish species diversity	Fish species structures in the intervened area of the canal may be changed temporarily due to canal re-excavation.	- Make protection from waste of construction materials. - A confinement area should be built by very minute mesh size (0.5 cm) net so that small fish and juvenile do not enter into construction site. - Indiscriminate fishing of brood and fry fishes should be prohibited along the canal.	Contractor	SE/ PMU
Waste management	Unplanned or unorganized storage of old and used equipment and other solid wastes can lead to poor aesthetic view and management of space in the project site.	- Rubbles generated from the construction site should be stored in appropriate bins/skips, well-covered and later buried in an approved landfill site. - All solid wastes, hazardous and non-hazardous, should be stored in designated sites prior to final disposal - Food waste and other bio-degradable waste, generated by workers and staff, should be placed at a designated site prior to final collection and disposal by local municipality or contract vendor.	EPC Contractor	PMU/ EHSU
Air Quality	Emissions of dust and gases will be generated - Due to rehabilitation of hydraulic structures and re-excavation of soil at CSE; - Demolition of existing abandon structures at CSE, BFDC Harbor, and BMC sub-Project Areas;	- Proper and prior planning and appropriate sequencing and scheduling of site preparation activities including land development and construction site preparation. - Dust Suppression Mechanism like water spraying should be done at least thrice in a day in dry season to control generation of excessive SPM. - Take measure at the whole construction site to minimize dust spreading outside.	EPC Contractor	SE/ESHSU

Issues	Environmental Impacts	Mitigation Measures	Institutional Responsibilities	
			Implementation	Supervision
	- Excavation of trenches for laying distribution lines; installing GIS and transformer at the substation areas, operation of construction equipment and vehicles, and material transport, which is injurious to human health at BFDC Harbor; and - Re-excavation of canals under Satkhira, Khulna, and Bagerhat Districts	- Construction materials like cement, sand, brick chips, stone chips etc. should be well covered with tarpaulin or other covering sheet. - Construction site vehicle speed limit of 10 km/hr-25 km/hr (Fugitive PM Emissions Control efficiency: 0%-80%) should follow strictly. - Regular inspection and maintenance of the Project vehicles should be carried out. - No unfit vehicles such as dump trucks, construction material trucks/lorries, etc. and other machines should be allowed to be in use. - Modern and energy efficient machineries should be used in the construction site. - Regardless of the size or type of vehicle, fleet owners /operators should implement the manufacturer recommended engine maintenance programs. - Regular operation and maintenance of the machineries should be carried out. - Regular monitoring should be conducted for checking air quality. - Environmental Code of Practice for Air Quality management ESCOP-10 (as mentioned in the Annex 34 of the Volume II: Annexures of Main Report) should be followed.		
Water quality	Improper storage and handling of fuels, lubricants, chemicals, hazardous goods/materials on-site, wash down from the Sub-project construction sites and and potential spills may contaminate the water bodies and harm the environment and health of construction workers.	The workers should be encouraged to use PPEs every time when handling oils, lubricants, chemicals and other hazardous materials.	Contractor	SE/EHSU

Issues	Environmental Impacts	Mitigation Measures	Institutional Responsibilities	
			Implementation	Supervision
Noise level	Noise will be generated from the moving and idling vehicles, welding operation, and heavy machineries.	- The machines/equipment/vehicles should be turned off when not in use. - Using PPEs during construction work. - Reduce unnecessary vehicular movement and speed limit (8 km to 16 km) of these vehicles should be maintained; - Limit the Project activities especially the noise generating works such as welding, mixing, breaking bricks etc. within daytime only.	Contractor	SE/EHSU
SEA/SH Risk	- Demand for sex by migrant workers will increase SEA/SH - Sexual harassment within the labor camp and nearby community. - Force and early marriage by construction workers. - Community school or college girls may be harassed or sexually abused by the project workers. - Salary discrimination among the female workers. - Cash transfer potentially inducing greater SEA/SH risks - Community mobilization and training activities in rural setting exposing to SEA/SH risks - Increase of COVID-19 spreading risk	- Public awareness creation. - Extend the Shock Response Social Protection System to mitigate future risk and resilience building - Awareness creation among local people and project workers. - Regular monitoring - Arranging workshop with school going girls for self-defense in any case of SEA/SH incident	Contractor	DoF/PMU
Operation Stage				
Environmental Quality ▪ Wastewater	<u>BFDC Harbor at Chattogram</u> Process wastewater, generated from the chiller, fish processing plant, shipyard etc. would be sent to the discharge settling pond and afterwards	An internal drainage system might be established through which water may be released to the nearby Karnaphuli River from the Fish Processing Plant after proper treatment through W/ETP or directly to the Karnaphuli River if is able to meet the discharge limit;	PMU	EHSU

Issues	Environmental Impacts	Mitigation Measures	Institutional Responsibilities	
			Implementation	Supervision
	to the river which may increase the pH level of river water at the receiving end; ▪ Oily waste water, generated from the car parking areas, plant equipment including transformer, oil storage tank and unloading areas, workshops, garage etc. may mix with the river water and create oil slick if it contains more than 10 ppm oil/ grease.	▪ The Internal drainage system may be covered up with a slab so that no solid waste is thrown to the drain; ▪ Regular monitoring through checking water quality of various parameters might be conducted and verifying with baseline results; ▪ Providing training and awareness program to the workers those might be engaged during operation stage.		
Fish Habitat	Rehabilitating canals ensures consistent water flow and optimal water levels, while also improving connectivity between water bodies.	Enhancement Measures ▪ Conduct regular inspections and maintenance of canals to remove debris, repair damages, and ensure unobstructed water flow. ▪ Implement a water quality monitoring program to detect and address pollutants or changes in water parameters that could affect fish health. ▪ Educate local communities about the importance of canal rehabilitation and encourage practices that support water quality and habitat health.	Contractor	SE/ PMU
Fish Migration	Fish migration will be improved due to re-excavation of the canals.	Enhancement Measures ▪ Maintenance re-excavation work should be conducted properly. ▪ Migration route should be maintained properly.	Contractor	SE/ PMU
Fish Production	Fish production would be increased due to modification of canal fish habitat and increasing aquaculture practice.	▪ Aware the local community to dig fish pond. Provide fish culture training to the pond owner to use scientific fish culture method in their pond for incremental production.	Contractor	SE/ PMU

10.5 Environmental and Social Monitoring Budget

The Environmental and Social Monitoring Budget for each sub-Project has been given individually in **Table 10.2** to **Table 10.5** and also mentioned the responsible agency to implement the ESMP.

Table 10.2: Monitoring Budget for CSE

VESEC/ Indicator	Monitoring Indicators	Location	Frequency	Method	Responsible Agency	Cost (Million BDT)	Cost (USD)
Construction Stage							
Air Quality	PM _{2.5} , PM ₁₀ , SO _x , NO ₂ , CO, O ₃	Selected locations as observed during the baseline study	Quarterly	24 hours Sampling	Third party monitoring	5.0	45,662
Water Quality	Surface water and Groundwater (Temperature, pH, Total alkalinity, Ammonium, BOD ₅ , COD, EC, Oil and Grease, Turbidity, TSS, TDS, TS, etc.)	Selected locations as observed during the baseline study	Quarterly	Composite sampling (In-situ and Lab test)		5.0	45,662
Noise	Day time (6:00 – 21:00) and Night time (21:00 – 6:00) Leq.	Selected locations as observed during the baseline study	Quarterly	Ambient noise level monitoring using ANSI Type II Noise Meter.		2.5	22,831
Fisheries resources	Fish Habitat, Fish biodiversity	Project location	Quarterly	In-situ investigation, FDG, water quality report	Third party monitoring	3.5	31,963
Employment (PAPs and Local people)	Labor Engagement for project activity	All over the study area Project Area	Quarterly	KIIs and FGDs in UPs and project area	Individual consultant	3.0	27,397
Occupational health and safety	First-aid Cases Medical Treatment Cases	Project Area	Quarterly	Walk through, Interview with employees and	Third party monitoring	1.3	11,872

VESC/ Indicator	Monitoring Indicators	Location	Frequency	Method	Responsible Agency	Cost (Million BDT)	Cost (USD)
	- Lost Time Injury - Number of near misses - Number of Walk-through Inspections by Project Managers, Construction Managers, Health and Safety Officer and OHS supervisors			workers, KIIs site manager			
Community Health, Safety and security	- Rates of COVID-19 and other communicable disease (Chikungunya and Dengue, and other vector-borne diseases), - Project related safety and security incidents, - Number of grievances or claims of Project related impacts on the community. - Availability of Potable Water, Drinking water quality, - Availability of Hygienic Toilet	Project Area	Quarterly	Walk through, Interview with employees and workers, KIIs site manager	Third party monitoring	0.75	6,849
Grievance Mechanism	Operation, Procedures, Records and Documents	At work site	Half Yearly	Register/Document review; visual inspection and enquiry to know the Grievance Mechanism	Third party monitoring	1	9,132
Gender issue	- Involvement of women in fisheries-related activities (skilled positions) - Involvement of women in resource management committees - Engagement of women in project-related activities	Selected locations as observed during the baseline study	Half Yearly	Walk through, Interview with employees and workers, KII, FGDs in union parishad	Third party monitoring	1.1	10,046

VESC/ Indicator	Monitoring Indicators	Location	Frequency	Method	Responsible Agency	Cost (Million BDT)	Cost (USD)
	• Women accessing formal credit facilities and the increase in women-led enterprises or businesses in the project areas • Women's access to health center • Disease prevalence among women • Access of women to WASH • Women income and contribution to households • Women's mobility • Presence of GBV • Occurrences of SEA-SH						
Post-Construction Stage							
Air Quality	PM _{2.5} , PM ₁₀ , SO _x , NO ₂ , CO, O ₃	Selected locations as observed during the baseline study	Bi-annually up to five (5) years	24 hours Sampling	Third party monitoring	2.5	22,831
Water Quality	Surface water and Groundwater (Temperature, pH, Total alkalinity, Ammonium, BOD ₅ , COD, EC, Oil and Grease, Turbidity, TSS, TDS, TS, etc.)	Selected locations as observed during the baseline study	Bi-annually up to five (5) years	Composite sampling (In-situ and Lab test)		2	18,265
Noise	Day time (6:00 – 21:00) and Night time (21:00 – 6:00) Leq.	Selected locations as observed during the baseline study	Bi-annually up to five (5) years	Ambient noise level monitoring using ANSI Type II Noise Meter.		1	9,132
Social Development and PAPs	Compensation of the PAPs, Income equity, livelihood condition, WATSAN condition, perception on the project works, etc.	People affected by proposed project activities	Biannually	Survey, Document checking, Institutional survey,	Third party monitoring	2	18,265

VESC/ Indicator	Monitoring Indicators	Location	Frequency	Method	Responsible Agency	Cost (Million BDT)	Cost (USD)
		within the sub-project sites		KII, Household Survey, FGD			
Fisheries resources	Fish Habitat, Fish biodiversity	Project location	Half yearly	In-situ investigation, FDG, review of water quality report	Third party monitoring	3	27,397
Grievance Mechanism	Operation, Procedures, Records and Documents	Nearby Project Area	Quarterly	Register/Document review; visual inspection and enquiry to know the Grievance Mechanism	Third party monitoring	2	18,265
Gender issue	• Involvement of women in fisheries-related activities (skilled positions) • Involvement of women in resource management committees • Women accessing formal credit facilities and the increase in women-led enterprises or businesses in the project areas • Women's access to health center • Disease prevalence among women • Access of women to WASH • Women income and contribution to household • Women's mobility • Presence of GBV • Occurrence of SEA-SH	Selected locations as observed during the baseline study	Yearly	Walk through, Interview with employees and workers, KII, FGDs in union parishad	Third party monitoring	0.5	4,566
36.15 Million BDT							330,137

Table 10.3: Monitoring Budget of BFDC Harbor at Chattogram

VESC/ Indicator	Monitoring Indicators	Location	Frequency	Method	Responsible Agency	Cost (Million BDT)	Cost USD
Construction Stage							
Air Quality	PM _{2.5} , PM ₁₀ , SO _x , NO ₂ , CO, O ₃	Selected locations as observed during the baseline study	Quarterly	24 hours Sampling	Third party monitoring	3.0	27,397
Water Quality	Surface water and Groundwater (Temperature, pH, Total alkalinity, Ammonium, BOD ₅ , COD, EC, Oil and Grease, Turbidity, TSS, TDS, TS, etc.)	Selected locations as observed during the baseline study	Quarterly	Composite sampling (In-situ and Lab test)		2.5	22,831
Noise	Day time (6:00 – 21:00) and Night time (21:00 – 6:00) Leq.	Selected locations as observed during the baseline study	Quarterly	Ambient noise level monitoring using ANSI Type II Noise Meter.		1.5	13,699
Fisheries resources	Fish Habitat, Fish biodiversity	Project location	Quarterly	In-situ investigation, FDG, water quality report	Third party monitoring	3.5	31,963
Occupational diversity		All over the study area	Quarterly	KIIs and FGDs in UPs and project area	Third party monitoring	3.0	27,397
Employment (PAPs and Local people)	Labor Engagement for project activity	All over the study area	Quarterly	KIIs and FGDs in UPs and project area	Third party monitoring	3.5	31,963
Occupational health and safety	- First-aid Cases Medical Treatment Cases - Lost Time Injury - Number of near misses - Number of Walk-through Inspections by Project Managers, Construction Managers,	Project Area	Quarterly	KIIs in Project site, manager	Third party monitoring	1.3	11,872

VESEC/ Indicator	Monitoring Indicators	Location	Frequency	Method	Responsible Agency	Cost (Million BDT)	Cost USD
	Health and Safety Officer and OHS supervisors						
Community Health, Safety and security	- Rates of COVID-19 and other communicable disease (Chikungunya and Dengue, and other vector-borne diseases), - Project related safety and security incidents, - Number of grievances or claims of Project related impacts on the community. - Availability of Potable Water, Drinking water quality, - Availability of Hygienic Toilet	Project Area	Quarterly	Walk through, Interview with employees and workers, KIIs site manager	Third party monitoring	0.75	6,849
Grievance Mechanism	Operation, Procedures, Records and Documents	At work site	Quarterly	Register/Document review; visual inspection and enquiry to know the Grievance Mechanism	Third party monitoring	1	9,132
Gender issue	- Involvement of women in fisheries-related activities (skilled positions) - Involvement of women in resource management committees - Engagement of women in project-related activities - Women accessing formal credit facilities and the increase in women-led enterprises or businesses in the project areas - Women's access to health center - Disease prevalence among women - Access of women to WASH	Selected locations as observed during the baseline study	Half Yearly	Walk through, Interview with employees and workers, KII, FGDs in union parishad	Third party monitoring	0.5	4,566

VESEC/ Indicator	Monitoring Indicators	Location	Frequency	Method	Responsible Agency	Cost (Million BDT)	Cost USD
	- Women income and contribution to households - Women's mobility - Presence of GBV - Occurrences of SEA-SH						
Post-Construction Stage							
Air Quality	PM _{2.5} , PM ₁₀ , SO _x , NO ₂ , CO, O ₃	Selected locations as observed during the baseline study	Bi-annually up to five (5) years	24 hours Sampling	Third party monitoring	2.5	22,831
Water Quality	Surface water and Groundwater (Temperature, pH, Total alkalinity, Ammonium, BOD ₅ , COD, EC, Oil and Grease, Turbidity, TSS, TDS, TS, etc.)	Selected locations as observed during the baseline study	Bi-annually up to five (5) years	Composite sampling (In-situ and Lab test)		2	18,265
Noise	Day time (6:00 – 21:00) and Night time (21:00 – 6:00) Leq.	Selected locations as observed during the baseline study	Bi-annually up to five (5) years	Ambient noise level monitoring using ANSI Type II Noise Meter.		1	9,132
Fisheries resources	Fish Habitat, Fish biodiversity	Project location	Half yearly up to 5 years	In-situ investigation, FDG, review of water quality report		3	27,397
Gender issue	- Monitor the percentage of women accessing formal credit facilities and the increase in women-led enterprises or businesses in the project areas - Track the increase in the percentage of women accessing maternal health services and the number of hygienic latrines constructed. Monitor the percentage of women reporting improved access to	Selected locations as observed during the baseline study	Yearly	Walk through, Interview with employees and workers, KII, FGDs in union parishad	Third party monitoring	0.4	3,653

VESC/ Indicator	Monitoring Indicators	Location	Frequency	Method	Responsible Agency	Cost (Million BDT)	Cost USD
	sanitation and reduced waterborne Measure the percentage increase in women's participation in management bodies and assess the correlation between women's involvement and improvements in sustainable fishing practices and community incomes • Monitor the increase in household incomes from diversified livelihoods, especially those led by women, and track the percentage of women participating in these initiatives • Track the establishment of safe spaces at fish processing facilities and the increase in community awareness • activities related to GBV in fishing communities						
						29.45 Million BDT	268,950

Table 10.4: Monitoring Budget of Brood Management Center (BMC) Area at DFTC, Teknaf

VESC/ Indicator	Monitoring Indicators	Location	Frequency	Method	Responsible Agency	Cost (Million BDT)	Cost USD
Construction Stage							
Air Quality	PM _{2.5} , PM ₁₀ , SO _x , NO ₂ , CO, O ₃	Selected locations as observed during the baseline study	Quarterly	24 hours Sampling	Third party monitoring	3	27,397
Water Quality	Surface water and Groundwater (Temperature, pH, Total alkalinity, Ammonium, BOD ₅ , COD, EC, Oil and Grease, Turbidity, TSS, TDS, TS, etc.)	Selected locations as observed during the baseline study	Quarterly	Composite sampling (In-situ and Lab test)		2.5	22,831
Noise	Day time (6:00 – 21:00) and Night time (21:00 – 6:00) Leq.	Selected locations as observed during the baseline study	Quarterly	Ambient noise level monitoring using ANSI Type II Noise Meter.		2	18,265
Fisheries resources	Fish Habitat, Fish biodiversity	Project location	Quarterly	In-situ investigation, FDG, water quality report	Third party monitoring	3.5	31,963
Occupational health and safety	- First-aid Cases Medical Treatment Cases - Lost Time Injury - Number of near misses - Number of Walk-through Inspections by Project Managers, Construction Managers, Health and Safety Officer and OHS supervisors	Project Area	Twice in a year	KIIs in Project site, manager	Third party monitoring	1.3	11,872
Grievance Mechanism	Operation, Procedures, Records and Documents	At work site	Monthly	Register/Document review; visual inspection and enquiry to know the Grievance Mechanism	Third party monitoring	1	9,132

VESC/ Indicator	Monitoring Indicators	Location	Frequency	Method	Responsible Agency	Cost (Million BDT)	Cost USD
Gender Issue	- Involvement of women in fisheries-related activities (skilled positions) - Involvement of women in resource management committees - Engagement of women in project-related activities - Women accessing formal credit facilities and the increase in women-led enterprises or businesses in the project areas - Women's access to health center - Disease prevalence among women - Access of women to WASH - Women income and contribution to households - Women's mobility - Presence of GRV - Occurrences of SEA-SH	Selected locations as observed during the baseline study	Half-Yearly	Walk through, Interview with employees and workers, KII, FGDs in union parishad	Third party monitoring	0.3	2,740
Post-Construction Stage							
Air Quality	PM _{2.5} , PM ₁₀ , SO _x , NO ₂ , CO, O ₃	Selected locations as observed during the baseline study	Bi-annually up to five (5) years	24 hours Sampling	Third party monitoring	2.5	22,831
Water Quality	Surface water and Groundwater (Temperature, pH, Total alkalinity, Ammonium, BOD ₅ , COD, EC, Oil and Grease, Turbidity, TSS, TDS, TS, etc.)	Selected locations as observed during the baseline study	Bi-annually up to five (5) years	Composite sampling (In-situ and Lab test)		2	18,265
Noise	Day time (6:00 – 21:00) and Night time (21:00 – 6:00) Leq.	Selected locations as observed during the baseline study	Bi-annually up to five (5) years	Ambient noise level monitoring using ANSI Type II Noise Meter.		1	9,132

VESC/ Indicator	Monitoring Indicators	Location	Frequency	Method	Responsible Agency	Cost (Million BDT)	Cost USD
Fisheries resources	Fish Habitat, Fish biodiversity	Project location	Half yearly up to 5 years	In-situ investigation, FDG, review of water quality report		3	27,397
Gender Issue	- Monitor the percentage of women accessing formal credit facilities and the increase in women-led enterprises or businesses in the project areas - Track the increase in the percentage of women accessing maternal health services and the number of hygienic latrines constructed. Monitor the percentage of women reporting improved access to sanitation and reduced waterborne Measure the percentage increase in women’s participation in management bodies and assess the correlation between women’s involvement and improvements in sustainable fishing practices and community incomes - activities related to GBV in fishing communities	Selected locations as observed during the baseline study	Yearly	Walk through, Interview with employees and workers, KII, FGDs in union parishad		0.2	1,826
22.3 Million BDT							203,653

Table 10.5: Monitoring Budget of Canal Rehabilitation for Cluster Farming under Satkhira, Khulna, and Bagerhat Districts

VESC/ Indicator	Monitoring Indicators	Location	Frequency	Method	Responsible Agency	Cost (Million BDT)	Cost USD
Construction Stage							
Air Quality	PM _{2.5} , PM ₁₀ , SO _x , NO ₂ , CO, O ₃	Selected locations as observed during the baseline study	Quarterly	24 hours Sampling	Third party monitoring	5.0	45,662
Water Quality	Surface water and Groundwater (Temperature, pH, Total alkalinity, Ammonium, BOD ₅ , COD, EC, Oil and Grease, Turbidity, TSS, TDS, TS, etc.)	Selected locations as observed during the baseline study	Quarterly	Composite sampling (In-situ and Lab test)		3.5	31,963
Noise	Day time (6:00 – 21:00) and Night time (21:00 – 6:00) Leq.	Selected locations as observed during the baseline study	Quarterly	Ambient noise level monitoring using ANSI Type II Noise Meter.		2.5	22,831
Fisheries resources	Fish Habitat, Fish biodiversity	Project location	Quarterly	In-situ investigation, FGD, water quality report	Third party monitoring	3.5	31,963
Employment (PAPs and Local people)	Labor Engagement for project activity	All over the study area	Quarterly	KIIs and FGDs in UPs and project area	Third party monitoring	3.0	27,397
Occupational health and safety	- First-aid Cases Medical Treatment Cases - Lost Time Injury - Number of near misses - Number of Walk-through Inspections by Project Managers, Construction Managers, Health and Safety Officer and OHS supervisors	Project Area	Quarterly	KIIs in Project site, manager	Third party monitoring	3.0	27,397

VESC/ Indicator	Monitoring Indicators	Location	Frequency	Method	Responsible Agency	Cost (Million BDT)	Cost USD
Community Health, Safety and security	- Rates of COVID-19 and other communicable disease (Chikungunya and Dengue, and other vector-borne diseases), - Project related safety and security incidents, - Number of grievances or claims of Project related impacts on the community. - Availability of Potable Water, Drinking water quality, - Availability of Hygienic Toilet	Project Area	Quarterly	Walk through, Interview with employees and workers, KIIs site manager	Third party monitoring	3.5	31,963
Grievance Mechanism	Operation, Procedures, Records and Documents	At work site	Quarterly	Register/Document review; visual inspection and enquiry to know the Grievance Mechanism	Third party monitoring	2.5	22,831
Gender Issue	- Involvement of women in fisheries-related activities (skilled positions) - Involvement of women in resource management committees - Engagement of women in project-related activities - Women accessing formal credit facilities and the increase in women-led enterprises or businesses in the project areas - Women's access to health center	Selected locations as observed during the baseline study	Half-Yearly	Walk through, Interview with employees and workers, KII, FGDs in union parishad	Third party monitoring	1.5	13,699

VESC/ Indicator	Monitoring Indicators	Location	Frequency	Method	Responsible Agency	Cost (Million BDT)	Cost USD
	• Disease prevalence among women • Access of women to WASH • Women income and contribution to households • Women's mobility • Presence of GRV • Occurrences of SEA-SH						
Post-Construction Stage							
Air Quality	PM _{2.5} , PM ₁₀ , SO _x , NO ₂ , CO, O ₃	Selected locations as observed during the baseline study	Bi-annually up to five (5) years	24 hours Sampling	Third party monitoring	2.5	22,831
Water Quality	Surface water and Groundwater (Temperature, pH, Total alkalinity, Ammonium, BOD ₅ , COD, EC, Oil and Grease, Turbidity, TSS, TDS, TS, etc.)	Selected locations as observed during the baseline study	Bi-annually up to five (5) years	Composite sampling (In-situ and Lab test)		2	18,265
Noise	Day time (6:00 – 21:00) and Night time (21:00 – 6:00) Leq.	Selected locations as observed during the baseline study	Bi-annually up to five (5) years	Ambient noise level monitoring using ANSI Type II Noise Meter.		1	9,132
Social Development and PAPs	Compensation of the PAPs, Income equity, livelihood condition, WATSAN condition, perception on the project works, etc.	People affected by proposed project activities near the project sites	Biannually	Survey, Document checking, Institutional survey, KII, Household Survey, FGD	Third party monitoring	2	18,265
Fisheries resources	Fish Habitat, Fish biodiversity	Project location	Yearly up to 5 years	In-situ investigation, FDG, review of water quality report		3	27,397

VESC/ Indicator	Monitoring Indicators	Location	Frequency	Method	Responsible Agency	Cost (Million BDT)	Cost USD
Gender Issue	• Involvement of women in fisheries-related activities (skilled positions) • Involvement of women in resource management committees • Engagement of women in project-related activities • Women accessing formal credit facilities and the increase in women-led enterprises or businesses in the project areas • Women's access to health center • Disease prevalence among women • Access of women to WASH • Women income and contribution to households • Women's mobility • Presence of GRV • Occurrences of SEA-SH	Selected locations as observed during the baseline study	Yearly	Walk through, Interview with employees and workers, KII, FGDs in union parishad	Third party monitoring	1	9,132
						39.5 Million BDT	360,731

10.6 Institutional Arrangement

The Department of Fisheries (DoF) is the key organisation responsible for fisheries development and management both in the inland and marine waters of Bangladesh which is currently functioning under the Ministry of Fisheries and Livestock (MoFL). There are three other fisheries related organizations that work under the administrative umbrella of the MoFL. These are (i) the Bangladesh Fisheries Research Institute (BFRI); (ii) the Bangladesh Fisheries Development Corporation (BFDC) and (iii) the Fisheries and Livestock Information Department (FLID).

The Project level organogram of DoF is presented in **Figure 10.1**.

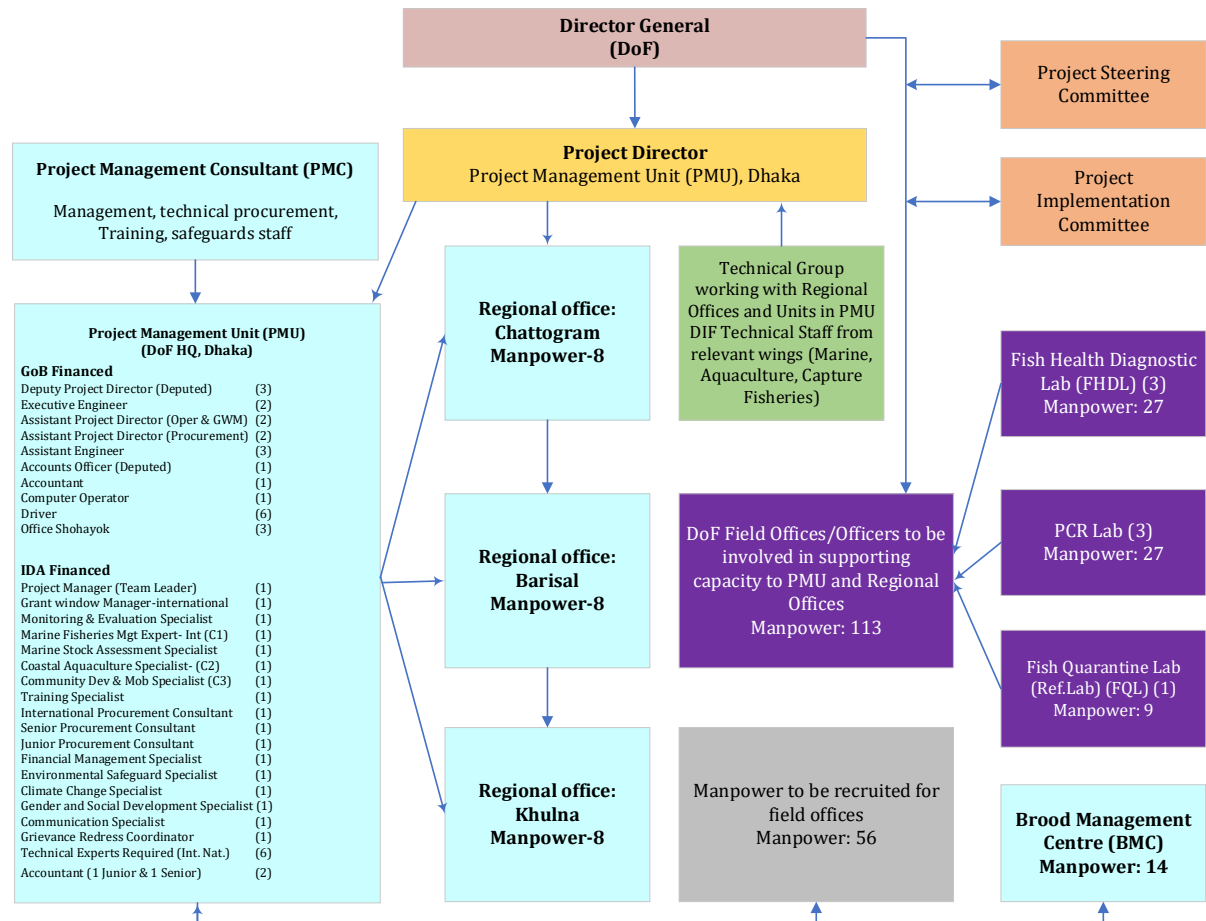


Figure 10.1: Organogram of SCMFP, DoF

On the other hand, the partial skeletal organogram of BFDC is showing major components of BFDC, Chattogram in **Figure 10.2**.

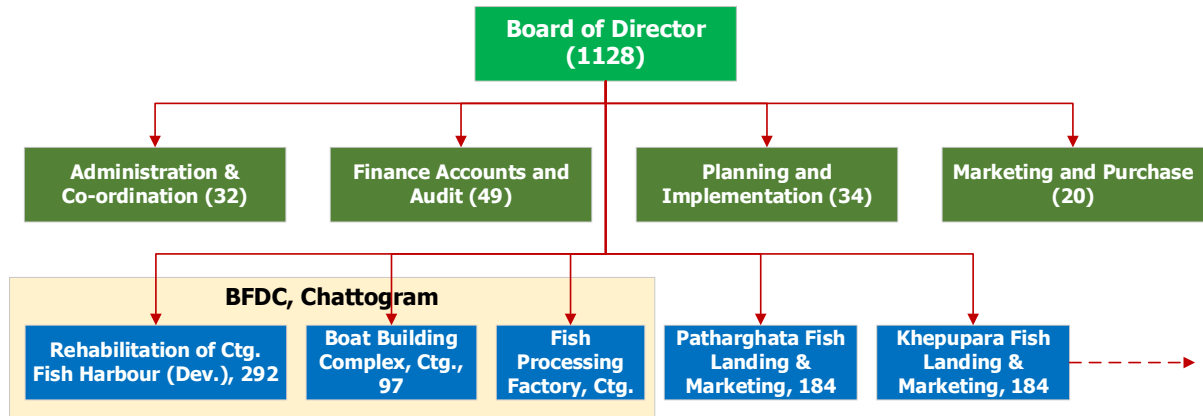


Figure 10.2: Organogram of Chattogram BFDC

For the operation of SCMFP, the DoF has created a Project Management Unit (PMU), under the office of the Director General, Department of Fisheries (DoF). The PMU consists of one Project Director (PD), three Deputy Project Director (DPD), Project Management Consultants (PMC), one National Consultant (Environment), one Executive Engineer (Structure), and an Assistant Director-cum-Accountant. To strengthen the PMU additional resources are required.

In order to implement the environmental and social management plan (ESMP) as proposed in this ESIA, an effective PMU with dedicated staff will be of crucial significance. Without qualified full-time staff, it would be nearly impossible to minimize and/or eliminate the effects of environmental hazards and risks and ensuring a safe working environment for the workers, staff, and staff family members (if any), who are residing in the project compound.

10.6.1 Proposed Institutional Strengthening of Sub-Project Management Units

In order to comply with the ESMP requirements that have been proposed in this ESIA, an effective EHS Unit with experienced and dedicated staff are essential. After a careful review of the proposed organogram of PMU, the Consultant made a proposal to strengthen the proposed organization structure, which is presented in **Figure 10.3**.

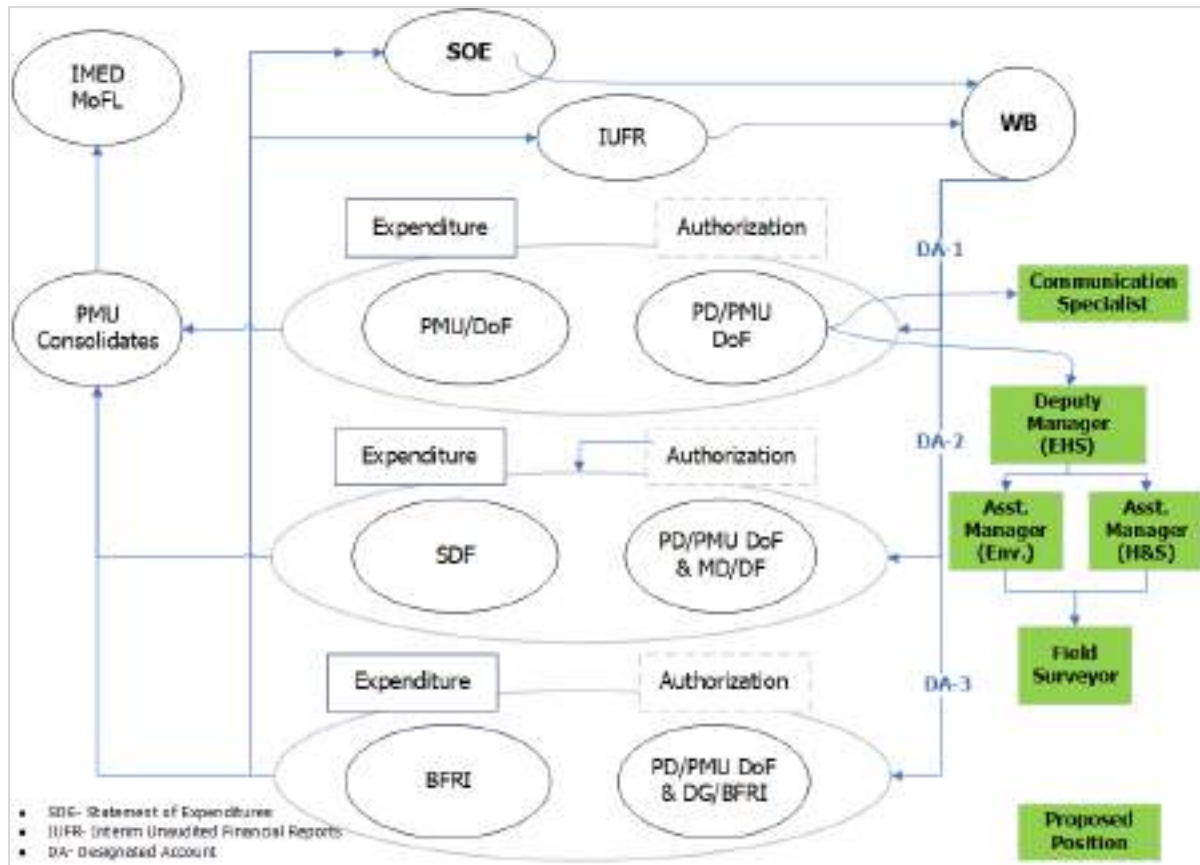


Figure 10.3: Organogram of SCMFP-PMU Proposed by the Consultant

The budget of the EHS staff and required logistics during one and a half years of construction and half a year of operation is presented in **Table 10.6**. The job descriptions of the key EHS staff with preferred responsibilities and qualifications are presented in **Table 5.4** under **Chapter 5 of Annex A: ESMP Report**.

Table 10.6: Budget for EHS Staff

Sl. No.	Items	Amount (USD)
1	Staff Budget (5 staff x 2 years)	208,696
2	Library	6,000
2	Furniture, Computers, Printer	10,000
3	Filming/Media/Publicity of Project Activities	7,000
4	Surveys, Analysis and Reports	10,000
Total		241,696

However, environmental and social trainings will be required to ensure the requirements of the ESMP are clearly understood and followed by all project personnel. Training should be carried out initially at induction of staff and repeated throughout the project. In this regard, a budget of USD 0.10 million has been earmarked for capacity building of PMU and the Terms of Reference for EHS Unit staff and the scope of work is included in **Appendix 1** and **Appendix 2** respectively under **Annex A: ESMP Report**.

To implement the ESMP an Institutional Framework has been proposed by the Consultant which is given below in **Figure 10.4**.

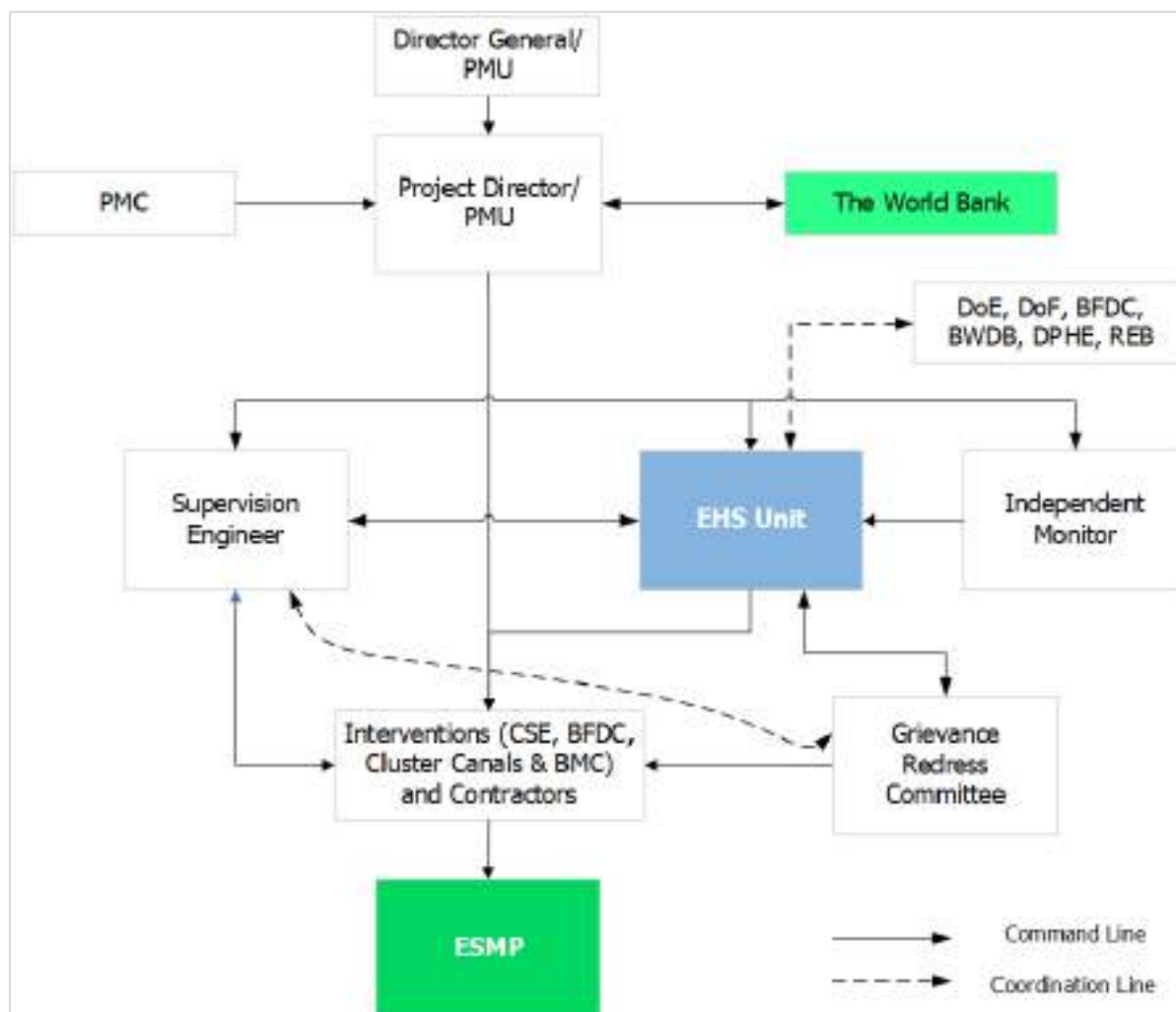


Figure 10.4: Proposed Institutional Framework for EMP Implementation

10.7 Cost Estimates for Institutional Strengthening

The cost estimates for all the institutional strengthening measures proposed in this chapter are given in the **Table 10.7**.

Table 10.7: Proposed Budget for Institutional Strengthening and Capacity Building

Sl.	Strengthening/Capacity Building Measure	Amount, USD
1	Strengthening of EHS Unit (Table 10.6)	241,696
2	Capacity Building and Training (Appendix 2 of Annex A: ESMP Report)	100,000
	Total	341,696

10.8 Summary of All Budgets

The total budget of the Environmental and Social Management Plan (ESMP) and Environmental and Social Monitoring Plan (ESMoP) is given in the following **Table 10.8**.

Table 10.8: The Summary of the Budget

Item	Sub-Item	Cost (Million BDT)	Cost (USD)
Environmental and Social Management Plan	Waste management plan	Contractor Cost	
	Biodiversity Management Plan		
	Emergency Response Plan		
	Demolition Plan		
	Drainage management Plan		
	Stakeholder Engagement Plan		
Environmental and Social Monitoring Plan	Sub-project 1	36.15	330,137
	Sub-project 2	29.45	268,950
	Sub-project 3	22.3	203,653
	Sub-project 4	39.5	360,731
Institutional arrangement	PMU budget	39.2	341,696
Indirect Project Benefits	Afforestation	19.6	169,987
DoE approval cost		1,2	10,434
Total Cost		186.2	1,685,587

11. Indirect Project Benefits and Measures Proposed Beyond Compliance

11.1 Preamble

The proposed project aims to deliver a myriad of indirect project benefits though, the Project might have sensitivity to environment and thus measures to go beyond regulatory requirements are introduced in the EIA and EMP. By fostering local economic growth, creating employment opportunities, and enhancing community welfare, the project will serve as a catalyst for regional development. Moreover, the shrimp estate is committed to advancing environmental stewardship through innovative conservation techniques, robust ecosystem management, and proactive mitigation strategies that safeguard biodiversity. These efforts underscore our dedication to not only meeting but exceeding industry standards, thereby promoting long-term ecological balance and socio-economic prosperity.

11.2 Indirect Project Benefits of CSE

11.2.1 Economic Benefits

Benefits of Value Chain Related Actors: The CSE's value chain involves farmers, processors, suppliers, distributors, and retailers, each contributing to and benefiting from the industry beyond direct economic gains. Processing facilities often adopt advanced technologies, such as packaging and freezing methods, which not only enhance shrimp quality but also drive innovation in local industries. The demand for supplies creates a ripple effect, boosting related sectors like manufacturing and transportation, thereby fortifying the local economy. Distributors tapping into international markets diversify their clientele, reducing reliance on any single market and fostering economic stability. Retailers gain by offering a diverse product range, including sustainably farmed shrimp, appealing to health-conscious consumers. Selling sustainably sourced shrimp enhances brand reputation and customer loyalty, ensuring long-term business success (The Nature Conservancy).

Employment Opportunities: The CSE can create numerous jobs in farming, processing, and associated industries, thereby reducing local unemployment.

Skill Development: Training programs for local employees can improve their skills, increasing their employability in other sectors.

Improved Transportation: Construction and maintenance of roads and transport facilities can benefit the entire community.

Enhanced Utilities: Better access to electricity, water, and communication infrastructure as a result of the project can improve local living conditions.

Support for Local Businesses: Local suppliers of PL, feed, equipment, and other materials can benefit from increased demand.

Market Expansion: The increased economic activity can lead to the growth of local markets and services.

11.2.2 Social Benefits

Higher Living Standards: Increased income from employment can lead to better housing, nutrition, and healthcare. Shared economic benefits can strengthen community ties.

Increased Access to Education: Higher family incomes can enable better educational opportunities for children.

11.2.3 Environmental Benefits

Promotion of Best Practices: Implementing and promoting sustainable shrimp farming practices can set an example for other local farmers.

Resource Management: Sustainable farming can help preserve important fish habitat areas, contributing to overall ecosystem health. Efficient use of resources like water and land can serve as a model for sustainable agricultural practices.

Mangrove Reforestation: Investing in mangrove restoration can help protect coastal areas and enhance biodiversity.

11.3 Touristic View of CSE- An Indirect Project Benefit

The implementation of the project in CSE can significantly enhance its touristic appeal by developing various types of tourism activities. Visitors can explore the shrimp farming operations, learning about sustainable aquaculture practices and the importance of environmental stewardship. Tours of the restored mangrove ecosystems will highlight their ecological significance and the diverse wildlife they support, such as bird-watching excursions. Educational programs on shrimp and salt farming techniques, environmental conservation, and sustainable development practices can be hosted for students, researchers, and interested tourists, alongside collaboration with universities and research institutions for field studies and internships. Recreational activities like boat tours and catch-and-release fishing in the canals and nearby waters can be offered, as well as developing walking and hiking trails through the mangrove forests. Showcasing the local culture, including traditional fishing methods, local cuisine, and crafts through cultural events and food festivals, provides opportunities for tourists to interact with local communities, offering insights into their way of life and the role of shrimp farming in their livelihoods. Additionally, tourists can participate in shrimp farming activities, such as feeding shrimp, harvesting, and understanding the lifecycle of shrimp farming, and stay in eco-friendly accommodations on or near the shrimp farms to experience farm life firsthand. By integrating these tourism activities, CSE can attract a diverse group of visitors, from eco-tourists and adventure seekers to students and researchers. This influx of tourists will provide indirect benefits such as increased local employment, economic growth, and heightened awareness of sustainable practices, contributing to the overall socio-economic development of the region.

11.4 Measures Under Corporate Social Responsibility

Corporate Social Responsibility (CSR) has become an important part of corporate obligations reflecting non-financial aspects of an organization's performance like DoF. These non-financial aspects have significant implications for a company's internal and external stakeholders, including nearby communities, civil society organizations, regulators, international financial organizations, and news media. Local people have the concern about corporate accountability and the impact of corporate strategies and operations on the physical, economic, and socio-political environments. Financial analysts often view adverse public opinion on corporate social performance as a measure of long-term reputational risk to a company's market value. Thus, CSR have become a competitive tool in promoting an organization's practices and values when compared with those of its peers and competitors. CSR activities for this project are therefore proposed as follows:

- The health facility presently available in the study area is in good shape and is not overloaded with patients. So, this facility can be available for the poor people around the area. Appropriate security measures may be taken;

- Providing sanitation facilities, such as setting up of public toilets ¹⁴at different hot spots of the study area following the guidelines for public toilet and with the coordination of Chakaria Administration. Management of those toilets may be based on lease system, so that it remains usable over a long run to a large number of people;
- Training of local youth so that they can, in turn, be employed during project construction and project operation. Bangladesh is one of the major manpower supplying countries of the world. But it supplies non-skilled to semi-skilled manpower particularly in the Middle East and South East Asian countries and earns low foreign currency compared to the countries which provide skilled manpower. There is a huge demand of agricultural workers. So, there is a scope of developing manpower in power sector in technical category and as such they can earn more foreign currency. In this connection, this Project can facilitate capacity development of the local youths through relevant training programs.
- AIGA helps to mitigate the risks associated with the shrimp farming industry. It will decrease the financial vulnerability of shrimp farmers and local fishers by spreading economic risks across various activities. This is particularly important in mitigating the impacts of shrimp diseases, market fluctuations, and climate change.
- Develop socio-cultural facilities such as mosques, playgrounds and community centers for the community.

Table 11.1: Estimated budget for CSR

Sl	Items	Quantity	Amount (US\$)
1	Public toilets	3	10,500
2	Training of local youths	200	15,000
3	Socio-cultural facilities	3	30,000

11.5 Use of ETP Rejected Water for Diverse Uses

The water treated by ETP, often referred to as ETP rejected water, can be repurposed for various uses instead of being wasted. Utilizing ETP rejected water not only promotes environmental sustainability but also provides economic benefits. Here the diverse uses of ETP rejected water produced from fish processing plants and their potential impacts.

Agricultural Irrigation: One of the primary uses of ETP rejected water is for agricultural irrigation. Treated water can be used to irrigate crops, particularly non-edible crops, which can benefit from the nutrients present in the water. The presence of organic matter and nutrients such as nitrogen and phosphorus in the treated water can enhance soil fertility. Utilizing ETP rejected water for irrigation conserves freshwater resources, which is critical in regions facing water scarcity. Reduces the need for chemical fertilizers, lowering the cost for farmers.

Aquaculture: ETP rejected water can be reused for aquaculture, where it is used in fish farming operations. Promotes a circular economy within the fish processing industry by reusing water. The nutrients in the water can support the growth of aquatic plants and fish. Reduces the discharge of treated water into natural water bodies, mitigating potential environmental harm.

¹⁴ WaterAid Bangladesh, 2006. Step by Step Implementation Guidelines for Public Toilet

Industrial Applications: Industries can use ETP rejected water for various processes, such as cooling, washing, and other non-potable applications. Helps industries reduce their freshwater consumption, promoting sustainable industrial practices. Lowers water procurement costs for industries. Reduces the burden on natural water sources and promotes the recycling of water within industrial processes.

Landscaping and Horticulture: ETP rejected water can be effectively used in landscaping and horticulture, particularly for watering lawns, parks, and gardens. Supports the maintenance of green spaces, which enhance the aesthetic value of urban areas and contribute to environmental well-being. Provides necessary nutrients to plants, promoting healthy growth. Encourages the recycling of water, reducing the demand for potable water for non-potable uses.

Construction Activities: In construction, ETP rejected water can be used for activities such as dust suppression, concrete mixing, and site cleaning. Makes efficient use of available water resources in construction projects. Reduces the cost associated with water procurement for construction purposes. Minimizes the environmental impact by reducing the extraction of groundwater or the use of freshwater resources.

11.6 Greenbelt Development

There will be some trees, shrubs, and grasses require clearing for the project footprint, which needs substituted by 3-5 times per tree felled to comply with DoE requirements as practice. In addition, wildlife habitat especially bird species will be affected. To compensate the trees and wildlife habitat loss, a plantation program under the project is considered in terms of green belt development beyond compliance within the project boundary. Locally available mangrove or low saline tolerant or inland tree species that are pollution resistant and with thick foliage will be selected for green belt development. A detailed description of the floral diversity of the terrestrial ecosystem within the Study Area is given in below:

BFDC Harbor at Chattogram

Floral Diversity of the Terrestrial Ecosystem within the Study Area

According to the information as collected from the BFDC, a number of 192 timber trees of primarily Arjun and Akashmoni species will be felled for the proposed interventions.

Brood Management Center

Floral Diversity of the Terrestrial Ecosystem within the Study Area:

There are 44 number of trees need to be felled in the proposed BMC intervention area at DFTC. The species composition in this area includes mangrove herbs and shrubs along with Narikel, Boroi, Jarul, Aam, and Kanthal. Three species predominate among the roughly six mangrove species that are found in the BMC area. Those are Hargoza, Ora, and Baen.

Canals Rehabilitation for Cluster Farming

Floral Diversity of the Terrestrial Ecosystem within the Study Area

According to the vegetation survey, the most common plants that are now being planted by local people on the dyke along the canals under Satkhira, Khulna and Bagerhat Districts are non-saline plant species such as Mango, Jackfruit, Guava, Banana, Papaya, Palmyra Palm etc.

Afforestation plan: Afforestation is an important intervention aiming for expanding vegetation coverage, enhance environmental sustainability, protect embankment from wave action and reduce

foreshore erosion. The afforestation plan is finalized after review of previous studies on afforestation, consultation with local people and field verification for selection of suitable species. Consequently, four types of plantations have been suggested for 138 km of the proposed construction dyke area. I) Mixed plantation –Mango (*Magnifera indica*); Narikel (*Cocos nucifera*), Taal (*Borassus flabellifer*), Khejur (*Phoenix sylvestris*) and babla (*Vachellia nilotica*); ii) Shrimp farm boarder plantation- Narikel (*Cocos nucifera*); iii) Mangrove plantation- Keora (*Sonneratia apetala*), Ora (*Sonneratia caseolaris*), Sada Baen (*Avicennia officinalis*). Type of plantation and tentative cost are given in following **Table 11.2**.

Table 11.2: Details of Plantation Types and Cost for Afforestation of the Study Area

Sl. No.	Description of Work	Plantation Length (km)	Spacing (m)	Location	No. of required Saplings/km	Total no. of required Saplings	Unit Cost/Sapling (USD)	Plantation Cost/Sapling (USD)	Total Cost (USD)
1	Mangrove plantation	65	2	Chakaria	500	32,500	3.15	0.45	117,295
2	Bank Plantation (Strip)	20	5	Chakaria; and DFTC, Teknaf	200	4,000	3.15	0.45	14,436
3	Mixed Plantation (Strip)	53	5	Chakaria; DFTC, Teknaf; BFDC Harbor at Chattogram; and dykes of the canals for cluster farming	200	10,600	3.15	0.45	38,256
Total		138				47,100			169,987

Chakaria Shrimp Estate

Approximate design by maintaining two steps:

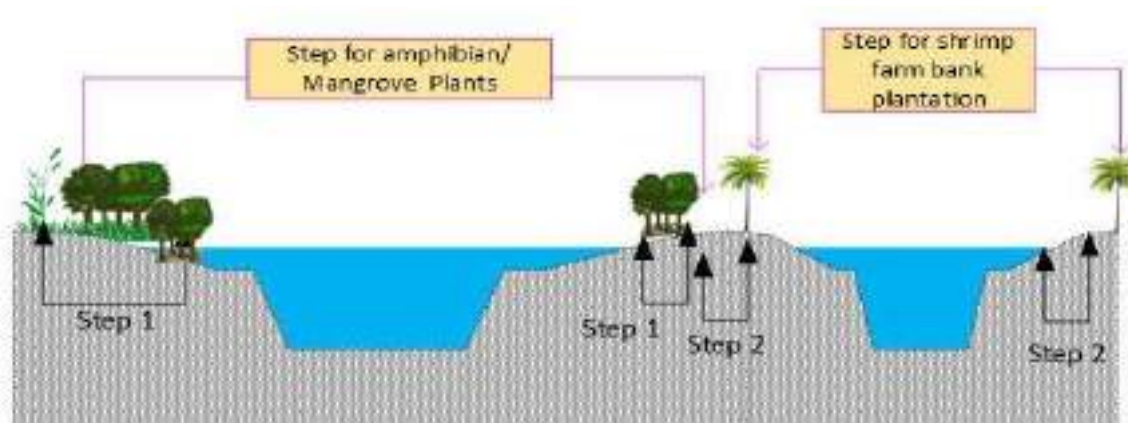


Figure 11.1: Plantation Design for CSE

BFDC Harbor Chattogram

A third-party contractor will carry out the plantation program, making use of any vacant space left over after all the planned work. Both timber and decorative species will be planted in the commercial area. The following species are appropriate for planting:

Plantation Type	Species
Timber plantation	Mahagoni (<i>swietenia mahagoni</i>) Teak (<i>Tectona grandis</i>)
Ornamental plantation	Krisnochora (<i>Delonix regia</i>) Sonalu (<i>Cassia fistula</i>) Narikel (<i>Cocos nucifera</i>)

Brood Management Center at DFTC, Teknaf

The land is suited for the mixed plantation and canal bank mangrove plantation scheme. The list of native species in that area is as follows:

Plantation Type	Species
Mangrove plantation	Keora (<i>Sonneratia apetala</i>), Ora (<i>Sonneratia caseolaris</i>), Sada Baen (<i>Avicennia officinalis</i>)
Mixed plantation	Mahagoni (<i>swietenia mahagoni</i>) Mango (<i>Magnifera Indica</i>) Krisnochora (<i>Delonix regia</i>) Narikel (<i>Cocos nucifera</i>)

Canals for Cluster Farming under Satkhira, Khulna and Bagerhat Districts

Figure 11.2: Plantation Design for the Canals for Cluster Farming

11.7 Carbon Sequestration in CSE

The development of greenbelts in the CSE has significant potential for carbon sequestration, particularly through the restoration and conservation of mangrove forests. Mangroves are known for their high capacity to sequester carbon, often referred to as blue carbon, which is carbon captured by the world's oceanic and coastal ecosystems.

Mangroves can sequester up to four times more carbon than terrestrial forests due to their ability to store carbon in both their biomass and the soil. This makes them a critical component in mitigating

climate change. For instance, reforested mangrove areas in the study area have shown substantial increases in carbon stocks. In a ten-year evaluation of a mangrove plantation reforested from an abandoned shrimp pond, significant increases in both standing biomass and soil organic carbon were observed. Specifically, the standing biomass of species like *Rhizophora mucronata* increased significantly, with soil organic carbon doubling in the top 5 cm of soil in areas where hydraulic conditions were properly managed [MDPI (The Nature Conservancy)].

The development of greenbelts in the CSE plays a crucial role in the reduction of greenhouse gases. These green areas, comprising trees, shrubs, and other vegetation, act as carbon sinks, absorbing carbon dioxide from the atmosphere through the process of photosynthesis. As the vegetation grows, it stores carbon within its biomass and in the soil, effectively removing CO₂ from the air and mitigating climate change. Additionally, the presence of greenbelts would help to reduce the emission of greenhouse gases by providing natural habitats for wildlife, which in turn supports biodiversity and ecosystem health. Furthermore, green spaces contribute to cooling the local environment, mitigating the urban heat island effect, and enhancing overall air quality. Overall, the establishment and maintenance of greenbelts in the CSE not only promote environmental sustainability but also provide multiple benefits for climate change mitigation and adaptation efforts.

Incorporating mangrove restoration into shrimp farming practices not only aids in carbon sequestration but also enhances the sustainability of the shrimp farming industry. For example, the integration of mangrove restoration in shrimp farms, as seen in successful projects, has resulted in the recovery of vital ecosystems and provided additional benefits such as coastal protection and biodiversity support (The Nature Conservancy).

Overall, developing greenbelts in CSE by restoring mangroves offers a viable path to enhance carbon sequestration, contributing positively to both climate change mitigation and the sustainability of shrimp farming.

11.8 Closing

The project is designed as environmentally sound project and an environmental management plan has been devised to take care of the environmental issues. With the apprehension that the Project might still have sensitivity to the environment, measures discussed above are considered to enhance environmental and social conditions of the project area. These measures are essentially beyond compliance requirements and can provide inspiration to other companies and corporations in Bangladesh to follow.

12. Conclusions and Recommendations

12.1 Conclusions

The Environmental and Social Impact Assessment study followed the ECR 2023 for satisfying national perspectives and Environmental and Social Management Framework (ESMF) prepared and adopted for SCMFP by the Project Proponent following the national framework and the World Bank Policy and Guidelines on ES risk management. Under this study, potential triggering factors have been identified for the impacts and make a linkage with the World Bank's OP/BP and applicable national legislatives.

The environmental impacts due to the proposed improvements of the Sub-Projects are diversified. In case of CSE, apart from obstruction to flow, increased water turbidity, fish habitat disturbance, vegetation draping, etc., shall not result in any major environmental impacts pertaining to siting of components in environmentally sensitive areas /locations. The impacts are largely construction related and can be addressed through adoption of appropriate mitigation measures during the construction period.

The proposed interventions of CSE are to be accommodated within the available land earmarked, and hence land acquisition has not been envisaged.

Based on the screening outcomes, a detailed ESIA Study has been conducted and potential impacts and corresponding mitigation measures have been given for selected VESCs individually for each sub-project. The ESIA Study has been conducted based on the ECR 2023 and the World Bank's OP/BP on environmental and social risk management.

A separate Environmental and Social Management Plan (ESMP) has been prepared for this Project and necessary Budget on ESMP and Environmental and Social Monitoring Plan (ESMoP) has been provided so that Supervising Consultant may use the document for the Project implementation works. The ESMP implementation during the Project implementation would be included in the bidding document and its cost will be included in the Project cost. The ESMP will take care of all the EHS issues in compliance with the national, the international guidelines. However, a summary of the Report is also included as **Chapter 10** under this Report. A set of ESCOPs has been provided as an integral part of the ESMP (as mentioned in the **Annex 34** of the **Volume II: Annexures of Main Report**) for attending the lower level of impacts that could be managed by the contractors with limited efforts.

An emergency response plan (ERP) for this Project as a whole has been prepared for effective response to effectively and efficiently deal with any emergency, major accidents or natural disasters. A management structure for the ESMP implementation has been proposed in this ESIA report under **Annex A: ESMP**.

In conclusion, by implementing the sub-projects, the Government of Bangladesh (GoB) through the Department of Fisheries (DoF) will be able to make the coastal and marine fisheries into a sustainable condition which in turn contribute to the national economy and poverty reduction. For implementing the sub-projects, the project authority would offer job opportunities for a large section of people during the life time where the local people will get priority based on their skills. Overall, it is expected that with the mitigations in place, the proposed project would be environmentally friendly. Therefore, considering all the measures and ESMPs and ESMoPs are in place and comprehending the importance of the project nationally, an ESIA approval may be obtained from the Department of Environment (DoE) before implementation of the Project.

12.2 Recommendations

The following recommendations are made based on the ESIA that should be considered for achieving the goal of minimizing environmental impact and optimum benefits:

- Findings and suggestion of ESIA should be considered and executed in Project planning, design and operation stages. As a part of the suggestions, reconciliation of afforestation plan for peripheral dyke obtained from the engineering team for CSE is deemed necessary to contextualize with the plan given under this study in **Chapter 4** in brief and in **Annex 36 of Volume II: Annexures of Main Report** in details.
- All activities under construction and operation stages should be implemented according to ESMP;
- Some identified guards, currently living at CSE, Rampur, should be shifted to other places providing them a sifting charge by the Proponent during construction stage;
- The Chakaria Shrimp Estate (CSE) is such a productive land through which local people around CSE may depend on various livelihood such as: Shrimp and fish farming, salt cultivation, cattle farming near Bura Matamuhuri River etc. Therefore, it is recommended to promote integrated cultivation system in the CSE through the Sub-Project authority;
- Observing siltation rate, it needs to define the interval of re-excavation/rehabilitation of the internal drainage and feeder canals.
- Environmental Management Plan and Safety Management Plan should be implemented at every suggested step during sub-project implementation
- The contractor's environmental experts shall have to prepare Site Specific Environmental Management Plan (SEMP) to adapt with the working time and conditions.
- Shifting of local People (not the owner) dependent on the land for living and subsistence activities in CSE should be provided with proper shifting charge.
- Establishing Institutional arrangement with proper logistic and training for Environment, Health and Safety in Project Management Unit during various stages (as required) of each sub-Project.
- Full environmental compliance monitoring activities to be ensured during construction stage (full period) and operation stage (at least up to 5 years' period) of the Project implementation.
- CCTV camera should be installed in each guard shed to ensure safety and security of the people involved different activities in the Chakaria Shrimp Estate,
- Salinity tolerant vegetables should be promoted as an integrated farming to boost up the household level income and meet the nutrition security of the people involved in the Chakaria Shrimp Estate.
- A maintenance re-excavation plan should be devised to keep the internal canals of the Chakaria Shrimp Estate flowing and facilitating water exchange between the canals and the shrimp ghers.
- At all levels, the stakeholders should be engaged and grievances of the local people should be addressed meticulously and timely. In case of not addressable, the communication specialist considered under the PMU should resolve it by discussing the issues with the community representatives.

Besides, to involve women into various works under fish products based ventures including other works based on their skills and expertise following recommendations should be considered under each sub-projects as relevant:

- Employment opportunity should be expanded for the women with equitable wages and with work station-based womanly civic facilities for them.
- Encourage women entrepreneurship by developing skill in fish and fish products-based ventures and accessing to financial resources and macro finance-based credit.
- Cease or limit the school level dropout of girls as much as possible by growing interests in fish and fish products-based ventures along with other opportunities in future even by offering stipends or incentives or scholarships.
- Support livelihood diversification programs that offer women alternative income-generating activities, such as small-scale aquaculture, fish processing businesses, or handicrafts related to the fisheries sector.
- The project might provide vocational training programs for women in sustainable resource management, shrimp farming techniques, aquaculture practices, and quality control.
- Having potential of CSE as a smart shrimp city, township in BMC and canal dyke as accessibility, these facilities should be created as gender friendly to facilitate maternal survival rates, access to healthcare, timely delivery of pregnant women, womanly civic facilities, etc.
- Awareness building to women, how to work in a climate stressed condition by keeping up their health condition and in case of inability facilitate them financially to the extent possible.
- The project should also prioritize constructing gender-sensitive sanitation facilities, especially in public areas like markets and processing plants.
- Introduce climate-resilient farming practices and technologies, focusing on training women in their use.
- Ensure women's active participation in community-based resource management and decision-making processes. The project could establish gender-sensitive governance structures within fisheries management bodies.
- Integrate GBV prevention and response measures specific to the fisheries and shrimp sector, including establishing safe spaces for women working in these industries, improving access to support services (legal, medical, and psychosocial) at processing plants, and conducting training programs to raise awareness about GBV in local fishing communities.

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Appendix 1: The IFC EHS Guidelines 2007 (Wastewater and Ambient Water Quality)

General EHS Guidelines [Complete version] at: www.ifc.org/ehsguidelines



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GENERAL EHS GUIDELINES: ENVIRONMENTAL
WASTEWATER AND AMBIENT WATER QUALITY



WORLD BANK GROUP

1.3 Wastewater and Ambient Water Quality

Applicability and Approach.....	25
General Liquid Effluent Quality.....	25
Discharge to Surface Water.....	26
Discharge to Sanitary Sewer Systems.....	26
Land Application of Treated Effluent.....	27
Septic Systems.....	27
Wastewater Management.....	27
Industrial Wastewater.....	27
Sanitary Wastewater.....	29
Emissions from Wastewater Treatment Operations.....	30
Residuals from Wastewater Treatment Operations.....	30
Occupational Health and Safety Issues in Wastewater Treatment Operations.....	30
Monitoring.....	30

- Understand the quality, quantity, frequency and sources of liquid effluents in its installations. This includes knowledge about the locations, routes and integrity of internal drainage systems and discharge points.
- Plan and implement the segregation of liquid effluents principally along industrial, utility, sanitary, and stormwater categories, in order to limit the volume of water requiring specialized treatment. Characteristics of individual streams may also be used for source segregation.
- Identify opportunities to prevent or reduce wastewater pollution through such measures as recycle/reuse within their facility, input substitution, or process modification (e.g. change of technology or operating conditions/modes).
- Assess compliance of their wastewater discharges with the applicable: (i) discharge standard (if the wastewater is discharged to a surface water or sewer), and (ii) water quality standard for a specific reuse (e.g. if the wastewater is reused for irrigation).

Additionally, the generation and discharge of wastewater of any type should be managed through a combination of:

- Water use efficiency to reduce the amount of wastewater generation
- Process modification, including waste minimization, and reducing the use of hazardous materials to reduce the load of pollutants requiring treatment
- If needed, application of wastewater treatment techniques to further reduce the load of contaminants prior to discharge, taking into consideration potential impacts of cross-media transfer of contaminants during treatment (e.g., from water to air or land)

Applicability and Approach

This guideline applies to projects that have either direct or indirect discharge of process wastewater, wastewater from utility operations or stormwater to the environment. These guidelines are also applicable to industrial discharges to sanitary sewers that discharge to the environment without any treatment. Process wastewater may include contaminated wastewater from utility operations, stormwater, and sanitary sewage. It provides information on common techniques for wastewater management, water conservation, and reuse that can be applied to a wide range of industry sectors. This guideline is meant to be complemented by the industry-specific effluent guidelines presented in the Industry Sector Environmental, Health, and Safety (EHS) Guidelines. Projects with the potential to generate process wastewater, sanitary (domestic) sewage, or stormwater should incorporate the necessary precautions to avoid, minimize, and control adverse impacts to human health, safety, or the environment.

In the context of their overall EHS management system, facilities should:

APRIL 30, 2007
25



Environmental, Health, and Safety (EHS) Guidelines
GENERAL EHS GUIDELINES: ENVIRONMENTAL
WASTEWATER AND AMBIENT WATER QUALITY



When wastewater treatment is required prior to discharge, the level of treatment should be based on:

- Whether wastewater is being discharged to a sanitary sewer system, or to surface waters
- National and local standards as reflected in permit requirements and sewer system capacity to convey and treat wastewater if discharge is to sanitary sewer
- Assimilative capacity of the receiving water for the load of contaminant being discharged: wastewater if discharge is to surface water
- Intended use of the receiving water body (e.g., as a source of drinking water, recreation, irrigation, navigation, or other)
- Presence of sensitive receptors (e.g., endangered species) or habitats
- Good International Industry Practice (GIIIP) for the relevant industry sector

General Liquid Effluent Quality

Discharge to Surface Water

Discharges of process wastewater, sanitary wastewater, wastewater from utility operations or stormwater to surface water should not result in contaminant concentrations in excess of local ambient water quality criteria or, in the absence of local criteria, other sources of ambient water quality.²⁵ Receiving water use²⁶ and assimilative capacity²⁷, taking other sources of discharges to

the receiving water into consideration, should also influence the acceptable pollution loadings and effluent discharge quality. Additional considerations that should be included in the setting of project-specific performance levels for wastewater effluents include:

- Process wastewater treatment standards consistent with applicable Industry Sector EHS Guidelines. Projects for which there are no industry-specific guidelines should reference the effluent quality guidelines of an industry sector with suitably analogous processes and effluents;
- Compliance with national or local standards for sanitary wastewater discharges or, in their absence, the indicative guideline values applicable to sanitary wastewater discharges shown in Table 1.3.1 below;
- Temperature of wastewater prior to discharge does not result in an increase greater than 3°C of ambient temperature at the edge of a scientifically established mixing zone which takes into account ambient water quality, receiving water use and assimilative capacity among other considerations.

Discharge to Sanitary Sewer Systems

Discharges of industrial wastewater, sanitary wastewater, wastewater from utility operations or stormwater into public or private wastewater treatment systems should:

- Meet the pretreatment and monitoring requirements of the sewer treatment system into which it discharges
- Not interfere, directly or indirectly, with the operation and maintenance of the collection and treatment systems, or pose a risk to worker health and safety, or adversely impact

²⁵ An example is the US EPA National Recommended Water Quality Criteria (<http://www.epa.gov/waterscience/criteria/wqc/criteria.html>)

²⁶ Examples of receiving water uses as may be designated by local authorities include: drinking water (with some level of treatment), recreation, agriculture, irrigation, general aquatic life, industrial, and navigation. Examples of health-based guideline values for receiving waters include World Health Organization (WHO) guidelines for recreational use (http://www.who.int/water_sanitation_health/legislation/guidelines/index.html)

²⁷ The assimilative capacity of the receiving water body depends on numerous factors including, but not limited to, the total volume of water, flow rate, flushing rate of the water body and the loading of pollutants from other effluent sources in

the area or region. A seasonally representative baseline assessment of ambient water quality may be required to use with established scientific methods and mathematical models to estimate potential impact to the receiving water from an effluent source.



Environmental, Health, and Safety (EHS) Guidelines
GENERAL EHS GUIDELINES: ENVIRONMENTAL
WASTEWATER AND AMBIENT WATER QUALITY



characteristics of residuals from wastewater treatment operations.

- Be discharged into municipal or centralized wastewater treatment systems that have adequate capacity to meet local regulatory requirements for treatment of wastewater generated from the project. Pretreatment of wastewater to meet regulatory requirements before discharge from the project site is required if the municipal or centralized wastewater treatment system receiving wastewater from the project does not have adequate capacity to maintain regulatory compliance.

Land Application of Treated Effluent

The quality of treated process wastewater, wastewater from utility operations or stormwater discharged on land, including wetlands, should be established based on local regulatory requirements.

Where land is used as part of the treatment system and the ultimate receptor is surface water, water quality guidelines for surface water discharges specific to the industry sector process should apply.²² Potential impact on soil, groundwater, and surface water, in the context of protection, conservation and long term sustainability of water and land resources should be assessed when land is used as part of any wastewater treatment system.

Septic Systems

Septic systems are commonly used for treatment and disposal of domestic sanitary sewage in areas with no sewerage collection networks. Septic systems should only be used for treatment of sanitary sewage, and unsuitable for industrial wastewater treatment. When septic systems are the selected form of wastewater disposal and treatment, they should be:

- Properly designed and installed in accordance with local regulations and guidance to prevent any hazard to public health or contamination of land, surface or groundwater.
- Well maintained to allow effective operation.
- Installed in areas with sufficient soil percolation for the design wastewater loading rate.
- Installed in areas of stable soils that are nearly level, well drained, and permeable, with enough separation between the drain field and the groundwater table or other receiving waters.

Wastewater Management

Wastewater management includes water conservation, wastewater treatment, stormwater management, and wastewater and water quality monitoring.

Industrial Wastewater

Industrial wastewater generated from industrial operations includes process wastewater, wastewater from utility operations, runoff from process and materials staging areas, and miscellaneous activities including wastewater from laboratories, equipment maintenance shops, etc. The pollutants in an industrial wastewater may include acids or bases (exhibited as low or high pH), soluble organic chemicals causing depletion of dissolved oxygen, suspended solids, nutrients (phosphorus, nitrogen), heavy metals (e.g. cadmium, chromium, copper, lead, mercury, nickel, zinc), cyanide, toxic organic chemicals, oily materials, and volatile materials, as well as from thermal characteristics of the discharge (e.g., elevated temperature). Transfer of pollutants to another phase, such as air, soil, or the sub-surface, should be minimized through process and engineering controls.

Process Wastewater — Examples of treatment approaches typically used in the treatment of industrial wastewater are summarized in Annex 1.3.1. While the choice of treatment

²² Additional guidance on water quality considerations for land application is available in the WHO Guidelines for the Safe Use of Wastewater, Excreta and Greywater, Volume 2: Wastewater Use in Agriculture http://www.who.int/water_sanitation_health/wastewater/guawg/en/index.html



Environmental, Health, and Safety (EHS) Guidelines
GENERAL EHS GUIDELINES: ENVIRONMENTAL
WASTEWATER AND AMBIENT WATER QUALITY



technology is driven by wastewater characteristics, the actual performance of this technology depends largely on the adequacy of its design, equipment selection, as well as operation and maintenance of its installed facilities. Adequate resources are required for proper operation and maintenance of a treatment facility, and performance is strongly dependent on the technical ability and training of its operational staff. One or more treatment technologies may be used to achieve the desired discharge quality and to maintain consistent compliance with regulatory requirements. The design and operation of the selected wastewater treatment technologies should avoid uncontrolled air emissions of volatile chemicals from wastewaters. Residuals from industrial wastewater treatment operations should be disposed in compliance with local regulatory requirements, in the absence of which disposal has to be consistent with protection of public health and safety, and conservation and long term sustainability of water and land resources.

Wastewater from Utilities Operations - Utility operations such as cooling towers and demineralization systems may result in high rates of water consumption, as well as the potential release of high temperature water containing high dissolved solids, residues of biocides, residues of other cooling system anti-fouling agents, etc. Recommended water management strategies for utility operations include:

- Adoption of water conservation opportunities for facility cooling systems as provided in the Water Conservation section below;
- Use of heat recovery methods (also energy efficiency improvements) or other cooling methods to reduce the temperature of heated water prior to discharge to ensure the discharge water temperature does not result in an increase greater than 3°C of ambient temperature at the edge of a scientifically established mixing zone which takes into

account ambient water quality, receiving water use, potential receptors and assimilative capacity among other considerations;

- Minimizing use of antifouling and corrosion inhibiting chemicals by ensuring appropriate depth of water intake and use of screens. Least hazardous alternatives should be used with regards to toxicity, biodegradability, bioavailability, and bioaccumulation potential. Dose applied should accord with local regulatory requirements and manufacturer recommendations;
- Testing for residual biocides and other pollutants of concern should be conducted to determine the need for dose adjustments or treatment of cooling water prior to discharge.

Stormwater Management - Stormwater includes any surface runoff and flows resulting from precipitation, drainage or other sources. Typically stormwater runoff contains suspended sediments, metals, petroleum hydrocarbons, Polycyclic Aromatic Hydrocarbons (PAHs), coliform, etc. Rapid runoff, even of uncontaminated stormwater, also degrades the quality of the receiving water by eroding stream beds and banks. In order to reduce the need for stormwater treatment, the following principles should be applied:

- Stormwater should be separated from process and sanitary wastewater streams in order to reduce the volume of wastewater to be treated prior to discharge
- Surface runoff from process areas or potential sources of contamination should be prevented
- Where this approach is not practical, runoff from process and storage areas should be segregated from potentially less contaminated runoff
- Runoff from areas without potential sources of contamination should be minimized (e.g. by minimizing the area of impermeable surfaces) and the peak discharge rate should



Environmental, Health, and Safety (EHS) Guidelines
GENERAL EHS GUIDELINES: ENVIRONMENTAL
WASTEWATER AND AMBIENT WATER QUALITY



be reduced (e.g. by using vegetated swales and retention ponds);

- Where stormwater treatment is deemed necessary to protect the quality of receiving water bodies, priority should be given to managing and treating the first flush of stormwater runoff where the majority of potential contaminants tend to be present;
- When water quality criteria allow, stormwater should be managed as a resource, either for groundwater recharge or for meeting water needs at the facility;
- Oil water separators and grease traps should be installed and maintained as appropriate at refueling facilities, workshops, parking areas, fuel storage and containment areas;
- Sludge from stormwater catchments or collection and treatment systems may contain elevated levels of pollutants and should be disposed in compliance with local regulatory requirements, in the absence of which disposal has to be consistent with protection of public health and safety, and conservation and long term sustainability of water and land resources

Sanitary Wastewater

Sanitary wastewater from industrial facilities may include effluents from domestic sewage, food service, and laundry facilities serving site employees. Miscellaneous wastewater from laboratories,

medical infirmaries, water softening etc. may also be discharged to the sanitary wastewater treatment system. Recommended sanitary wastewater management strategies include:

- Segregation of wastewater streams to ensure compatibility with selected treatment option (e.g. septic system which can only accept domestic sewage);
- Segregation and pretreatment of oil and grease containing effluents (e.g. use of a grease trap) prior to discharge into sewer systems;
- If sewage from the industrial facility is to be discharged to surface water, treatment to meet national or local standards for sanitary wastewater discharges or, in their absence, the indicative guideline values applicable to sanitary wastewater discharges shown in Table 1.3.1;
- If sewage from the industrial facility is to be discharged to either a septic system, or where land is used as part of the treatment system, treatment to meet applicable national or local standards for sanitary wastewater discharges is required
- Sludge from sanitary wastewater treatment systems should be disposed in compliance with local regulatory requirements, in the absence of which disposal has to be consistent with protection of public health and safety, and conservation and long term sustainability of water and land resources



Environmental, Health, and Safety (EHS) Guidelines
GENERAL EHS GUIDELINES: ENVIRONMENTAL
WASTEWATER AND AMBIENT WATER QUALITY



Table 1.3.1 Indicative Values for Treated Sanitary Sewage Discharges*		
Pollutants	Units	Guideline Value
pH	pH	6 – 9
BOD	mg/l	30
COD	mg/l	125
Total nitrogen	mg/l	10
Total phosphorus	mg/l	2
Oil and grease	mg/l	10
Total suspended solids	mg/l	50
Total coliform bacteria	MPN/100 ml	400+
Notes: * Not applicable to centralized, municipal, wastewater treatment systems which are included in EHS Guidelines for Water and Sanitation. † MPN = Most Probable Number		

Emissions from Wastewater Treatment Operations

Air emissions from wastewater treatment operations may include hydrogen sulfide, methane, ozone (in the case of ozone disinfection), volatile organic compounds (e.g., chloroform generated from chlorination activities and other volatile organic compounds (VOCs) from industrial wastewater), gaseous or volatile chemicals used for disinfection processes (e.g., chlorine and ammonia), and bioaerosols. Odors from treatment facilities can also be a nuisance to workers and the surrounding community. Recommendations for the management of emissions are presented in the Air Emissions and Ambient Air Quality section of this document and in the EHS Guidelines for Water and Sanitation.

Residuals from Wastewater Treatment Operations

Sledge from a waste treatment plant needs to be evaluated on a case-by-case basis to establish whether it constitutes a hazardous

or a non-hazardous waste and managed accordingly as described in the Waste Management section of this document.

Occupational Health and Safety Issues in Wastewater Treatment Operations

Wastewater treatment facility operators may be exposed to physical, chemical, and biological hazards depending on the design of the facilities and the types of wastewater effluents managed. Examples of these hazards include the potential for trips and falls into tanks, confined space entries for maintenance operations, and inhalation of VOCs, bioaerosols, and methane, contact with pathogens and vectors, and use of potentially hazardous chemicals, including chlorine, sodium and calcium hypochlorite, and ammonia. Detailed recommendations for the management of occupational health and safety issues are presented in the relevant section of this document. Additional guidance specifically applicable to wastewater treatment systems is provided in the EHS Guidelines for Water and Sanitation.

Monitoring

A wastewater and water quality monitoring program with adequate resources and management oversight should be developed and implemented to meet the objective(s) of the monitoring program. The wastewater and water quality monitoring program should consider the following elements:

- **Monitoring parameters:** The parameters selected for monitoring should be indicative of the pollutants of concern from the process, and should include parameters that are regulated under compliance requirements;
- **Monitoring type and frequency:** Wastewater monitoring should take into consideration the discharge characteristics from the process over time. Monitoring of discharges from processes with batch manufacturing or seasonal process variations should take into consideration of time-dependent



Environmental, Health, and Safety (EHS) Guidelines
GENERAL EHS GUIDELINES: ENVIRONMENTAL
WASTEWATER AND AMBIENT WATER QUALITY



variations in discharges and, therefore, is more complex than monitoring of continuous discharges. Effluents from highly variable processes may need to be sampled more frequently or through composite methods. Grab samples or, if automated equipment permits, composite samples may offer more insight on average concentrations of pollutants over a 24-hour period. Composite samplers may not be appropriate where analytes of concern are short-lived (e.g., quickly degraded or volatile).

- **Monitoring locations:** The monitoring location should be selected with the objective of providing representative monitoring data. Effluent sampling stations may be located at the final discharge, as well as at strategic upstream points prior to merging of different discharges. Process discharges should not be diluted prior or after treatment with the objective of meeting the discharge or ambient water quality standards.
- **Data quality:** Monitoring programs should apply internationally approved methods for sample collection, preservation and analysis. Sampling should be conducted by or under the supervision of trained individuals. Analysis should be conducted by entities permitted or certified for this purpose. Sampling and Analysis Quality Assurance/Quality Control (QA/QC) plans should be prepared and implemented. QA/QC documentation should be included in monitoring reports.



Environmental, Health, and Safety (EHS) Guidelines
GENERAL EHS GUIDELINES: ENVIRONMENTAL
WASTEWATER AND AMBIENT WATER QUALITY



Annex 1.3.1 - Examples of Industrial Wastewater Treatment Approaches

Pollutant/Parameter	Control Options / Principle	Common End of Pipe Control Technology
pH	Chemical, Equalization	Acid/Base addition, Flow equalization
Oil and Grease / TPH	Phase separation	Dissolved Air Flotation, oil water separator, grease trap
TSS - Settleable	Settling, Size Exclusion	Sedimentation basin, clarifier, centrifuge, screens
TSS - Non-Settleable	Flotation, Filtration - traditional and tangential	Dissolved air flotation, Multimedia filter, sand filter, fabric filter, ultrafiltration, microfiltration
HI - BOD (> 2 Kg/m ³)	Biological - Anaerobic	Suspended growth, attached growth, hybrid
Lo - BOD (< 2 Kg/m ³)	Biological - Aerobic, Facultative	Suspended growth, attached growth, hybrid
COD - Non-Biodegradable	Oxidation, Adsorption, Size Exclusion	Chemical oxidation, Thermal oxidation, Activated Carbon, Membranes
Metals - Particulate and Soluble	Coagulation, Flocculation, precipitation, size exclusion	React mix with settling, filtration - traditional and tangential
Inorganics / Non-metals	Coagulation, flocculation, precipitation, size exclusion, Oxidation, Adsorption	React mix with settling, filtration - traditional and tangential, Chemical oxidation, Thermal oxidation, Activated Carbon, Reverse Osmosis, Evaporation
Organics - VOCs and SVOCs	Biological - Aerobic, Anaerobic, Facultative, Adsorption, Oxidation	Biological - Suspended growth, attached growth, hybrid, Chemical oxidation, Thermal oxidation, Activated Carbon
Emissions - Odors and VOCs	Capture - Active or Passive, Biological, Adsorption, Oxidation	Biological - Attached growth, Chemical oxidation, Thermal oxidation, Activated Carbon
Nutrients	Biological Nutrient Removal, Chemical, Physical, Adsorption	Aerobic/Anaerobic biological treatment, chemical hydrolysis and air stripping, chlorination, ion exchange
Color	Biological - Aerobic, Anaerobic, Facultative, Adsorption, Oxidation	Biological Aerobic, Chemical oxidation, Activated Carbon
Temperature	Evaporative Cooling	Surface Aeration, Flow Equalization
TDS	Concentration, Size Exclusion	Evaporation, crystallization, Reverse Osmosis
Active Ingredients/Emerging Contaminants	Adsorption, Oxidation, Size Exclusion, Concentration	Chemical oxidation, Thermal oxidation, Activated Carbon, Ion Exchange, Reverse Osmosis, Evaporation, Crystallization
Radionuclides	Adsorption, Size Exclusion, Concentration	Ion Exchange, Reverse Osmosis, Evaporation, Crystallization
Pathogens	Disinfection, Sterilization	Chlorine, Ozone, Peroxide, UV, Thermal
Toxicity	Adsorption, Oxidation, Size Exclusion, Concentration	Chemical oxidation, Thermal oxidation, Activated Carbon, Evaporation, crystallization, Reverse Osmosis

Appendix 2: Participant List and Some Photographs of Public Consultation and Disclosure Meeting at Cox's Bazar

Participant List

Government of the People's Republic of Bangladesh
District Fisheries Office
Cox's Bazar.

Subject: Public Consultation and Disclosure Ceremony on Environment and Social Impact Assessment (ESIA) for Govt. Shrimp Farm,
Chakaria, Cox's Bazar.

Venue: Hubel Saptal Shikhi, Cox's Bazar

Date: 13 January, 2021.

Distribution of Daily Allowance Sheet

(Not according to serially)

S.L.	Name and Designation	Office	B-Kash No.	Signature
1.	Mr. [Name] [Designation]	[Office]	01921-275225	[Signature]
2.	Mr. [Name] [Designation]	[Office]	01719-142195	[Signature]
3.	Mr. [Name] [Designation]	[Office]	01717034442	[Signature]
4.	Mr. [Name] [Designation]	[Office]	01715546833	[Signature]
5.	Mr. [Name] [Designation]	[Office]	01680045432	[Signature]
6.	Mr. [Name] [Designation]	[Office]	017345-20152	[Signature]
7.	Mr. [Name] [Designation]	[Office]	0171202012	[Signature]
8.	Mr. [Name] [Designation]	[Office]	01712912363	[Signature]

Government of the People's Republic of Bangladesh
District Fisheries Office
Cox's Bazar.

Subject: Public Consultation and Disclosure Ceremony on Environment and Social Impact Assessment (ESIA) for Govt. Shrimp Farm,
Chakaria, Cox's Bazar.

Venue: Hubel Saptal Shikhi, Cox's Bazar

Date: 13 January, 2021.

Distribution of Daily Allowance Sheet

(Not according to serially)

S.L.	Name and Designation	Office	B-Kash No.	Signature
9.	Mr. [Name] [Designation]	[Office]	0170473042	[Signature]
10.	Mr. [Name] [Designation]	[Office]	01717034442	[Signature]
11.	Mr. [Name] [Designation]	[Office]	01646294800	[Signature]
12.	Mr. [Name] [Designation]	[Office]	01924-224343	[Signature]
13.	Mr. [Name] [Designation]	[Office]	0171202012	[Signature]
14.	Mr. [Name] [Designation]	[Office]	01712912363	[Signature]
15.	Mr. [Name] [Designation]	[Office]	01986-762660	[Signature]
16.	Mr. [Name] [Designation]	[Office]	01712580819	[Signature]

Government of the People's Republic of Bangladesh
District Fisheries Office
Cox'sbazar.

Subject: Public Consultation and Disclosure Ceremony on Environment and Social Impact Assessment (ESIA) for Cox's, Shering Star, Chakaria, Cox'sbazar.

Venue: Md. Saiful Shikder, Cox'sbazar

Date: 13 January, 2023.

Distribution of Daily Allowance Sheet

(Not according to seniority)

S.L.	Name and Designation	Office	#	B-Kash No.	Signature
17	Mr. KUTUBUDDIN Saha Deputy Deputy	Def. Cox'sbazar		071454738	
18	Mr. Touhidul Islam Regional Fisheries Officer	Def. Cox'sbazar		0712519870	
19	Mr. KAMARUZZAMAN	Def. Cox'sbazar		01816611710	
20	SHOHABUDDIN KAMRAN	ASSTANT Def. Cox'sbazar		0769901387	
21	A.N.M. Mostaqur Rahman A.P.O., SCMP	Def. Cox'sbazar		01715109217	
22	Dr. Mohammad Shaukat Dean, DAB, SCMP	Def. Cox'sbazar		01911241203	
23	Nasirul Hossain A.D.O.	DAF, Cox'sbazar		01918436775	
24	Tajuddin Mannan Accounts Officer	Def. SCMP		01711108395	

Government of the People's Republic of Bangladesh
District Fisheries Office
Cox'sbazar.

Subject: Public Consultation and Disclosure Ceremony on Environment and Social Impact Assessment (ESIA) for Cox's, Shering Star, Chakaria, Cox'sbazar.

Venue: Md. Saiful Shikder, Cox'sbazar

Date: 17 January, 2023.

Distribution of Daily Allowance Sheet

(Not according to seniority)

S.L.	Name and Designation	Office	#	B-Kash No.	Signature
25	Mr. KUTUBUDDIN Saha Deputy Deputy	Def. Cox'sbazar		0765905654	
26	Mr. Touhidul Islam Regional Fisheries Officer	Def. Cox'sbazar		01816611710	
27	Mr. KAMARUZZAMAN	Def. Cox'sbazar		01816611710	
28	SHOHABUDDIN KAMRAN	ASSTANT Def. Cox'sbazar		01537548183	
29	A.N.M. Mostaqur Rahman A.P.O., SCMP	Def. Cox'sbazar		01715109217	
30	Dr. Mohammad Shaukat Dean, DAB, SCMP	Def. Cox'sbazar		01911241203	
31	Nasirul Hossain A.D.O.	DAF, Cox'sbazar		01918436775	
32	Tajuddin Mannan Accounts Officer	Def. SCMP		01711108395	

Government of the People's Republic of Bangladesh
District Fisheries Office
Com' share.

Subject: Public Consultation and Disclosure Ceremony on Environment and Social Impact Assessment (ESIA) for (Govt. Shrimp Farm, Chakira, Com' share).

Venue: Hotel Sepul Shunda, Com' share.

Date: 13 January, 2021.

Distribution of Daily Allowance Sheet

(Not according to seniority)

S.L.	Name and Designation	Office	Id-Card No.	Signature
33	মিঃ মোঃ হারুন- উল-আব্বাস	জি.ও. অফিস	01706148901	
34	মিঃ মোঃ হারুন- উল-আব্বাস	জি.ও. অফিস	01999945785	
35	মিঃ মোঃ হারুন- উল-আব্বাস	জি.ও. অফিস	01715-636735	
36	মিঃ মোঃ হারুন- উল-আব্বাস	জি.ও. অফিস	01739-858968	
37	মিঃ মোঃ হারুন- উল-আব্বাস	জি.ও. অফিস	01817-04475	
38	মিঃ মোঃ হারুন- উল-আব্বাস	জি.ও. অফিস	01739150595	
39	মিঃ মোঃ হারুন- উল-আব্বাস	জি.ও. অফিস	01532399640	
40	মিঃ মোঃ হারুন- উল-আব্বাস	জি.ও. অফিস	01750497701	
Total=				



Appendix 3: Matching of Contents of ESIA Report with the Contents of EIA Report as in Schedule 11 of ECR 2023 (DoE Approved ToR)

DoE EIA Structure	ESIA Report of SCMFP
1. Executive Summary	1. Executive Summary (Page No. 1)
1.1 Description of the Project	1.1 Description of the Project
1.2 Study Findings	1.2 Study Findings
2. General Information	2. General Information (Page No. 11)
2.1 Project and Project Proponent	2.1 Project and Project Proponent (Page No. 11)
2.2 EIA Consultant	2.2 EIA Consultant (Page No. 11)
2.2.1 EIA Team	2.2.1 EIA Team (Table 2.1: Team Composition- Page No. 11)
3 Project Description	4. Project Design and Description
3.1 Needs of the Project	Section 4.2 (Page No. 18)
3.1.1 Rationale of the Project	Sub-Section 4.2.1 (Page No. 18)
3.1.2 Project Objective	Section 4.2.2 (Page No. 18)
3.1.3 Project Benefits	Section 4.2.3 (Page No. 19)
3.2 Land Area and Tenancy	Section 4.6.1 (Page No. 27)
3.3 Project Location and Surroundings	Section 4.7: Project Location, (Page No. 28); Section 4.11: Benchmark Around the Project site, (Page No. 55)
3.4 Description of the Project	Section 4.5 (Page No. 20)
3.4.1 Site Layout	Section 4.9: Site Design and Layout, (Page No. 53)
3.5 Project Activities and Project Implementation Schedule	--
3.5.1 Land Development	Section 4.16 (Page No. 60)
3.5.2 Project Activities	Section 4.10 (Page No. 53)
3.5.3 Project Implementation Schedule	Section 4.14 (Page No. 57)
3.6 Project Extension Potential	Section 4.13 (Page No. 56)
3.7 Resource and Utility Demand	Section 4.19 (Page No. 66)
3.7.1 Material Storage and Handling	Section 4.20 (Page No. 67)
3.7.2 Civil Structure and Urban Facilities	Section 4.18 (Page No. 66)
3.7.3 Employment Opportunity	Section 4.21: Manpower Loading (Page No. 67)
3.8 Pollution Potential	Section 4.23 (Page No. 71)
3.9 Alternative Analysis	Section 4.24 (Page No. 73)
4 Environmental and Social Baseline	Environmental and Social Baseline (Chapter 5, 6 & 7)
4.1 Physical Environment	Separate Chapter: Chapter 5: Description of Baseline Scenario of Physical Environment
4.1.1 Topography	Section 5.1.4: Topography of the Sub-Projects (Page No 113)

DoE EIA Structure	ESIA Report of SCMFP
4.1.2 Geology	Section 5.2: Geological Settings (Page No. 114): Tectonic Settings, Physiography, Seismicity
4.1.3 Geomorphology	Section 5.1: Geomorphology and Topography (Page No. 77)
4.1.4 Soil	Section 5.3: Soil and Land Resources (Page No. 120)
4.1.5 Hydrology and Water Resources	Section 5.7 (Page No. 166)
4.1.6 Climate and Meteorology	Section 5.4 (Page No. 129)
4.1.7 Ambient Air and Water Quality	Section 5.8: Environmental Quality- 5.8.1, 5.8.2 (Page No. 192 and 195 respectively)
4.1.8 Acoustic Noise Level	Section 5.8.3: Environmental Quality; Page no 210
4.2 Biological Resources	Separate Chapter: Chapter 6: Description of Baseline Scenario of Biological Environment; Page no. 219
4.3 Land use	Sub-Section 5.3.4 (Page No. 124 in Chapter 5: Description of Baseline Scenario of Physical Environment)
4.4 Social Environment	Separate Chapter: Chapter 7: Description of Baseline Scenario of Socio-Economic Environment (Page No. 299)
4.4.1 Population Distribution	Section 7.2: Demographic Profile (Page No. 300)
4.4.2 Economic Activities	Section 7.3: Livelihoods (Employment Status and Field of Activity) (Page No. 301)
4.4.3 Physical Establishment and Utilities	Section 7.6: Living Standards (Page No. 305)- (Housing Condition, Drinking Water, Sanitation Facilities, Electricity Coverage, Health Condition)
4.4.4 Social Facilities and Amenities	Section 7.9 (Page No. 309)
4.5 Maps, Graphs and Images	Attached as and where relevant.
4.6 Map of Project site and Surroundings	Attached as and where relevant.
4.7 Project Site Map	Attached as and where relevant.
5 Impact Prediction and Evaluation	Chapter 9 (Page No. 331)
5.1 Impact Identification	Impact Identification, Prediction & Evaluation are consolidated in Tables by VESCs.
5.2 Impact Prediction	
5.3 Impact Evaluation	
6 Mitigation Measures	Chapter 9 (Page No. 331): Mitigation Measures are given just after the impact evaluation table of each selected VESC. Mitigation measures have been conducted based on the mitigation hierarchy adopted by the World Bank.
7 Monitoring Program	Chapter 10 (Page No. 377): Environmental and Social Management Plan (N.B: A separate and Detailed ESMP has been prepared and attached accordingly with this Report)

Appendix 4: Newspaper Advertisements, Attendance List, Photographs and Meeting Minutes of PDM

Newspaper Advertisements

“The Chakaria News” (চকরিয়া নিউজ)

৯ ঢাকা, রোববার, ২০ জুলাই ২০২৫

বন্ধুনিষ্ঠ ও নিরপেক্ষতায় অবিচল
chakarianews.com
চকরিয়া নিউজ

প্রবন্ধ কল্পবাজার চট্টগ্রাম পূর্বত জেলা জাতীয় রাজনীতি সারাবাংলা বিনোদন ক্রীড়া সাহিত্য আরও -

চকরিয়ায় বিএনপি নেতাকর্মীদের প্রতিরোধের মুখে এনসিপি... কল্পবাজারে জলবায়ু উষ্ণত্বের দ্ব্যুটি প্রকবণালীসের দখলে চকরিয়ায় বদরখানীতে সিএনজি-ইঞ্জিনাইকের সংঘর্ষে নিহত-১... কল্পবাজারে প্রেসক্রাবে জুলাই '২৪ শহীদদের স্মরণে আলোচনা সভা...

প্রবন্ধ... চকরিয়া... মৎস্য অধিদপ্তরের সাসটেইনেবল কোস্টাল এন্ড মেরিন ফিশারিজ প্রজেক্টের অবহিতকরণ সভা ২০মে

ডেস্ক নিউজ
প্রকাশ: ২০২৫-০৫-১৮ ০৯:৫১:৫০

মৎস্য অধিদপ্তরের সাসটেইনেবল কোস্টাল এন্ড মেরিন ফিশারিজ প্রজেক্টের অবহিতকরণ সভা ২০মে



বিজ্ঞাপন: মৎস্য অধিদপ্তর কর্তৃক সাসটেইনেবল কোস্টাল এন্ড মেরিন ফিশারিজ প্রজেক্ট (এসসিএমএফপি) (১ম সংশোধিত) জুলাই/২০১৮ হতে জুন/২০২৫ মেয়াদে বাস্তবায়নাবীন রয়েছে।

এই প্রকল্পের আওতাধীন চারটি উপ-প্রকল্প: চকরিয়ায় অবস্থিত সরকারি চিথি এন্ডেট; চট্টগ্রাম বিএফডিসির উন্নয়নমূলক কার্যক্রম; বিএমসি স্থাপন; এবং খুলনা, বাগেরহাট ও নাতক্ষীরা জেলার অন্তর্গত নির্বাচিত ১৮টি খালের পলি অপসারণ ও পুনর্বাসন কার্যক্রম বাস্তবায়নকালে প্রকল্প প্রভাবিত এলাকায় উদ্ভূত সম্ভাব্য পরিবেশগত ও আর্থ-সামাজিক প্রভাব নিরূপণের জন্য সরকারি ট্রাস্ট ও বুদ্ধিবৃত্তিক সেবা প্রদানকারী প্রতিষ্ঠান সেন্টার ফর এনভায়রনমেন্টাল এন্ড জিওগ্রাফিক ইনফরমেশন সার্ভিসেস (সিইজিআইএস)-কে পরামর্শক প্রতিষ্ঠান হিসেবে নিয়োজিত করেছে। প্রতিষ্ঠানটি এরই মধ্যে পরিবেশগত ও আর্থ-সামাজিক প্রভাব নিরূপণ বিষয়ক একটি প্রতিবেদন প্রস্তুত করেছে। এই মর্মে সমীক্ষার অংশ হিসেবে সংশ্লিষ্ট বিভিন্ন সরকারি ও বেসরকারি প্রতিষ্ঠান ও জনগনকে সমীক্ষার ফলাফল জানানো এবং এই বিষয়ে তাদের সূচিস্তিত মতামত ও পরামর্শ প্রদানের লক্ষ্যে আগামী ২০ মে, ২০২৫ ইং, রোজ মঙ্গলবার সকাল ১১:০০ ঘটিকায় কল্পবাজার জেলার চকরিয়া উপজেলা পরিষদ মিলনায়তনে একটি অবহিতকরণ সভার আয়োজন করা হয়েছে। উক্ত সভায় উপস্থিত থেকে আমন্ত্রিত অতিথিবৃন্দকে তাদের সূচিস্তিত মতামত প্রদানের জন্য সবিনয় অনুরোধ জানানো যাচ্ছে।

ধন্যবাদান্তে কর্তৃপক্ষ

“The Daily Manabjamin” (দৈনিক মানবজমিন)

মানবজমিন

সোমবার ১৯শে মে ২০২৫, ৫ই জ্যৈষ্ঠ ১৪৩২, ২০শে জিলকুদ ১৪৪৬ মানবজমিন ২৮তম বর্ষ, সংখ্যা ৮৯, www.mzamin.com, ২৪ পৃষ্ঠা দাম ১০ টাকা

মৎস্য অধিদপ্তর কর্তৃক সাসটেইনেবল কোস্টাল অ্যান্ড মেরিন ফিশারিজ প্রজেক্টের অবহিতকরণ সভা

মৎস্য অধিদপ্তর কর্তৃক সাসটেইনেবল কোস্টাল অ্যান্ড মেরিন ফিশারিজ প্রজেক্ট (এসসিএমএফপি) (১ম সংশোধিত) জুলাই/২০১৮ হতে জুন/২০২৫ মেয়াদে বাস্তবায়নাধীন রয়েছে। এই প্রকল্পের আওতাধীন চারটি উপ-প্রকল্প: চকরিয়ায় অবস্থিত সরকারি চিংড়ি এস্টেট; চট্টগ্রাম বিএফডিসি'র উন্নয়নমূলক কার্যক্রম; বিএমসি স্থাপন; এবং খুলনা, বাগেরহাট ও সাতক্ষীরা জেলার অন্তর্গত নির্বাচিত ১৮টি খালের পলি অপসারণ ও পুনর্বাসন কার্যক্রম বাস্তবায়নকালে প্রকল্প প্রভাবিত এলাকায় উদ্ভূত সম্ভাব্য পরিবেশগত ও আর্থ-সামাজিক প্রভাব নিরূপণের জন্য সরকারি ট্রাস্ট ও বুদ্ধিবৃত্তিক সেবা প্রদানকারী প্রতিষ্ঠান সেন্টার ফর এনভায়রনমেন্টাল অ্যান্ড জিওগ্রাফিক ইনফরমেশন সার্ভিসেস (সিইজিআইএস)-কে পরামর্শক প্রতিষ্ঠান হিসেবে নিয়োজিত করেছে। প্রতিষ্ঠানটি এরইমধ্যে পরিবেশগত ও আর্থ-সামাজিক প্রভাব নিরূপণ বিষয়ক একটি প্রতিবেদন প্রস্তুত করেছে। এই মর্মে সমীক্ষার অংশ হিসেবে সংশ্লিষ্ট বিভিন্ন সরকারি-বেসরকারি প্রতিষ্ঠান ও জনগণকে সমীক্ষার ফলাফল জানানো এবং এই বিষয়ে তাদের সুচিন্তিত মতামত ও পরামর্শ প্রদানের লক্ষ্যে আগামী ২০শে মে, ২০২৫ইং, মঙ্গলবার সকাল ১১টায় কক্সবাজার জেলার চকরিয়া উপজেলা পরিষদ মিলনায়তনে একটি অবহিতকরণ সভার আয়োজন করা হয়েছে। বিজ্ঞপ্তি

Attendance List



জাতি উপাধেশ পরিষদ নিয়ন্ত্রণ, ঢাকা, বাংলাদেশ
প্রজ্ঞাপিত "মাসটাইনেবল রোস্টেল এন্ড ডেভিল ফিশারি" প্রকল্পের আওতাধীন কক্সবাজার জেলায় চকিয়ায় অবস্থিত সরকারি চিঠি এন্ড টি উপ প্রকল্পের পরিবেশনক ও অর্থ.সামগ্রিক
প্রভাব নিয়ন্ত্রণ বিষয়ে



তারিখ: ২০ মে, ২০২৫ ইং

অবহিতকরণ সভায় অংশগ্রহণকারীদের তালিকা

Sl. No.	Name	Designation	Phone/mobile	Email	Signature
০১	Muhammad Afique Rahman	UNO	০১৭৩৩৩৭৩২১৫	unochakam'a@gmail.com	
০২	Md. Anwarul Amini	SOFO	০১৭১০৫৭০০৫২	anwar05004@gmail.com	
০৩	Md. Shaikh Ullah	Pa	০১৮১৭৬১০০৫৭	Saiful100100@gmail.com	
০৪	০১৭২৩৩	০১৭২৩৩	০১৭৭৫৫৫৭৭ ৭৭		
০৫	Mosadddekul Islam	MFO	০১৭৩৮১৫০৫৩৩	mosadddekul@gmail.com	
০৬	Zia uldin	DoF	০১৭৮১৩৮৩৮৫৮	uldinziach@gmail.com	



স্থান: উপজেলা পরিষদ মিলনায়তন, চকরিয়া, কক্সবাজার

প্রস্তাবিত "সাবস্টেইনেবল কোস্টাল এন্ড মেরিন ডিভার্সিটি" প্রকল্পের আওতাধীন কক্সবাজার জেলায় চকরিয়ায় অবস্থিত সরকারি চিড়ি এলাকায় উপ-প্রকল্পের পরিবেশগত ও অর্থ-সামাজিক প্রভাব নিরূপণ বিষয়ে

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তারিখ: ২০ মে, ২০২৫ ইং

অবহিতকরণ সভায় অংশগ্রহণকারীদের তালিকা

Sl. No.	Name	Designation	Phone	Email	Signature
০৭	মোহাম্মদ হোসেন চিগ্রা	হাট প্রতিনিধি চকরিয়া চিগ্রা হাট	৯৮৭০৫৭৯৬৬	z.hanz6@gmail.com	মোহাম্মদ হোসেন
০৮	সায়দ হামিদ	হাট প্রতিনিধি চকরিয়া চিগ্রা হাট	০১৬৭৩-০২৫১৫৫	Sayedcox699@gmail.com	সায়দ হামিদ
০৯	মো: আবদুল হামিদ সাবস্টেইনেবল	Session Chairist	০১৫৫ ৭১০৫২৩৬	abulabul69@gmail.com	মো: আবদুল হামিদ
১০	ইমাম: হানিফ ইমদাদ	Sample collector	০১৮১৪৪৪২০১	হানিফ	ইমাম: হানিফ ইমদাদ
১১					
১২					



স্থান: উপজেলা পরিষদ মিলনায়তন, চকরিয়া, কক্সবাজার
প্রতিষ্ঠান: "সসটেইনেবল কেস্টেল এন্ড মেইন সিপিআর" প্রকল্পের আওতাধীন কক্সবাজার জেলায় চকরিয়ায় অবস্থিত সরকারি চিহ্নিত এনসেট উপ-প্রকল্পের পরিবেশগত ও আর্থ-সামাজিক
প্রভাব নিয়ন্ত্রণ বিষয়ক

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তারিখ: ২০ মে, ২০২৫ ইং

অবহিতকরণ সভায় অংশগ্রহণকারীদের তালিকা

Sl. No	Name	Designation	Phone	Email	Signature
13	মাজিহুল হুসাইন	সহকারী সচিব (সংস্কৃতি) চকরিয়া, কক্সবাজার	০১৮১৭৭৫০৫৩	021201140ahman141@gmail.com	
14	ড. মোহাম্মদ মোস্তাকিম বিল্লাহ	Veterinary Surgeon Livestock office	০১৬২৬-০৬৭২২৭	muntakimbillah3@gmail.com	
15	মোহাম্মদ হুসাইন আলী	সহকারী সচিব (সংস্কৃতি) চকরিয়া	০১৮১৬-৫১৭২২৭	md.fayusmi72@gmail.com	
16	মানসীক কুমার শান এমআই (সিঃ)	এমআই (সিঃ)	০১৬২৬-২৭৭০৭০	kumarsanisib20@gmail.com	
17	মোহাম্মদ মোস্তাকিম	সহকারী সচিব (সংস্কৃতি) চকরিয়া (কক্সবাজার)	০১৭২৬২৫৪৭৭৭	nirca.nbaunf@gmail.com	
19	মোহাম্মদ মোস্তাকিম	সহকারী সচিব (সংস্কৃতি) চকরিয়া, কক্সবাজার	০১৭৪৭-৪৭৭৭০৪	imn3113@gmail.com	



স্থান: উপজেলা পরিষদ মিলনায়তন, চকরিয়া, কক্সবাজার

তারিখ: ২০ মে, ২০২৫ ইং
প্রস্তাবিত "সাসটেইনেবল কোস্টাল এন্ড মেরিন রিসোর্সেস" প্রকল্পের আওতাধীন কক্সবাজার জেলার চকরিয়ায় অবস্থিত সরকারি ডিবি এসেট উপ-প্রকল্পের পরিবেশগত ও আর্থ-সামাজিক
প্রভাব মূল্যায়ন বিবরণ

CEGIS

অবহিতকরণ সভায় অংশগ্রহণকারীদের তালিকা

Sl. No.	Name	Designation	Phone	Email	Signature
17	Mohammed Mukteruzzaman	Director (In-Charge) PEMRD, CEGIS	01778617994	mdzaman@cegisbd.com	
20	Bilqish Gullame	Jr. specialist PEMRD, CEGIS	01721815829	bilqishgullame@gmail.com	
21	Ms. Alimghin Hossain	Jr. specialist CEGIS	01710059181	emgh, cegis@gmail.com	
22	DEEBA FARZANA MOUMITA	Sr. SPECIALIST, CEGIS	01913941367	dfmoumita@cegisbd.com	
23	RAFIQUL ISLAM	RA, PEMRD, CEGIS	01710 564066	icrafiz29@gmail.com	
24	Md. Faruk Sarkar	Research Consultant PEMRD, CEGIS	01796 978424	farukfmb@cegisbd.com	



জাতীয় উপদেষ্টা পরিষদ মিলনায়তন, ঢাকা, কক্সবাজার

প্রকল্পের "সামুদ্রসৈনিক বোর্ডিং এন্ড মেরিন ডিশারিট" প্রকল্পের আওতাধীন কক্সবাজার জেলার সরকারি ডিওডি এজেন্ট উপ-প্রকল্পের পরিবেশগত ও অর্থ-সামাজিক প্রভাব নিরূপণ বিষয়ক

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তারিখ: ২০ মে, ২০২১ ইং

অবহিতকরণ সভায় অংশগ্রহণকারীদের তালিকা

Sl. No.	Name	Designation	Phone	Email	Signature
১৫	Syedur Razvi	Jr. Sp. Officer Sangbad	০১৮২২৫২২৬১	razviurba161@gmail.com	
১৬	উম্মেদুদ্দিন	সহ চাফী	০১৮১১২৬৬৮৪২		উম্মেদুদ্দিন
২৭	আব্দুল হক	ডি.ও. চাফী	০২৬৬৭ ৬০ ৬০২৬		আব্দুল হক
২৮	আব্দুল উদ্দিন	ডি.ও. চাফী	০১৬০৭৭৫৪২৫৭	Afennadkorzi@gmail.com	আব্দুল উদ্দিন
২৯	ফাহিম	ডি.ও. চাফী	০১৭২০৬০৩৭০৭		ফাহিম
৩০	মুহাম্মদ উদ্দিন	ডি.ও. চাফী	০১৮৬৭০৬২৭৭১		মুহাম্মদ উদ্দিন



ସ୍ଥାନୀୟ ପଞ୍ଚାୟତ ପରିଷଦ ବିଳମ୍ବପୁର, ଚକ୍ରବର୍ତ୍ତୀ, କଟକସହର
 ପ୍ରକଳ୍ପ ନାମ "ସମ୍ବେଦନଶୀଳ କୋଷ୍ଠିଳ ଏବଂ ଯୋଗ୍ୟ ଶିକ୍ଷାପ୍ରାପ୍ତି" ପ୍ରକଳ୍ପର ଆବେଦନୀୟ କର୍ମକାରୀଙ୍କ ତାଲିକା ଉପରେ ଉପସ୍ଥାପନ କରାଯାଇଥିବା ଅନୁମତି ପତ୍ର ଏବଂ ଆବେଦନୀୟ କର୍ମକାରୀଙ୍କ ବିବରଣୀ

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ତାରିଖ ୨୦ ଡି. ୨୦୨୦

ଅବହତିକରଣ ସଭା ଅଂଶଗ୍ରହଣକାରୀଙ୍କ ତାଲିକା

Sl. No.	Name	Designation	Phone	Email	Signature
୩୧	ଉତ୍ତମ ଚନ୍ଦ୍ର	ପ୍ରଶାସନିକ ପରିଚାଳକ	୦୯୮୧୨ ୮୦୨୮୮	Mr. Mahendra Chandra Chandra	ଉତ୍ତମ ଚନ୍ଦ୍ର
୩୨	ସାମୁଏଲ ଆନ୍ତୋନିଓ	ପ୍ରଶାସନିକ ପରିଚାଳକ	୦୯୮୧୨ ୬୧୧୩୩	happy.chakraborty@gmail.com	ସାମୁଏଲ
୩୩	ଡାକ୍ତର ଇମ୍ରାନ୍	ଅଧ୍ୟକ୍ଷ ପରିଷଦ	୦୧୮୧୨ ୩୬୪୪୦	Dr. Arifan@gmail.com	ଡାକ୍ତର ଇମ୍ରାନ୍
୩୪	ସି.ଏଚ୍.ଏଚ୍.ଏଚ୍.	ଅଧ୍ୟକ୍ଷ	୦୧୬୧୧ ୮୫୫୩୩		ସି.ଏଚ୍.ଏଚ୍.ଏଚ୍.
୩୫	ଆର୍.ଏଚ୍.ଏଚ୍.	ଅଧ୍ୟକ୍ଷ	୦୧୮୮୮ ୩୬୫୫୫		ଆର୍.ଏଚ୍.ଏଚ୍.
୩୬	ଡାକ୍ତର ଇମ୍ରାନ୍	"	୦୧୮୮୮ ୨୨୩୨		ଡାକ୍ତର ଇମ୍ରାନ୍



জামাল উপজেলা পরিষদ নিম্নবর্ণিত, চকরিয়া, কক্সবাজার
প্রদর্শিত "সংসদেইংগেল রেস্টার্স এন্ড মেম্বার ডিপার্টমেন্ট" প্রকল্পের আওতাধীন কক্সবাজার জেলার চকরিয়ায় অবস্থিত সরকারি ডিগ্রি এন্ডেট উপ প্রকল্পের পরিবেশনক ও আর্থ-সামাজিক
প্রভাব নিরূপণ বিদ্যাক

C&GIS

তারিখ: ২০ মে, ২০২৫ ইং

অবহিতকরণ সভায় অংশগ্রহণকারীদের তালিকা

Sl. No.	Name	Designation	Phone	Email	Signature
৩৮	MEHAMMAD ZAFOR IBBAL	Dof (Enumerator)	০১৬৪৪১১৫৩৪	jabalthi3@gmail.com	
৩৯	Mohadul Islam Hruday	Dof MLSS	০১৪৪০৪১৬৭২৬		
৩৭	Sade K	.			
৭০	৪২৮৭৭৭	৪২৮৭	০১৭৬৬৭২৭৭৭		
৭১	২০৭৭৭৭				
৭২	৪২৮৭	(৪২৮৭)	০১৭৬৬৭৭৭৭৭		



খুলনা উপজেলার পরিদপন মিলনায়তন, ঢাকারিয়া, কক্সবাজার
প্রস্তুতকৃত "সমন্বিত ইনসেবল কোর্সটাল এন্ড মেরিন মিশারিং" প্রকল্পের আওতাধীন কক্সবাজার জেলার ঢাকারিয়ায় অবস্থিত সরকারি চিঠি এন্ডেট উপ-প্রকল্পের পরিবেশন ও অর্থ-সামগ্রিক
প্রত্যয় নিশ্চয়ন বিষয়ক

CZGIS

তারিখ: ২০ মে, ২০২২ ইং

অবহিতকরণ সভায় অংশগ্রহণকারীদের তালিকা

Sl. No.	Name	Designation	Phone	Email	Signature
৭৩	আব্দুল হকিম	চিঃ ডিঃ মন্ত্রী	০১৮৩৭-৫০১২৩১		আব্দুল হকিম
৭৪	আব্দুল হকিম	"	০১৭২৫-৩৬৭৭৪৪	আব্দুল হকিম	আব্দুল হকিম
৭৫	হুমায়ুন কবীর	"	০১৮৭৭৭৭৬৬৭		হুমায়ুন কবীর
৭৬	আব্দুল হকিম	ইন্সপেক্টর	০১৮৩২৬৮২৫৭		আব্দুল হকিম
৭৭	একমাদ আলী	মহান চাকরী	০৩৬২৩৩৬৬৬৬		একমাদ আলী
৭৮	আব্দুল হকিম	ইন্সপেক্টর	০১৩২৬৬৮১১১৭		আব্দুল হকিম



ছাত্র উপজেলা পরিষদ মিলনায়তন, ঢাকারিয়া, কক্সবাজার
প্রস্তুতকৃত "সিস্টেমস্ট্রেন্থক বেসিসিক এন্ড মেডিয়াম ডিস্ট্রিবিউশন" প্রকল্পের আওতাধীন কক্সবাজার জেলার চকরিয়ায় অবস্থিত সরকারি ডিগ্রি এসেট উপ-প্রকল্পের পরিবেশনাম ও আর্থ-সামাজিক
প্রভাব নিরূপণ বিষয়ে

C&GIS

তারিখ: ২০ মে, ২০২১ ইং

অবহিতকরণ সভায় অংশগ্রহণকারীদের তালিকা

Sl. No.	Name	Designation	Phone	Email	Signature
৫৭	মোঃ আলম কাদের				
৫০	মোঃ ইউনুস ইমাম	০১৪৪৪৩১৬৪৪৪			
৫১	মুহাম্মদ ইমদাদ	০১৪৬৭০৬২৭৭১			
৫২	হুসেইন	০১৭২০৬০৩০০৭			
৫৩	আব্দুল হক	০১৬০৭৭৫৪২৫৭			
৫৪	আব্দুল হক				

Photographs



Meeting Minutes

প্রদ্ব্যবিত সরকারি চিহ্নি এল্টেট, চকরিয়া, কল্লাবাজার (কিএকডিসি, চট্টগ্রাম; কিএমসি, টেকনাফ এবং চিহ্নি ফের-সংযোগ ঙল, বাপেরহাট, ঙুলনা ও সাতঙ্গীয়া) উপ-গ্রকল্লের পরিবেশগত ও সামাজিক গ্রভাব নিরূপণ বিষয়ক সমীক্ষার অবহিতকরণ সভার কার্যবিবরণী

স্মারক নং

তারিখঃ ২২ মে ২০২৫

বিষয়ঃ অবহিতকরণ সভার কার্যবিবরণী গ্রসরে ।

আহবায়ক	:	জমির উদ্দিন, পরিচালক, পরিবেশ অধিদপ্তর, কল্লাবাজার
সভাপতি	:	মোঃ আনোয়ারুল আমিন, সিনিয়র উপজেলা মণ্ডা কর্মকর্তা, চকরিয়া, কল্লাবাজার
গ্রধান অতিথি	:	মোহাম্মদ আতিকুর রহমান, উপজেলা নির্বাহী কর্মকর্তা, চকরিয়া, কল্লাবাজার
বিশেষ অতিথি	:	রূপায়ন দেব, সরকারি কমিশনার (ভূমি), উপজেলা ভূমি অফিস, চকরিয়া, কল্লাবাজার শাহনাজ ফেরদৌসি, উপজেলা কৃষি কর্মকর্তা (ভারপ্রাপ্ত), চকরিয়া, কল্লাবাজার ডাঃ মোহাম্মদ মোজাক্কিম বিল্লাহ, ভ্যাটেরিলারি সার্জন, গ্রাদিসম্পদ অফিস, চকরিয়া, কল্লাবাজার
সভাস্থল	:	উপজেলা পরিষদ মিলনায়তন কক্ষ
সভার তারিখ	:	২০ মে ২০২৫
সময়	:	সকাল ১১ঃ০০ ঘটিকা

সভাপতি মহোদয় উপস্থিত সকলকে স্বাগত জানিয়ে অবহিতকরণ সভায় অংশগ্রহণের জন্য ধন্যবাদ জ্ঞাপন করে সভার কার্যক্রম শুরু করেন। অতঃপর, সভাপতি মহোদয়ের অনুমতিক্রমে সভার ঘোষক, আলমগীর হোসাইন ইমন, সমাজবিদ, সিইজিআইএস, কার্যভাষিকা অনুযায়ী কার্যক্রম পরিচালনা করেন। অবহিতকরণ সভাটি গ্রায় বায়ান্ন (৫২) জন বিভিন্ন শ্রেণিপেশার অংশীজনদের উপস্থিতিতে অনুষ্ঠিত হয়, যেখানে স্থানীয় সরকারের প্রশাসনিক প্রতিনিধি, সরকারী কর্মকর্তা (অফিস প্রধান), জনপ্রতিনিধি, মহিলা প্রতিনিধি, শিক্ষক, বিভিন্ন পেশাজীবী সংগঠনের প্রতিনিধি, সাংবাদিক, বাবসায়ী, কৃষক, জেলে এবং ছাত্র উপস্থিত ছিলেন। গ্রসরক্রমে, অংশীজনের একটি তালিকা নিচে সংযুক্ত করা হল। উপস্থাপ্ত যে, পরিবেশ সংরক্ষণ বিধিমালা ২০২৩ এর নির্দেশনার আলোকে চকরিয়া নিউজ নামক স্থানীয় ও মানবজমিন নামক জাতীয় দৈনিক পত্রিকায় প্রকাশিত বিজ্ঞাপণ ও নাওয়াত পত্রের মাধ্যমে সরাসরি অংশীজনদের উক্ত সভার আমন্ত্রণ জানানো হয়।

পূর্বনির্ধারিত সূচি অনুযায়ী সভার শুরুতে স্বাগত বক্তব্য এবং গ্রকল্প সংক্রান্ত সার্বিক বিষয়ের উপর পাওয়ায় পয়েন্ট উপস্থাপনার মাধ্যমে সংশ্লিষ্ট আলোচনা করেন মণ্ডল অধিদপ্তরের প্রতিনিধি মোঃ আনোয়ারুল আমিন, সিনিয়র উপজেলা মণ্ডল কর্মকর্তা, চকরিয়া, কল্লাবাজার। পরবর্তীতে, সিইজিআইএস এর সমীক্ষা দলের শক্ষ হতে জনাব মোহাম্মদ মোজাক্কিমজামান, পরিবেশ বিশেষজ্ঞ, প্রদ্ব্যবিত উপ-গ্রকল্লের পরিবেশগত এবং আর্থ-সামাজিক গ্রভাব নিরূপণ সমীক্ষার উপরে একটি পাওয়ায় পয়েন্ট উপস্থাপনা করেন। অতঃপর, সভার অংশীজনরা উন্মুক্ত আলোচনার অংশগ্রহণ করেন এবং চকরিয়া চিহ্নি এল্টেট এর ভূমি সংক্রান্ত বিষয়, গ্রাষ্ট্রীয় ভেড়ীবীথ মেরামত ও উন্নয়ন, ভেড়ীবীথের বহিরাংশে বনায়ন, অভ্যন্তরীণ হাসানন ও জলবাহী কাঠামোর পুনর্বাসন ও মেরামত, চিহ্নি এল্টেট এর নিরাপত্তা, সন্ধ্যা পরিবেশগত ও সামাজিক গ্রভাব, বিশেষ করে পরিবেশ (বায়ু, পানি ও শব্দ) দূষণ, দূষণের গ্রতিকার, রোপমুক্ত চিহ্নি উৎপাদন বৃদ্ধি, স্থানীয় লোকজনের কর্মসংস্থানের সুযোগ এবং পরিবেশগত ব্যবস্থাপনা পরিকল্পনা সম্পর্কে বিশদ আলোচনা করেন। সিইজিআইএস এর সমীক্ষা দলের দলনেতা জনাব মোহাম্মদ মোজাক্কিমজামান ও মণ্ডল অধিদপ্তরের প্রতিনিধি, সিনিয়র উপজেলা মণ্ডল কর্মকর্তা, চকরিয়া, বৌখভাবে উন্মুক্ত আলোচনায় উদ্ধৃত উপস্থিত অংশীজনদের বিভিন্ন গ্রপের যথাযথ উত্তর দেন ও অন্যান্য গ্রাসনিক ঙ্টিনটি বিষয়ের উপর আলোকপাত করেন। পরিশেষে, সভার অংশীজনরা প্রদ্ব্যবিত গ্রকল্প ও সমীক্ষার আদ্যোপান্ত সম্পর্কে পরিচর ধারণা পেয়েণ করেন এবং প্রদ্ব্যবিত গ্রকল্লের প্রতি ইতিবাচক মনোভাব ও অগ্রহ প্রকাশ করেন। গ্রতনসঙ্গে, তাঁরা আরো বিশ্বাস করেন যে, গ্রকল্পটি বাস্তবায়িত হলে তা এলেকার পাশাপাশি সমগ্র জাতির অর্থনৈতিক উন্নয়নে গুরুত্বপূর্ণ অবদান রাখবে। উন্মুক্ত আলোচনার সারসংক্ষেপ নিম্নে উপস্থাপন করা হলো।

ক্রম নং	অংশগ্রহণকারীর নাম এবং পদ	আলোচনা/ পরামর্শ/ দিক নির্দেশনা	গৃহীত সিদ্ধান্ত/ মন্তব্য
১.	জনাব এম. আর মাহমুদ, সিনিয়র সাংবাদিক, দৈনিক সমকাল	এই উপ-প্রকল্পের পরিবেশগত ও সামাজিক প্রভাব নিরূপণ বিষয়ক সমীক্ষার অবহিতকরণ সভার মাধ্যমে স্থানীয় প্রকল্প বিষয়ে অংশীজনদের সম্পৃক্ত করায় ও উক্ত প্রকল্প সম্বন্ধে সম্যক ধারণা দেওয়ার জন্য তিনি এখমেই সভার আয়োজকদের অভিনন্দন জানিয়েছেন এবং কৃতজ্ঞতা প্রকাশ করেছেন। সেই সাথে তিনি প্রকল্প সংশ্লিষ্ট কিছু মূল্যবান তথ্য তুলে ধরেছেন ও কিছু দিক নির্দেশনাও দিয়েছেন। - উক্ত এলাকায় মানস্রোত বন কেটে সেখানে ১৯৮০ সালে সরকারীভাবে মৎস্য অধিদপ্তরের মাধ্যমে ব্যাপকভাবে চিংড়ি চাষ শুরু হয়। - চকরিয়া সুন্দরবনের গাছ কেটে অপরিণতিভাবে মাছের ঘের তৈরি ও চাষের জন্য এখানকার জীববৈচিত্র্য নষ্ট হচ্ছে, বিশেষ করে সুন্দরী গাছ কিলীন হয়ে গেছে। - এই উপ-প্রকল্পের ফলে সৃষ্ট ভেতীবাঁধ এবং বিন্যস্ত ও প্রজ্জ্বলিত জলবাহী কাঠামো/ সুইচ গেইটের কারণে প্রকৃতিক দুর্যোগপূর্ণ এই জায়গাটি সুরক্ষিত হয়েছে। - চকরিয়া চিংড়ি এস্টেট এর দুই দিকে মাতামুহুরি ও বুড়া মাতামুহুরি নদী এবং অভ্যন্তরীণ সংযুক্ত খালসমূহ অতিরিক্ত পলি পড়ে ভরাট হয়ে যাচ্ছে যার ফলে এসব এলাকায় মাছের আবাসস্থল বিনষ্ট হচ্ছে ও মাছের আধিক্য হ্রাস পাচ্ছে। - প্রকল্পে একটি প্রদর্শনী পুকুর ছিল, যা লাভজনক ছিল ও যার মাধ্যমে স্থানীয় চিংড়ি চাষীরা আধুনিক পদ্ধতিতে চিংড়ি চাষে উদ্বুদ্ধ হত। প্রকল্পের প্রদর্শনী পুকুরটি প্রয়োজনীয় সংস্কার করে আধুনিক ব্যবস্থাপনার মাধ্যমে সংরক্ষণ করা উচিত। - চকরিয়া চিংড়ি এস্টেট এর নিরাপত্তা জোড়দার করতে একটি সক্রিয় পুলিশ ফাঁড়ির ব্যবস্থা নেওয়া উচিত।	অবহিতকরণ সভার আলোচিত বিষয়ের অধিকাংশ বিষয়সমূহ ইতিমধ্যে প্রকল্পের আওতায় প্রণীত পরিবেশগত ও সামাজিক প্রভাব নিরূপণ সমীক্ষা প্রতিবেদনে বিবেচনা ও উল্লেখ করা হয়েছে। উক্ত সভায়, নতুন ফেলকল বিষয় আলোচনায় এসেছে, সেসকল বিষয়সমূহ প্রতিবেদনে প্রয়োজ্যক্ষেত্রে বিবেচনা করা হয়েছে।
২.	আবদুর জব্বার, চিংড়ি চাষী, বদরখালী	চকরিয়া চিংড়ি এস্টেট-এ বিদ্যমান সুইচ গেইটসমূহের অধিকাংশই অকেজো এবং কর্তৃপক্ষীয় নিয়ন্ত্রণহীন। সুইচ গেইটের	পরামর্শ গৃহীত ও প্রতিবেদনে উল্লেখিত হয়েছে।

ক্রম নং	অংশগ্রহণকারীর নাম এবং পদ	আলোচনা/ পরামর্শ/ নিক নির্দেশনা	গৃহীত সিদ্ধান্ত/ মন্তব্য
		অপরিকল্পিত ও অনিয়ন্ত্রিত ব্যবহারের ফলে, এস্টেট এর অভ্যন্তরীণ খালসমূহ পলি দ্বারা ভরাট হয়ে পানির প্রবাহ বাধিত হচ্ছে। - এই বিষয়ে আঞ্চলিক মতল্য কর্মকর্তা (RFO)- কে আরও সক্রিয় ভূমিকা পালন করতে হবে। - এরই নিমিত্তে সংশ্লিষ্ট প্রশাসনের সহযোগিতা অতীব প্রয়োজন।	
৩.	আবুল কাশেম, চিংড়ি চাষী	- চকরিয়া চিংড়ি এস্টেট-এ ডাকাতি, চানাবাজী এবং চাবের মাহ লুট একটি নিত্যনৈমিত্তিক ঘটনা। অন্যতরুণিত এসকল ঘটনা নির্মূল বা কমিয়ে আনার জন্য যথাযোগ্য ব্যবস্থা গ্রহণে সংশ্লিষ্ট প্রশাসনের সহযোগিতা একান্ত প্রয়োজন। - চকরিয়া চিংড়ি এস্টেট এর অভ্যন্তরে চাব সংক্রান্ত নৈশ কার্যক্রম ও চিংড়ি খের পাহারা দেওয়ার জন্য বৈদ্যুতিক সংযোগের যথাযথ ব্যবস্থা গ্রহণ করতে হবে। - ক্ষুদ্র চাষীগণ, যারা এই এস্টেট এর খেরগুলো মুখ্য এলাকায় কাছ থেকে এক বছরের জন্য লীজ হিসেবে নেয়, তাদেরকে পরবর্তী সময়ে বাৎসরিক বর্ধিত মূল্যে মুখ্য এলাকায় রাখার ক্ষমতাকে, ক্ষুদ্র চাষীগণও খেরের ন্যায় লীজ মূল্য থেকে বঞ্চিত হচ্ছে।	পরামর্শ গৃহীত ও প্রতিবেদনে উল্লেখিত হয়েছে।
৪.	মোবারক হোসেন সিদ্দিক, ছাত্র প্রতিনিধি, বৈষম্য বিরোধী ছাত্র আন্দোলন	চকরিয়া চিংড়ি এস্টেট এর নিরাপত্তা রক্ষার্থে একটি সক্রিয় পুলিশ ফাঁড়ি অত্যাৱশ্যক।	পরামর্শ গৃহীত ও প্রতিবেদনে উল্লেখিত হয়েছে।
৫.	শাহনাজ ফেরদৌসি, উপজেলা কৃষি কর্মকর্তা (ভারপ্রাপ্ত)	- চকরিয়া চিংড়ি এস্টেট এর নিরাপত্তা জোরদার করতে হবে। - যারা এই প্রকল্প বাস্তবায়নের ক্ষেত্রে ইতিমধ্যেই জড়িত, তাদেরকে প্রকল্প বাস্তবায়নের যোগ্যসুত্রে বিবিধ কার্যক্রমে আরও সক্রিয়ভাবে কাজে লাগানো যায় কী-না সেদিকে গুরুত্বারোপ করতে হবে। - উন্নত ও গুণগত মানসম্পন্ন চিংড়ি উৎপাদন এবং তা রপ্তানি করে বৈদেশিক মুদ্রা অর্জনের মাধ্যমে দেশের অর্থনীতিতে গুরুত্বপূর্ণ ভূমিকা রাখতে পারে।	
৬.	মোঃ আবদুল হালিম, সিনিয়র কেমিস্ট, কক্সবাজার	প্রকল্পের প্রকল্পের কর্তৃপক্ষকে নিজ দায়িত্বে পরিবেশ ও প্রতিবেশ ঠিক ও যথাযথ রাখার অনুরোধসহ ইতিবাচক সুবিধাগুলিকে আরও	সমীক্ষা দলের পক্ষ হতে প্রকল্পের ইতিবাচক প্রভাবের বর্ধিতকরণ ও নেতিবাচক প্রভাবের প্রশমন ব্যবস্থা তুলে

ক্রম নং	অংশগ্রহণকারীর নাম এবং পদ	আলোচনা/ পরামর্শ/ দিক নির্দেশনা	গৃহীত সিদ্ধান্ত/ মন্তব্য
		বৃদ্ধি এবং নেতিবাচক নিকটস্থির প্রশমনের বিভিন্ন বিষয়াদিও উল্লেখ করেন। পাশাপাশি গত ২০ মে, ২০২৫ তারিখের অবহিতকরণ সভার সারসংক্ষেপ বিষয়ে আলোকপাত করেন এবং সমীক্ষায় তুলে ধরা নিশ্চিত করতে অনুরোধ করেন।	ধরা হয়। পাশাপাশি মতবিনিময় সভায় প্রাপ্ত মতামত সমূহ পরিবেশগত এবং আর্থ-সামাজিক প্রভাব নিরূপণ সমীক্ষায় ইতোমধ্যে তুলে ধরা হবে মর্মে জানানো হয়।
৭.	ডায় মোহাম্মদ মোক্তাকিম বিল্লাহ, জ্যোটেইনারি সার্জন, প্রাণিসম্পদ অফিস	- চিহ্নিতপোনার গুণগত মান নিশ্চিত করতে হবে। - প্রকল্পের নির্মাণকালীন কার্যক্রম বিশেষ করে খাল পুণর্খনন ও জলবাহী কাঠামো পুনর্বাসন করার ক্ষেত্রে মাছের প্রজনন ও ডিম ছাড়ার সময়কে বাদ দিতে হবে। এরই নিমিত্তে সংশ্লিষ্ট কর্তৃপক্ষের যথাযথ ব্যবস্থা গ্রহণ করতে হবে। - চকরিয়া সুন্দরবন পুনর্বাসনের উদ্দেশ্যে ভেড়ীবাঁধ সংলগ্ন এলাকায় সুন্দরবনে পূর্বে যেসকল প্রজাতির গাছ ছিল সেসব প্রজাতির গাছ রোপণ করতে হবে।	পরামর্শ গৃহীত ও প্রতিবেদনে উল্লেখিত হয়েছে।
৮.	মোহাম্মদ আতিকুর রহমান, উপজেলা নির্বাহী কর্মকর্তা, চকরিয়া উপজেলা, কক্সবাজার	- চকরিয়া চিহ্নিত এস্টেট উপ-প্রকল্পের অধীনে এর চারদিকে ৭০ কি.মি ভেড়ীবাঁধকে সচল রাখার জন্য যে ২৭টি জলবাহী কাঠামো/ মুইস গেইট পুনর্বাসনের যে ব্যবস্থা গ্রহণ করা হয়েছে তা সঠিকভাবে নিয়ন্ত্রণের জন্য উপজেলা পর্যায়ে সংশ্লিষ্ট কর্তৃপক্ষের সক্রিয় ভূমিকা পালন করতে হবে। এই কাজের দায়িত্ব জেলা বা বিভাগীয় পর্যায়ে না হয়ে উপজেলা পর্যায়ে থাকলেই তা বেশি সক্রিয় হতে পারে। এক্ষেত্রে, আঞ্চলিক মফা কর্মকর্তা (RFO)-এর পরিবর্তে সিনিয়র উপজেলা মফা কর্মকর্তা (চকরিয়া)-কে দায়িত্বভার দেওয়া সমীচীন হবে। ফলে, চকরিয়া চিহ্নিত এস্টেটের মনিটরিং কার্যক্রম আরো জোড়দার হবে। - যদিও এই উপ-প্রকল্পের প্রধান উদ্দেশ্য চিহ্নিত এস্টেট এর উন্নয়ন, তবে এই উপ-প্রকল্পের আওতায় ল্যান্ডিং সেন্টারের ও বিশেষ উন্নয়নের প্রয়োজনীয়তা রয়েছে। - এই উপ-প্রকল্পের অধীনে চকরিয়া চিহ্নিত এস্টেট ও তৎসংলগ্ন এলাকার মানুষের কর্মসংস্থানের ব্যবস্থা হবে যা এই উপ-প্রকল্পের একটি ইতিবাচক দিক। তবে ল্যান্ডিং সেন্টারের বিভিন্ন কাজ যেমনঃ মফা প্রক্রিয়াজাতকরণ, প্যাকেজিং ও সেলিং এর	পরামর্শ গৃহীত ও প্রতিবেদনে উল্লেখিত হয়েছে।

ক্রম নং	অংশগ্রহণকারীর নাম এবং পদ	আলোচনা/ পরামর্শ/ দিক নির্দেশনা	গৃহীত সিদ্ধান্ত/ মন্তব্য
		জন্য এলাকার জনগণকে বিশেষকরে অগ্রাধী নারীদেরকে কাজে অঙ্গভুক্ত করা যেতে পারে। সেক্ষেত্রে, নারীদের জন্য প্রয়োজনীয় সুরক্ষা ব্যবস্থা করতে হবে। ■ পুশিশ ফাঁড়ি স্থাপনের সাথে সাথে চিংড়ি এস্টেট এর অভ্যন্তরে অবস্থিত গার্ড রুমে সি সি টিভি ক্যামেরার ব্যবহার করে এলাকার নিরাপত্তাকে আরও জোড়দার করা সম্ভব। ■ এছাড়াও টেনশ গ্রহণের সংখ্যা বাড়িয়ে এখানকার নিরাপত্তাকে আরো বাড়ানো যেতে পারে। ■ এলাকার বিভিন্ন উন্মুক্ত জায়গায় বিশেষকরে চিংড়ি খেজের অভ্যন্তরীণ বাঁধে শবণ সহিষ্ণু সবজি চাষের উদ্যোগ নেওয়া যেতে পারে যা সংশ্লিষ্ট ক্ষুদ্র চিংড়ি চাষীদের আরো স্বাক্ষরী ও তাদের পুষ্টি নিরাপত্তা নিশ্চিত করতে পারে। ■ চকরিয়া চিংড়ি এস্টেট এর উন্নয়নের নিমিত্তে মৎস্য ও কৃষি বিভাগ একত্রিত হয়ে পরিকল্পনায় অংশগ্রহণ করতে হবে, যা একটি সমন্বিত উদ্যোগ হিসেবে দৃষ্টান্ত স্থাপন করতে পারে। ■ এলাকাটি প্রাকৃতিক দুর্যোগ, বিশেষ করে সাইক্লোন ও বন্যা গ্রবণ। বর্ষা মৌসুমে মাতামুহুরি নদীর catchment এলাকায় পানি উপচে অভ্যন্তরীণ খালসমূহ এবং পাশবর্তী এলাকাকে প্রাণিত করে। যার ফলে চকরিয়া চিংড়ি এস্টেট এর অভ্যন্তরীণ খালসমূহ ভরাট হয়ে যায়। তাই এই খালসমূহকে সময়মত পুনঃখননের ব্যবস্থা করতে হবে। ■ চকরিয়া চিংড়ি এস্টেট এর সংশ্লিষ্ট সকল কর্মকাণ্ডে স্থানীয় লোকদের দক্ষতার তিষ্ঠিতে কর্মসংস্থানের ব্যবস্থা করতে হবে, যা পরবর্তীতে এলাকার জনগণের অর্থনৈতিক প্রবৃদ্ধিতে সহায়ক ভূমিকা পালন করবে ও সেই সাথে দেশের GDP'র প্রবৃদ্ধিতেও ভূমিকা রাখবে। ■ চকরিয়া চিংড়ি এস্টেট এর উন্নয়নের জন্য এস্টেট এর অভ্যন্তরীণ ও তৎসংলগ্ন এলাকার জনগণের মধ্যে সামাজিক সচেতনতা বৃদ্ধিতে কর্তৃপক্ষের একনিষ্ঠ ভূমিকা রাখতে হবে।	



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