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Blue Gold Program

Final Report

on

Environmental Impact Assessment (EIA) on Rehabilitation of Polder 22

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CEGIS Center for Environmental and Geographic Information Services

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Abbreviations and Acronyms

ADB	Asian Development Bank
AEZ	Agro-ecological Zone
ASA	Association of Social Advancement
AWD	Alternate Wetting and Drying System
BANCID	Bangladesh National Committee of ICID
BAU	Bangladesh Agriculture University
BBS	Bangladesh Bureau of Statistics
BCCSAP	Bangladesh Climate Change Strategy and Action Plan
BCSAP	Biodiversity Conservation Strategy and Action Plan
BG	Blue Gold
BMD	Bangladesh Metrological Department
BNBC	Bangladesh National Building Code
BOD	Biochemical Oxygen Demand
BUET	Bangladesh University of Engineering and Technology
BWDB	Bangladesh Water Development Board
CAS	Catch Assessment Survey
CBO	Community Based Organizations
CDSP	Char Development and Settlement Projects
CEGIS	Center for Environmental and Geographic Information Services
CEIP	Coastal Environmental Improvement Project
COD	Chemical Oxygen Demand
Cos	Community Organizers
DAE	Department of Agriculture Extension
dBA	DeciBel
DC	District Commissioner
DEM	Digital Elevation Model
DG	Director General
DO	Dissolve Oxygen
DoE	Department of Environment
DoF	Department of Fisheries
DPHE	Department of Public Health and Engineering
DPP	Development Project Proforma
EA	Environmental Assessment
ECA	Environmental Conservation Act
ECR	Environmental Conservation Rules

EIA	Environmental Impact Assessment
EKN	Embassy of the Kingdom of Netherlands
EMP	Environmental Management Plan
ERD	Economic Relations Division
FAO	Food and Agriculture Organization
FCD	Flood Control and Drainage
FCD/I	Flood Control Drainage/ Irrigation
FCBO	Fisheries Community Based Organization
FES	Fishing Effort Survey
FGD	Focus Group Discussion
FGs	Functional Groups
FMD	Foot and Mouth Disease
FS	Frame Survey
FPCO	Flood Plan Co-ordination Organization
GIS	Geographic Information System
GoB	Government of Bangladesh
GoN	Government of Netherlands
GPA	Guidelines for Project Assessment
GPWM	Guidelines for Participation of Water Management
GSB	Geological Survey of Bangladesh
GW	Ground Water
Ha	Hectare
HH	Household
HTW	Hand Tube Well
HYV	High Yielding Variety
ICM	Integrated Crop Management
IEC	Important Environmental Component
IEE	Initial Environmental Examination
IESC	Important Environmental and Social Component
IRRI	International Rice Research Institute
IPM	Integrated Pest Management
IPSWAM	Integrated Planning for Sustainable Water Management
IS	Institutional Survey
ISC	Important Social Component
IUCN	International Union for Conservation of Nature
IWM	Institute of Water Modeling
IWMP	Integrated Water Management Plan

Kg	Kilogram
KII	Key Informant Interview
LCS	Labor Contracting Society
LGED	Local Government Engineering Department
LGIs	Local Government Institutions
LGRD	Local Government and Rural Development
Lpc	Litre per capita
MoEF	Ministry of Environment and Forest
MoWR	Ministry of Water Resources
MP	Murate of Potash
MSL	Mean Sea Level
MT	Metric Ton
MW	Mega Watt
NCA	Net Cultivable Area
NCS	National Conservation Strategy
NDVI	Normalized Difference Vegetation Index
NEMAP	National Environmental Management Action Plan
NGO	Non-Governmental Organization
NIR	Near- Infrared
NOCs	No Objection Certificates
NWRD	National Water Resources Database
O and M	Operation and Maintenance
OHP	Occupational Health Plan
PCM	Public Consultation Meeting
PCP	Public Consultation Process
PD	Project Director
PP	Project Proforma
PPM	Parts per Million
PPR	Pest Des Pititis Ruminants
PRA	Participatory Rural Appraisal
PSF	Pond Sand Filter
PWD	Public Works Department
RL	Reduced Level
RRA	Rapid Rural Appraisal
RS	Remote Sensing
SAAO	Sub Assistant Agriculture Officer
SIA	Social Impact Assessment

SIS	Small Indigenous Species
SRDI	Soil Resource Development Institute
STW	Shallow Tube Well
SW	Surface Water
SWAIWRPMP	South West Area Integrated Water Resources Planning and Management Project
T. Aman	Transplanted Aman
ToR	Terms of Reference
TSP	Triple Super Phosphate
UFO	Upazila Fisheries Officer
UNDP	United Nation Development Program
UNO	Upazila Nirbhahi Officer
WARPO	Water Resources Planning Organization
WMA	Water Management Association
WMC	Water Management Committee
WMF	Water Management Federation
WMGs	Water Management Groups
WMIP	Water Management Improvement Project
WMO	Water Management Organizations

Glossary

Aila	Major cyclone, which hit Bangladesh coast on May 25, 2009
Aman	A group of rice varieties grown in the monsoon season and harvested in the post-monsoon season. This is generally transplanted at the beginning of monsoon from July-August and harvested in November-Dec. Mostly rain-fed, needs supplemental irrigation in places during dry spell.
Arat	Generally an office, a store or a warehouse in a market places from which Aratdar conducts his business.
Aratdar	Main actor act as a wholesaler or commission agent or covers both functions at the same time; carries out public auctions and is the main provider of credit in the marketing chain.
Aus	A group of rice varieties sown in the pre-monsoon season and harvested in the monsoon season. These are broadcast/transplanted during March-April and harvested during June-July. Generally rain-fed, needs irrigation for HYV T. Aus.
B. Aus	When preceding a crop means broadcast (B. Aus)
Bagda	Shrimp (*Penaeus monodon*), brackish/slightly saline water species.
Bazar	Market
*Bee*l	A saucer-shaped natural depression, which generally retains water throughout the year and in some cases, seasonally connected to the river system.
Boro	A group of rice varieties sown and transplanted in winter and harvested at the end of the pre-monsoon season. These are mostly HYV and fully irrigated, planted in December-January and harvested before the onset of monsoon in April- May.
Golda	Prawn (*Macrobrachium rosenbergii*), non-saline/fresh water species
Gher	Farm lands converted into ponds with low dykes and used for cultivation of shrimp/prawn/fish.
Haat	Market place where market exchanges are carried out either once, twice or thrice a week, however not every day.
Jaal	Different types of fishing net to catch fish from the water bodies.
Jolmohol	Section of river, individual or group of beels (depression), or individual pond owned by the government but leased out for fishing. They are also called Jalkar, or Fishery.
Jhupri	Very small shed for living, made of locally available materials. A type of house/hut used by very poor community members.
Kutcha	A house made of locally available materials with earthen floor, commonly used in the rural areas.
Khal	A water drainage channel usually small, sometimes man-made. . These may or may not be perennial.

Kharif	Pre-monsoon and monsoon growing season. Cropping season linked to monsoon between March-October, often divided into kharif-1 (March-June) and kharif-2 (July-October).
Kutcha Toilet	The earthen made latrine consist of a hole without cover.
Mahajan	A traditional money lender and a powerful intermediary in the value chain r.
Perennial *khal*	A khal where water is available all the year round.
Pucca	Well constructed building using modern masonry materials.
Rabi	Dry agricultural crop growing season; mainly used for the cool winter season between November and February
Ring slab	The simple pit latrine consists of a hole in the ground (which may be wholly or partially lined) covered by a squatting slab or seat where the user defecates. The defecation hole may be provided with a cover or plug to prevent the entrance of flies or egress of odor while the pit is not being used.
Seasonal *khal*	Water not available in the khal all the year round.
Sidr	Major cyclone, which hit Bangladesh coast on November 15, 2007.
T. Aman	When preceding a crop means transplanted (T. Aman).
Upazila	Upazila is an administrative subdivision of a district.
Water sealed	A water sealed latrine is simply a pit latrine that has a water barrier to prevent odors. These latrines are simply pits dug in the ground in which human waste is deposited. A water sealed latrine has a bowl fixture that has a set amount of water retained in it. It is operated on the pour to flush system. These types of latrines can be connected to a septic tank system.

Conversion Units

1 m^2	= 10.77 ft^2
1 Decimal **(শতাংশ)**	= 435.60 ft^2
1 Decimal **(শতাংশ)**	= 40.47 m^2
1 Katha **(কাঠা)**	= 1.653 Decimal **(শতাংশ)**
1 Bigha **(বিঘা)**	= 33 Decimal **(শতাংশ)**
1 Bigha **(বিঘা)**	= 20 Katha **(কাঠা)**
1 Acre **(একর)**	= 3 Bigha **(বিঘা)**
1 Acre **(একর)**	= 60 Katha **(কাঠা)**
1 Acre **(একর)**	= 100 Decimal **(শতাংশ)**
1 Hector **(হেক্টর)**	= 247 Decimal **(শতাংশ)**
1 Hector **(হেক্টর)**	= 7.5 Bigha **(বিঘা)**
1 Hector **(হেক্টর)**	= 2.47 Acre **(একর)**

Executive Summary

Background

Bangladesh, the largest river delta in the world, has about 700 km of coast line on the Bay of Bengal. About 38% of the population in the coastal region live below the poverty line and face high vulnerabilities in terms of insecurity of food, income, water and health which needs to be improved through water management programs. Integrated and participatory water resources management contributes significantly to food security, safety, income level, health and economic growth. In this connection, the Government of the Netherlands (GoN) as a development partner of Bangladesh has been supporting water management projects in Bangladesh since 1975, especially in the water sector. The projects are mostly operated by the Bangladesh Water Development Board (BWDB).The Blue Gold Project, initiated in January 2013, is expected to end in December 2018. The project is built on the results and lessons learned in managing water resources from previous programs and projects. The explicit objective of Blue Gold is to reduce poverty of the people in the coastal areas in an integrated way as well as to increase income through value chain development. Initially, 26 polders from three coastal districts have been included in the program where the fine tuning and rehabilitation of water control structures will be carried out. According to the Environment Conservation Rules (ECR, 1997), construction/reconstruction/expansion of flood control embankments, polders, dikes, etc. are '**red**' category projects which must be subjected to Environmental Impact Assessment (EIA) study. Therefore, the Blue Gold authority entrusted CEGIS initially with the EIA study of five selected polders (Polder 22, 30, 43/2A, 43/2D and 43/2F). This document is the Draft EIA study report of Polder 22.

Objective

The objective of the Environmental Impact Assessment (EIA) study is to ensure environmental sustainability of the outcomes of proposed interventions under a development project which will improve the socio-economic condition of the entire project area.

Approach and Methodology

The guideline for environmental impact assessment of water sector projects, developed by the Flood Plan Co-ordination Organization (FPCO) in 1992 and updated by the Water Resources Planning Organization (WARPO) in 2003 was followed to conduct this EIA study.

Project Description

Polder 22 is located in Deluti union under Paikgachha upazila of Khulna district. Polder 22 is 75 km away from the Bay of Bengal and it undergoes tidal influence. The polder is surrounded by Bhadra, Badurgachi and Habrakhali rivers. The gross area of the polder is 1,485 ha with a Net Cultivable Area (NCA) of 1,070 ha (70%).

The polder is bounded by a 19.3 km embankment that was built to protect the area against tidal and storm surges as well as salinity intrusion. There are two culverts, seven drainage sluices and outlets, and twenty flushing inlets within the area. Most of the structures are not functioning up to the desired level. The drainage outlets cannot drain out water properly during heavy rainfall events, and especially during post monsoon. The sluice gates are not able to prevent the saline water from intruding inside even when the gates are closed as they are ill-fitting. Similar problems exist in the flushing inlets of the polder. The length of the

internal drainage channels is 22 km. Some of the drainage channels have silted up due to top soil erosion from adjacent land, coupled with improper maintenance over the years.

Existing problems and works under the proposed interventions

About 19 km of embankment encircle the polder offering protection against tidal and storm surges and salinity intrusion. In addition, there are also two culverts, seven drainage sluices and outlets and twenty flushing inlets in place. The existing condition is good except for some of the places where the slope is not of standard while some other places are frequently subjected to bank erosion. Besides, most of the structures are not functioning up to the desired level which fails to prevent saline water intrusion and enable to drain out water during heavy rainfall. Siltation in the drainage channels also makes the situation more complicated. All these problems are impeding the lives and livelihoods of the inhabitants of the polder. The most severe problem identified by the local people is salt water intrusion which has contaminated both the surface and ground water due to which drinking water crisis becomes severe during dry season. Salinity intrusion also contributes to soil salinity that affects Rabi crops.

Considering the existing problems and needs of the local residents, the Blue Gold Program has taken up interventions like re-sectioning of embankments, repair of sluice and drainage outlets, re-excavation of selected drainage channels, and construction of water reservoirs and temporary bank protection.

Environmental and Social Baseline

The project area experiences a tropical climate where monthly maximum temperature varies from 19.3°C to 30.4°C and monthly minimum temperature varies within the range of 15.37°C to 25.2°C. The maximum rainfall ever recorded in the area is 343 mm in the month of July and the lowest rainfall is observed in the month of December which is 7 mm. The monthly average relative humidity of the Khulna BMD station varies from 72 to 87%. Daily average sunshine hours are more than 7 hours (October to May) which reduces to 5 hr from June to September.

Polder 22 is 75 km away from the Bay of Bengal, and undergoes tidal influence. The polder is directly surrounded by the Bhadra River (north), the Badurgachi River (east), and the Habarkhali River (west). The Badurgachi and Habarkhali rivers are connected together to form the Sibsa River.

Agriculture is the mainstay of livelihood of these people. During Kharif I season, 100% of the NCA remains fallow, during Kharif II Local transplanted Aman (both HYV and local) is cultivated and during Rabi season, sesame, watermelon, Mungbean and some vegetables are cultivated. Although Aman is completely rainfed, farmers have to suffer due to scarcity of irrigation water during Rabi season. The cropping intensity of this polder is 196%. The khals, which are seasonal and retain water for six to eight months, and peripheral rivers are important fish habitat for capture fisheries. Culture fisheries are not very widespread here. Although the water quality is good for fisheries, fisheries biodiversity still shows a declining trend as most of the water bodies are seasonal in nature. The terrestrial flora and fauna are not very rich here and the density of vegetation is not uniform throughout the polder. Both the density and diversity of terrestrial flora are low in the polder peripheries because of soil salinity.

Public Consultation and Disclosure

A Public Consultation Meeting (PCM) and number of informal discussions were conducted at different locations of Polder 22. The participants included 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 some aspects of the Project. Moreover, representatives of NGOs, government departments concerned such as local government institutions (LGI), BWDB, the MoWR, and the Blue Gold officials in Khulna participated in the meeting and gave their views and opinions.

Impact Assessment

The proposed interventions will affect many environmental and social components either positively or negatively. For instance, repair of water control structures will prevent saline water from intruding into the polder and contribute to reducing water and soil salinity within the polder. About 25% of the areas which would be affected by salt water intrusion in the future would no longer carry any surface water salinity. Reduced soil as well as surface water salinity will bring about an additional 4,880 tons of production. However, the fisheries sector will experience some negative impacts e.g. there is currently a brackish water habitat close to the water control structures as the structures fail to prevent leakage. However after repair, this habitat will be lost. In addition, re-excavation of the silted internal khal would increase water depth and water availability round the year which would improve water quality of open water fisheries in the polder area. However during re-excavation many fish species, especially bottom dwellers like the *Cuchia* would be lost. Terrestrial vegetation will be also benefited due to the reduction of soil salinity. The density and diversity of vegetation near the reservoirs and re-excavated canals will improve. Both the reservoirs will be a blessing to the inhabitants of the polder especially the residents who live the approximately half km buffer zone of the reservoirs. Currently, they are facing severe drinking water crisis but the reservoirs will offer them a saline free source of drinking water. The re-excavated canals also serve as an important source of domestic water use like water for bathing, washing and cooking.

Furthermore, the cumulative and induced effects of the proposed interventions in Polder 22 have been investigated based on qualitative assessments. The study infers positive long term cumulative effects in Polder 22 due to other proposed regional and local projects. The proposed Ganges Barrage may largely change the surface water salinity frontier of the area in the future; whereas other large scale projects like the Bangladesh Delta Plan 2100 would have significant positive impacts on the polder. The implementation of the Coastal Embankment Improvement Project (CEIP) in adjacent polders may generate some risks of storm surge and tidal inundation as well as river erosion in the future. The rehabilitation works in Polder 22 may generate some minor induced effects in connection with river siltation, employment generation and food security. The reciprocal impacts of climate change on the polder have also been assessed. Impacts of climate change have been evaluated through advanced applications of hydrological (SWAT) and hydrodynamic (Delft3D) modelling tools. The study infers that water level and surface water salinity in adjacent areas may increase in the future due to climate change, whereas dry season water availability may decrease. The climate resilience of local people in Polder 22 has also been found to have become enhanced due to the implementation of many capacity development initiatives.

Environmental Management Plan

This study has also proposed a set of mitigation measures to offset the negative impacts and an enhancement plan to boost the positive impacts.

- Crop rotation with leguminous crops, application of more organic materials and green manure to improve soil fertility in the project area.
- Practice of crop diversification for improving soil nutrient status and fertility.
- Avoiding fish migration periods e.g. the months of May, June and July during project implementation.
- Protection of indigenous fishes and other aquatic creatures by implementing segment-wise re-excavation.
- Planting native mixed trees along the embankment slopes and toes wherever possible to enhance green coverage
- Involving local communities in the operation and maintenance of structures for ensuring sustainability of the interventions.

Furthermore, a thematic Spoil Management Plan (SMP) has been proposed by the study team for controlled and sustainable disposal of excavated spoil. Following the plan is essential for safeguarding the environmental sustainability of the construction sites.

The study infers that there could be some temporary impacts during the construction phase, but no significant negative or irreversible impacts may occur in the future. The mitigation measures suggested in the EMP and other construction modalities included in the SMP would ensure the sustainable development of the project area. As such, the Project may be undertaken for implementation.

1 Introduction

1.1 Background

1. Bangladesh, the largest river delta in the world, depends largely for its economic growth on integrated and participatory water resources management. The three major river systems of the country mark it's physiography and life of it's people. Effective management of this immense natural resource remains a continuing challenge and offers at the same time tremendous opportunities. About 38% of the population in the coastal regions live below the poverty line and face high vulnerabilities in terms of insecurity of food, income, water and health (Inception Report, Blue Gold Program, 2013). However, There are ample opportunities to harness the resources of the coastal areas which can alleviate poverty, create a sustainable environment and provide security and well-being to present and future generations.

2. The Government of the Netherlands (GoN) has been supporting water management projects in Bangladesh since 1975, as a development partner of Bangladesh Water Development Board (BWDB) for the development of sustainable and participatory water management options throughout the country. The Government of Bangladesh (GoB) considers integrated water resources development as one of its priority activities as this will build community resilience against the tidal and storm surge flooding and salinity intrusion without compromising the ecosystem needs and allow the community to utilize the available water resources for productive use and human consumption. In the coastal region of Bangladesh, participatory approaches in water resource management has successfully been introduced since 2003 in line with the water resources development strategies of the GoB where GoN participation was the as development partner. These projects include the Integrated Planning for Sustainable Water Management (IPSWAM), the South West Area Integrated Water Resources Planning and Management Project (SWAIWRPMP), the Char Development and Settlement Projects (CDSP) and the Water Management Improvement Project (WMIP). As a follow up project of IPSWAM, GoN developed a programme called "Blue Gold" with the active involvement of the rural communities. Water or "Blue Gold" is regarded as the fundament for changing people's life and turning water from a foe into a friend as the trigger for sustainable development in the coastal areas of Bangladesh.

3. Blue Gold builds on the results and lessons learned in managing water resources from previous programmes and projects in Bangladesh. The explicit objective of Blue Gold is to reduce poverty of the people in the coastal areas by enhanced productivity of crops, fisheries and livestock in an integrated way and to increase the income by improved processing and marketing of agricultural commodities with value chain development. The project started in January 2013 and will end in December 2018. Its operations concentrate on the polders of three coastal districts: Satkhira, Khulna and Patuakhali which are part of the South-west and South-central hydrological zones. The total land area of the three districts is 11,463 km² and the total population is 5.6 million. This gives an average population density of 493 people per km² and an average household size of 4.3 persons (BBS, 2011). These districts are chosen because of (i) higher incidence of poverty, (ii) effective coordination with the local administration and private sector, and (ii) prevalence of water-related challenges like sedimentation, storm surges and salt water intrusion. Initially, it was anticipated that 26 polders from these three districts will be included in the program area which are illustrated in Table 1.1. All nine IPSWAM polders viz Polder 22, Polder 29, Polder 30, Polder 43/1A,

Polder 43/2A, Polder 43/2B, Polder 43/2D, Polder 43/2E and Polder 43/2F are included in the program. However, final selection of the other polders will be made in accordance with the established selection criteria and project objectives.

Table 1.1: Tentative District-wise Distribution of Polders Based on the Preliminary Selection

District	Tentative number of polders			
	IPSWAM Fine Tuning	Other Fine Tuning	New Rehabilitation	Total
Patuakhali	6	6	2	14
Khulna	3	4	2	9
Satkhira	0	2	1	3
Total	9	12	5	26

Source: Inception Report, Blue Gold Program, 2014

4. The main implementing partners of the program are BWDB and the Department of Agriculture Extension (DAE). The program will cooperate closely with the related Ministries, the Local Government institutions, knowledge based institutes and private sector including the NGOs. The overall approach is innovative and therefore, whenever needed, the program will strengthen the technical and strategic capacity of Government officials and their operational capacity in particular, at local (Union, Upazila and District) level, concentrating on polder development in the three districts.

5. The Blue Gold program has five distinct and interlinked components: (i) community mobilization and institutional strengthening, (ii) water resources management, (iii) food security and agricultural production, (iv) business development and private sector involvement, and (v) cross-cutting issues. From environmental point of view, activities of two components i.e. the water resources management component (component ii) and the food security and agricultural production component (component iii) need to be taken into special consideration. Accordingly, the Blue Gold Authority engaged CEGIS for carrying out the Environmental Impact Assessment (EIA) study of five initially selected polders viz: Polder 22, Polder 30, Polder 43/2A, Polder 43/2D and Polder 43/2F under component (ii), which mainly includes fine tuning and some rehabilitation of water management infrastructures in selected polders. As the interventions are relatively smaller in size, the EIA study of these five polders combined into a single study project titled as “Environmental Studies for Blue Gold Program”.

1.2 Rationale of the Study

6. Sustainable development cannot be uni-focused; it includes economic development as well as protection of the environment. Polders are constructed in the coastal area of Bangladesh with the objective of providing protection to the agricultural lands, settlements, homesteads etc from tidal flooding. However, polders are playing crucial role to the economic development of the country, simultaneously have some adverse effect on the ecosystem. Considering the importance, GoB has declared the construction/reconstruction/expansion of flood control embankment; polder, dike, and the like are ‘red’ category projects which must be subjected to Environmental Impact Assessment (EIA) study (ECR, 1997).

7. Component (ii) of Blue Gold program includes rehabilitation of water resources management infrastructure in selected polders. The rehabilitation works inside the polders include re-sectioning of embankments, repair and/or improvement of drainage outlets and irrigation inlets, re-excavation of internal canals and improvement of on-farm water

management. These interventions must be subjected to EIA to obtain an environmental clearance prior to their implementation.

8. The EIA study identified the cumulative and induced environmental impacts of different interventions within and outside the polder. Identification of such impacts is very crucial before implementation of such interventions because some of the impacts are reversible and some are irreversible. Through the public disclosures, the implications of the interventions are informed to the local people and their concerns are also identified during conducting the EIA. Therefore, conducting a comprehensive EIA is very vital for sustainable environmental management.

1.3 Study Area

9. Polder 22 is a part of the study area (Map 1.1) which is located in Deluti union under Paikgachha upazila of Khulna district. The geographical coordinates of the polder ranges from 22035’03.3”N to 22038’39.3”N as latitudes and 89024’24.6”E to 89027’32.2”E as longitudes. The gross area of the polder is 1,485 ha including Net Cultivable Area (NCA), rivers and water bodies, settlements and roads.

1.4 Objectives of the Study

10. The overall objective of EIA study is to ensure environmental sustainability of the outcomes of proposed interventions under a development project which will improve the entire socio-economic condition. The specific objectives include the following:

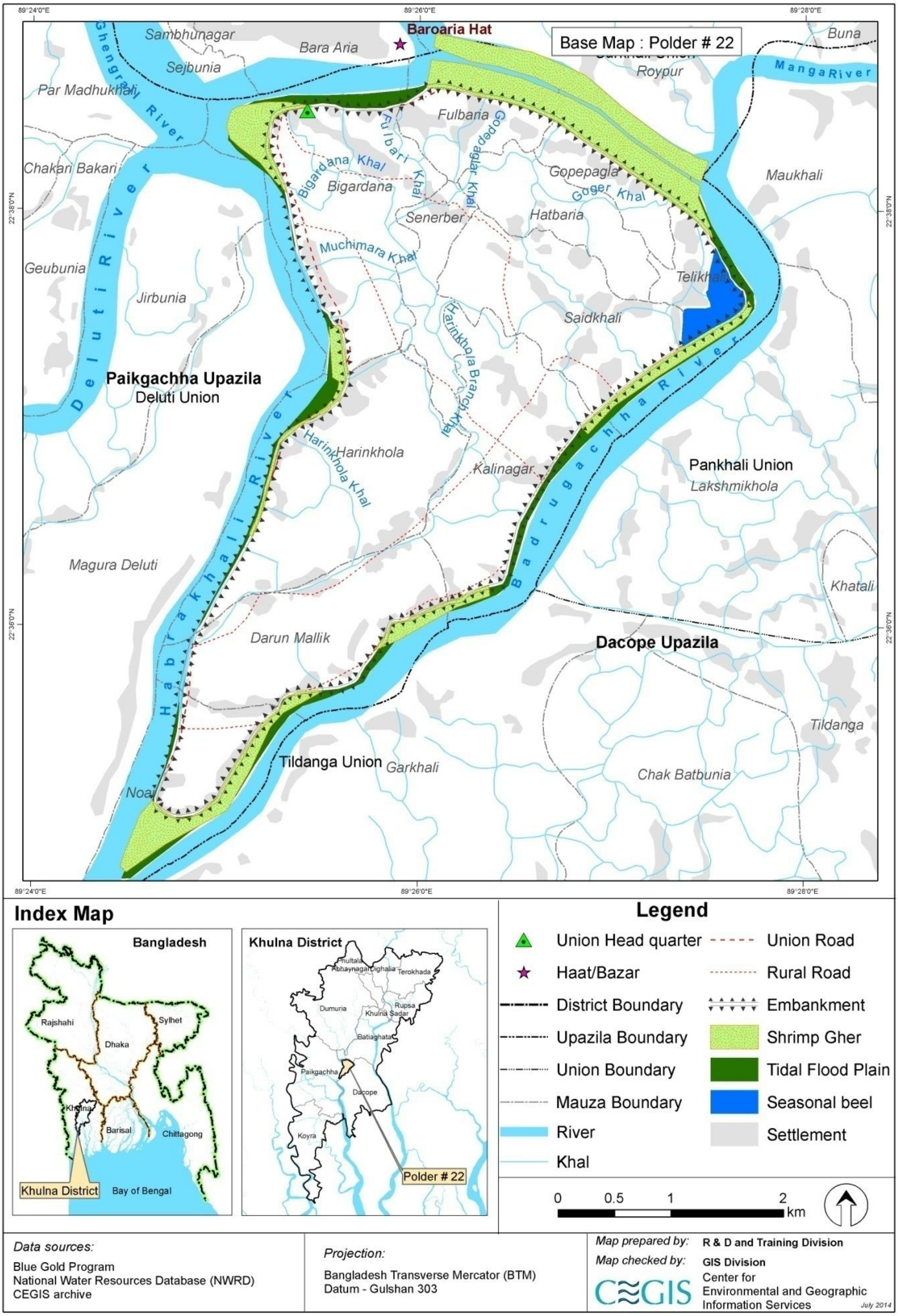
- to improve understanding of the physical processes and the interactions among the physical systems, human systems and implications of interventions.
- to identify key environmental issues/concerns that are likely to be impacted by the proposed interventions
- to assess potential environmental impacts (cumulative, induced and reciprocal) of the proposed interventions on the natural system (water, soil, air, biological system, human health), anthropogenic systems (settlements and infrastructure), social and economic systems (work, education, recreation, health services) and cultural systems (beliefs, art, literature)
- to identify mitigation measures for minimizing/mitigating the negative impacts and enhancement measures to boost up the positive impacts;
- to prepare Environmental Management Plan (Mitigation and enhancement plan, compensation and contingency plan) with monitoring plan.

1.5 Scope of Work

11. The scope of work of the assignment is summarized below.

i. Carry out detail field investigation for the environmental and social baseline, especially on the critical issues such as tidal flooding and associated impact on crop and fish production, land loss, and socio-economic condition of affected persons.

ii. Assess environmental quality and conduct laboratory test (soil and water quality) of the polder area.



Map 1.1: Map Showing the Study Area

iii. Determine the potential impacts due to the project through identification, analysis and evaluation on sensitive areas.

iv. Identify the Important Environmental and Social Component (IESCs) which may be impacted by the proposed interventions.

v. Identify the specific reciprocal impact of climate change and polder.

vi. Preparation of landuse map and ground truthing.

vii. Conduct landuse and land cover classification, damage assessment including flood and erosion mapping using remote sensing technologies.

viii. A small section in the EIA (EMP) will indicate occupational health and safety measurements to be undertaken for the works implementation, but a detailed Occupational Health and Safety Plan (OHP) will not be established as part of the EIA.

ix. Investigate the existing institutional contexts (local institutions, NGOs, government policies and regulations etc.) for polder management.

x. Prepare detailed Environmental Management Plans (mitigation and enhancement plan, compensation and contingency plan as well as monitoring plan).

1.6 Limitations

12. This is a comprehensive study and needed huge data coverage while duration of the study is very short. This study needed data of a full hydrological cycle which was not possible to collect within the specified period. Under this study, baseline data collection and public consultation in 5 polders and screening of data would need more time than that provided in the ToR. Therefore, most of the baseline data have been collected from secondary sources and primary data during field visit within the given time.

1.7 EIA Study Team

13. The multi-disciplinary EIA study team included the following professional from CEGIS:

Dr. Ahmadul Hassan, Water Resources Engineer/ Team Leader

Mr. Mobsher Bin Ansari, Socio-economist

Mr. Md. Ebrahim Akanda, Soil and Agriculture Specialist

Dr. Ashraful Alam, Fishery Specialist

Mr. Md. Amanat Ullah, Ecologist

Mr. Mohammad Saidur Rahman, GIS/RS Specialist

Mr . Fahad Khadim Khan, Junior Engineer

Ms. Laila Sanjida, GIS/RS Analyst

Mr. Md. Azizur Rahman, Field Researcher

Mr. Md. Shahadat Hossain, Field Researcher

Mr. Md. Shahidur Rahman, Enumerator

14. The following professionals from different discipline were also been involved in the EIA study in order to strengthen the team further.

Mr. Mujibul Huq, Environmental Advisor

Mr. Syed Ahsanul Haque, Disaster Management Specialist

Ms. Anushila Mazumder, Environmentalist

Ms. Tahmina Tamanna, Civil Engineer

Mr. Tanvir Ahmed, Water resources Modeller

Mr. Md. Shafi-Ul-Alam, GIS Analyst

Ms. Mashuda Parvin, Junior Ecologist

1.8 Report Format

15. This EIA report contains the following 11 (eleven) chapters:

Chapter 1: Background, study area, objectives, scope of work in addition to presenting the list of the multi-disciplinary EIA study team members.

Chapter 2: The policy, legal and administrative framework.

Chapter 3: Approach and Methodology followed for conducting the EIA study.

Chapter 4: Description of the project including the present status of the infrastructure and the proposed interventions.

Chapter 5: Environmental condition with respect to meteorology, seismicity, water resources, land resources, agriculture, livestock, ecological resources and socio-economic condition.

Chapter 6: Social condition with respect to demography, livelihood, quality of life etc. in the polder area.

Chapter 7: Public Consultation and Disclosure.

Chapter 8: Assessment of the impacts of the proposed interventions of the rehabilitation plan on the environmental and social components pertaining to water resources, land resources, agriculture, livestock, ecological resources and socio-economic condition.

Chapter 9: Assessment of Cumulative, Induced and Reciprocal Impact.

Chapter 10: Environmental Management Plan (EMP).

Chapter 11: Conclusion and Recommendations.

2 Policy, Legal and Administrative Framework

16. Development projects are governed by legal and/or institutional requirements. Thus, review of relevant policy, strategy and regulatory issues are very important for any project proponent before actual execution of a program or plan. The proponent has to be well aware of these requirements and comply with the provisions as applicable and necessary. A review of the relevant national legislative, regulatory and policy requirements are presented in the following sections. The key pieces of policy and legislation which apply to such project execution program are described in this chapter.

2.1 National Policies and Legislations

2.1.1 The National Environment Policy, 1992

17. The National Environment Policy was adopted by the Government of Bangladesh in 1992, with the aim to maintain ecological balance and overall development through protection and improvement of environment and to protect the country against any natural disaster. The Policy provides the broader framework of sustainable development in the country. It also stated all major undertakings, which will have a bearing on the environment and need an initial environmental examination (IEE) and environmental impact assessment (EIA) before initiation of the project. The Policy designates the Department of Environment (DoE), as the approving agency for all such IEE/EIAs to be undertaken in the country.

18. The policy guidelines of fifteen sectors are stated in the Policy. Under the 'Water Development, Flood Control and Irrigation' sector (Section 3.5), it states that it is required to conduct EIA before undertaking projects for water resources development and management (Section 3.5.7).

19. Section 3.5.2 states that it is required to ensure water development activities and that irrigation networks should not create adverse environmental impacts and the Section 3.5.3 provides, 'ensure that all steps taken for flood control, including construction of embankments,.... be environmentally sound at the local, zonal and national level'. According to the Section 3.5.5 of the Policy, the rivers and all water bodies are to be free from pollution. The Environment Policy sets out the basic framework for environmental action, together with a set of broad sectoral action and guidelines (MoEF, 1992).

2.1.2 National Environmental Management Action Plan (NEMAP) 1995

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

21. NEMAP has the following broad objectives:

- Identification of key environmental issues affecting Bangladesh;
- Identification of actions necessary to halt or reduce rate of environmental degradation;
- Improvement of the natural and built environment;
- Conservation of habitats and biodiversity;

- Promotion of sustainable development, and
- Improvement in the quality of life of the people. (MoEF, 1995)
- Proposed National Wetland Policy (Draft 1998)

22. The Wetland Policy is dated April 1998 but refers to documents dated December 1998, and appears to be in an early draft stage. The draft policy defines wetlands as areas of land surface which are seasonally flooded or remain under water permanently, either naturally or artificially, that may perform some known functions such as water reservoir, groundwater recharge, capture fishery area, aquaculture fish sanctuary, wild life sanctuary, navigation channel, cultivated area, etc. Such a broad definition effectively encompasses most of the country.

2.1.3 The National Water Policy, 1999

23. The National Water Policy of 1999 was adopted to ensure efficient and equitable management of water resources, proper harnessing and development of surface and ground water, availability of water to all concerned and institutional capacity building for water resources management. The policy considers water as being essential for human development, socio-economic development, poverty alleviation and preservation of the natural environment.

24. Sub-clause (b) of Section 4.5 states that planning and feasibility studies of all projects (relevant to water resources management or development or have interference on water sector) will follow the Guidelines for the Project Assessment (GPA), the Guidelines for Peoples Participation (GPP), the Guidelines for Environmental Impact Assessment (EIA), and all other instructions that may be issued from time to time by the Government. Giving importance on the navigation sector, sub-clause (a) of section 4.10 states that if a project may cause disruption to navigation, adequate mitigation measures should be taken. The stated objectives of the draft policy are:

- Establish the key principles by which wetland resource can be used in a sustainable manner;
- End existing unsustainable practices in wetlands, so as to stop and reverse the decline in their productivity;
- Ensure that measures are taken to maintain existing levels of biological diversity in wetlands;
- Maintain the functions and values derived from wetlands throughout Bangladesh;
- Actively promote the recognition and integration of wetland functions in resource management and economic development decision-making, with particular regard to sectoral policies and programs in the water, fisheries, agriculture, industries and infrastructure sectors.

25. The draft describes the importance of wetlands to the environment of Bangladesh and makes cross-references to the various recent government policy issues that relate to wetland management. In its draft form, it provides a series of recommendations as found in other policies (MoEF, 1999).

2.1.4 The National Biodiversity Strategy and Action Plan for Bangladesh 2004

26. The Biodiversity Conservation Strategy and Action Plan 2004 (BCSAP) is a wide ranging and multi-faceted plan, which is also closely related to the statements set out in the National Environment Policy. The BCSAP has the following broad objectives:

- Identification of key environmental issues affecting Bangladesh;
- Identification of actions necessary to halt or reduce the rate of environmental degradation;
- Improvement of the natural and built environment;
- Conservation of habitats and biodiversity;
- Promotion of sustainable development;
- Improvement in the quality of life of the people (MoEF, 2004).

2.1.5 Bangladesh Climate Change Strategy and Action Plan (BCCSAP)

27. The Bangladesh Climate Change Strategy and Action Plan 2009 is built on the following Six pillars:

i. Food security, social protection and health to ensure that the poorest and most vulnerable in society, including women and children, are protected from climate change and that all programs focus on the needs of this group for food security, safe housing, employment and access to basic services including health;

ii. Comprehensive disaster management to further strengthen the country's already proven disaster management system to deal with increasingly frequent and severe natural calamities;

iii. Infrastructure to ensure that existing assets are well maintained and fit-for-purpose and that urgently needed infrastructure is put in place to deal with the likely impact of climate change;

iv. Research and knowledge management to predict the likely scale and timing of climate change impacts on different sectors of the economy and socio-economic groups, to underpin future investment strategies and to ensure that Bangladesh is networked with the latest global thinking on science and best practices of climate change management;

v. Mitigation and low carbon development to ensure low carbon development options and implement these as the country's economy grows over the coming decades and the demand for energy increases; and

vi. Capacity building and institutional strengthening to enhance the capacity of government ministries and agency, civil society and the private sector to meet the challenges of climate change and mainstream them as part of development action (MoEF, 2009).

2.2 Legal Framework

2.2.1 Water Resources Management Legislation

The Irrigation Act, 1876 (Bengal Act Iii Of 1876)

28. This Act provides the government with the power to regulate the application or use of irrigation water in Bangladesh. It also provides the provision for compensation or disclaimer to the government with regard to irrigation project activities.

The Protection and Conservation of Fish Act, 1950 (Bengal Act XVIIIOf 1950)

29. This Act provides power to the government to:

- Make and apply rules in any water or waters for the purposes of protection of fisheries.
- Prohibit or regulate the erection and use of fixed engines; and the construction, temporary or permanent, of weirs, dams, bunds, embankments and other structures.
- Prohibit the destruction of fish by explosives, guns, and bows in inland or coastal areas.
- Prohibit the destruction of fish by means of poisoning, pollution and effluents.
- Prescribe the seasons during which fishing is allowed.
- Prohibit fishing in all waters during spawning periods.
- Specify the officials with authority to detect breaches.

The Embankment and Drainage Act 1952

30. This is an Act to consolidate the laws relating to embankment and drainage and make better provisions for the construction, maintenance, management, removal and control of embankments and watercourses or the better drainage of lands and for their protection from floods, erosion or other damage by water.

31. According to the Section 4 (1) every embankment, watercourse and embanked tow-path maintained by the Government or the Authority, and all land, earth, pathways, gates, berms and hedges belonging to or forming part of, or standing on, any such embankment or water-course shall vest in the Government or the Authority, as the case may be.

32. The Section 56 (1) states that, persons will be subjected to a penalty of500 taka or imprisonment… if he erects, or causes of willfully permits to be erected, any new embankment, or any existing embankment, or obstructs of diverts, or causes or willfully permits to be obstructed or diverted, any water course. This section could be applied to the person causing damage to the protective works.

The Inland Water Transport Authority Ordinance, 1958(E.P. Ordinance No. LXXV of 1958)

33. This is an ordinance to set up an authority for the development, maintenance and control of inland water transport and certain inland navigable waterways in Bangladesh. The authority is mandated to perform any other function such as, carrying out river conservancy work, including river training for navigation purposes and aiding navigation; drawing up programs on dredging requirements and priorities for the efficient maintenance of existing navigable waterways; and reviving dead or dying rivers, channels, or canals, including developing new channels and canals for navigation.

The Government Fisheries (Protection) Ordinance, 1959 (Ordinance No. XXIV of 1959)

34. This ordinance provides power to the government to declare any area as Khas managed fishery' to bring it under the management and control of the government. No person shall fish in such an area without a valid fishing license issued by such authority as may be prescribed under the Act.

The Bangladesh Irrigation Water Rate Ordinance, 1983 (Ordinance No. XXXI of 1983)

35. An Ordinance to consolidate and amend the law related to the imposition of a water rate for the supply, regulation or storage of water for irrigation or drainage purposes. Imposition of water rate - (I) Whenever the government is of the opinion that lands within any

area is benefited or is likely to be benefited by water supplied or regulated by the government or the Board or the Corporation through any canal during any financial year. The Government may, by notification, declare its intention to impose in such area, hereinafter referred to as the notified area, a water rate for such financial year provided that the water rate so specified for a crop season shall not exceed such rate as may be prescribed and provided further that the water rate intended to be imposed may vary from one notified area to another.

The Ground Water Management Ordinance, 1985 (Ordinance No.Xxvit of 1985)

36. This is an Ordinance to manage ground water resources for agricultural production. This act authorizes the Thana Parishad to grant license for installing tube wells in their jurisdiction areas. It may grant the license if the Thana Parishad is satisfied that the installation of the tubewell applied for

- will be beneficial to the areas where it is to be installed, or
- will not have any adverse affect upon the surrounding areas, or
- is otherwise feasible.

The Protection and Conservation of Fish Rules (1985)

37. These are a set of rules in line with the overall objectives of the Fish Act. Section 5 of the Rules requires - “No person shall destroy or make any attempt to destroy any fish by explosives, gun, bow and arrow in inland waters or within coastal waters”. Section 6 of the Rules states -“No person shall destroy or make any attempt to destroy any fish by poisoning of water or the depletion of fisheries by pollution, by trade effluents or otherwise in inland waters”.

Panishampad Parikalpana Ain (Water Resources Planning Act, 1992)

38. Under this Act, the government is authorized to set up a Water Resources Planning Organization (WARPO), which would prepare a master plan for the development of water resources and through a technical committee, advice all other agencies related to the issue of water resources development use.

2.2.2 Environmental Legislation

39. Bangladesh Wild Life (Preservation) Order, 1973 (P.0. No. 23 of 1973) and Act, 1974

The Bangladesh Wild life Preservation (Amendment) Act 1974 provides for the following main effects:

- This Act provides power to the government to declare areas as game reserves, wild life sanctuaries and national parks to protect the country’s wild life. This Act also provides legal definitions of the protected areas as follows:
  - “Game reserve” means an area declared by the government as such for the protection of wild life and increase in the population of important species wherein capturing of wild animals shall be unlawful;
  - ‘National park’ means comparatively large areas of outstanding scenic and natural beauty with the primary objective of protection and preservation of scenery, flora and fauna in the natural state to which access for public recreation and education and research may be allowed;

- 'Wild life sanctuary' means an area closed to hunting, shooting or trapping of wild animals and declared as such under Article 23 by the government as undisturbed breeding ground primarily for the protection of wild life inclusive of all natural resources, such as vegetation, soil and water.

- Under this law hunting, killing, capturing, trading and exporting of wild life and wild life products are regulated. The Act also designates a list of protected species and game animals.

40. Provided that the government may, for scientific purposes or for aesthetic enjoyment or betterment of scenery, relax all or any of the prohibitions specified.

Environment Conservation Act (1995, Amended in 2000 & 2002)

41. The Bangladesh Environment Conservation Act of 1995 (ECA '95) is currently the main legislation in relation to environment protection in Bangladesh. This Act is promulgated for environment conservation, environmental standards development and environment pollution control and abatement. It has repealed the Environment Pollution Control Ordinance of 1977.

42. The main objectives of ECA '95 are:

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

43. The main strategies of the Act can be summarized as:

- Declaration of ecologically critical areas and restriction on the operations and processes, which can or cannot be carried/initiated in the ecologically critical areas;
- Regulations in respect of vehicles emitting smoke harmful for the environment;
- Environmental clearance;
- Regulation of the industries and other development activities' discharge permits;
- Promulgation of standards for quality of air, water, noise and soil for different areas for different purposes;
- Promulgation of a standard limit for discharging and emitting waste; and
- Formulation and declaration of environmental guidelines.

44. Before any new project can go ahead, as stipulated under the rules, the project promoter must obtain Environmental Clearance from the Director General. An appeal procedure does exist for those promoters who fail to obtain clearance. Failure to comply with any part of this Act may result in punishment to a maximum of 3 years imprisonment or a maximum fine of Tk. 300,000 or both. The Department of Environment (DoE) executes the Act under the leadership of the Director General (DG) (MoEF, 1995).

The Environment Conservation Rules, 1997

45. These are the first set of rules, promulgated under the Environment Conservation Act of 1995 (so far there have been three amendments to this set of rules - February and August 2002 and April 2003).

46. The Environment Conservation Rules of 1997 has provided categorization of industries and projects and identified types of environmental assessments needed against respective categories of industries or projects.

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

48. The Rules are not explicit for water development projects. Rather, this is covered under the broader heading of "exploration, extraction and distribution of mineral resources" under the 'Red' category projects.

49. The DoE has issued EIA Guidelines and addresses the IEE and EIA for several sectors and activities. Each Project Proponent shall conduct an IEE or EIA and is expected to consult and follow the DoE guidelines (MoEF, 1997).

Bangladesh Environment Conservation Act (Amendment 2000)

50. This amendment of the Act focuses on: (1) ascertaining responsibility for compensation in cases of damage to ecosystems, (2) increased provision of punitive measures both for fines and imprisonment and (3) fixing authority on cognizance of offences.

Environment Court Act, 2000

51. The Environmental Court Act, 2000 provide for the establishment of environment courts and matters incidental thereto. This act also provides the jurisdictions of environment court, penalty for violating court's order, trial procedure in special magistrate's court, power of entry and search, procedure for investigation, procedure and power of environment court, authority of environment court to inspect, appeal procedure and formation of environment appeal court.

Bangladesh Environment Conservation Act (Amendment 2002)

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

2.3 Procedure for Environmental Clearance

53. The Environmental Legislation in Bangladesh, particularly the Bangladesh Environment Conservation Act, 1995 (Amended in 2002), states that any development project shall require 'Environmental Clearance' from the Department of Environment (DoE) so as to ensure environmental sustainability. The proposed rehabilitation activities of coastal polders under Blue Gold Program (Component 2: Water Resources Management) falls under the "Red Category" as per the Environment Conservation Rules, 1997, which requires submitting a report on the Environmental Impact Assessment (EIA) to DoE, including a detailed Environmental Management Plan (EMP). This report is to be assessed by the DoE and based on the overall environmental friendliness and socio-economic viability of the project, Environmental Clearance may be obtained. The process of obtaining clearance from the DoE is presented in Figure 2.1 below.

54. The Environment Conservation Rules place construction/reconstruction/expansion of flood control embankments, polders, and dykes into the Red category. The proposed project, according to the DoE, is considered under the Red category of the Environmental Conservation Rules, 1997.

55. In order to obtain an Environmental Clearance Certificate for the project from the DoE, the following documents/ materials are to be submitted with the application:

- Feasibility Report for the Project (where applicable)
- Environmental Impact Assessment (EIA) Report
- Environmental Management Plan (EMP)
- No Objection Certificate from relevant Local Authority (where applicable)
- Other necessary information, (where applicable)

2.4 Environmental Quality Standards

56. Environmental quality standards for air quality and noise for Bangladesh are furnished in the following tables.

Table 2.1: Bangladesh Standards for Ambient Air Quality (all values in micrograms per cubic meters)

Sl. No.	Area	Suspended Particulate Matters (SPM)	Sulfur Dioxide (SO2)	Carbon Monoxide (CO)	Oxides Nitrogen (NOx)
1	Industrial and mixed	500	120	5000	100
2	Commercial and mixed	400	100	5000	100
3	Residential and rural	200	80	2000	80
4	Sensitive	100	30	1000	30

Source: Schedule-2, Rule 12, Environment Conservation Rules of 1997 (Page 3123. Bangladesh Gazette, 28 August 1997) (translated to English)

Note:

At national level, sensitive area includes monuments, health center, hospital, archeological site, educational institution, and government designated areas (if any).

Industrial units located in areas not designated as industrial areas shall not discharge pollutants which may contribute to exceeding the standard for air surrounding the areas i e residential and rural areas and sensitive areas.

Suspended Particulate Matter means airborne particles of a diameter of 10 micron or less.

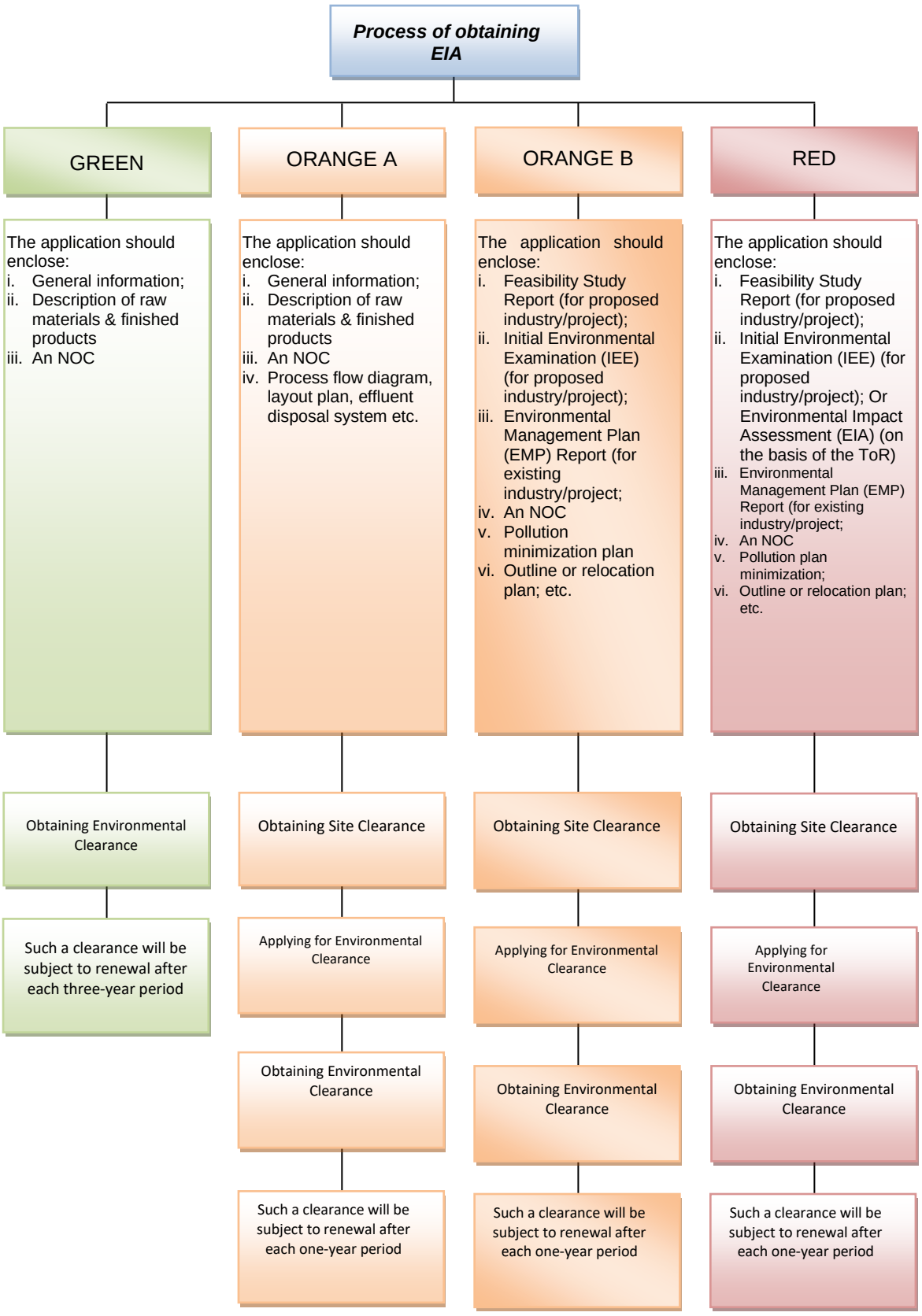


Figure 2.1: Steps Involved in Environmental Clearance Following DoE Guidelines

Table 2.2: Bangladesh Standards for Noise

Sl. No.	Area Category	Standard Values (all values in dBA)	
		Day	Night
1	Silent Zone	45	35
2	Residential area	50	40
3	Mixed area (basically residential and together used for commercial and industrial purposes)	60	50
4	Commercial area	70	60
5	Industrial area	75	70

Source: Schedule 4, Rule-12, Environment Conservation Rules, 1997 (Page 3127, Bangladesh Gazette, 28 August 1997) (translated from Bengali to English)

Note:

- The time from 6 a.m. to 9 p.m. is counted as daytime.
- The time from 9 p.m. to 6 a.m. is counted as night time.
- Area up to a radius of 100 meters around hospitals or educational institutions or special institutions/ establishments identified/to be identified by the Government is designated as Silent Zones where use of horns of vehicles or other audio signals, and loudspeakers are prohibited.

2.5 Administrative Framework

57. Bangladesh Water Development Board (BWDB) is responsible for implementing flood control/drainage improvement/irrigation/ river erosion related water development projects in Bangladesh. The organization has long experience in implementing such projects with its own institutional resources. There are planning, design, implementation and Operation & Maintenance (O&M) sections to implement this kind of projects. It has also project evaluation section, which monitors and evaluates the implementation status of projects.

58. Within the organizational structure of BWDB, there is no position for taking care of environmental issues. Although BWDB has few positions of environment, forestry and fisheries professionals as Research Officers working in BWDB head office in Dhaka, there is no such professional position in Zone/Circle/Division office at local level, who can implement and monitor the 'Environmental Management Plan (EMP)' of any project. In current practice of BWDB, there is no provision for keeping such professional or forming any unit for implementing EMP while implementing any project. Nevertheless, there are officers at junior and senior levels, who have training on environmental management of water resources development projects. Those officers can contribute towards implementation of EMP and monitor the environmental concerns of the projects. Since BWDB has large institutional set up and human resources from national to local level, it will be very much convenient to mobilize required resources for implementing EMP.

3 Approach and Methodology

3.1 EIA Process

59. The guideline for environmental impact assessment of water sector projects, developed by the Flood Plan Co-ordination Organization (FPCO) in 1992 and updated by the Water Resources Planning Organization (WARPO) in 2003 is followed for conducting the Environmental Impact Assessment (EIA) study of “Rehabilitation of Polder 22”.The process followed for conducting the EIA study included 9+1 steps as shown in Figure 3.1 and activities undertaken in each step is described in the following sections.

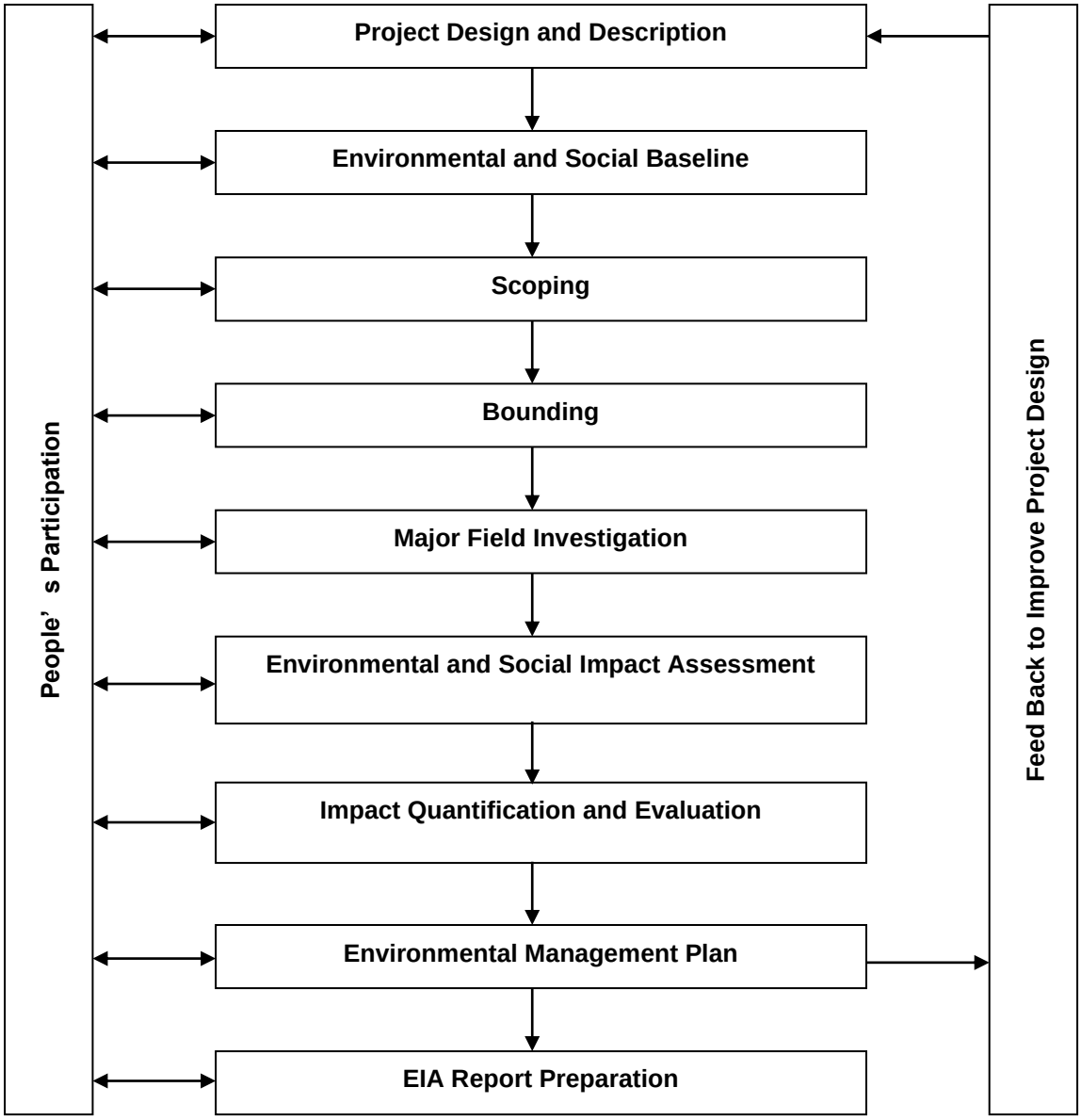


Figure 3.1: The EIA Process

3.2 Project Design and Description

60. The rehabilitation activities or interventions which are to be implemented under the Blue Gold Program were identified. The area of influence (or Project area for short) was demarcated. This included the area inside the polder where most of the Project interventions would take place, and the area immediately outside the polder embankments (this area could be used for staging of construction works, material stockpiling, and/or earth borrowing). A detailed description of the proposed works to be carried out has been provided. Supplementary information on design and implementation of the project interventions were collected from Blue Gold officials. Afterwards, a field investigation was carried out by the EIA study team, which helped in the verification of locations and rationale of proposed interventions, and identified the existing water management and other small scale problems. The existing situation of the available water management infrastructures have been inspected during field investigation. An Operation and Maintenance plan for the rehabilitation works has been developed. Furthermore, the potential benefits of the project have also been assessed. Environmental and Social Baseline

61. Baseline data collection was conducted as a pre-requisite for this EIA study. The baseline condition of the project area was drawn according to information collected from secondary and primary data sources through literature review, field investigations and consultation with different stakeholders. The baseline condition was established in respect of meteorology, seismicity, water resources, land resources, agriculture, livestock, fisheries, ecosystems and socio-economic conditions including identification of problems in respect to the proposed project site and adjoining area. The baseline data collection and analyzing methodology are presented in the following section:-

3.2.1 Source and Methodology of Data Collection/ Analysis

a. Climate and Meteorology

62. Data on different meteorological prarameters such as rainfall, evapo-transpiration, temperature, sunshine hours, humidity and wind speed were used for assessing the existing climate which is directly related to the water resources of the study area. The nearest station of Bangladesh Meteorological Department (BMD) at Khulna (which is 7 km away from Polder 30), was selected. The data was collected from the National Water Resources Database (NWRD), which contains long time series of temporal data showing daily values for meteorological stations. For better accuracy, monthly average data on rainfall has also been analyzed using the rainfall stations of Bangladesh Water Development Board (BWDB) at Dumuria (8 km away from polder) and Chalna (2.5 km away from the polder).A thiessen polygon was plotted around the BWDB rainfall stations, using the ArcGIS software, and the spatial contribution of rainfall into the polder from different stations were assessed. . Reference evapotranspiration (ETo) values (from 1984 to 1998) and pan evaporation values (from 1992 to 2011) have been collected for the Khulna BMD station (NWRD). The pan evaporation values have been multiplied by a co-efficient of 0.8 (Mainuddin et al, 2014) to get the actual evapotranspiration. The issue of climate change has been discussed on a regional scale. Through the review of existing literatures on different climate change scenarios for Khulna district, an understanding has been obtained regarding the probable climate change consequences in future.

b. Topography and Seismicity

63. The general geological features and the seismicity of the project and its surrounding areas were collected from available secondary literature and Geological Survey of

Bangladesh. The topographical data was collected from Geological Survey of Bangladesh and National Water Resources Database (NWRD) of Water Resources Planning Organization (WARPO).

c. Water Resources

64. Water resource data under the heading river hydrology, river morphology, ground water availability, drainage pattern, ground and surface water quality and water use were collected from secondary sources and primary observation. Multidisciplinary professionals from the study team received feedbacks from local people during their field investigations. Major river systems were identified for hydrological and morphological investigation through historical and current data collection and analysis. Specific areas or points of interest were selected for collecting data on special hydrological and morphological events such as river-khal-beel network, water availability, drainage pattern, water quality (surface and ground water), flash flood, risk of erosion or sedimentation etc.

65. Field visits were made to the study area and primary data on water resources components were collected through discussion with stakeholders. A checklist was used to obtain the information on different resources. Local knowledgeable persons and community representatives were also interviewed. During field visits, the multidisciplinary EIA team members made professional observations pertaining to their individual areas of expertise. The impact of the 'Rehabilitation of Polder 22' on water resources components were assessed by analyzing collected data, community knowledge analysis and professional justification of water resources managers. The management plan for water resources components was incorporated to assess impact risk and water resources status using stakeholders' requirement and experts' judgment.

66. The specific data on different events of water resources were collected from the different sources. The monthly average water levels were collected from the BWDB surface water measuring station at Chalna (Rupsa-Passur River). Values on monthly average groundwater levels and annual variation of Ground Water Table (GWT) were collected from the BWDB observation well at Chalna (KHU003). Data on water quality were measured in site, collecting surface and ground water samples from different locations within the polder. Surface water salinity was measured from different locations during high tide (mostly near the high water slack period). Information on different water resources functions, problems and uses were collected through intensive local level consultations.

d. Land Resources

67. The Agro-ecological Region of the proposed study area has been identified using secondary sources (FAO/UNDP). The land use, land type, soil texture data have also been collected from Upazila Land and Soil Resources Utilization Guide (Upazila Nirdeshika) of Soil Resources Development Institute (SRDI). The secondary data of these parameters have been verified at field level through physical observations as well as in consultation with the local people and officials of the DAE during field visit.

e. Agricultural Resources

68. Data on agricultural resources included farming practices, crop production constraints, existing cropping patterns, crop variety, crop yield, crop damage and agricultural inputs used. Agriculture data were collected from primary sources through extensive field survey by developing questionnaire and in consultation with local people and concerned agricultural officials. Agricultural resources data were also collected from secondary sources from the upazila DAE office. Crop production was determined using the formula:

- Total crop production = damage free area × normal yield + damaged area × damaged yield.
- The crop damage (production loss) was calculated using the formula:
- Crop production loss = Total cropped area ×normal yield-(damaged area ×damaged yield+ damage free area × normal yield).

69. The crop damage data were collected from the field for last three years.

f. Livestock Resources

70. Present status of livestock (cow/bullock, buffalo, goat and sheep and poultry (uck and hicken) in the study area have been evaluated at field level survey in consultation with the local people through Participatory Rural Appraisal (PRA), Rapid Rural Appraisal (RRA) and Key Informants Interview (KII). Livestock resources data were also collected from secondary sources from upazila livestock office.

g. Fisheries Resources

Data Collection Methods

71. The fisheries data were collected for the EIA study by considering the seasonal variance of dry and wet seasons. Prior to going for data collection, a checklist and questionnaire were developed (Appendix I). The checklist included all kinds of information in the context of existing and potential structures of the project. A combination of survey techniques was used for data collection. The survey techniques included sampling site selection, data collection, data analysis and reporting. The sequential interpretations of the methodological approach are described below:

Sampling Site Selection

72. Existing and proposed basin wise sites were selected for data collection. Sampling sites varied depending on the size of the water bodies. During site selection concentration was given on the intervened area and non-intervened area to find the difference between them in terms of fisheries impact.

Data Collection

73. Data were collected in multiple ways which can be broadly classified into two classes, for instance, (i) primary data and (ii) secondary data. Primary data were collected from the fishing community, fisher households and local key informants, and secondary data were collected from upazila fisheries' office during field visits.

Habitat Identification

74. Fish habitat classification was made based on physical existence and were categorized into capture and culture fish habitats. The capture fish habitats included river, khal, floodplain, borrow pit and beel. The culture fish habitats included homestead culture fish pond, commercial fish farm etc.

Capture and Culture Fish Habitats

75. Capture fish habitat assessment was done through Fishing Effort Survey (FES), Frame Survey (FS), micro scale Catch Assessment Survey (CAS), habitat based species diversity & composition, identification of species of conservation significance, identification of potential fish habitat prescribing to restore for fish conservation, fish migration survey,

habitat identification for fish conservation. Culture fish habitat assessment was done through homestead culture fish pond survey and commercial fish farm survey.

Associated Information

76. Information on post harvest activities, forward and backward linkages, fisher livelihood information, fisheries management issues, potential fish recruitment, fish infrastructure and fisher vulnerability, etc. were also collected.

Secondary Data Collection

77. Relevant secondary data were collected from the upazila fisheries office from their annual report and from various literature/study.

Data Analysis and Output

78. Fish production for individual habitats were obtained through a series of calculation procedures using the collected information of FES, FS, CAS and Habitat area. An aggregate of the fish production from all habitat types, was estimated to be the total fish production of the study area. Secondary information those were collected from the UFOs and literatures were blended with primary data for production estimation

h. Ecological Resources

79. Information on bio-ecological zones and their characteristics has been collected from the publication of International Union for Conservation of Nature (IUCN). For ecological baseline, terrestrial and riverine ecology including flora, birds, reptiles, amphibians, mammals, and migratory birds. The field activities included collection of ecosystem and habitat information, sensitive habitat identification, identifying ecological changes and potential ecological impact.

80. The land use information on different ecosystem was generated through analysis of the high resolution optical satellite images. Time series images of five years were used to analyze the changes in land use over time. The selected images were Landsat MSS (80 m resolution) of 1972 and 1973, Landsat 5 TM (30m resolution) of 1989, Landsat ETM (30m resolution) of 2003, IRS P6 LISS III (24m resolution) of 2013 and RapidEye (5m resolution) of 2014. All of the images were geo-rectified into “Bangladesh Transverse Mercator” (BTM) projection. ERDAS IMAGINE software was used to perform the image classification. The mean signature plot for each class was verified with ground truth data.

81. In addition to land use, the Normalized Difference Vegetation Index (NDVI) values in the study area were also generated to identify the vegetation development pattern in the area. The NDVI is a simple numerical indicator which uses the visible (VIS) and near-infrared bands (NIR) of electromagnetic spectrum that were used to analyze the changes of vegetation in different years. The NDVI is calculated from the following equation::

$$NDVI= (NIR - VIS)/ (NIR + VIS)$$

82. Field investigation methods included physical observation; transect walk, habitat survey and consultation with local people. Field visits were carried out in delineating the ecological baseline condition. Public consultation was carried out through Focus Group Discussions (FGD) and Key Informants Interview (KII) methods. Inventory of common flora and fauna was developed based on field survey and data base of IUCN.

i. Socio-economic Condition

83. The socio-economic baseline information including the study area, demographic information, occupation and employment, literacy rate, drinking water, sanitation, electricity

facilities etc. were collected from secondary sources, i.e. BBS, 2011. The income expenditure of the local people inside polder area, land ownership pattern, poverty status, migration, social overhead capitals and quality of life, disasters, conflicts of the study area, information on NGOs, cultural and heritage features of the study area were collected mainly from primary sources through PRA and FGDs and public consultations.

84. The steps considered for collecting socio-economic data were as follows:

a. Data was collected from BBS, 2011;
b. Reconnaissance field visit and discussion with BWDB officials and local stakeholders for primary data collection;
c. PRA /RRA, FGDs, KII for primary data collection
d. Institutional Survey (IS) for primary data collection in upazila level offices which included Local Government Engineering Department (LGED) office, civil surgeon office, social service office etc.

3.3 Scoping

85. A scoping process was followed for selecting Important Environmental and Social Components (IESCs) which are likely to be impacted by the proposed interventions of 'Rehabilitation of Polder 22'. Scoping was done in two stages. Individual professionals of EIA study team made a preliminary list of the components pertaining to their disciplines, which could be impacted by the project. The second stage included village scoping sessions where stakeholder perceptions were obtained about those environmental and social components. Professional judgment of the EIA team members as well as the stakeholder opinion obtained in the scoping sessions was considered in selecting the IESCs.

3.4 Bounding

86. Area likely to be impacted by 'Rehabilitation of Polder 22' was delineated in consultation with the Blue Gold Authority and feedback received from the local people during baseline consultation. In addition, processed RS tools were also used for this purpose.

87. A semi-distributed hydrological model SWAT (Soil and Water Assessment Tools) was setup in order to assess availability of water for the study area. Hydrodynamic modeling was simulated using Delft 3D as modeling tool. All data used in the model calibration (including topography, soil maps, land use maps, and weather data, river network and cross-section, water level, discharge and salinity) and simulation were obtained from different sources. Furthermore, participatory public consultations were carried out for validation of the model outputs, and drawing socio-technical conclusions.

3.5 Major Field Investigation

88. The EIA study team members collected intensive data on possible impact of the project after obtaining the detailed rehabilitation plan from the project authority.. Intensive data on the IESCs were collected from the field during major field investigation stage. In this case, information on the IESCs were gathered through a mixed method including RRA, PRA and KII using checklists for water resources, land resources, agriculture, livestock, fisheries, ecosystem and socio-economic components. Intensive consultation with the local people was carried out in each case for securing people's participation. The multidisciplinary EIA study team members also made professional observations and justification during the field visits. This time the concentration was on the historical status and public responses for the IESCs and the possible condition of the same against the proposed interventions.

89. Environmental and Social Impact Assessment Environmental and social impacts of the proposed interventions for 'Rehabilitation of Polder 22' on the IESCs have been assessed through several sets of activities. Impacts are caused as a result of interaction of specific project activities with the existing environmental settings. The impacts of proposed interventions were estimated on the basis of difference between the future-without-project condition and the future-with-project condition. Conditions were generated through trend analysis and consultation with the local people. This reflected conditions of IESCs in absence of the proposed interventions. Changes expected to be brought about due to the proposed interventions were assessed to generate the condition. Comparison and projection methods were used for impact prediction. This included both positive and negative impacts which were considered in the preparation of the environmental management plan.

90. The sequence of assessment of environmental and social impact was as follows:

i. Changes in the status of the IESCs pertaining to water resources;

ii. Changes in the status of the IESCs pertaining to land resources, agriculture, livestock and poultry;

iii. Changes in the status of the IESCs pertaining to fisheries;

iv. Changes in the status of the IESCs pertaining to ecological resources; and

v. Changes in the status of the IESCs pertaining to socio-economic condition.

3.6 Impact Quantification and Evaluation

91. At this stage, attempts were made to quantify the impacts of the proposed interventions on the IESCs. However, it was not possible to quantify all impacts, especially the impacts on some of the environmental and social components. In those cases, qualitative impacts were assessed and scores were assigned with plus (+) sign for positive impacts and minus (-) sign for negative impacts. The magnitude of both positive and negative impacts was indicated in a scale of 1 to 10 on extent, magnitude, reversibility, duration and sustainability considerations.

3.6.1 Assessment Methodology

92. The assessment of effects and identification of residual impacts takes account of any incorporated mitigation measures adopted due to any potential impact of Project activities, and will be largely dependent on the extent and duration of change, the number of people or size of the resource affected and their sensitivity to the change. Potential impacts can be both negative and positive (beneficial), and the methodology defined below has been applied to define both beneficial and adverse potential impacts.

93. The criteria for determining significance are generally specific for each environmental and social aspect but generally the magnitude of each potential impact is defined along with the sensitivity of the receptor. Generic criteria for defining magnitude and sensitivity used for the Project are summarized below.

3.6.2 Magnitude

94. The assessment of magnitude has been undertaken in two steps. First, the key issues associated with the project were categorized as beneficial or adverse. Next , potential impacts have been categorized as major, moderate, minor or negligible based on consideration of the parameters such as:

- Duration of the potential impact;

- Spatial extent of the potential impact;
- Reversibility;
- Likelihood; and
- Legal standards and established professional criteria.

95. The magnitude of potential impacts of the project has generally been identified according to the categories outlined in Table 3.1.

Table 3.1: Parameters for Determining Magnitude

Parameter	Major	Moderate	Minor	Negligible/Nil
Duration of potential impact	Long term (more than 35 years)	Medium term lifespan of the project (5 to 15 years)	Less than project life span	Temporary with no detectable potential impact
Spatial extent of the potential impact	Widespread far beyond project boundaries	Beyond immediate project components, site boundaries or local area	Within project boundary	Specific location within project component or site boundaries with no detectable potential impact
Reversibility of potential impacts	Potential impact is effectively permanent, requiring considerable intervention to return to baseline	Baseline requires a year or so with some interventions to return to baseline	Baseline returns naturally or with limited intervention within a few months	Baseline remains constant
Legal standards and established professional criteria	Breaches national standards and or international guidelines/ obligations	Complies with limits given in national standards but breaches international lender guidelines in one or more parameters	Meets minimum national standard limits or international guidelines	Not applicable
Likelihood of potential impacts occurring	Occurs under typical operating or construction conditions (Certain)	Occurs under worst case (negative impact) or best case (positive impact) operating conditions (Likely)	Occurs under abnormal, exceptional or emergency conditions (Occasional)	Unlikely

3.6.3 Sensitivity

96. The sensitivity of a receptor has been determined based on review of the population (including proximity / numbers / vulnerability) and presence of features on the site or the

surrounding area. Criteria for determining receptor sensitivity of the project's potential impacts are outlined in Table 3.2.

Table 3.2: Criteria for Determining Sensitivity

Sensitivity Determination	Definition
Very High	Vulnerable receptor with little or no capacity to absorb proposed changes or minimal opportunities for mitigation.
High	Vulnerable receptor with little or no capacity to absorb proposed changes or limited opportunities for mitigation.
Medium	Vulnerable receptor with some capacity to absorb proposed changes or moderate opportunities for mitigation
Low / Negligible	Vulnerable receptor with good capacity to absorb proposed changes or/and good opportunities for mitigation

3.6.4 Assessment of Residual Impacts

97. The final step in the impact assessment process is determining the significance of the residual impacts, which essentially are the impacts which would be experienced even after implementing the mitigation/ compensatory measures. Ideally, all of the residual impacts should be of negligible to low significance. For any residual impacts having moderate significance, monitoring mechanism is necessary to ensure that their significance does not increase. No residual impacts having major or critical significance are generally acceptable.

3.7 Environmental Management Plan

98. An Environmental Management Plan (EMP) for the proposed project is prepared comprising the mitigation/ enhancement measures with institutional responsibilities, environmental monitoring plan, training and capacity building plan, and reporting and documentation protocols.

3.8 EIA Report Preparation

99. At the end of the process, the present report is prepared incorporating all findings of the EIA study.

4 Project Description

4.1 Background

100. Among the five components of Blue Gold Program, EIA investigation only entails to -- Component (ii) namely, water resources management which mainly deals with the fine tuning and some new rehabilitation of water management infrastructures in the selected polders. To enable the polder against emerging challenges of erosion and sedimentation, increased salinization of groundwater, and cyclone surges and climate change, innovative and effective solutions have been suggested in connection with increasing infrastructure sustainability and stability. Capacity building of the BWDB officers and other responsible persons to ensure participatory water resources development with the community as well with other stakeholders, high quality standards of design and implementation, introduction of innovative concepts and technical solutions are the salient features of the project.

4.2 Objective and Rationale

101. The objective of the component two of Blue Gold Program is to ensure participatory water resources management in the polders for sustainable water resources development. The specific objectives of the program are to:

- Ensure sustainability of the development of polders through effective community participation.
- Protect floods and use water resources effectively.
- Increase farmers' income and strengthen livelihood through improved productivity.
- Improve environment and nearly 100% coverage of drinking water and sanitation.

4.3 Polder Overview

102. Polder 22 was constructed in 1970-72, and later on was rehabilitated under the IPSWAM project from 2003 to 2011. The polder is located in the South-Western hydrological region of Bangladesh, with administrative jurisdiction lying within the Khulna O&M Division, BWDB, Khulna. The triangular shaped polder is surrounded by Bhadra River in its North, Badurgachhi and Habarkhali rivers in its East and West direction respectively. (Map 1.1)In the southern portion of the polder, the two rivers i.e. Badurgachhi and Habarkhali's confluence creates the Sibsa River, which directly meets the sea.

4.4 Present Status of Water Management Infrastructures

103. In Polder 22, there are some typical water management infrastructures in place i.e. peripheral embankments, drainage sluices, drainage outlets, flushing inlets and culverts. Based on field investigation carried out in May 2014, the study team has collected the following information regarding the existing infrastructure status.

Embankments

104. The Embankment is of 19.3 km length, with a top width of about 4 m, and crest level of around 4.5 m +PWD (Public Works Datum), above the Mean Sea Level (MSL). The side slopes are 1:2 in the Country Side (C/S) and 1:3 in the River Side (R/S), with a setback distance of 45-50m. The embankment plays a crucial role to the life and livelihood of the inhabitants inside the polder through providing protection against tidal and storm surges and salinity intrusion, facilitating the communication system as well. In dry season, the

embankment remains dry and various modes of transportations are found. The existing condition of the embankment is good, except some places where the riverside slope is not maintaining the standard. In addition, the setback distance is not uniform throughout the embankment length; there are some points along the polder (at Kalinagar, Naldanga, Darunmallik and Bigordana) which are often subject to river bank erosion. Considering these, the embankment needs re-sectioning works to mitigate the associated risks. The status of existing embankment is shown in Picture 4.1.

Picture 4.1: Existing Status of Embankments

(a) earthen surface along most of the peripheral embankment, (b) erosion point at Kalinagar with nominal setback distance)

Water Control Structures and Culverts

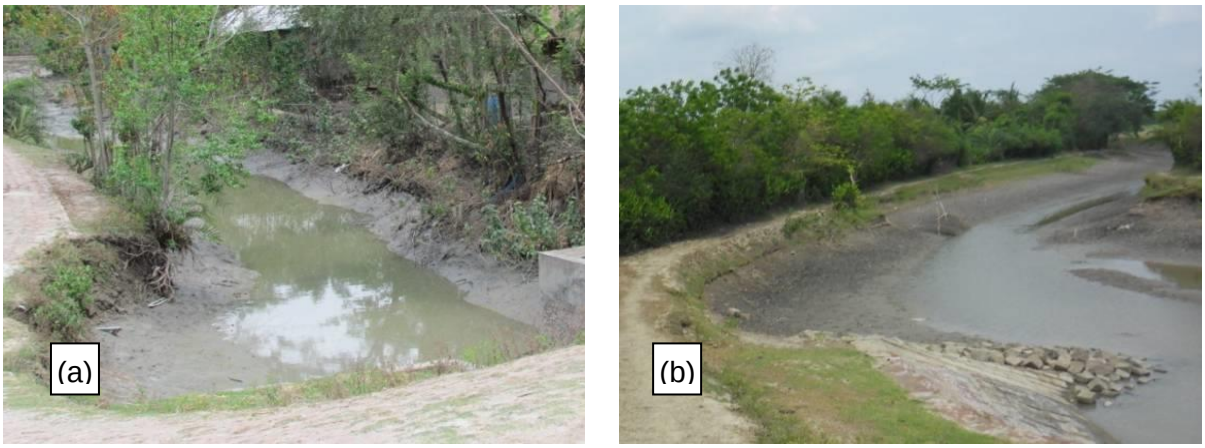
105. There are two culverts, seven drainage sluices and outlets, and twenty flushing inlets within the area. Most of the structures are not functioning upto the desired level. The drainage outlets cannot drain out water properly during heavy rainfall events, and especially during post monsoon. The sluice gates are not effective to protect the saline water to intrude even when the gates are closed as the gates are mis-fitted. Similar problems exist in the flushing inlets of the polders. Therefore, the water control structures need immediate repairing. Existing status of sluice gates are shown in Picture 4.2a & b

Picture 4.2: Existing Status of Sluice Gates

(a) Drainage Sluice at Durgapur needs replacement of gate (b) Non-functional Pipe Sluice at Telikhali needs replacement of pipe

4.5 Present Status of Drainage Channels

106. The length of the internal drainage channels is 22 km. Some of which have been silted up due to top soil erosion from adjacent land, coupled with the improper maintenance of the channels over the years (Picture 4.3). Siltation of drainage channels has triggered many other problems like: it impedes the local inhabitants to store rainwater for their irrigation use during dry season, and the domestic use as well. Some of the drainage channels should be re-excavated as such, for facilitating drainage and flushing events within the polder.



Picture 4.3: Narrow and Silted up drainage channels

[(a) Durgapur khal (b) Harinkhola khal]

4.6 Problems and Issues

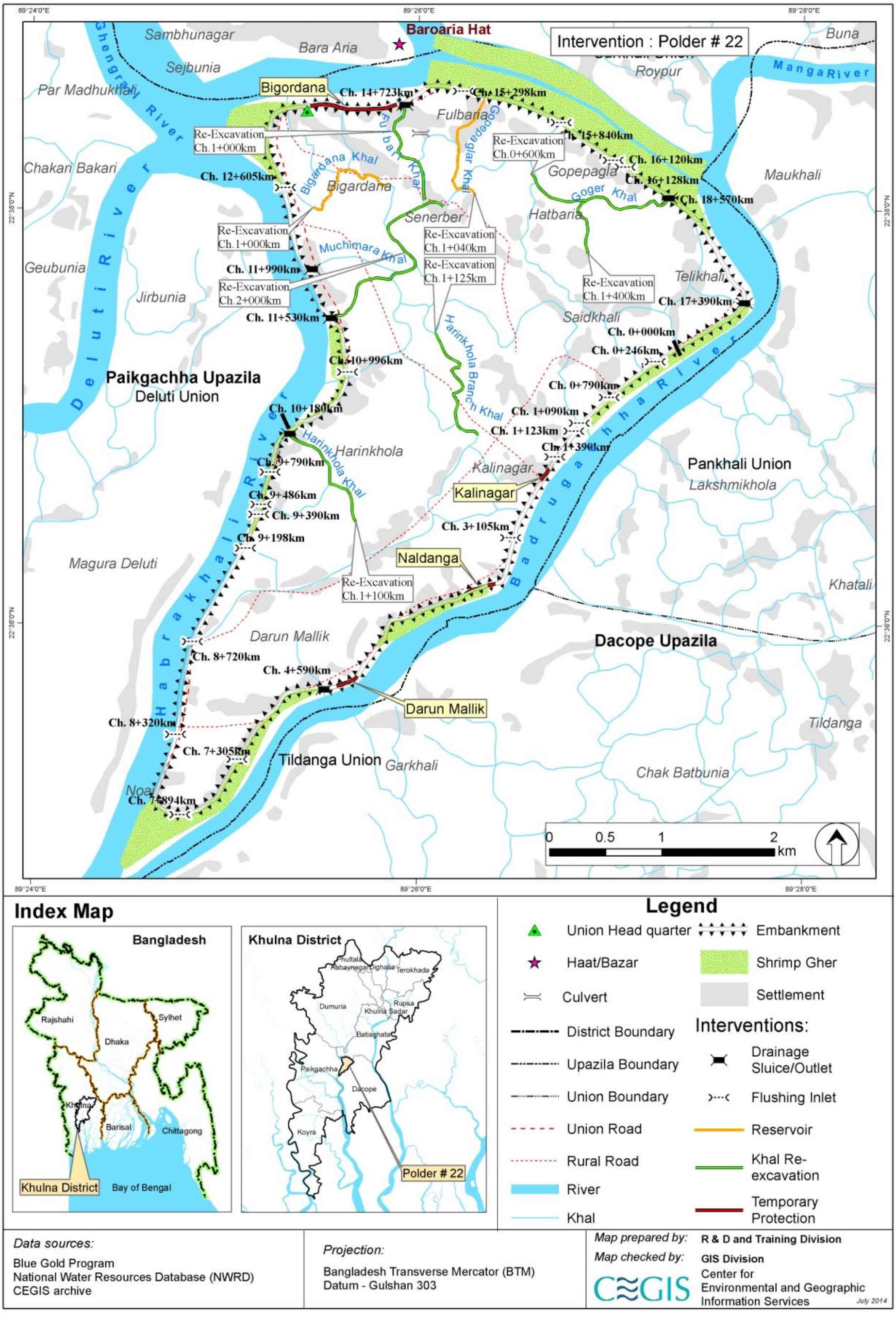
107. The polder as a whole carries immense potential for development. However, a number of internal problems and issues are hindering its development potential at the moment. The most severe problem within the area is the saline water intrusion, which has contaminated both the surface water as well as ground water system. Intrusion of saline water increases soil salinity that increase stress on vegetation. Non-functioning of water control structures like regulators, caused insufficient drainage and flashing capacity of the polder area that triggered vegetation damage. In addition, internal canal bed siltation and riverbank erosion are also threats and affect the livelihood of the local residents every year.

4.7 Proposed Interventions

108. Taking the status of existing infrastructures into account, as well as the problems resulting from their damaged state, the Blue Gold program has planned the following interventions in Polder 22. The locations of interventions have been shown in Map 4.1.

4.7.1 Re-sectioning of Embankment

109. Along the entire peripheral embankment, re-sectioning works would be carried out. The design crest width of the embankment is 4.27m, with varying side slopes at different chainages. The total length of the embankment is 19.275 km, and the design elevation of the crest of the embankment is roughly at 4.75 m +PWD (above Mean Sea Level). The cross sections of the proposed re-sectioned embankments at different chainages are provided in the Appendix 2.



Index Map

Legend

- Union Head quarter
- Haat/Bazar
- Culvert
- District Boundary
- Upazila Boundary
- Union Boundary
- Union Road
- Rural Road
- River
- Khal
- Embankment
- Shrimp Gher
- Settlement

Interventions:

- Drainage Sluice/Outlet
- Flushing Inlet
- Reservoir
- Khal Re-excavation
- Temporary Protection

Data sources:

Blue Gold Program
National Water Resources Database (NWRD)
CEGIS archive

Projection:

Bangladesh Transverse Mercator (BTM)
Datum - Gulshan 303

Map prepared by: R & D and Training Division
Map checked by: GIS Division
Center for Environmental and Geographic Information Services
July 2014

Map 4.1: Location of Proposed Interventions in Polder 22

4.7.2 Repairing of Water Control Structures and Culverts

110. A total number of four sluice gates will be repaired under the project. Amongst these, three are typical drainage sluices (at Durgapur, Telikhali, and Darunmallik) with lift gates in the country side, and flap gates in the river side. One pipe sluice at the mouth of Gopipagla canal is also proposed to be repaired. The gate at Durgapur would require replacement of gate and the pipe sluice at Gopipagla would require replacement of pipe. The other sluices would require some minor repairs for example, plastering, rail repairing, repairing of sill etc. The barrel pipes and the gates of all the four drainage outlets are damaged and will be replaced. Out of four irrigation inlets (600mm dia), one at Harinkhola has already been washed away and should be reconstructed while the remaining three irrigation inlets will be repaired. An existing culvert at Fulbari severely impedes the drainage flow, which will be reconstructed with a wider opening.

4.7.3 Temporary Protection

111. There are some erosion points at Kalinagar, Naldanga, Darunmallik and Bigordana where temporary protection works are proposed by the Water Management Association. From the major field investigation carried out by the study team in May 2014, the information collected regarding the proposed temporary bank protection works are given in Table 4.1.

Table 4.1: List of Vulnerable Erosion Points in Polder 22

Location	GPS Reading	River	Cause of Erosion	Remarks
Kalinagar	22º36’35.0” N: 89º26’22.5” E	Badurgachi River	Wave action	At present the embankment has been retired for a length of 300 ft at Kalinagar, the embankment just at its d/s is vulnerable to erosion
Naldanga	22º36’27.5” N 89º26’18.8” E	Badurgachi River	Wave action	Erosion relatively more severe compared to other points. Eroded upto 45 feet inwards in one year (in the past)
Darunmallik	22º35’43.9” N 89º25’21.0” E	Badurgachi River	Wave action	Erodes almost once in every three-four years, eroded around 25 feet inwards in 2009
Bigordana	22º38’22.7” N 89º25’16.2” E	Bhadra River	Wave action	Erodes about 10~12 feet per year

4.7.4 Khal Re-excavation

112. In order to enhance the drainage and flushing functions of the polder as a whole, 4 numbers of khals have been proposed and approved for re-excavation. Re-excavation length is 1.00 km along Fulbarikhal, 2.00 km along Muchimarakhal, 1.10 km along Harinkholakhal, and 1.40 km along Gogerkhal. In addition, another two khals namely Bigordanakhal and Gopipaglakhal will be converted into reservoir for rainwater storage and use of the same during dry season for irrigation and domestic use.The lengths of the reservoirs are 0.50 km and 1.04 km respectively. The design bed width, bed level, and design slopes vary with khals, as well as along the chainages of each khal. Some relevant long and cross sections of each khal under the re-excavation plan are shown in Appendix 2.

4.8 Construction Details

113. The details about construction schedule, man power and material requirement, requirements for labour shed and construction camps are given in following sections.

4.8.1 Description of Activities

Works on Embankment

114. After validating the final design, soil will be excavated or carried earth will be deposited in selected areas. The sloping and shaping of embankment will be developed after proper compaction in layers. Then required turfing with grass will be provided on the embankment. Watering and fertilizer will also be provided.

Works on Drainage Sluices and Outlets

115. Before starting the repairing activities of drainage sluices, ring bundh and diversion channel will have to be constructed. After construction of approach roads, fitting and fixing of gates and hoisting devices will be carried out. The intake and outfall of the gate will be constructed as per design.

Construction/ Repairing of Flushing Inlets

116. Alternative diversion channels will be constructed before starting of the construction works. Pipe and machine pipe along with construction allied and fittings and collar joints will be made as and where required. After completion of all activities, the approach embankments will be constructed and turfed with grass. Finally, a channel is to be excavated through lead cut and tail cut to divert the flow through the flushing gate.

Re-excavation of drainage channels

117. At first a schematic diagram showing centre line and layout plan will be prepared for the re-excavation work and the design depth and width of excavation are to be noted. The entire channel will then be divided into a number of segments. The excavation will be started from the upstream portion of the channel. Cross dams are to be provided at the starting and final locations of the reach and then soil from the channels will be excavated and removed upto achievement of the targeted depth and width. The excavated soil/ sludge would be disposed as per the Spoil Management Plan (SMP) prepared by the EIA study team (discussed in Chapter 10). Proper compaction would be made on khal banks, and after finalizing of excavation in one reach, the other reach at its downstream would be excavated following similar procedures as stated for the first reach. Accordingly, all the reaches of the khal will be re-excavated.

Temporary Bank Protection Works

118. Temporary bank protection works would be carried out by installing bamboo fencing and placing geo-bags at the vulnerable locations. A small launching apron will be prepared with the geo-bags in place and bamboo fencing would be provided along the toe of the embankment. To summarize, a list of activities under each phase is shown in Figure 4.1 below.

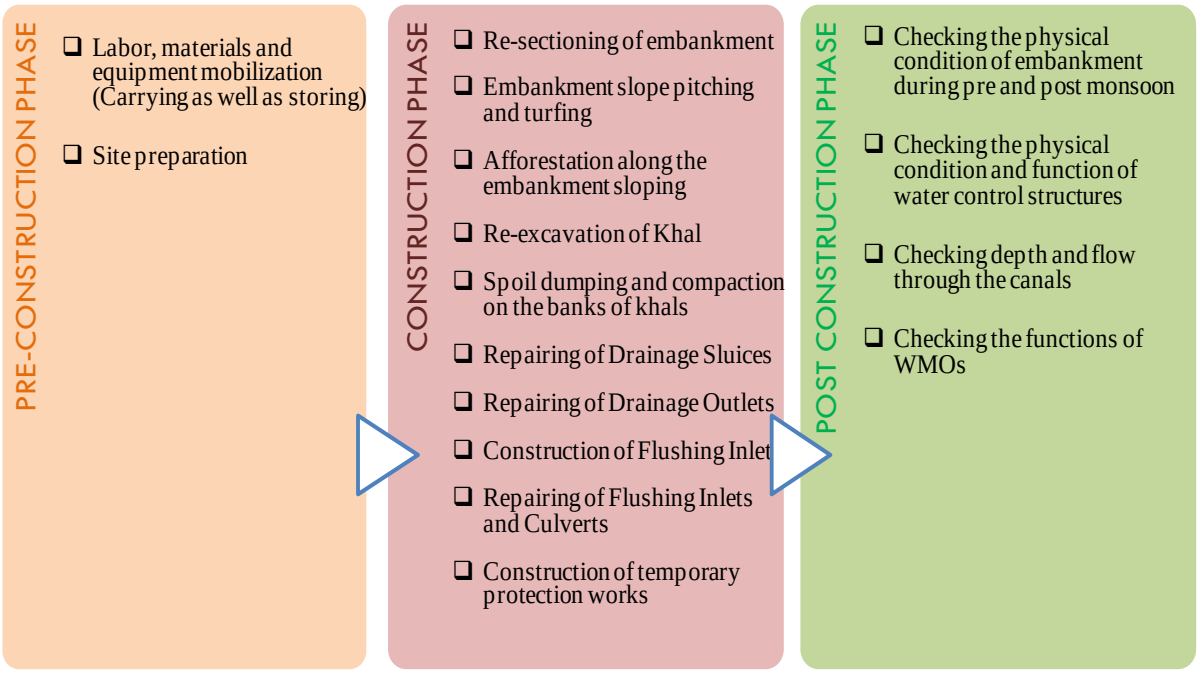


Figure 4.1: Phase-wise List of Activities in Polder 22

4.8.2 Construction Schedule

119. The construction works would be carried out during dry season, and will be kept at abeyance during wet season. Other supportive works would be carried out throughout the year. The interventions proposed in Polder 22 are likely to be completed by June 2015. The activity schedules of proposed interventions are given in Table 4.2

Table 4.2: Construction Schedule in Polder 22

Key Activities	2013				2014				2015			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Screening, hiring and orientation of Community Organizers (COs)												
Community mobilization for Water Management Planning (Fine tuning works)												
In-depth information dissemination/ campaigns on Blue Gold Goals, Objectives, Components and Initial discussions with WMGs												
Assessment of WMO Functionality												
Strengthening/ capacity building of WMO based on outcome of Assessment												

Key Activities	2013				2014				2015			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Community Mobilization for Village Development Plan (VDP) and Polder Development Plan (PDP) Firm-up water management development options Firm-up Sustainable Environmental Management Plan (SEMP)					▬	▬	▬	▬				
Implementation of Water Management fine tuning works with active participation of the WMGs/ WMA through the Quality Control/ Block Committee					▬	▬	▬	▬	▬	▬		

Source: Inception Report 2013, Blue Gold Program and CEGIS field investigations 2014.

4.8.3 Materials Requirement

120. The construction materials required for re-sectioning and retired embankment, water regulatory sluices and flushing inlets, and bank protection work will include soil, cement, steel, and sand. Estimated quantities of these materials are presented in Table 4.3.

Table 4.3: Construction Materials Requirement in Polder 22

Sl	Description	Quantity	Sources
Re-sectioning of embankment			
1	Materials for Earthwork	1,04,000 m3	From the set-bag location and other khas lands as well as materials dug out from river bed
2	Shovel, Hoe and Basket	200 nos. each	To be procured
3	Compactor	30 nos.	To be procured
Repairing of sluices and flushing inlets			
4	Lift Gate	1 (1.5 m x 1.8 m)	To be procured
5	Flap Gate	1 (1.5 m x 1.8 m)	To be procured
6	Pipe	1 (dia: 0.600 m)	To be procured
7	Materials for Plastering, Railing and other repairing works	N/A	To be procured
Temporary Bank Protection			
8	Bamboo	400 nos.	To be procured
9	Geo-bags	50 nos.	To be procured
10	Other materials	N/A	N/A
Khal Re-excavation			
11	Hoe and basket	50 nos. each	To be procured
12	Compactor	20 nos.	To be procured
13	Earth Material (for temporary cross dam)	50 m3 for each Khal	River bed

Source: Blue Gold Program 2014 and CEGIS Estimations 2014

4.8.4 Manpower Requirement

121. Both technical and non-technical manpower will be required for the construction works. This will include engineers, technicians, supervisors, surveyors, mechanics, foremen, machine operators, drivers, skill and un-skilled labors. The implementation of the project would be carried out by both LCS (Labor Contracting Society) and contractors, on 50-50 basis. The LCS would entail 60% male and 40% female, and all of them would be engaged from the local area.

4.8.5 Construction Camps and Labour Shed

122. The office of WMA of Polder 22 is located in Bigordana. The project works will be carried out by the local people, and therefore no labor shed would be required. The WMA will monitor the progress of the project.

4.9 Project Management and Implementation

123. The project will be implemented in a participatory manner, ensuring local community based participation at all stages of the project. The issues considered for implementation of the project, the responsibilities of different stakeholders and actors, and the status of WMOs/ CBOs functioning within Polder 22 are discussed in the following sections.

4.9.1 Implementation Considerations

124. Coordination, management and supervision of actions and contributions of different actors and stakeholders require strong and coherent management structure. For the rehabilitation works and other infrastructural works by BWDB, a separate administrative arrangement will be signed. The Technical Assistance team (TA-consultants) will provide technical support during the design and other preparations, whenever needed. A certain percentage of works to be carried out by BWDB will be fixed for the overhead (office and other costs). Separate DPPs will be prepared then, for the activities to be implemented under Blue Gold Program.

125. The main objective of TA-consultant is to create community participation through creating cooperatives which will be in the drivers' seat for economic development. Furthermore, they will facilitate creation of enabling environment, supportive towards these cooperatives and the overall sustainable development; thereby realizing increased rural income and poverty alleviation. All interventions/ contributions by actors and stakeholders will be planned and coordinated by the TA-consultants, and the interventions concerned with the Government institutions will be done in close coordination with the concerned Government Departments and Local Government Institutions (LGIs). If and where needed, on-the-job training will be provided to the Government staff as to further reinforce their capacity.

126. The Water Management component of Polder 22 will be integrated through BWDB, as the BWDB staff will be directly responsible for the overall implementation process: from planning to approval of the works to be completed and O&M of the main infrastructures. Technical assistance will be mainly deployed in fields where BWDBs capabilities are not sufficiently developed.

127. District Commissioners (DC), and the elected Chairpersons of the Upazilas and Unions will regularly be informed about the progress. For implementation, TA-consultant will call upon the Union chairman/ councilor to actively participate during the mobilization phase of the cooperatives. Table 4.5 shows the list of major actors and stakeholders, as well as their responsibilities to be involved in implementation of the Blue Gold program of Polder 22.

Table 4.4: Major Actors and Stakeholders for Project Implementation of Polder 22

Type	Organization/ Agency	Roles and Responsibilities
Donor Agency	EKN	✓ Program approval, monitoring and supervision. ✓ Initiation/approval of innovations.
National Agencies	Planning Commission/ Economic Relations Division (ERD)	✓ Program approval, monitoring and supervision
	Inter-Ministerial Steering Committee	✓ Coordination of contributions of involved GoB agencies at national level.
	BWDB	✓ Overall management, implementation of component (ii) in Polder 22.
	Min of LGRD and Cooperatives; LGED	✓ Registration of WMO under Cooperative Law and training and supervision of annual audits. ✓ Coordination of Construction and maintenance work
	National Agricultural Research System	✓ Obtaining information on potentially relevant agricultural production practices for on farm trials.
	WMIP/ SWAIWRPMP/ CDSP/ CEIP	✓ Exchange of experiences and harmonization of approaches
LGIs	DDCC	✓ Coordination of BG interventions with District level development agencies. Participation of BG representatives in coordination meetings
	UDCC	✓ Coordination of BG interventions with Upazila level development agencies.
	Union Parishad	✓ Coordination of interventions. Participation of BG ✓ representatives in coordination meetings

128. The project has also perceived research contributions from different organizations namely Institute of Water Modelling (IWM), CEGIS, IFI, Technical UN Agencies, Bangladesh University of Engineering and Technology (BUET), Bangladesh Agriculture University (BAU), International Rice Research Institute (IRRI), CGIAR, Bangladesh National Committee of ICID (BANCID), Delft Hydraulics, and Dutch private enterprises.

4.9.2 Community Participation through WMO/ CBO

129. BWDB managers and field staffs in Divisions, Sub-Divisions and Section offices might not have adequate expertise and experienced manpower to carry out the O&M of coastal polders properly. The numbers of field staffs are also insufficient and inadequate in some places with respect to the actual requirement. In such case it is needed to ensure sustainable operation of the project through participation of Water Management Organization (WMO) and Community Based Organizations (CBOs). Therefore, a three tier organizational structure comprising of Water Management Groups (WMG) at the lowest level, Water Management Associations (WMA) at the mid-tier and Water Management Federation (WMF) at the apex would be in place. These groups, associations and federations in a particular sub-project is together termed as the Water Management Organizations (WMOs) which has been considered in this project. Polder 22 comprises of 14 WMGs and 1 WMA, under Blue Gold Program.

130. WMOs would play vital roles in maintenance activities. While engaging any of the functional groups of these WMOs in this polder, care should be taken to improve methodologies slightly in some of the aspects as per local situation and project provisions so that it really fits in. Under this project, WMOs are conceived to have been included in the Water Management Groups (WMGs) as Functional Groups (FGs). The FGs have the scope of working in the O&M activities of the polder under the purview of WMG. The Following CBOs have been recommended for this polder under Blue Gold Program.

Water Management Committee (WMC)

131. For operation of water control structures i.e. flushing inlets, drainage outlets and drainage sluices a separate group would be acting locally, termed as WMCs. The responsibilities of maintaining water control structures at their best condition are to be laid down to the WMCs. Each WMC would comprise of 5 to 11 members, depending on the significance of the intervention.

Labor Contracting Society (LCS)

132. LCSs are the groups selected from landless people consisting of approximately 60 members or more per group. They are responsible to carryout earthworks in a single contract. During formation of CBOs women participation in all groups will have to be ensured.

4.10 Operation and Maintenance Plan

133. Since construction, Polder 22 has been playing a vital role in safeguarding the polder area. As it was observed, some of the structures within the area are not adequate to cater to the diversified needs of local people. Changes in land use pattern also created social disputes in some places as such newer dimensions for the existing structures were proposed, to allow flows of water both ways. Therefore, maintenance of the polder system with embankments and structural elements built and rehabilitated over there has become a permanent and important task. In this regard, 'Guidelines for O&M Planning and Budgeting, August 2001; CERP-II' has been studied and an O&M plan for the Blue Gold Program in Polder 22 has been proposed.

4.10.1 Operational Plan

134. Operational plan involves setting out the schedule of activities related to operation of gates of structures by the users' organization to control water levels best suited to water management and agricultural needs. The activities recommended for the operation plan of Polder 22 are narrated below:

Regulation of Gates

135. During pre-monsoon period (March to May), the gates of each sluice should be kept closed for retention of water for irrigation and other use. During monsoon (July to September), the vertical lift gates should normally be kept closed, but may be opened to drain out excess water from the polder as and when required. In addition, the gates should kept open in June, which is considered as the starting period for fish breeding and migration. During post monsoon season (October to November), the gates need to be operated properly so as to retain water in drainage channels without overtopping channel banks. Moreover, consultations must be made with the beneficiaries of all occupational sectors i.e. farmer, fisher etc. Operation of outlets and inlets should also undergo similar practices with maximum involvements of different beneficiaries' organizations. The O&M section of BWDB

and WMOs and will assist local stakeholders in effective management of water inside the polders.

Frequent Monitoring of Embankments and Structures

136. This is a typical monitoring activity, to be carried out by the BWDB O&M staff. It is intended mainly to detect weak sections, gullies, slips at abutments, damage of protective works, wing walls, periodic damage of flap gates, fall boards, cuts in the embankments to accommodate homesteads, embankment subsidence and erosion, and settlement of protective works. The functional WMOs in the polders will assist in the problem detection process.

Supervision of Preventive Maintenance Works

137. Preventive maintenance works are done by community-based functional groups (e.g. LCSs) as and when required round the year. The works are usually the most simple, cheap and cost effective maintenance works, and are implemented more or less continuously. The field staffs of O&M section of BWDB supervise all preventive maintenance works. During the cropping seasons, monthly, weekly or even daily operational adjustments may be required. Routine monitoring of water management situation and hydrological conditions will supply data which will dictate the needs for adjusting the operational measures. Participation of beneficiaries in the farming and fishing community is essential in establishing the seasonal or long term water management plan. The daily operation of hydraulic structures should be shifted to the WMCs if they have adequate training and management capabilities.

4.10.2 Maintenance Plan

138. Maintenance of embankments and structures is necessary because it helps in keeping the infrastructure in good and functional condition so as to minimize investments, and prevent high rehabilitation costs. Since this is included in the day to day tasks schedule and needs continuous efforts, maintenance of coastal polders put emphasis on simple and cost effective community based interventions., The works which will directly serve water management should be regularly maintained under the ‘component II’ of Blue Gold program in Polder 22.

Preventive or Routine Maintenance

139. The preventive maintenance works can be implemented through community-based functional groups such as LCSs. The works may include;

- All activities related to vegetative covers on embankment i.e. new (or re-) planting; enrichment planting; and maintenance of vegetation and small earthworks on the embankment by LCSs.
- Cleaning, greasing, and painting of structures by LCSs;
- Cleaning of khals and outfall drains

Periodic Maintenance

140. Periodic maintenance works are also to be implemented by LCSs, which are to be identified during the field assessment at regular intervals. The works can further be classified as minor and major requirements.

a. Minor Periodic Maintenance Works

- Minor earth works on the embankments by LCSs, i.e., shaping and minor fillings including repair of access ramps;
- Minor repair of protective works by LCSs i.e re-positioning of the displaced blocks;
- Minor repair of structures by LCSs i.e. small patching of brick works, replacing of rubber sills; and
- Re-excavation of Khals and removal of earthen cross dams by LCSs and

b. Major Periodic Maintenance Works

- Major earth works by LCSs i.e. re-sectioning of embankments including turfing;
- Major repair of structures by LCBs i.e. repair or replacement of metal works / hinges, lifting mechanisms, gates, block works, head / wing walls;
- Re-excavation of Khals) by LCSs

Emergency Maintenance

141. Emergency works cover unforeseen interventions that may require immediate actions to protect the polder as a whole or a part thereof from the adverse effects of flooding or uncontrolled saline intrusion associated with damage of lives and properties. This type of work requiring immediate attention includes the closure of an embankment breach, the repair and replacement of flap gates, or construction of cross dams over canals if structure fails.

4.11 Expected Benefits

142. The foreseeable benefits which are likely to occur due to the implementation of Blue Gold program in Polder 22 are listed in Table 4.5 below:

Table 4.5: Expected Benefits and Outcome of Proposed Interventions

Interventions	Benefits
Re-sectioning of Embankment	Protection of saline water intrusion. Increased side slopes will enhance the stability of the embankment. Communication facilities may improve.
Repairing of Water control structures	Sluices will function properly; agricultural activities during dry and pre-monsoon seasons may be improved. Drainage situation would improve; salt water intrusion may be prevented.
Temporary bank protection	Temporary protection of river bank erosion. Schools, offices and other infrastructures may be secured.
Khal re-excavation	Potential rainwater storage may be possible Better irrigation during dry and pre-monsoon seasons Better navigation as well as drainage
Outcome of the Project	Apart from the aforementioned foreseeable benefits, the project may create some socio-economic developments i.e. employment generation, reduction of poverty etc. As a result, the local economy in the area may further improve.

4.11.1 No Objection Certificate

143. There is no archaeological site or any cultural heritage in the polder area which might affect the normal activities of the polder after rehabilitation. There will be no problem of land acquisition or displacement of people since rehabilitation will be made on existing infrastructures. No Objection Certificates (NOCs) from the union chairmen have been obtained and are attached in Appendix 3.

5 Environmental Baseline

5.1 Physical Environment

5.1.1 Meteorology

144. The following sections provide analyses on meteorological information (temperature, rainfall, humidity, evaporation) of the polder area.

Rainfall

145. The average monthly rainfall variation at Khulna (from 1978 to 2008) has been shown in Figure 5.1. The hyetograph shows that the highest and lowest values of rainfall are usually observed during the months of July (343 mm) and December (7 mm) respectively.

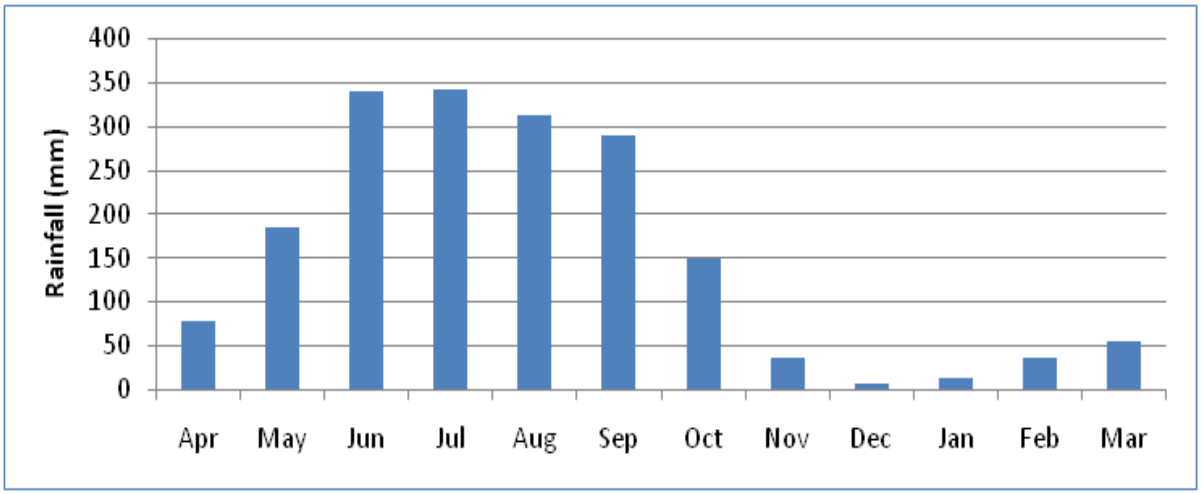


Figure 5.1: Average Monthly Rainfall at Khulna BMD

146. In order to take account of the spatial variation of rainfall, Theissen's Polygons have been delineated (shown in Map 5.1) using the rainfall data for 1978 to 2008 of Paikgachha and Chalna BWDB station (Subramanya, 1994). The polder comprises 30% and 70% areas of polygons of Paikgachha and Chalna respectively. The area-weighted average values of monthly rainfall in Polder 22 have been plotted in Figure 5.2 and the peak rainfall is observed as 503 mm in June, which is around 1.5 times higher than the same observed in Figure 5.2.

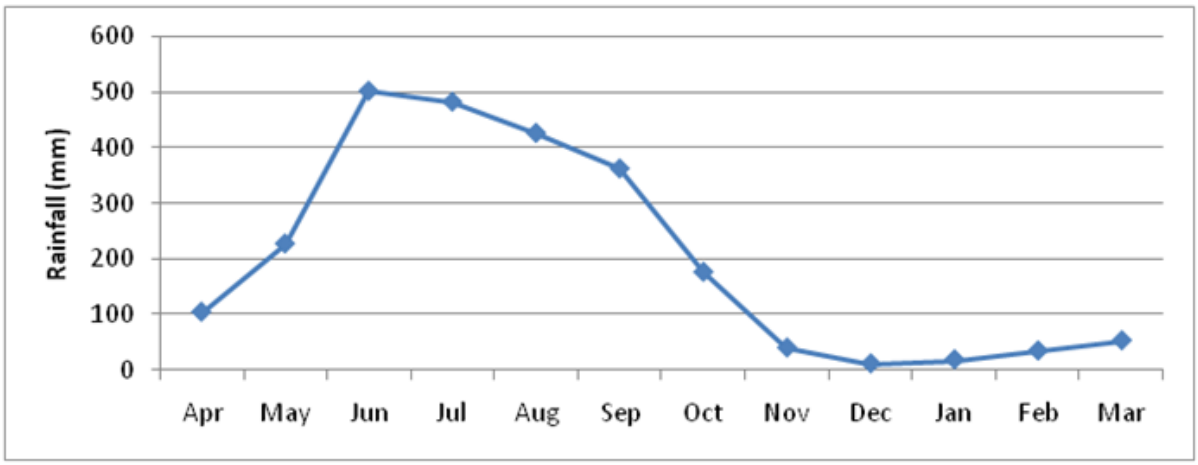


Figure 5.2: Average monthly rainfall in Polder 22 (using Theissen Polygon method)

Temperature

147. Mean maximum temperature stays between 19.3°C to 30.4°C over the year with the highest temperature experienced in the month of May. There is also significant fluctuation in minimum temperature, which varies between 15.37°C to 25.2°C. The lowest temperature is experienced in the month of January. The results of monthly average, maximum and minimum temperature variations of the polder are shown in Figure 5.3

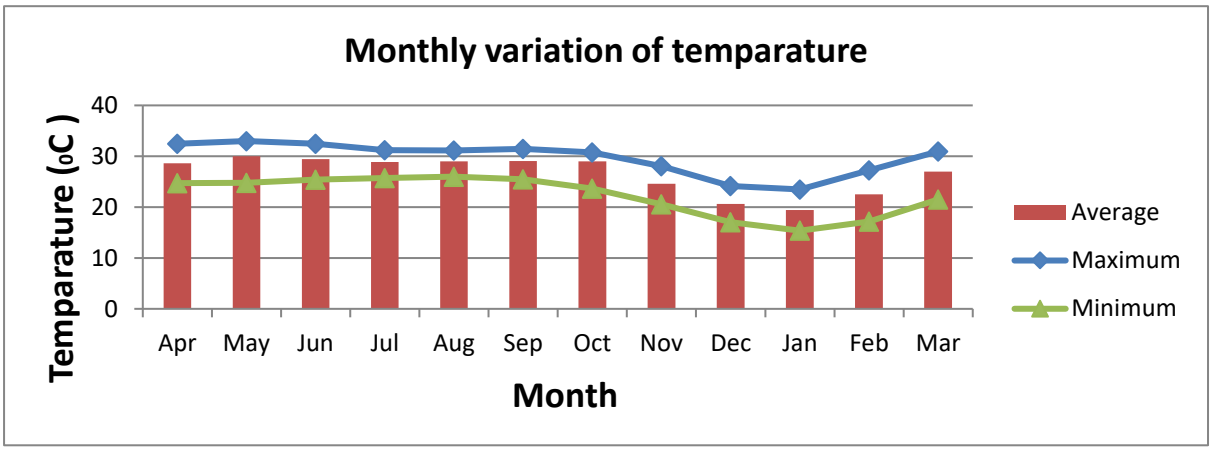
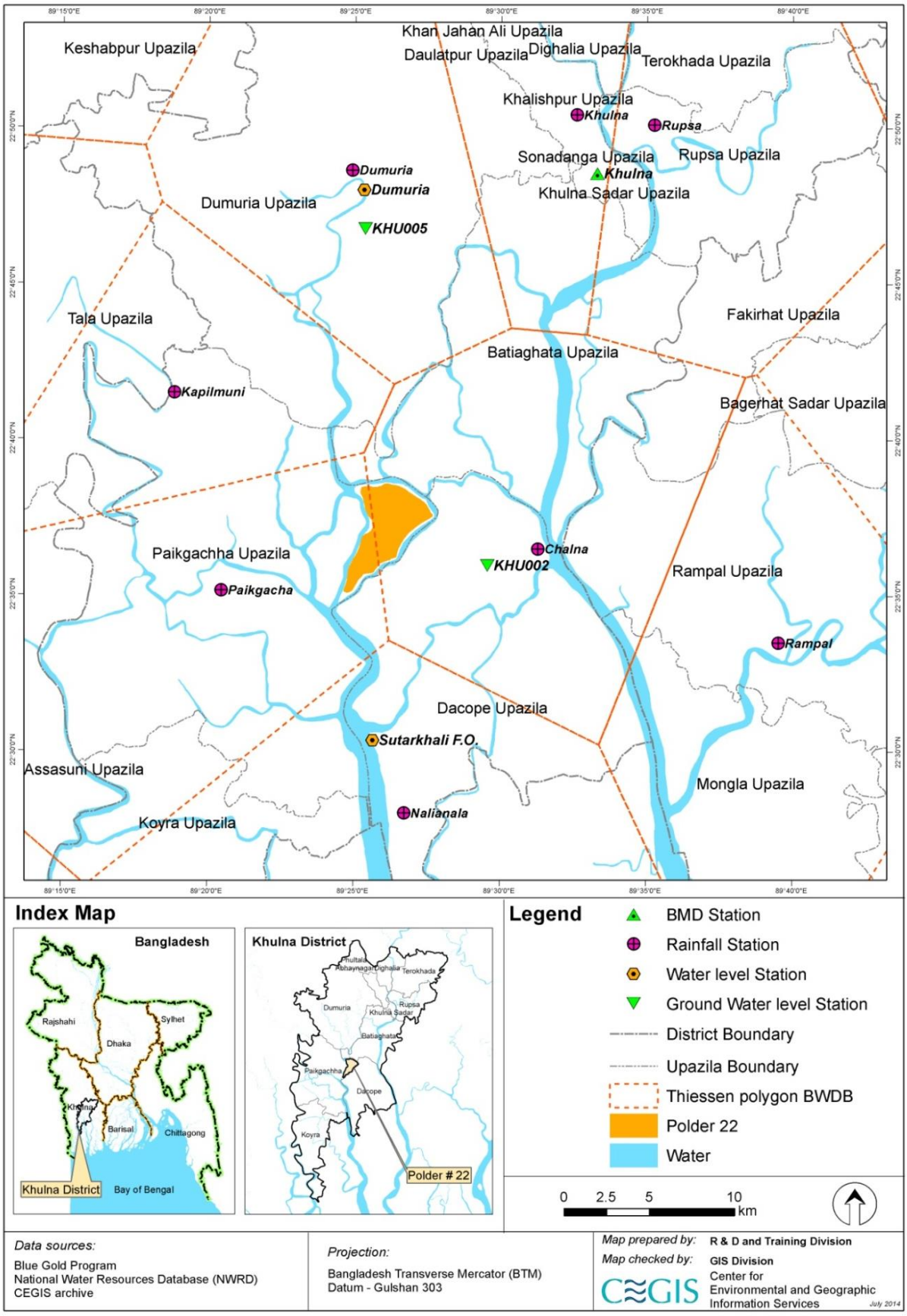


Figure 5.3: Average of Maximum and Minimum Temperatures at Khulna BMD Station



Map 5.1: Map showing Theissen Polygon of BWDB Rainfall, Water Level and Ground Water Stations

Relative Humidity

148. Figure 5.4 shows the variation of monthly relative humidity, as recorded by the Khulna BMD station (1978-2011). A significant fluctuation has been observed as relative humidity values start to increase from April (start of summer) due to the increase in atmospheric water vapors coupled with temperature rise. Relative humidity rises above 85% in monsoon (June to September), and starts decreasing from post monsoon season following the monsoon rainfall.

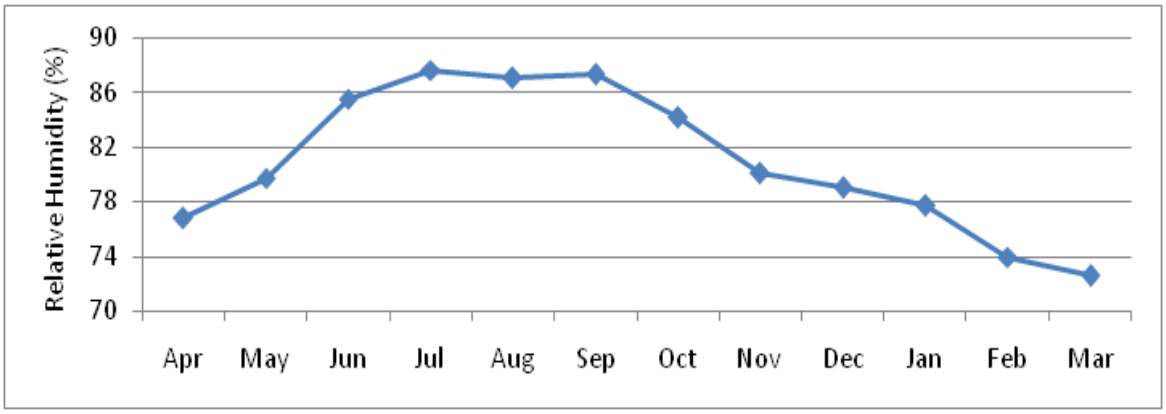


Figure 5.4: Average Relative Humidity at Khulna BMD Station

Evapotranspiration

149. The monthly variations of evaporation, actual ET and reference ET in given in Figure 5.5 provide. Maximum evapotranspiration has been observed during monsoon (June to September) and except dry season all the other months experience significant evapotranspiration. ET is actually an indicator that defines crop and plant health, and observed results in Polder 22 therefore implies for better plant health (especially in Kharif-I and Kharif-II seasons).

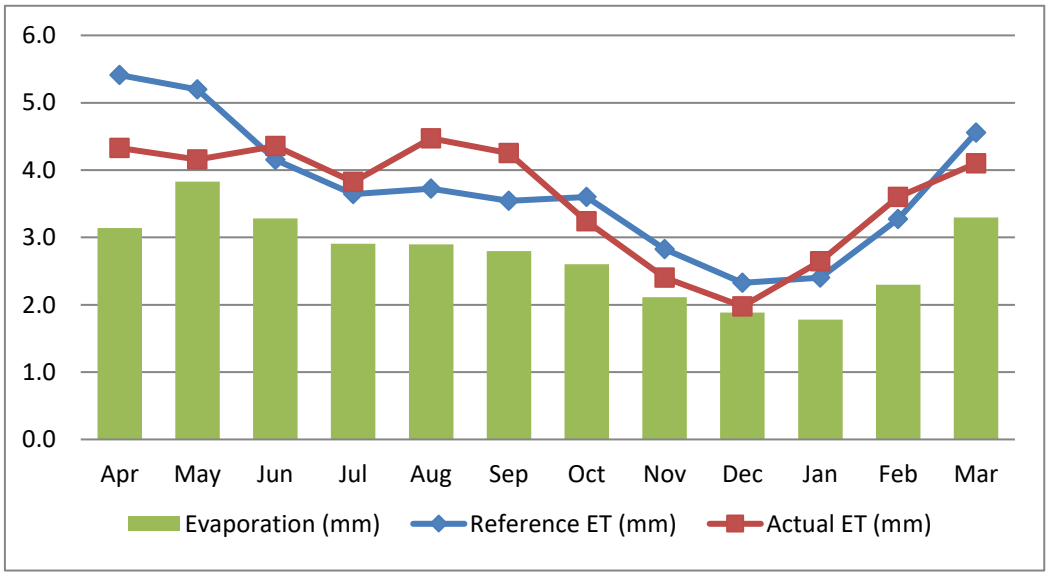


Figure 5.5: Monthly Variation of Evaporation, Reference ET and Actual ET for Khulna BMD Station

Wind Speed

150. Distribution of average monthly wind speeds, at Khulna BMD station (from 1978 to 2012) is shown in Figure 5.6. From the figure it is observed that, wind speed is at the highest in April (around 160 kph) and the lowest in November (around 40 kph). During cyclone Sidr

(2007) and Aila (2009), 1 minute sustained wind speeds were recorded as 260 kph and 120 kph respectively and the former one created devastating impacts due to the high wind speed.

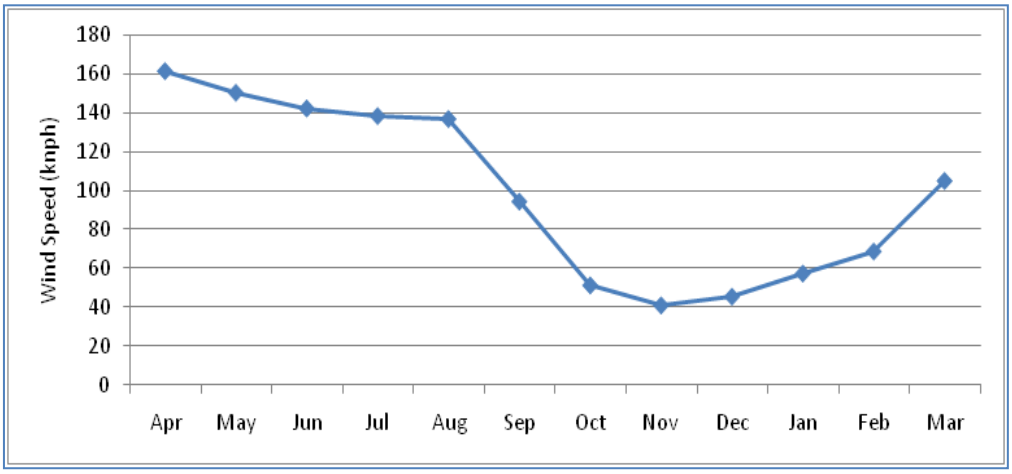
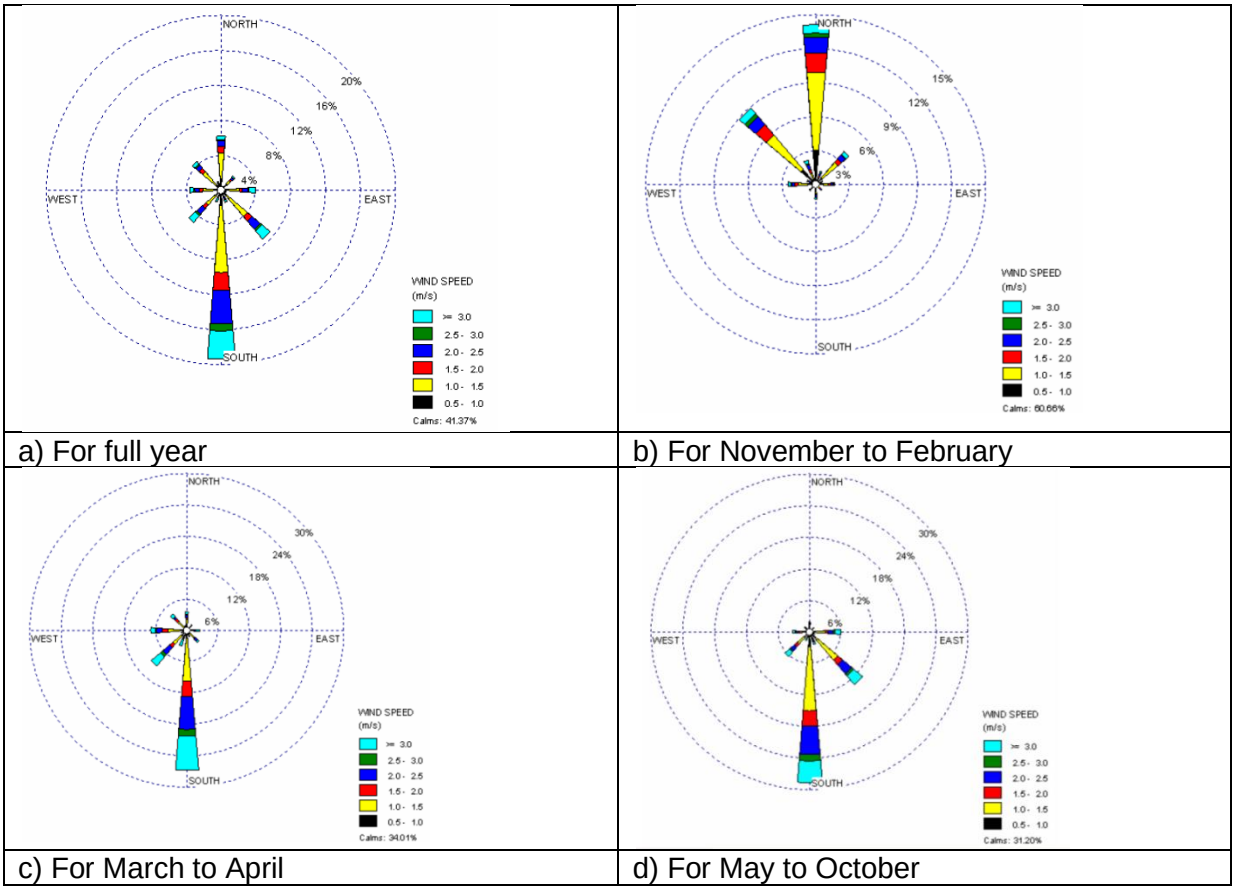


Figure 5.6: Variation of Average Wind Speed at Khulna BMD Station

151. As per Bangladesh National Building Code, the basic wind speeds for Khulna is 238 kph (BNBC, 1993). The wind roses were generated using observed data of 2006 showing average wind direction and speed for different periods of a year. The yearly average wind rose shows that the prevailing wind flows from south to north during most periods of the year (Figure 5.7a). During November to February, maximum prevailing wind flows from north and north-west to south and southwest direction and for the rest of the period it flows from south (Figure 5.7 b). During March to April, wind mostly flows from south and southwest to north and northeast (Figure 5.7 c), and for May to October it flows from south and southeast to north and northwest direction (Figure 5.7 d).



a) For full year

b) For November to February

c) For March to April

d) For May to October

Figure 5.7: Wind Rose for Khulna Station

Sunshine Hour

152. The average sunshine hour data for 1990-2010 has been collected analyzed and shown in Figure 5.8. Figure shows that from October to May, daily average sunshine hours are higher than 7 hours, but due to increased extent of cloud cover in monsoon (June to September) the values drop below 5 hours.

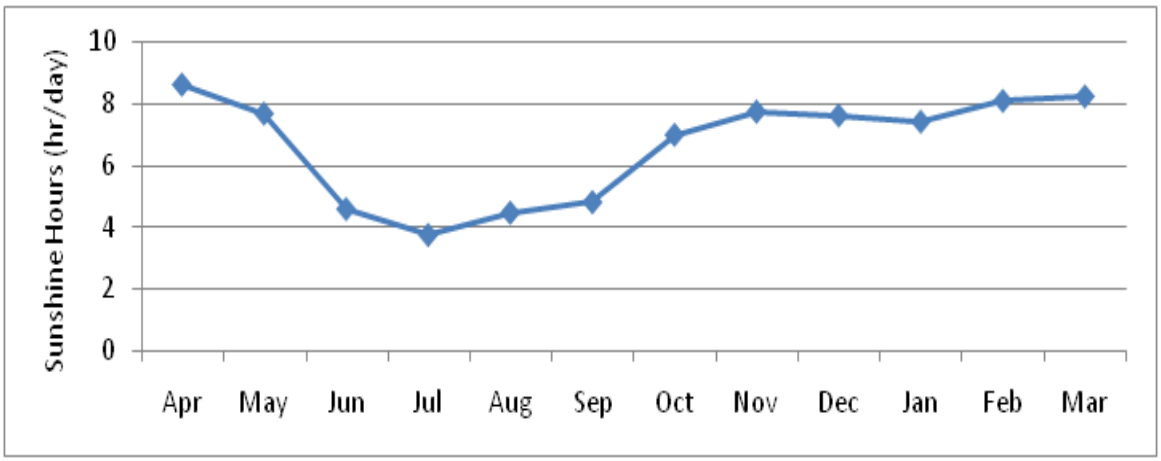
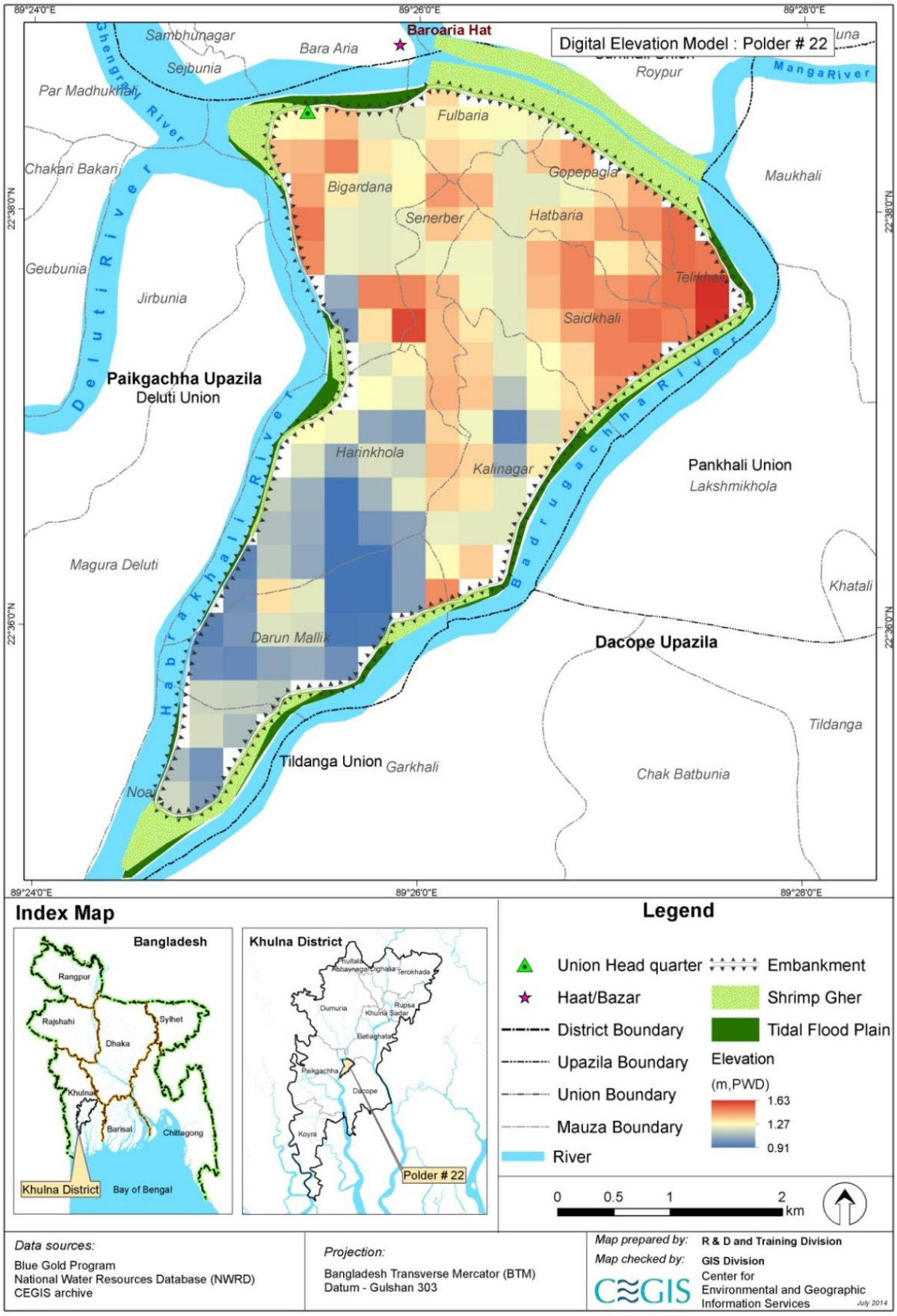


Figure 5.8: Monthly Variation of Average Sunshine Hours at Khulna BMD Station

5.1.2 Topography

153. The study area falls in the southern hydrological zone of the country, with very low average elevations. From the Digital Elevation Model (DEM), produced by CEGIS in 1997 (Map 5.2) it is found that 30% land of the areas have elevation between 0.91 to 1.21m +PWD and about 50% of the study area has elevation between 1.21 to 1.41 m +PWD and remaining18% of the total area has elevations in between 1.41 ~ 1.63 m+ PWD. The northern portion is relatively high with average RLs of around 1.31 m +PWD whereas the southern portion is relatively low with RLs of approximately 1.06 m +PWD. This indicates a mildly downgraded slope towards the south which eventually draws water from the up-stream basins to the Sibsa River through the peripheral rivers (Bhadra, Badurgacha and Habarkhali).

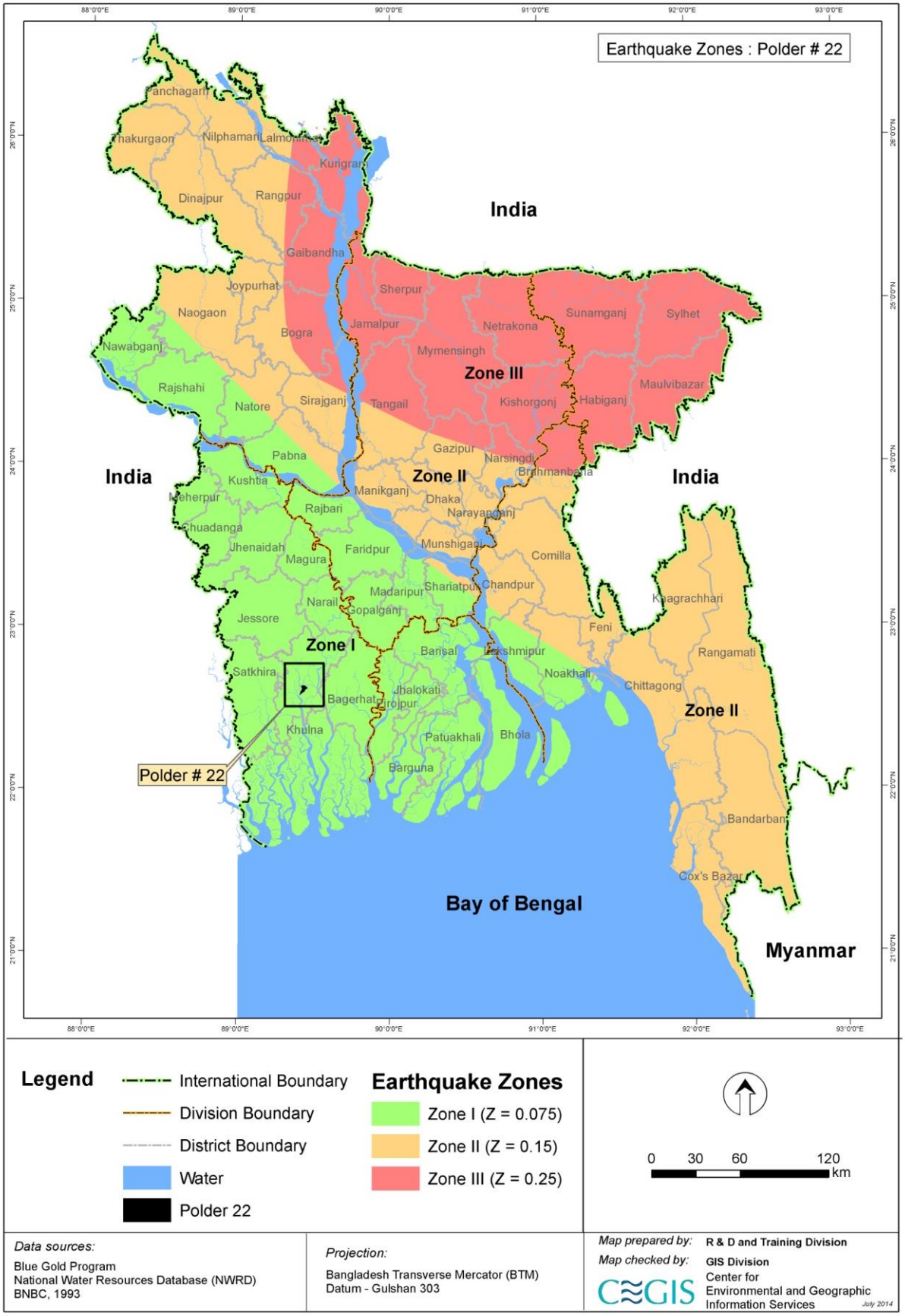
154. DEM analysis also infers that the RLs inside the polder vary from 0.91 to 1.63 m PWD (from Mean Sea Level), with average RL of around 1.27 m +PWD. The high tidal water levels observed in Bhadra (Dumuria station) and Sibsa (Sutarkhali F.O. station) rivers, and higher than the lowest tidal water levels for the same. The water levels at Bhadra and Sibsa rivers have been discussed in Article 5.4.3.



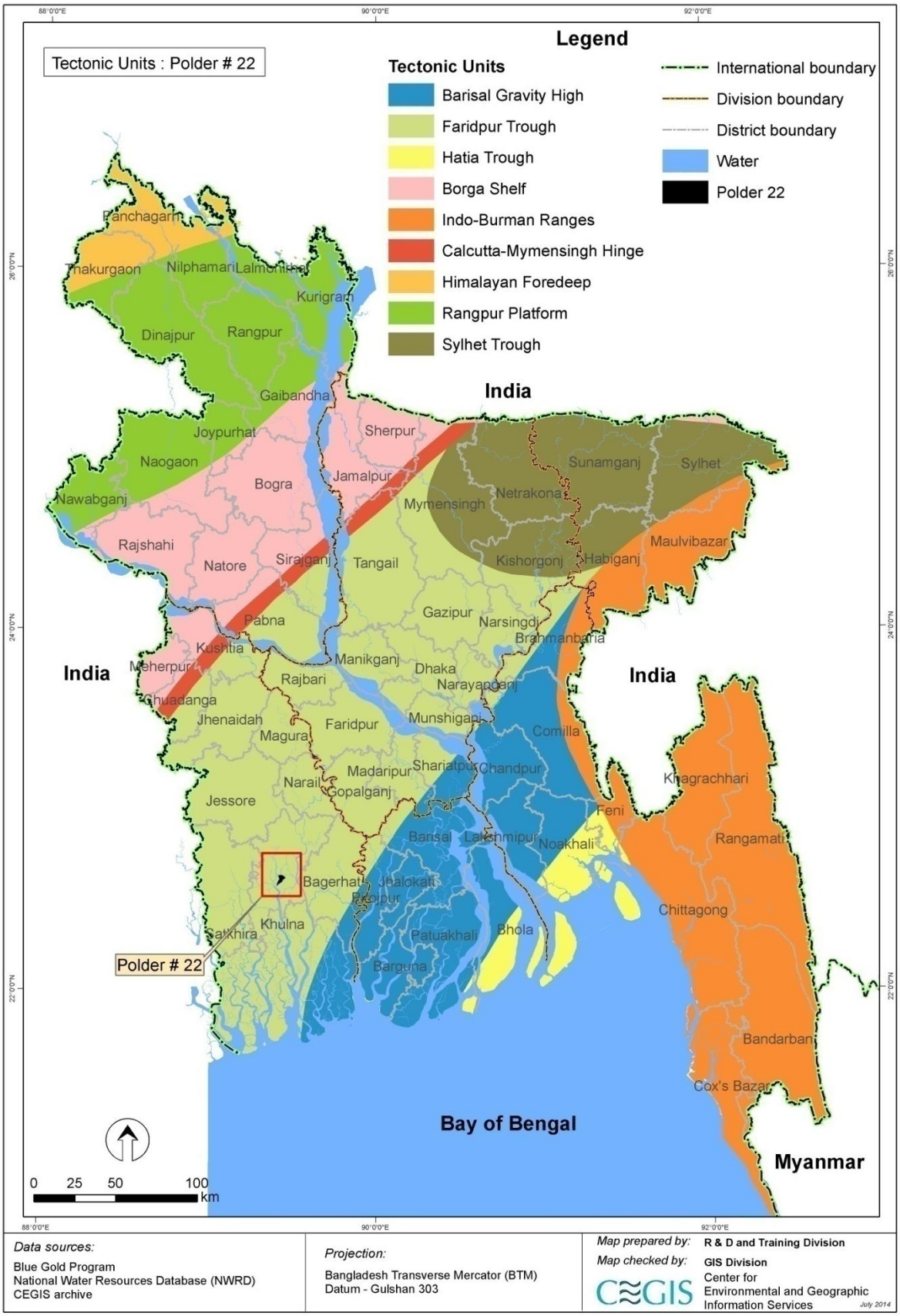
Map 5.2: Digital Elevation Model (DEM) and Flow Direction around Polder 22

5.1.3 Seismicity

Geological Survey of Bangladesh (GSB) has prepared a seismic zoning map of Bangladesh in 1979 dividing the country into three seismic zones: Zone-I, Zone-II, and Zone-III (Map 5.3). Later, a new updated seismic zoning map and detailed seismic design provisions have been incorporated in Bangladesh National Building Code (BNBC), 1993 (www.ddm.gov.bd). Polder 22 falls under Zone-III which is considered as a seismically quiet and tectonically stable zone with a seismic zone coefficient of 0.075. Map 5.1 shows the seismic location of Polder 22. A tectonic map showing location of the Polder 22 is given in Map 5.4.



Map 5.3: Earthquake Zones of Bangladesh and Location of Polder 22



Map 5.4: Tectonic Units of Bangladesh and Location of Polder 22

5.1.4 Agro-ecological Regions

155. Thirty agro-ecological zones and 88 sub-regions have been identified by adding successive layers of information on the physical environment which are relevant for land use and assessing agricultural potential. These layers are (i) Physiography (land forms and parent materials), (ii) Soils and their characteristics, (iii) Depth and duration of seasonal inundation, (iv) Length of the rainfed kharif and rabi growing seasons, (v) Length of the pre-kharif season of unreliable rainfall, (vi) Length of the cool winter period and frequency of occurrence of extremely low (below 15^0C) winter temperature and (vii) Frequency of occurrence of extremely high (>40^0C) summer temperature (FAO,1988). The soil fertility status of these regions varies considerably mainly due to variation in soil texture and organic matter content of the soil. Individual farmers have fragmented the land into small plots causing wide variation in the management of each and every piece of land. The polder area falls in one agro-ecological zone (AEZ) namely Ganges Tidal Flood Plain (AEZ-13).

Ganges Tidal Floodplain (AEZ-13)

156. The Ganges Tidal Floodplain has low relief compared to the Ganges River Floodplain. The area is criss-crossed by innumerable tidal rivers and creeks whose banks generally stand less than a meter above the adjoining basins. The whole of this zone lies in the south west area of the country and exposed to the cyclonic hazard.

157. Under natural conditions, this area is flooded at high tide, either throughout the year or during rainy season when rivers entering from the north bring in increased flows. The surrounding embankments have cut off the tidal flooding from the rivers, but basin sites are flooded by rain water which accumulates in the monsoon season. The rivers in the western part of the zone, are saline throughout the year. In the east, they carry fresh water to the coast during rainy season, and only become saline in their lower courses during the dry season. Most of the eastern half of the unit is non-saline throughout the year, therefore, tidal and seasonal flooding are mainly shallow, but basin centers in the north are moderately deeply flooded in the monsoon season. The Ganges Tidal Floodplain consists of three subunits namely, non-saline, saline and Sunderbans. There is pattern of grey, slightly calcareous, heavy soils on river banks and grey to dark grey, non-calcareous, heavy silty clays in the extensive basins. Non-calcareous Grey Floodplain soil is the major component of general soil types. Acid Sulphate soil also occupies significant part of the area where it is extensively acidic during dry season. In general, most of the top soils are acidic and sub-soils are neutral to mildly alkaline. Soils of Sundarbans area are strongly alkaline. The fertility level is generally high with medium to high organic matter content.

5.1.5 Land Use

158. The gross area of the polder is 1,485 ha of which 72% is net cultivable area (NCA). The coverage of settlements, roads and water bodies are about 22%, 3% and 3% respectively of the total polder area. Detailed of land use of the polder area is presented in Table 5.1 and Map 5. 5.

Table 5.1: Detailed Land Use of the Polder Area

Land use	Area (ha)	Percent of total area
NCA	1,070	72
Settlements	325	22
Roads	40	3
Water bodies (ponds and khals)	50	3
Gross Area	1,485	100

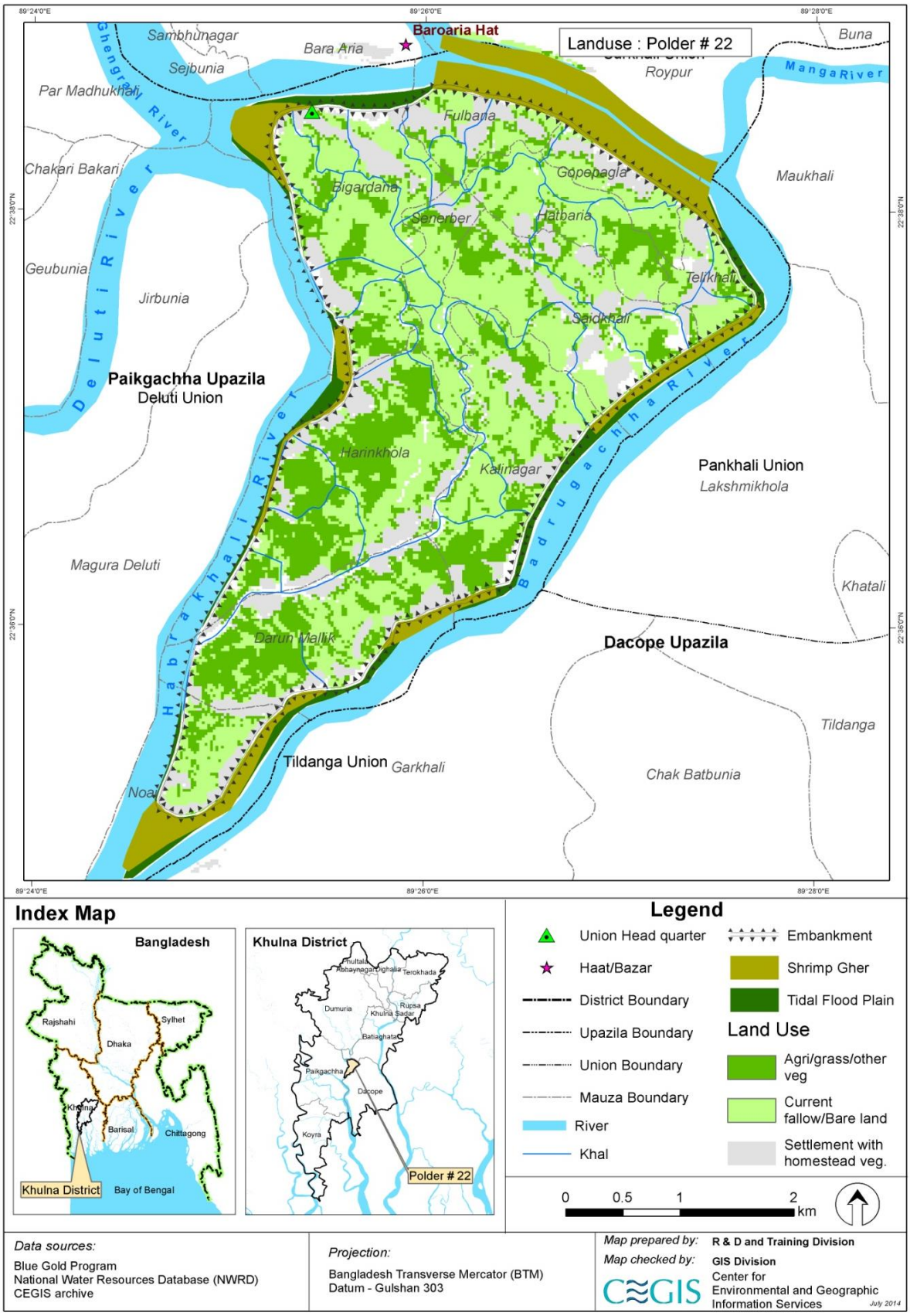
Sources: CEGIS estimation from SOLARIS–SRDI, 2006

5.1.6 Land Type

159. Land type classifications are based on depth of inundation on agriculture land during average monsoon season. In terms of depth of flooding, the five classes of land type are recognized by SRDI, (1988). The entire polder area is under medium highland (F1) which is normally flooded between 0 - 90 cm depth of water continuously more than two weeks to few months during the monsoon season.

5.1.7 Soil Fertility

160. In general, the organic matter content of the soil in the coastal region of Bangladesh, are low, (Haque, 2006). Thus, in addition to salinity, plant nutrients in soils affect plant growth. Farmers reported that the soils are in general poor in organic matter content. Soil sample were collected from four locations in three depths (0-10 cm, 10-20 cm and 20-30 cm) inside the polder area in the month of May, 2014, but salinity may be more in the month of March-April. A snap of soil sample collection is shown in Picture 5.1.



Map 5.5: Detailed Land Use Map of the Polder 22

Picture 5.1: Soil sample collection at Telikhali in Polder 22

161. The collected soil samples were analyzed in the laboratory of the Soil Resource Development Institute (SRDI), Dhaka. Detailed analysis results of soil quality of the polder area are presented in Table 5.2. The findings show that salinity level ranges from 6.07 to 9.77 in top soil in all locations. The pH ranges from 4.5-8.4 in AEZ 13. It is also observed that pH ranges from 6.7-7.5 in three depths of all locations of the polder. It indicates that, pH ranges are within the limit. OM content ranges from 1.2-2.7 in all locations in three depths. But OM status in the AEZ is low to medium. It indicates that, soil of the polder area is quite suitable for crop production. K, ranges from 0.26 to 1.00 in all locations of the soil. But in the soils of AEZ, it ranges from medium to optimum.. N level is low in the AEZ but it will not hamper for crop production. We found from the table that, N ranges from 0.07 to 0.15 in all locations of the polder area and N ranges from 0.07 to 0.15 are not good for crop production. P level is very low to low in the overall AEZ area and 0.01-0.20 is suitable for crop production. On the other hand, it ranges from 2.44 to 8.28 in three locations of the polder area. However, the soil of the polder area is good for crop production. In case of the quality of S in the soils of AEZ, it is medium to optimum. According to laboratory test S ranges 9.05 to 57.74 was found in all locations of the polder area.

Table 5.2: Chemical Properties of Soil on Agriculture Land

Location	GPS reading	Depth (cm)	EC (ds/m)	pH	OM (%)	K (ml equivalent / 1oo gm soil	Total N (%)	P(µg/gm)	S (µmg/gm)
Noaibeel	E-89° 24′50″ N-22° 35′33″	0-10	9.77	7.1	2.7	1.00	0.15	4.99	20.29
		10-20	4.89	7.2	2.1	0.82	0.12	4.45	45.86
		20-30	3.85	7.3	1.2	0.78	0.07	2.44	57.74
Telikhali	E-89° 36′7″ N-22° 39′32″	0-10	8.60	7.5	2.7	0.50	0.15	6.82	25.26
		10-20	4.58	6.8	2.6	0.51	0.15	4.79	9.05
		20-30	3.33	6.9	1.3	0.54	0.07	5.54	23.21
Hatbaria	E-89° 26′17″ N-22° 38′9″	0-10	6.07	6.7	2.4	0.35	0.13	5.50	19.05
		10-20	4.42	6.9	2.0	0.26	0.12	8.64	11.35
		20-30	3.26	7.0	1.7	0.27	0.10	6.18	22.02

5.1.8 Soil Texture

162. Soil texture is the relative proportions of sand, silt and clay. It is very important for agricultural crop production. In the polder area, 100% of the NCA is of clay texture.

5.1.9 Soil Salinity

163. The soils of the polder area become saline in the dry season (Jan-May). The soil and water salinity gradually increases with dryness from January and reach maximum level in the months of April-May and then decreases due to onset of monsoon rainfall. From the SRDI soil salinity data, it is found that over the period's soil salinity inside the polder increases gradually. For instance, in 1973, 100% of the NCA inside the polder was slightly saline whereas in 2000, 23% of the NCA became strongly saline, and in 2009, 69% of the NCA became strongly saline. However, one of the objectives behind polder construction is to protect the area inside the polder from salinity. In this polder, it is found that most of the water control structures are not functioning properly. As a result, this is unable to restrict the saline water to intrude inside the polder, thereby, this is reported as the major cause of the salinity increment inside the polder. Detailed soil salinity of the polder area is presented in Table 5.7 and Map 5.3.

Table 5.3: Detailed Soil Salinity in the Polder Area

Soil Salinity class (EC=ds/m)	Description	1973		2000		2009	
		Area (ha)	% of NCA	Area (ha)	% of NCA	Area (ha)	% of NCA
8.1 - 12.0	Slightly saline with some moderately saline	1070	100				
12.1 - 16.0	Moderately saline with some strongly saline			820	77	330	31
>16.0	Strongly saline with some very strongly saline			250	23	740	69
Total		1070	100	1070	100	1070	100

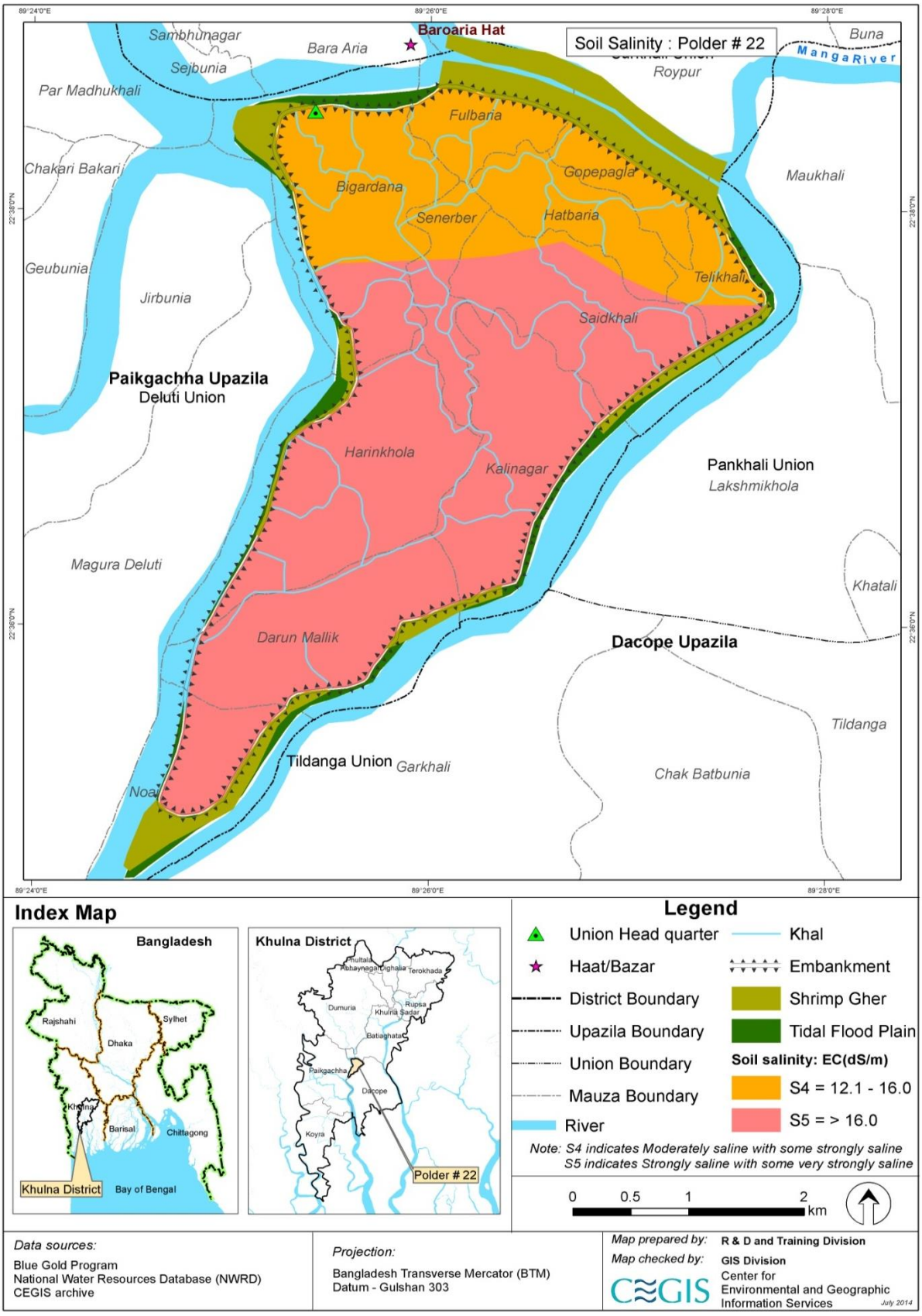
Sources: CEGIS estimation from SOLARIS-SRDI, 2006

5.1.10 Soil Moisture

164. The available soil moisture is very important for the cultivation of Rabi/dry season crops. The entire polder area (100%) is covered with low level of available soil moisture i.e. Plant extractable soil moisture remained in the field level less than one month.

5.1.11 Drainage Characteristics

165. Drainage plays a vital role in the management of soil (salinity, soil health) in the polder area. As per the SRDI (1988), the drainage characteristics have been divided into six classes from the agriculture point of views. Total area of the NCA is under poorly drained condition i.e. the soil remains under water from 15 days to 7/8 months and water is drained from the soil slowly. In most cases, the land remains wet/water logged for a considerable period of time after the rainy season. Soil of the polder area indicates that the removal of water in rainy/ monsoon season is the main constraint for growing dry land crops in the polder area.



Map 5.6: Soil Salinity Map

5.1.12 Farming Practices

166. Farming practices in the polder area are largely controlled by physical, biological, climatologically and socioeconomic factors. Agricultural crops are grown by cropping seasons. There are two distinct cropping seasons in a year. They are kharif and rabi seasons. The Kharif season starts from March and ends in October while the rabi season starts from November and ends in February. Based on crop suitability and farming practice, the kharif season has been further sub-divided into the Kharif-1 (March-June) and the Kharif-II (July-October) season.

167. The climatic condition in Kharif-I season is characterized by high temperature, low humidity, high evaporation, high solar radiation. The season also demonstrates uncertainty of rainfall means low alternating dry and wet spells. In this season land remains fully fallow, because salinity level increases which goes beyond the tolerance level of crops usually grown in this season like Aus, maize etc. The Kharif-II/monsoon cropping season is characterized by high rainfalls, lower temperatures, high humidity, and low solar radiation. This season has high probability of flooding that recedes at the end of the season. Rice is the predominant crop grown during this season due to the submergence of soil. Excessive soil moisture and higher temperature restricts other crops grow in that area. . In this polder local transplanted aman (LT Aman) and High Yielding Varieties of Transplanted Aman (HYV T Aman) are grown in this season.

168. The Rabi (winter) cropping season starts from November and ends in February. During this period, crops are favoured with high solar radiation, low humidity and temperature. But due to salinity and inadequate soil moisture, the crop yield became low in this polder area. Wide ranges of crops can be grown in this season. Major crops grown in this season in the polder area are watermelon, sesame, mungbean and few winter vegetables. However, there are occasional overlaps such that Kharif-II season crops (Aman rice) are harvested in Rabi season and some Rabi season crops (very few winter vegetables) are harvested in Kharif-I season.

5.1.13 Crop Production Constraints

169. The main constraints in the polder area are salinity scarcity of irrigation water in Rabi season, siltation and drainage congestion. Siltation of different internal drainage channels caused drainage congestion which affected transplantation of Aman, Watermelon, Sesame, Sunflower and Vegetables crops in winter season. Farmers are growing some vegetables in the homestead area. The salinity causes loss of fertile agriculture lands in the polder area.

5.1.14 Cropping Pattern by Land Type

170. Total land in the polder area is medium highland (F1). The most prominent cropping pattern is Fallow-HYV Aman-Sesame which occupies about 50% of the Net Cultivable Area (NCA). The next two dominant cropping patterns are Fallow-HYV Aman-Mungbean which covers about 25% of the NCA and Fallow – HYV Aman – Watermelon which covers about 15% of the NCA. For HYV Aman, BR23 is the only variety practiced here. In case of local Aman, kalamadari, haitta, karangal, dudkalam, sarnamasuri, kajalshail etc. are the common. Among the vegetables crops, red amaranth, Indian spinach, bottlegourd, ash gourd, dhundal etc. are popular among the farmers. Detailed cropping patterns along with land type are presented in Table 5.4.

Table 5.4: Existing Cropping Pattern by Land Type

Land type	Kharif-I (March-June)	Kharif-II (July-Oct)	Rabi (Nov-Feb)	Area (Ha)	% of NCA
F1	Fallow	HYV Aman	Watermelon	161	15
	Fallow	HYV Aman	Sesame	535	50
	Fallow	HYV Aman	sunflower	54	5
	Fallow	LTAman	Mungbean	268	25
	Fallow	LT Aman	Fallow	43	4
	Fallow	LT Aman	Vegetables	11	1
Total				1070	100
Cropping Intensity (%)				196	

Source: CEGIS field survey, 2014 and secondary data from UAO, DAE.

Picture 5.2: Sesame field at Noaibil inside Polder 22

Picture 5.3: Homestead garden at Hatbaria in Polder 22 area

5.1.15 Cropped Area and Cropping Intensity

171. Total cropped area is about 2,099 ha of which the coverage of rice is about 51% and non rice is 49%. The single and double cropped area is about 4% and 96% respectively. Therefore, cropping intensity of the project is about 196%. Detailed cropped area and cropping intensity is presented in Table 5.9.

5.1.16 Crop Damage

172. Crop production loss has been calculated using the formula: Crop production loss = Total cropped area × normal yield - (damaged area × damaged yield+ damage-free area × normal yield). Local farmers reported that total loss of rice production is about 106 ton from 144 ha and loss of non-rice production is about 96 tons from 93 ha due to drainage congestion, for siltation of drainage channels, salinity, natural calamities etc. Table 5.13

5.1.17 Input Use

173. Soil fertility is an important factor for crop production. Local people reported that in general the polder area is quite low in soil fertility. The organic matter content of the top soils ranges from less than 1% to 1.5%. The low organic content in soils indicates poor physical condition of the polder soils. Thus in addition to salinity, plant nutrients in soils affect plant growth. According to the local farmers the soils are in general poor in organic matter content. Seed, labour, fertilizer, pesticide and irrigation are the major inputs for crop production.

Seed

174. The role of seeds is very important for growing crops. Selection of seeds should be considered on the basis of more than 85% germination rate, free from disease infestation, good shape and size and high yield potential. According to land zone (AEZ 13) recommended seed rate presented in Table 5.10. The seed rate used by the farmers in the polder area is also presented in the same Table 5.10. In case of rice, farmers are using more seed than recommended as they normally use more seedlings per hill. Most of the cases, seedlings are affected by monsoon flood and salinity. Sometimes, they have to re-transplant due to damage caused by heavy rainfall during monsoon season. The seed rate of vegetables generally depends on the size and viability of the seed. The available seeds were in very good condition. The lands were prepared smoothly. The price of seeds was high. For this reason, farmers of the area used less seeds than the recommended rate. Local farmers reported that sesame seed and fertilizer were provided by Blue Gold program and BRAC.

Labour

175. In the polder area, almost 85% of the cultural practices for crop production are being done manually. So, agricultural labour is considered as one of the essential inputs for crop production. The labour requirement is not uniform throughout the year. The number of labour requirement varies from crop to crop and season to season. The average number of labour (male and female) used per hectare in the polder area is presented in Table 5.10.

Fertilizer

176. The rate of fertilizer use per hectare varies considerably from farmer to farmer depending on soil fertility, cropping pattern and financial ability. The major fertilizers used in this area are Compost, Urea, TSP, MP and Gypsum. On the other hand they are using less chemical fertilizer than the recommended doses in all crops. According to SAAO and local farmers, there is one fertilizer dealer in Fulbari bazaar, they said farmers are not aware about the recommended rate. On the other hand they do not have enough money to buy fertilizer too. About 50-60% of the households have compost pit in their homestead area. Compost is mainly used in watermelon pits. Fertilizer recommendation rate as developed by BARC, on the basis of agro-ecological zone (AEZ 13) is presented in Table 5.10.

Pesticides

177. The use of pesticides depends on the degree of pest infestation. The major insects as reported by the farmers are Stem borer, green leaf hopper, and Rice bug. Local farmers reported that they are using different types of pesticides such as Basudin, Furatar, Fighter, Rovral, Ridomil gold etc. Both liquid and granular pesticides are being used to prevent pest infestation in the rice, watermelon and vegetables cultivation. Ripcord and trap are used in watermelon for prevention of pest infestation. Detailed information of pesticides used is presented in Table 5.5.

Table 5.5: Inputs (seed, labour, fertilizer and pesticides) Used in the Polder 22

Crop name	Seed		Labor (No./ha)	Current fertilizer application rate (Kg/ha)					Recommended dose (kg/ha)					Current pesticide application rate	
	Farmers used (Kg/ha)	Recommended seed (kg/ha)		Compost	Urea	TSP	MP	Zn	Compost	Urea	TSP	MP	Zn	No. of application	Liq. (ml/ha) approx.
HYV Aman	35*	25	160	0	50	15	20	0	0	163	35	30	1	1	800
Lt Aman	50	40	130	0	40	10	0	0	0	97	14	17	0	0	0
Mungbean	14*	25	125	0	40	20	0	0	0	43	67	20	0	1	1000
Sesame	4*	7	100	0	60	20	0	0	0	170	60	31	1.3	0	0
Watermelon	0.7	0.8	150	500	100	50	20	0	6,000	141	56	30	3	4	2000
Amaranth	1.5	2	70	0	40	0	0	0	5,000	150	44	25	0	1	200
Indian spinach	0.4	0.5	90	400	40	20	10	0	5,000	163	29	25	0	1	200
Bottle gourd	4.5	5	50	0	50	20	10	0	5,000	141	80	33	1	1	200
Ash gourd	4.3	5	50	0	50	20	10	0	5,000	141	55	25	1	0	0
Dhundal	4	Not found	50	0	50	20	10	0	No recommended dose was found					0	0

*Source: Hand Book of Agricultural Technology, BARC, 2012 and Farmers interviewed, April, 2014; *Seed rate varies in different crops*

5.1.18 Integrated Crop Management (ICM)

178. The practice of integrated crop management (ICM) is quite recent in some areas that were covered by the polder. DAE has taken active part on ICM. In this system, insects are controlled biologically. Farmers of the ICM areas use branches of trees, bamboo and jute sticks etc to make favourable perches for birds in fields with standing crops. The birds eat the insects which help control infestation. In this process, the crops are protected without applying pesticides. Trap is another technique for controlling pests under ICM. This system is used in the agriculture fields especially on watermelon for attracting insects. At the base of the trap, there is a sheet generally made of steel that slopes downward. Thus, it is possible to control the harmful insects without the application of pesticides. In the polder areas the ICM technique is mainly applied on watermelon and mungbean and different vegetables. Field information, i.e. farmers and Sub-Assistant Agriculture Officer (SAAO) of DAE indicates that ICM is being practiced in the fields covering about 10-12% of the cultivated areas in the polder area and the impact has been found very encouraging.

5.1.19 Irrigated Area by Crop

179. The surface water is the only source of irrigation water. Ponds and khals are source of surface water for very limited time. Irrigation is provided only in watermelon and sometimes in homestead vegetables garden. Occasionally, Low Lift Pumps (LLPs) are being used in watermelon cultivation for surface water irrigation as supplementary irrigation. Detailed information on irrigation is presented in Table 5.6.

Table 5.6: Irrigated Area by Crop

Crop name	Irrigation (Surface water)		
	Irrigated area (ha)	% of NCA	Charge (tk/ha)
Watermelon	54*	5	6,500
Vegetables	11*	1	5,000

*Source: CEGIS estimation on field information; 2014 * Supplementary irrigation*

5.1.20 Yield Level (Normal and damaged)

180. Soil salinity is the major constraint to crop production inside the polder. Normally, HYV Aman and watermelon crops are being damaged due to salinity. In addition, early rain causes damage of watermelon and Aman seedbed and Aman crops at early growing stages. This causes reduction of average yields. Detailed normal and damaged yield of crops are presented in Table 5.7.

Table 5.7: Crop Yield Level (normal and damaged) by Different Crops

Crop name	Yield(ton/ha)		
	Normal (about)	Damage (about)	Damage free (about)
HYV Aman	2.10*	0.80*	1.30*
Lt Aman	1.30*	0.50*	0.80*
Sesame	0.95	0.25	0.70
Mungbean	1.00	0	-
Vegetables	14.00	0	-
Sunflower	1.20	0.25	0.95
Watermelon	30.00	10.00	20.00

*Source: Based on field information, and SAAO, DAE 2014. * indicates milled rice/cleaned rice.*

5.1.21 Crop Production

181. In the polder area, the annual total crop production stands at about 7,600 tons of which about 1,887 tons of rice are produced after loss of 106 tons and 5,713 tons non-rice is produced after loss of 96 tons of non-rice in the polder area. Among the rice crops, the contribution of HYV Aman and Lt Aman are about 79% and 21% respectively. Detailed crop production and crop production loss with percentage are presented in Table 5.8.

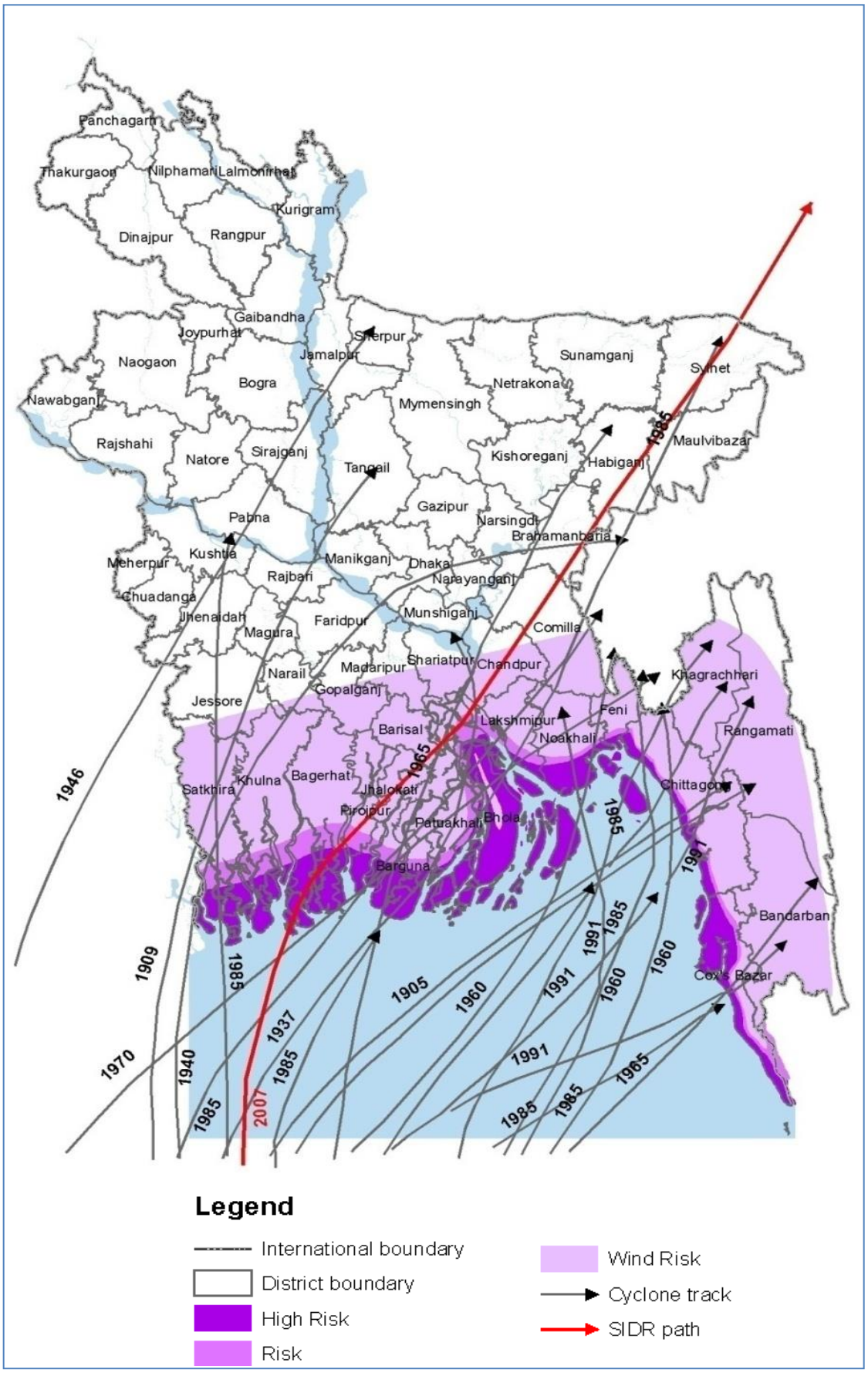
Table 5.8: Existing Crop Production and Crop Production Loss of the Polder Area

Crop Name	Crop Area (ha)	Damage Free		Damaged		Total Production (ton)	Production lost (ton)
		Area (ha)	Yield (ton/ha)	Area (ha)	Yield (ton/ha)		
HYV Aman	750	638	2.1*	112	1.3*	1,485	90
LT.Aman	321	289	1.3*	32	0.8*	401	16
Total rice	1071	927	-	144		1,887	106
Sesame	535	455	0.95	80	0.7	488	20
Vegetables	11	11	14	-	-	154	-
Watermelon	161	153	30	8	20	4,740	75
Mungbean	268	268	1	-	-	268	-
Sunflower	54	49	1.2	5	0.95	63	1
Total non-rice	1,029	936	47.15	93	21.65	5,713	96
Total	2,100	1,815	-	229	-	7,600	197

*Source: CEGIS field survey, 2014 and secondary data from UAO of DAE. * Indicates cleaned rice*

5.1.22 Water Resources

182. The water resources system is the source of water supply, and plays an indispensable role in assimilating and diluting waste, attenuating and regulating flood, drainage, recharge into the aquifer, and maintaining the environment for aquatic habitats.



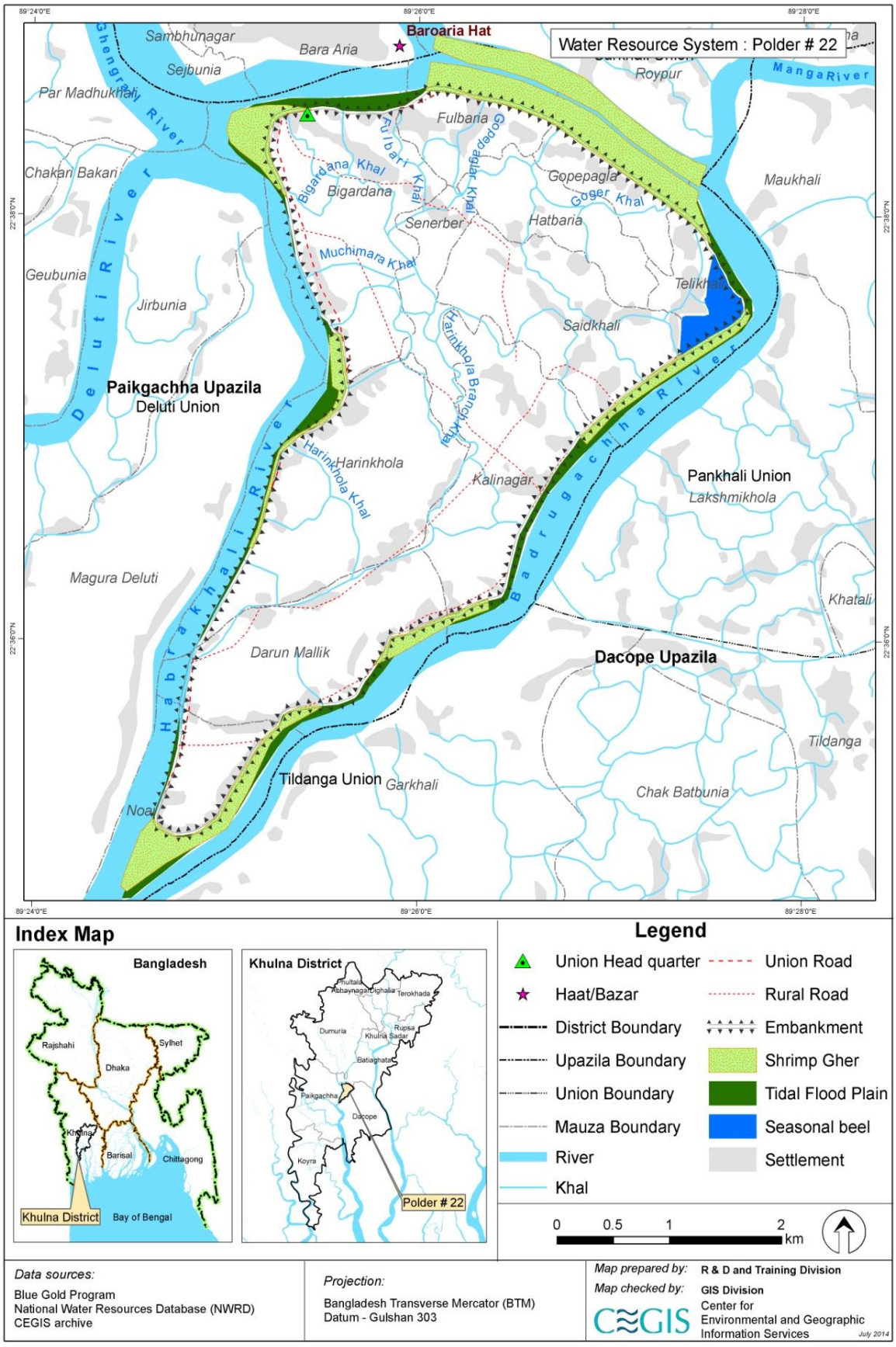
Map 5.7: Cyclone Tracks in Bangladesh and Risk Areas

5.1.23 River System

183. Polder 22 is 75 km away from the Bay of Bengal, and falls within 16 km buffer radius from the Sundarbans mangrove forest. The polder undergoes tidal influence as the Sibsa River directly meets the sea. The polder is directly surrounded by the Bhadra River (north), the Badurgachia River (east), and Habarkhali River (west). Badurgachia and Habarkhali rivers are connected together to form the Sibsa river. The river system of the area is shown in Map 5.8 and snapshot of Bhadra and Badurgachi rivers is shown in Picture 5.4 and Picture 5.5.

Picture 5.4: Bhadra River

Picture 5.5: Badurgachia River



Map 5.8: Water Resources System of the Area

5.1.24 Hydrological Connectivity

184. The drainage channels and rivers in and around Polder 22 experience diurnal cycles of high and low tides. During high tide, water flows from the Bay of Bengal to the Sibsa and other peripheral rivers (Habarkhali, Badurgachia and Bhadra). A number of khals exist within the polder i.e. Horinkhola khal, Muchimara khal, Goger khal, Fullbari khal etc. Tidal water is not allowed to enter the polder during dry season (in order to prevent probable salt water intrusion), but during monsoon, when sluice gates are opened, fresh water flow takes place on both in and out of the polder.

5.1.25 Surface Water Level

185. The surface water levels of two BWDB stations at Dumuria (Bhadra river) and at Sutarkhali F.O. (Sibsa river) from 1970 to 2000 have been analyzed (Figures 5.9 and 5.10). Water levels during high tide range from 1.5 to 2.26 m +PWD at Dumuria, and 2 to 2.78 m +PWD at Sutarkhali. On the other hand, the low tidal water levels range from 0.8 to 1.39 m below the MSL at Dumuria, and to0.01 to 0.78 m below MSL at Sutarkhali.

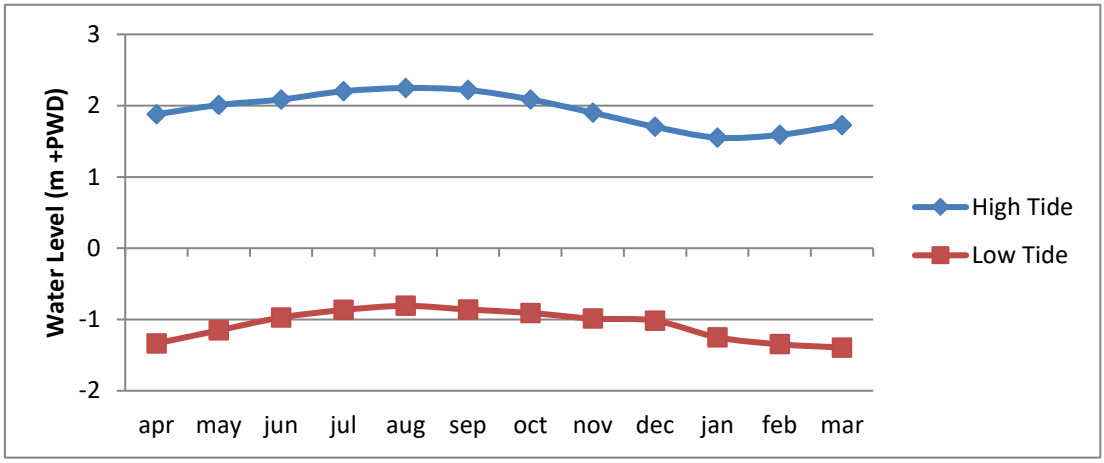


Figure 5.9: Surface Water Level at Dumuria (Bhadra river)

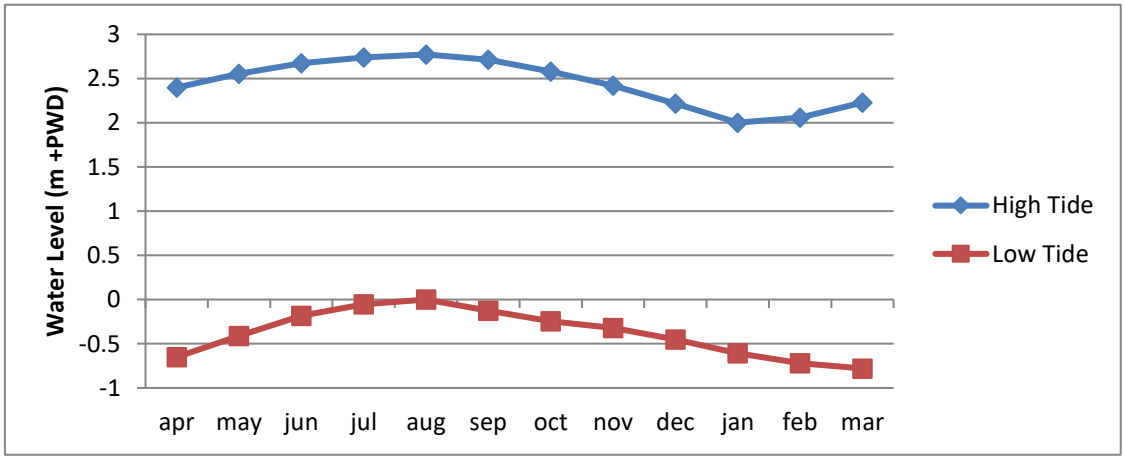


Figure 5.10: Surface Water Level at Sutarkhali F.O. (Sibsa River)

5.1.26 Ground Water

186. Monthly variations in ground water levels from 1990 to 2010 have been plotted in Figure 5.11 for two ground water observation wells namely, KHU002 (at Dacope, 4.5 km east from the polder) and KHU005 (at Dumurua, 15 km upstream of the polder). The variation pattern for KHU002 station shows that the Ground Water Table (GWT) is the lowest during April and the highest in September. For KHU005 station the GWT values are fairly

low, with lowest and highest values found in April and December respectively. The lower values of GWT for KHU005 are expected as it is situated more upstream where ground water abstraction takes place and at downstream ground water recharge are expected in coastal areas.

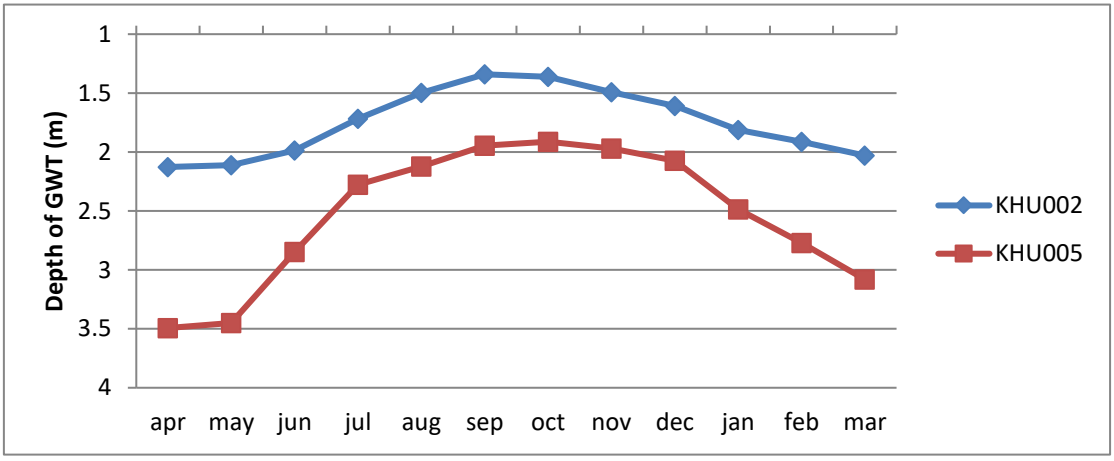


Figure 5.11: Average Monthly Variations of GWT

187. Further analyses have been carried out to understand the annual variations of GWT The values of annual average depth of GWT for KHU005 station have been plotted versus time (year) in Figure 5.142below. The Figure indicates a gradual drop of GWT for the station over the years.

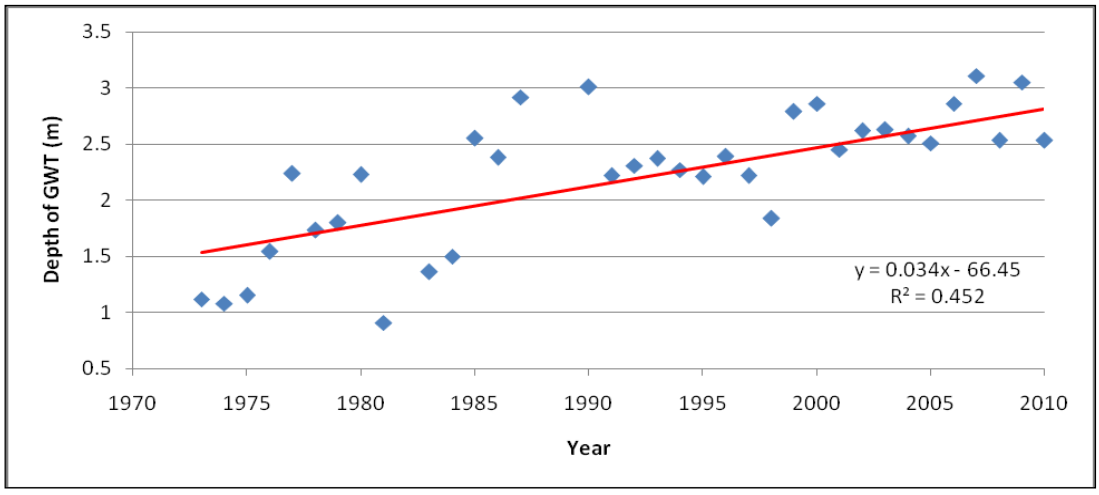


Figure 5.12: Annual Variation of GWT for KHU005 Station

(b) Water Use

Domestic Use

188. From the field observation in Polder 22, it was found that the average daily use of water is around 20 lpc, whereas, for the other rural areas of Bangladesh this demand is 50 lpc (Ahmed and Rahman, 2010). Accordingly, it is estimated that about 279 m^3 water is needed in this polder to meet the daily drinking and domestic water demand.

Irrigation Use

189. The local farmers in Polder 22 practice LT Aman and HYV Aman during Kharif-II season (July-October) and watermelon, sesame and other vegetables during Rabi season (November-February). From field investigations it has been found that around 300 mm water is required for each ha of LT Aman cultivation whereas 250 mm water should be available for each ha for watermelon and vegetables (Table 5.4). The local farmers fully rely on rainfall

for aman cultivation as rainfall is sufficient to meet the demand (from the data provided in Figure 5.9, it can inferred that around 14 Mm^3 total rainfall occur in the Polder 22 during June and July).

Table 5.9: Irrigation Water Requirements in Polder 22

Season	Aman (ha)	Watermelon, vegetables (ha)	Water Required (mm per ha)	Water Used (Mm3)	Source of Irrigation
Kharif-II	1070	-	300	3.21	Rain Water
Rabi	-	65	250	0.16	Surface Water

Source: CEGIS Estimation, 2014

5.1.27 Water Resources Functions and Problems

(a) Problems

Tidal Flood

190. Local people in Polder 22 opined that the peripheral embankment effectively offers protection from regular tidal flooding in the area even some of the water control structures are subject to flow leakage, the amount of flow entering the polder are minimal. As such it can be said that, no tidal flooding takes place inside Polder 22. Local people also informed that during Aila (2009), water overtopped the peripheral embankments and around 30% of the area was flooded. During Sidr (2007) a breach took place in the embankment at Noai, which flooded a minor portion of the polder.

Water Logging and Drainage Congestion

191. According to the local people, there is no problem related to water logging inside the polder. Some people opined that water logging existed before the 80s as there were only 2 sluice gates in the entire polder back then. With more khals and sluice gates constructed over the periods under different development projects, water logging problems have been reduced. However, as some of the sluice gates (Telikhali, Durgapur) are damaged and totally kept sealed by local people, drainage congestion problems have emerged on those khal openings. Around 2-3% of the total lengths of khals suffer from drainage congestion problems at this moment.

Erosion

192. There are some erosion hot spots along the peripheral embankment of the polder. Erosion takes place continually, due to the wave action of peripheral rivers. During field investigations, four locations namely, Kalinagar (Picture 5.6), Naldanga, Darunmallik, and Bigordana (Photo 5.7) were identified as locations prone to river bank erosion. The first three aforementioned locations are along the Badurgachia River, and the last spot is adjacent to the Bhadra River. The rate of erosion along these locations and their GPS co-ordinates has been shown previously in Table 4.1 of the Project Description chapter.

Picture 5.6: Erosion point at Kalinagar

Picture 5.7: Erosion point at Bigordana

Navigation

193. The peripheral rivers around the polder are predominantly used for water-way navigation. Small boats as well as large streamers navigate through those rivers. However, very little navigation takes place inside the polder area. Only fishing boats navigate through the khals inside the polder during monsoon.

5.2 Biological Environment

5.2.1 Fish Habitat

194. Polder 22 and its adjacent areas are characterized by the presence of diversified brackish and fresh water fisheries habitats (Map 5.9). The Polder is bounded by Bhadra River on the north and east side, Habrakhali River on west and south side and Badurkhali River on the east and south side. A number of khals exist in the polder which is connected with peripheral rivers. Considering the catchment of the polder area, the most important fisheries habitats include river and khal, tidal floodplain, seasonal water bodies (called Seneber beel) inter tidal floodplain, and pond habitats. These diversified fisheries habitats are divided into two groups, for instance capture fishery and culture fishery. Capture fish habitat includes the peripheral rivers, internal khals, seasonal beels, tidal floodplain and inter tidal floodplain whereas the culture fish include homestead pond and commercial pond, and golda gher (rice cum golda with white fish culture). Although peripheral rivers and tidal floodplain influence fish migration as well as fish production inside the polder, the peripheral rivers and tidal floodplain has not been considered for fish production estimation of the polder area. It is reported that most of the tidal floodplain is occupied by shrimp gher.

Capture Fisheries

195. The estimated open water fish habitat of the polder area is 70 ha comprising mainly khal and seasonal water body (Senerber beel). The distribution of fisheries habitat inside the polder is presented in Table 5.10.The khals inside the polder are mainly seasonal in nature and normally water retain for six to eight month of the year. Even there is no deep pool in these khals where water retains round the year for fish sheltering.

Table 5.10: Fish Habitat Status of the Polder Area

Sl. No.	Fisheries Category	Habitat Types	Area (Ha)
1	Capture	Khal	50
		Seasonal beel (Sereber beel)	20
Sub-total			70
2	Culture	Culturable pond	25
		Cultured pond	5
		Golda gher/rice cum fish culture	30
Sub-total			60
Grand Total			130

Source: Field visit, CEGIS estimation, 2014

196. The depth of internal khals varies from 0.5 to 2.5 m and average depth is about one (01) meter which is not sufficient for fish habitation and for sheltering of fish juveniles/fry in dry season. During dry season especially March to May, these khals become dry totally. Local people reported that he internal fish habitats like khal beds are silted up by about (2-3) cm per year due to top soil erosion from agriculture land. The detailed information of internal khals is given in the following Table 5.11.

Table 5.11: Detailed Information of Internal Khals of Polder 22

Sl. No.	Name of Khal	Length (m)	Width (m)	Depth (m)	Nature of water Bodies
1	Bigardana Branch Khal1	1090	1.68	1.00	Seasonal
2	Bigardana Branch Khal2	730	5.50	1.00	Seasonal
3	Fulbaria Branch Khal	560	5.44	1.00	Seasonal
4	GopepaglaKhal	1420	15.70	1.00	Seasonal
5	Saidkhali-HatbariaKhal	2710	9.86	1.00	Seasonal
6	Saidkhali Branch Khal	1040	5.92	1.00	Seasonal
7	Telikhali Khal	1080	5.50	1.00	Seasonal
8	Muchimara Branch Khal 2	860	16.44	1.00	Seasonal
9	Seneber Khal	750	7.30	1.00	Seasonal
10	Kalinagar-SaidkhaliKhal	3180	6.00	1.00	Seasonal
11	KalinagarKhal	1560	5.50	1.00	Seasonal
12	Harinkhola Branch Khal1	810	7.88	1.00	Seasonal
13	DarunMallikKhal	1680	11.87	2.50	Seasonal
14	DarunMallik Branch Khal	620	4.15	1.00	Seasonal
15	MuchimaraKhal	2310	7.36	0.83	Seasonal
16	Muchimara Branch Khal1	860	6.50	0.60	Seasonal
17	BigardanaKhal	1890	16.68	1.21	Seasonal
18	FulbariaKhal	1260	8.65	0.81	Seasonal
19	Gopepagla Branch Khal	1100	15.71	0.92	Seasonal
20	GorerKhal Branch	510	6.85	0.09	Seasonal
21	GorerKhal	1540	9.88	0.91	Seasonal
22	HarinkholaKhal	5330	7.10	0.81	Seasonal
23	Harinkhola Branch Khal2	1040	5.32	0.63	Seasonal

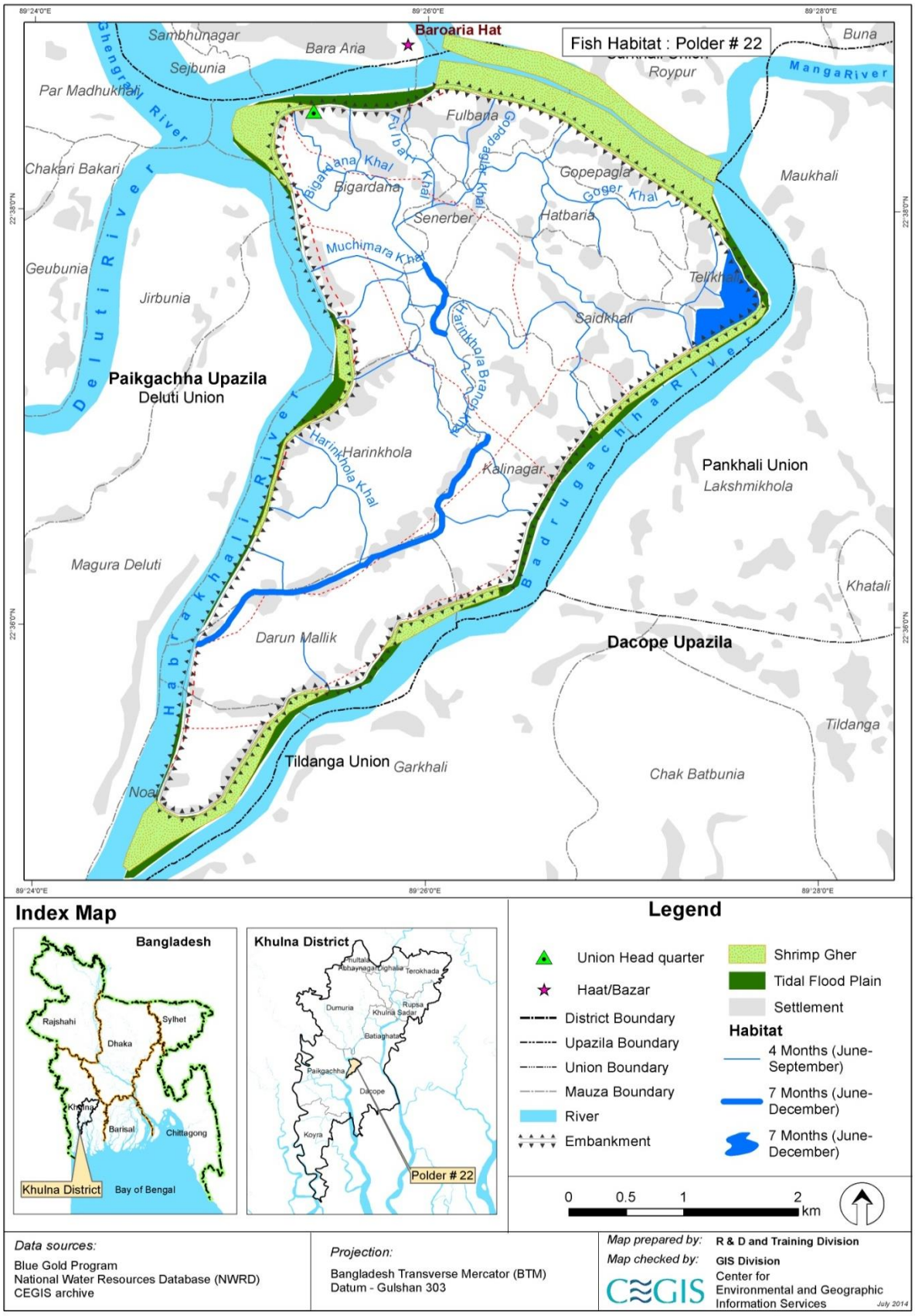
Culture fisheries

197. Different types of fish culture systems are adopted by the local people including mono, poly, mixed-culture, rice cum prawn with white fish culture. Among the aquaculture, rice cum white fish culture is expanding gradually in the polder area. The local people culture prawn with white fish in the T. Aman rice field during monsoon. Commercial fish culture is not expanding significantly due to shortage of water during dry season and lack of knowledge and training on aquaculture. Estimated area under culture practice is 60 ha. The gher and pond fish culture of this area are mainly traditional in nature while improved technology is also adopted by some commercial farmers especially for Telapia and Pangus culture.

Commercial fish pond

Traditional fish pond

Picture 5.8: Different Types of Fish Pond in the Polder Area



Map 5.9: Fish Habitats of the Polder 22

5.2.2 Water Quality of Fish Habitat

198. Surface water quality parameters that are related to fish habitat suitability measured in the peripheral river, pond and khal in the polder area (detailed results are given in Table 5.20). From the data it is observed that pH values are slightly higher (Between 8.1-8.9) which means water is alkaline and it is bad for fisheries (According to Mazid 2002 and Jack M. et al, 2002, the recommended pH for fisheries is 6.5-6.5). The value of water temperature in different fish habitats is found within the limit of fisheries resources (recommended 28-34^{0}C). DO content in water in the polder is found within the limit of Bangladesh standard (>5.0 mg/l) for fish culture except the Hatbari edge point. The salinity in water bodies at outside the polder is very high while inside the polder is low. The higher salinity is suitable for brackish water fisheries especially suitable for shrimp culture (for shrimp culture salinity values must be >25 ppt and for prawn acceptable limit is 0-4 ppt) and unsuitable for fresh water fisheries. However, all water quality parameters are almost within the permissible limits for fisheries resources.

5.2.3 Fish Production

199. Estimated total fish production of the polder area is 89 tons of which 84% are coming from culture fisheries while the rest comes from capture fisheries habitats (Table 5.12). Fish production trend from capture fisheries is declining in the polder area which is mostly due to destruction of khal habitat due to siltation; indiscriminate fishing using monofilament gill net, net jal, etc and overexploitation of fishes by using huge number of small meshed ESBN (Estuarine Set Bag Net) fishing; improper operation of water regulator structures; increasing of rice cum gher practices in the floodplain. Pond production is also not increasing remarkably in the polder area due to shortage of water during dry season and inadequate knowledge of aquaculture.

Table 5.12: Fish Production from Different Habitats of the Polder Area

Sl.	Fisheries Category	Habitat Types	Total production (tons)
1	Capture	Khal	9
		Seasonal water bodies	5
Sub-total			14
2	Culture	Culturable pond	43
		Cultured pond	11
		Golda gher/Rice cum fish culture	21
Sub-total			75
Grand Total			89

Source: Field Survey, 2014 and FRSS, 2012

5.2.4 Fish Biodiversity

200. The polder area is moderate in fish biodiversity. About 80 fish species are present in this area. The biodiversity of fishes has the declining trend over the years due to aforesaid reasons (earlier section 5.6.3).The polder area comprises an assemblage of both fresh and brackish water fish species (Picture 5.9).

Picture 5.9: Typical Catch Composition in and around the Polder

201. Checklist of the fishes of different habitats reported by local fishermen is analyzed to draw a tentative scenario of the local fish biodiversity of the polder area. Among the local fish species Chingri (Peneanus spp), Puti (*Puntius* spp), Shol (*Channa striatus*), Taki (*Channa puctatus*), Koi (*Anabas testudineus*), Shing (*Heteropneustes fossilis*), Tengra (*Mystus vittatus*), Baim (*Mastacembelus* spp), Cuchia (Cuchia spp) etc. are dominant fish species in the polder area which play vital role in fish production in there. The abundance of the fresh water fish species has declined due to siltation and saline water intrusion in internal khal. The dominant culture fishes are Rui (*Labeo rohita*), Catla (*Catla catla*), Silver carp (*Hypophthalmichthys molitrix*) and Grass carp (*Ctenopharyngodon idella*) etc. Currently, farmers are practicing Telapia and Pangus culture in intensive method. List of the fishes of different habitats of the polder area are given in Table 5.13.

Table 5.13: Indicative Fish Species Diversity of Different Fish Habitats in the Polder Area

Scientific Name	Local Name	Habitat Type			
		Periphery River	Khal	Gher	Fish Pond
Brackish Fish Species					
Pama pama	Poa	M	NA	NA	NA
Taeniodes anguillaries	Chewa	H	H	NA	NA
Apocryptes bato	Chewabele	M	L	NA	NA
Lates calcarifer	Koral/Bhetki	H	L	NA	NA
Tenualosa ilisha	Ilish	H	NA	NA	NA
Mugil cephalus	Bata	M	L	NA	L
Metapeneaus monocerus	Horina Chingri	M	L	NA	NA
Penaeus monodon	Bagda chingri	H	L	H	M
Setipinna taty	Phasa	L	NA	NA	NA
Pangasius pangasius	Pungus	L	NA	NA	H
Polynemous paradiseus	Tapasi	M	NA	NA	NA
Sillago domina	Tolardandi	M	NA	NA	NA
Scylla serrata	Kankra	H	M	L	L
Macrobrachium rosenbergii	Golda chingri	M	L	M	L
Harpodon nehereus	Lotia	L	NA	NA	NA
Liza parsia	Bata mach	M	L	L	L
Liza tade	Bata mach	M	L	L	L
Mystus gulio	Tengra	H	H	M	NA
Fresh water fish species					
Puntius sophore	Jatputi	NA	L	L	L
Glossogobius giuris	Bele	H	M	NA	NA
Channa punctatus	Taki	NA	M	L	NA
Channa striatus	Shol	NA	M	L	L

Scientific Name	Local Name	Habitat Type			
		Periphery River	Khal	Gher	Fish Pond
Anabas testudineus	Koi	NA	L	L	L
Heteropneustes fossilis	Shing	NA	M	L	L
Mystus vittatus	Tengra	M	H	M	L
Mastacembelus pancalus	Chirkabaim	L	L	NA	NA
Mastacembelus aculeatus	Tara baim	NA	M	M	L
Wallago attu	Boal	L	L	L	L
Sperata seenghala	GuizzaAyre	L	NA	NA	NA
Puntius chola	Cholaputi	L	M	L	L
Eutropichthyes vacha	Bacha	M	L	NA	NA
Clarius batrachus	Magur	NA	L	NA	NA
Lepidocephalus guntea	Gutum	NA	M	L	L
Culture fish species					
Labeo rohita	Rui	L	L	M	H
Catla catla	Catla	L	L	M	H
Hypophthalmichthys molitrix	Silver Carp	NA	L	L	H
Ctenopharyngodon idella	Grass Carp	NA	L	L	H
Cirrihinus mrigala	Mrigal	L	L	L	M
Pangasius pangasius	Pungus	L	NA	NA	M
Telapia nilotica	Telapia	NA	NA	L	H
Cyprinus carpio	Carpio	L	L	NA	L
Puntius gonionotus	Sarputi	L	L	NA	L

Source: Field Survey, 2014: Note Abundance, H=High, M= Medium, L= Low, and NA= Not Available

5.2.5 Species of Conservation Significance

202. Fish species which are locally unavailable for last 10-15 years or became rare as reported by the local fishers and concerned elderly people are given in the following Table 5.14.

Table 5.14: List of Species of Conservation Significance

Scientific Name	Local Name	Local Status	
		Rare	Unavailable
Channa Marulius	Gojar	√	
Puntius sarana	Sarputi	√	
Nandus nandus	Roina/Veda	√	
Mystus aor	Ayre	√	
Nemapteryx nenga	Kata gogat	√	
Wallago attu	Boal		√
Clarius batrachus	Magur		√
Setipinna taty	Phasa		√

5.2.6 Area of Conservation Significance

203. There is no khal where water is retained round the year. Consequently, feeding and spawning ground of open water fishes are being hampered. It is observed that Penakhali khal closed by an embankment was previously used as feeding and spawning ground of fresh water fisheries in the polder area. At present, local people have encroached that khal and converted it into culture pond. Hence, there is no scope for fish sanctuary development in the existing khal to conserve the locally rare and unavailable fish species.

5.2.7 Fish Marketing and Post- harvest Facilities

204. Edible fish quality is good for human intake. But fish processing facility is not good in the area which sometimes deteriorates the fish edible quality especially during the dry season. Local fishers sell bulk of their catch either directly to the local fish market (Fulbaria bazar, DarulMallik Hat, etc.) or to fish traders or buyers (Bepari) coming from Khulna and Batiaghata. Due to poor road communication, fish traders (Bepari) from the other districts do not come here. Fish farmers sell their fishes either to the local fish traders or the local people directly. There is no real fish arat inside the polder. No structured fish landing center is found in the area. Ice is collected from ice plants in Batiaghata bazar and Khulna for ice storing of the harvested fish. There is no good fish storage facility in this area. There is a fish depot at a Fulbaria bazar where local fish traders store their purchased fish for maximum two days. Fish transportation facility at the root level is moderately developed. There is no private/ government fish hatchery inside the polder area. Fish seeds for culture fishery are collected from different fish hatcheries and nurseries which are mostly situated at Khulna and Bagerhat. Post Larva (PL) of Golda and Bagda are collected from Khulna, Bagerhat, Chalna, and Paikgachha. Availability of fish feeds for culture ponds are insufficient. Fish feeds are collected from the nearest local markets and also from Batiaghata and Khulna. Low quality of fish feeds is the major threat for the fish farmers which hinder expected fish production.

5.2.8 Fisheries Management

205. There is no community based fishermen's association. Fishing right on existing fish habitats is significant particularly on common resources. Department of Fisheries (DoF) has limited activity (observe fishing ban.) for fisheries resource conservation and management in this area. Some national and local NGOs (BRAC, Grameen Bank, Fulbaria Somobai Somity etc) are working in this area, but they have mostly micro-credit function rather than extension services and aquaculture training. The fishers have full access to fishing on existing fish habitats. Enforcement of fisheries regulation is very weak. Recently, Blue Gold Program has initiated a vast program (technology transfer on pond and gher aquaculture practices through training) for the improvement of fisheries resources and the improvement of the fishers' livelihood in the polder area.

5.2.9 Bio-ecological Zones

206. IUCN-The World Conservation Union has identified 25 bio-ecological zones (Nishat et al, 2002) in Bangladesh. The aspects on which these zones are delineated are physiography, climate, soil type, flooding depth and biodiversities. These bio-ecological zones can be classified as major ecosystems of the country. Polder 22 area falls in the Saline Tidal Floodplain. A brief description of which is presented below.

Saline Tidal Floodplain

207. Saline tidal floodplain, which is located in the administrative district of Satkhira, Khulna, Bagerhat, Jhalokathi and Borguna has a transitional physiography. The polder is situated at Batiaghata, Gangarampur and Surkhali Union of Batiaghata Upazila of Khulna district. It has a low ridge and basin relief, crossed by innumerable tidal rivers and creeks. Local differences in elevation are less than 1 m. The sediments are mainly composed of non-calcareous clays, although in the riverbanks, they are silty and slightly calcareous. The soil is non-saline throughout the year over substantial amount of areas in the north and east, but they become saline to varying degrees in the dry season in the south west and remain saline for much of the year in Sundarbans. The rivers carry fresh water throughout the year to the east and northeast, but saline water penetrates increasingly further inland towards the

west mainly in the dry season, and for most or all of the monsoon season in the southwest. In the northeast, there is moderately deep flooding during the monsoon season, mainly due to accumulation of rainwater on the land when water level in the Ganges distributaries and the lower Meghna are high. Elsewhere, there is mainly shallow flooding at high tide, either throughout the year or only in the monsoon season, except where tidal flooding is prevented by embankments. Within embankments, seasonal flooding only occurs through accumulation of rainwater (Brammer, 1996).

208. Several types of palms and bamboo clumps grow in almost all the villages in the polder area. Narikel (*Cocos nucifera*) and Supari (*Areca catechu*) are the two common palm of this area. The mango (*Mangifera indica*), Sirish (*Albizia saman*), Babla (*Acacia Arabica*), Khai Babla (*Pithocelobium dulci*),Taal (*Borassus flabeliffer*), Gab(*Diospyros perigrina*)etc supply the timber and are used for daily needs. Existence of mangrove patches along riverside or even beside homestead forest indicates presence of water and soil salinity of that zone.

209. The dominant aquatic floral types in the polder are: the Kochuripana (*Eicchornia crassipes*), Panimorich (*Polygonum orientale*), Jhanji (*Hydrilla verticillata*), Helencha (*Alternanthera philoxeroides*), Topapana (*Pistia strateotes*), Chechra (*Schenoplectus articulatus*), Keshordam (*Ludwigia adscendense*), Kolmi (*Ipomoea aquatica*), Dhol kolmi (I. fistulosa) etc. Innumerable indigenous weeds grow in beel areas.

210. The zone offers very lucrative place to game bird waters. At the advent of winter season, numerous game birds which include wild goose, wild duck, cranes, spines, jungle fowl and various waterfowl, begin to flock both in the Sundarban and the beel and char areas of this zone. Mangrove, the network of rivers and expanse of beels of this zone teem with different species of fishes.

Tidal Flooded Area (Polder 22)

211. Tides are caused by the gravitational pull of the sun and moon on a 24 hour cycle, so there are two high tides a day. Twice a month when Earth, Sun, and Moon are in a straight line these daily high tides are at their highest. This may be sufficient to cause minor flooding by itself.

212. This polder lies within the tidal flooded area. It is surrounded by Bhadra river in its north, Badurgachi and Habarkhali rivers in its east and west directions respectively. In the southern portion of the polder, the confluence of the two rivers i.e. Badurgachhi and Habarkhali creates the Sibsa River, which directly flows into the sea. The local people reported that when this polder was not formed, surrounding vegetation of the polder area used to be affected all the time due to tidal flooding. But, this polder has been prepared by IPSWAM 6 to 7 years ago and after that no tidal flooding occurred in this polder area. But salinity is still prevalent in the polder area.

5.2.10 Terrestrial Ecosystem

a. Terrestrial Flora

Settlement/Homestead vegetation

213. Homestead vegetation is the major type of terrestrial flora of the polder area. In the polder there is about 325 ha settlement which is the major source of terrestrial vegetation. However, the density and diversity of terrestrial vegetation in the homestead vegetations is not uniform. From the field observation as well as NDVI analysis from RS images, it is found that the density of homestead trees along polder peripheries is low because soil is saline in nature. The trees which are successfully adapted in peripheral homesteads are: Sirish (*Albizia saman*), Babla (*Acacia Arabica*), Khai Babla (*Pithocelobium dulci*), palm (*Borassus flabeliffer*) and coconut (*Cocos nucifera*). On the other hand, the homesteads, far from polder peripheries, show comparatively higher density and diversity of vegetation. According to the vegetation survey, several tree species are present in different canopy layers and their composition is diversified all over the polder area. The most common plants that are now planted by local people are: mango, banana, berry (boroi), wood apple, tamarind, guava etc. With regards to utilization and annual return, the homestead habitat is the highest productive land. In addition to providing food, fodder, medicine and other household requirements, homestead vegetation is also the major source of timber and renewable biomass energy. Bamboo bushes are commonly found in each homestead and are a big source of earning also. Figure 5.13 illustrates dominant tree species of homestead vegetation according to canopy coverage.

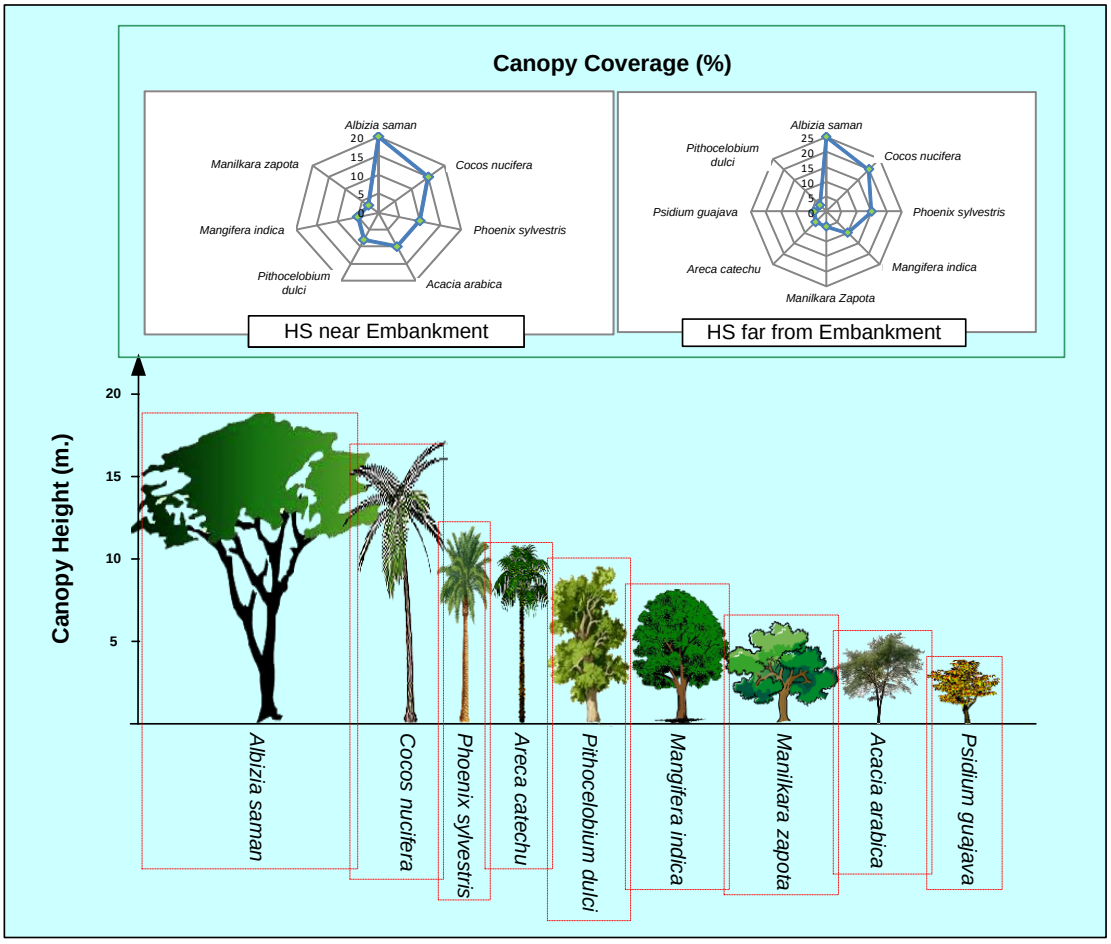


Figure 5.13: Profile of the Species of the Major Homestead Trees by Canopy Height and Coverage

214. Many species of undergrowth wild plants are found in homestead vegetation and village groves. Among this type, Swetkan (*Euphorbia thymifolia*), Bhuiamla (*Phylanthus niruri*), Nata (*Caesalpinia bonduc*), Dudhikalmi (Ipomoea alba) are common. Sezi (*Euphorbia antiquorum*) and Jiga (*Lenneacoro mandelica*) are indicative fencing plants followed each homestead boundaries of this polder area. Major homestead plants including their status and importance are presented in Table 5.15.

Table 5.15: Major Trees Species within the Homestead Area

Tree Species Name	Family Name	Local Status	Saline Susceptibility	Habit	Utilization	Ecological Value
Battle nut (*Areca catechu*)	Palmae	VC	2	Monocot	Fruit and Thatching	3
Coconut (*Cocos nucifera*)	Palmae	VC	3	Tall monocot	Fruit and Thatching	1,2
Mango (*Mangifera indica*)	Anacardiaceae	C	1	T	Fruit and timber	1,2
Black berry (*Syzygium* sp)	Myrtaceae	C	1	T	Fruit and timber	1,2
Banana (*Musa* sp	Musaceae	C	2	H	Fruit	1,2,3
Sapota (Safeda) (*Manilkara zapota*)	Zapotaceae	VC	2	T	Fruit	1
Bot(*Ficus benghalensis*)	Moraceae		1	T	Timber	1,2,3
Babla (*Acacia nilotica*)	Fabaceae	VC	3	T	Timber, fuel wood and fruit	1,2,3
Khai Babla (*Pithecolobium dulce*)	Mimosaceae	VC	2	T	Timber, fuel wood and fruit	1,2,3
Akashmoni (*Acacia auriculiformis*)	Mimosaceae	O	2	T	Timber and fuel wood	3
Gab(*Diospyros perigrina*)	Ebenaceae	C	2	T	Fruit and fuel wood	1,2
Berry (*Zizyphus* sp)	Rhamnaceae	C	2	T	Fruit and fuel wood	2
Date (*Phoneix sylvestirs*)	Palmae	VC	3	Monocot	Fruit	1,2
Bamboo (*Bamboosa* sp.)	Gramineae	C	1	CL	Thatching	1,2,3
Wood apple (*Agle marmelos*)	Rutaceae	R	1	T	Fruit and Medicine	2
Tamarind (*Temarindus indica*)	Leguminosae	VC	2	T	Timber and Fruit	2
Nim (*Azadirachta indica*)	Meliaceae	VC	2	T	Timber and fuel wood	2
Ipil ipil (*Leucauna laucocephalata*)	Mimisaceae	C	2	T	Timber	2
Sirish(*Albizia lebbeck*)	Leguminosae	VC	2		Timber and fuel wood	2
Palm(*Boassus flabelifer*)	Palmae	VC	2	Tall monocot	Fruit and thatching	1,2
Guava (*Psitium guajava*)	Myrtaceae	VC	2	T	Fruit	2
Jambura(*Citrus fistula*)	Rutaceae	C	1	T	Fruit	2
Fig (*Ficus religiosa*)	Moraceae	C	2	S	Fruit , Fuel wood	2,3

Tree Species Name	Family Name	Local Status	Saline Susceptibility	Habit	Utilization	Ecological Value
Tulshi (*Ocimum americanum*)	Labiatae	VC	1	H	Medicine	3
Jackfruit (*Artocarpus heterophyllus*)	Moraceae	O	1	T	Timber and fruit	1,2
Mahogany (*Swietenia mahagoni*)	Meliaceae	C	2	T	Timber and medicine	2
Sezi (*Euphorbia antiquoram*)	Euphorbiaceae	VC	3	S	Fencing and Medicine	1,2,3
Jiga (*Lenneacoro mandelica*)	Anacardiaceae	VC	2	S	Fencing	2,3
Thespiciapopulina	Malvaceae	C	4	T	Fuel and Timber	2

Note: Local Stratus: C= Common, VC = Very Common, O = Occasionally, R= Rare

Habit: T= tree, H= Herb, S= Shrub, V=Vine; VC= Very Common, C= common, UC= Uncommon CL=Clump

Saline Susceptibility: 1 = Highly Susceptible, 2 = Moderately Susceptible, 3 = Slightly Susceptible, 4 = Resistant

Ecological Value: 1 = For Wildlife, 2 = For Avifauna, 3 = For micro-Ecosystems

Picture 5.10: Homestead Vegetation

Crop field vegetation

215. The net cultivated area in the polder area is 1,070 ha. Land is used mainly for LT Aman in rain feed condition in Kharif–II season while, in Kharif-I season land remains fallow. In Rabi season farmers grow sesame, watermelon, mungbean, sunflower and very little vegetables. Varieties of crops and cropping patterns have been discussed in the agricultural section of this report.

Picture 5.11: View of Sesame Field in the Polder 22

Fallow land vegetation

216. A part of crop fields remains seasonally fallow for 3-4 months (March – June) of a year when grassy vegetation with some other wild herbs grow in the fallow land. Durba (Cynodon sp.)is prevalent with Echinocola, Brachiara, Digiteria, Hemarthrira, cyperus and Paspalum spp. among the grass species. Croton, Xanthium, Amaranthus also grow sporadically along with grasses. The seasonal fallow lands have important roles in ecosystem functioning as they support grazing for cattle, feeding and breeding habitats of many arthropods, reptiles and avifauna which is shown in Figure 5.14. However, vegetation in fallow land has been decreasing with increased intensity of soil salinity especially at the southern portions of the polder, especially during the dry season (late December to late April) when the grazing land has shortage of grass. This is due to salinity which acts as the main barrier for the grasses to grow.

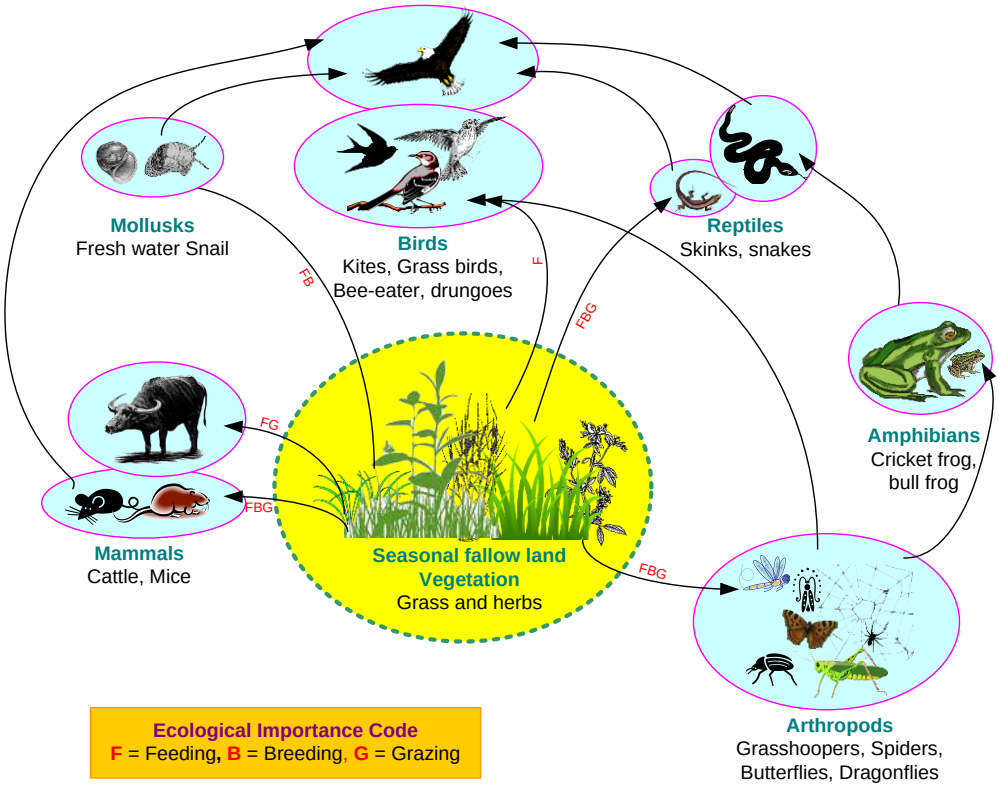


Figure 5.14: Ecological Importance of Seasonal Fallow Land's Vegetation for Different Faunal Communities along with Partial Food Web

i. Embankment/Roadside vegetation

217. Major species found along the village roads are: Sirish (*Albizia odoratissima*), Babla (*Acacia nilotica*), palm (*Boassus flabelifer*), coconut (*Coccos nucifera*), battle nut (*Areca catechu*), and date (*Phoenix sylvestris*) etc. The roads which have passed between two homesteads mostly have Jiga (*Lennea coromandelica*) and Khejur as these have been planted for fencing as well as peripheral plants. Akand (*Calotropis procera*), Vaant (*Clerodendron viscossum*), sech/sezi (*Euphorbia grandialata*) and Hatisur (*Heliotropium indicum*) are common wild shrubs and herbs sighted along most of the roadsides.

218. Riverside embankment is exclusively dominated by Babla (*Acacia Arabica*) and Sirish (*Albizia odoratissima*) which can adapt to salinity as well as low moisture in soil. These plants are mostly planted by villagers for providing timber and fuel wood. Vegetation of this type supports good habitats for local avifauna. Figure 5.15 presents ecosystem diversity and vegetation composition and plant diversity according to soil salinity in the polder area.

Picture 5.12: Rows of Babla tree along the embankment sides at the polder

Picture 5.13: A portion of internal village road showing Jiga and Khejur plant

Figure 5.15: Ecosystem Diversity and Vegetation Composition with Major Plant Species according to Soil Salinity in the Polder Area

(b) Terrestrial Fauna

Amphibians

219. Amphibian species favour wetland areas and the marginal dried areas. Common toad (*Bufo melanostictus*), bull frog (*Hoplobactruchus crassus*), cricket frog (*Rana cyanophlyctis*) and tree frog (*Rana temporalis*) are commonly found in the polder area. Presence of small ditches, homesteads ponds and marginal areas of internal canals favour all of these amphibian species.

Reptiles

220. Among the reptiles, House Lizard (Hemidactylus brookii), Common Garden Lizard (*Calotes versicolor*), Common Kukri Snake (*Oligodon arnenesis*), Buffstriped Keelback (*Amphiasma stolata*), Rat Snake (*Ptyas mucosus*) and Monocellate Cobra (*Naja kaouthia*) have been seen within polder area. Homestead, cropland and garden vicinity are the habitats of these species.

Mammals

221. Local farmers reported that the population of mammalians is very low in the polder area. Big mammals have already disappeared, because of change of land use and different human activities. According to the farmers, it is reducing since the last 6-10 years, as jungle area is reducing. Common mammals inhabit in village grooves, road and embankment sides and crop fields. Small mammals, such as the jackal (*Canis aureus*), grey mask shrew (*Suncus murinus*), small Indian civet (*Viverricula indica*), common Mongoose (*Herpestes edwardsii*), jungle cat (*Falis chaus*), Bengal bandicot rat (*Bandicota bengalensis*), common house rat (*Rattus rattus*), squirrel (*Cllosciurus pygeryhrus*) and bats like short-nosed bat (*Cyynopterus sphinx*) are found in the polder area.

Avifauna

222. Terrestrial birds can be divided into two major groups: birds observed in floodplains and wetland, and birds observed in dry habitat such as homestead, open woodland, scrub and grass land. Birds of prey survive well in the area. Common bird of prey species found in the polder area are Brahminy kite (*Heliastur indus*). Other common bird species in the project area are common myna (*Acridotheres tristis*), red-vented bulbul (*Pycnonotus cafer*), oriental magpie robin (Copsychus saularis), spotted dove (*Streptopelia chinensis*), blue rock pigeon (*Columba livia*), black Drongo (*Dicrurus macrocercus*), Asian Koel (*Eudynamys scolopacea*), and large-billed crow (*Corvus macrohynchos*).

5.2.11 Aquatic Ecosystem

223. Aquatic ecosystems of the polder area can be divided according to wetland types and its duration of water holding period. The polder and its surrounding area contain different types of wetlands like rivers, canals, homestead ponds and intertidal plains

224. The polder is surrounded by three rivers (Bhadra, Badurgachi and Habarkhali) those contain tidal flow throughout the year. But water salinity of these rivers varies in different seasons. Numerous canals have crisscrossed through all over the polder area and some of which are connected with surrounding rivers. Most of the canals are shallow and silted up from a long time. Only the reaches near rivers hold tidal water throughout the year. Canals of this polder have a major contribution in keeping the drainage facility for the polder area. Each of the homesteads contains one or two ponds inside the polder holding fresh water for whole of the year.

225. Inter tidal plains exist outside the polder between the embankment and the river. Fluctuation of water level due to regular tidal effect creates this land as a different form of wetland to support succession for saline tolerant flora as well as a number of crustaceans, fishes, mudskippers and shorebirds. The intertidal plains of this polder are now compartmentalized with numerous pockets for doing shrimp culture. For this reason, inter tidal area is losing its original characteristics day by day.

a. Aquatic Flora

226. Aquatic floras mainly concentrate in internal canals and homesteads ponds. Due to having continuous tidal water flow in the channels of the rivers, aquatic macrophytes do not grow nor develop inside or along the bank line. Hence, no aquatic vegetation is observed in the river and river side canals. Within the polder area the ponds and khals contain different types of aquatic floras such as free floating, rooted floating, submerged and amphibian vegetations like sedges and meadows. Water hyacinth (*Eichhornia crassipes*), Kutipana

(*Azolla pinnata*) and Khudipana (*Lemna perpusilla*) are also common species among the free floating type.

227. Submerged plants in both perennial and seasonal wetlands are Jhangi (Hydrillaverticillata), Ghechu (*Aponogeton natans*), Bicha (*Vallisneria spiralis*) etc. Almost all of these plants belong to closely related families like Aponogetonaceae, Hydrocharitaceae and Potamogetonacea.

228. Sedges and meadows are amphibian species. This type of vegetation has the highest species density and one of the most important wetland's plant communities in the polder area. They include Dholkolmi (Ipomoea aquatic) and Kochu (*Colocasia* spp.) etc.

229. Throughout the intertidal plains, some species of brackish grasses (like *Paspalumscro biculatum*) are dominant. In addition, sporadic patches of Gewa (*Ecocaria agallocha*) trees are observed on the torus and along riverside toe of the embankment. Aquaculture in this tidal plain hinders regular tidal fluctuation that decreases succession of natural vegetation and reduced habitat suitability of dweller animals.

b. Aquatic Fauna

230. The life cycle of aquatic fauna is dependent on seasonal variation as well as inundation depth and availability of water in all types of wetlands. Naturally, wetlands provide food and shelter to the aquatic fauna. Compared to other polders, this polder has lower population and diversity of aquatic fauna. Siltation of internal canals, compartmentalization of intertidal area and application of pesticides are the major causes of poor faunal diversity. A brief description of aquatic fauna is presented below.

Amphibians

231. Among amphibians, the skipper frog (*Euphlyctis cyanophlyctis*) is common and found in all wetland and has been the most successful in adapting to the existing habitats. Bullfrogs (*Hoplobactruchus tigerinus*) are also found frequently during monsoon.

Reptiles

232. Snakes are the main type of aquatic reptiles of the polder area. Common aquatic snakes include the checkered keelback (*Xenocrophis piscator*), smooth water snake (*Enhydrisen hydris*), rat snake (*Ptyas mucosus*), common wolf snake (*Lycodon aulicus*) are commonly found in all types of wetlands.

Avifauna

233. Availability of small fishes in all types of shallow wetlands support feeding habitats to the aquatic avifauna. The aquatic bird like little egret (*Egretta garzetta*), Great Egret (*Casmerodiou salbus*), common kingfisher (*Alcedoa atthis*), little cormorant (*Phalacrocorax niger),* Grey Heron (*Ardea cinerea*) are frequently found along mudflats, canal systems and seasonal wetlands throughout of the year. During winter, few numbers of migratory birds roam along the riverside of the polder.

5.2.12 Ecosystem Goods and Services

a. Output of Ecosystem Services

234. Biological diversity in ecosystem plays key role in producing goods and regulating ecosystem services. Goods produced by ecosystems include food (meat, fish, vegetables etc.), water, fuels, and timber, while services include water supply and air purification, natural recycling of waste, soil formation, pollination, and the regulatory mechanisms that

nature left to itself, control climatic conditions and populations of animals, insects and other organism(European Commission, 2009) providing beauty, inspiration, and recreation etc.

235. Homestead vegetation is very important for fruit production. Banana (*Musa* Spp), mango (*Mangifera indica*), guava (*Psidium guajava*), coconut (*Cocos nucifera*), betel nut (Areca catechu), etc and various types of fruit species are also a big output from homestead vegetation. Timber for house and furniture are provided from homestead's timber trees. Homestead vegetation also provide important habitat of wildlife like bamboo grove, scrub jungle etc. are habitats for birds, reptiles and small mammals. Total amount of fish production is included in the fisheries section of this report. Aquatic plants and micro organisms are important for fishes and also have the role to keep a balanced ecosystem of a wetland. Product of ecosystem and its services in Polder 22 are given in Table 5.16.

Table 5.16: Ecosystem Product and Its Services in the Polder Area

Item	Source	Use
Food	Betel nut (Areca catechu), coconut (*Cocos nucifera*), Mango (*Mangifera indica*), black berry (*Syzygium* sp), banana (*Musa* sp), sapota (*Manilkara zapota*), guava (*Psidium guajava*), etc	Fruit
	Ghechu (*Aponogeton* spp.)	Rootstock
	Helencha (*Enhydra fluctuans*) and Kolmishak (*Ipomoea aquatica*)	Leaf and stem
Fodder	Water hyacinth, (*Eichhornia crassipe*), Phutku (*Hygroryza aristata*) etc.	Leaf and stem
Wood, timber	Mango (*Mangifera indica*),Jam (*Syzygium* sp), Bot(*Ficus benghalensis*), Babla(*Acacia nilotica*), Mahogany (*Swietenia mahagoni*),	Trunk
Medicine	Mahogany (*Swietenia mahagoni*), Tulshi(*Ocimum americanum*),Sezi (*Euphorbia antiquoram*), wood apple (*Agle marmelos*),Nim (*Azadirachta indica*)	Roots, Leaf, Stem
Thatching and mat making	Cyperus platystylis, betel nut (*Areca catechu*), coconut (*Cocos nucifera*),bamboo (*Bamboosa* sp.),wood apple(*Agle marmelos*),palm (*Boassus flabelifer*)	Thatching and fencing for huts and as protective screen in homestead.
Fuel	Babla (*Acacia nilotica*), Akashmoni (*Acacia auriculiformis*) Boroi (*Zizyphus* sp), Gab(*Diospyros perigrina*) etc.	Brunches, Leaf
Biofertilizer/Guano	Water hyacinth	As compost,
Hydroponics	Water hyacinth to make baira (floating platforms)	to grow seedlings and vegetables
Bio-gas	Water hyacinth, Khudipana (*Lemna* and *Spirodela* sp.) and other aquatic plants.	All parts of the pant

Source: Field Survey, 2014

b. Evaluation of Ecosystem Services

236. A number of the household owners earn bulk amount of cash each year by selling fruits like coconut, betel nut, mango, banana, guava etc. The estimated average amount of earning from fruits per household is about 1800 tk/year and 200 tk from hard wood/timber. Homestead vegetation is another important source of fuel wood worth of about 6,000tk/year/household. Bamboo groves have an important contribution to provide thatching and house making materials. Table 5.17 provides a list of major timber yielding plants and its local prices.

Table 5.17: Major Timber Yielding Trees and Their Approximate Value/Rate in the Polder Area

Sl. No.	Species name	Family name	Value/CFT (Taka)
1	Sirish (*Albizia saman*)	Leguminosae	500-800
2	Akashmoni(*Acacia moniliformis*)	Mimosaceae	550-750
3	Koroi (*Albizia procera*)	Leguminosae	350-400
4	Chambol (*Albizia richardiana*)	Leguminosae	250-300
5	Aam (*Mangifera indica*)	Anacardiaceae	200-250

Source: CEGIS Field survey, 2014

5.2.13 Existence of Protected Area/ Important Habitat

237. No Ecologically Critical Area (ECA) or designated protected area is located within or near the polder area.

5.2.14 Present threats on ecosystem

238. Soil salinity and internal canal bed siltation are the main threats to the ecosystems of this polder. Salinity in the settlement area near the embankment is higher than in the central portions of the polder as river water remains saline for more than 8 month of the year. Intrusion of saline water creates stress on vegetation and its succession. Reduction of water conveyance capacity reduces soil moisture that hampers natural succession at canal side. In addition, riverbank erosion is also another threat that destroys homestead vegetation in each year. Non-functioning of water control structures like regulators, causes insufficient drainage and flashing capacity of the polder area that damages vegetation. Loss of vegetation density and succession ultimately impact on wildlife habitats.

5.2.15 Livestock and Poultry

239. A large number of the population of the polder area earns their livelihood through work associated with raising livestock / poultry. About 60% of the households are rearing cows/ bullock, 30% goat, and 8% sheep, while 70% raise chicken, 55% duck, and 20% rear pig. According to the local people, there are 83 small and 5 medium poultry farms in the polder area. Detailed status of livestock and poultry in the household level is presented in Table 5.18.

Table 5.18: Detailed Status of Livestock/Poultry in the Polder Area

Live Stock/Poultry	% of Household	Number of Livestock/ Poultry in the Polder Area
Cattle/cow/bullock	60	2,742
Goat	30	2,057
Sheep	8	183
Chicken	70	1,600
Duck	55	7,541
Pig	20	914

Source: Based on field information and ULO, DLS, 2014

Picture 5.14: View of Poultry Farm in the Polder 22 Area

Picture 5.15: View of hatching in the Polder 22 Area

Picture 5.16: View of Pig-Pen in the Polder 22 Area

Picture 5.17: View of Sheep in the Polder 22 Area

Feed and Fodder of livestock

240. The owners of the livestock population are facing problems in respect of availability of fodder and feeds during the monsoon season due to non-availability of grazing land. During monsoon, aman crops remain in the field, when rice straw is the main sources of fodder. In addition, rice husk and oil cakes, etc. are other common fodders in this polder area. But, during the dry season (especially from late December to late April) there is grazing land but shortage of grass due to salinity which acts as the main barrier for the grasses to grow. Poultry population and duck at family level survives by scavenging and generally no feed supplements are provided.

Livestock and Poultry Diseases

241. Productions of livestock and poultry are mainly constrained due to diseases and death of the population. Every year livestock population is affected by different diseases like Tarka; Anthrax, Foot and Mouth Disease (FMD), Black Quarter (BQ) and Hemorrhagic Septicemia (HS). Diarrhoea and Pest Des Petits Ruminants (PPR). Major poultry diseases are duck plague, Ranikhet (Newcastle), Fowl Pox and Fowl cholera. During monsoon season, the soggy condition of the animal shelter promotes various kinds of diseases to the bullock and cows. Moreover the unhygienic condition of the courtyard during this season increases the diseases of poultry birds. However, there is vulnerable period in between July to October (rainy season) months for spreading diseases to livestock and poultry population. Three pigs rarer informed that they have not observed any pig disease.

5.3 Environmental Quality

5.3.1 Sound Quality

242. Polder 22 is a rural area relatively quiet in nature. There is a bazaar which is the only place where gathering which takes place once in a week. Other than that there is no such office, industries or heavy vehicular movements. Noise levels in the study area have been measured during the field visit in May 2014. Location of measurement have been selected considering some criterion like location of project interventions and other secondary activities which may generate sound, elements like settlements, schools which are likely to be affected by any anomalies in sound levels. The measured values of sound level are given in Table 5.19.

Table 5.19: Sound Levels for Different Locations in the Study Area

Location	GPS reading	Sound (dB)	Standard level	Deviations from standard
Durgapur sluice	22º37'31.3''N 89º25'22.9''E	53-68	50 dB during daytime (Residential Zone)	21%
Noai (Mujibur Professor's House)	22º35'22.8''N 89º24'54.1''E	55-65		20%
FulbariKhal	22º37'31.3''N 89º25'22.9''E	55-60		20%

Source: CEGIS Field Survey, May 2014

243. According to ECR 1997, the study area can be regarded as residential zone where the standard noise level is 50 dB during day time. During the visit, the observed levels are found to be about 20% higher than the standard level.

Picture 5.18: In-situ water quality measurements

5.3.2 Water Quality

244. Five major water quality parameters of surface water have been measured in May 2014, in six locations of the study. One snap of water quality measurement is shown in Picture 5.18. The in-situ measurement results are given in Table 5.20. The pH values in these locations are higher than the neutral value (pH=7) which means the water in these locations is alkaline in nature. Local people opined that the typical pre-monsoon rainfall did not start until then which may be the underlying factors of such alkalinity. Values of TDS were found very high (1600 ppm to above 1960 ppm) in the outside portion of the polders as usually coastal rivers carry more sediment. Values of DO were mostly found close to the standard values set by DoE for both irrigation (5 to 6 mg/l) and fishing (5 mg/l) (MoEF, 1997).

Table 5.20: Water Quality Parameters

Location	GPS reading	Sampling Water Source	pH	TDS (ppm)	Temp. (ºC)	DO (mg/l)	Salinity (ppt)
Durgapur sluice (river side)	22º37'31.3''N 89º25'22.9''E	SW	8.5	>1960	31.8	5.9	16
Noai (river side)	22º35'22.8''N 89º24'54.1''E	SW	8.1	>1960	31.3	6.2	17
Fulbari Khal (river side)	22º37'31.3''N 89º25'22.9''E	SW	8.7	1300	33.8	5.5	20
Teli Khali Sluice(river side)	22º37'36''N 89º27'31.6''E	SW	8.9	1600	29.2	5.4	4
Manik Khali(country side)	22º35'34.3''N 89º24'50.1''E	SW	8.4	1200	30.7	6.5	5
Hatbari Edge (country side)	22º37'32.7''N 89º26'50.0''E	SW	8.3	600	28.5	4.9	-
Hatbari (inside poldrt)	22º37'37.8''N 89º26'46.2''E	GW	-	-	-	-	3
Tube well (inside polder)	22º37'37.8''N 89º26'41.7''E	GW	-	-	-	-	4

Note: SW: Surface Water and GW: Groundwater. Source: CEGIS Field Survey, May 2014

245. In addition to the surface water sources, salinity was measured from two ground water locations. Salinity values of water outside of the polder were found to be approximately five times higher than that of water inside the polder (Table 5.2). Also spatial variation was found in salinity concentration outside the polder, from downstream to upstream like locations in the southern direction had higher salinity. In the month of May, highest salinity was observed as 20 ppt in Fulbari Khal. The two ground water locations had salinity values of around 3 to4 ppt which is not suitable for drinking purpose. Local people opined that this situation prevails around half of the year, when they have to purchase processed mineral water to meet up their drinking water needs.

5.4 Climate Change

5.4.1 Climatic Trends

246. Khulna is identified as one of the 15 most climate change vulnerable areas of the world. Cyclone, storm surge induced flooding, riverine coastal flooding, water logging, salinity intrusion and coastal erosion are the main climate and hydrologic hazards in the area. Commissioning of the Farakka Barrage on the Ganges River in India in 1975 has reduced the fresh water inflows to the region, and construction of coastal polder has gradually reduced the flood-plain storage areas for tidal waters from the Bay of Bengal (Mondal, et al, 2012).

247. The following sections provide a comprehensive discussion on the trends in temperature, sunshine hour, humidity, rainfall in Khulna, and trends of variation in annual maximum and minimum tidal water levels at Sutarkhali F.O. station in Sibsa River, a location which is around 11 km downstream of Polder 22.

Temperature

248. The average maximum temperature during the monsoon season in the polder area is rising at 0.037°C per year and the average minimum temperature during the winter season is rising at 0.047°C per year. The temperature of extremely cold nights is less than or equal to 9.7°C. However, the extremely hot days having temperature greater than or equal to 37.2°C was found not to be changing significantly (Mondal, et al, 2012).

249. The number of extremely cold nights having temperature less than or equal to 9.7°C, which corresponds to the 10th percentile of the daily minimum temperature in the month of January, was found to be decreasing. However, the number of extremely hot days having temperature greater than or equal to 37.2°C, which corresponds to the 90th percentile of the daily maximum temperature in the month of April, was found not to be changing significantly. The long-term temperature data indicated an increasing trend in the diurnal temperature range in the difference between the daily maximum and minimum temperatures during the months of May to October. However, such trends have not become significant and deceasing in recent years (Mondal, et al, 2012).

Sunshine

250. There is a decreasing trend in seasonal sunshine durations, except for the monsoon season. The average durations of sunshine in the winter, pre-monsoon, monsoon and post-monsoon seasons were found to be about 7.7, 8.0, 4.9 and 7.4 hours a day, respectively. The decreasing trend in the winter season is about 0.6 hours a day per decade, which is equivalent to a decrease of 7.8% in average sunshine duration in a decade. The post-monsoon season has a decreasing trend of 0.4 hours a day per decade, which is equivalent to a decrease of 4.9% in average sunshine duration in a decade (Mondal, et al, 2012).

251. On a monthly scale, the sunshine duration has a decreasing trend for all months, except for June, July and August. The trends in December and January of the winter season are statistically significant at 99% and 95% level of confidence, respectively (Mondal, et al, 2012).

Humidity

252. The relative humidity at Khulna has increasing trends of 2.3%, 1.3% and 0.3% per decade in the winter, post-monsoon and pre-monsoon seasons, respectively. In contrast, the monsoon season has a decreasing trend of 0.4% per decade. The trends in the winter and post-monsoon seasons are significant at a level of confidence of 99%. The decreasing trend at the monsoon season is significant at a lower level of confidence (90%). The trend of the pre- monsoon season is not significant (Mondal, et al, 2012).

253. There are two likely reasons for increasing trend of humidity: one due to increases in temperature and the other due to increases in wetness of land surface. Though the temperature has an increasing trend in the country, the combined effect of temperature, sunshine and humidity on potential evapotranspiration is found to be negative, rather than positive. Since the irrigated area in the country has witnessed a phenomenal increase over the last three decades, particularly in the dry season (November-May), which also coincides with the periods of higher increases in humidity and decreases in sunshine, it is most likely that the irrigation development (along with the shrimp aquaculture in the polder area) for rice cultivation using standing water on firms has contributed largely to the increase in humidity in Bangladesh (Mondal, et al, 2012).

Rainfall

254. The analysis of rainfall data for a period of 63 years (1948-2010) at Khulna indicates that the rainfalls have increasing trends of 8 mm, 31 mm, 9 mm and 6 mm per decade during the winter, monsoon, post-monsoon and pre-monsoon seasons, respectively. The trend in the winter season is significant at 95% level of confidence and that in the monsoon season is significant at 80% level of confidence. However, the trends in the pre and post- monsoon seasons are not significant at 80% level of confidence. Among the monsoon months, June has a non-significant negative trend of 6 mm a decade, July has a non-significant positive trend of 5 mm a decade, August has a positive trend of 14 mm a decade being significant at 80% level of confidence, and September has a positive trend of 7 mm a decade being significant at 90% level of confidence. Thus, the monsoon is found to be strengthening towards the end of the season. The annual total rainfall is found to be increasing at 53 mm a decade which is significant at 95% level of confidence (Mondal, et al, 2012).

255. The number of rainy days in a year is found to be increasing at 0.8 days per annum, which is significant at 99% level of confidence. The numbers of rainy days during the wet (June-October) and dry (November-May) seasons show increasing trends of 0.6 days and 0.2 days a year, respectively. Both these trends are significant at 99% level of confidence. The nonparametric technique results show similar trends, both in magnitudes and significance levels. The maximum number of consecutive rainy days in a year is found to be increasing at 99% level of confidence. The maximum number of consecutive non-rainy days in a year is found to be decreasing at 99% level of confidence. The nonparametric technique results slightly lower decreasing trend than the parametric technique in case of consecutive non-rainy days (Mondal, et al, 2012).

256. The maximum rainfalls in one day, in consecutive 3 days, and in consecutive 7 days, though increasing, are not statistically significant. Also, the numbers of days with rainfall of more than 50 mm and 100mm, though show increasing trends, are not statistically significant. Nevertheless, climate model results indicate an increase in the frequency of extreme rainfall events of shorter duration (6 hours) at Khulna in future. The rainfall trend is found to be consistent, in general, with the sunshine and humidity trends at Khulna and Satkhira (Mondal, et al, 2012).

Tidal Water Level

257. The analysis of tidal water levels in Sibsa river at Sutarkhali F.O. station, Khulna for a period of 33 years (1968-2001) indicates that the annual maximum high tidal water levels are increasing at a rate of 25 mm per year and the annual minimum low tidal water levels are decreasing at a rate of around 18 mm per year (Figures 5.9 and 5.10). Confidence level of 90% indicates a range of $0.41 \leq R2 \leq 0.74$ for High Tidal Water Levels, and $0.31 \leq R2 \leq 0.67$ for Low Tidal Water Level. The station at Sutarkhali F.O. is located around 80 km away from the sea coast and it is understood that the extremes in tidal water levels are more prominent in inland areas compared to those near the sea. The possible reasons for the decreasing trends in annual minimum water levels at Sibsa River could be the reduction in fresh water flow from upstream areas or the reduction in storage areas of saline tidal water or both. The increasing trends in annual maximum water levels could result either from silting up of the rivers, reduction in flood tide propagation areas, or a rise in the sea level, or a combination of these factors. However, if sea level rise had any effect on the observed trends, the effect had been much lower than that of anthropogenic interventions as the high and low tidal levels have significant opposite trends. The rising trend in high tidal water level can be explained by a sea level rise phenomenon but not the falling trend in the low tidal water level. The embankments constructed around each polder blocked the entry of tidal waters into the

polders. As a result, heavy loads of silt, carried by the tides, settled on the river beds, which gradually rose above the levels of the lands within the polders and closed the exits of the sluices. Simultaneously, subsidence continued within the polders without having compensating silt deposits. These coastal polders and the Farakka barrage had contributed to the gradual siltation of the coastal rivers and are the principal factors contributing to the tidal water level extremes.

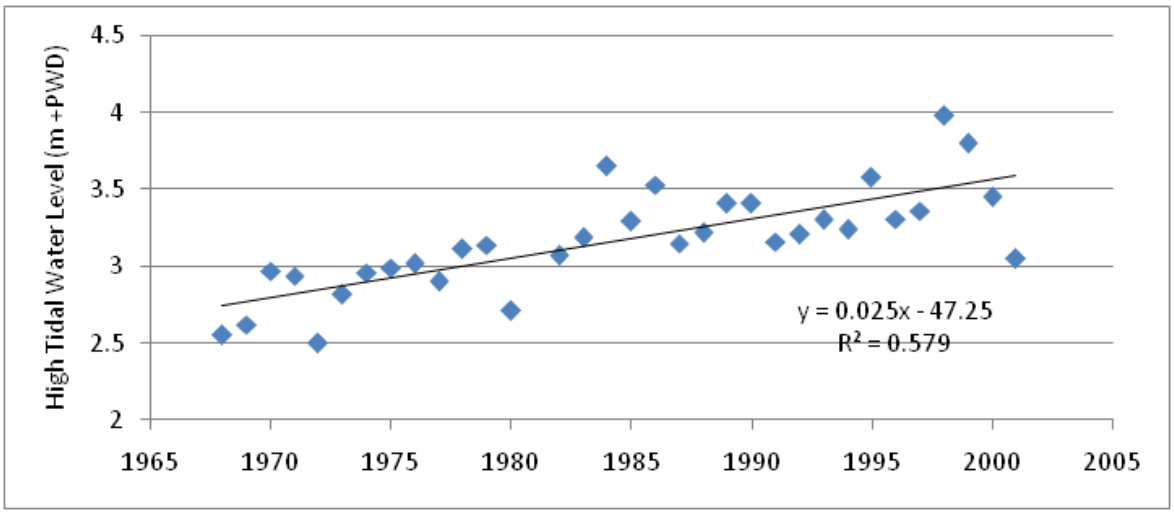


Figure 5.16: Trend in Annual Maximum High Tidal Water Levels (2001)

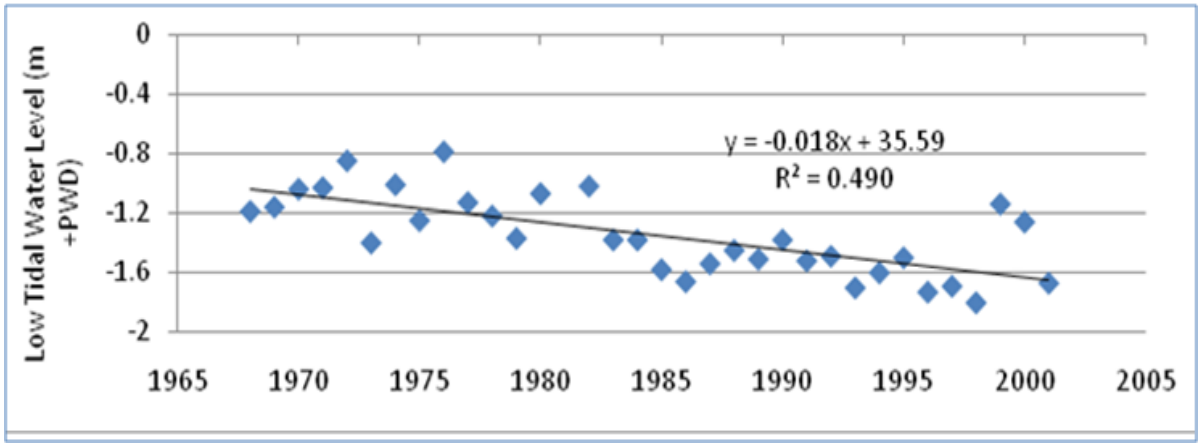


Figure 5.17: Trend in Annual Minimum Low Tidal Water Levels.

5.4.2 Climate Change Projection

258. Two greenhouse gas emission scenarios, A2 and B1, from the Special Report on Emissions Scenarios by the Intergovernmental Panel on Climate Change (IPCC) were used because they represent the high and low brackets of the estimated global temperature increases under the report story lines. A2 is the business-as-usual scenario, a very heterogeneous, market-led world, with high population growth, slow economic development, and slow technological change. B1, however, is the sustainable development scenario, a convergent world with rapid changes in economic structures toward a service and information economy, with resulting lower greenhouse gas emissions (Table 5.21).

Table 5.21: Summary Features of Climate Projections for Khulna

Scenario	A2	B1
Temperature	The average monthly temperature rise by 2050 varies from +0.50C in October to +1.70C in January and February	The average monthly temperature rise by 2050 varies from +0.50C in June, July, and August to +1.50C in February and April.
Rainfall	The annual rainfall increases by about 5% by 2050 (1,860 mm per year) from the reference value (1,769 mm)	The annual rainfall increases by about 9.3% by 2050 (1,739 mm per year) from the reference value (1,591 mm)
Seasonal Rainfall	Increase in July-September by 4.6% and a decrease December-February by 2.6%	Increase in July-September by 10.5% and a decrease in December-February by 46.2%.
Rainfall Intensity	50 mm or more rainfall in 6 hours increases from 4.2 times per year to 5.9 times per year in 2050.	50 mm or more rainfall in 6 hours marginally increases from 4.2 times per year to 4.25 times per year in 2050.

5.4.3 Cyclones and Storm Surges in Polder 22

259. Tropical cyclones from the Bay of Bengal accompanied by storm surges are one of the major disasters in the coastal regions in Bangladesh. The high number of casualties is due to the fact that cyclones are always associated with storm surges, sometimes with surge heights of even more than 9m. For example, the 1876 cyclone had a surge height of 13.6 m and in 1970 the height was 9.11 m (www.ddm.gov.bd). Observing the tracks of different cyclones affecting the country in the last decade, the countries southward portion has been classified into three risk zones namely, high risk zone, risk zone, and wind risk zone (Map 5.5). Polder 22 falls in the wind risk zone which possesses some level of vulnerability due to the strong winds, and surge heights associated with cyclones. And even though none of the recently devastating cyclones i.e. Sidr (2007), Aila (2009), and Mohaseen (2013) directly hit the polder area, there was a notable embankment breach incident at Noai village, in 2007 due to Sidr, which also caused embankment damage at Telikhali.

6 Socio-economic Condition

6.1 Demography

260. There are 2,285 households in the polder area with a total population of 9,311 of which the male female distribution is almost equal. The average male-female ratio is 99 i.e.; there are 99 males per 100 females which is lower than the national figure of 100.3. The density of population is about 1,007 persons per sq. km which is also smaller than the national density of 1,015 persons per sq. km (BBS, 2011). About 71.87% of the total population in the polder area is Hindu while 28 % are Muslim and only 0.09% Christian. The key demographic data of the polder is presented in Table 6.1.

Table 6.1: Demographic Data of Polder 22

HHs	Total Population					
	Both	Male	Female	Hindu	Muslim	Christian
2,285	9,311	4,637	4,675	6,691	2,612	8
-	100%	49.80%	50.20%	71.87%	28.04%	0.09%

Source: Population Census 2011, BBS

6.1.1 Age Composition and Dependency Ratio

261. Table 6.2 shows the age group composition of the people in the polder. From it data it is inferred that the age distribution in the polder is normal and major share (about 64%) of the population belongs to labour force (age between 15 to 59 years). However, it is generally assumed that population aged up to 14 years and above 59 years usually depends on the labour force. Hence, dependency ratio is calculated as the ratio of dependent population to the working age population and for this polder it is 57.

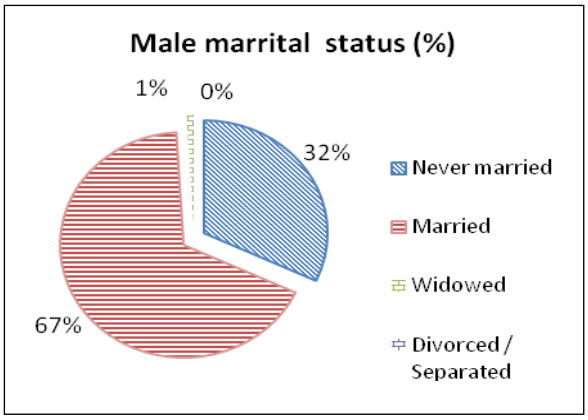
Table 6.2: Age Distribution in Polder 22

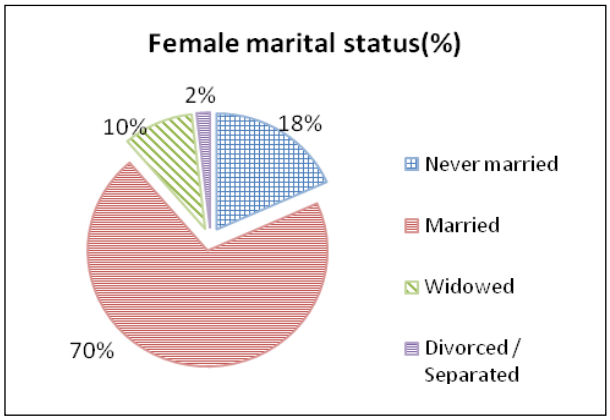
Age Range (Years)	0-4	5-9	10-14	15-19	20-24	25-29	30-49	50-59	60-64	65+
Percent of Population	7	8.6	10	7.5	8.4	9.5	29.5	8.7	3.2	7.6

Source: Population Census 2011, BBS

6.1.2 Marital Status

262. According to BBS, around 69% people are ever married where as 25% people are never married (it includes children). There has been discrepancy seen for male population is (32%) and female counterpart is (18%) in terms of never married persons. It indicates that young people are gradually becoming interested to be involved in business and entrepreneurial activities. Among all population, 5% are widow and 1% is divorced or separated. Following figure (Figure 6.1) shows the marital conditions at polder area.



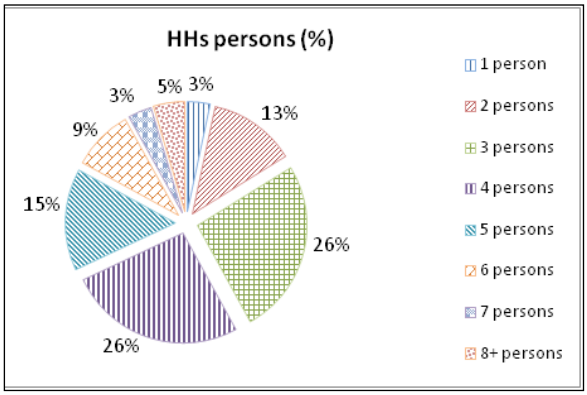


Source: Population Census 2011, BBS

Figure 6.1: Male-Female Marital Status at Polder Area

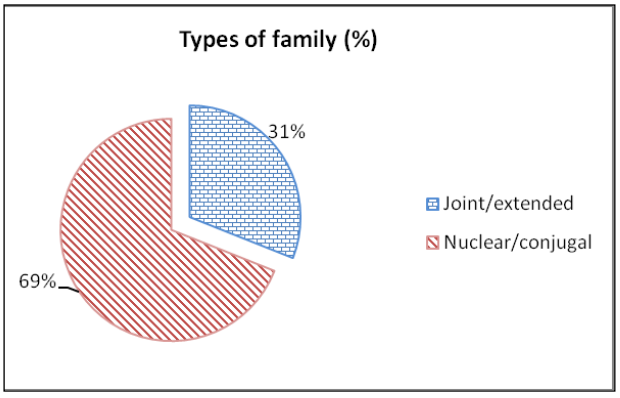
c. Household Size and Types of Family

263. The average household size is 4.07, which is smaller than the national household size of 4.5 (BBS, 2010). In terms of the types of family1, most of the households (69%) live in either a nuclear or a conjugal family while only 31% live in extended or joint family. Distribution of household members and population by types of family are shown in Figure 6.2 and 6.3.



Source: Population Census 2011, BBS

Figure 6.2: Distribution of Household Members at Polder Area



Source: CEGIS fieldwork, 2014

Figure 6.3: Distribution of Population by the Types of Family

6.2 Livelihood

6.2.1 Employment and Occupation

264. The occupation in this polder is not very diversified. Agriculture is the single largest sector providing 98% of the total employment. About 1% population is engaged in salaried service sector and another one percent in industry, petty trading, handicrafts and other manual sectors. (Figure 6.4)

[1]In a case, where a married couple and their unmarried children live together, it is referred to as a nuclear family. On the other hand, a family where only a married couple without any children live together, is referred to as a conjugal family. A family in which relatives-such as grandparents, aunts, or uncles-live in the same home as parents and their children, in known as an extended family (for details, see Schaefer, Richard T. Sociology: A Brief Introduction, Fifth Edition, Macgraw Hill, 2004, Pg-281)

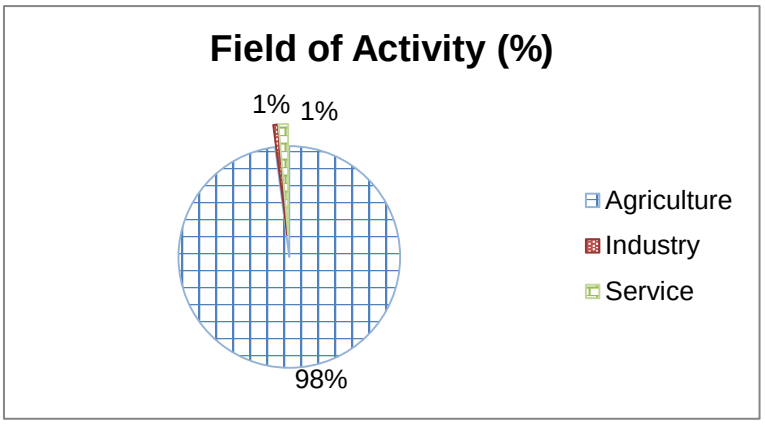


Figure 6.4: Distribution of Population by Field of Activity

Source: Population Census 2011, BBS

265. Field findings also shows that these large section of agricultural group which includes farmer 40%, agricultural labor 30%, fishers 20%, day labors and other 10% etc. there is no mentionable fishery communities in the study area. Besides, those practices agricultural activities during harvesting period, they are also catch fish during monsoon. Local fishers sell bulk of their catch either directly to the local fish market (Fulbaria bazaar, Darulmallik Hat etc.) or to fish traders (Bepari) coming from Khulna and Batiaghata. Due to poor road network, traders from other districts do not come here.

266. There is no fish arat inside the polder. No structured fish landing center is found in the area. Ice is collected from ice plants in Batiaghata bazar and Khulna for ice storing of the harvested fish.

267. Similarly, about 29% of the total population is employed, 50% is engaged in household work, another 20% are not working (it includes children and physically challenged population who are not able to work). Table 6.3 shows the employment status of the people in the polder area. It is observed that most of the women are engaged in household work and are not employed.

Table 6.3: Employment Status in Polder 22

Employed (%)			Looking for Work (%)			Household Work (%)			Do Not Work (%)		
Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total
28.4	0.7	29.1	0.2	0.2	0.4	0.7	49.6	50.3	7.3	12.8	20.1

Source: Population Census 2011, BBS

6.3 Availability of Labor and Wage Rate

268. Field findings reveals that people usually try to cultivate their own land rather than depending on sharecropping system. About 10-12% of total household hire labor for agricultural production. The wage rate varies between 350-400 Tk./day for male whereas women wage rate is about 200-250 Tk. and usually they work 20 days continuously in a month. However, women are mainly engaged in crop agriculture or fisheries sector. During harvesting period, they work with men in the same agricultural field. Some of them also collect fish fry from river or participate in earthwork.

Picture 6.1: Different Modes of Livelihood Activates in Polder Area

6.4 Population Migration

269. Migration scenario is seldom found in the study area. Permanent migration is insignificant in both type of migration (in/out migration). However, seasonal labor migration is common. People from the polder area tend to migrate to Gopalganj, Khulna, Dhaka for search of better livelihood and lack of employment opportunity over the polder (Table 6.4) from April to June. Very few of the households are migrating into city only for work in garments sector. On the other hand, a considerable section of labors (20-25%) migrate to the polder area during cropping period from August-October in a year with a view to subsisting. In terms of in-migrants, most of them are male, aged between 15 to 49 years and are from the economically impoverished segment of the society. On the other hand, out-migrants from the project area are both male and female and from socially deprived segments.

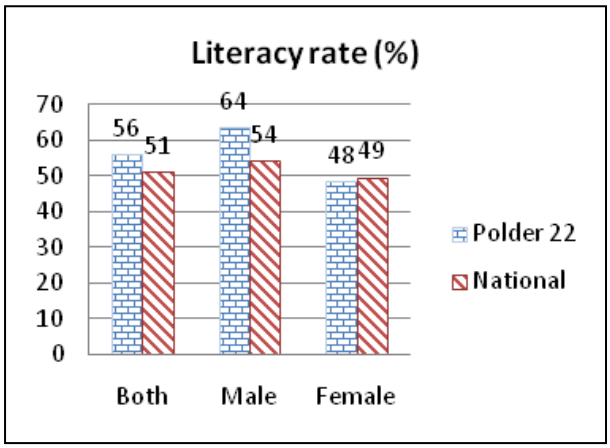
Table 6.4: Migration Status in the Polder Area

Type of Migration	Out Migration		In Migration	
	Place of destination	% of total population	Place of origin	% of total population
Seasonal labor migration	Gopalganj, Khulna, Dhaka	10-12	Periphery from the polder	20-25
Permanent household migration	Khulna, Dhaka	-	-	-

Source: RRA, 2014

6.5 Education

270. The average literacy rate in the study area is about 60% which is higher than national level (51%) (Figure 6.5).It is observed like other parts of Bangladesh that the male population (64%) is more educated than their female counterpart (48%). Local people opined that, unemployment and lack of facilities are the main hindrance behind the development of education among women. But now they perceive that they have to find out the way to overcome this present situation and that only education can lead them towards emancipation. Most of the girls are trying to complete their secondary level and some of them are also going to Khulna or Dhaka for higher study. Similarly, school attendance rate of the female population is poor in the polder area (Figure 6.6).



Source: Population Census 2011, BBS

Figure 6.5: Literacy Rate at Polder 22 Area

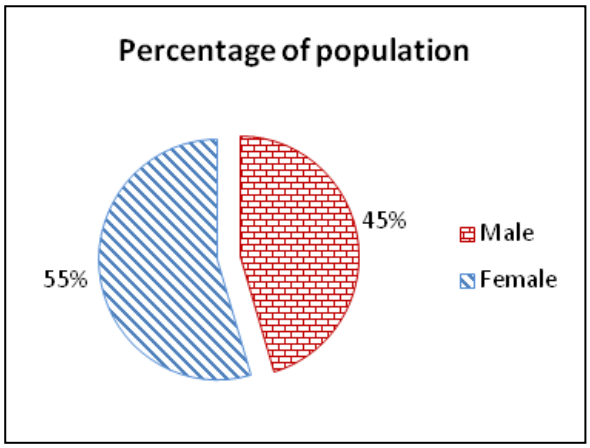


Figure 6.6: Percentage of Population aged 7+ years not attending school

6.6 Health

a. Disease Prevalence

271. The health profile of the local people living in the Polder is presented in the Table 6.6. According to the ranking, the incidence of diarrhoea and dysentery ranked one during the dry season when salinity is high in both surface and ground water. As a result, they are forced to drink water from unsafe sources to get saline free water. Other diseases like cough/cold, skin diseases are also common (Table 6.5).

Table 6.5: Disease Profile in Polder 22

Disease	Ranking by Incidence
Diarrhea/dysentery	1
Skin diseases	2
Influenza/Common fever	3
Hypertension	4
Diabetes	5
Heat stroke	6

Source: CEGIS Fieldwork, 2014

b. Health Service and Facilities

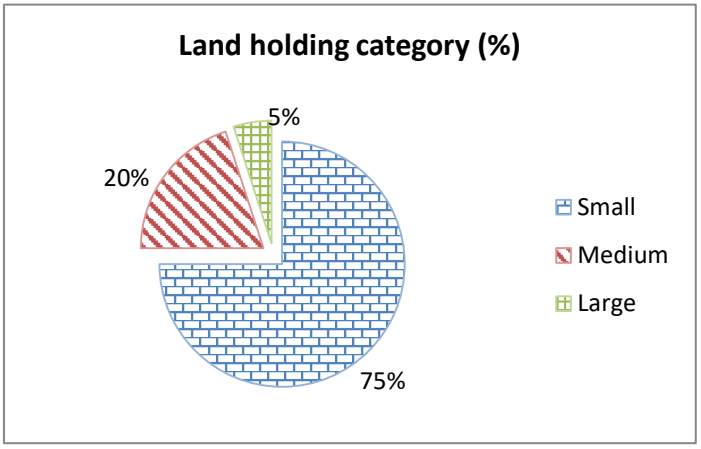
272. Quality of health services and facilities is very poor in the polder. Field findings show that no hospital (private or public) is operating in the polder area. There is only one community clinic in Hatbari village (Picture 6.2) which is at the periphery of the polder wherefrom they receive only primary treatment. In case of serious illness they go to hospitals and clinics of upazila and district centers. It is observed that communication between polder area and upazila is good such that now patients can go to Batiaghata or Khulna for better treatment easily.

Picture 6.2: Only community clinic in the polder area

273. From the field, it is also found that about 40 % people receive health services from quack doctors and 35 % from paramedic/ diploma physicians and only 10 % from trained physicians. It is noteworthy that about 5 % do not receive treatment facility due to their impoverishment and lack of consciousness.

6.7 Landownership and Land Price

274. Landownership pattern[2] can be an indicator to understand the poverty incidence in a given area. Statistics shows that there are 75% small, 20% medium and only 5% large landholders. In the study area, arable land is mainly used for crop production. The large farmers are mostly from absentee category. They are usually living in Khulna or Batiaghata and appoint caretaker to take care of their land. (Figure 6.7).



Source: BBS, Agriculture Census, 2008

Figure 6.7: Landownership Pattern in Polder

275. Land price is increasing day by day in the polder area. As per field findings from RRA, local people opined that agricultural land prices are relatively less than Gher. Price of

[2] Agricultural Census by BBS defined farm holding into three broad categories such as- a) small: having minimum cultivated land 0.05 acre but operated land more than this minimum but upto 2.49 acres; b) medium: having operated land in between 2.50 to 7.49 acres; and c) large: having operated land 7.50 acres and above.

homestead land is the highest in comparison to other land. The detailed land prices are shown in the Table 6.5.

Table 6.6: Sale Value of Land at Polder 22

Land Type	Sale Value	Year
Homesteads land	3-3.5 lacks per decimal (depends on location)	2014
Agricultural land/gher	7000-10000 Tk. Per decimal	2014
Commercial land	1.5-2 lacks per decimal (depends on location)	2014

Source: CEGIS fieldwork, 2014

6.8 Household Income and Expenditure

276. The income and expenditure at the household level in the Polder area is shown in Table 6.7. It is found that most of the people belong to 1,000-2,000 TK per month both in terms of income and expenditure category.

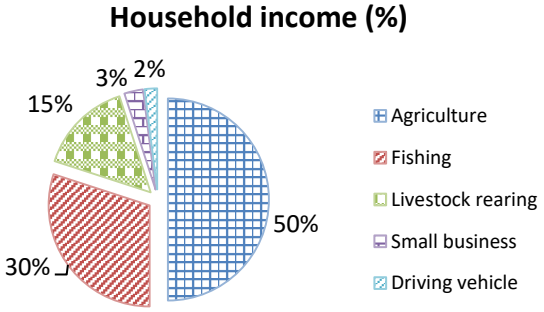
Table 6.7: Monthly Income and Expenditure Level

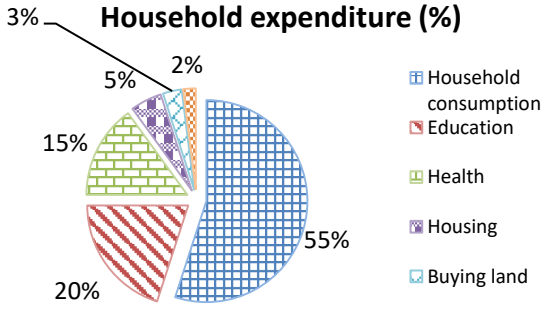
Range in Taka	Percentage of Households	
	Income	Expenditure
Less than 1,000	15	10
1,000 - 2,000	45	48
2,000 – 5,000	25	28
5,000 - 9,000	7	6
9,000 - 20,000	5	5
More than 20,000	3	3

Source: CEGIS Fieldwork, 2014

Sectors of income and expenditure

277. Field findings shows that most of the income comes mainly from two sectors i.e. agriculture (50%) and fishing (30%). On the other hand, most of the expenditure incurred for household consumption (60%) which includes everyday food, clothing and other necessary things and housing purpose (20%). Sector wise income and expenditure in the polder are presented in Figure 6.8 and 6.9 respectively. To some extent, they are now feeling discomfort due to current price hike in every sector of expenditure. In some cases, expenditure goes beyond their income. As a result, they are compelled to borrow money from NGOs.





Source: CEGIS Fieldwork, 2014

Figure 6.8: Proportional Distribution of Household Income

Figure 6.9: Proportional Distribution of Household Expenditure

6.9 Susceptibility to Disasters

278. The local inhabitants have identified tidal flooding, salinity intrusion and cyclones as the major hazards in the area which frequently affected them. They especially cited the recent cyclone Sidr and Aila that took place in 2007 and 2009 respectively. These two cyclones caused loss of livelihood opportunities, standing crops, fisheries and other household assets which had lasting effects. The decreased availability of food led to malnutrition and school drop-out rates increased at that time as some people were forced to migrate to contribute to the household income. Currently, salinity is also very prevalent and its intensity has exceeded the tolerance limit. Crop production, homestead gardening, livestock and wage labor have been seriously hampered. Besides, sources of pure drinking water, freshwater fish culture have diminished. Details about the disasters and their effects on their livelihood in the area are presented in Table 6.8.

Table 6.8: Effects of Recent Natural Disaster in Polder Area

Disaster	Affected Year	Affected Area (%)	Affected House Holds(%)	Crop Damaged(%)	Major Damaged Crop
Tidal Flood	2007	10	10	20	Rice
Salinity	2007, 2009, 2011	30	10	20	Rice, water melon, sesame
Cyclone	2007 (Sidr), 2009 (Aila)	20	30	20	Rice, water melon, sesame

Source: CEGIS fieldwork, 2014

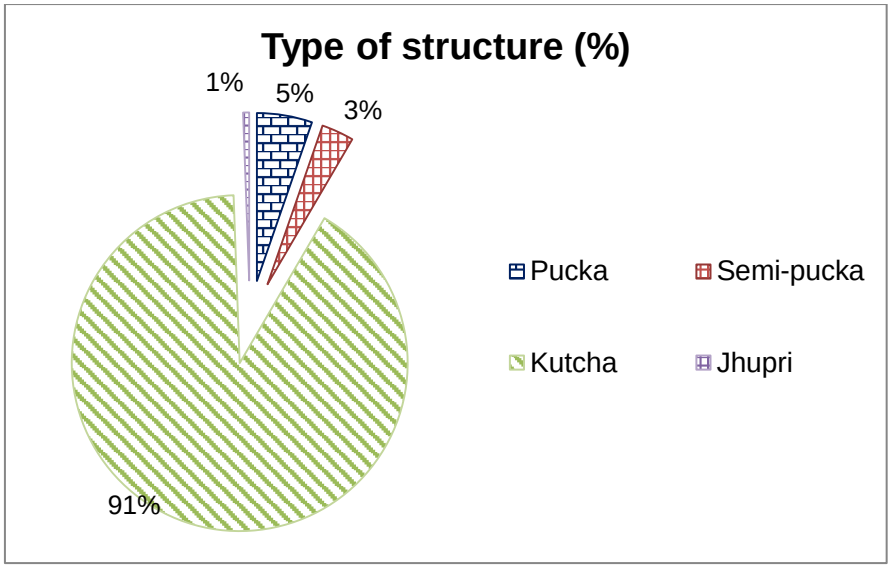
6.10 Quality of Life

6.10.1 Housing tenancy and housing condition

279. In the study area, almost 95% of the people possessed own household. Tenant Contractual dwellers are insignificant (only 1%) who came from other locations for job purposes or do not own homestead land, and around 4% people are living in rent free houses.

280. Overall housing condition3 is not satisfactory. On an average about 91% are kutcha and 5% houses are pucca which is very low as compared to national level (according to BBS, 2012, at national level, 25% of the households reported to have used brick/cement in the walls of the main dwelling structure). Use of hay/straw/bamboo/leaves as wall material has decreased substantially and due to salinity, people of the study area are unwilling to build their houses with earth/cheap materials. Details of structures of main dwelling houses in the polder are given in Figures 6.10 and some view of common houses types are shown in Picture 6.3 and 6.4.

[3] BBS distinguishes housing structures into four classes such as- i) **Jhupri**: House which consist mud walls of 1.5 to 3.0 ft thickness, which carry the roof load. Earthen floor, thatch or CI sheets are used as roofing materials. . There is no monolithic joint between the wall and the roof. ii) **Kutcha**: Walls: Organic materials like jute stick, catkin grass, straw, and bamboo mats. Split are bamboo framing. In some areas wall are made by earth. Foundation: Earthen plinth with bamboo or timber posts. Roof: Thatch-rice or wheat or maize straw, and catkin grass, with split bamboo framing; iii) **Semi-pucca**: Walls: Bamboo mats, CI sheet, Timber or bamboo framing. In some areas wall are made by earth, sometimes part or full brick. Foundation: Earthen plinth; Brick perimeter wall with earth infill; Brick and concrete also use. Roof: CI sheet with timber or bamboo framing; and iv) **Pucca**: House which is made by fully concrete, cement, and iron.



Source: Population Census 2011, BBS

Figure 6.10: Housing Types in Polder Area

Picture 6.3: Kutcha house

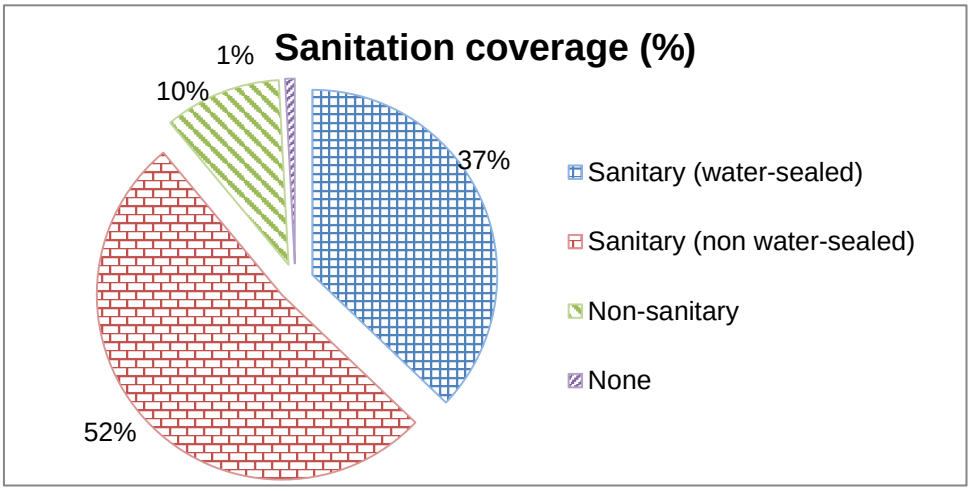
Picture 6.4: Pucca house

6.10.2 Sanitation

281. Sanitation system is a crucial indicator for measuring the health circumstances in a given locality. The sanitation facilities[4] adopted by households of the polder area are presented in Figure 6.11 and Picture 6.5. It shows that 37% of the households have hygienic sanitation facility (water-sealed), 52% have non water-sealed sanitation facility, 10% have non-sanitary sanitation facility and only one percent has no sanitation facility. However, this sanitation situation is better compared to the national level where about 35% of the

[4] BBS defined four types sanitation in Bangladesh such as **(i) Sanitary (water-sealed):** A water sealed latrine is simply a pit latrine that has a water barrier to prevent odors. These latrines are simply pits dug in the ground in which human waste is deposited. **(ii) Sanitary (not water-sealed/ring slab),** latrine with a slab or other secure cover over the drop hole, or a polyethylene flap preventing insects from flying into or coming out of the pit; and **(iii) Non-sanitary (Kucha):**latrine is a frame or platform extending over earth or water; an "open pit latrine" does not have a squat platform or slab on the pit and **(iv) No facilities:** Defecation in bushes or fields or other outdoor locations.

population has access to hygienic sanitation facility. However, this improved situation has been achieved because of the NGO-activities and increasing consciousness of the people.



Source: Population Census 2011, BBS; and CEGIS fieldwork, 2014.

Figure 6.11: Sanitation Facilities in the Polder

Picture 6.5: Sanitation facility in the polder area.

6.10.3 Drinking Water

282. Status of drinking water in the polder area is deplorable. Salinity is the main problem for drinking water especially during dry season. Most of the people depend on inadequate number of ponds and pond sand filter (PSF) for drinking water. Among 12 villages of the polder, 5 are situated in relatively lower portion where drinking water crisis is very severe especially from November to May. During this period, the villagers buy drinking water from the neighboring Gaoghera village at a cost of 20tk for every 30 litre jar. During monsoon i.e. June to October, they collect rain water and preserve it to meet their drinking water demand. Major sources of drinking water in Polder 22 are shown in Picture 6.6 to 6.9.

Picture 6.6: Domestic level rain water harvesting

Picture 6.7: Domestic level PSF

Picture 6.8: A 20 year old tube well

Picture 6.9: A small pond as source of drinking water

6.10.4 Electricity Coverage and Fuel Consumption

283. There is no Grid/REB coverage in the polder area. Only 20% of the households are using solar electricity. In terms of fuel consumption, all households of study areas depend on local materials i.e. straw, wood, leaf etc. They usually suffer from scarcity of fuel for cooking during monsoon. Local people expressed their need for connecting to electricity facility with national grid as early as possible.

Picture 6.10: A solar panel on a house inside Polder 22

6.11 Social Amenities

6.11.1 Roadways

284. Road networks and communication system are relatively better in the polder area. Local people commute using both roadways and waterways. There is only one approach road from the upazila center to the polder area (Table 6.9) and (Picture 6.11). Most of the peripheral roads are paved and have brick soling.

Table 6.9: Road Network in Polder Area

SL No	Description	Type of Road	Length (Km)
1	Noai to Fulbari to Gollamari	Paved/Brick soling	8/9 km
2	Bigordana to Telikhali	Brick soling	4 Km
3	Gopipagla to Darunmallik	Brick soling	8Km

Source: CEGIS fieldwork, 2014

Picture 6.11: Paved and brick-soling roads in the polder area

6.11.2 Waterways

285. Waterway is one of the important modes of communication system in this polder area. There are two boat/kheya ghats where 12 boats are operating. The ghats are used more for loading and unloading of goods and materials, instead of as a landing for commuting people. Picture 6.11 shows the navigation status of that area.

Picture 6.12: Navigation in the polder area

6.11.3 Markets and Growth Centers

286. The current status regarding market and growth center at polder area is not satisfactory. There is no growth center and only 2 markets/bazaars are observed in Polder 22 area. Among them one is in Fulbari village which is open in every Friday and Monday and another one is in Noai village which opens in every Tuesday. According to local people, these facilities are not enough to serve all necessary purpose in their day to day life. Besides, there is a growth center situated in Batiaghata upazilla where the accessibility is quite good. Therefore, people also buy and sell their products over there.

Local small Shop at Noai village

Fultola Bazar in polder area

Picture 6.13: Small shops and Bazar in Polder 22

6.12 Social Cultural Capital

6.12.1 Social Safety Nets

287. The major social safety nets and poverty reduction programs initiated in the area include the Vulnerable Group Development (VGD), Food/Taka for Work (F/TFW), Food for Education/Cash for Education, Rural Maintenance Program (RMP), Old Age Allowance, Freedom Fighter Allowance and Integrated Poverty Reduction Program. According to local people, these programs have created food security as well as social safety nets among the targeted poor households and vulnerable communities to some extent. Table 6.9 shows the current social services and facilities for alleviating poverty in the study area.

Table 6.10: Households Served by Different Social Safety Nets Programs

Social Safety Net Programs	Households/Communities Served (%)
Vulnerable Group Development (VGD)	6
Food/Taka For Work (F/TFW) of PIO	4
Food for Education/Cash for Education	10
Rural Maintenance Programme (RMP)	6
Old Age Allowance	5
Freedom Fighter Allowance	3
Integrated Poverty Reduction Program of BRDB	6

Source: CEGIS Fieldwork, 2014

6.12.2 NGO Coverage

288. A number of local, national and international NGOs are working in the polder area. The major NGOs working in the area include BRAC, ASA (Association for Social

Advancement), Jirbunia multipurpose co-operative society (Table 6.11). These NGOs are conducting mainly micro credit programs among the rural poor and landless women/men. In addition to micro credit, BRAC is also working for non-formal education, health, human rights, water and sanitation, gender and children development programs and Uttaran is working to build awareness for natural disaster. About 45 % of households are found to benefit from the NGO's interventions. After the disasters (Sidr and Aila) the Jirbunia Multipurpose Co-operative Society appeared to be the most important NGO for the local people.

Table 6.11: NGOs and Their Programs in the Polder Area

NGOs	Type of Programs						
	Credit	Education	Water and Sanitation	Health	Disaster	Gender	Children
BRAC	✓	✓	✓	✓	-	-	-
ASA	✓	-	-	-	-	-	-
Jirbunia multipurpose co-operative society	✓		-	-	-	-	-
Dheu society	✓	-	-	-	-	-	-
Dihimura society	✓	-	-	-	-	-	-
Uttaran	✓	-	-	-	✓	-	-

Source: CEGIS Fieldwork, 2014

6.12.3 Rituals and Festivities

289. Traditional Hindus are the dominant inhabitants (72%) at the polder area followed by Muslims and a very few Christians. In terms of rituals and festivities, there exists good social bonding and cohesion between the Hindus and Muslims. Hindus mainly gather for their largest religious festival as Durga puja, amid much fanfare and festivity during occasion. On the other hand Muslims and other religions group take part in their rituals and festivities simultaneously in a peaceful way.


Picture 6.14: Hindu Temple in polder area

6.12.4 Common Property Resources

290. The common property places/resources of the area include mosques, graveyards, temples, cremation grounds, playgrounds and Eidgahs (place for offering Eid prayers).

These places are used frequently by the local people for the purposes of religious, social and cultural gathering. Besides these, the BWDB embankment is also used very commonly for different livelihood purposes by the local inhabitants. There are 4 mosques, 4 temples, 2 graveyards and 2 crematoriums in the polder area. There is no cyclone shelter inside the polder. However, there is no known historical and archaeological site declared by government.

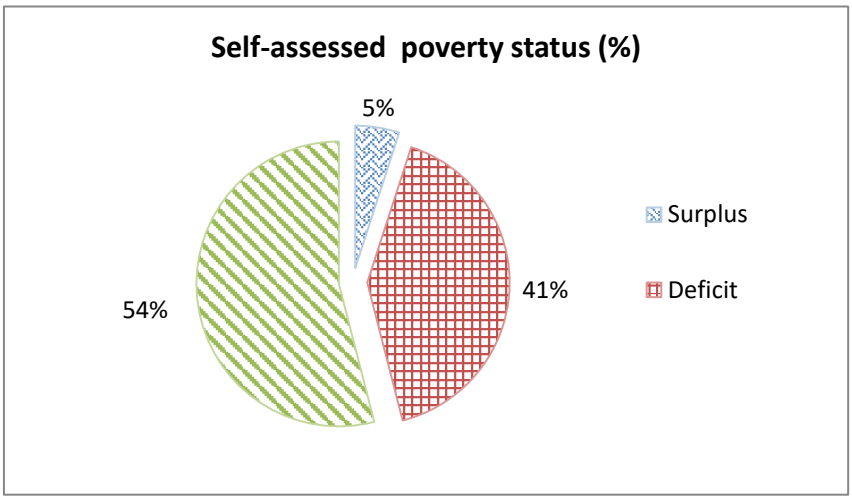
6.12.5 Conflict of Interest

291. There is no mentionable occupational conflict in the polder area. Local people opined that sometimes family level conflict occur regarding land, catching fish which are usually resolved by them very quickly.

6.13 Poverty Situation

6.13.1 Self-assessed Poverty

292. Poverty profile has been prepared by the participants of the RRA themselves through a self-assessment exercise. The assessment is based on the year-round income along with the food consumption of the inhabitants within three different categories (Figure 6.12). It is observed that about 41 % of the households on average are in the 'deficit' categories which have been identified in the RRA as the poor households of the polder area. Considering the standard consumption of food (three meals in a day), the deficit group was usually taking two meals a day in the lean period i.e. March and April since they could not afford three full meals.



Source: CEGIS fieldwork, 2014

Figure 6.12: Self-assessment of Poverty Status

6.14 Gender Issue

6.14.1 Education Enrolment

293. Enrolment in education shows the difference regarding attending and not attending school for both sexes. School enrolment scenario in Polder 22 is shown in Figure 6.13. In terms of attending school both male and female rate of education for 6 to 10 years and 11 to 14 years is almost similar while this situation is very poor for higher studies. It is clear that women are still behind the male counterpart in education. This tradition is now changing as people of the area are concentrating on female education.

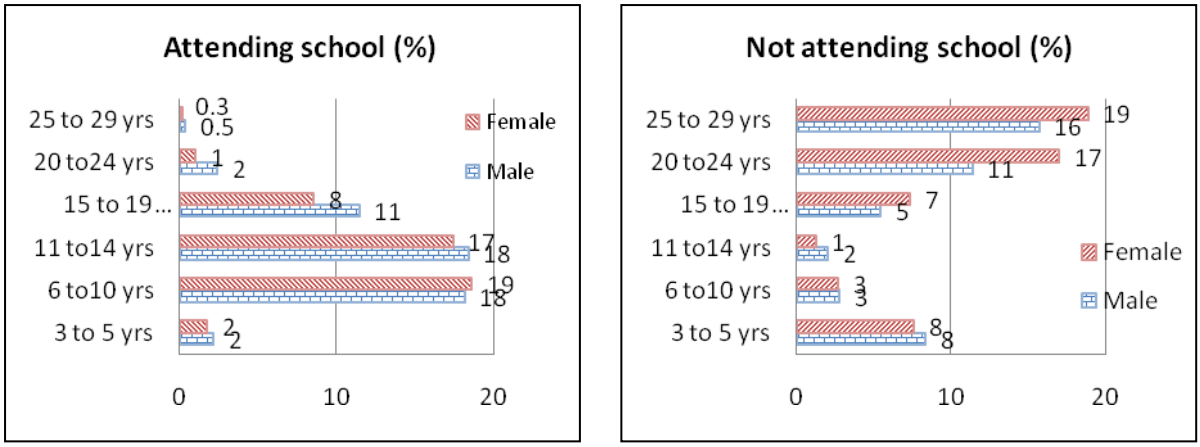


Figure 6.13: School Enrollment at Polder Area

6.14.2 Health

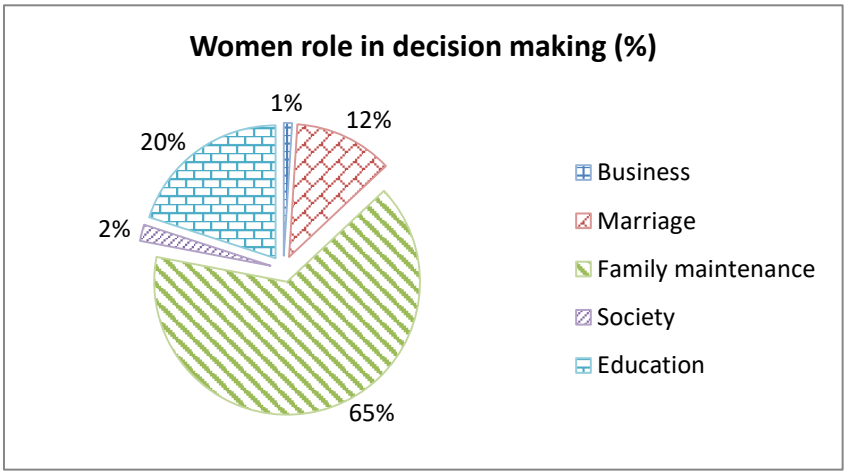
294. About 20 % of the women are living in good health while the rest are suffering from diseases, such as low blood pressure and premature delivery. About 15% of women are getting proper nutrition and about 10 % have access to the health centers. Mortality rate of the pregnant women during delivery period has reduced over time which is mainly due to the growing consciousness among the local people as well as the health services provided by the public and other health centers, including the programs of the NGOs.

6.14.3 Employment

295. Participation of female member is nominal in comparison to male participation. In the polder area among the employed population, only 2 % are female. Women are mainly involved in seasonal earthwork, household level handicraft, poultry farm etc.

6.14.4 Role in Decision-making

296. Most of the decisions related to family maintenance (65%) are usually taken by the women but they have limited access to social sphere. Though, now women are increasingly involving themselves in different income generating activities. Figure 6.14 shows the distribution of the role of women in family decision making.



Source: CEGIS fieldwork, 2014

Figure 6.14: Scope of Decision-making by Women

6.14.5 Empowerment

297. In the polder, women's status has changed greatly during the last few decades. Many of the Hindu women have come out of the kitchens. They are working alongside men in all spheres of work i.e. earthwork, tailoring, teaching etc. Like other parts of the country, Muslim women are somewhat restricted to household works. They mostly stay at home except for seeking medical treatment, fetching water and visiting relatives (Picture 6.15).

Picture 5.15: Women empowerment at Polder area

7 Public Consultation and Disclosure

7.1 Introduction

298. This chapter provides details of the consultations held with the stakeholders at the Project site. The GoB as well as international donors (e.g. the Govt of Netherlands) place great importance on involving primary and secondary stakeholders for determining the environmental and social impacts associated with project implementation. In addition, EIA Guidelines of the DoE, also make public participation obligatory for the EIAs of the Red Category projects. In order to gather local knowledge for baseline conditions, understand perceptions of the community regarding impact significance, and propose meaningful mitigation measures, participation of stakeholders is an integral part of the EIA process. During the present EIA, an attempt has been made to consult with a full range of stakeholders to obtain their views on project interventions. Public participation through consultations in the water sector project is also mandated according to the Guidelines for the Participatory Water Management (GPWM) of the BWDB.

299. The present EIA has been conducted after consultation with local communities, non-governmental organizations (NGOs) and concerned government departments/ organizations dealing particularly with related fields, thus ensuring that their views and concerns are taken into account in the study.

7.2 Objectives

300. The following objectives have served as the moving force for the design, implementation and fact findings during the participation process:

- To provide key Project information and create awareness among various stakeholders about the project intervention;
- To have interaction for primary and secondary data collection with project beneficiaries, affected people, and other stakeholders;
- To identify environmental and social issues such as safety, hazards, employment, and vulnerable persons;
- To begin establishing communication and an evolving mechanism for the resolution of social and environmental problems at local and Project level;
- To involve project stakeholders in an inclusive manner i.e. establish and empower community organizations/ water management organizations (WMOs) to sustainably manage their water resources and to make these resources more productive; and
- To receive feedback from primary stakeholders on mitigation and enhancement measures to address the environmental and social impacts of the Project.

7.3 Identification of Stakeholder

301. Stakeholders include all those who affect and are being affected by policies, decisions or actions within a particular system. Stakeholders can be groups of people, organizations, institutions and sometimes even individuals. Stakeholders can be divided into primary and secondary stakeholder categories.

7.3.1 Primary Stakeholders

302. Primary stakeholders are people who would be directly benefited or impacted by a certain project intervention. In case of the proposed rehabilitation in Polder 22, the primary stakeholders include the people living within the project area particularly those who reside within and in the immediate vicinity of the interventions. The primary stakeholders of the project include the farmers, fishermen, local business community as well as women groups, and caretakers of community properties who will be benefited and/or negatively affected by the project, local leaders, community members and other local representatives.

7.3.2 Secondary Stakeholders

303. 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. For this project NGOs, concerned government departments like local government institutions (LGI), BWDB, the MoWR, DAE other government agencies, academia, NGOs, the Blue Gold officials at Khulna, the Netherlands govt. officials and general public at large fall under this category.

7.4 Approach and Methodology

304. Participatory approach was followed in conducting the public consultation meeting (PCM) in the Polder 22. The consultants discussed first with the BWDB officials and then the Upazila Parishad Chairman (UZPC) and/or the Upazila Nirbahi Officers (UNOs), the Blue Gold officials, the Project Implementation Officers (PIOs) of the polder area to share the Feasibility and EIA process of the Blue Gold program. The BWDB and local government officials/representatives were consulted to identify the potential stakeholders at the Polder level With the available support from the Blue Gold officials and UP chairman, the union level public representatives as well as the key persons were contacted over telephone and informed about the specific consultation meetings and requested them to be present in the meeting. In this way, the venue, date and time of the consultation meetings were fixed. Later, the consultant team organized the meetings at the local level. The participants provided their names, occupations and addresses in that meeting.

305. Besides, a number of informal discussions were held as public consultation process. In order to conduct these discussions, five checklists were prepared covering the aspects including an overview of the proposed Blue Gold program, information on the ongoing EIA process, and seeking information on the problems of the area with their potential solutions. The local needs and demands have been discussed by giving equal opportunity to all participants attending in the meeting. During consultation meeting all relevant issues within the water resources, land resources, socio-economic resources, and disaster aspects were discussed in detail.

306. During the discussions, the EIA team displayed maps of the Project area, shared the initial concepts on proposed interventions and facilitated the response of the participants. The stakeholders of the Polder 22 were asked to share their needs, problems, possible sustainable solutions, and their views on the Project interventions. The stakeholders' perceived views on important environmental and social components (IESCs) and Project's impacts on them, along with perceived benefits, risks, threats and demand from the Project were identified during discussions.

7.5 Public Consultation and Disclosure Meetings

7.5.1 Consultation Process

307. A PCM and number of informal discussions were conducted at different locations of the Polder 22. The details of these discussions are presented in Table 7.1 and some Photos of these meetings are given in Photo 7.1 to 7.3.

Table 7.1: Consultation Details

Sl	District	Upazila	Union	Meeting venue	Type of consultation	Meeting date	Time
1	Khulna	Sadar	Sadar	Blue gold office	Sharing meeting with Blue gold officals	28/04/2014	10:00
3	,,	Paikgaccha	Deluti,	Fulbari Bazar	Consultation meeting with WMO	28/04/2014	12:00
4		"	"	Telikhali	Informal discussion	28/04/2014	14:00
5	"	"	"	Darun Mallik	"	28/04/2014	16:30
6	"	"	"	Hatbari School	"	29/04/2014	10:00
2		“	“	Deluti UP	PCM	03/09/14	10:00

Picture 7.1: A view of PCM at Deluti Union parishad

Picture 7.2: Meeting with WMO at Fulbari Bazaar

Informal discussion (a) at Telikhali village (b) at Darun Mapllik village

Picture 7.3: Consultation with WMO and Local people

Note: The people-engagement situation in these 2 photos do not confirm to the FGD methodology. The Pictures 6.1 maybe accepted as an FGD groupt [minus the gentleman making phone-call]

308. Issues discussed, problems identified, and solutions suggested.

309. At the outset of these meetings and FGDs, an overview of the proposed Project including the ongoing activities of the implementing agencies and the EIA process, was

shared with the participants. Subsequently, the key environmental, social, and socioeconomic aspects listed below were discussed.

- Water Resources:
  - Surface water (tidal flooding, drainage, salinity, siltation)
  - Water management (flood control, drainage, irrigation)
- Land Resources:
  - Cropping practice,
  - Production and yield,
  - Water logging and drainage congestion
  - Crop damage.
- Socio-economic Aspects:
  - Occupation and Employment (unemployment / joblessness)
  - Migration (temporary/permanent out-migration)
  - Poverty (food and income poverty)
  - Education (poor literacy rate, non-schooling, less female education, drop out etc)
  - Health and nutrition (illness, diseases, poor nutrition)
  - Quality of life (poor housing and sanitation facilities, scarcity of drinking water, fuel and fodder)
- Disasters:
  - Cyclones
  - River erosion
  - Associated damages
- The sustainable and integrated solutions of the main problems being faced in the Polder:
  - Water resources management
  - Agriculture and fisheries management
  - Land resource management
  - Disaster management.
- Community involvement

– To establish and empower community organizations/ water management organizations (WMOs) to sustainably manage their water resources and to make these resources more productive.

7.6 Community Concerns and Suggested Solutions

310. The outcomes of the PCM and discussions in terms of concerns and the suggested solutions were noted and organized by themes as presented in the Table 7.2 below.

Table 7.2: Community Concerns and Suggested Solutions

Themes/ Topics	Concerns/Issues/Problems	Suggested Solution/Remedies
Overall	Salinity intrusion and cyclone are the main community concerns in the polder area.	Comprehensive rehabilitation of the polder should be taken up at the earliest with active involvement of the local community.
Water resources	The water control infrastructures are not suitably functional in this polder and salinity intrusion due to damaged gates of the structures and height of embankment has reduced; Water unavailability Siltation of khals	Damaged part of the embankment should be re-sectioned as early as possible and slope of embankment must include protection with forestation. Bank protection measures should be taken in the critical river bank erosion prone areas. Replace the damaged/non-functional sluice gates and construct new ones where required Re-excavation of proposed khals
Agriculture resources	Soil salinity Drainage congestion Siltation and scarcity of irrigation water in Rabi season Lack of quality seeds during hervesting period Irrigation problem during the dry season Lack of adequate number of power tiller Lack of irrigation facility Lack of quality seed for tree plantation and vegetable cultivation Lack of agriculture related training and facility The general soil productivity is degrading day by day due to excessive use of fertilizer Lack of spray machine	Salt tolerant varieties of rice need to be practiced and in this regard necessary extension works need to be organized by the respective departments; The repair / re-sectioning of embankment, repair of sluice gate, re-excavation of khals would prevent the intrusion of saline water into the agriculture fields and is expected to decrease soil salinity which may enhance crop production and may reduce crop damage and introduce new crops. Arrangement of pipelines from Fulbari sluice gate to Gari Gopal, Pramanik and Mozumdar canals for the betterment of irrigation system Proper spoil management system during the excavation of canals Giving training facilities on insecticide using to the local farmers Providing technical equipments and quality seeds for tree plantation and vegetable cultivation Providing loan facilities at easy terms and conditions to the local people Building culvert on canals for making a better transportation system Excavation of Gopi pagla, Fulbari, and Hatbari canals
Fishery resources	Siltation of internal khals is causing loss to the year round river-khal connectivity. Habitat quality degraded due to siltation and increase of salinity especially in dry season in the polder area.	Re-excavation of internal khals and repairing or improvement of water control structures should be conducted to increase the fish habitat quality as well as the richness of fish species, both brackish and fresh water, in the polder area.

Themes/ Topics	Concerns/Issues/Problems	Suggested Solution/Remedies
	Indiscriminate fishing using monofilament gill net, net jal, etc and overexploitation of fishes by using huge number of small meshed ESBN (Estuarine Set Bag Net) fishing. Lack of surface water for capture fishery Lack of good quality brood fish Lack of training in culture fish Water pollution due to excessive use of fertilizer and pesticides	Fisheries rules and regulations should be implemented by Government. Creating sanctuary in the river Application of law to stop net Making reservoir in the Muchi mara, Bigordana, Fulbari
Ecological resources	Soil salinity and internal khal siltation are the main threats to ecosystems of this polder. In addition, riverbank erosion is also another threat that destroys homestead vegetation each year. Non-functioning of water control structures like regulators, causes insufficient drainage and flushing capacity of the polder area that damages vegetation. Intrusion of saline water expands soil salinity that increases stress on vegetation. The existing reptiles are being under threat due to catch of these species Afforestation is being disturbed due to salinity and drought Trees are being damaged due to the increase of temperature Various type of birds are going to be abolished Lack of salinity tolerant trees	Removing siltation by re-excavation of khal. Embankment re-sectioning and repairing water control structure along the embankment to protect settlement, road, inter tidal area and crop fields from the existing problem. Enforcement of law to protect the wild animals from poachers Entrance of saline water should be protected Tree plantation program should be taken under this development project Combined and comprehensive pesticides mechanism should be initiated
Socio-economic resources	Scarcity of fresh water is the main problem in the polder area during dry season. Due to malfunctioning of water control structures, lack of reserve fresh water in khals, saline water is being trapped for long time in almost whole polder area and this is responsible for intrusion of salinity in the groundwater aquifers. Lack of adequate expertise and experienced manpower to carry out the O&M of the polder and the numbers of field staffs are also insufficient and inadequate in some places of the polder with respect to the actual requirement. Local powerful persons, including the political leaders, illegally interfere on the water control/ management	Scope of fresh water storage may be improved within internal khals and protective ponds by proper functioning of associated water control structures; For sustainable operation of the project, participation of Water Management Organization (WMO) and Community Based Organizations (CBOs) needs to be ensured and also the water control structures i.e. embankment, sluice gate, regulator, inlets, culverts etc must be managed properly, and there should be growth of consciousness among the community in the polder. The Government should rehabilitate the affected farmers who are affected by salinity intrusion; Need awareness building about water management among the communities.

Themes/ Topics	Concerns/Issues/Problems	Suggested Solution/Remedies
	infrastructure. The occupations of local people has been changed due to salinity and closeness to urbanization Lack of hospitals with trained physician The doctors do not show professionalism in their activities Lack of cyclone center Lack of place for dumping spoiled materials Lack of training on livestock rearing Poor communication system within the polder Lack of growth centers	Alternative occupation opportunities should be created for the farmers Adequate number of trained physician should be recruited for this area It is very urgent to develop the internal communication facility of this area Market management should be strengthened Providing alternative training facilities for income generation

7.7 List of Participants

311. The name of the participants of these different informal discussions, their age, occupation and address including cell phone number (if any) are provided in Table 7.3 while the participant list of PCM is presented in Appendix-4

Table 7.3: Particulars' of the Participants

SL	Name	Age	Occupation	Address/Mobile No
01	Azizur Rahman	55	Sr. Quality Control Engr.	01711-044421
02	Md. Naimul Islam	46	Civil Engr.	01711-231608
03	Dr. Kabil Hossain	48	Environmental Expert	01716-408420
04	Md. Rabiul Alam	42	Do	01819-241442
05	Md. Zahangir Alam	55	Agriculturist	01715-209046
06	Nirodh Bihari Mollik	65	Chairman, WMO, Deluti Union	01720-568005
07	Gurudash Roy	68	Vice chairman, WMO, Deluti	01716-017629
08	Palash Roy	35	Secretary, WMO, Deluti	01714-571273
09	Abdur Razzaq	38	Farmer	01936-038992
10	Dhiren Tikadar	50	Do	Fultala Bazar
11	Joydev Goldar	42	Business	01724-114728
12	Liton Goldar	32	Do	01914-830092
13	Ram Tikadar	35	Business	01718-848767
14	Nirapor	60	Do	01734-086881
15	Nirodh Bihari Mallik	65	Teacher (Ret.)	01720-568005
16	Jahir Uddin Sheikh	52	Member, Deluti Union	01757-808411
17	Babul Tikadar	45	Business	01739-644774
18	Soshan Sala	40	Business	01944-982870
19	Promoth Nath Roy	65	Farmer	Kheya ghat, Telikhai
20	Pranab Mondal	19	Business	01964-961316
21	Chinta Rani Goldar	44	Housewife	Kheya ghat, Telikhai
22	Monoranjan Mondal Goldar	55	Farmer	01758-272876
23	Obinash Mondal	30	Business	01949-884010
24	Ojit Roy	46	Business	01981-687484
25	Md. Shahin Sheikh	26	Business	01954-038759
26	Md. Ismail Sheikh	40	Van driver	01710-027263
27	Md. Imran Sheikh	25	Van driver	01929-651331
28	Sumon Mallik	17	Student	01952-128817
29	Md. Islam Gazi	18	Van driver	01948-101617
30	Subrata Mallik	17	Student	01988-030274
31	Gourango Kumar Sarkar	30	Van driver	01729-608248

SL	Name	Age	Occupation	Address/Mobile No
32	Animesh Kumar Rao	30	Van driver	Hatbari
33	Mrittunjoy Mondal	30	Van driver	01943-518328
34	Lipika Goldar	30	Teacher	01759-180179
35	Ashoke Kumar Mondal	48	Teacher	01731-277334
36	Biplab Halder	28	Farmer	01750-442509
37	Soumen Halder	28	Student	01965-215910
38	Nimai Halder	58	Farmer	Hatbari
39	Bipannya Halder	18	Student	01932-637079
40	Partha Pratim Halder	35	Farmer	01710-028579
41	Ram Prashad Halder	30	Farmer	01923-875121
42	Pushpa Rani Halder	45	Housewife	Hatbari
43	Parbati Halder	25	Housewife	Do
44	Hridoy Nath Roy	70	Elderly Man	Do
45	Rudra Halder	21	Student	01911-146433
46	Rajani Kanta Roy	52	Farmer	Hetal Bunia
47	Jagadish Sena	30	Farmer	01939-663150
48	Sushanto Boiragi	42	Business	01933-851822
49	Ranajit Shingh	65	Farmer	Hetal Bunia
50	Krishna Boiragi	66	Farmer	Do
51	Mamata Boiragi	26	Housewife	Do
52	Krishnapad Boiragi	70	Elderly Man	Do
53	Sripad Roy	75	Do	Do
54	Anarati Boiragi	50	Housewife	Do
55	Krishna Mistri	65	Elderly Man	Do
56	Nitu Boiragi	25	Farmer	01862-518099
57	Haritash Boiragi	32	Farmer	Hetal Bunia
58	Rudra Pratap Mondal	45	Business/Farmer	Do

7.8 Perceptions towards proposed interventions

312. The interventions proposed by the Blue Gold Program for rehabilitation of the polder were discussed with local people by the EIA study team. A list of identified problems and the suggested solutions made by the local people are shown in Table 7.2. The solutions opted by the local people are mostly found similar to these proposed by the Blue Gold Program for this polder. During public consultation meeting conducted by this team, the participants were also requested to provide their overall perception about the proposed interventions. The opinions received were positive, as almost all the local participants spoke in favour of the proposed interventions. The generalized perception was that they believe that the interventions proposed (discussed in Chapter 4) have the outright potential to remove the existing water management problems and concerns in Polder 22.

8 Identification, Prediction and Evaluation of Potential Impacts

313. This chapter describes the Important Environmental and social components (IESCs) which are likely to be impacted by the project interventions. Evaluation of potential impacts is also discussed in this chapter.

8.1 Identification of IESCs and Rationale

314. All environmental and social components are not impacted by project interventions. Some components may be impacted while others are independent of the interventions. Environmental and social components which are likely to be impacted by project interventions are termed as Important Environmental and Social Components (IESCs). Important Environmental and Social Components (IESCs), likely to be impacted by proposed interventions have been selected based on the rationale against each IESC are presented in the following table below 8.1

Table 8.1: Identified IESCs and Rationale

IESCs	Rationale
Water Resources	
Saltwater Intrusion	At the moment, the polder is severely affected by surface water salinity intrusion. Some of the interventions in Polder 22, i.e. repairing of sluice gates and re-sectioning of embankments would prevent the entry of tidal water inside the polder. For this reason, saltwater intrusion has been considered as an Important Environmental Component (IEC).
Surface Water Availability	Due to khal re-excavation works, the availability of surface water in Polder 22 may be increased and this might facilitate the multi-purpose use of water. As such, surface water availability has been selected as an IEC.
Sedimentation	The prevention of tidal water entry through the khals would reduce the volume of sediments entering the polder. As a result, the khals might experience benefits regarding low sediment transportation. Moreover, the river sediments may get deposited over the flood plain areas outside the polder, which might increase the peripheral river siltation. Considering these, sedimentation has been considered as an IEC.
Erosion	Temporary bamboo protection works would be provided at four vulnerable points, as per WMOs recommendations in Polder 22. The works may offer protection against seasonal wave actions of the peripheral Bhadra and Badurgachi rivers, and this might temporarily affect the river bank erosion in Polder 22. Therefore, erosion has been considered as an IEC.
Drainage Congestion	The re-excavation works in the khals may improve the drainage status of the area, and diminish the risk of emergence of water logging problems at some portions of the polder. Therefore, drainage congestion has been considered as an IEC.
Land and Agricultural Resources	
Soil Salinity	Soil salinity increases with the intrusion of saline water in the polder area. The proposed interventions (repair/re-sectioning of entire embankment, repair of

IESCs	Rationale
	sluices, etc.) are expected to check the intrusion of saline water which in turn would help in the reduction of soil salinity. Soil salinity has, therefore, been selected as an IEC.
Crop Production	Agricultural crop production is expected to increase for the improvement of drainage congestion due to excavation, and rainwater harvest in the Khals. The crop damage would reduce due to repairing of retired/repaired embankments. The embankments might protect the crops from early flooding. The re-excavation of khals would help to drain out excess water from crop field through sluices. Moreover, the surface water of the re-excavated khals would be used as irrigation purpose. As such crop production has been selected as an IEC.
Crop Damage	Crops are presently damaged in the polder area due to water logging in the pre-monsoon and rainy season, drainage congestion, salinity, drought, etc. which are expected to be checked due to implementation of the proposed interventions. Reduction in crop damage would be reflected in aerial extent as well as increased yield per hectare contributing to increase in crop production in consideration of which crop damage has been selected as an IEC.
Irrigated Area	Surface water is more preferable over ground water for irrigation use because of its low cost and sediment content contributing towards maintaining the soil nutrient status. The proposed interventions are expected to increase the availability of surface water for irrigation use in consideration of which irrigation has been selected as an IEC.
Fisheries Resources	
Fish Habitat Quality	The proposed interventions might change the water depth and water quality like DO, pH, turbidity etc of open water in the Polder area. Increased water depth may support different depth suitability of several fish species. In this context, fish habitat quality has been considered as an IEC of the study.
Movement of Fish Hatchlings	Internal water bodies mainly the khals are connected with the surrounding rivers. Though the movement of fish from peripheral river is controlled by water regulating structures and flow regime of the canals, hatchling movement from river to khal is still the driving force for capture fisheries of the polder area. Proposed interventions e.g. repairing of existing sluice and re-excavation of internal khal may change the hatchling movement inside the polder area. Thus, hatchlings' movement has been considered as an IEC.
Fish Biodiversity	About 80 fresh and brackish water fish species are available in the Polder area. Apart from this, number of snail, mussels, crabs and turtles are also present in the polder area. There are some variations of species composition in the river/canal and in the floodplain. The proposed interventions in the polder area may change the fish biodiversity and their composition. Therefore, fish biodiversity has been considered as an IEC.
Capture Fish Productivity	Fish production of different open water sources e.g. khals, seasonal water bodies has the declining trends over the years. Reasons include siltation of khal bed, saline water intrusion because of malfunctioning of regulators/sluices and increased water temperature during dry season and disrupted fish hatchling movement for improper operation of gates. Proposed interventions are expected to change capture fisheries productivity. Hence, fish production has been considered as an IEC of this study.
Ecological Resources	
Habitat Condition	Proposed intervention is expected to minimize river erosion as well as countryside saline intrusion, increase depth of khals and reduce tidal flood. In addition, all

IESCs	Rationale
	types of proposed construction activities are likely to change the existing vegetation at construction sites. So habitat condition is considered as an important IEC.
Socio-economic Condition	
Social Use of Water	One of the main utility of water is its social use i.e. taking shower, washing chores and other social uses. At present, during the summer, there is no water in the Polder 22 area where the proposed two canals are to be dug. As a result, people cannot use water for their social needs. Hence, it can be said that if the two proposed canals are made, it will ensure the various social use of water. Therefore, social use of water is regarded as an ISC.
Crisis of Drinking Water	.There is a dearth of drinking water in the polder area As a result, a good number of people are suffering from diarrhoea every year because of the crisis of drinking water. At least seven villages of the polder area depend on the water of neighbouring villages for seven months in the year because of salinity. Therefore,it can be said that,if the proposed two canals are reexcavated,the dearth of drinking water during dry season will be solved. As a result, theincidenceof diseases will be decreased and the scarcity of drinking water will beremovedHence, crisis of . drinking water isregarded as an.ISC
Employment Generation	The construction work will generate a significant amount of employment over its construction period for the local people. People will also be involved to carry out the operation and maintenance related jobs to operate the hydraulic structures. It is expected that the agriculture production would increase while salinity problem would decrease due to the project which will create opportunities indirectly, for agriculture, business and commercial services. Hence, employment generation can be considered as an ISC.
Gender Promotion	Construction work requires various types of skilled and unskilled labors. It is found that in Bangladesh, a portion of construction labors are women. These women are vulnerable, mostly distressed and widow who are dependent on others and do not have any definite source of income. Therefore, employment access for them in the construction works and during operation/maintenance phase is expected to be positive. Thus, gender promotion has been selected as an ISC.
Livelihood Development	The project is expected to increase resilience of people within Polder 22. Increase in agriculture production, reduction of drainage congestion, income generation is expected to improve the livelihood of the people. Thus, livelihood development has been considered as an ISC.

8.2 Evaluation of Potential Impacts

8.2.1 Preamble

315. This section identifies the potential environmental and social impacts that may be caused by various project activities during the three stages of construction works: pre-construction, construction, and Operation & Maintenance (O&M) stages, on already identified IESCs. Potential Proposed interventions which may cause potential environmental impacts during pre-construction, construction, and O&M stages have been identified in Chapter four (4). The following detailed investigations have been carried out to assess the magnitude of these prioritized impacts:

- RRA survey to assess the loss of vegetation, occupation, income and poverty levels of the affected households, etc.

- Environmental quality baseline monitoring of noise, surface water, groundwater and soil,
- Ecological surveys comprising vegetation, wildlife and fisheries covering both terrestrial and aquatic ecosystem,
- Land surveys in the Polder area comprising socio-economic status and environmental settings,
- Expert consultations, focus group discussions, and public consultation

8.2.2 Impact Screening

316. As part of the environmental impact assessment process, a screening matrix was used tailored specifically to the proposed Project, focusing the potential environmental impacts during the pre-construction, construction and operation phases. The matrix examined the interaction of project activities with various components of the environment. The impacts were broadly classified as physical, biological and social, and then each of these broad categories further divided into different aspects. The potential impacts thus predicted were characterized as follows:

- Highly negative (adverse) impact;
- Moderately negative impact;
- Insignificant impact;
- Highly positive (beneficial) impact;
- Moderately positive impact.

317. The potential environmental impacts on the IESCs by the proposed interventions during pre-construction, construction as well as post-construction stages are presented in the following screening matrix (Table 8.2).

Table 8.2: Screening Matrix

Project Phases and activities	Water					Land & Agriculture					Fisheries				Ecology	Socio economic				
	Saltwater intrusion	Surface water availability	Sedimentation	Erosion	Drainage congestion	Soil salinity	Induced climate change	Crop production	Crop damage	Irrigation area	Fish habitat quality	Movement of fish hatchling	Fish Biodiversity	Capture fish productivity	Habitat condition	Social use of water	Crisis of drinking water	Employment generation	Gender promotion	Livelihood development
Pre-Construction Phase																				
Labor, materials and equipment mobilization (carrying,and storing) and site preparation	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	MN	NI	NI	HP	MP	MP
Construction Phase																				
Re-sectioning of embankment	NI	NI	NI	MP	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	HN	NI	NI	MP	I	MP
Embankment slope pitching and turfing	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	HN	NI	NI	MP	I	I
Re-excavation of Khal	NI	HP	NI	NI	HP	HP	NI	HP	HP	HP	HP	HP	HP	HP	HP	HP	MP	MP	I	I
Construction of reservoirs	NI	HP	NI	NI	I	MP	NI	HP	HP	HP	MP	NI	MP	MP	HP	HP	HP	MP	NI	HP
Spoil dumping and compaction on the banks of khals	NI	NI	NI	MP	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	MN	NI	NI	NI	NI	NI
Repairing of drainage sluices and outlets	HP	I	HP	NI	HP	MP	MP	HP	HP	MP	HN	MN	MN	MN	HP	MP	MP	I	I	MP
Repairing of flushing inlets and culverts	HP	I	HP	NI	HP	MP	MP	HP	HP	MP	HN	MN	MN	MN	HP	MP	MP	I	I	MP
Construction of temporary protection works	NI	NI	NI	HP	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI

Note: Highly negative (adverse) impact (HN); moderately negative impact (MN); Insignificant impact (I); Highly positive (beneficial) impact (HP); Moderately positive impact (MP); No impact (NI).

8.2.3 Impact during Pre-construction Phase

There would be no significant impact on environmental components during this phase by the proposed interventions. The proposed activities may generate some temporary impacts on social conditions. The descriptions of such impacts as well as their magnitudes have been shown in Table 8.3 below.

Table 8.3: Location Specific Impact Assessment Matrix during Pre-construction Phase

IESC	Location	Baseline Condition	Impact	Impact (+/-)/ Magnitude (1-10)
Water Resources				
There will be no impacts during the pre-construction phase.				
Land and Agricultural Resources				
There will be no impact during pre-construction phase as there will be no labour sheds requirement because local labors will work and stockyard would be constructed on existing embankment and non-agriculture land.				
Fisheries Resources				
There will be no impact on fisheries related IECs against the activities during pre-construction phase.				
Ecological Resources				
There will be no impact in this phase.				
Socio-economic Condition				
Activity: (i) Labor, materials and equipment mobilization (carrying and storing (ii) Site preparation				
Quality of life (income generation)	Periphery and inside of the Polder 22 where different activities will be initiated.	Most of the HHs income comes mainly from two sectors i.e. agriculture (50%) and fishing (30%). Mainly male are working here.	Local unemployed labours will be recruited for carrying and storing of materials, site preparation. Thus, the income of labor will increase temporality	2

* *Low impact (1-3); Medium impact (4-6); High impact (7-10)*

8.2.4 Impact during Construction Phase

The implementation of the proposed activities may generate some temporary impacts during the construction phase on different environmental and social resources. The descriptions of such impacts as well as their magnitudes have been shown in Table 8.4 below.

Table 8.4: Location Specific Impact Assessment Matrix during Construction Phase

IESC	Location	Baseline Condition	Impact	Impact (+/-)/ Magnitude (1-10)
Water resources				
There will be no impacts during construction phase.				
Land and agricultural resources				
There would be no impact during construction phase as the excavated spoil materials would be dumped on existing embankment and non-agriculture land.				
Fisheries Resources				
Activity: Re-excavation of khal				
i) Habitat quality ii) Fish biodiversity	1.Fulbari khal 2.Muchimara khal 3.Harinkhola khal 4.Goger khal Re-excavation for rain water storing 5.Bigordana khal 6.Gopipagla khal	All the khals are seasonal. Average depth of the khals is 0.9 m and water retains six to eight months. No water exists in the dry season. But a little volume of water is found at the intertidal floodplain near the regulators. More than 80 fish species (both brackish and fresh water) is reported in and around the polder area.	• Temporary loss of feeding ground, and feed for bottom dweller would be unavailable. Due to re-excavation of khal, turbidity of water would be increased. But after one (01) year the habitat quality of fish will improve. • Intertidal floodplain fish habitat would be impacted. • Some particular fish species like vetki, Pairsa, Chingri, Bele etc. would be lost temporarily. • During re-excavation of Bigordana khal and Gopipagla khal for rain water storing, the habitat of the eel fish specifically, the habitat of Cuchia fish will be affected significantly.	-1
Ecological Resources				

IESC	Location	Baseline Condition	Impact	Impact (+/-)/ Magnitude (1-10)
Activity: Re-sectioning of embankment				
Habitat Condition	Along both side of the embankment at re-sectioned points	Habitat created by few medium sized tree, herbs and shrub species such as Babla, Sirish, Akand, Vaant, sech/sezi, Hatisur. Provide feeding ground for mammals, birds, reptiles and amphibians.	Herbs, shrubs, various type of grass, bushes will be temporary damaged due to soil dumping for re-sectioning work. Re-located wildlife due to temporary habitat loss.	-1
Activity: Construction of temporary protection work				
Habitat Condition	Vill: Kalinagar, Naldanga, Darunmalik and Bgardana.	Riverside habitats are at risk due to bank erosion. Species diversity and density of vegetation are poor in terrestrial part. Few trees, small herbs and shrubs have been found. This existing vegetation favors mongooses, mice, birds, snakes and frogs. Aquatic portions are dwelling by fishes, crabs and mudskippers.	Minor damages of embankment side herbs and shrubs due to earthwork activities. Deterioration of aquatic habitat condition for placement of geo-bag.	-1
Activity: Re-excavation of Khal and construction of reservoirs				
Habitat Condition	Fulbari khal Muchimara khal Harinkhola khal Goger khal Bigordana khal Gopipagla khal	Most of the khals are shallow and silted from a long time and are waterless in dry season. No aquatic vegetation is observed in the river and river side khals because of tidal flow and salinity. Vegetation along internal khal side is low, some grasses are found along the marshy parts of proposed Khals.	• Eel fish like 'Cuchia' and water depended fauna like skipper frog, bullfrog, kingfisher, egret, common aquatic snake, etc. will be temporary re-located due to habitat loss in the khal area. • Grasses will be damaged due to storage of soil along both side of the khal.	-2

IESC	Location	Baseline Condition	Impact	Impact (+/-)/ Magnitude (1-10)
Socio-economic Condition				
Activity: (i) Re-sectioning of embankment (ii) Embankment slope pitching and turfing (iii) Re-excavation Khals (iv) Spoil dumping and compaction on the banks of Khals (v) Repairing of drainage sluices, drainage outlets, flushing inlets and culverts (viii) Construction of temporary protection works				
Quality of life (Employment)	Periphery and inside of the Polder 22 where different activities will be initiated.	About 29% of total population is employed, 50% is engaged in household work and about 20% of total population do not work.	A significant number of local labour will be recruited for earth work, re-sectioning of embankment and afforestation, soil dumping and compaction of earth.	2
Quality of life (income generation)	Do	Most of the HHs income comes mainly from two sectors i.e. agriculture (50%) and fishing (30%). Both male and female are working here, simultaneously.	Local unemployed labor will be recruited during construction intervention work. Thus, the income of labor will increase temporality	2
Gender Promotion	Periphery and inside of the Polder 22 where different activities will be initiated.	Females are mainly involved in household activity and very few of them are working as a day labor or earth worker.	According to the project plan, the LCS entails 60% male and 40% female all of them would be engaged from the local area. Thus, employment access to females in the construction works and during operation /maintenance phase, will be promoted significantly and they can also take part in different decision making processes.	3

** Low impact (1-3); Medium impact (4-6); High impact (7-10)*

8.2.5 Impact during O & M Phase

During Operation and Maintenance phase, possible impacts of the proposed interventions on the selected IESCs have been assessed comparing the future-without-project (FWOP) condition with the future-with-project (FWIP) condition. The impacts on the IESCs under different resources are presented in the following sections and summary in of impact are presented in a Table (Table 8.7).

8.2.6 Water Resources

Saltwater Intrusion

i) Future without Project

318. Saltwater concentration in the surface water system of the polder would increase in future, if the sluice gates are not repaired. Almost all the water control structures of the polder are not functioning up to the desired level. At present salt water enters into the polder during dry season through the structural leakages, and approximately 50 m inside the polder periphery the salinity concentration was found around 5 ppt and around 2 ppt of salinity levels were observed for further 150 m inwards buffer area. If the existing water control structures are not repaired then in the next 30 years, salinity within 50 m buffer will increase to 5 ppt and 2 ppt salinity contour line may rise to 3 ppt. The impacts on water resources are shown in Map 8.1 where changes in surface water salinity are shown. Furthermore, the situation might aggravate if any of the water control structures experience accidental failure in future.

Future with Project

319. The salt water leakage into the polder may be permanently prevented, if the existing sluice gates, flushing inlets and drainage outlets are repaired. In future, the 2 ppt salinity contour line would be shifted within the 50 m buffer area inside the polder. No salinity would remain inside the polder, beyond the 50 m buffer line considered from the polder boundary.

Impacts

320. Significant positive impacts would be achieved regarding the prevention of salt water intrusion inside the polder. Salinity values will drop from around 4 ppt to around 2 ppt in approximately 6% areas inside the polder. Furthermore, 25% of the area which could be affected due to saltwater intrusion in future would no longer carry any surface water salinity.

ii) Surface Water Availability

Future without Project

321. At present, people of Polder 22 are suffering from water scarcity. They cannot meet domestic and drinking water requirements and at the same time, as well as irrigation potential Aus crops during Kharif-I season. If the khal re-excavation works are not carried out, the water scarcity in the polder would be severe. The topsoil erosion will cause further siltation in the khals, and the water carrying capacity would tremendously deteriorate.

Future with Project

322. Additional 38,920 m3 of water would be available in Fulbari, Muchimara, Harinkhola and Goger khals, which can serve a significant number of people, if the project is implemented,. From the spatial distribution of settlements it is observed that around 34%

population inside Polder 22 are directly dependent in Fulbari, Muchimara, Harinkhola and Goger khals, of which around 15% would be benefited from the increased availability of water in these channels. Bigordana and Gopipagla khals to be re-excavated for rainwater storage would undergo a volume increase of around 76,490 m^3. Assuming 30% loss due to seepage, evaporation and other natural happenings, the water to be carried by the Bigordana and Gopipagla khals have the capacity to meet up the domestic needs of around 2,900 people in a year. From the spatial distribution of settlements, it can be foreseen that 21% of the existing population would directly be benefited from the different water uses from the Bigordana and Gopipagla khals.

Impacts

323. Around 36% people inside Polder 22 would get access to surface water, and this would result in immense benefits in water use. Domestic purposes of water would be served, and water for irrigation would also be available substantially.

iii) Sedimentation

Future without Project

324. The internal khals of Polder 22 are subjected to siltation by both top soil erosion as well as sediment transportation. Sediments from the peripheral rivers enter the polder through the leakage in the water control structures. If the water control structures are not repaired, in future the sedimentation situation might be further aggravated.

Future with Project

325. The entry of tidal water would be prevented effectively during most parts of the year,if the water control structures around the polder are repaired,. As such, the entry of sediments from the peripheral rivers would largely be limited. This will result in having significant water depths inside the khals of Polder 22.

Impacts

326. The sedimentation situation inside the polder would be improved significantly. As tidal water would not enter the polder during the dry, and pre-monsoon seasons, there will be no sediment transportation inwards Polder 22 during these periods. This may ensure sufficient depth for water courses inside the Polder.

iv) Erosion

Future without Project

327. There are four erosion hot-spots in Polder 22 namely, Kalinagar, Naldanga, Darunmallik, and Bigordana which are vulnerable to erosion due to the morphological shift of peripheral rivers. From image analysis of 2003, it is observed, around 15 ha of lands within the peripheral river were eroded, and additional 60 ha of land is prone to erosion by next 30 years. However, if erosion prevention measures are not taken immediately, the risk remains that a significant portion of lands in the aforementioned areas might be eroded. Map 8.1 shows changes in erosion also.

Future with Project

328. River erosion would temporarily be stopped, if the four identified hot-spots are dealt with temporary erosion prevention measures. The placement of geobags would make the river banks more stable, whereas the bamboo erection works would reduce pressure on the embankments. Moreover, risk of erosion would considerably decrease.

Impacts

329. The four locations mentioned above would be protected from erosion. The post-monsoon recession of water levels would not be able to create much stress on the banks of the peripheral rivers, and the embankments would be safe against erosion.

v) Drainage Congestion and Water Logging

Future without Project

The khals proposed for re-excavation need to drain out a large volume of water after any major rainfall events, as such drainage congestion problems emerge in some areas. Currently about 10 ha of land is suffering from drainage congestion and it khals are not re-excavated, there is additional 12 ha of land will be subjected to water in the next 30 years (See map 8.1).

Future-with Project

330. Re-excavated khal would reduce the drainage congestion problems in the upstream portions of the khals would diminish, and rain water would be drained out properly from the area.

Impacts

331. Considering the 'future without project' and the 'future with project' scenarios, it can be said that around 22 ha areas within Polder 22 would be saved from probable water logging problems, due to the overall improvement in drainage capacity of khals.

8.2.7 Land Resources

i) **Soil Salinity**

Future without project

332. Soils inside the polder are saline especially in the southern part. It is found that about 69% of the NCA of the polder is strongly saline. If the interventions (repair of sluices gates, khals re-excavations) are not implemented in the polder, then saline tidal water intrusion in the agriculture land would remain. As such salinity would continue to increase under the future without project condition.

Future with Project

333. Proposed interventions would prevent the intrusion of saline water into the agriculture fields which may enhance crop production and may reduce crop damage. It is expected that proper WMG/WMA/WMF management may protect the undesirable entry of saline water and would allow draining out of rain water and reduction of salt from agriculture land. The above work will have positive impact in reducing soil salinity.

Impact

334. The intervention would reduce soil salinity inside the polder in future with project ultimately the entire project area would be benefited.

ii) **Induced Climate Change**

Future without Project

335. Salinity and drainage congestion would continue to remain same or aggravate under the future without project situation.

Future with project

336. Implementation of proposed interventions (according to the design (repair/ re-sectioning of embankment, repair of sluice gate, khals re-excavation) would improve the hydrologic regime of the project in future with project.

Impact

337. The intervention would change the hydrologic regime of the project in future with project. The entire project area would be benefited.

8.2.8 Agricultural Resources

i) **Crop Production**

Future without Project

338. Presently, total crop production is 7,600 tons of which, rice production is about 1,885 tons and non-rice crop production is about 7,713 tons. Under the future without project condition, the crop production would be 5,043 tons due to increase of salinity, siltation of khals, drainage congestion etc.

Future with Project

339. The successful implementation of the interventions would have positive impact on crop production. The crop production would be boosted up significantly under the future with project condition. The total rice production would be 2,199 tons which would be about 37% higher than the production of future without project. About 7,725 tons of non-rice crops would also be produced under the future with project condition which would be 124% higher than that of future without project. The production of rice would be increased due to increase of area under HYV Aman and reduction of Lt Aman rice area. (Table 8.5).

Impact

340. Additional 4,881 tons of crops will be produced under future with project scenario (Table 8.5) of which 598 tons are rice and 4,284 tons are non-rice.

Table 8.5: Impact on Crop Production under Future without Project and Future with Project Condition in the Study Area

Sl No.	Crop Name	Production (ton)				% of Change
		Baseline	Future without project	Future with project	Impact (future with project-future without project)	
1	HYV Aman	1484	1157	1,890	734	63
2	LT Aman	401	445	309	-136	-31
Total rice		1,885	1,602	2,199	598	37
3	Sesame	488	433	627	194	45

Sl No.	Crop Name	Production (ton)				% of Change
		Baseline	Future without project	Future with project	Impact (future with project-future without project)	
4	Vegetables	154	154	154	0	0
5	Water melon	4,740	2,600	6,741	4,141	159
6	Mungbean	268	254	203	-51	-20
7	Sunflower	65	57	64	7	12
Total non-rice		5,713	3,442	7,725	4,284	124
Total crop production		7,600	5,043	9,925	4,881	97

Source: Field information, 2014

ii) **Crop Damage**

Future without Project

341. Presently, drainage congestion/water logging is causing about 260 tons of crop production loss of which rice is 154 tons and non-rice is 106 tons. The situation would be aggravated under future without project condition.

Future with Project

342. Crop damage would be reduced due to implementation of interventions and its proper management. Therefore, these interventions would have positive impact in reducing crop damage area as well as crop production loss. The total crop production loss would be about 178 tons of which 61 tons rice and 117 tons non-rice under the future with project condition.

Impact

343. It is expected that 93 tons of rice and 11 tons of non-rice crop production loss would be reduced under future with project (Table 8.6).

Table 8.6: Crop Production Losses in the Polder Area

Sl No.	Crop Name	Production Loss (In Ton)				% of Change
		Baseline	Future without project	Future with project	Impact (Future with project-Future without project)	
1	HYV Aman	90	129	55	-74	-57
2	LT Aman	17	26	6	-20	-77
Total rice		107	154	61	-93	-60
3	Sesame	20	29	9	-20	-69
5	Water melon	75	75	107	32	43
7	Sun flower	1	2	1	-1	-50
Total non-rice		96	106	117	11	10
Total crop production		203	260	178	-82	-32

Source: Field Information, 2014

iii) **Irrigated Area**

Future without Project

344. Presently, irrigated area is about 65 ha. The situation would be aggravated under future without project condition i.e. irrigated area would be about 30 ha. This would happen due to siltation of existing khals. The changes in irrigated area with and without project situation are shown in Map 8.2.

Future with Project

345. Irrigated area would be increased due to implementation of interventions (Re-excavation of khals-Fulbari khal, Muchi mara khal, Harinkhola khal, Gogerkhal, Bigordana khal and Gopi pagla khal) and its proper management. Therefore, these interventions would have positive impact i.e. water would be preserved in two khals (Bigordana and Gopi pagla khal) for supplementary irrigation under the future with project condition. It is expected that, irrigated area would be about 110 ha in future with project (Map 8.2).

Impact

346. It is expected that, irrigated area would be about 80 ha under future with project over future without project.

8.2.9 Fisheries Resources

i) **Fish Habitat Quality**

Future without Project

347. Most of the internal khals of the polder are silted up and their bed levels are being raised gradually resulting in reduced water depth in these khals. Local people reported that no water is found in these khals during dry season except inter tidal floodplain area near the regulators. Currently about 30 ha of brackish water habitat is prevailing near the water control structures and the water logged area. If the interventions are not implemented in future it would be 44 ha due to increasing water logged area.

348. Under future without project, the depth of khal would be reduced by 50% from the existing level. Water surface of the internal khals would be reduced during wet season due to the ongoing process of heavy siltation. Low water depth would cause change in essential water quality parameters (water temperature, DO, pH etc) for fish life. Values above or below this range inhibit good fish growth and reproduction. Although the measured pH values of the water bodies was found within the tolerable limit but the values of pH and DO may decline due to reduction of water depth. Thus, such water bodies would become unsuitable for habitation of carp and SIS fishes. On the other hand, the salinity in the water bodies inside the polder area would increase due to leakage and mal-functioning of water regulatory structures. If this situation continues, Khals as well as dependant floodplain habitat would be converted into brackish or saline water prone fish habitat. The congenial environment for fresh water fisheries would be impacted causing local people to be interested to practice rice cum shrimp/prawn culture inside the polder area especially in the southern part of the polder. Moreover, the existing eroded embankment may breach by river erosion or by storm surges would result in overtopping culture ponds and damage to pond dyke.

Future with Project

349. Re-excavation of silted up internal khal would increase water depth and water availability round the year which would improve water quality. The increased water depth as well as improved water quality would create congenial environment for habitation of different type of fish species at different layer in the re-excavated khals. At the same time current brackish water habitat of 30 ha would be reduced to 24 ha. The saline water intrusion through mal-functioning of sluices would be stopped due to repairing of regulators and sluices which would also restore fresh water habitat for capture fisheries.

350. Rice-cum prawn with white fish culture would be increased gradually. Inter tidal floodplain near the sluice gate would be reduced thoroughly under future with project situation. The aquatic vegetation, both micro and macrophytes, will grow in the saline free water bodies which will not only use for fish feeding but also will use as sheltering for snake headed and cat fishes. Re-sectioning of embankment and repairing of sluices would reduce the flood risk which would lead to increase the culture fisheries practices significantly. Moreover, many culturable ponds would be converted into culture pond.

Impacts

351. Water depth as well as habitat quality will be improved. Water habitat will be reduced by 6 ha with respect to present condition and 20 ha with respect to future without project condition. The spatial distribution of impacts on fisheries resources in shown in Map 8.3. Saline water prone habitat would be converted into brackish to fresh water fish habitat. The improved habitat will support different types of aquatic vegetation which would be helpful for fish feeding and habitation.

ii) **Hatchling Movement**

Future without Project

352. Fish hatchling as well as some brackish and freshwater fish species move through the sluice gate at some stage for their life cycle to access spawning, nursery and feeding grounds. The hatchling movement through these routes has been disrupted. The driving factors for intensifying the disruption of those movement routes from khal to floodplain include substantially progressing khal bed siltation leading to reduced water depth, fixing more in-stream barriers like cross fish pata and encroachment in terms of fish culture and agricultural activities, etc.

Future with Project

Due to repairing of regulators/sluices, the hatchling movement through mal-functioning of regulators would be obstructed. But internal fish migration would be facilitated for the re-excavation of khals. Movement of brackish water fish species like *Vetki, Pairsa, Chingri*, and *Bele* etc which moves on the regular basis during high tide would be impacted.

Impacts

353. Hatchling movement from river to polder area through regulators would be obstructed. Some brackish water fish species include *Vetki, Pairsa, Chingr*, and *Bele* etc migrates on the regular basis during high tide would be impacted.

iii) **Fish Biodiversity**

Future without Project

354. The baseline fish species diversity condition in the polder area is moderate to low. Potential causes of decline of the fish biodiversity of the polder area include progressive deposition of massive silt on khal bed causing less water during dry season, habitat degradation and its adverse effect on aquatic environment, saline water intrusion through regulators, overfishing of undersized fishing, killing associated fry of different fish species during PL collection from peripheral river. Due to lack of perennial water bodies and short duration of water in the internal khals, brood stock would be depleted and dispersal of fishes in the upper reaches would be limited. Species composition would be changed through appearance of brackish water fish species (invasive species) and disappearance of indigenous fresh water fish species in the polder area. In future, the reported rare and unavailable fish species in this area may be extinct locally.

Future with Project

355. Due to re-excavation of khal and saline water prevention through regulators, capture fish species diversity would be increased by the small indigenous species (SIS) of fish. But currently reported brackish water fish species would disappear from this area. The dominancy of *Sarputi, Ayre, Boal, Magure* which are locally rare would be enhanced due to increase of water depth. Due to protection of flooding water, culturable fish pond would be converted into cultured. Rice-cum-prawn habitat would be dominated by the major and other carps instead of naturally intruded white fish. Accordingly, culture fish species (both native and exotic fish) would be increased in the polder area.

Impacts

356. Capture fish species diversity would be increased by the small indigenous species (SIS) of fish. Fish species composition would be changed. Rare and unavailable fish species would be conserved in water storing khals and their abundance would also be enhanced.

iv) **Capture Fisheries Productivity**

Future without Project

357. In the polder area, currently capture fisheries productivity are 170 kg/ha from khal and 231 kg/ha from seasonal water bodies (called *Senerber beel*) respectively. Normally changes of water surface area would change the fish productivity. Due to the ongoing process of siltation, the khals bed would be raised gradually and in turn reduce water availability period and cause reduce the fish productivity. This habitat would become less suitable for fish habitation in some extent. It is expected that capture fisheries productivity would be reduced by 10% from the base condition under the future without project condition.

Future with Project

358. Restoration of the internal khals by re-excavation and saline water prevention through regulator repair, it is expected that the capture fisheries productivity both khal and seasonal water bodies would be increased by 20% from the base condition.

Impacts

359. Capture fisheries productivity, both in khal and seasonal water bodies would be increased by 20% from the base condition. The productivity of khal and seasonal water bodies would be 184 kg/ha and 236 kg/ha respectively. Additional fish productivity would be

31kg/ha from khal habitat and 5 kg/ha from seasonal water bodies and thereby the net production from the capture fisheries habitat would be gained.

8.2.10 Ecological Resources

i) Habitat Condition

Future without Project

360. Terrestrial habitat condition would be further deteriorated due to increase of soil salinity and riverbank erosion. Currently, there is no high density settlement; about 50% of the settlements are with moderate density and 45% with low density. And it is also observed that density is high in the middle of the polder and low near the peripheral settlement of the polder. Aquatic habitat condition would also be degraded for continuing siltation of khal beds. In addition, yearly riverbank erosion, natural disaster is also another threat that destroys homestead vegetation. Malfunctioning of water control structures like regulators causes insufficient drainage and flashing capacity of the polder area, which causes vegetation damage. Intrusion of saline water would degrade habitat quality, and cause vegetation loss.

Future with Project

361. By controlling saline water inundation through re-sectioning of embankment and repairing of regulators and flash inlets will reduce saline water intrusion and protect climatic effects. It will be enhanced vegetation coverage that ultimately improves habitat suitability for dweller animals as well as species diversity for viable population to continue ecosystem services. Improvement of drainage system and water conveyance capacity through re-excavation of khals will positively impact on aquatic habitat condition in terms of area as well as water quality.

Impacts

362. In future both the terrestrial and aquatic habitat quality will improve. The spatial distribution in terrestrial vegetation density is shown in Map 8.4. From the map it is observed that after the implementation of the interventions about 28% of the settlement will be high density settlement as there will be reduced salinity.

8.2.11 Socio-economic Condition

i) Social Use of Water

Future without Project

363. People cannot use water for taking shower, washing chores and others purposes due to unavailability of fresh water bodies. They make up their necessity for water through tube well. At present 1,840 numbers of families are deprived from such facility and without project situation this number will be more.

Future with Project

364. With the intervention, numbers of families would be benefited. They can use water in different social aspects. Moreover, it enhances social bonding and cohesion among them.

Impacts

365. The standard of life for 1840 people in the polder will be enhanced since they would have facility for social use of water. Moreover, it enhances their social bonding and cohesion in every aspects of life.

ii) **Drinking Water**

Future without Project

366. There is a dearth of safe drinking water in polder area. Currently, about 21% of the settlement are facing severe drinking water crisis where approximately 1980 people live and the remaining 7330 people are facing moderate drinking water crisis. It is also observed that, due to lack of fresh water, at least 100 families from 7 villages buy water and depend on neighbouring village for 7 months. They buy drinking water at 30 litres for 20 Tk which is expensive for them. Without project situation, this misery would gradually increase and may reach into intolerable stage (some people may be forced to migrate to cities).

Future with Project

367. The reservoir would be highly beneficial for resolving the drinking water crisis to the neighbouring areas. In future, 11% of the settlement will have better access to drinking water facility and an additional 20% will have better access to domestic water facility. The impacts of proposed interventions, especially reservoir and canal re-excavation, on both drinking water and domestic water are shown in Map 8.5.

Impacts

368. About 1040 people directly benefited from these two proposed reservoirs and it can ensure fresh water during dry period. And, in addition, 1850 people will have better access to domestic water facility in future.

iii) **Gender Promotion**

Future without Project

369. In the polder area, most of the people are living under poor condition. Specially the women who are mostly vulnerable, distressed and widow who are dependent on others and do not have any definite sources of income. Therefore, in without project situation they will be more vulnerable and become burden to society.

Future with Project

370. About 40% of the labour under total local constructing society (LCS) will be females. It is expected that they will be directly benefited by this intervention.

Impacts

371. The employment opportunity for women in the construction works and during operation/maintenance phase can promote them into better life and livelihood

iv) **Quality of Life (Income generation, employment opportunity)**

Future without Project

372. The quality of life with regards to income generation, employment opportunities, housing condition and sanitation is still not good as they continue to live under poor

economic condition and have very few options to develop or adapt this condition. Their sufferings may further deteriorate.

Future with Project

373. On the other hand, proposed intervention can ensure improved quality of life. More income opportunities and possibilities of employment in different interventions can ensure better life and livelihood of the people of the polder.

Impacts

374. Creating new employment opportunities are increasing the means for generating more income for the people of the polder. This ensures improvement of the standard of life and well-being of the people here. Additional income, augments brings solvency, steady of the family.

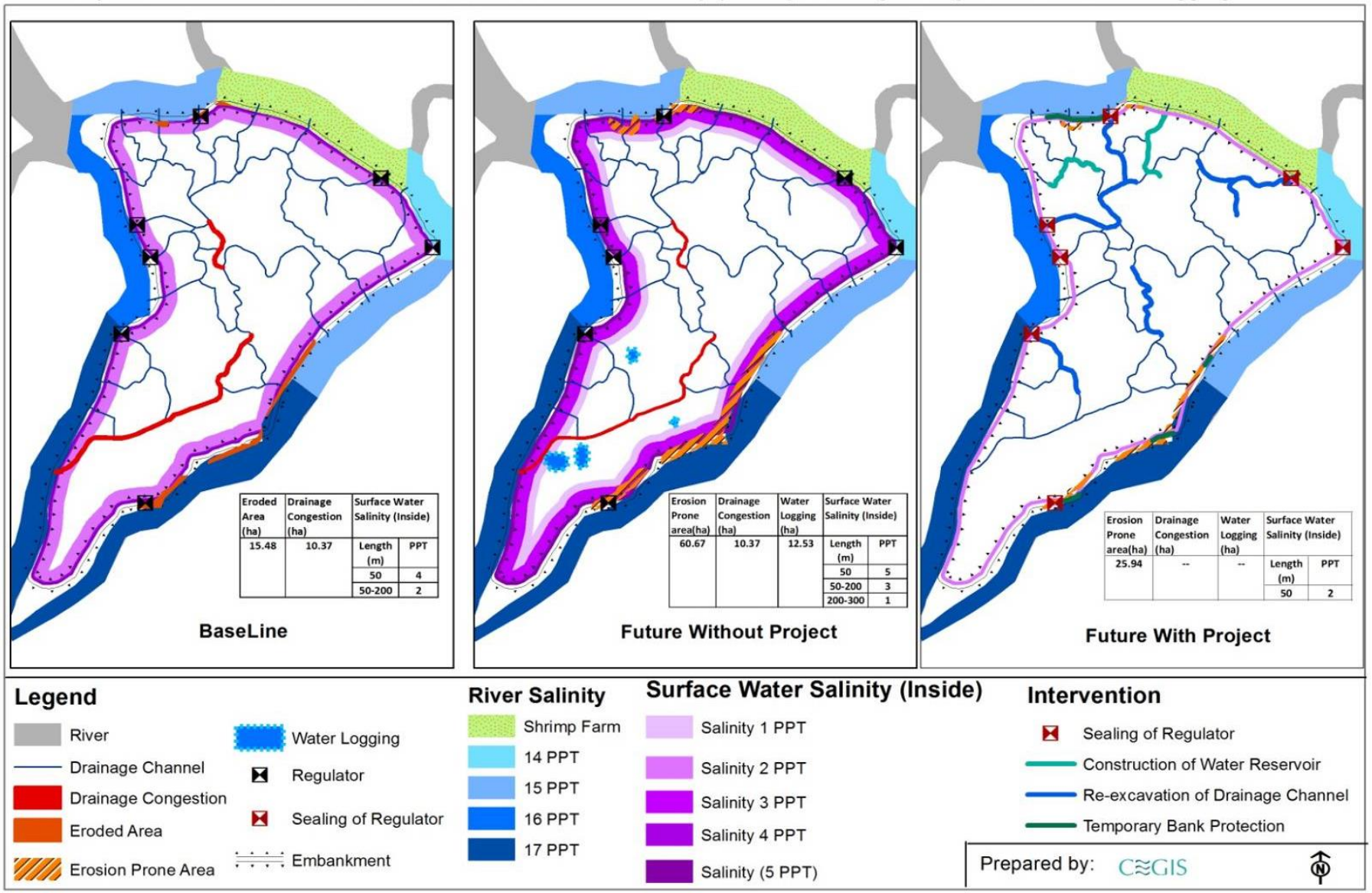
Table 8.7: Location Specific Impact Assessment Matrix under O & M Phase

IESC	Baseline	Future without Project	Future with Project	Impact (+/-) / Magnitude 1-10
Water Resources				
Saltwater Intrusion	4 ppt and 2 ppt salinity values within the 50 and 200m buffer areas from polder.	The 2 ppt salinity contour line would be shifted inwards at a distance of 250m inside the polder	Within 50m inwards buffer area the salinity values would drop by 2 ppt, and no salinity would remain from beyond the 50 buffer zone inside the polder.	+6
Surface Water Availability	People from Polder 22 cannot meet their domestic and drinking water requirements and at the same time irrigation during Kharif-I season cannot be provided.	Water availability would be restricted and use of water could be severely constrained.	Around 15% of the people would be benefited from the increased water availability in Fulbari, Muchimara, Harinkhola and Goger khal. Furthermore, 21% of the population would be directly benefited from Bigordana and Gopipagla khals.	+5
Sedimentation	The internal khals are subjected to siltation by both top soil erosion as well as sediment transportation from peripheral rivers.	Sedimentation situation might be further aggravated.	Significant water depths inside the khals of Polder 22.	+2
Erosion	Four erosion hot spots at Kalinagar, Naldanga, Darunmallik, and Bigordana are vulnerable to erosion due to the morphological shift of peripheral rivers	A significant portion of land might be eroded.	Risk of erosion at the four locations would be considerably decreased.	+2
Drainage Congestion and Water Logging	Drainage congestion at (10) km water courses inside the polder, but there are no water logging problems.	Around 12 ha areas may face water logging problems	Drainage congestion in the upstream portions of the khals would diminish	+3
Land Resources				
Soil Salinity	About 69% of NCA are strongly saline with some very strongly saline, 31% of NCA is moderately saline with some strongly saline in 2009.	It will be the same as base condition or may deteriorate in the polders if the polder project is not implemented.	Salinity situation would decrease due to prevention of intrusion of saline water in the polder area.	+2
Induced Climate Change	Soil fertility status is low due to drainage congestion and salinity problems.	Impact of induced climate change may remain same or aggravate under the future without project condition.	Hydrologic regime will improve if the interventions are implemented according to the design (re-excavation of khals, earth work in	+2

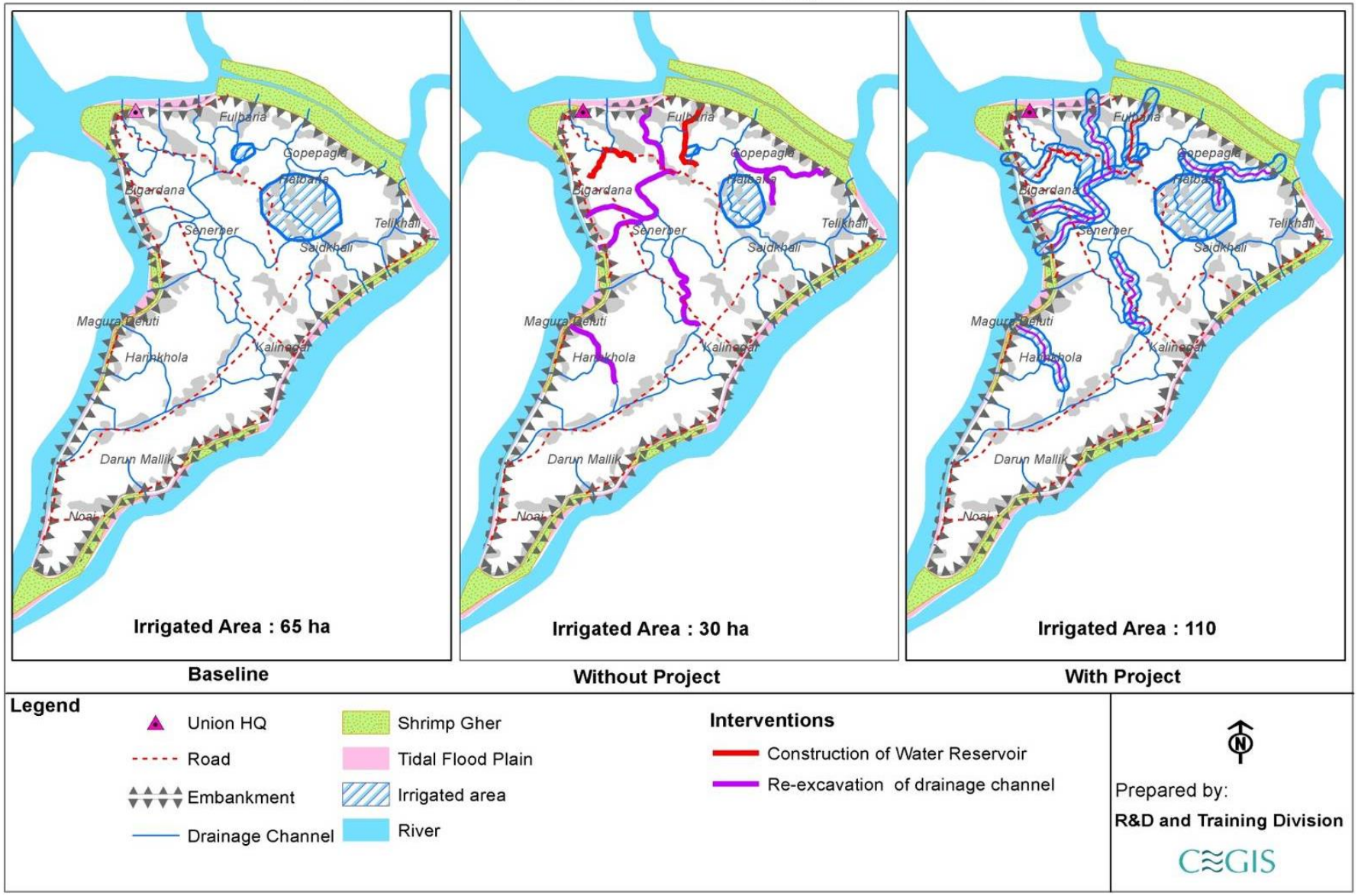
IESC	Baseline	Future without Project	Future with Project	Impact (+/-) / Magnitude 1-10
			repair/re-sectioning of embankments and repair of sluice).	
Agricultural Resources				
Crop Production	Total crop production is 7,600 tons of which rice crop is 1,887 tons and non-rice is 5,713 tons.	Total crop production would be 5,043 tons [rice crop of 1,602 tons and non-rice 3,442 tons].	Crop production would increase by 37% in future with project.	+3
Crop Damage	Rice production damage is 107 tons and non-rice production loss is 96 tons.	Rice production damage would be about 154 tons and non-rice production loss would be 106 tons.	Loss of crop production would decrease as follows: Rice: 60% Non-rice: 10% in future with project over future without project.	+2
Irrigated Area	Irrigated area is about 65 ha.	Irrigated area would be about 30 ha.	Irrigated area would be about 110 ha	+5
Fisheries Resources				
Fish Habitat Quality	All khals are seasonal. Average depth of the khal is 0.9 m and retains water for six to eight months. No water exists in the dry season. Water quality values of DO, PH, turbidity and salinity inside the polder is found within limit of usable for fisheries.	With the ongoing siltation process, khals bed will be elevated, thus the water retention capacity in the dry season will reduce. The water quality for fish life would be deteriorated.	Habitat quality will be improved.	+2
Hatchling Movement	Low	Same as base condition	Obstruct hatchling movement	-2
Fish Biodiversity	Moderate	Decline	Increase	+2
Capture Fisheries Productivity	Khal (kg/ha): 170	153	184	+2
	Seasonal water bodies(kg/ha): 257	231	236	+1
Ecological Resources				
Habitat Condition	Moderate	Terrestrial and aquatic habitat will deteriorate due to continuation of existing problems in the polder area.	Improve terrestrial and aquatic habitat.	+3
Socio-economic Condition				
Social Use of Water	People cannot use water for taking shower, washing chores and others purposes due to unavailability of fresh	In without situation, people cannot use water for taking shower, washing chores and	With the intervention, numbers of families are benefited. They can use water in different social aspects.	+2

IESC	Baseline	Future without Project	Future with Project	Impact (+/-) / Magnitude 1-10
	water bodies. They make up their needs for water through tube well.	others purposes due to unavailability of fresh water bodies. They make up their needs for water through tube well.	Moreover, it enhances social bonding and cohesion among them.	
Safe Drinking Water	There are 12 villages in polder area, of them, 5 are situated in relatively lower portion of the polder area. Therefore, drinking water crisis is prevalent in those 5 villages during dry season, i.e. November to May (7 months). During this period, the villagers buy drinking water from the neighbouring Gaoghera village @ 30 litre for 20 Tk. During monsoon i.e. June to October, they collect rain water and conserve it for these five months.	In without project situation, this misery would gradually increase and may reach an intolerable stage (forcing some people to migrate to cities)	Safe drinking water can ensure the well being of life and livelihood. As a result, the rate of disease will decrease and expenditure to buy water will decrease also..	+2
Gender Promotion	In the polder area only 2 % female members are working whereas 98 male members are engaged in income generating activities.	In polder area, most of the people are living under poor condition. Specially, women are mostly vulnerable and widows who are dependent on others and do not have any definite sources of income. Therefore, in without project situation they may be adversely affected.	The employment opportunity for women in the construction works and during operation/maintenance phase can promote them into better life and livelihood.	+3
Quality of Life	The quality of life regarding income generation, employment opportunities, housing condition and sanitation are still not good. Because they are living under poor economic condition and they have very few options to develop or adapt this condition.	In without project situation, these sufferings may be same condition or will be deteriorated in future.	Proposed intervention can ensure improvement in the quality of life. More income opportunity and employment in different interventions can ensure better life and livelihood of stakeholder of the polder.	+2

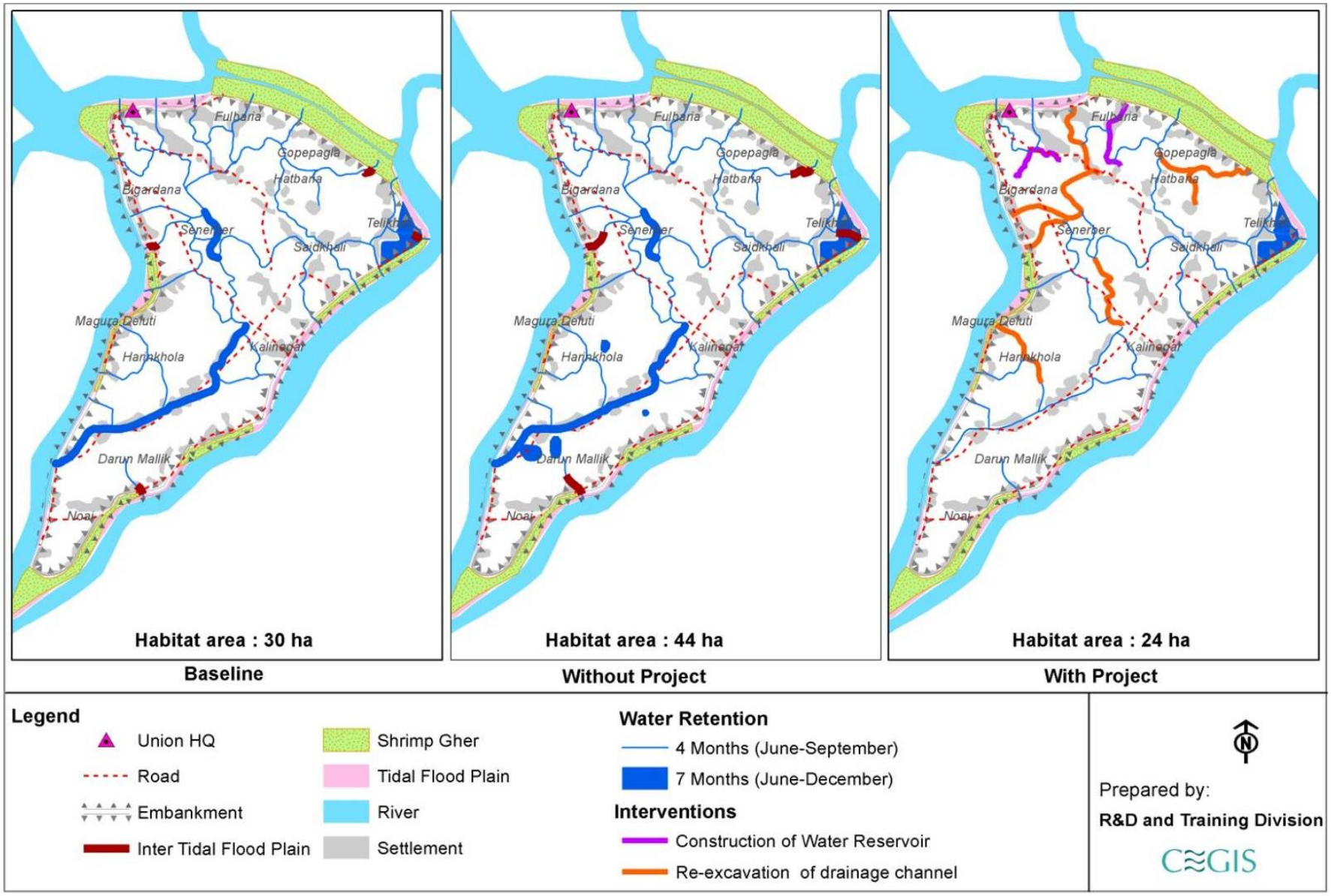
** Low impact (1-3); Medium impact (4-6); High impact (7-10)*



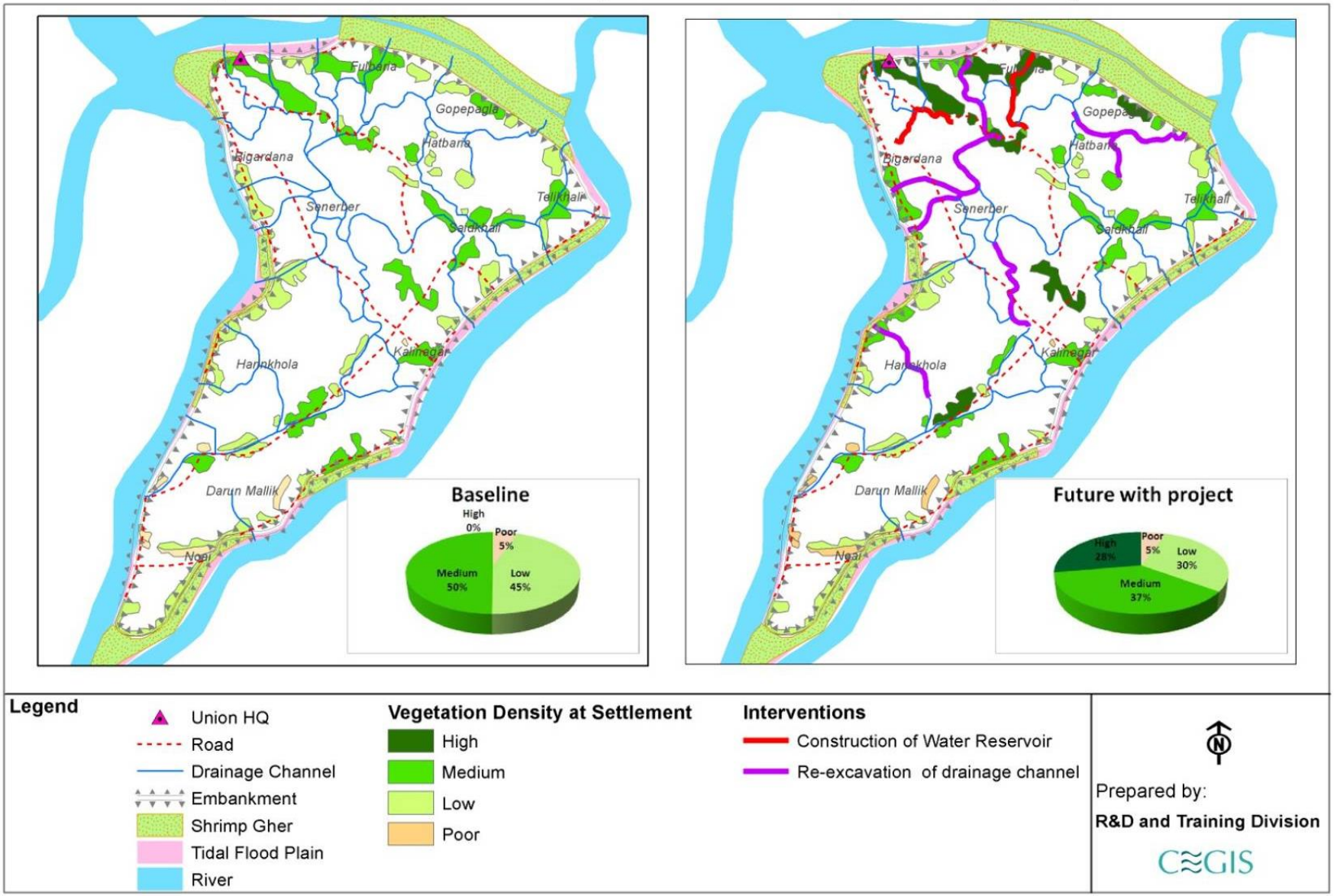
Map 8.1: Impacts on Water Resources in Future without Project and Future with Project Conditions on Polder 22



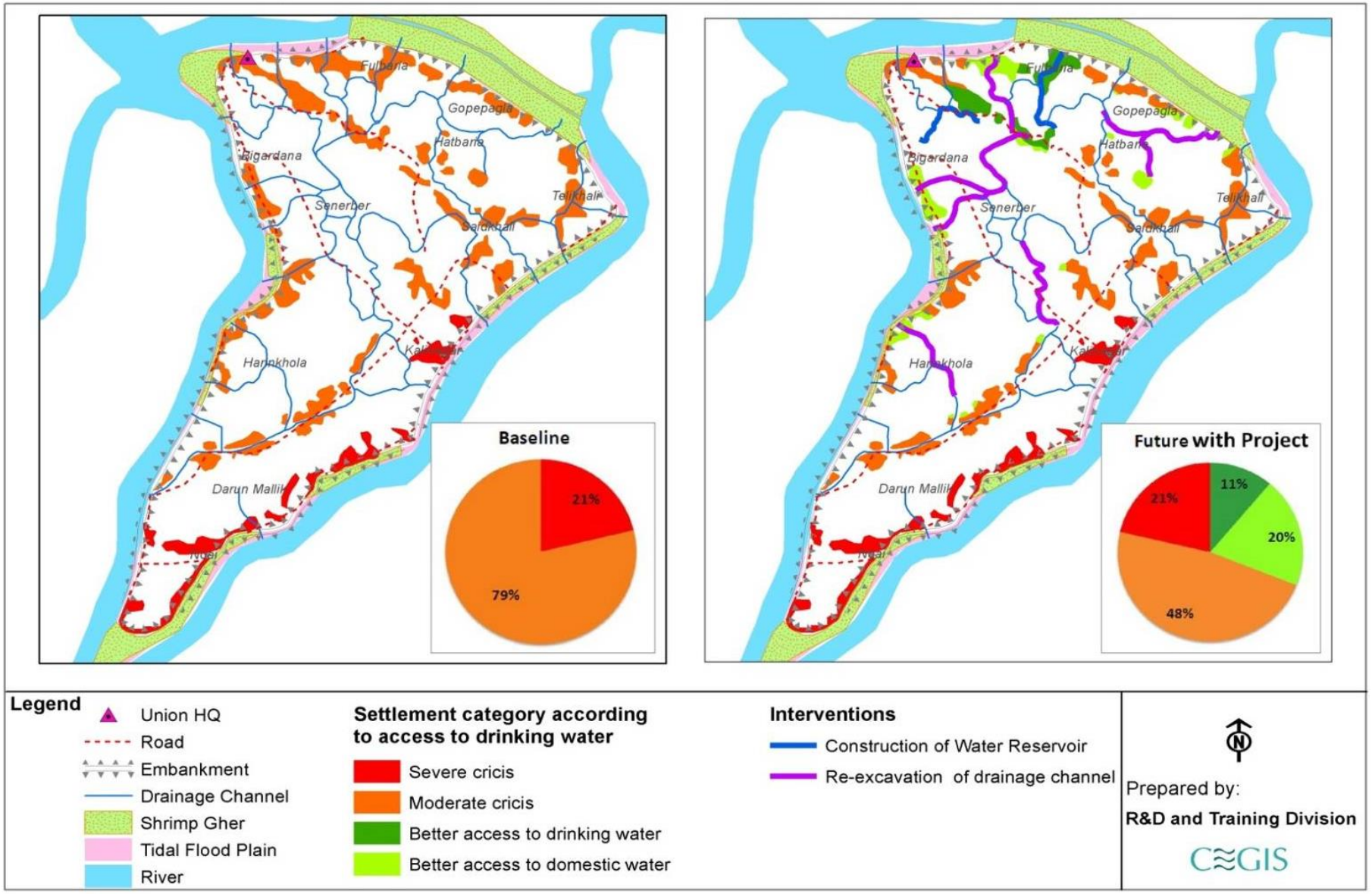
Map 8.2: Impact on Land and Agricultural Resources Showing Changes in Irrigated Area



Map 8.3: Impact on Fisheries Resources Showing Change in Fish Habitats



Map 8.4: Impact on Ecological Resources Showing Changes in Habitat Condition



Map 8.5: Impact on Socio-economic Condition Showing Changes in Drinking Water Status

9 Assessment of Cumulative, Induced and Reciprocal Impacts

9.1 General

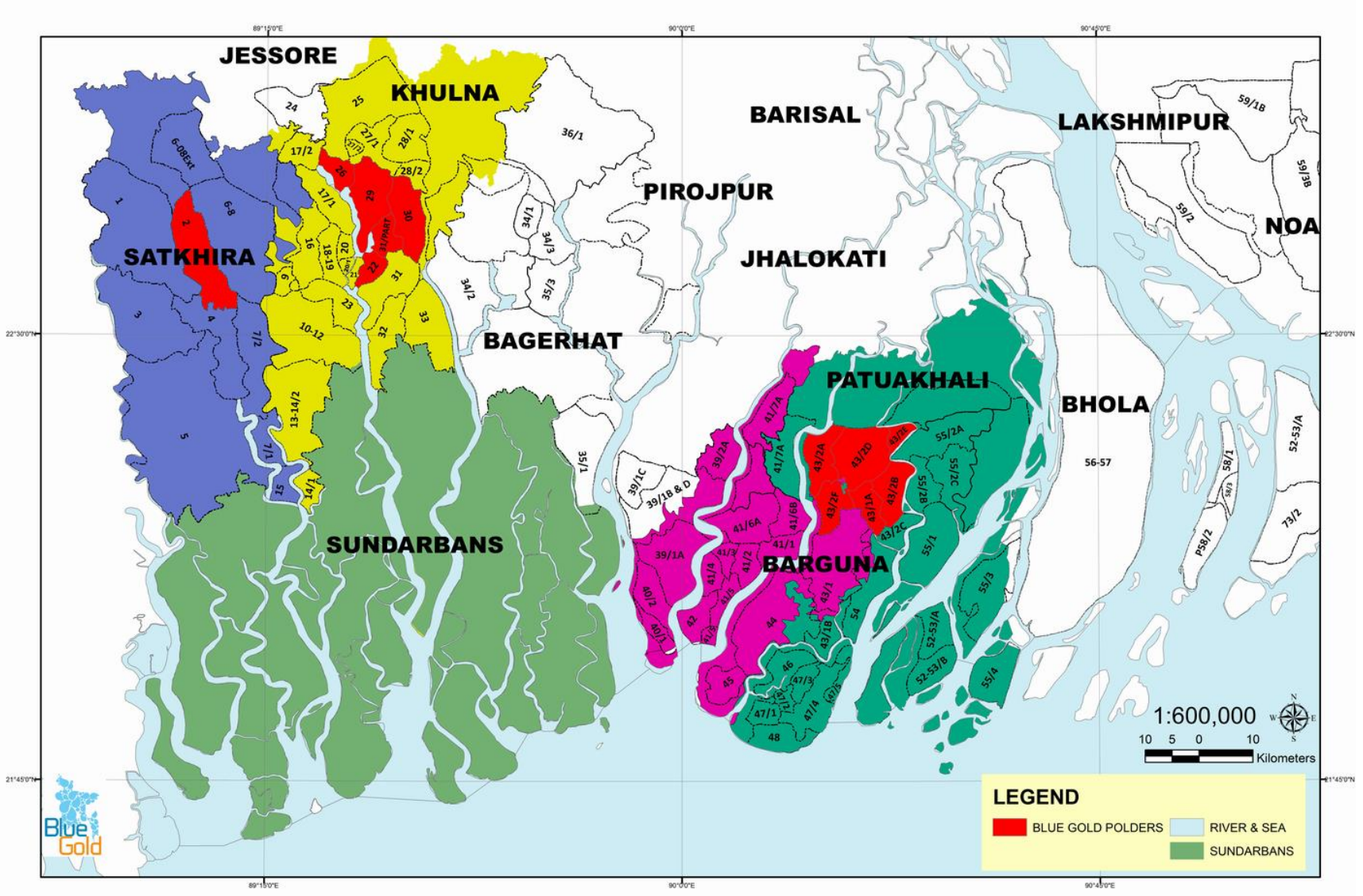
375. This Chapter attempts to analyze several indirect effects regarding the implementation of different interventions proposed under Blue Gold Program in Polder 22. These effects include cumulative and induced impacts of Polder 22, and the reciprocal impacts of climate change and polder. Cumulative impacts entail the total of all impacts to a particular resource that have occurred, or occurring, or may occur as a result of any action or influence in the surrounding area. In the vicinity of Polder 22, a number of other projects also exist apart from the Blue Gold polders. Such projects are affecting the life and livelihood of people, environmental quality, natural ecosystem, flora-fauna etc. Induced impacts, on the other hand are the indirect effects caused for implementation of any project, but occur later in time or at a distance far away from the polder. The reciprocal impacts of climate change and polder include long term effects of climate change induced phenomena into the polder, and the climate change resilience developed in the particular polder due to implementation of Blue Gold program.

9.2 Cumulative Impacts of all Blue Gold interventions on Polder 22

376. A total number of 12 polders in Satkhira, Khulna and Patuakhali districts have been selected for implementation of the program in the first phase. The selected polders are shown in Map 10.1 below. Among these, four polders (Polders 26, 29, 30 and 31/part) are located adjacent to Polder 22 and therefore may generate some impacts in future. The existing crest levels of these polders range from 3.5 m to 3.8 m above Mean Sea Level. If re-sectioning works are carried out along the periphery of these polders up to the design elevation of 4.27 m (same as Polder 22), there would be more floodplain sedimentation adjacent to the upstream polders. This may result in increase sedimentation along the Bhadra river system. With reduced river cross sections along the upstream, the tidal flow velocity might increase which would create more pressure along the peripheral embankment of Polder 22. Furthermore, repairing of existing water control structures of Polders 26, 29, 30 and 31/part under Blue Gold program would ensure reduction of dry season flow towards the polders. As such, surface water salinity, surrounding the Bhadra-Sibsa river system may increase, which might affect the existing river ecosystem, as well as the multifaceted surface water use of Polder 22. Moreover, if any permanent bank protection works are carried out in future in the aforementioned polders (26, 29, 30 and 31/part) under Blue Gold program, the morphological behavior of peripheral rivers may be changed. This might increase risk of river erosion in Polder 22.

9.2.1 Synopsis of projects around Polder 22

377. Apart from Blue Gold interventions, there are some other development projects nearby Polder 22, implemented locally or regionally. Activities of these projects may generate cumulative impacts on the polder in future. Table 9.1 below shows a list of various projects in relevance with Polder 22, undertaken by different line agencies in Khulna.



Map 9.1: Location of Polders selected for Blue Gold Program (First Phase)

Table 9.1: List of Water Management Projects

Agency	Project Name	Duration	Location	Sensitivity	Remarks
National					
MoWR, BWDB	Construction of Ganges Barrage	To be implemented	Pangsha, Ganges River	High	
MoDMR	Comprehensive Disaster Management Program (CDMP), Phase II	2010- ongoing	Entire country (40 districts with direct interventions)	Low	
BWDB	Projects under Climate Change Trust Fund	2013-ongoing	Entire country	Low	
	Capital Dredging of River system of Bangladesh	2012-ongoing	Entire country	Low	
	Water Management Improvement Project (WMIP)	2010-ongoing	Entire country	Negligible	No WMIP schemes nearby Polder 22
Regional					
DMB, BWDB, LGED	Emergency 2007 Cyclone Recovery and Restoration Project (ECRRP)	2008- ongoing	Coastal Zone	Negligible	ECRRP polders are far from Polder 22
BWDB	Coastal Embankment Improvement Project (CEIP)	2012- ongoing	Coastal zone	Moderate	
Local					
LGED	Flood Rehabilitation Project in the Area of Rural Development Project-18 (Greater Khulna, Jessore and Kushtia District)	2000-2003	Khulna, Satkhira, Bagerhat	Negligible	
	Greater Khulna District Infrastructure Development Project	2000-2004	Khulna, Satkhira, Bagerhat	Negligible	
	Biodiversity Conservation in Sundarban Reserve Forest.	1999-2005	Satkhira, Khulna, Bagerhat	Negligible	
	Rural Infrastructure Development Project	2008-ongoing	Khulna, Bagerhat andSatkhira	Negligible	
	Union Infrastructure Development Project	2010-ongoing	Khulna, Bagerhat andSathkhira	Negligible	
DoF	Extension of Culture Technology of Marine Shrimp	1997-2004	Khulna, Bagerhat, Satkhira and Cox's Bazar	Negligible	
KCC	Solid Waste Disposal and Environmental Improvement in Khulna City Corporation	1996-2004	Khulna	Negligible	

378. The projects (listed in Table 9.1) which have or may have Moderate or low sensitivities on some of the environmental or social components of Polder 22 are briefly discussed in the following sections.

9.2.2 Cumulative Impacts of proposed Ganges Barrage

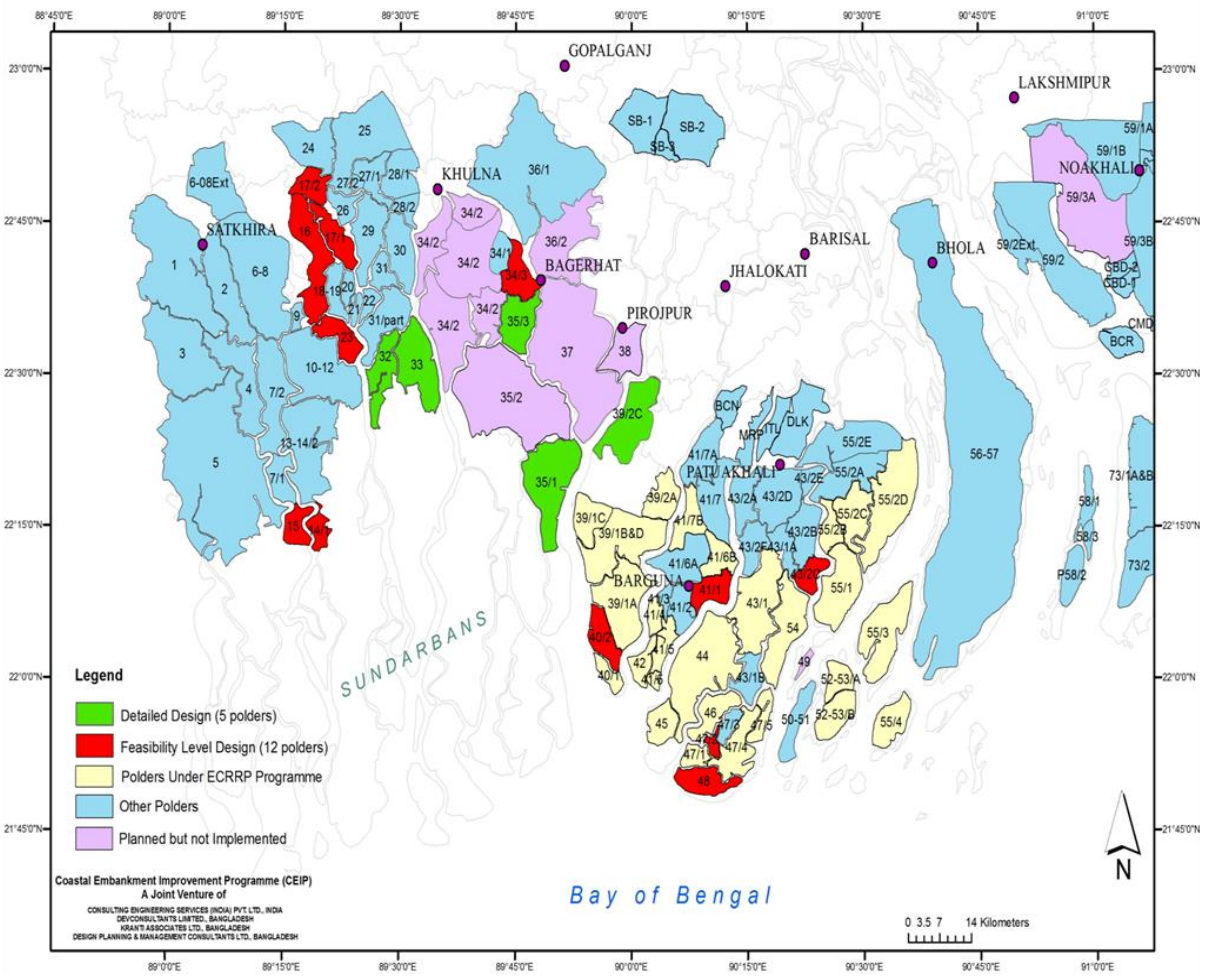
379. Ganges Barrage Project is perhaps the most significant project for the downstream region (coastal zone) of Bangladesh. The project is planned to manage the water resources system, promoting socio-economic development in equitable fashion, and to recover the existing environmental degradation. GoB already finalized the feasibility level investigation of the project. The selected site at Pangsha is situated at the lower stretch of the river, at 32 km upstream of the Jamuna-Ganges confluence. The main function of the 2116.50 m long barrage would be to store water for dry season through flow control.

380. Sufficient dry season flow may cause great hydrological changes in the Ganges and adjacent river systems. The Barrage will meet up the demand of utilizing Ganges water of different sectors, leading to sustainable development of the Ganges Dependent Area (GDA). Diversion of Ganges water from the upstream of the barrage through the Hisna-Mathabhanga-Kopotaksha system, the Gorai- Modhumati-Nabaganga system and the Chandana-Barasia system will rejuvilinate these rivers with flow of fresh water in dry season which would push down the salinity frontier. In addition, the increased upland discharge would result in lowering the rate of river sedimentation. The mean annual water level of downstream reaches would decrease. An overall situation of enhanced water security would be established.

381. Polder 22 is located within the GDA, and bears high sensitivity towards the proposed Ganges Barrage. The most significant impact of the barrage on Polder 22 would be the reduction of surface water salinity in its adjoining river system. Dry season water use may be benefited tremendously and more surface water irrigation is expected to increase inside the polder. This would eventually enhance the production and food security of the area. Several saltwater species may face extinction in the long run, creating scopes for new ecological diversities of freshwater tolerant species. On a social context, the effects may be significant as more livelihood shifting phenomena would take place. Existing shrimp farming practices along the polder floodplain may disappear, and the rural livelihood would shift towards enhanced farming practices. More regional and local developments are foreseen, and the environment of the polder may be highly benefited as a whole.

9.2.3 Cumulative Impacts of Coastal Embankment Improvement Project (CEIP)

382. CEIP is a multi-phased effort laid down by the GoB to refocus its strategy on the coastal area by providing extra emphasis on frequent storm surges. The long term objective of the project is to increase the resilience of the entire coastal population to tidal flooding as well as natural disasters by upgrading the whole embankment system. The embankment improvement and rehabilitation approach will be adopted over a period of 15 to 20 years and in this regard a total number of 17 polders have been selected through a participatory screening process. Of these 17 polders (shown in Map 9.2), five polders (Polders 32, 33, 35/1, 35/3, 39/2C) were selected for rehabilitation works under the first phase of CEIP (CEIP-I), which are already being implemented. The other 12 polders have undergone pre-feasibility studies and would be further investigated and implemented gradually in later phases.



Map 9.2: Location of CEIP polders

383. Polder 17/1 is located within 5 km upstream of Polder 22 along the Sibsa River. The existing crest level of Polder 17/1 ranges between 3.2 to 3.5 m above MSL. Embankment re-sectioning works are proposed in the polder under CEIP, which would increase the crest level up to 4.27 m above MSL. This increase would reduce storm surge to enter into the polder, but additional storm surge may be diverted towards Polder 22. Furthermore, if bank revetment works are implemented in Polder 17/1, the stability of river banks may increase, but would create pressure on the North-West corner of Polder 22 (near Bigordana) and the risk of river erosion in this part would increase.

384. The other two CEIP polders adjacent to Polder 22 are Polders 23 and 32. Polder 32 is included in the first phase of CEIP. The existing average crest level of the polder is around 3.2 m above MSL and the design level is 5.8 m. For polder 23, design level is the same as polder 32, with an existing average crest level of around 3.45 m above MSL. This refers to increases in crest levels of worth 2.6 m (Polder 32) and 2.35 m (Polder 23) in future, which would clearly increase the flow velocity of the river near Polder 22. Storm surge inundation risks are to be transferred to Polder 22 and the increased pressure of flow through Sibsa River may cause regular river erosion along the Southern corner of Polder 22 (near Noai). Moreover, the increased floodplain sedimentation adjacent to Polders 23 and 32 would offer less flow section through the Habarkhali River, which would substantially reduce river flow during low tide. During storm surge events there are chances of river water to overtop Polder 22 due to the reduced flow sections.

9.2.4 Cumulative Impacts of Other Projects

385. As shown in Table 10.1, a number of other projects are functioning near Polder 22 with low sensitivity. Most of the projects have much significance on the coastal region in general, but are located far away from Polder 22. A synopsis of the minor indirect effects of these projects with low sensitivity on Polder 22 is discussed below.

Projects under Climate Change Trust Fund (CCTF)

386. Considering Bangladesh's vulnerability to climate change, GoB decided to finance climate change adaptation initiatives from its own revenue budget as Climate Change Trust Fund (CCTF), for implementing more projects on climate change adaptation and mitigation. Up until now feasibility level investigations have been completed for a total number of 30 projects of BWDB, some of which are being implemented throughout the country. The second phase of CCTF is in the pipeline for implementation, with a number of newly proposed projects. Among all the CCTF projects, the geographic extent of one scheme (rehabilitation works in Polder 31) lies within the vicinity of Polder 22. However, the interventions proposed under the project are localized within the polder and no large-scale embankment re-sectioning works are proposed. Therefore the cumulative effects of the CCTF project on Polder 31 would have negligible influence in Polder 22.

Comprehensive Disaster Management Program, Phase II (CDMP-II)

387. CDMP was launched by GoB in 2003 as a key strategy to advance combined risk reduction efforts. CDMP ensures established and fully operational Disaster Management Regulatory Framework, strengthened capacities and integration of line agencies and ministries, improved functioning of Disaster Management Committees, effective early warning communication and response in all coastal districts, reduced risks through structural and non-structural interventions etc. There are 66 schemes under CDMP in the Dacope, Dumuria, Koyra and Paikgacha upazilas of Khulna district. The schemes are maintained from the Local Disaster Risk Reduction Fund (LDRRF) of CDMP, and are mostly software initiatives which include local level capacity strengthening on Climate Change and Disaster Management. There are 5 schemes under CDMP-II adjacent to Polder 22. The schemes are located in Chalna, Tildanga unions of Dacope upazila, and Deluty, Sholadana and Paikgacha unions of Paikkgacha upazila. During public consultations conducted in field investigations for EIA study of Blue Gold in Polder 22, it was found that local people have a comprehensive insight and capacity regarding climate resilience. Implementation of CDMP has contributed in the overall disaster management preparedness of local people, which in turn have indirectly facilitated their interest and credibility towards implementation of the Blue Gold program.

Capital Dredging of River system

388. The GoB planned to implement dredging works under the 'Capital Dredging and Sustainable River Management' project. So far, 23 rivers have been selected for dredging under the project by BWDB. Project works along Upper and Lower Meghna Rivers are relevant to Polder 22. Bank protection works would be constructed at some places along the upper Meghna River, which would have negligible impacts on Polder 22. However, dredging activities, proposed only in the Lower Meghna would increase fresh water flow in the downstream distributaries. This may confront the existing regional salinity frontier to a minor extent and there are chances that the surface water salinity situation around Polder 22 may slightly be benefited. In future, if more similar dredging works are initiated nearby, Polder 22 may be further benefited.

9.3 Induced Impacts of Polder 22

389. The interventions in Polder 22 may cause some spatial and temporal effects to a number of environmental and social components near the polder. The following sections entail detail discussions on such components which are to be indirectly impacted. It is to be mentioned here that Polder 22 is an existing polder and was further developed under IPSWAM. The proposed rehabilitation works are to cause very minor alteration of the environmental setup outside the polder. Therefore, induced impacts likely to occur are minor and as such discussed qualitatively.

River Sedimentation

390. The proposed interventions in Polder 22 will safeguard the polder against direct intrusion of tidal water. Therefore, water from Sibsa, Habarkhali, Badurgachi, and Bhadra rivers carrying sediments will move further downstream or upstream and may cause induced sedimentation. New morphological changes (i.e. formation of new lands, river course shifting) may be developed as a result in the Sibsa and Bhadra rivers. Some portion of the Bhadra River may be subjected to increased floodplain siltation due to sedimentation in the upstream and other anthropogenic factors caused by Polder 22 (i.e. waste generation, increased fertilizers etc.).

Tidal and Storm Surge Flooding

391. Polders 21, 23, 29 and 31 are adjacent to Polder 22. As per design, the crest level of Polder 22 would be raised up to 4.27 m above MSL, which may cause tidal and storm surge to overtop the adjacent polders (Polders 21, 23, 29 and 31) during extreme events. Tidal water may not be able to enter polder 22 during these events, and will be diverted elsewhere. This may increase the risk of flooding in the aforementioned nearby polders.

392. Table 9.2 below shows the existing average crest levels in Polders 21, 23, 29 and 31. The levels of Polders 29 and 31 are relatively lower compared with the same of Polders 21 and 23. This means that flooding risk would be higher in Polders 29 and 31.

Table 9.2: Existing Average Crest levels of Polders adjacent to Polder 22

Polder	Existing crest level (m +PWD)
Polder 21	3.83
Polder 23	3.83
Polder 29	3.75
Polder 31	3.67

Affect on water quality

393. The interventions in Polder 22 would lead to infrastructural developments, increased settlements and other human induced output. This would generate debris/ waste which may reach the peripheral rivers. Pollution phenomena might increase in the downstream of Habarkhali and Badurgachi rivers. Furthermore, due to expansion of agricultural area, more agriculture practices and industrialization are expected, which might pollute the chemical composition of surface water system near the polder.

Changes in aquatic habitat, species migration and biodiversity

394. Due to increased floodplain sedimentation outside the polder, aquatic habitat may slightly be affected. Flow cross sections may decrease considerably and spacing for aquatic

habitat might change. With the increased flow velocity along the upstream and downstream of the polder, new options for species migration and biodiversities may be opened up. Salinity concentration might increase in the peripheral rivers in future, and the salinity tolerant aquatic species may dominate while fresh water aquatic species may decrease. Biodiversity of aquatic life may also decrease in the Sibsa River.

Employment opportunities and Livelihood improvement

395. The development of the polder would create better scope for employment of local people, as well as the people living adjacent to the polder. In a few years time, due to the development of Polder 22, new employment opportunities would be created. This will encourage people from outside the polder to visit the polder for work and improve their livelihood status.

Enhanced local and regional food security

396. The proposed interventions would drive agro-economic development inside the polder. Thus, the area may provide enhanced food security to the surrounding areas. In future, Polder 22 would not only be able to resist the damage of cyclonic hazards or flooding, but may also provide safety against food crisis of the nearby areas undergoing probable damage. In greater context, the agro-economic development of the polder would contribute to the regional food security as well.

9.4 Reciprocal Impacts of Climate Change and Polder

397. In order to investigate the reciprocal impacts of Climate Change and Polder 22, both quantitative assessments and qualitative judgments have been carried out. Two separate hydrological and hydrodynamic models have been setup and simulated with data input from climate and hydro-meteorology to assess the impact of climate change on some sensitive issues of the polder namely, water availability, flood security and salinity. On the other hand, resilience towards climate change developed in the polder has been discussed based on field findings.

9.4.1 Development of Models

398. In order to assess availability of water for the study area, a semi-distributed hydrological model SWAT (Soil and Water Assessment Tools) has been setup. Hydrodynamic modeling has been simulated using Delft 3D as modeling tool. All data used in the model calibration (including topography, soil maps, land use maps, and weather data, river network and cross-section, water level, discharge and salinity) and simulation were obtained from different sources.

Digital Elevation Model (DEM)

399. The point elevation, existing river network and water body data have been utilized for the generation of a 20 m resolution DEM using ArcGIS for the Polder area. The 20 m resolution is better enough for identification of internal rivers and regulator locations.

River Bathymetry Data

400. Bathymetry of the Sibsa and Passur rivers have been generated for the existing cross-section data collected from the National Water Resources Database. Available cross-sections have been interpolated for the generation of sections at 100 m interval. The interpolated cross-sections have been utilized for preparation of a continuous bathymetry of the system.

Discharge and Water level data

401. BWDB regularly measures the water level and discharge data at the key locations on the major rivers. BIWTA also measures the water level data for the rivers which are used as their navigation route. The discharge and water level data has been collected from BWDB and BIWTA.

Land Use Data

402. The land use data for the study areas were obtained from the CEGIS database. These land types were linked with SWAT land type classification for use in the SWAT model. There are four land use types classified, i.e., agricultural land, settlement, roads and water bodies. Agricultural land is the predominant land class in both study areas. The settlement areas are mainly concentrated along the rivers.

Soil Data

403. Information on soil data was obtained from Soil Research Development Institute (SRDI), Bangladesh. For agriculture EC, pH, OM, N, P, K and S. Soil bulk density, available water content and hydraulic conductivity were estimated from the available soil attributes for each horizontal layer using the Pedo Transfer Function (PTF) developed by Saxton and Rawls.

Weather Data

404. On the basis of the location of the meteorological stations, Thiessen polygons or sub catchments were generated. Daily precipitation, maximum and minimum air temperature were used for the study area. The data has been collected from the BMD for the period of 1981 to 2012.

Climate Change Data

405. The 50 percentile values of 16 GCM ensembles for climate change scenario A1B has been considered. Climate change data for the polder has been selected using the nearest grid point method and summarized in Table 9.3. The results infer that monthly rainfall values may increase from March to October and decrease from November to February. Around 20% of the monthly rainfall will be decreased by 2050s for December and January, though the amount is very low during that period. Monthly flow will increase by 2.6% and 4.4% for July and September respectively by 2050s. Monthly temperature values will increase by 1.60C to 2.00C with an average rise of 1.80C by 2050s in the polder area.

Table 9.3: Change in monthly temperature and rainfall for the climate change scenario A1B with 50% ensemble of 16 GCM results by 2050s for polder 22.

Month	Climate Variables	
	Change in Rainfall (%)	Change in Temperature (0C)
Jan	-20.2	2.1
Feb	-4.5	2.1
Mar	1.6	2.0
Apr	2.1	1.9
May	3.7	1.8
Jun	3.2	1.6
Jul	2.6	1.7
Aug	4.4	1.8

Month	Climate Variables	
	Change in Rainfall (%)	Change in Temperature (0C)
Sep	2.1	1.7
Oct	7.2	1.7
Nov	-1.1	1.7
Dec	-19.8	1.8

Source: Climate Wizard, Washington University; Note: the negative (-) value in the table represent the decrease in rainfall or temperature

Sea Level Rise

406. Projected global average sea level rise during 2090-2099 with respect to 1980-1999 has been presented in Table 9.4 according to IPCC AR4. The sea level rise values presented show the model-based range excluding future rapid dynamical changes in ice flow. The maximum sea level rise has been predicted for climate scenario A1F1. For A1B scenario, the range of sea level rise is 0.21 to 0.48 m.

Table 9.4: Predicted global sea level rise for different climate change scenario by 2100

Scenarios	Sea Level Rise (m)
B1	0.18 – 0.38
A1T	0.20 – 0.45
B2	0.20 – 0.43
A1B	0.21 – 0.48
A2	0.23 – 0.51
A1FI	0.26 – 0.59

Source: IPCC AR4

9.4.2 Model Schematization

407. The following sections provide detail discussions on schematization and calibration of both the SWAT and Delft 3D models. The concept of water balance used in the model schematization has also been discussed below.

SWAT model Setup

408. Five sequential steps were followed to schematize the SWAT model: watershed delineation, Hydrological Response Unit (HRU) definition, weather data definition, assembling and editing SWAT inputs, and the actual simulation run. The watershed delineation was performed with the automatic delineation tool of SWAT 2012 using the DEM and the river network. All the watershed delineation steps such as filling sink, defining flow direction and accumulation have been done automatically through the user interface. The watershed delineation results 92 watersheds for the entire polder area. The delineated watershed for polder 22 is shown in Map 9.3. Afterwards, 356 numbers of HRUs were computed with 4 land classes, 4 soil classes and 92 watersheds.

Delft 3D model Setup and Calibration

409. A 2-D hydrodynamic model was setup for the Gorai-Passur and Sibsa river system. The schematization of the model is shown in Figure 10.1. The model starts from Gorai to the Bay of Bangal. The bathymetry of the river has been generated from the interpolation of available cross-sections at a distance of 100 m using the HEC-RAS model. Daily discharge data of BWDB at Gorai Rail Bridge has been utilized as upstream flow boundary and hourly water level data of BIWTA at Hiron point has been utilized as downstream boundary condition. The model has been simulated with a time step of 10 min for the year 2000 and 2001. It has been simulated for water level, discharge and salinity.

410. The model has been calibrated using Manning's n values for the rivers, against the water level data at Mongla as shown in Figure 10.2. The model shows good agreement with the observed water level. It can simulate both high and low water level during the calibration period.

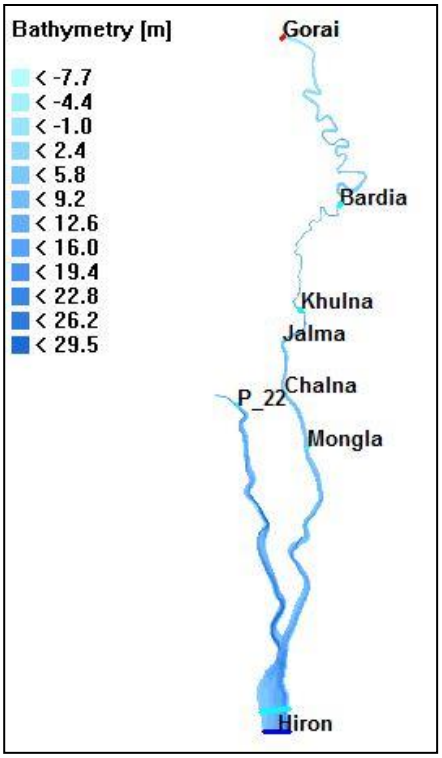
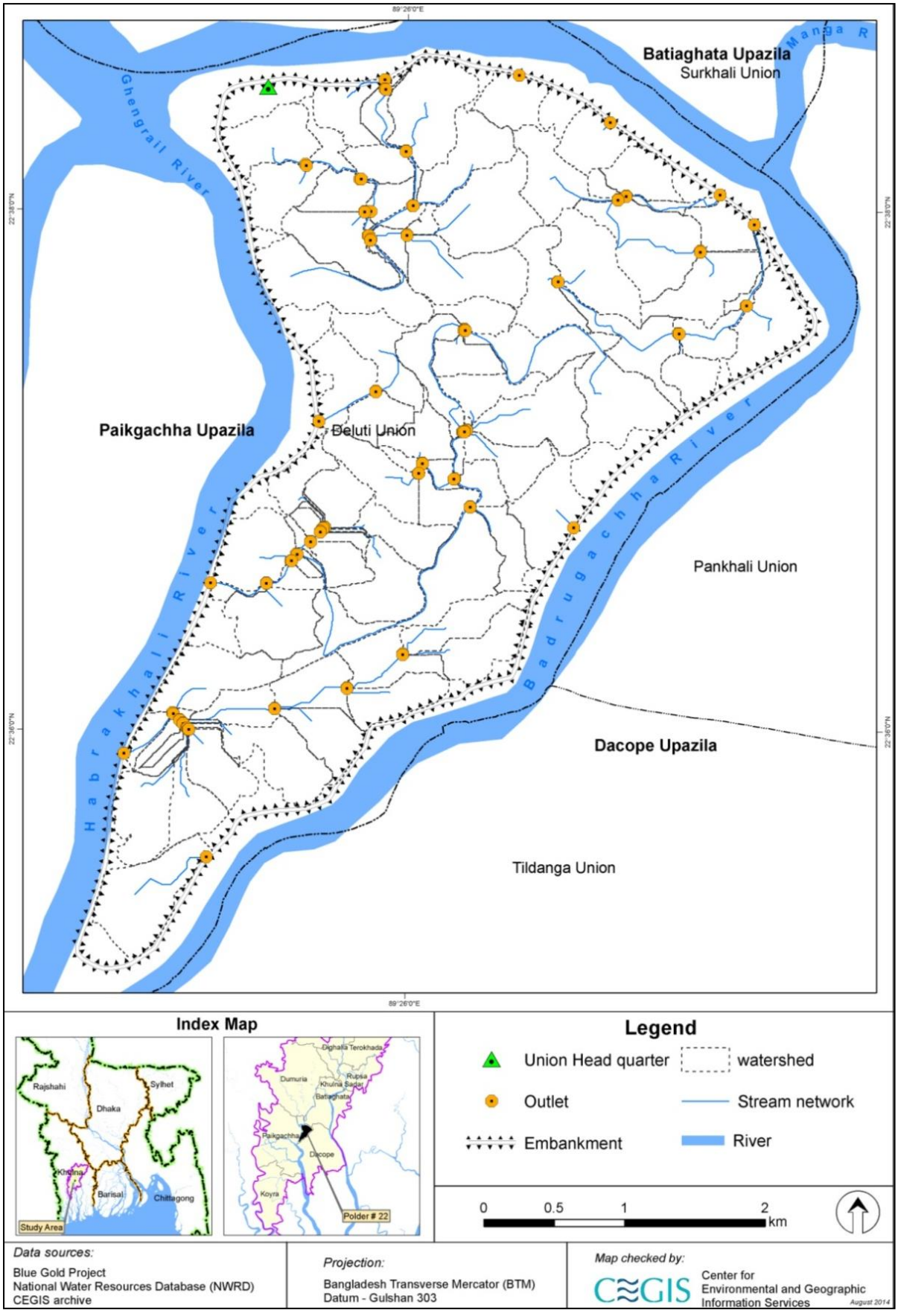


Figure 9.1: Schematization of hydrodynamic model using Delft 3D



Map 9.3: Delineated watershed during model schematization using SWAT for polder-22

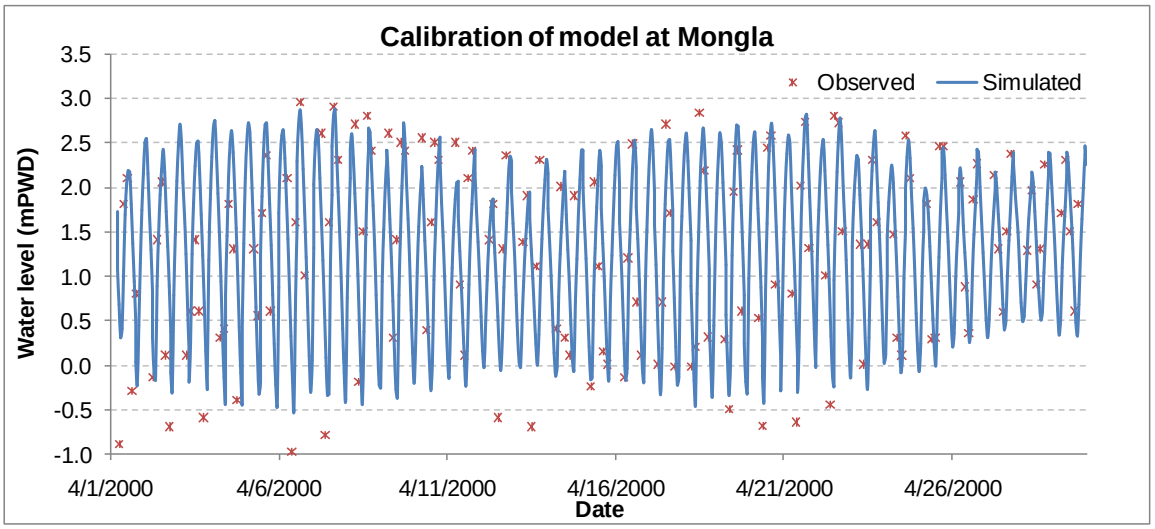
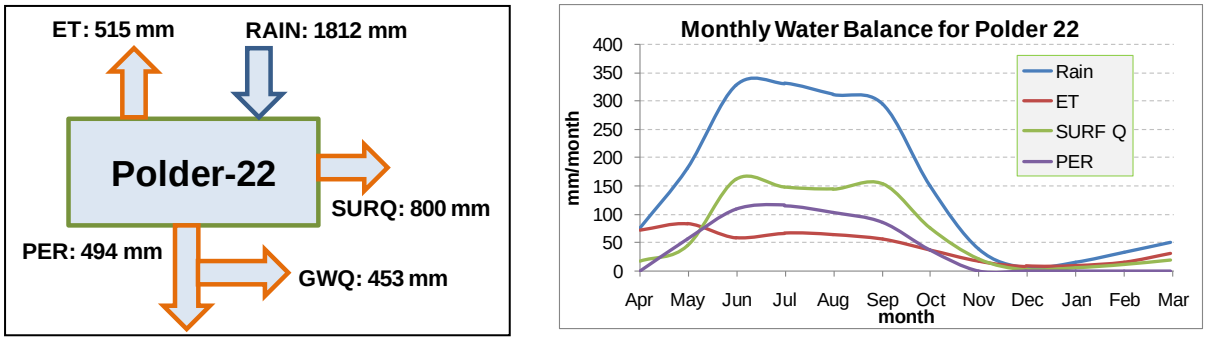


Figure 9.2: Calibration of model results at Mongla for April, 2000

Water Balance of the Study Area

411. Water balance is the assessment of water resources and its use in the system. The model has been simulated for the period of 1981 to 2008 to estimate the availability of water during base period (1981 to 2012). The annual water balance for the polder 22 is shown in Figure 9.3.



Note: Rain - Rainfall; ET - Evapotranspiration; PER - Percolation; SURQ - Surface Runoff

Figure 9.3: Water balance for polder 22, (a) average annual, (b) average monthly during the period of 1981 to 2012

412. Input to the water balance is rainfall while losses occur through evapotranspiration and percolation and as water contributing to stream flow through surface runoff. The annual actual evapotranspiration of the area is 515 mm which is 28% of the annual rainfall. The evapotranspiration is maximum during April and May and which is about 80 mm per month. The evapotranspiration rate is minimum during December to January. The percolation rate for the polder area is 494 mm per year which is 27% of the annual rainfall. The percolation rate follows similar trend like rainfall and the maximum rate is 160 mm per month. After the losses of water through evapotranspiration and percolation, the remaining water contributes to stream flow as overland flow and lateral (subsurface) flow. Around 45% (800 mm) of rainfall contributes to stream flow through surface runoff while the lateral flow is negligible.

9.4.3 Climate Change Impact on Water Availability

413. The precipitation, temperature and other climate parameters are assumed to change in future under various climate change scenarios. To understand the impact of climate change, the model was run for A1B climate change scenarios for the year 2050s.

414. The climate change impact on annual water balance for the Polder 22 is given in Table 9.5 for climate change scenario A1B by 2050s.The annual average rainfall for the polder area will be 1865 mm which is about 3% more than the base condition. The surface runoff also increases as there is an increase in annual rainfall. There is a little increase in annual evapotranpiration (3 mm/year) which is mainly due to the increase of temperature. There is also a bit increase in annual percolation due to climate change.

Table 9.5: Climate change impact on water balance for the scenario A1B by 2050s

Climate parameter	Amount (mm)	
	During base (1981-2012)	CC_2050s
Rainfall	1812	1865
Surface Runoff	800	844
Evapotranspiration	515	518
Percolation	494	500
Baseflow	453	458

415. The generated water yields were estimated and compared with base condition to assess the impact of climate change on water availability. Water yield is the net amount of water that leaves the polder and contributes to stream flow in the reach during the period (water yield = surface runoff +lateral flow + base flow- total loss- abstraction). The monthly water yield for the base and climate change condition is given in Figure 9.4.

416. The availability of water will increase during June to October as there is an increase in rainfall during that period. During the dry period (Dec-Feb), the water availability will decrease due to climate change by 2050s. The increase in around 10-15 mm and decrease is around 2 mm per month.

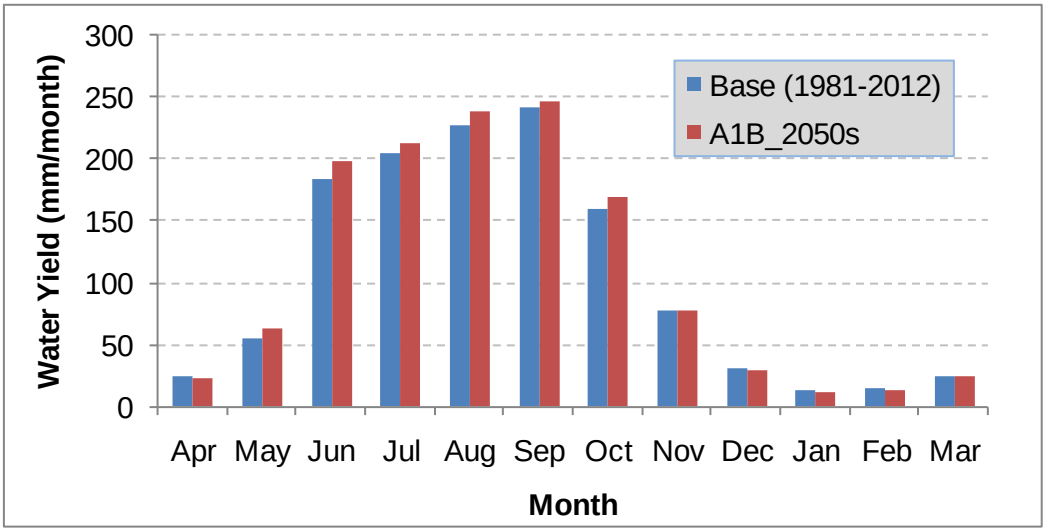


Figure 9.4: Climate change impact on monthly water yield for climate scenario A1B by 2050s

417. Table 9.6 below show the changes in seasonal water yield due to climate change by 2050s for scenario A1B. The Table shows considerable increase in seasonal water yield

during monsoon (38.8 %). Minor seasonal water yields during pre-monsoon and monsoon would also occur.

Table 9.6: Climate Change impact on seasonal water yield by 2050s for scenario A1B

Season	Water Yield during base (mm)	Change in water yield due to CC (%)
Pre-monsoon (Mar-May)	80	6.0
Monsoon(Jun-Sep)	857	38.8
Post-monsoon (Oct-Nov)	237	9.2
Dry (Dec-Mar)	81	-4.3

9.4.4 Climate Change Impact on Water Level

418. The sea level supposed to be increased due to the climate change by 2050s. Sea level rise during the 21st century is projected to have substantial geographical variability. The patterns from different models are not generally similar in detail, but have some common features, including smaller than average sea level rise in the Southern Ocean, larger than average in the Arctic, and a narrow band of pronounced sea level rise stretching across the southern Atlantic and Indian Oceans. The rise in sea water level will affect the increase of the river water level outside of the polder area. In Bangladesh, the impact of sea-level rise may be worsened by other effects of global warming, such as variable precipitation, more frequent droughts and floods, and shrinking of the glaciers that supply water to the rivers of the delta. The rainfall during the monsoon will be increased due to climate change which will result the increase in extreme flow during monsoon which ultimately result the increase in flood water level. Recently CEGIS conducted a study on climate change impact on stream flow for the GBM basin and found that the dry season flow will be reduced and monsoon flow will increase. For climate change scenario A1B, there is a 15% reduction of dry season flow and 16% increase of monsoon flow for the Ganges basin.

419. The calibrated and validated Delft 3D model for the Gorai-Passur and Sibsa system has been utilized to investigate the impact of sea level rise and increase of upstream water flow to assess the impact on flood water level outside the polder area. As there is a variability of prediction of sea level rise, an increase of 0.5 m of sea level at Hiron point has been assumed for the present study. At the same time, 16% increase of monsoon flow for the Gorai River has been assumed for the model setup. The model has been simulated for the combination of above two scenarios and the simulated maximum water level during the monsoon has been compared with the base year (2000) to assess the impact of climate change and sea level rise on flood level.

420. From the model simulation, it has been found that the flood level adjacent to the polder area will increased by 50 cm for only the increase of sea level and by 5 cm for only the increase of upstream water flow. The combined effect of sea level rise and increase of upstream water results an increase of 57 cm increase of maximum water level of the rivers surrounding Polder 22. The increase in flood water level might be a threat for the embankment and it also interrupt the drainage from the inside polder area. The climate change and sea level rise may increase the drainage congestion and flood risk for the polder.

9.4.5 Climate Change Impact on Salinity

421. Sea level rise can cause saline water to migrate upstream to points where freshwater previously existed or can intensify the salinity. Several studies indicated that sea level rise would increase the salinity in estuaries, which would result in changes in stratification and estuarine circulation. Salinity migration could cause shifts in salt-sensitive habitats and could

thus affect the distribution of flora and fauna. In addition to sea level rise, the decrease in flow during dry season can increase the salinity of rivers through encroaching seawater that moves upstream during periods of low flow.

422. To assess the impact of climate change and sea level rise on salinity, the delft 3D model has been utilized. It has been assumed that the dry season flow of the Gorai River will be reduced by 15% and 0.5 m of sea level rise has been considered for the scenario model setup. The model has been simulated for those two assumptions and the result has been compared with the base condition. From the simulation, it has been found that the salinity level of the rivers adjacent to the Polder 22 will increase by 1.5 ppt during the dry period. The increase in river salinity may cause the increase in groundwater salinity which will intensify the scarcity of drinking water and irrigation water for the polder area.

9.4.6 Climate Change Resilience Developed in Polder 22

423. During field investigations it was found that the local people are mostly aware of the climate change consequences and events. In recent years they have been the victim of climate change induced natural disasters, frequently hitting them and causing massive loss of lives and properties. Increased saltwater intrusion within the polder is severely impacting their daily lifestyle as well as livelihood occupation. Due to some of the initiatives taken through different software interventions by programs other than Blue Gold, the insight of climate resilience is already developed within the polder habitants. Through the community mobilization in Blue Gold program, people from the root levels have now become more active and towards building a climate resilient society. They are now driven by the concept of climate smart village. Most of the people who can afford are now re-building their houses and infrastructures on a relatively higher level. Local people claimed that they would use the excavated spoil from the internal khals for their household purpose if available. This will allow them to have their house and other infrastructures on a re-built higher land. The local farmers are now more concerned about climate change issues as well. They regularly follow take part in the knowledge development and capacity building programs organized by Blue Gold, which they believe have enhanced their understanding and preparedness on flood and disaster management.

10 Environmental Management Plan

424. Environmental management plan is presented in the following matrix for pre-construction, construction and operation and maintenance (O & M) phases against the impacts on the IESCs pertaining to water resources, land and agriculture resources, fisheries resources, ecological resources and socio-economic condition together with necessary monitoring program.

10.1 Water Resources

425. There would be no need of EMP during pre-construction and construction phases.

10.1.1 Operation and Maintenance (O & M) Phase

426. The implementation of proposed interventions may generate some long term impacts on water resources, as discussed in Chapter 8. Some of the impacts would require different levels of mitigation measures for negative impacts, enhancement for positive impacts, compensation, or contingency measures as shown in following Table 10.1.

Table 10.1: EMP Matrix for O & M phase on water resources

Impact	Mitigation Measure	Enhancement/ Contingency/ Compensation	Residual Impact (+/-)/ Magnitude (1-10) with EMP	Responsible Agency
Salinity values will drop from around 4 ppt to around 2 ppt in approximately 6% area inside the polder. And 25% of the area which could be affected due to saltwater intrusion in future; would not carry any salinity.	Not required	Not required	-	-
Around 36% people inside Polder 22 would be guaranteed sufficient surface water availability.	Not required	Not required	-	-
No inward sediment transportation in Polder 22 during these periods. This may ensure sufficient depth of water courses inside the Polder.	Not required	Not required	-	-
The post-monsoon recession of water levels would not be able to create much stress on the banks of the	Not required	Not required	-	-

Impact	Mitigation Measure	Enhancement/ Contingency/ Compensation	Residual Impact (+/-)/ Magnitude (1-10) with EMP	Responsible Agency
peripheral rivers, and the embankments would be temporarily safe against erosion.				
No drainage congestion would remain, and around 23 ha area would be improved from probable water logging problems	Not required	Not required	-	-

10.2 Land Resources

10.2.1 During Pre-construction Phase

427. There would be no need of EMP during pre-construction phase.

10.2.2 During Construction Phase

428. There would be no need of EMP during construction phase.

10.2.3 During O & M Phase

429. The implementation of proposed interventions may generate some long term impacts on land resources, as discussed in Chapter 8. Some of the impacts would require different levels of mitigation measures for negative impacts, enhancement for positive impacts, compensation, or contingency measures as shown in following Table 10.2.

Table 10.2: EMP Matrix for O & M phase on land resources

Impact	Mitigation Measure	Enhancement/ Contingency/ compensation	Residual Impact (+/-)/ Magnitude (1-10) with EMP	Responsible Agency
Salinity situation would decrease due to prevention of intrusion of saline water in the polder area.		Intrusion of saline water need to be stopped through smooth functioning of the regulators and strengthening of embankment with the involvement of WMGs/WMA/WMF Drainage system should be strengthened for proper functioning.	+3	BWDB, DAE, WMGs/WMA /WMF

Impact	Mitigation Measure	Enhancement/ Contingency/ compensation	Residual Impact (+/-)/ Magnitude (1-10) with EMP	Responsible Agency
Hydrologic regime will improve if the interventions are implemented according to the design (re-excavation of Khal, earth work in repair/re-sectioning /protection of embankments and repair of sluice/irrigation inlet /drainage outlet).		Formation of WMGs/WMA/WMF strengthening through imparting training need to be done. Involvement of WMGs in project activities (maintenance of embankment, functioning of regulators, etc) would improve the climate change induced impact. Crop rotation with leguminous crops, application of more organic materials, organic manure, and green manuring and soil management should be practiced to improve soil fertility in the project area. Crop diversification with multi-crops might improve environmental condition of the soil.	+3	BWDB, DAE and WMGs

10.3 Agricultural Resources

10.3.1 During Pre-construction Phase

430. There would be no need of EMP during pre-construction phase.

10.3.2 During Construction Phase

431. There would be no need of EMP during construction phase.

10.3.3 During O & M Phase

432. The implementation of proposed interventions may generate some long term impacts on agricultural resources, as discussed in Chapter 8. Some of the impacts would require different levels of mitigation measures for negative impacts, enhancement for positive impacts, compensation, or contingency measures as shown in following Table 10.3.

Table 10.3: EMP Matrix for O & M Phase on Agricultural Resources

Impact	Mitigation Measure	Enhancement/ Contingency/ Compensation	Residual Impact (+/-)/ Magnitude (1-10) with EMP	Responsible Agency
It is expected that crop production would increase by 37% in 'future with project' over 'future without project'.	-	Organic manure should be applied for the restoration of soil fertility. Farmers' group should have close contact with DAE for adaptation of various measures on IPM/ICM. Irrigation should be provided to optimum level with minimum conveyance loss from Khals. Involvement of WMGs/WMA/WMF in project activities would enhance crop production. Introduction of HYV crops cultivars along with crop diversification need to be practiced.	+4	BWDB, DAE, BADC and WMGs/WMA /WMF
It is expected that crop production loss would decrease as follows: Rice: 60% Non-rice: 10% in 'future with project' over 'future without project'.		The WMGs/ WMA/ WMF should be involved in the construction and post construction phase which might reduce crop damage. WMGs/WMA/WMF should be given orientation to protect their crops from re-excavation of Khal and re-sectioning/ repair of embankment works /protection work of embankment and development on farm water management etc.	+3	BWDB, DAE, BADC and WMGs/WMA/WMF
It is expected that irrigated area would be expanded about 80 ha in 'future with project' over 'future without project'.	-	Training of 'Integrated water management' and 'on farm development' of WMGs would help to increase the expansion of irrigated area The WMGs/WMAs/WMFs should be involved in the integrated water management through proper maintenance of regulators (sluice gate, inlets and outlets) for the expansion of irrigated area. The irrigation water should be used at optimum level so that the area might be increased with limited resources of water.	+6	BWDB, DAE, BADC and WMGs/WMA/WMF

10.4 Fisheries Resources

10.4.1 During Pre-construction Phases

433. As there would be no impact during pre-construction phase, no EMP is required.

10.4.2 During Construction Phase

434. The implementation of proposed interventions may generate some temporary impacts on fisheries resources, as discussed in Chapter 8. Some of the impacts would require different levels of mitigation measures for negative impacts, enhancement for positive impact, compensation or contingency measures as shown in following Table 10.4.

Table 10.4: EMP Matrix for Construction Phase on Fisheries Resources

Impact	Mitigation Measures	Enhancement/ Compensation/ Contingency	Residual Impact(+/-) Magnitude(1-10) with EMP	Responsible Agency
Temporary loss of feeding ground and unavailability of fish feed for bottom dweller would happen. Due to re-excavation of khal, turbidity of water would be increased. But after one (01) year the habitat quality of fish will be improved Intertidal floodplain fish habitat would be impacted Some particular fish species like Betki, Pairsa, Chingri, Bele etc. would be impacted During re-excavation of Bigordanakhal and Gopipaglakhal for rain water storing, the habitat of eel fish, especially habitat of *Cuchia* fish will be affected significantly. And Gopipaglakhal, for rain water storing, the habitat of eel fish, especially habitat of Cuchia fish will be affected significantly.	Avoid re-excavation during fish migration period e.g. month of May to July. Earth spoils to be dumped outside the khal area To protect the indigenous fishes and other aquatic creators, re-excavation should be implemented by segments and one after another.	N/A	0	Contractor, BWDB, DoF

10.4.3 During O & M Phase

435. The implementation of proposed interventions may generate some long term impacts on fisheries resources, as discussed in Chapter 8. Some of the impacts would require different levels of mitigation measures for negative impacts, enhancement for positive impacts, compensation, or contingency measures as shown in following Table 10.5.

Table 10.5: EMP Matrix for O & M phase on Fisheries Resources

Impact	Mitigation Measures	Enhancement/Compensation/ Contingency	Residual Impact(+/-) Magnitude(1-10) with EMP	Responsible Agency
Water depth as well as habitat quality will be improved. Saline water prone habitat would be converted into brackish to fresh water fish habitat. The improved habitat will support different types of aquatic vegetation which would be helpful for fish feeding and habitation.		Awareness development on natural resources, campaigning against indiscriminate fishing and reinforcement of fisheries laws and regulation Apply IPM instead of pesticides for protection of capture fish habitat Remaining khals with branch khals should be re-excavated	+2	DoF
Hatchling movement from river to polder area through regulators would be obstructed. Some brackish water fish species include Vetki, Pairsa, Chingr, and Bele etc migrate on the regular basis during high tide would be impacted.		Avoid the construction activity in the month of May to July to avoid the peak period of fish migration. Properly and timely gate will be open for the entrance of the fish hatchling in the month of May to July except the tidal surge. Gate management committee should be formed for properly operating f gates.	0	DoF
Capture fish species diversity would increase by the small indigenous species (SIS) of fish. Fish species composition would be changed. Rare and unavailable fish species would be conserved in water storing khals and their abundance would also be enhanced.		Avoid fish culture in Gopepagla khal, Bigordana khal. Release native rare and unavailable fish species as well as SIS in those khals Awareness development on natural resources, campaigning against indiscriminate fishing and reinforcement of fisheries laws and	+3	DoF

Impact	Mitigation Measures	Enhancement/Compensation/ Contingency	Residual Impact(+/-) Magnitude(1-10) with EMP	Responsible Agency
		regulation		
Capture fisheries productivity both khal and seasonal water bodies would increase by 20% from the base condition. The productivity of khal and seasonal water bodies would be 184 kg/ha and 236 kg/ha, respectively. Additional fish productivity would be 31kg/ha from khal habitat and 5 kg/ha from seasonal water bodies and thereby, the net production from the capture fisheries habitat would be gained.		Demonstration of pond should be implemented in the study area. Ensure pure strain and native fish species for aquaculture	+3	DoF

10.5 Ecological Resources

10.5.1 During Pre-construction Phase

436. As there is no impact during post construction phase, no EMP is needed.

10.5.2 During Construction Phase

437. The implementation of proposed interventions may generate some temporary impacts on ecological resources, as discussed in Chapter 8. Some of the impacts would require different levels of mitigation measures for negative impacts, enhancement for positive impact, compensation or contingency measures as shown in following Table 10.6.

Table 10.6: EMP Matrix for Construction Phase on Ecological Resources

Impact	Mitigation Measure	Enhancement/ Contingency/ Compensation	Residual Impact (+/-)/ Magnitude (1-10) with EMP	Responsible Agency
Activity: Re-sectioning of embankment				
Herbs, shrubs, various type of grass, bushes will be minor and temporary damaged due to soil dumping for re- sectioning work. Re-located wildlife due to habitat loss temporary.	N/A	-	-1	Contractor and BWDB
Activity: Construction of temporary protection work				
Minor damages of embankment side herbs and shrubs due to earthwork activities. Deteriorate aquatic habitat condition for placement of geo-bag	N/A	-	-1	Contractor and BWDB
Activity: Re-excavation of khal				
Eel fish like 'Cuchia' and water dependent fauna as Skipper frog, Bullfrog, Kingfisher, Egret, common aquatic Snake, etc. will be temporary re-located due to habitat loss in the khal area. Grasses will be damaged due to storage of soil along the both side of the khal.	Keep the deepest points of the khal untouched as much as possible. Create new habitat adjacent to the existing habitat before re-excavation of khal.	-	0	Contractor and BWDB

** Low impact (1-3); Medium impact (4-6); High impact (7-10)*

10.5.3 During O & M Phase

438. The implementation of proposed interventions may generate some long term impacts on ecological resources, as discussed in Chapter 8. Some of the impacts would require different levels of mitigation measures for negative impacts, enhancement for positive impacts, compensation, or contingency measures as shown in following Table 10.7.

Table 10.7: EMP Matrix for O & M Phase on Ecological Resources

Impact	Mitigation Measure	Enhancement/ Contingency/ Compensation	Residual Impact (+/-)/ Magnitude (1-10) with EMP	Responsible Agency
Improve Terrestrial and Aquatic Habitat.	-	Plant a mix of native trees along the embankment slopes and toes wherever possible to enhance green coverage.	+4	Contractor ,BWDB and local stakeholder

** Low impact (1-3); Medium impact (4-6); High impact (7-10)*

10.6 Socio-economic Condition

10.6.1 During Pre-construction Phase

439. The implementation of proposed interventions may generate some temporary impacts on socio-economic condition during pre-construction phase, as discussed in Chapter 8. Some of the impacts would require different levels of mitigation measures for negative impacts, enhancement for positive impact, compensation or contingency measures as shown in following Table 10.8.

Table 10.8: EMP Matrix for Construction Phase on Socio-Economic Condition

Impact	Mitigation measure	Enhancement/ Contingency/ compensation	Residual Impact (+/-)/ Magnitude (1-10) with EMP	Responsible agency
Quality of Life (Income Generation)	-	Ensuring engagement of local labour and paying proper wages.	+2	BWDB

** Low impact (1-3); Medium impact (4-6); High impact (7-10)*

10.6.2 During Construction Phase

440. The implementation of proposed interventions may generate some temporary impacts on socio-economic condition during construction phase, as discussed in Chapter 8. Some of the impacts would require different levels of mitigation measures for negative impacts, enhancement for positive impact, compensation or contingency measures as shown in following Table 10.9.

Table 10.9: EMP Matrix for Construction Phase on Socio-Economic Condition

Impact	Mitigation Measure	Enhancement/ Contingency/ Compensation	Residual Impact (+/-)/ Magnitude (1-10) with EMP	Responsible Agency
Quality of life (Employment)	-	Ensure employment for local people for both technical and non-technical works. If possible, maximum labor should be recruited locally.	+2	BWDB
Quality of Life (Income Generation)	-	Ensuring engagement of local labour and paying proper wages.	+2	BWDB
Gender Promotion	-	According to the project work, the LCS entail 60% male and 40% female, all of them would be engaged from the local area. Thus, ensure more gender promotion activities for female in future.	+3	BWDB

** Low impact (1-3); Medium impact (4-6); High impact (7-10)*

10.6.3 During O & M Phase

441. The implementation of proposed interventions may generate some long term impacts on socio-economic condition, as discussed in Chapter 8. Some of the impacts would require different levels of mitigation measures for negative impacts, enhancement for positive impacts, compensation, or contingency measures as shown in following Table 10.10.

Table 10.10: EMP Matrix for Construction Phase on Socio-Economic Condition

Impact	Mitigation Measure	Enhancement/ Contingency/ Compensation	Residual Impact (+/-)/ Magnitude (1-10) with EMP	Responsible Agency
Social Use of Water	-	re-excavate rest of Khals for more social use of water	+4	BWDB
Safe Drinking Water	-	Install rain water harvesting system by Blue gold entrepreneurship.	+3	BWDB
Quality of Life	-	Initiate different income generating activities for better life and livelihood of the people.	+2	BWDB

** Low impact (1-3); Medium impact (4-6); High impact (7-10)*

10.7 Spoil Management Plan (SMP)

442. The term 'Spoil' is used for soil or dirt resulting from excavation of earthen canals or khals, and discarded off site. Effective management of spoil is necessary because its volume usually inflates three times after excavation. The spoil may also cause other problems if not dumped in a planned and controlled manner. The physical quality of nearby water courses may be hampered due to debris transportation, agricultural lands may be disrupted, and social conflicts may arise regarding site selection for spoil dumping. It is therefore important to transport and dispose the spoil away from the excavation site in a controlled and systematic manner, taking proper accounts of all the environmental and social issues of the area. Disposal may either be through mechanical equipments, or by manual means.

10.7.1 Framework Proposed for SMP

443. Polder 22 of Blue Gold program entails excavation of a number of khals which would generate a volume of around 1,15,000 m^3 of spoil. This volume should be temporarily stored on the Khal openings to block the entry of flow. The rest should be used for different purposes before commencing the actual dumping process. The public consultation meetings of the EIA study inferred that the local people are willing to collect the excavated spoil earth for their own household uses. Figure 10.2 provides a framework which includes the major components of the proposed Spoil Management Plan for rehabilitation of Polder 22 under Blue Gold Program. The framework entails six basic steps for excavation, collection, use, transportation, dumping and compaction of earth materials in connection with the proposed khal re-excavation works.

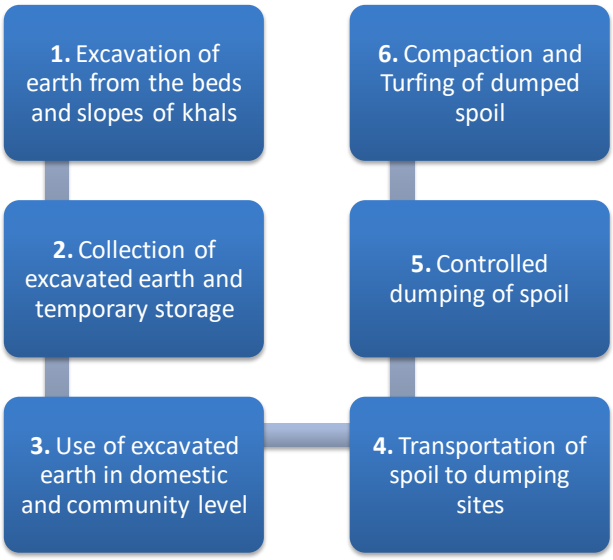


Figure 10.1: Framework for Spoil Management Plan

444. Table 10.11 below provides a tentative account of the volume of excavated earth, and its multifaceted uses proposed in the Spoil Management Plan. Around 86% of the excavated earth (1 lakh m^3) can be used in embankment re-sectioning works. The rest should then be made available for local people for their multifaceted uses. Local people can collect a portion of the excavated spoil, and use it to fulfill their domestic requirements. The spoil may be used for raising the plinth level of their earthen kacha houses as well as individual house yards. Spoil may also be collected and used on community basis to strengthen the basements and earthen portions of other rural sheds and shelters such as mosques, community clinics etc. The residual portion (around 8~10 thousand m^3) of spoil may then be disposed in a controlled manner.

Table 10.11: Tentative volume calculation and distribution of excavated spoil

Khals to be Excavated	Volume (m3)	Uses of Excavated Soil	Volume (m^3)
Goger Khal	9960	Embankment Re-sectioning	1,00,000
Goger Branch Khal	3930	Societal uses (uses in household, mosques,	5,000
Muchimara Khal	9295		

Khals to be Excavated	Volume (m3)	Uses of Excavated Soil	Volume (m^3)
Horinkhola Khal	4815	clinics or other shelters)	
Horinkhola Branch Khal	3110		
Fulbari Khal	8120		
Bigordana Simana Khal	35510		
Gopipagla Simana Khal	40260	Dumping	10,000
Total Excavation	1,15,000	Total Use	1,15,000

10.7.2 Phase wise activities of Spoil Management

445. A number of activities are proposed to be carried out during different phases associated with the efficient management of re-excavated spoil (Figure 10.2). Before the commencement of the khal re-excavation, a number of works are to be carried out, which would include both desk works and field level investigations. These activities would finalize the locations of dumping of spoil. During implementation of re-excavation works of khals, a number of activities have been recommended as well. These activities would ensure the environmental sustainability and social viability of the excavation works. Moreover, some activities are suggested to be carried out to enhance the stability of dumping spots, and ensure the environmental sustainability of the area.

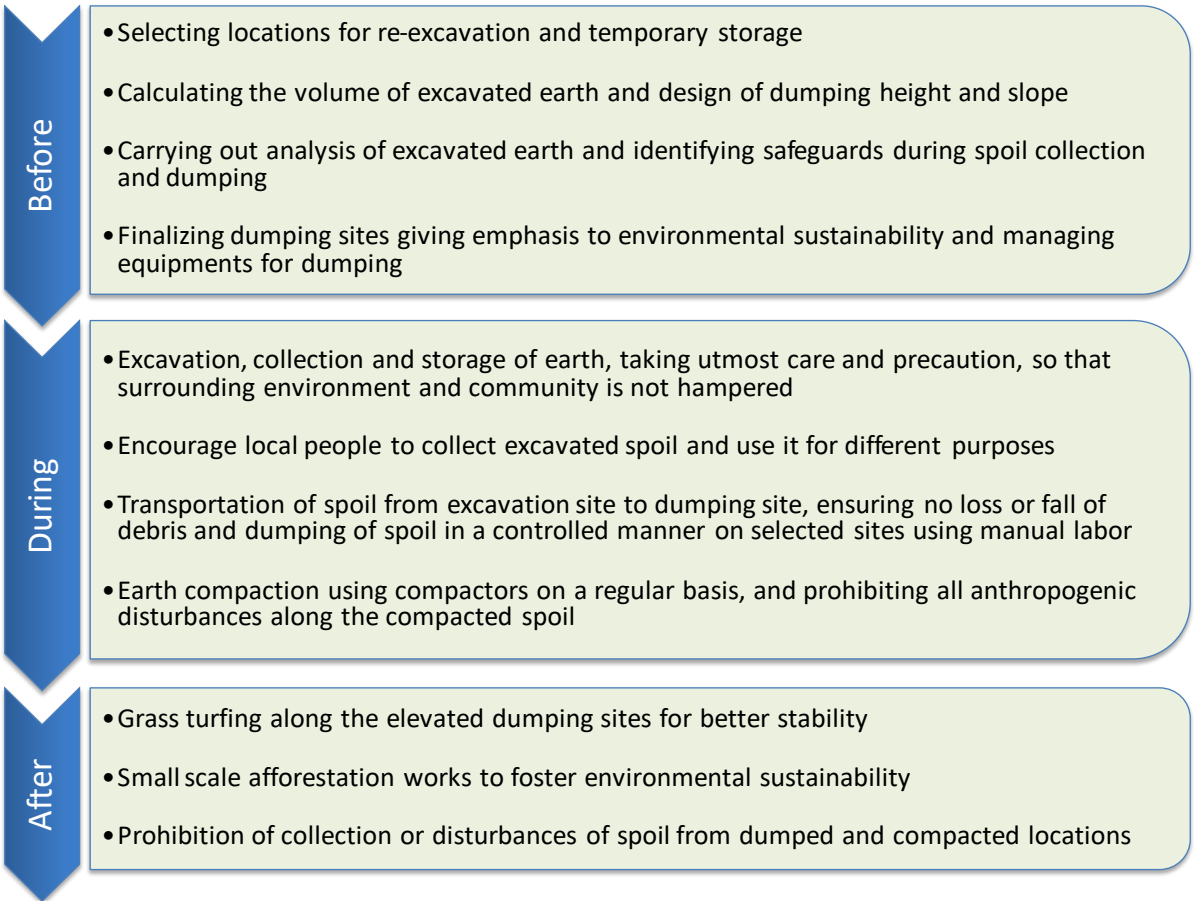


Figure 10.2: Phase wise activities of Spoil Management

10.7.3 Method of Spoil Dumping

446. The proposed re-excavation works for Polder 22 would require dumping of a significant amount of spoil (around 8~10 thousand m3). For a 2 meter wide and 0.5 meter thick wedge, this equivalents to around 8 to 10 km length of dumped spoil. Around 7.04 km of khals would be re-excavated in Polder 22, and if the excavated spoil is dumped on both sides of the excavated portion of khals, around 4~5 km lengths on both sides can be used

as dumping sites. Figures 10.3 and 10.4 below show the conceptual layouts of proposed dumping technique.

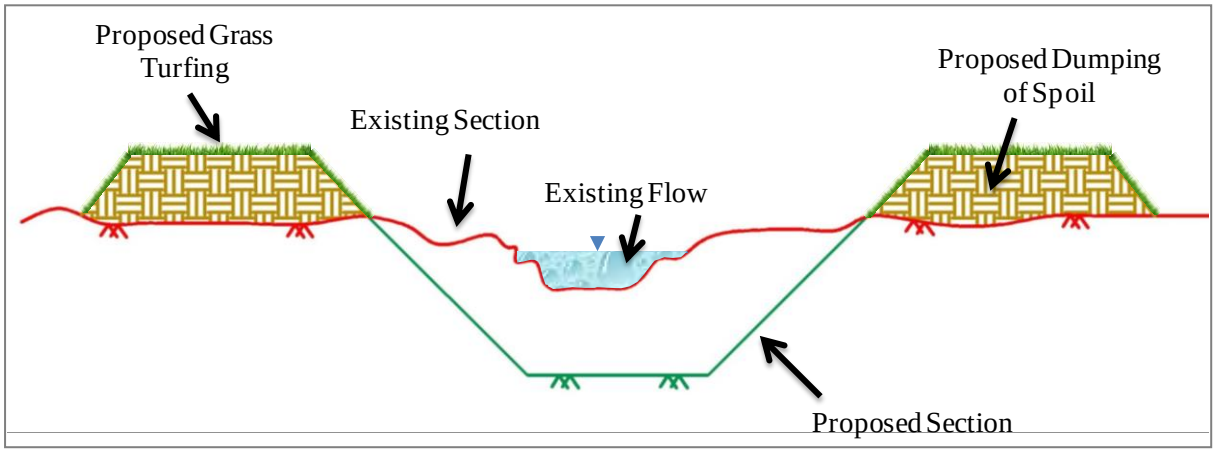


Figure 10.3: Conceptual Cross Section of a typical khal to be re-excavated

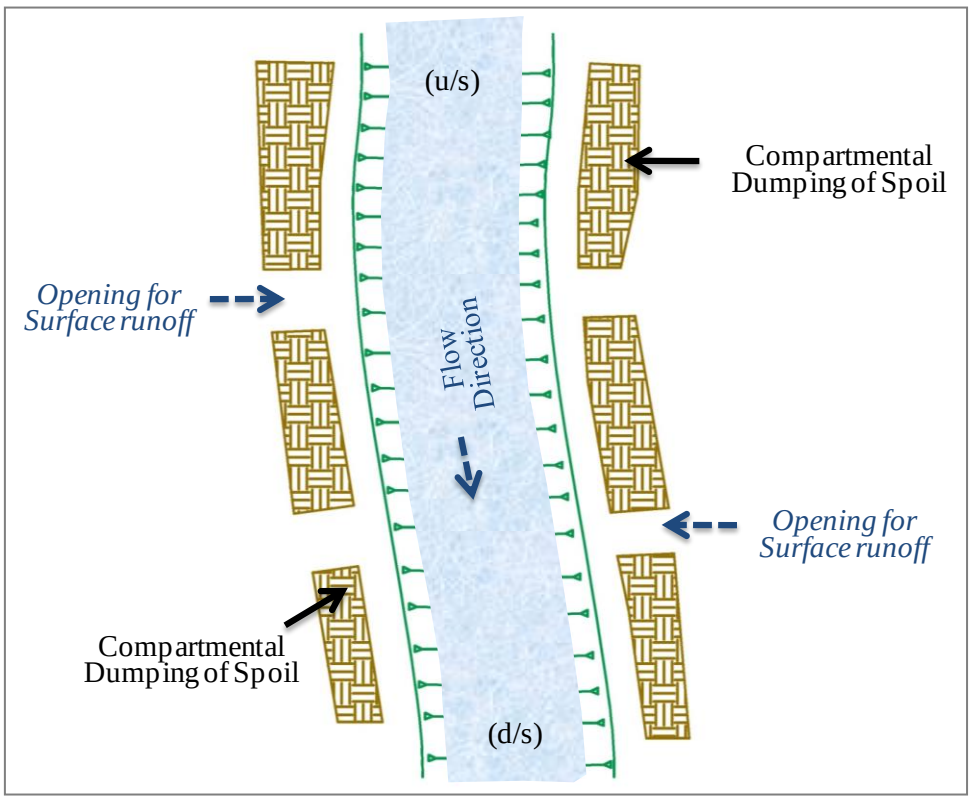


Figure 10.4: Plan form of a typical khal to be re-excavated

447. Figure 10.4 illustrates the cross section of a typical khal which is to be re-excavated under the Blue Gold Program. The depths of khals have decreased over the years and re-excavation works would be carried out through the centerline of the khals. The sides of the khals would be used for spoil dumping. These are government owned khas lands which fall within the actual width of the khals. Spoil earth would be dumped on both sides of the khal, on these khas lands. This would provide raised level through the bank lines of excavated khals, which may prevent khal siltation in future through erosion of top soil. Figure 4.5 shows a plan form of the khal which is to be re-excavated. The figure shows that compartmental dumping spots would be created along the sides of the excavated khals, so that surface runoff following rainfall events can enter the excavated khals and drain out properly.

10.7.4 Safety Measures and Precautions

448. Along with the activities discussed above, a number of safety measures and precautions are to be maintained by the corresponding communities and agencies, during the process of excavation, collection, transportation and dumping of spoil earth. These are important measures to be followed, to get rid of possible social and environmental bottlenecks and hence safeguard the environmental sustainability. The safety measures and precautions recommended to be carried out during implementation of khal re-excavation works are listed below:

- ✓ The laborers used for collection, carriage and dumping of spoil should properly be made aware of the health and hygienic aspects of it.
- ✓ Sufficient washing and cleaning arrangements are to be in place for the LCS laborers
- ✓ Dumped spoil needs to be compacted thoroughly, following the disposal of a certain height of spoil (e.g. 6~8 inches)
- ✓ When construction works are not in operation, the dumping locations may be covered with plastic or other water proof substances to avoid weather or moisture effects, this may reduce the strength or stability of the dumped spoil
- ✓ Dumping should be made firmly on the selected locations, and barriers or other measures may be provided on sensitive locations to ensure that no debris from the dumped spoil falls back into the water courses
- ✓ It should also be ensured that the dumped spoil is not weathered and transported to any privately owned lands or lands with agricultural interests

10.8 Environmental Monitoring

10.8.1 Monitoring Plan for Pre-construction Phase

449. No specific monitoring plan is required to follow during the pre-construction phase for any of the sectors in Polder 22.

10.8.2 Monitoring Plan for Construction Phase

450. Prepare Monitoring Schedule (example below) under this section considering all the project construction and mitigation works.

Blue Gold Program

Bangladesh Water Development Board

EMP IMPLEMENTATION

Book No. _____ Monitoring Report No._____

Date:_____ Time:_____

Contract:_____

Contractor:_____

Work Sites (s):_____

A	DAILY EHS CHECKLIST	Yes	No	Score Yes=+5 No=-5	A	DAILY EHS CHECKLIST	Yes	No	Score Yes=+5 No=-5
1	Correct dumping of spoil					No pollution from construction site			
2	Inconsistencies or mismanagement in embankment re-sectioning works				5	Wildlife Occurrence			
	Properly dumping of earth spoil				6	Vegetation clearance			
3	Compaction of earth materials on embankment				7	Any threat caused to river bank area			
4	Inconsistencies in water control structures repairing works				8	Obstruction of fish migration/movement route			

B. EXPLANATION (of any of above points) **Total Scores = _____%**

C.NON COMPLIANCE:

Period Description :	Class
	1. Minor: Under One Month (Contractor alerted)
	2.Moderate: Over One Month but under Two Months (Contractor warned)
	3.Major: About Two Months (Contractor's local bill withheld by RE* till compliance)
	4.Critical: Over Three Months (Contractor's overall bill withheld by RE and PM* till compliance)

D.CIRCULATION

1) PD, Blue Gold Program 2) DG, DoE 3) Embassy of the Kingdom of Netherlands 4) DG, BWDB 5) Blue Gold Program, Local Office

Field EHS* Monitor of Consultant	Field EHS Expert of Contractor
(Full Name & Signature)	(Full Name & Signature)
*EHS- Environment Health & Safety	
*RE – Resident Engineer	
***ES – Environmental Supervisor of Consultants.**	

Socio-economic Condition

10.8.3 Monitoring Plan for O & M Phase

Water Resources

Indicator	Method	Location	Frequency	Responsible Agency
Surface Water Salinity	In-situ testing	All the khals inside the polder	Once in a month (from December to May)	BWDB
Depth of Khals	Field survey (e.g. boat and led method)	All the khals inside the polder	Once in a dry season and once in a wet season	WMOs and BWDB
Water Logging	Field observation	Inside the polder	Once in dry season and once in post-monsoon	WMOs and BWDB
Erosion	Field observation	Throughout the peripheral embankment of Polder 22	Once in a week (during monsoon and post-monsoon)	WMOs and BWDB

Land and Agriculture Resources

Indicator	Method	Location	Frequency	Responsible Agency
Crop Production	Focus Group Discussion (FGD) and individual discussion with farmers should be followed.	Entire project area	At harvest time of each cropping season (Will continue two years).	Contractor ,DAE and WMGs
Crop Damage	Focus Group Discussion (FGD) and One-to-One discussion with farmers should be followed.	Entire project area	At harvest time of each cropping season (Will continue two years).	BWDB, DAE and WMGs
Irrigated Area	Focus Group Discussion (FGD) and One-to-One discussion with farmers should be followed.	Entire project area	During Rabi season (Will continue two years).	BWDB, DAE, BADC and WMGs/WMA/WMF

Fisheries Resources

Indicator	Method	Location	Frequency	Responsible Agency
Fish Hatchling Movement	Catch monitoring	All Sluice gates	Twice per week during fish migration period	DoF
Species Diversity	Catch monitoring and local fish market survey	All over the water bodies inside the polder including Gopepagla khal and Bigordana khal	Twice per month in each location	DoF

Ecological Monitoring

451. No monitoring is required in this phase

Socio-economic Condition

Indicator	Method	Location	Frequency	Responsible Agency
Quality of Life	Union wise Public consultation/ RA during post project phase	Representative villages within the polder area	Once in a year	Independent social monitoring institute along with Blue gold and BWDB contractors
Gender Promotion	Village wise RRA/FGD	Periphery within the polder	Every year	Blue gold
Safe Drinking Water	RRA during post project phase	Whole polder	After every 6 month in a year	Blue gold and BWDB
Social Use of Water	Village wise RRA/FGD	Whole polder	Every year	

10.9 EMP Cost Estimate

Agriculture Resources

Sl. No	EMP measure	Cost (Lakh Tk.)	Sl. No	Monitoring Item	Cost (Lakh Tk.)
1	Formation of WMGs (GPWM-2002), strengthening of WMGs through imparting training on re-excavation of Khal. Embankment management Group (EMG), landless Contacting Society (LCS), on farm water management and development etc. Involvement of WMGs in project activities would change positively.	1.00	1	Re-excavation of Khal, disposal of spoil earth materials for spoil management, and re-sectioning/ repair/ protection work of embankments	0.50
2	Organic manure should be applied for the restoration of soil fertility; Farmers group should have close contact with DAE for adaptation of various measures on IPM/ICM; Irrigation should be provided in optimum level with minimum conveyance loss; Involvement of WMGs in project activities would enhance crop production. Introduction of HYV crops with crop diversification need to be practiced.	1.50	2	Crop Production	0.50
3	The construction materials like sand, cement, concrete, block, etc. should be placed in non-agricultural land as far as possible. Dumping of spoil earth materials on non-agricultural land. WMGs/WMA/WMF should be involved in the construction and	1.00	3	Crop Damage	0.50

Sl. No	EMP measure	Cost (Lakh Tk.)	Sl. No	Monitoring Item	Cost (Lakh Tk.)
	post construction phase which might reduce crop damage.				
4	Training of 'Integrated water management' and 'on farm development' of WMGs would help to increase the expansion of irrigated area The WMGs/WMAs/WMFs should be involved in the integrated water management through proper maintenance of regulators (sluice gate, inlets and outlets) for the expansion of irrigated area. The irrigation water should be used at optimum level so that the area might be increased with limited scale of water.	1.00	4	Irrigated Area	0.50
Total		4.50			2.0
Total Cost for EMP & Monitoring for Land and Agriculture = 6.5 Lakh Taka					
Fisheries					
1	Awareness development on natural resources, campaigning against indiscriminate fishing	1.8	3	Fish Hatchling Movement	1.5
2	Demonstration of pond on improved fish culture in the study area.	2.4	4	Species Diversity	2.5
Total cost for EMP		4.2	Total Cost For Monitoring		4.0
Total Cost for EMP & Monitoring for Fisheries= 8.2 Lakh Taka					
Ecological resources					
1	Planting of timber/fruit plant along both the sides of the submersible embankment	1.0	1.	Terrestrial vegetation	0.20
Total Cost for EMP & Monitoring for Ecology= 1.2 Lakh Taka					
Socio-economic Condition					
		-	Total Monitoring Cost		3.40
Grand Total EMP and Monitoring Cost: 19.3 Lakh Taka					

452. The total EMP and monitoring cost is BDT 19, 30,000 of which EMP cost is BDT 9, 70,000 and monitoring cost is BDT 9,60,000.

11 Conclusion and Recommendations

11.1 Conclusion

453. This project aims to improve water management and productivity by rehabilitation of existing embankments and other water control infrastructures like sluices and regulators. Since it does not involve construction of any new regulators, no major environmental damage is expected. Some minor effects may be predictable during the construction and post-construction phases. The interventions proposed for Polder 22 include re-sectioning of the embankment, repair of water control structures, re-excavation of khals, construction of reservoirs and temporary bank protection. Salinity is very prevalent in Polder 22 especially in dry season when people suffer severe drinking water crisis. In addition, due to salinity they cannot cultivate Boro crops during the Rabi season and Kharif I seasons, and so 100% of the NCA remains fallow. The proposed interventions will bring about huge beneficial effects, especially for resolving drinking and domestic water crisis, increasing irrigated area, reducing soil salinity and ultimately increasing crop production, improving vegetation density etc. However, during the construction phase there will be some negative impacts on terrestrial vegetation and fisheries. During re-sectioning of the embankment, loss of vegetation like herbs and shrubs will occur i.e. there will be a temporary loss of habitat for some small reptiles and mammals such as rats, frogs etc. In addition, saline water currently intrudes through the leakage of water control structures and creates a brackish water habitat close to the structures. Once these structures are renovated, this habitat will be lost permanently. The structures also impede the hatchling movement from the rivers to khals or khals to rivers which is very important for capture fisheries. The reservoirs are considered as a blessing for the local inhabitants as these will serve as sources of water for drinking, bathing and other domestic use. However, these two reservoirs are not enough to serve the whole polder. More saline free sources of drinking water are very crucial for the people living in the polder.

11.2 Recommendations

454. Based on the EIA study, the following recommendations are made to improve performance and sustainability of the Project:

- A good water management plan should be prepared for proper utilization of surface water for agriculture cultivation.
- Gate operation rule should strictly follow to ensure that sufficient water is retained in the internal khals.
- Crop rotation with leguminous crops, application of more organic materials and green manure to improve soil fertility in the project area.
- Introducing crop diversification with multi-crops for improving condition of the soil.
- Monsoon period should be avoided for implementation of the proposed interventions, especially from May to July which is very crucial for fish migration.
- Re-excavation should be implemented segment- wise to protect indigenous fishes and other aquatic creatures.
- Native mixed trees should be planted along the embankment slopes and toes wherever possible to enhance green coverage

- Local communities should be made involved in operation and maintenance of the structure for ensuring sustainability of the interventions.

The long-term impact of the Project is reduction in both soil and surface water salinity, which will reduce drinking water crisis and increase crop production leading to poverty reduction. There are some negative impacts as well, some of which may be overcome through appropriate mitigation measures and timely monitoring. As such, the Project may be granted necessary clearance for implementation.

References

Ahmed M. F. and Rahman M. M, 2010. Water Supply and Sanitation: Rural and Low income urban countries, Fourth Edition, ITN, BUET, Dhaka.

BARC . 2005. Fertilizer Recommendation Guide, Bangladesh Agricultural Research Council, Farmgate, Dhaka, Bangladesh

BARC, 2012. Handbook of Agricultural Technology, Bangladesh Agricultural Research Council, Farmgate, Dhaka, Bangladesh

BBS, 2010. Report of the Household income and Expenditure Survey 2010, Bangladesh Bureau of Statistics, Government of People's Republic of Bangladesh, Dhaka, Bangladesh

BBS, 2012. Statistical Yearbook of Bangladesh, Bangladesh Bureau of Statistics, Government of People's Republic of Bangladesh, Dhaka, Bangladesh

Blue Gold Program, 2013, Inception Report, Embassy of the kingdom of Netherlands and Bangladesh Water Development Board, Government of people's Republic of Bangladesh, Dhaka, Bangladesh

European Commission, 2009, Ecosystem Goods and Services, Ecosystem Supporting Services, European Commission

FAO/UNDP, 1988. Land Resources Appraisal of Bangladesh for Agricultural Development (Report-2), "Agro-ecological Regions of Bangladesh", Prepared by Food and Agricultural Organization (FAO), United Nations.

FRSS, 2012. Fisheries Statistical Yearbook of Bangladesh 2011-2012. Fisheries Resources Survey System (FRSS), Department of Fisheries, Bangladesh, Volume 29:44 p.

http://www.ddm.gov.bd/cyclone.php accessed on 01 July, 2014

Jack M. Whetstone, Gravil D. Treece, Craig L. Browdy, and Alvin D. Stokes, 2002. Opportunities and Constraints in Marine Shrimp Farming, SAARC Publication No. 2600, July 2002

Mainuddin M, Kirby M, Chowdhury RAR, Sanjida L, Sarker MH, and Shah-Newaz SM (2014) Bangladesh Integrated Water Resources Assessment supplementary report: land use, crop production, and irrigation demand. CSIRO: Water for a Healthy Country Flagship, Australia.

Mazid. M.A 2002, Development of Fisheries in Bangladesh, Plans for Strategies for Income Generation and Poverty Alleviation, Momin Offset Press, Dhaka1205

Ministry Of Environment and Forest, 1992. The National Environmental Policy, Government of the People's Republic of Bangladesh, Dhaka, Bangladesh

Ministry of Environment and Forest, 1995, National Environment Management Action Plan (NEMAP), Government of the People's Republic of Bangladesh, Dhaka, Bangladesh

Ministry Of Environment and Forest, 1995. The Bangladesh Environment Conservation Act, Government of the People's Republic of Bangladesh, Dhaka, Bangladesh

Ministry Of Environment and Forest, 1997. The Environment Conservation Rules, Government of the People's Republic of Bangladesh, Dhaka, Bangladesh

Ministry Of Environment and Forest, 2004. The National Biodiversity Strategy and Action Plan for Bangladesh 2004, Government of the People's Republic of Bangladesh, Dhaka, Bangladesh

Ministry of Environment and Forest, 2009. Bangladesh Climate Change Strategy and Action Plan (BCCASP), Government of the People's Republic of Bangladesh, Dhaka, Bangladesh

Ministry of Water Resources, 1999. The National Water Policy, Government of the People's Republic of Bangladesh, Dhaka, Bangladesh

Mondal S., Jalal M R, Khan M. S. A, Kumar U., Rahman R., Huq H 2012. Hydro-Meteorological Trends in Southwest Coastal Bangladesh: Perspectives of Climate Change and Human Interventions, American Journal of Climate Change, 2013, 2, 62-70, Scientific Research Inc., 2012

Nishat, A., Huq, S.M Imamul, Barua, Suvashish p., Reza, Ali A.H.M., Khan, Moniruzzaman A.S. (eds.), 2002. Bio-ecological Zones of Bangladesh, IUCN Bangladesh Country Office, Dhaka Bangladesh

Pak. J. Bot., 2006. Salinity problems and crop production in coastal Regions of Bangladesh, 38(5): 1359-1365,

SOLARIS (Soil and Land Resources Information System), 2009. SOLARIS Model developed by Center for Environmental and Geographic Information Services (CEGIS) for Soil Resource and Development Institute (SRDI)

SRDI (Soil Resource and Development Institute). 1988. Guideline for land and soil resources use. Soil Resource and Development Institute, Thana Nirdashika, Farmgate, Dhaka

Subramanya. K., 1994,. Engineering Hydrology, Second Edition, Tata McGraw Hill Publishing Company Limited, Nel Delhi, India

WARPO, 2005. Guidelines for Environmental Assessment of Water Management (flood control, Drainage and Irrigation) projects. National Water Management Project. Water Resources Planning Organization (WARPO), Dhaka

Appendix 1: Checklist

Water Resources

Baseline Data Collection Form

Environmental Studies for Blue Gold Program

Name of Data Collector: Date:

Project Name:

A. Administrative Information

BWDB Division:	**BWDB Circle:**
BWDB Zone:	Hydrological Zone:
District(s):	Upazila(s):
Union(s):	Mouza(s):

B. Secondary data (to be obtained before going to the field)

Field	**Source**	**Station(s)**	**Year(s)**	**Analysis**		
				Max.	Min.	Avg.
Rainfall						
Temperature						
Humidity						
Evaporation						
Wind speed						
Sunshine hours						
Climate change						

C. Primary data (To be collected during field visit)

1. River system & flow direction (inside and outside the project)	
2. Name and location of beels and connectivity with rivers and khals	
3. Name of canals/khals and connectivity with rivers and beels	
4. Topography and Drainage pattern	
5. Location specific drainage congestion (% of extent, and delineate boundary in field map)	

6. Location specific water logging (% of extent, and delineate boundary in field map) in the month of February				
7. Flooding (depth, % of extent, onset, pick and recession)				
8. River/ khal erosion	River/khal	Area (ha) eroded	Length (m)	Reason
9. Accretion	River/khal	Area (ha) accreted	Reason	

D. Water Quality (people's perception/measurement)		
	People's Perception	Measurement
1. Ground water: (Arsenic/Iron/Salinity)		Arsenic: Iron: Salinity:
2. *Surface water: (Salinity, pH, DO, TDS, BOD, COD)		Salinity: pH: DO: TDS: BOD: COD:
*Note: It can be extended according to Client demands		

E. Pollution status (people's perception)	
1. Source of pollution	
2. Type of effluent	

F. Water Use

Sources	**Domestic**	**Agriculture**	**Fisheries**	**Others (industry…)**
Surface water				

Sources	Domestic	Agriculture	Fisheries	Others (industry…)
Ground water				

G. Historical severe flood:

Year of recent severe flood	Flood damage			
	Extent (Days)	Flood level (cm)	Damage of resources	
1988				
1994				
1998				
2004				
2007				
Last 5 years	Flood year			Flooding areas:
	Non-flood year			

H. People's opinion about the project

Present problems:
Causes of problems:
Probable Solution/Improvement:
Natural disasters:

I. Collect Project description related information from field office:

Name of re-excavation Khals with length

Catchment area of the Khals

Outfall information of Khals

Drainage network of Khals

Drainage pattern of Khals

Cross section of Khals with other design information

Re-excavation length of individual Khal and volume of earth spoil

Location specific Spoil management plan for individual khal

Sl	Name of Khal	Location-dumping of spoil earth	Volume	Number of unskilled/skilled labor	Use of machineries with number	Remarks
1						
2						

Sl	Name of Khal	Location-dumping of spoil earth	Volume	Number of unskilled/skilled labor	Use of machineries with number	Remarks
3						
4						
5						
10						
..						
..						

Location of labor shed with their water and sanitation facilities system

Number of labor (foreign labor or local labor)

Area of land acquisition and requisition with name of place, if necessary

Carrying system of spoil earth

Time period of construction/earth works

Activities involved in re-excavation

Phase	Name of activities	Remarks
Pre-construction phase		
During construction		
Post-construction		

Stockyard information during construction time:

Baseline data collection for EIA study: Land, Agriculture and Livestock Resources

Land Resources: Secondary information: SRDI/SOLARIS/NWRD/GIS database

Agro-ecological regions

Name of AEZ	Area (ha)	%	Soil characteristics

Land use

Land use	Area (ha)	Percent of gross area
Gross area		
Net Cultivated Area (NCA)		
Settlements		
Water bodies		
Rivers/ Khals		
Forest		

Land use	Area (ha)	Percent of gross area
Others		

Land type

Land Type	Flooding depth	Area (ha)	Percentage
F0	0 to 30 cm		
F1	30 to 90 cm		
F2	90 to 180 cm		
F3	180 to 300 cm		
F4	More than 300 cm		
	Total:		

Soil Texture

Texture Name	Top-soil		Sub-soil		Sub-stratum	
	Area (ha)	Area (%)	Area (ha)	Area (%)	Area (ha)	Area (%)

Soil Salinity

Agriculture Resources: (Primary information to be collected from the field)

Location:

Farming practices

Collect information on adjustment of crop production practices with agro-climatic condition, crops grown in different cropping seasons, flooding, drainage, drought, marketing facilities, availability of agricultural labor etc.

Major Cropping Pattern by land type

Land Type	Kharif-I (March-June)	Kharif-II (July-October)	Rabi (Nov-February)	% of area

Crop Damage

Name of Crop	Location	% damaged	Timing	Cause of damage

Name of Crop	Location	% damaged	Timing	Cause of damage

Crop yield rate and market price

Crop Name	Yield (ton/ha)		Price (Tk/ton)	By-product (Tk/ha)
	Normal	Damaged		

Inputs Used

Crop Name	Urea (Kg/ha)	TSP (Kg/ha)	MP (Kg/ha)	Others (Kg/ha)	Seed (Kg/ha)	Labour (No/ha)	Pesticide (No. of spray)	Land preparation (Tk/ha)
Note: Name of pests and pesticides:								

Irrigation

Crop Name	Irrigation (Surface water)			Irrigation (Ground water)		
	Area irrigated	% of Area	Charge (Tk/ha)	Area irrigated	% of Area	Charge (Tk/ha)

Crop production constraints (including land degradation)

Factors	Year of starting LD	Location	Result of LD
Soil erosion			
Sand carpeting			
Salinisation			

Factors	Year of starting LD	Location	Result of LD
Acidification			
Nutrient deficiency			
Pesticide use			
Water logging			
Others			

Livestock Resources: Primary and Secondary Information

Livestock and poultry production

Name of Livestock/poultry	% of HH having Livestock/Poultry	No. of Livestock/poultry per HH
Cow/bull		
Buffalo		
Goat		
Sheep		
Chicken		
Duck		

Feed and Fodder

Name of Livestock/poultry	Feed/Fodder Scarcity (Timing)	Causes	Remarks
Cow/bull			
Buffalo			
Goat			
Sheep			
Chicken			
Duck			

Diseases

Name of Livestock/poultry	Name of Disease	Disease (Timing)	Causes	Remarks
Cow/bull				
Buffalo				
Goat				
Sheep				
Chicken				
Duck				
Note: Support Services-				

Fisheries Baseline Checklist

Environmental Studies for Blue Gold Program

Vill: Mouza: Union: Upazila: District: BWDB Circle: BWDB Division:

Background Water bodies: Name: Alphabetic, Area: in Ha/% of area/Ana, Length: in km, Depth/Inundation depth: in Meter, Flood Duration: in Months, Production: metric ton

Problem/ Issue	Fishing Effort	Habitat Type	Water Quality	Avg. Production	Production Trend (+/-) and Reason	List of Gears	% of gears	List of Habitat Name	Present					Past (15-20 yrs back)				
									Area	Length	Width	Depth	Duration	Area	Length	Width	Depth	Duration
Capture Fisheries:	a. Total No. of fisher HHs: b. %/No. of CFHHs:	River																
Culture Fisheries: Indiscriminate Fishing Activities:	c. %/No. of SFHHS: d. No. of Days spend annually in fishing by CFHHs: SFHHs: e. Hrs/Day spend in fishing by CFHHs:	Beel (Leased/non leased)																
		Khal																

Problem/ Issue	Fishing Effort	Habitat Type	Water Quality	Avg. Production	Production Trend (+/-) and Reason	List of Gears	% of gears	List of Habitat Name	Present					Past (15-20 yrs back)				
									Area	Length	Width	Depth	Duration	Area	Length	Width	Depth	Duration
	SFHHs:	Floodplain																
		Mangrove area																
		Fish pond																
		Baor																
		Ghers																

Fish Migration		Fish Biodiversity		Species List					Species Composition				
				River	Khal	Beel	Pond	Other	Group	River	Khal	Beel	Pond
Previous Migration Status		Fish diversity status (Poor/Moderate/Rich)/%							Major carp				
									Exotic carp				
									Other carp				
									Catfish				
									Snakehead				
Present Obstacle to fish migration:	1.	Reasons of increase or decrease	1.						Live fish				
									Other fish				
	2.		2.						Shrimp/prawn				
	3.		3.						Hilsa/Bombay duck/Indian salmon				
			4.						Pomfret				

Fish Migration					**Fish Biodiversity**		**Species List**					**Species Composition**				
							River	**Khal**	**Beel**	**Pond**	**Other**	**Group**	**River**	**Khal**	**Beel**	**Pond**
Important breeding, feeding and over wintering ground						5.						Jew fish				
												Sea cat fish				
												Shark/Skates/ Rays				
												Rui				
												Catla				
Horizontal Migration pattern	Species: 1. 2. 3. 4. 5.	Season (Months):	Routes:	Significant areas		1. 2. 3.						Mrigal				
												Koi				
												Sarputi				
												Large shrimp				
												Small shrimp				
Vertical Migration Pattern	Species: 1. 2. 3. 4. 5.	Season (Months):	Habitats:	Species of Conservation Significance		Rare:						Silver carp				
												Carpio				
												Grass carp				
												Tengera				
						Unavailable:						Chapila				
												Others				

Post Harvest Activities		**Fishermen Lifestyle**	
Fish edible quality:		Socio-economic Status of subsistence level fishermen:	
Source of pollution in each habitat:		Socio-economic Status of Commercial fishermen:	

Post Harvest Activities		**Fishermen Lifestyle**	
Seasonal vulnerability:		Other conflict (with muscle men/ agriculture/ other sector/laws):	
Ice factory (Number, location and name):		Fishermen community structure (Traditional/Caste/Religion)	
Landing center, whole sale market, other district markets, etc.:		Traditional fishermen vulnerability (Occupation change/others):	
Storage facility (number, location and name):		Existing Fisheries Management	
Fish market (Number, location and name):		Fishermen Community Based Organizations (FCBOs):	
Marketing problems:		WMOs activity:	
Fish diseases (Name, Host species, Season, Syndrome, Reason, etc.):		Fishing right on existing fish habitats (Deprived/Ltd. access/Full access):	
Other backward and forward linkages (Number, location and name):		Leasing system:	
Transport facility (Mode of fish transportation, cost, other involvements)		Enforcement of fisheries regulation (Weak/strong):	
Dry fish industries (Number, location and name):		Department of Fisheries (DoF) activity:	
Others information:		NGOs activities:	

Note: 1. Major Carp - Rui, Catla, Mrigal, 2. Exotic Carp - Silver Carp, Common Carp, Mirror Carp, Grass Carp, 3. Other Carp - Ghania, Kalbasu, Kalia, 4. Cat Fish - Rita, Boal, Pangas, Silon, Aor, Bacha, 5. Snake Head - Shol, Gazar, Taki, 6. Live Fish - Koi, Singhi, Magur, 7. Other Fish - Includes all other fishes except those mentioned above.

Marine: Hilsa/Illish, Bombay Duck (Harpondon nehereus), Indian Salmon (Polydactylus indicus), Pomfret (Rup_Hail_Foli Chanda), Jew Fish (Poa, Lambu, Kaladatina etc.), Sea Cat Fish (Tachysurus spp.), Sharks, Skates & Rays, Other Marine Fish.

Beels: Rui (Labeo rohita), Catla (Catla catla), Mrigal (Cirrhinus mrigala), Kalbasu (Labeo calbasu), Ghonia (Labeo gonius), Boal (Wallago attu), Air (Mystus aor / Mystus seenghala), Shol/Gazar (Channa spp.), Chital/Phali (Notopterus chitala / N. notopterus), Koi (Anabas testudineus), Singi/Magur (Heteropneustes fossilis /Clarias batrachus), Sarpunti (Puntius sarana), Large Shrimp (Macrobrachium rosenbergii /M. malcomsonii), Small Shrimp, Silver Carp (Hypophthalmichthys molitrix), Carpio (Cyprinus carpio), Grass Crap (Ctenopharyngodon idellus), Pabda (Ompok pabda), Punti (Puntius spp.), Tengra (Mystus spp.), Baim (Mastacembelus spp.), Chapila (Gudusia chapra), Others.

Pond: Rui (Labeo rohita), Catla (Catla catla), Mrigal (Cirrhinus mrigala), Kalbasu (Labeo calbasu), Mixed Carp, Silver Carp (Hypophthalmichthys molotrix), Grass Carp (Ctenopharyngodon idellus), Mirror Carp (Cyprinus carpio var. specularis), Tilapia (Oreochromis mossambicus / O. niloticus), Shrimp, Aor (Mystus aor / Mystus seenghala), Boal (Wallago attu), Shol/Gazar & Taki (Channa spp.), Chital/Foli (Notopterus chitala / N. notopterus), Koi (Anabas testudineus), Singi/Magur (Heteropneustes fossilis / Clarias batrachus), Sarpunti (Puntius sarana), Thai Sarpunti (Puntius gonionotus), Punti (Puntius spp.), Others.

Ecological Data Collection Form for ESIA Study

Environmental Studies for Blue Gold Program

Date		Name of the interviewer	
Name of the Project			
District/s		Upazila/s	
Location of the FGD			
Latitude		Longitude	
Gross area:		Net Area:	

Bio-ecological Zone(s):

Terrestrial Ecosystem

Major land use types of terrestrial habitat of the study area (please put Tick where applicable)

Agriculture land		Forest patches including social forestry	
Settlement/Homesteads		Canal and ponds	
Orchard		Grasslands	
Fallow		Reserve forest	
Embankment and roadside vegetation		Others	

Terrestrial Biodiversity

Major Terrestrial Flora

Common Species	Rare Species	Extinct Species	Exotic Species

Major Terrestrial fauna

Species Name	Habitat1	Food Habit2	Breeding Time	Status3	Migration Status4

Species Name	Habitat1	Food Habit2	Breeding Time	Status3	Migration Status4

1 Habitat: 1= Homestead forest, 2= floodplains, 3= wetlands, 4= river

2 Habit: 1=Herbivore, 2= Carnivore, 3= Both

3Status: 1= Very common, 2=Common, 3= Rare, 4= Very Rare

4 Migration Status: 1= Local, 2= Local Migratory, 3= Migratory

Aquatic Ecosystem

Wetlands and types of aquatic habitat (specify, area per type, flooding depth etc)

Name of wetland	Type of Wetland5	Area in ha		Flooding depth (m)	Connectivity with river		Importance6
		Seasonal	Perennial		from	to	

1= Open water wetlands, 2= Rivers, 3= Estuarine and mangrove forest, 4= Beels and haors, 5= Floodplains, 6= Closed water wetlands,

7= Ponds, 8= Baors (oxbow lake), 9= Brackish water farms

2 1=Fish; 2= migratory bird; 3= other wildlife; 4=aquatic flora;

Aquatic flora

Ecology and plant community (depending on water depth and flooding)

Species name	Type1	Abundance2	Growing period	Utilization7

1 1=Submerged, 2=Free floating, 3=Rooted floating, 4=Sedges, 5=Marginal

2 1= High, 2= Moderate, 3= Low

31=food; 2=fuel; 3=medicinal; 4=fiber/thatching; 5=Bio-fertilizer 6=others (specify if any)

[5] 1= Open water wetlands, 2= Rivers, 3= Estuarine and mangrove forest, 4= Beels and haors, 5= Floodplains, 6= Closed water wetlands, 7= Ponds, 8= Baors (oxbow lake), 9= Brackish water farms

[6] 1=Fish; 2= migratory bird; 3= other wildlife; 4=aquatic flora;

[7] 1=food; 2=timber; 3=fuel; 4=medicinal; 5=fiber/thatching; 6=others

Aquatic Fauna

Species name	Status1	Species name	Status1
Amphibians			
Reptiles			
Birds			
Mammals			
1=Very common, 2=Common, 3=Occasional, 4=Rare			

Present status and negative impacts on flora & fauna

Impacted Species	Existing Status	Cause of impact

Anticipated impacts on flora and fauna due to project activity (according to people opinion)

Victim Species	Anticipated Impact	Cause of impacts

Necessity of wildlife management practices (According to people's opinion):

☐ Yes ☐ No

How	

Ecosystem Services

Type of Service	Estimated Cost/House	Total Cost in project Area	Grand Total Cost
Fuelwood			
Timber			
Fruit production			
Thatching			
Fodder			
Bio-fertilizer			
Other			

Presence of Important Ecosystem (If any)

Important Ecosystem	Name	GPS Coordinate/waypoint
Ecologically Critical Area		
Important Bird Area		
Reserve Forest		
Natural Forest		
National Park		
RAMSAR Site		
Wildlife Sanctuary		
Game Reserve		
Eco-park		

Note (If any):

SOCIO-ECONOMIC BASELINE DATA COLLECTION

Checklist for Rapid Rural Appraisal (RRA)

Facilitation Information

Name of Facilitator	
Date of Facilitation	

Project Information

Name of Project	
Gross Area (ha.)	
Net Area (ha.)	

Study Area

Mauza	
Union/Ward	
Municipality (if any)	
Upazila/Thana	
District	

Educational Institution

Sl. No.	Type of facility	Nos. of Institution	Type of facility	Nos. of Institution
1	Primary School		Ebtedayee Madrasha	
2	High School		Dakhil Madrasha	
3	College		Alim/Fazil Madrasha	

Note: The category “Primary School” includes only Government Primary School (GPS) and Registered Non-government Primary School (RNGPS)

Disease Prevalence

Ranking by Incidence	Name of Disease	Ranking by Incidence	Name of Disease
1		6	
2		7	
3		8	
4		9	
5		10	

Note: If the facilitator can collect disease profile from the Upazila Health Complex then this question could be skipped

Health Facilities

Sl. No.	Type of Facility	Number of Facilities
1	District/Sadar Hospital	
2	Upazila Health Complex	
3	Union Sub-Center	
4	Union Family Welfare Center	
5	Community Clinic	
6	Private Health Clinics/hospitals	
7	Other (if any)	

Peripheral Health Facilities (if any)

Number	
Name	
Description/status	

Sources of Treatment Facilities

Sl. No.	Source of treatment facilities	Percentage of Households Received
1	Trained physician	
2	Paramedic/diploma physician	
3	Quack doctor & informal treatments	
4	No treatment facilities at all	

Electricity Coverage

Sl. No.	Type of facility	Percentage of Households
1	Grid	
2	Solar	
3	Biogas	
4	Other (if any)	

Note: Percentage of households covered by grid electricity will be cross-checked with the data given in the Population and Housing Census 2011 of Bangladesh Bureau of Statistics

Income and Expenditure

Range (Tk./month)	Percentage of Households	
	Expenditure	Income
Less than 1,000		
1,000 - 2,000		
2,000 – 5,000		
5,000 - 9,000		
9,000 - 20,000		
More than 20,000		

Labor and Wage

Type of Activity	Male Labor		Female Labor	
	Availability (put √)	Daily Wage (Tk.)	Availability (put √)	Daily Wage (Tk.)
Farming	H M L		H M L	
Non-Farming	H M L		H M L	

Note: H=High; M=Medium; L=Low. Farming activities include agricultural activity and Non-farming activities include earthwork, brickfield work, construction work etc)

Self Assessed Subsistence Poverty

Sl. No.	Poverty Status	Percentage of Households
1	Deficit	
2	Balance/Breakeven	
3	Surplus	

GO/NGO Safety Net Programs

Name of GO/ NGO Department	Activity	% of HHs Coverage

Land Price

Sl. No.	Lands Type	Sale Value (Tk./per acre)
1	Homesteads land	
2	Agricultural land	
3	Commercial Land	
4	Others (if any)	

Disaster and Damage (in last five years)

Most Prevalent Disasters	
Ranking by Incidence	1) 2) 3) 4) 5)
Tangible loss due to Disasters	
Intangible loss due to Disasters	
Impacts on Households	

Impacts on Livelihood	
Proposed Mitigation	

Note: These data will be cross-checked with the multidisciplinary information

Migration Trend

Type of Migration	Out Migration		In Migration	
	Place of destination	Number/ Percentage*	Place of origin	Number/ Percentage*
Seasonal Labor migration				
Permanent Household migration				

*Percentage of migration will be applicable in case of seasonal labor migration; whereas number will be applicable in case of permanent migration of households

Professional/occupational Conflict

Type of Conflict	
Reasons of Conflict	
Area	
Groups engaged in conflict	
Proposed solutions	

Miscellaneous

Particulars	Number	Name	Brief Description
Ethnic Community			
Vulnerable Community			
Cultural Heritage Site			
Common Property Resources			

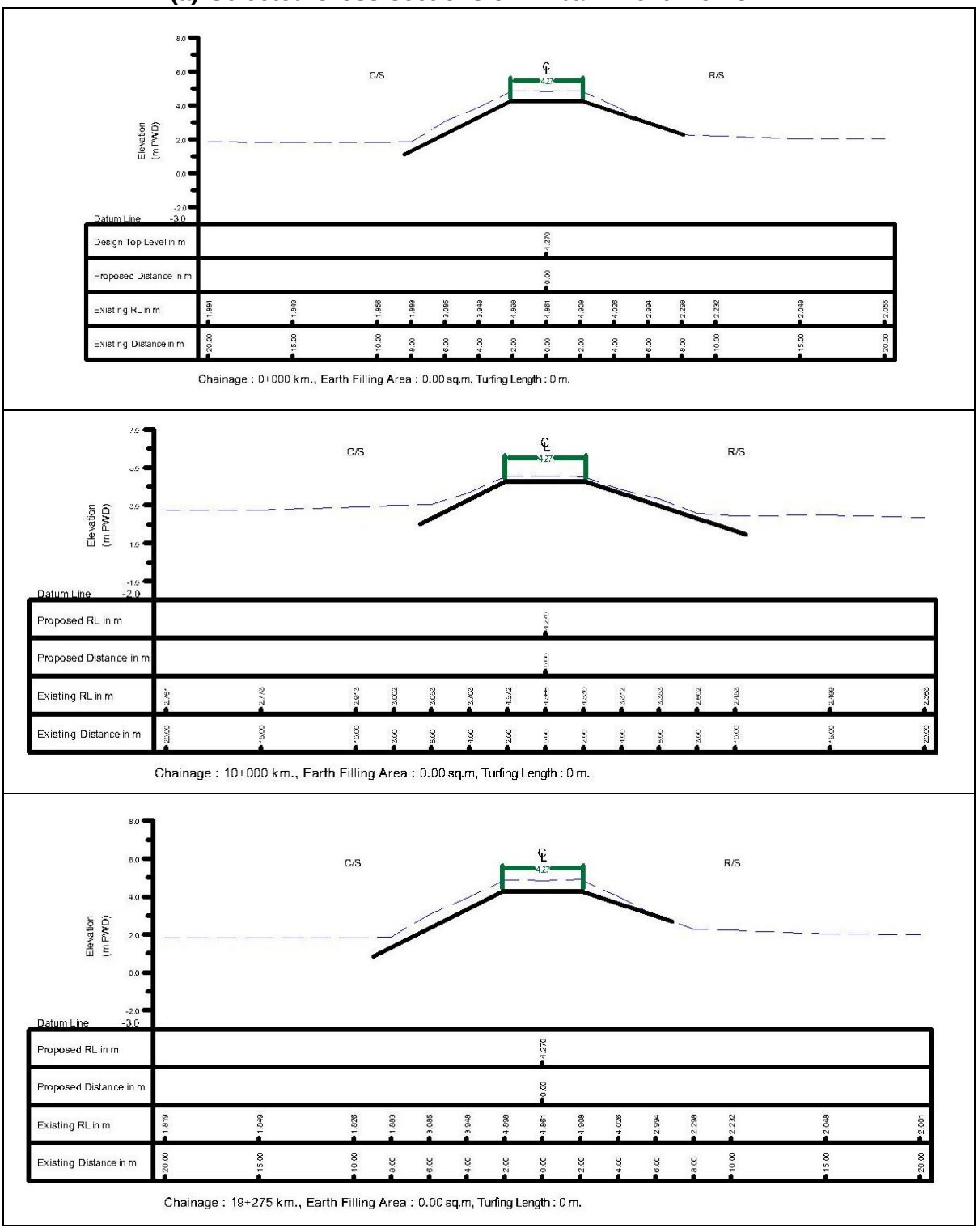
Profile of RRA Participants

Name	Age	Occupation	Address/ Mobile no.

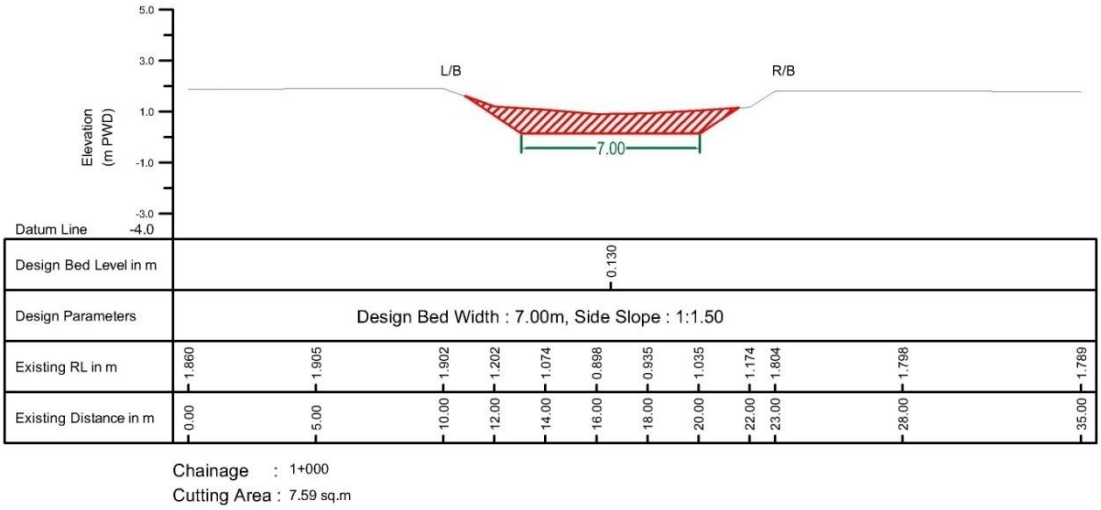
Required Photographs: Educational Institutions, Housing Pattern, Water-Sanitation Facilities, Solar/Biogas Plant, Health Facilities, Transportation/Communication Network, Markets, Adverse Affects of Disasters etc

Appendix 2: Cross Section of Embankment and Khal Re-excavation

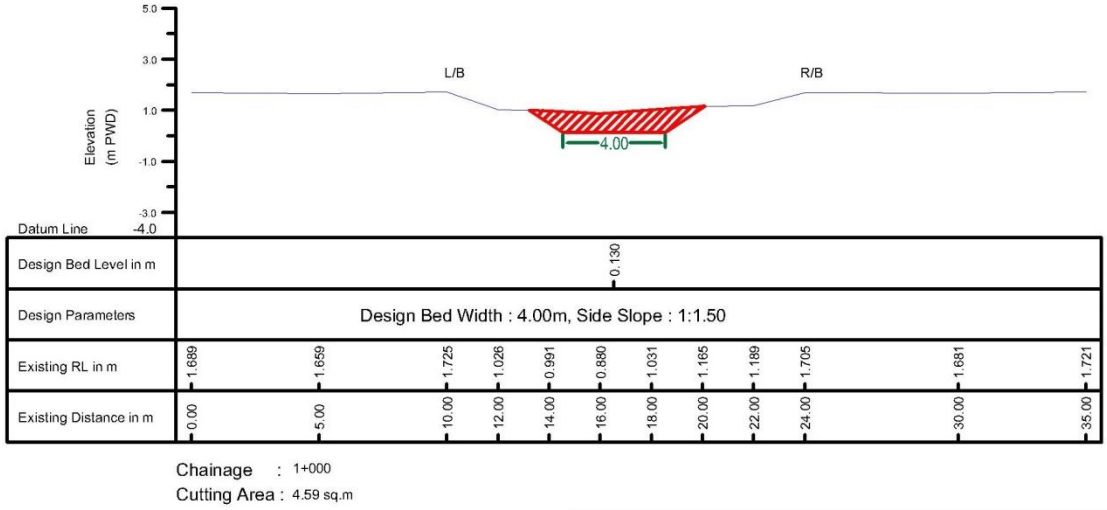
(a) Selected Cross-sections of Embankment Works



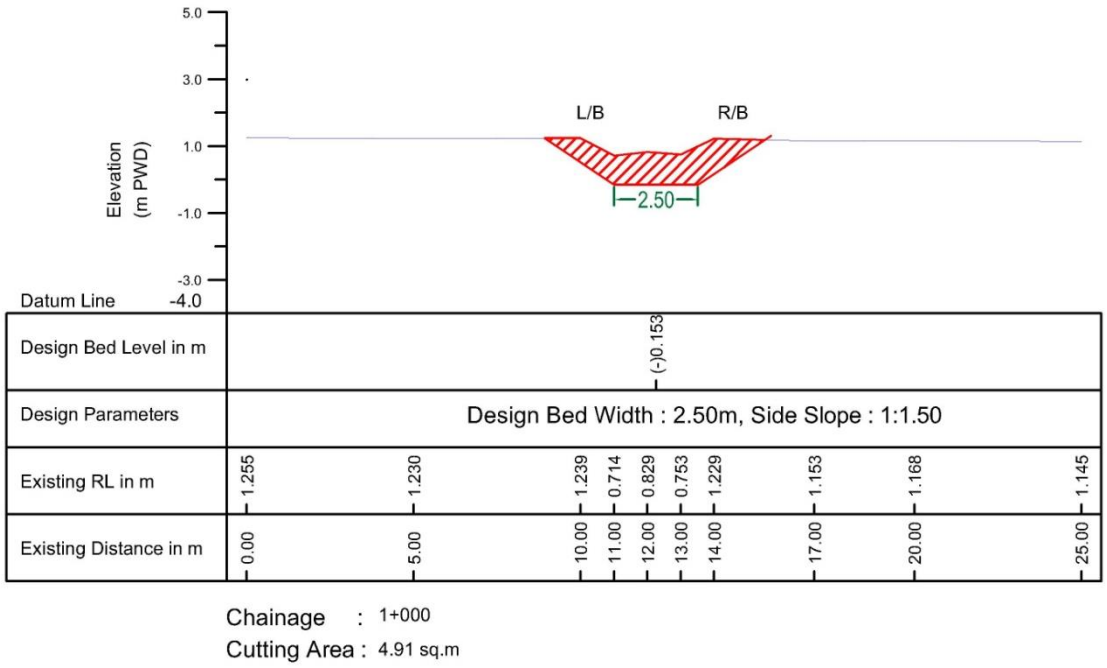
(b) Selected Cross-sections of Khal Re-excavation Works



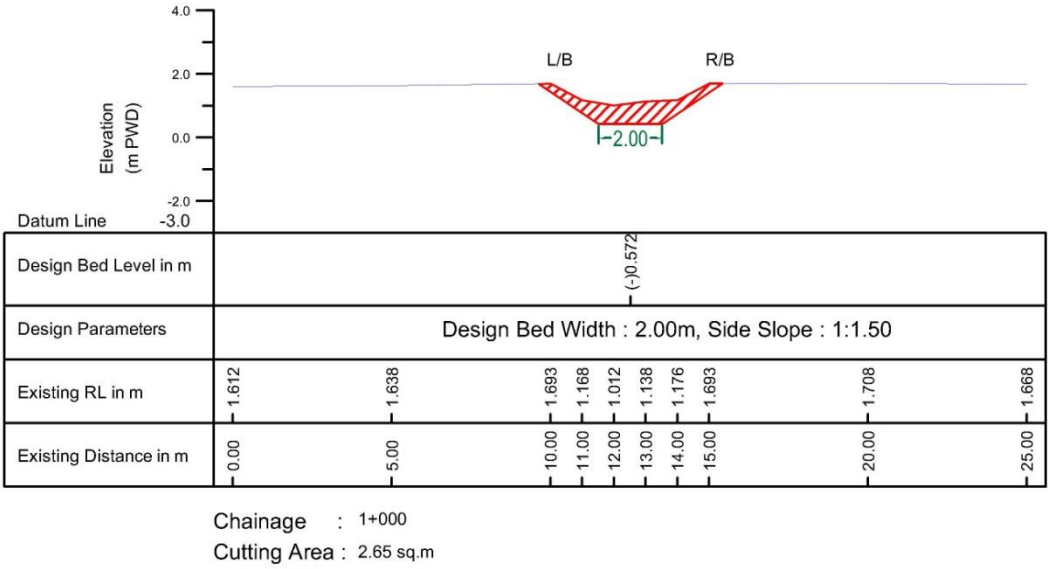
Goger Khal



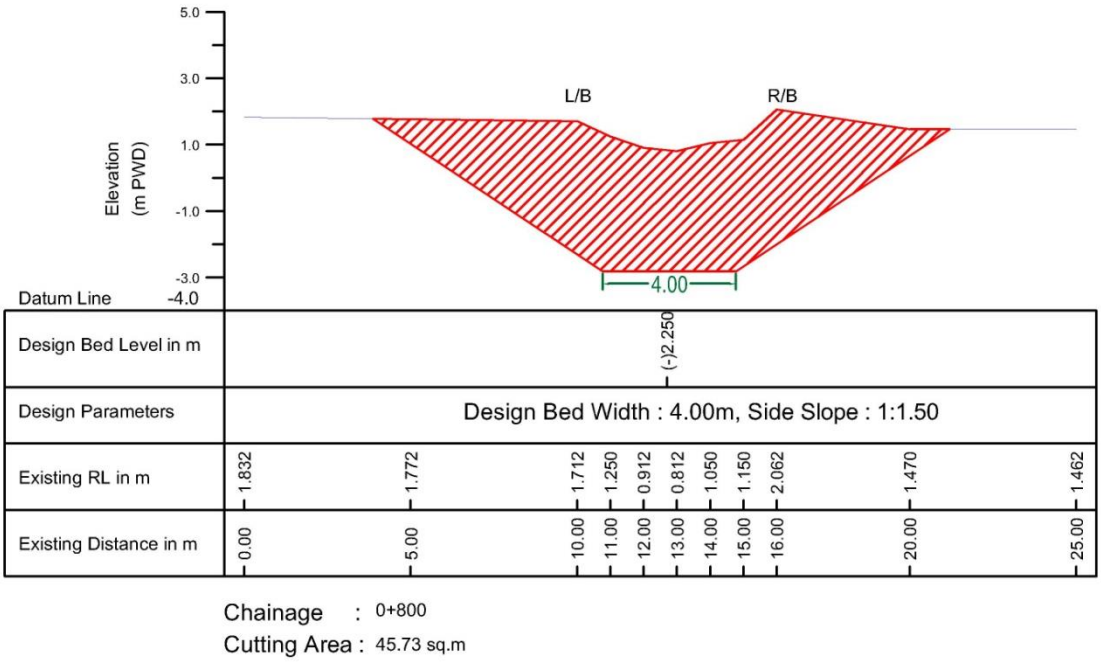
Muchimara Khal



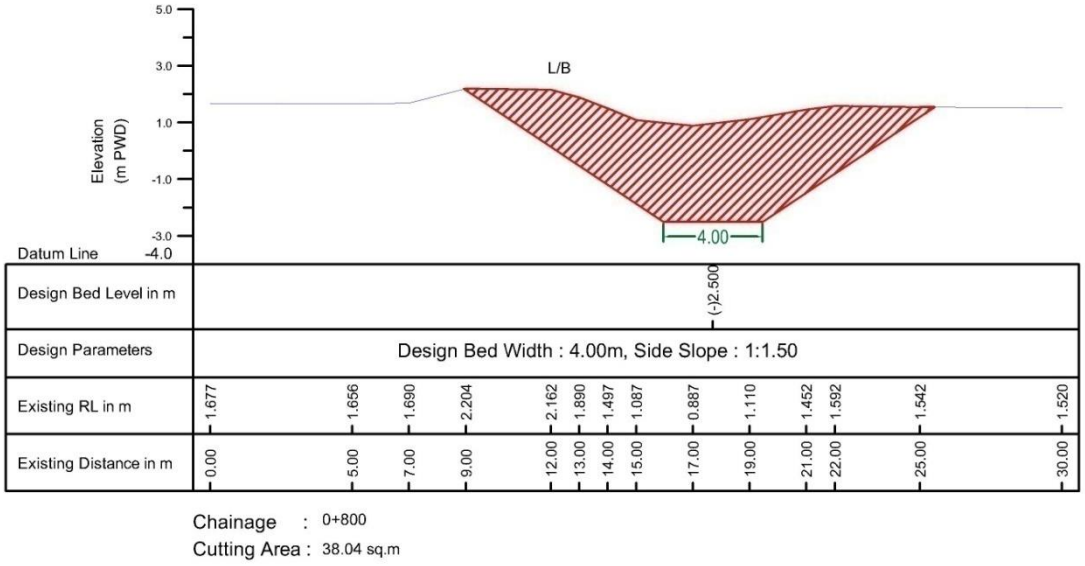
Harinkhola Khal



Fulbari khal



Gopipagla khal



Bigordana khal

Appendix 3: No Objection Certificate

কার্যালয়

৪ নং দেলুটি ইউনিয়ন পরিষদ

উপজেলা-পাইকগাছা,জেলা-খুলনা।

স্মারক নং ২৪,নি ৪/৪৬(৩)১৫ তারিখ-২৫/৩/১৫

অবস্থানগত/পরিবেশগত ছাড়পত্রের স্থানীয় কর্তৃপক্ষ কর্তৃক প্রদেয় অনাপত্তিপত্রের ছক

১। আবেদনকারীর নাম ঃ পরিচালক, পরিকল্পনা-৩ এবং প্রোগ্রাম কো-অর্ডিনেটিং ডাইরেক্টর, ব্লু গোল্ড প্রোগ্রাম, বাংলাদেশ পানি উন্নয়ন বোর্ড ।

২। পিতা/স্বামীর নাম ঃ প্রযোজ্য নয়

৩। আবেদনকারীর ঠিকানা ঃ পরিকল্পনা-৩, বাংলাদেশ পানি উন্নয়ন বোর্ড, হাসান কোর্ট (৮ম ও ৯ম তলা) ২৩/১ মতিঝিল বানিজ্যিক এলাকা, ঢাকা-১০০০।

৪। প্রকল্পের অবস্থানগত ঠিকানা ঃ পোল্ডার ২২ খুলনা জেলার পাইকগাছা উপজেলায় অবস্থিত।

৫। প্রকল্পের তফসিল ঃ

জেলার নাম	থানার নাম	মৌজার নাম	খতিয়ান নং	দাগ নং	জমির ধরন	মোট জমির পরিমান
খুলনা	পাইকগাছা				মাঝারি উচু ভূমি	১৪৮৫ হেক্টর

৬। প্রকল্পের কার্যক্রম ঃ বাঁধ উচুকরন, স্লুইজ গেট ও রেগুলেটর মেরামত, খাল পূনঃখনন ইত্যাদি।

উপরোক্ত তথ্যাদির আলোকে পোল্ডার ২২ পূর্নবাসন প্রকল্প বাস্তবায়নের জন্য নিম্নেবর্ণিত অনাপত্তি প্রদান করা হলো।

শর্তাবলী ঃ

১। প্রকল্প স্থাপন ও পরিচালনার ক্ষেত্রে পরিবেশ সংরক্ষণ আইন ও বিধি যথাযথভাবে অনুসরণ করতে হবে।
২। পরিবেশ অধিদপ্তর হতে বিধি দ্বারা নির্ধারিত ছাড়পত্র গ্রহণ করতে হবে।
৩। কর্মরত শ্রমিকদের পেশাগত স্বাস্থ্য ও নিরাপত্তা নিশ্চিত করতে হবে।
৪। উপযুক্ত অগ্নি নির্বাপক ব্যবস্থা রাখতে হবে। এবং অগ্নিকান্ড কিংবা অন্য কোন দূর্ঘটনার সময় জরুরী নির্গমন ব্যবস্থা থাকতে হবে।
৫। বায়ু ও শব্দ দূষন করা যাবে না।
৬। প্রকল্প সৃষ্ট তরল বর্জ্য অপরিশোধিত অবস্থায় বাইরে নির্গমন করা যাবে না।

উপরোল্লিখিত যে কোন শর্ত লঙ্ঘন করলে যথোপযুক্ত কর্তৃপক্ষ কর্তৃক প্রকল্পের বিরুদ্ধে আইনানুগ ব্যবস্থা নেওয়া যাবে।

তারিখ ঃ

স্থানীয় কর্তৃপক্ষের স্বাক্ষর ও সীলঃ

২৫/৩/১৫
সমর কান্তি হালদার
চেয়ারম্যান
৪নং দেলুটি ইউনিয়ন পরিষদ
পাইকগাছা, খুলনা।

Appendix 4: List of Participants of PCM

Environmental Study for Blue Gold Program

EIA and SIA study conducted by CEGIS

Participant list of PCM

Venue: দেলুটি ইউনিয়ন পরিষদ, পাইকগাছা, খুলনা। Date: ০৩/০৩/২০১৮

SL	Name	Occupation	Age	Address	Mobile No.
০১	মোঃ রহিম উদ্দিন শেখ	কৃষক	৫৮	দেলুটি ইউপি, ৫ নং [illegible]	01757808411
০২	Nirod B. Mallick	President WMA.	67	Delutia	01720-568005
০৩	Dr. Kabil Hossain	Env. Expert	45	Blue Gold Khulna	01715-974701
০৪	Mst. Shamima Nasrin	Trg. Coordi	45	"	01716-281955
০৫	Umme Asma Khanam	Jr. Socio-Economist	38	Blue-Gold	01711-278518
০৬	Dipti Chakravorty		44	U.P. Member	01719503600
০৭	Rabita Mondol	Service	35	Blue Gold Program	01913-599789
০৮	Gobinda Mondal	Service	36	Horein Khola	01735-570899
০৯	ঊর্মিলা সরদার	গৃহিনী	45	হরিণ খোলা	—
১০	সুধা সরকার			দেলুটি	
১১	সত্যরঞ্জন সরকার	কৃষক		দেলুটি	01740832997
১২	ইতিকা চক্রবর্তী	ইউ.পি. সদস্য	30	দেলুটি ইউনিয়ন	01927033032
১৩	[illegible]	উদ্যোক্তা	27	দেলুটি ইউ.পি.	01711-272086
১৪	নিরাপদ মল্লিক	সদস্য-ইউ.পি.	52	দেলুটি ইউ.পি.	01719-137047
১৫	মোঃ [illegible]	[illegible]	৬০		[illegible]
১৬	[illegible] Halder	Chairman Deluti		Deluti	01716841014
১৭	Hafsa Khanom	[illegible]	26	[illegible]	01771041206
১৮	কৃষ্ণা রানী	গৃহিনী	[illegible]	[illegible]	01798-99918
১৯	সার্থ প্রতীম মল্লিক	চাকরী	২৮	দেলুটি	01955785812

Center for Environmental and Geographic Information Services
(A Public Trust under The Ministry of Water Resources)
House No. 6, Road No. 23/C, Gulshan-1, Dhaka-1212, Bangladesh
Tel: 880-2-8821570-1, 8817648-52 Fax: 880-2-8855935, 8823128 e-mail: cegis@cegisbd.com http://www.cegisbd.com

Appendix 5: Terms of Reference

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

Memo No: DoE/Clearance/5309/2014/ 158 Date: 10/07/2014

Subject: Approval of Terms of Reference for EIA of the Proposed Rehabilitation and Improvement of Infrastructure of Five Coastal Polders under Blue Gold Program.

Ref: Your Application dated 20/04/2014.

With reference to the above, the undersigned is directed to convey the approval of the Terms of Reference (TOR) for Environmental Impact Assessment (EIA) of the proposed Rehabilitation and Improvement of Infrastructure of five coastal Polders under Blue Gold Program.

I. The project authority shall submit a comprehensive Environmental Impact Assessment (EIA) considering the overall activity of each polder in accordance with the TOR and time schedule submitted to the Department of Environment (DOE) and additional suggestions provided herein..

II. The EIA report should be prepared in accordance with following indicative outlines:

1. Executive summary
2. Introduction: (Background, brief description, scope of study, methodology, limitation, EIA team, references)
3. Legislative, regulation and policy consideration (covering the potential legal, administrative, planning and policy framework within which the EIA will be prepared)

4a. Project activities:

- A list of the main project activities to be undertaken during site clearing, construction as well as operation
- Project Plan, Design, Standard, Specification, Quantification, etc.

4b. Project schedule: The phase and timing for development of the Project

4c. Resources and utilities demand: Resources required to develop the project, such as soil and construction material and demand for utilities (water, electricity, sewerage, waste disposal and others), as well as infrastructure (road, drains, and others) to support the project.

4d. Map and survey information

Location map, Cadastral map showing land plots (project and adjacent area), Topographical map, Geological map showing geological units, fault zone, and other natural features.

5. Baseline Environmental Condition should include, inter alia, following: (Identification and Quantification of Physical Situation that has been proposed to be changed)

- Physical Environment : Geology, Topology, Geomorphology, Land-use, Soils, Meteorology, and Hydrology
- Biological Environment : Habitats, Aquatic life and fisheries, Terrestrial Habitats and Flora and Fauna
- Environment Quality : Air, Water, Soil and Sediment Quality
- Relate baseline in both Quantitative and Qualitative term with the anticipated outcomes, achievement of goals, objectives and changes due to project interventions

6. Socio-economic environment should include, inter alia, following:

- Population: Demographic profile and ethnic composition
- Settlement and housing
- Traffic and transport
- Public utilities: water supply, sanitation and solid waste

1

- Economy and employment: employment structure and cultural issues in employment
- Fisheries: fishing activities, fishing communities, commercial important species, fishing resources, commercial factors.

7. Identification, Prediction and Evaluation of Potential Impacts (identification, prediction and assessment of positive and negative impacts likely to result from the proposed project).

   In identification and analysis of potential impacts'-the 'Analysis' part shall include the analysis of relevant spatial and non-spatial data. The outcome of the analysis shall be presented with the scenarios, maps, graphics etc. for the cases of anticipated impacts on baseline. Description of the impacts of the project on air, water, land, hydrology, vegetation-man maid or natural, wildlife, socio-economic aspect shall be incorporated in detail.

8. Management Plan/Procedures:

   For each significant major impact, proposed mitigation measures will be set out for incorporation into project design or procedures, impacts, which are not mitigable, will be identified as residual impacts Both technical and financial plans shall be incorporated for proposed mitigation measures.

   An outline of the Environmental Management Plan shall be developed for the project.

   In Environmental Monitoring Plan, a detail technical and financial proposal shall be included for developing an in-house environmental monitoring system to be operated by the proponent's own resources (equipments and expertise).

9. Consultation with Stakeholders/Public Consultation (ensures that consultation with interested parties and the general public will take place and their views taken into account in the planning and execution of the project)

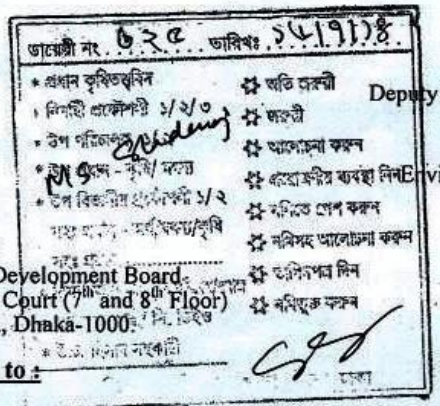
   Beneficial Impacts (summarize the benefits of the project to the Bangladesh nation, people and local community and the enhancement potentials)

10. Conclusion and Recommendations

III. Without approval of EIA report by the Department of Environment, the project authority shall not be able to open L/C in favor of importable machineries.

IV. Without obtaining Environmental Clearance, the project authority shall not be able to start the physical activity of the project.

V. The project authority shall submit the EIA along with a filled-in application for Environmental Clearance in prescribed form, the applicable fee in a treasury chalan, the no objection certificates (NOCs) from the local authority, NOCs from forest department (if it is required in case of cutting any forested plant, private or public) and NOC from other relevant agencies for operational activity etc. to the concerned divisional office of DOE with a copy to the Head Office of DOE in Dhaka.



10.07.2014
(Syed Nazmul Ahsan)
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and
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2) Assistant Director, Office of the Director General, Department of Environment, Head Office, Dhaka.

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