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Blue Gold Program

Final Report on
Environmental Impact Assessment (EIA) on Rehabilitation of Polder 43/2B

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Table of Contents

List of Tables

List of Figures

List of Photographs

List of Maps

Abbreviation and Acronyms

AEZ	Agro -Ecological Zone
ASA	Association for Social Advancement
BAU	Bangladesh Agricultural University
BCCSAP	Bangladesh Climate Change Strategy and Action Plan
BCSAP	Biodiversity Conservation Strategy and Action Plan
BG	Blue Gold
BMD	Bangladesh Metrological Department
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 Project
CEGIS	Center for Environmental and Geographic Information Services
CEIP	Coastal Environmental Improvement Project
COD	Chemical Oxygen Demand
COs	Community Organizers
DAE	Department of Agricultural Extension
dBA	DecciBel
DC	District Commissioner
DEM	Digital Elevation Model
DG	Director General
DO	Dissolved Oxygen
DoE	Department of Environment
DoF	Department of Fisheries
DPHE	Department of Public Health 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 of the United Nations
FCD	Flood Control and Drainage
FCD/I	Flood Control Drainage/ Irrigation
FCBO	Fisheries Community Based Organization
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 the Netherlands
GPA	Guidelines for Project Assessment
GPWM	Guidelines for Participatory 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 Forests
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 & M	Operation and Maintenance
OHP	Occupational Health and Safety Plan
PCM	Public Consultation Meeting
PCP	Public Consultation Process
PD	Project Director
PP	Project Proforma
PPM	Parts per Million
PPR	Peste des Petits 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
SWAT	Soil and Water Assessment Tools
T. Aman	Transplanted Aman
ToR	Terms of Reference
TSP	Triple Super Phosphate
UAO	Upazila Agriculture Officer
UFO	Upazila Fisheries Officer
UNDP	United Nations Development Programme
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 Organization

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-December.
Arat	Generally an office, a store or a warehouse in a market place from which Aratdar conducts the business.
Aratdar	A wholesaler and/or commission agent. At times covers both functions, who carries out public auctions and often is the main provider of credit in the marketing chain.
Aus	A group of rice varieties sown in the pre-monsoon season and harvested during the monsoon season. These rice varieties are broadcast/transplanted during March-April and harvested during June-July.
B. Aus	When preceding a crop means broadcast (B. Aus)
Bagda	Shrimp (*Penaeus monodon*), brackish/slightly saline water species.
Bazar	Market
Beel	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 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, but not every day.
Jaal	Fishing net used 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 communities.
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 consists of a hole without cover.
Mahajan	A traditional money lender and a powerful intermediary in the value chain.
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	An administrative unit 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.

Unit Conversion

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 710 km of coast line along the Bay of Bengal. About 38.5 million peoples live in the coastal area. About 38% of the population in the coastal region live below the poverty line and faces high vulnerabilities in terms of access to food, employment, income, water and health service. Integrated and participatory water resources management has the potential to contribute significantly to food security, safety, income level, health and economic growth. In this context, the Government of the Netherlands (GoN) as a development partner of Bangladesh has been supporting water resources management projects in Bangladesh since 1975.These projects are mostly operated by the Bangladesh Water Development Board (BWDB).The Blue Gold Program (BGP) is one of such initiative that will cover 26 polders in three coastal districts of Bangladesh. This program, initiated in January 2013 and expected to end in December 2018, is built on the results and lessons learnt in managing water resources from previous programs and projects. The explicit objective of Blue Gold Program is to reduce poverty and increase people's income through value chain development in an integrated approach. Initially, in the selected polders of the coastal districts all water control structures will be rehabilitated and fine tuned in line with project objectives. However, to proceed with implementation, the BGP needs environmental clearance from the Department of Environment. This is due to the fact that under the Environment Conservation Rules (ECR, 1997), construction/reconstruction/expansion of flood control embankments, polders, dikes, etc. are classified as **'red'** category projects, and are subject to mandatory to Environmental Impact Assessment (EIA) study. In view of this, the Blue Gold Program management authority entrusted CEGIS to carry out the EIA study of seven selected polders (Polder 2, 26, 29, 31-part, 43/1A, 43/2B and 43/2E) in its first phase. This document is the Final EIA report of Polder 43/2B.

Objective of the study

The objective of the Environmental Impact Assessment (EIA) study is to comprehensively assess the environmental aspects of the proposed interventions under project aimed for eco-friendly development and improving the socio-economic condition of the entire project area.

Approach and Methodology

The guidelines 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 to conduct this EIA study.

Project Description

Polder 43/2B is located in Amkhola union under Galachipa Upazila and Auliapur union under Patuakhali sadar Upazila of Patuakhali District. The polder covers an area of 5,700 ha, with a net cultivable area (NCA) of 4,078 ha (73%).

The polder was constructed in 1985-87, and later rehabilitated under the Integrated Planning for Sustainable Water Management (IPSWAM) project from 2003 to 2011. The polder is

bounded by a 39.83 km embankment that was built to protect the area against tidal and storm surges as well as saline water intrusion. There are 6 drainage sluices, 20 closers and 39 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 especially during post monsoon. The sluice gates can not prevent the saline water from intruding inside the project area even when the gates are closed as they are ill-fitted. Similar problems also exist in the flushing inlets of the polder. The total internal drainage channel of the polder is around 136 km. Some of the drainage channels have been silted up due to top soil erosion from adjacent land, coupled with improper maintenance over the years.

Existing Problems and the Proposed Interventions

The existing condition of the embankment is good except in some places where the slope are not up to the standard level. There is a number of breaches along the peripheral embankment (500m continuous breach at Dari Baherchar, 200 m discrete breach at Jainkathi and around 300 m discrete breach at Bauria) which are tremendously hampering the communication system. Apart from this, poor water resources management, marked by the low maintenance and improper use of water management infrastructures (sluice gates, outlets and inlets) is a major concern. The siltation of khals is another problem, which not only lowers the water availability for irrigation and but also causes unfavorable condition for aquatic biota. Currently, drainage congestion and water logging, river bank erosion, tidal flooding in some places in the polder area are reported as water related problems. All these problems are impeding the lives and livelihoods of the inhabitants of the polder.

Considering the existing problems and needs of the local residents, the Blue Gold Program has included interventions like re-sectioning of embankments, repairing of drainage/ flushing sluices and outlets, repairing of Irrigation Inlets and re-excavation of selected drainage channels in its work program.

Environmental and Social Baseline

The project area experiences a tropical climate where the average maximum temperature varies from 29°C (January) to around 36°C (April) and minimum temperature varies from 10.3°C (January) to 24°C (August).The maximum rainfall ever recorded in the area is 610mm in the month of July while the lowest rainfall is observed in the month of December which is 7.6 mm. The monthly average relative humidity of the Patuakhali BMD station varies from 74 to 90%. An increasing trend of sunshine hours is observed from April to July, with daily maximum sunshine hour recorded for March as 7.65 hrs/ day.

Polder 43/2B is 39 km away from the coast (Bay of Bengal), and undergoes diurnal tidal influence. The polder is surrounded by Lohalia River on the north and east directions. The western periphery of the polder is surrounded by Golkhali khal. The river Lohalia is originated from the off take of the Payra River, at about 18 km north from the polder. Apart from these rivers, there are approximately 136 km of drainage and irrigation canals within the polder.

Agriculture is the main livelihood activity of the people residing in the polder. The most prominent cropping pattern in the polder area is fallow – local transplanted aman (Lt. Aman) - watermelon and fallow – local transplanted aman - fallow which are practice in 22% (each) of the NCA. The next dominant cropping pattern is Fallow - Lt Aman - Groundnut which is practices in 17% of the NCA. For high yielding variety aman, BR-23 is the only variety cultivated by farmers. Among the *Rabi* crops and varieties, farmers are growing Sesame-BARI Sesame-2, mungbean-Mubarik, watermelon-Local, chilli-Local,

khasari-Local and sunflower (Kironi) etc. Total cropped area is about 7,746 ha of which the coverage of rice is 59% and non rice is 41**%** respectively. Cropping intensity of the polder area is about 190%.

Internal khals are the main source of open water fish habitats in the polder area. Most of the khals are seasonal and retain water for six to eight months. The peripheral rivers are perennial in nature and play important roles for capture fisheries. Fish biodiversity inside the polder shows a declining trend in the polder area due to siltation in the khals, salt water intrusion during dry season etc. The culture fish habitat includes homestead and commercial pond. Of the culture fish habitat, homestead pond is dominant. The culture fisheries practice is increasing in the polder area day by day. The terrestrial flora and fauna are very rich and the density of vegetation is almost uniform throughout the polder. But breaching of embankment, pests and diseases attack, improper homestead space planning, and natural disaster are identified as the major threat to vegetation in the polder.

The 8,070 households living in the polder area have a total population of 35,425, of which 17,620 are male and 17,805 female. The average density of population is 491 persons per sq. km which is less than half of the national density i.e. 1,015 persons per sq. km. The inhabitants of this polder belong to three religious groups; the Islam, Hinduism and Buddhism. About 96% of total population are Muslim and the rests are Hindu and Christian. The average literacy rate in the study area is 48% which is slightly lower than the national level (52%). Agriculture is the main occupation of the people, and around 88% people are engaged in agriculture sector.

Public Consultation and Disclosure

One Public Consultation Meeting (PCM) and number of informal discussions were conducted at different locations of the polder. The participants included those who may or may not be directly affected but have interests that could contribute to the study, play some roles in implementation at stage, or affect decision-making of the project. Moreover, representatives of NGOs, government departments concerned such as local government institutions (LGI), the Blue Gold Program officials in Patuakhali participated in the meeting and gave their valuable views and opinions.

Impact Assessment

The proposed interventions will affect many environmental and social components either positively or negatively. For instance, re-excavation of khal would improve the drainage facility. It is expected that about 15 km khals (11% of total) would be benefited through easing of drainage congestion in future, due to the overall improvement in drainage capacity of re-excavated khals. Moreover, around 6,500 people (18% of total population) in Banshbunia, Nijsuhati, Amkhola, and Ramananda Moauzas would have sufficient surface water and access to the same. The re-sectioning of embankment would protect about 20 ha of land at Dari Baherchar from probable tidal flooding consequences. The irrigated area would increase to 380 ha. Additional 2,617 tons (61% higher) of rice and 9,242 tons (77% higher) of non-rice would be produced after implementation of the proposed interventions. Re-excavation of the silted internal khals would increase water depth and water availability round the year which would improve water quality of open water fisheries in the polder area. The open water fish diversity especially brackish water fisheries as well as its production will be increased. Terrestrial vegetation will be also benefited due to the reduction of soil salinity. The density and diversity of vegetation near the re-excavated canals will improve. Access to open water bodies of the local people will be increased. The re-excavated canals will also serve as important source of domestic water use like water

for bathing, washing and cooking. The communication and employment opportunity of the people within the polder will be enhanced.

Environmental Management Plan

The study has proposed a set of mitigation measures to offset the negative impacts and an enhancement plan to boost up the positive impacts. Some of the measures suggested are as follows:

- Avoid khals re-excavation works during fish migration periods e.g. month of May to August
- Earth spoils to be dumped outside the khal
- Re-excavation should be implemented segment wise and one after another to protect indigenous fishes and other aquatic biota
- Crop rotation with leguminous crops, application of more organic materials and green manure to improve soil fertility in the project area.
- Crop diversification for improving soil nutrient status and fertility should be practiced
- Irrigation should be provided in optimum level with minimum conveyance loss from khals
- Planting of native mixed deep rooted trees along the embankment slopes and toes wherever possible to enhance green coverage
- Farmers group should have close contact with the Department of Agricultural Extension (DAE) for adaptation of various measures on integrated pest management/integrated crop management (IPM/ICM)
- Most of all earthworks should be awarded to LCS. At least 40% of LCS members should be female. To ensure female labourers participation in the work, necessary physical facilities (e.g., toilet for women labourers) should be put in place.

In addition, a conceptual Spoil Management Plan (SMP) has been proposed by the study team for controlled and sustainable disposal of excavated spoil. Follow up the plan is essential to safeguard the environmental sustainability of the construction sites.

The study infers that there would be some temporary negative impacts during the construction phase, but no significant negative or irreversible impacts would occur after the construction. The mitigation measures suggested in the EMP will ensure the sustainable development of the project area. The project management should pay due attention and incorporate the EMP recommendations into its work plan.

1. Introduction

1.1 Background

1. Bangladesh, the largest river delta in the world has about 710 km of coast line along the Bay of Bengal (DoE, 2001). The three major river systems of the country mark its physiography and the shapes the lives of its people to a large extent. Effective management of this immense natural resource remains a continuing challenge and offers at the same time tremendous opportunities for economic development. Around 38.5 millions of people live in the coastal areas (BBS, 2011). About 38% of the population in the coastal region lives below the poverty line and faces high vulnerabilities in terms of access to food, income, water and health services (Inception Report, Blue Gold Program, 2013). However, there are ample opportunities to harness the resources of the coastal areas which can alleviate poverty, create sustainable environment and provide security and enhance human well-being of the present and future generations.

2. The Government of the Netherlands (GoN), a development partner of the Government of Bangladesh, since 1975 is supporting water in management projects of Bangladesh Water Development Board (BWDB), for the development of sustainable and participatory water management systems and institutions throughout the country. The Government of Bangladesh (GoB) considers integrated water resources development as one of its priority activities as it will build community resilience against tidal and storm surge flooding and salinity intrusion without compromising with the ecosystem needs and allow the communities to utilize available water resources for productive use and human consumption. Participatory water management received a new impetus in Bangladesh with the adoption of National Water Policy in 1999. The participatory water resources management has been successfully introduced in the coastal region of Bangladesh, since 2003 in line with the National water Policy and water resources development strategies of the GoB. The GoN in this effort became a partner and extended its support through several projects. These 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 Project (CDSP) and the Water Management Improvement Project (WMIP). As a follow up project of IPSWAM, the GoB and GoN concluded to initiate the “Blue Gold Program” to address poverty and improve human well-being using the water resources management as an entry point, with active involvement of rural communities. In the context of this program, water is termed as “Blue Gold” and considered as a fundamental resource for changing people’s lives and supporting sustainable development of the coastal Bangladesh.

3. Blue Gold Program builds on the results and lessons learned in managing water resources from previous programs and projects in Bangladesh. The explicit objective of the Blue Gold Program is to reduce poverty in the coastal areas by enhancing productivity of crops, fisheries and livestock in an integrated way and increase people’s income by creating opportunities for 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 are limited to selected polders of three coastal districts: Satkhira, Khulna and Patuakhali which are part of the South-west and South-central hydrological zones.

4. 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 having (i) higher incidence of poverty, (ii) ineffective coordination between local administration and private sector and (iii) 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, as illustrated in Table 1.1.

Table 1.1: Tentative district-wise distribution of polders based on preliminary selection criteria

District	Tentative Number of Polders with reference to selection criteria			
	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, 2013

5. The key implementing partners of the program are the BWDB and the Department of Agricultural Extension (DAE). The program will cooperate closely with the related ministries, the Local Government Institutions (LGIs), knowledge institutes and private sector including NGOs. The overall approach is innovative and hence, the program as per requirement will strengthen the technical and strategic capacity of the government officers along with their operational capacities of the institutions, in particular at local level (union, upazila and district), concentrating on polder development in the three districts.

6. 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 the environmental point of view, the activities of two components i.e. the water resources management (component ii) and the food security and agricultural production (component III) need special attention. Accordingly, CEGIS has been engaged to undertake Environmental Impact Assessment (EIA) studies of the component (ii) of Blue Gold Program, for a total number of seven polders, selected from the nine IPSWAM polders.

1.2 Rationale of the Study

7. Generally polders have been constructed in the coastal area of Bangladesh with the objective of providing protection to agricultural land, settlements, homesteads etc from tidal flooding. Although polders play crucial role in accelerating the economic development of the country, experiences show that such physical interventions have created adverse impacts on the ecosystem. Considering the importance and value of ecosystem services, and the vulnerability of the ecosystems in process of polder development, the GoB under the Environment Conservation Rules (ECR, 1997) has declared the construction/ reconstruction/ expansion of flood control embankments, polders, dykes, etc. as '**red**' category projects. This means in accordance to ECR 1997 for planning and implementation of such project Environmental Impact Assessment (EIA) study is mandatory. Under the ECR 1997, the proponent of the project is obliged to carry out EIA study through independent experts to solicit clearance from the Department of Environment, Government of Bangladesh.

8. Component (ii) of the Blue Gold Program includes rehabilitation of water resources management infrastructures in the selected polders. Polder 43/2B is one of them. The rehabilitation works of the polder includes 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. To proceed with these interventions, the Blue Gold Program needs environmental clearance from the DoE. To fulfill the obligation, the Blue Gold Program, engaged CEGIS to conduct the EIA study.

1.3 Study Area

9. The Polder 43/2B covered under this EIA study is located in Amkhola union of Galachipa upazila and Auliapur of Patuakhali sadar upazila under Patuakhali district. The polder covers an area of 5,700 hectare Map 1.1 shows the base Map of the Polder.

1.4 Objectives of the Study

10. The overall objective of EIA study is to comprehensively assess the environmental aspects of the proposed rehabilitation interventions. The specific objectives include the followings:

- To prepare environmental and social baseline of the project area;
- To assess potential environmental impacts as well as cumulative, induced and reciprocal impacts for the proposed interventions;
- To identify mitigation measures for minimizing the negative impacts and enhancing the positive impacts; and
- To Prepare Environmental Management Plan (Mitigation and enhancement plans, compensation and contingency plan with monitoring plan.

1.5 Scope of Work

11. The scope of work of the assignment are to:

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

ii. Identify the Important Environmental and Social Components (IESCs) which are likely to be impacted by the proposed interventions.

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

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

v. Identify the specific reciprocal impact of climate change on polder infrastructures.

vi. Prepare a landuse map and ground truthing.

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

viii. A small section of the EIA (EMP) will indicate occupational health and safety measures to be undertaken for the implementation of the work, but no detailed occupational health plan (OHP)

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

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

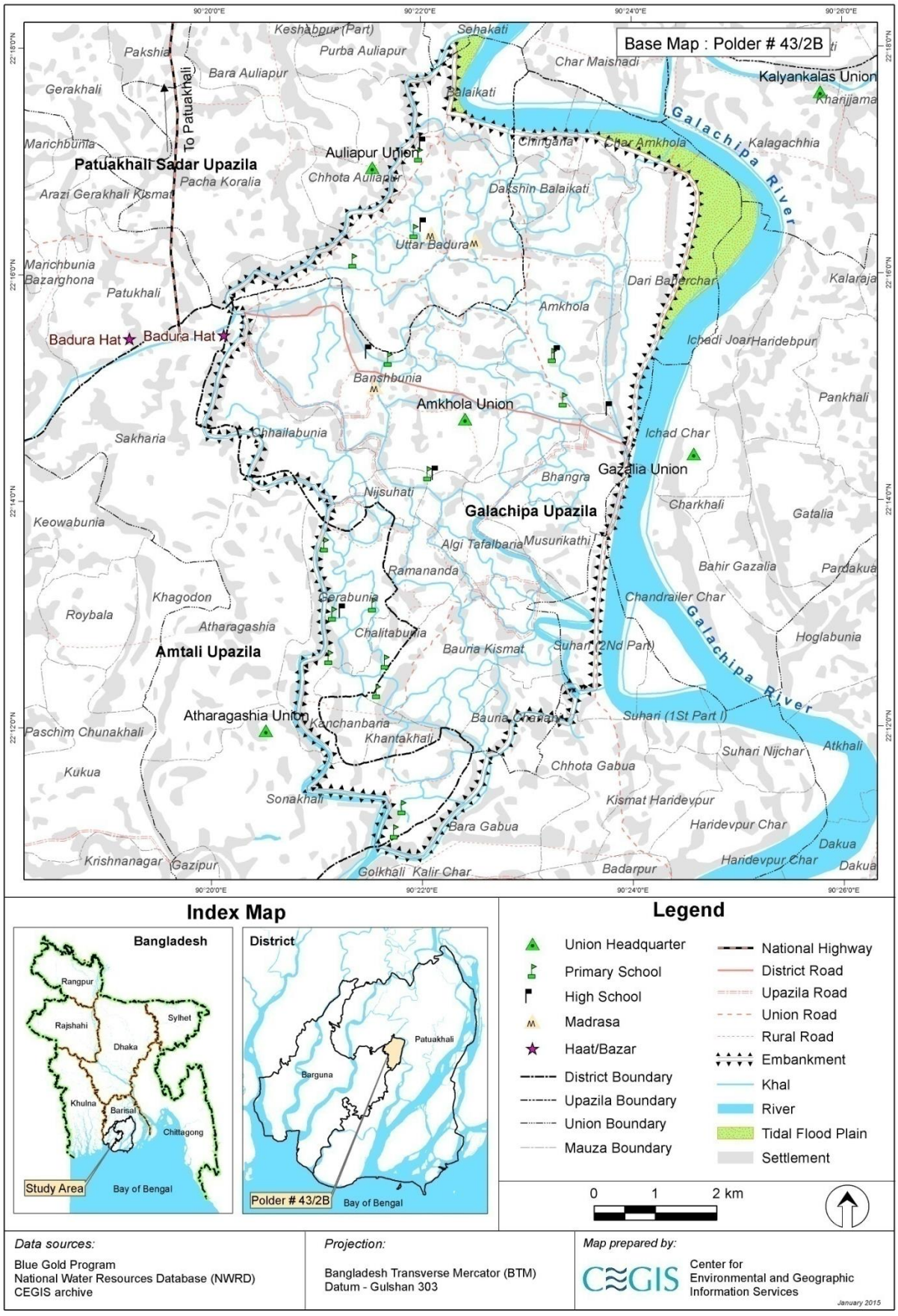
1.6 Limitations

12. The limited time assigned for conducting the EIA studies of 7 (seven) project was a major concern and was not adequate. The secondary data and information used in this study have been collected from existing data sources for different time intervals, which has some influence on the results and remarks included in this study. For such time limitations, more localized primary data on hydrology, meteorology; household status etc. could not be collected for a full hydrological cycle. Furthermore, the inference drawn from implied hydrologic and hydrodynamic models are mostly subjected to the authenticity of used data.

1.7 EIA Study Team

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

1. Mr. Md Sarfaraz Wahed, Water Resources Engineer/ Team Leader
2. Mr. Mujibul Huq, Environmental Advisor
3. Mr. Md. Ebrahim Akanda, Soil and Agriculture Specialist
4. Dr. Ashraful Alam, Fishery Specialist
5. Mr. Mobsher Bin Ansari, Socio-Economist
6. Mr. Fahad Khadim Khan, Junior Water Resources Engineer
7. Mr. Tanvir Ahmed, Water Resource Modeller
8. Ms. Mashuda Parvin, Ecologist
9. Mr. Nasrat Jahan, GIS/RS Specialist
10. Mr. S.M. Shafi-Ul-Alam, GIS Analyst
11. Mr. Md. Amanat Ullah, Ecologist
12. Mr. Md. Azizur Rahman, Field Researcher
13. Mr. Md. Shahadat Hossain, Field Researcher
14. Eva Chowdhury, Field Researcher
15. Mr. Md. Shahidur Rahman, Enumerator



Map 1.1: Base Map of Polder 43/2B

1.8 Report Format

14. This EIA report has the following 11 (eleven) chapters:

Chapter 1: ***Introduction*****:** This chapter describes the background of the project, study area, objectives, scope of works with a list of the multi-disciplinary EIA study team members.

Chapter 2: ***Policy, Legal and Administrative Framework***: This chapter briefly discusses the national rules and regulations relevant with the EIA study

Chapter 3: ***Approach and Methodology:*** This chapter presents the detail procedures followed for conducting the EIA study including data sources and methodology of data collection, processing and impact assessment .

Chapter 4: ***Project Description****:* Description of the project including the present status of the infrastructure and the proposed interventions are discussed in this chapter.

Chapter 5: ***Environmental Baseline:*** Environmental condition with respect to meteorology, seismicity, water resources, land resources, agriculture, livestock, fisheries, ecological resources are described in this chapter.

Chapter 6: ***Socio-economic Condition:*** This chapter discuses the demography, livelihood, quality of life along with the socio-economic conditions of the project area.

Chapter 7: ***Stakeholder Disclosure:*** This chapter gives an overview of the public consultations held in the project sites as well as disclosure and results including methodology, public opinions and suggestions derived through the consultations.

Chapter 8: ***Identification, Prediction and Evaluation of Potential Impacts:*** This chapter lists the important environmental and social components likely to be impacted by the proposed interventions with brief description. The possible impacts of proposed interventions on the environmental and social components are also highlighted with the evaluation of impacts.

Chapter 9: ***Assessment of Cumulative, Induced and Reciprocal Impacts***: This chapter discusses cumulative, induced and reciprocal impacts due to implementation of the proposed interventions as well as climate change.

Chapter 10: ***Environmental Management Plan***: This chapter provides a detailed Environmental Management Plan (EMP) along with the EMP implementation and monitoring cost.

Chapter 11: ***Conclusions and Recommendations***: Conclusions and recommendations summarize the key findings of the EIA study.

2. Policy, Legal and Administrative Framework

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

2.1 National Policies and Legislations

2.1.1 The National Environment Policy, 1992

16. 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 the environment and to protect the country against any natural disaster. The Policy provides the broader framework of sustainable development in the country. It also states that all major undertakings, which will have a bearing on the environment, will 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.

17. 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 resource development and management (Section 3.5.7).

18. Section 3.5.2 states that it is required to ensure water development activities and that irrigation networks should not create adverse environmental impacts. 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

19. The National Environmental Management Action Plan (NEMAP) is a wide ranging 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 sets out the framework within which the recommendations of the National Conservation Strategy are to be implemented.

20. NEMAP has the following broad objectives:

- Identification of key environmental issues affecting Bangladesh;
- Identification of actions necessary to halt or reduce the rate of environmental degradation;

- Improvement of the natural and built environment;
- Conservation of habitats and biodiversity;
- Promotion of sustainable development; and
- Improvement of the quality of life of the people. (MoEF, 1995)

2.1.3 The National Water Policy, 1999

21. 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 resource management. The Policy considers water as being essential for human development, socio-economic development, poverty alleviation and preservation of the natural environment.

22. 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 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 Conservation Strategy and Action Plan for Bangladesh 2004

23. 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), 2009

24. 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 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 agencies, civil society and the private sector to meet the challenges of climate change and mainstream them as part of development action (MoEF, 2009).

2.1.6 National Water Management Plan, 2001 (Approved in 2004)

25. The National Water Management Plan (NWMP) 2001, approved by the National Water Resources Council in 2004, envisions establishing an integrated development, management and use of water resources in Bangladesh over a period of 25 years. Water Resources Planning Organization (WARPO) has been assigned to monitor the national water management plan. The major programs in the Plan have been organized under eight sub-sectoral clusters: i) Institutional Development, ii) Enabling Environment, iii) Main River, iv) Towns and Rural Areas, v) Major Cities; vi) Disaster Management; vii) Agriculture and Water Management, and viii) Environment and Aquatic Resources. Each cluster comprises of a number of individual programs, and a total of 84 sub-sectoral programs have been identified and presented in the investment portfolio. Most of the programs are likely to be implemented in coastal areas.

2.1.7 Coastal Zone Policy, 2005

26. The Government has formulated the Coastal Zone Policy (CZP) that provides a general guidance to all concerned for the management and development of the coastal zone in a manner so that the coastal people are able to pursue their life and livelihoods within secure and conducive environment.

27. The coast of Bangladesh is known as a zone of vulnerabilities as well as opportunities. It is prone to natural disasters like cyclone, storm surge and flood. In this regard, for reducing risk, the policy emphasizes the improvement of coastal polders and seeks to enhance safety measures by combining cyclone shelters, multi-purpose embankments, road system and disaster warning system.

2.1.8 Coastal Development Strategy, 2006

28. The Coastal Development Strategy (CDS) focuses on the implementation of the coastal zone policy. The CDS was approved by the Inter-Ministerial Steering Committee on ICZMP on 13 February 2006. Nine strategic priorities, evolved through a consultation process, guide interventions and investments in the coastal zone:

- ensuring fresh and safe water availability
- safety from man-made and natural hazards
- optimizing use of coastal lands
- promoting economic growth emphasizing non-farm rural employment
- sustainable management of natural resources: exploiting untapped and less explored opportunities
- improving livelihood conditions of people especially women
- environmental conservation
- empowerment through knowledge management
- creating an enabling institutional environment

2.1.9 National Conservation Strategy (NCS) 1992

29. The National Conservation Strategy was drafted in late 1991 and submitted to the government in early 1992. This was approved in principle. However, the final approval of the document is yet to be made by the government.

2.2 Legislation, Act and Rules

2.2.1 National Water Act, 2013

30. The Water Act 2013 is based on the National Water Policy, and provides the legal framework for integrated development, management, abstraction, distribution, usage, protection and conservation of water resources in Bangladesh. The Act provides for the formation of a high-powered National Water Resources Council (henceforth termed as the Council) headed by the Prime Minister. An Executive Committee under the Ministry of Water Resources will implement the decisions taken by the Council.

31. As per this Act, all forms of water (e.g., surface water, ground water, sea water, rain water and atmospheric water) within the territory of Bangladesh belong to the government on behalf of the people. Private landowners will be able to use the surface water inside their property for all purposes in accordance with the Act.

32. The Act addresses the water needs in irrigation and urban areas in the context of available surface water, groundwater, and rainwater.

33. The management of water resources within the territory of the country in rivers, creeks, reservoirs, flood flow zone, and wetlands has been assigned to the Executive Committee under the Ministry of Water Resources.

34. Draining of wetlands that support migratory birds has been prohibited by the Act. Consequently, without prior permission from the Executive Committee, building of any structure that can impede the natural flow of water has been prohibited.

35. A few activities like dredging of rivers for maintaining navigability, land reclamation projects by filling wetlands, and flood control and erosion control structures will be exempted pending prior permission.

36. The Act provides provisions for punishment and financial penalty for non-compliance, including negligence to abide by government policy, ordinance, non-cooperation with government officials, refusal to present necessary documents, providing false information, affiliation with perpetrators, and protection measures for water resources management. The maximum penalty for violations is set to five years of imprisonment and/or a monetary penalty of Taka10,000.00 (Ministry of Law, Justice and Parliamentary Affairs, 2013).

2.2.2 The Embankment and Drainage Act 1952

37. This is an Act that 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 better drainage of lands and for their protection from floods, erosion or other damage by water.

38. 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.

39. The section 56 (1) states that, persons will be subject to penalty (500 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.

2.2.3 The Inland Water Transport Authority Ordinance, 1958 (E.P. Ordinance No. Lxxv Of 1958)

40. 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.

2.2.4 The Government Fisheries (Protection) Ordinance, 1959 (Ordinance No. Xxiv Of 1959)

41. 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.

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

42. 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. Water rate can be imposed, 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.

2.2.6 The Ground Water Management Ordinance, 1985 (Ordinance No.XxvitOf 1985)

43. 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 its jurisdiction. The Thana Parishad may grant the license if the Parishad is satisfied that the installation of the tube well applied for

a) will be beneficial to the areas where it is to be installed, or

b) will not have any adverse affect upon the surrounding areas, or

c) is otherwise feasible.

2.2.7 The Protection and Conservation of Fish Rules (1985)

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

2.2.8 Panishampad Parikalpana Ain (Water Resource Planning Act, 1992)

45. Under this Act, the government is authorized to set up a Water Resource 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 resource development use.

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

46. The Bangladesh Wild Life Preservation (Amendment) Act 1974 provides the 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, capture, trade and export of wild life and wild life products are regulated. The Act also designates a list of protected species and game animals.

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

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

48. 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.

49. The main objectives of ECA '95 are:

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

50. 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.

51. Before any new project can go ahead, as stipulated under the rules, the project promoter must obtain Environmental Clearance from the Director General of the DoE. An appeal procedure does exist for those promoters who fail to obtain clearance. Failure to comply with any part of this Act may result in punishment to a maximum of 3 years imprisonment or a maximum fine of Tk. 300,000.00 or both. The DoE executes the Act under the leadership of its Director General (MoEF, 1995).

2.2.11 The Environment Conservation Rules, 1997

52. 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).

53. 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.

54. 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.

55. 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.

2.3 Procedure for environmental clearance

56. 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 the 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.

57. Environment Conservation Rules, 1997, places 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.

58. 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)

59. The process of obtaining clearance from the DoE is presented in Figure 2.1 below.

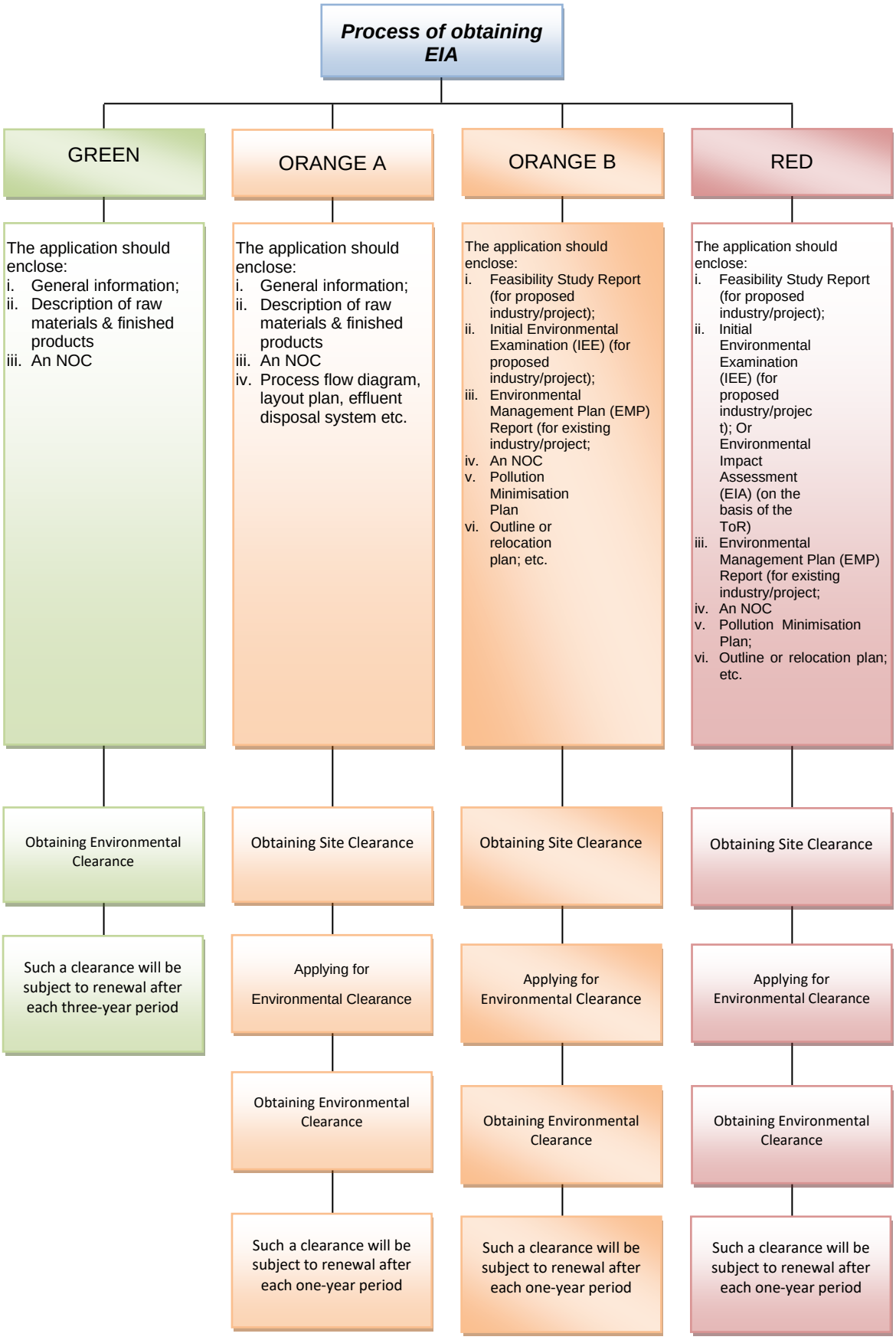


Figure 2.1: Steps Involved in Environmental Clearence folllowing DoE Clearence

2.4 Administrative Framework

60. 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.

61. Within organizational structure of BWDB, there are few positions of environment, forestry and fisheries professionals as “Research Officer” all of whom are posted in 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 many junior to senior level officers who have training on environmental management of water resources development projects. These 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

62. The study has been developed following the guideline for environmental impact assessment of water sector projects, which was developed by the Flood Plan Co-ordination Organization (FPCO) in 1992 and updated by Water Resources Planning Organization (WARPO) in 2003. There is another guideline for EIA, formulated by the Department of Environment (DoE) in 1997, which only includes the industrial projects of the country, and has very limited emphasis on water sector developments. As such, the EIA guideline of WARPO has been preferred in this study.

63. The process followed for conducting the EIA study included 9 steps (people's participation and feedback were considered in each step) as shown in Figure 3.1 and the activities undertaken at each step is described in the following sections.

Figure 3.1: The EIA process

3.2 Project Description

64. The rehabilitation activities i.e. interventions which are to be implemented under the Blue Gold Program have been identified. The area of influence (project area for short) has been demarcated. This includes the area inside the polder where most of the Project interventions would take place, and the area immediately outside the polder embankment (area to 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 the 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 was 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.

3.3 Environmental and Social Baseline

65. Baseline data collection was conducted as a pre-requisite for this EIA study. The baseline condition of the project area was drawn according to the information collected from secondary and primary data sources through literature review, field investigations and consultation with different stakeholders through using comprehensive baseline-checklist (Appendix-1). During the field visits, the multidisciplinary EIA team members made professional observations pertaining to their individual areas of expertise. 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 of the proposed project site and adjoining areas. The baseline data collection methodology is presented in the following section:

3.3.1 Climate and Meteorology

66. A discussion on climate change based on secondary literature review has been made. The issue was discussed on a regional scale, with respect to the different hydrological regions and administrative divisions of Bangladesh. Long term impacts of climate change have been investigated on temperature and rainfall. An earlier study carried out by CEGIS using PRECIS model (CEGIS, 2014) has been reviewed in this regard. Information regarding change in temperature and rainfall for different regions and districts over the last 100 years has been analyzed. The same study was also reviewed for providing an understanding on different climate change scenarios as well. In addition, field level information on the recently occurred natural disasters and their impacts are investigated.

67. Data on different meteorological parameters such as rainfall, temperature, sunshine hours, humidity and wind speed were used for assessing the existing climate which is related to the water resources of the study area. The nearest station of the Bangladesh Meteorological Department (BMD) at Patuakhali (located within 5 km from Polder 43/2B) was selected for meteorological data collection and analysis. The data were collected from the Bangladesh Meteorological Department (BMD) through National Water Resources Database (NWRD), a web portal maintained by WARPO and CEGIS which contains long time series of temporal data showing daily values for meteorological stations. Spatial

analysis using Thiessen's Polygon method has been used for rainfall variation as the entire polder falls inside the polygon around Patuakhali station.

3.3.2 Topography and Seismicity

68. To understand the topography of the area through visualization of Reduced Levels (elevations) of different locations within the polder, an analysis using Digital Elevation Model (DEM) has been carried out. To establish the DEM, re-sampled 500m×500m grid levels (elevations) were captured from BWDB's one foot contour maps, which were produced in the late sixties. These spot levels were interpolated into a continuous surface known as the DEM, produced by CEGIS in 1997. The DEM has been downscaled within the processing extent of Polder 43/2B, to develop an understanding of the topographic features inside the polder.

69. The general geological features and the seismicity of the project and its surrounding areas were collected from available secondary literature and the Geological Survey of Bangladesh (GSB). A seismic zoning map of Bangladesh was proposed in 1979 by the GSB, on the basis of distribution of earthquake epicenters and tectonic behavior of different tectonic blocks, dividing the country into three seismic zones: zone-I, zone-II, and zone-III. In this study, the spatial location of the polder with respect to the seismic zones of the country has been assessed. In addition, the existing tectonic units of Bangladesh were also superimposed on the polder map, to visualize the polders tectonic location.

3.3.3 Water Resources

70. Water resource data in connection with river hydrology, morphology, groundwater availability, water related problems, functions and use were collected from the polder area during field visits and from secondary sources. The major river systems were identified for hydrological and morphological investigations 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 hydrological network, water availability, drainage issues, erosion, navigation or sedimentation etc.

71. The monthly average surface water levels from 1990 to 2009 were collected from the BWDB station at Amtali (station ID: 20, Payra river). The station is situated 12 km from the south-west corner of the polder. Another station of BWDB at Galachipa (station ID: 185, Lohalia River) was found closer to the polder (within 5 km distance on the east), however the station only provides data from 1968 to 1988, and no recent information was found. As such, the station at Amtali has been selected instead of that at Galachipa. For investigating the monthly variations in Ground Water Table (GWT), the observation well of BWDB at Amtali (BAG001) has been considered. The station is located within 2 km away from the polder. Monthly average data on GWT from 1978 to 2013 was analyzed. Analyses have also been carried out to understand the long term annual variations of GWT from 1978 to 2013 at BAG001 station, for the month of March (driest period) and August-September (wettest period).

3.3.4 Land and Soil Resources

72. 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 were collected from the Upazila Land and Soil Resources Utilization Guide (Upazila Nirdeshika) of the Soil Resources Development Institute (SRDI). Secondary data on these parameters were verified at field during field visits through physical observations as well as in consultation with the local people and officials of the Department of Agricultural Extension (DAE).

3.3.5 Agricultural Resources

73. Data collected 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 using a questionnaire and in consultation with local people and relevant agricultural officials. Agricultural resources data were also collected from secondary sources from the upazila DAE office. Crop production was determined using the formula:

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

75. Crop production loss = Total cropped area ×normal yield - (damaged area × damaged yield + damage free area × normal yield). The crop damage data were collected from the field for the last three years.

3.3.6 Livestock Resources

76. The present status of livestock (cows/bullock, buffalo, goats and sheep) and poultry (ducks and chickens) in the study area have evaluated through field level survey in consultation with the local people using methods namely PRA, (Participatory Rural Appraisal) RRA (Rapid Rural Appraisal) and KII (Key Informant Interview). Livestock resources data were also collected from secondary sources from the upazila livestock office.

3.3.7 Environmental Quality

77. Under the environmental quality component, noise and water quality were measured at different selected locations in Polder 43/2B. One suitable site was selected at Keowabunia bazaar to measure sound levels and compares the standard levels and in-situ values. The location was selected from the polder periphery, where embankment rehabilitation works would be carried out. During field inspection, sound levels were collected near construction site with 10 minute sampling periods. L_{50} (50-th percentile value) value was computed with the observed sound levels. For a normal time series distribution of sound levels, L_{50} is assumed to be equal to Leq, which is the Equivalent Noise Level. The computed Leq was then compared with the standard noise level suggested in Environmental Conservation Rules 1997 of Department of Environment, Bangladesh.

78. For collecting information on water quality, importants water quality parameters (e.g. pH, TDS, Temp., DO and Salinity) were measured on site in January 2015, from five different sampling locations of the polder. One of the five samples was collected from a Deep Tube Well (DTW) at Atharagasia Junior School. The other four samples were all collected from different surface water sources (three from outer side of the polder and one from the inner side).

3.3.8 Fisheries Resources

79. **Data collection methods:** Prior to undertaking data collection a checklist/ questionnaire was developed. The checklist covered all points for collection of information including existing and potential structures of the project. Different survey techniques were used for data collection. The sequential interpretations of the methodological approach were as follows:

80. **Sampling site selection:** Existing and proposed basin-wise sites were selected for data collection. The sampling sites varied depending on the size of the water bodies. During site selection, the focus was on intervened and non-intervened area to find out the difference in terms of fisheries impact.

81. **Data Collection:** 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 fisher community, fisher households and local key informants and fish market survey and secondary data were collected from upazila fisheries office during field visits.

82. **Habitat Identification:** Fish habitat classification was done based on physical existence and categorized into capture and culture fish habitats. The capture fish habitats included river, khal, tidal floodplain and burrow pit. The culture fish habitats included homestead culture fish pond, commercial fish farm etc.

83. **Capture and Culture Fish Habitats:** Capture fish habitats were assessed identification of species of conservation significance, identification of potential fish habitat prescribing to restore fish conservation, fish migration survey, and habitat identification for fish conservation. Culture fish habitats were assessed through homestead culture fish pond survey and commercial fish farm survey.

84. **Associated Information:** Information on post harvest activities, forward and backward linkages, fisher livelihood information, fisheries management issues, potential fish recruitment, fish infrastructure and fisher vulnerability, etc. was also collected.

85. **Secondary Data Collection:** Relevant secondary data were collected from the upazila fisheries office (UFO) from their annual reports and from various literatures/studies.

86. **Data Analysis and Output:** Fish production for individual habitats was obtained through a series of calculation procedures using the collected information of FES and Habitat area. Aggregating the fish production from all habitat types, the total fish production of the study area was estimated basinwise and then holistically. Secondary information was collected from the UFOs and literatures were blended with primary data for production estimation.

3.3.9 Ecological Resources

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

88. Land use information on different ecosystems was generated through analysis of 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 Rapid Eye (5m resolution) of 2014. All of the images were geo-rectified into “Bangladesh Transverse Mercator” (BTM) projection. The ERDAS IMAGINE software was used to perform the image classification. The mean signature plot for each class was verified with ground truth data.

89. In addition to land use, 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:

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

90. 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 use of FGD and KII methods. An inventory of common flora and fauna was developed based on field survey and the IUCN database.

3.3.10 Socio-economic Conditions

91. The socio-economic baseline information including study area, demographic information, occupation and employment, literacy rate, drinking water, sanitation, electricity facilities etc. were collected form secondary sources, i.e. the 2011 publication of Bangladesh Bureau of Statistics (BBS). Information on the income-expenditure of local people inside the polder area, land ownership pattern, poverty status, migration, quality of life, disasters, conflicts over resource use in the study area, presence of NGOs, and cultural and heritage features of the study area were collected mainly from primary sources through PRA and FGDs and public consultations.

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

a) Data collated 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; and

d) Institutional Survey (IS) for primary data collection in upazila level offices which included Local Government Engineering Department (LGED) office, Civil Surgeon's office, Social Services office etc.

3.4 Scoping

93. A scoping process was followed for selecting IESCs which are likely to be impacted by the proposed interventions of 'rehabilitation of Polder 43/2B'. Scoping was performed in two stages. Individual professionals of the EIA study team made preliminary lists 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 judgments of the EIA team members as well as the stakeholder's opinion obtained in the scoping sessions were considered in selecting the IESCs.

3.5 Bounding

94. The area likely to be impacted by 'rehabilitation of Polder 43/2B' was delineated in consultation with the experts of Blue Gold Program and feedback received from the local people during baseline consultation. In addition, processed Remote Sensing (RS) tools were also used for this purpose.

95. 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 a 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 simulations were obtained from different sources. Furthermore, participatory public consultations were carried out for validation of the model outputs and for drawing socio-technical conclusions.

3.6 Major Field Investigation

96. The EIA study team members collected intensive data on possible impact of the project after obtaining the detailed rehabilitation plan from the project authority. The study team carried out a number of comprehensive field investigations during 10 to 19 January, 2015 in order to collect primary data and solicit feedback from local people. Intensive data on Baseline and IESCs were collected from the field during this stage. Information on the IESCs were collected 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 consultations with the local people were carried out for their feedback on the key parameters. This process helped the multidisciplinary EIA study team to qualify their professional observations. In such exercise attention was given to understand the historical status of the IESCs and the possible condition of the same against the proposed interventions.

3.7 Environmental and Social Impact Assessment

97. Environmental and social impacts of the proposed interventions i.e. 'Rehabilitation of Polder 43/2B' on the IESCs have been assessed through several sets of activities. Impacts are created as a result of interaction of specific project activities with the existing environmental settings. The impacts of the proposed interventions were estimated on the basis of the difference between the future-without-project (FWOP) conditions and the future-with-project (FWIP) conditions. FWOP conditions were generated through trend analysis and consultation with the local people. This reflected the conditions of IESCs in the absence of the proposed interventions. Changes expected to be brought about due to the proposed interventions were assessed to generate the FWIP conditions. 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.

98. 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 conditions.

99. In addition, hydrological and hydrodynamic model have been setup for the study area to assess the impact of climate change on water availability, salinity intrusion and highest flood level. SWAT (Soil and Water Assessment tool) model has been used for hydrological analysis and Delft 3D model has been utilized for hydrodynamic analysis. Available topography, soil maps, land use maps, weather data, river network, cross-section, water level, discharge and salinity data have been used for modelling exercise.

3.7.1 Impact Quantification and Evaluation

100. 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 such cases, impacts were assessed in qualitative terms, and scores were assigned with plus (+) sign for positive impacts and minus (-) sign for negative impacts. The magnitude of both positive and negative impacts is indicated in a scale of 1 to 10 on extent, magnitude, reversibility, duration and sustainability considerations.

3.7.2 Assessment Methodology

101. 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.

102. 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. The generic criteria for defining magnitude and sensitivity used for the project are summarized below:

Magnitude

103. The assessment of magnitude was undertaken in two steps. Firstly, the key issues associated with the project were categorized as beneficial or adverse. Secondly, the potential impacts were categorized as major, moderate, minor or negligible based on consideration of parameters such as:

- Duration of potential impact
- Spatial extent of potential impact
- Reversibility
- Likelihood, and
- Legal standards and established professional criteria

104. The magnitude of the 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

Parameter	Major	Moderate	Minor	Negligible/Nil
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 to occur

Sensitivity

105. 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. The 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

Assessment of Residual Impacts

106. 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 the residual impacts should be of negligible to low significance. For any residual impacts having moderate significance, a monitoring mechanism is necessary to ensure that their significance does not increase. No residual impacts having major or critical significance are generally acceptable.

3.8 Environmental Management Plan

107. An Environmental Management Plan (EMP) for the proposed project has been prepared suggesting mitigation/ enhancement measures with institutional responsibilities, an environmental monitoring plan, training and capacity building plan, and reporting and documentation protocols.

3.9 EIA Report Preparation

108. At the end of the process, the present report on "Environmental Impact Assessment of Rehabilitation of Polder 43/2B" is prepared incorporating all the findings of the study.

4. Project Description

4.1 Background

109. The Blue Gold Program attempts to provide innovative and effective solutions to increase infrastructure sustainability and stability, and to make the polder effective against emerging challenges of freshwater scarcity, tidal flooding, food security, climate change etc. Capacity building activities are considered an integral component of the project to ensure participatory water resources development involving the community as well as other stakeholders. Furthermore, high quality standards of design and implementation; introduction of participatory working concepts and technical solutions are the salient features of the project.

4.2 Objective

110. The objective of the Blue Gold Program are to:

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

111. The objective of the second component of Blue Gold Program i.e. Water Resources Management in Polder 43/2B is to improve the existing status of water management, through rehabilitation and fine-tuning of infrastructures. In short, the specific objectives of the program are to:

- Improve the embankment stability, enhance peripheral communication and improve protection against tidal storm surge.
- Repair the existing water control structures to allow better control on drainage and flushing, and hence improve agricultural production.
- Conduct re-excavation of khals so as to ensure efficient drainage system as well as irrigation, and rainwater storage to enhance water use.

4.3 Polder Overview

112. Polder 43/2B covers mostly Auliapur, Atharagashia, Amkhola union and some portion of Jainkati, Gazalia, Golkhali union of Galachipa and Patuakhali Sadar upazila, Patuakhali district. The polder was constructed in 1985-87, and was later rehabilitated under the IPSWAM project from 2003 to 2011. The polder is located in the South-Central hydrological region of Bangladesh, with administrative jurisdiction lying within the Barisal O&M Circle of the BWDB, Barisal (Map 1.1). Moreover, in the Polder area, the Water Management Groups (WMGs) under the Water Management Associations (WMAs) are in the process of formation.

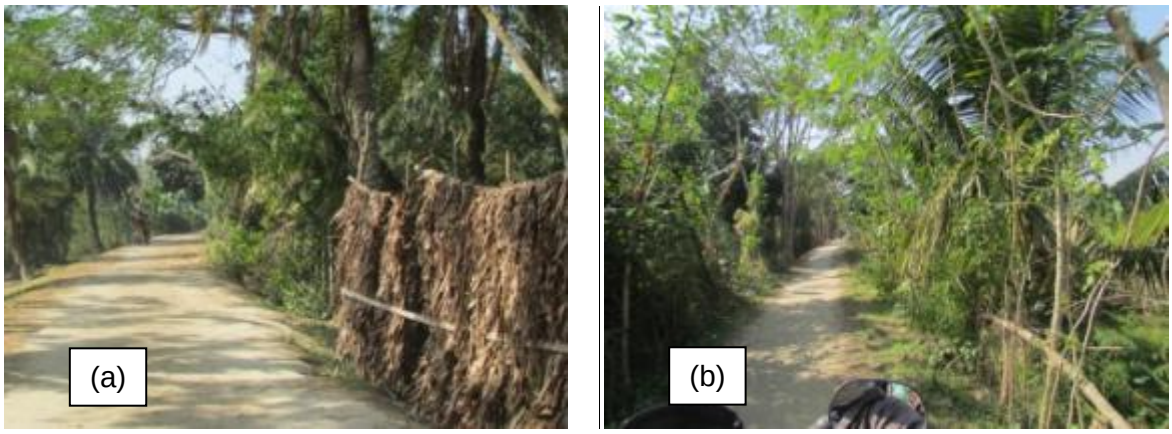
4.4 Water Management Infrastructures

113. Water management infrastructures are the physical interventions which are built to ensure sustainable management and optimal use of water resources. In Polder 43/2B, there

are some typical water management infrastructures i.e. peripheral embankment, sluices, closers, flushing inlets. Based on field investigation carried out in January 2015, the study team compiled the following information regarding the status of existing infrastructure.

Embankment

114. The Embankment is of 39.83 km lengths, with crest width varying from 2.0 m to 4.0 m, and crest levels of around 3.0 m to 4.0 m above Mean Sea Level (MSL). Existing side slopes varies between 2.0 to 3.0 m as hypotenuse in river side and 2.5 m to 3.0 m in country side, with sufficient setback distance (around 50 m to 120m). But around 500 m embankment near Dari Baher Char does not have any setback distance due to erosion. The existing situation of embankment is good at most locations and, offer protection against tidal and storm surges and salinity intrusion. However, the transportation facility of the embankment was found very poor. A significant portion of the peripheral embankment is unpaved, which restrict vehicular movements. The local people opined that during wet season the unpaved portion of embankment surface becomes slippery and unsuitable for vehicular movements. Overall, at several points degradation of the embankment is rather visible and vehicular movements are at stake in these stretches.



*(**a**) unpaved road surface over embankment of the Polder at Jainkathi, (**b**) unpaved road surface at Bauria Union*

Photo 4.1: Existing Status of Embankments

Water Control Structures and Culverts

115. There are 6 drainage sluices, 20 closers and 39 flushing inlets constructed by BWDB. These structures need repairing as almost all of these are not functioning upto the desired level. A number of gates can not be operated properly due to damage of the wheels and shafts which are used to elevate gates. Some of the gates were found to be tied with ropes and logs, and local people opined that around 10 people are required to uplift such a damaged gate manually. During field investigation it was found that, Musurikati sluice covered with fishing net, which interrupt normal flow of the channel. Functionally, the drainage outlets cannot drain out water properly after heavy rainfall, especially during post monsoon. The sluice gates are not able to provide full protection against salinity intrusion. There are also mismanagement issues regarding the water control structures. There are some structures which have attached fishing nets, for which the natural flow is often hampered. Some routine works and practices (establishment of navigation ghats, construction of shops or houses near the gates etc.) of the local people also harm the structural condition of the gates.

116. During field visit (January 2015), the study team found that most of the existing sluice gates and outlets have been subjected to structural damage in recent years and are not maintained properly by the local people. Among these the sluice gate at Nasaisil was found to have severe damage, as the flap gate underneath cannot be operated mechanically because there is no wheels and shafts. The gate of the sluice needs to be replaced and a new hoisting system has to be installed.

117. The structures at Musurikati, Bauria, Badura, Masuakhali and Amkhola were also found functionally damaged; with severe mismanagement issues observed at some locations such as using fishing net, rope etc. The hoisting system needs reinstallation for most of them. From field investigation it is found that, the gate openings at Badura and Musurikati sluices are to be cleaned from debris as well as water hyacinths which hamper natural flow through the structures. The other water control structures were found with more or less limitations in functionality.

(a) *Amkhola sluice with almost decent operation and functionalities, (**b**) Bauria sluice need to be repaired as there is no proper management water controlling structures, (**c**) Musurikati sluice requiring proper management as local people cover it with fishing net, (**d**) Opening of Badura sluice covered by uncontrolled existence of water hyacinths*

Photo 4.2: Existing Status of Sluice Gates

4.5 Present Status of Drainage Khals

118. The total length of the drainage channel inside the polder is around 136 km. Topsoil erosion, and other land filling activities have resulted in gradual decrease of water courses within the polder over the years. Some of the khals of the polder (Bauria Khal, Badrar Khal, Bangrar Khal, Karimjatala Khal, Ostakhali Khal, Sobaram Khal, Kalabunia Khal, etc.) have become very narrow (as low as 5 feet wide) at some locations. Most of the khals were found in low flow condition, during the field investigation in January 2015. The hydrological connectivity was found disrupted at some locations where water from low lying lands does not carry into the khals, a situation which generates drainage congestion. Furthermore, following heavy rainfall, local people have to pump out water from their own areas into the adjacent drainage khals.

Photo 4.3: Masuakhali Khal with low flow condition within the polder

4.6 Problems and Issues in the Polder

119. During the field work a number of prominent problems and issues were observed by the study team. Local people claimed that the most severe problem within the area is the poor peripheral communication system. There is a number of breaches along the peripheral embankment (500 m continuous breach at Dari Baherchar, 200 m discrete breach at Jainkathi and around 300 m discrete breach at Bauria) which are tremendously hampering the communication system. Apart from that, poor water resources management, marked by the low maintenance and improper use of water management infrastructures (sluice gates, outlets and inlets) is another major issue. The siltation of khals is another problem, which results in low water availability for irrigation.

4.7 Proposed Interventions in Polder 43/2B

120. Considering the status of existing infrastructures, and the problems resulting from their damaged state, the Blue Gold Program has planned the following categories of interventions in Polder 43/2B. The locations of interventions have also been shown in Map 4.1.

4.8 Re-sectioning of Embankment

121. Re-sectioning works along the peripheral embankment is proposed to be carried out in some locations where they are damaged. The proposed crest width along the entire chainage is 4.27 m, with side slopes of 1(V): 2(H) on country sides, and 1(V): 3(H) at R/S. The design elevation of the crest of the embankment is at 4.27 m, PWD.

4.9 Repairing of Water Control Structures

122. All existing drainage/ flushing sluices, irrigation inlets and drainage outlets of BWDB within the polder will be repaired. Some sluices would require new shafts and wheels, whereas some would require replacements of barrels and gates. The drainage outlets and

irrigation inlets would also require repairing. The sizes of each vent for all the sluices are 1.5m x 1.8m. Details of the proposed interventions to be undertaken are presented in Table 4.1 and Table 4.2.

Table 4.1: Detail information on proposed repairing of Drainage/ Flushing Sluices

Sl. No.	Local name of sluice	Number of vent	Vent size (m)	Chainage (km)
1	Musurikati Sluice	2-V	1.5 ×1.8	0+000
2	Bauria Sluice	2-V	1.5 ×1.8	4+150
3	Nasaisil Sluice	2-V	1.5 ×1.8	14+900
4	Badura Sluice	2-V	1.5 ×1.8	19+950
5	Masuakhali Sluice	1-V	1.5 ×1.8	25+200
6	Amkhola Sluice	2-V	1.5 ×1.8	36+970

Source: Blue Gold Program Office, 2015

Table 4.2: Detail information on proposed Repairing of Irrigation Inlets

Sl. No.	Local Name of Inlets	Size (mm)	Location
1	Suhri	300	East side of Noshu Mirdha's house
2	Suhri	600	Beside the House of Mosharraf Hosain
3	Suhri	300	Beside the House of Latif Khan
4	Bouria Chariani	300	Near the House of Jalil Chowkidar
5	Bouria	450	Beside the House of Zakir Hossain
6	Bouria Chariani	600	Beside the House of Rajamia Hawladar
7	Sonakhali	450	Near the House of Abdur Rob Mirdha
8	Purba Sonakhali	600	South side of Sobhan Khan's House
9	Sonakhali	450	West side of Razzaque Mirdha's House
10	Purba Sonakhali	450	Beside the House of Shahjahan para
11	Sonakhali	450	North side of Secondary Molla's House
12	Algi	450	North side of Kadir Hawladar's House
13	Algi	450	East Side of Mofez Member's House
14	Near Munshir Hat	450	North Side of Talukdar's House
15	Gerabunia	450	Beside the House of Badal Molla
16	Soilabunia	600	South Side of Siddique Khan's House
17	Soilabunia	450	South Side of Ismail Talukdar's House
18	Soilabunia	450	South Side of Dholu Gazi's House
19	Soilabunia	450	East side of Delowar Chowkidar's House
20	Soilabunia	600	Beside the House of Salam Hawladar
21	Soilabunia	450	South side of Milon Hawladar's house
22	Soilabunia	450	Beside the House of Bashar Munshi
23	Badura	450	Near the Badura Hat Kaumi Madrasa
24	Badura	450	South side of Selim Hawladar's House
25	Badura	450	Beside the House of Nuru Hawladar
26	Badura	600	North side of Chawkidar's House
27	Badura	450	Beside the House of Jahangir Mirdha
28	Badura	450	Beside the House of Rahman Chowkidar
29	Boloikati	450	South side of Abdul Mannan Maulana

Sl. No.	Local Name of Inlets	Size (mm)	Location
30	Boloikati	450	North side of Belayet Hossain Master's House
31	Boloikati	450	Beside the House of Al Islam
32	Boloikati	450	West side of Rari Bari Masjid
33	Chinguria	600	Beside the Chinguria primary school
34	Chinguria	450	West side of Moslem Biswas House
35	Uttar Amkhola	450	East side of Sohrab Shikdar's House
36	Baherchar	450	North side of Ismail Hawladar's House
37	Dari Baherchar	450	Beside the House of Raja Chowkidar
38	Dari Baherchar	450	South side of Nuruzzaman House
39	Dari Baherchar	450	South of Mozaffar Hawladar's House
40	Dari Baherchar	450	Chinage 35+194 km
41	Dari Baherchar	450	East side of Rashid Biswas's House
42	Dari Baherchar	300	South side of Shah Alam's House
43	Amkhola Bazar	450	Beside the House of Khaled Mia
44	Bhangra	450	Beside the House of Salam Hawladar
45	Mashurikati	600	East Side of Late Hashem Gazi House
46	Mashurikati Sluice	450	East of Late Hazi Afaz Uddin's House

Source: Blue Gold Program Office, 2015

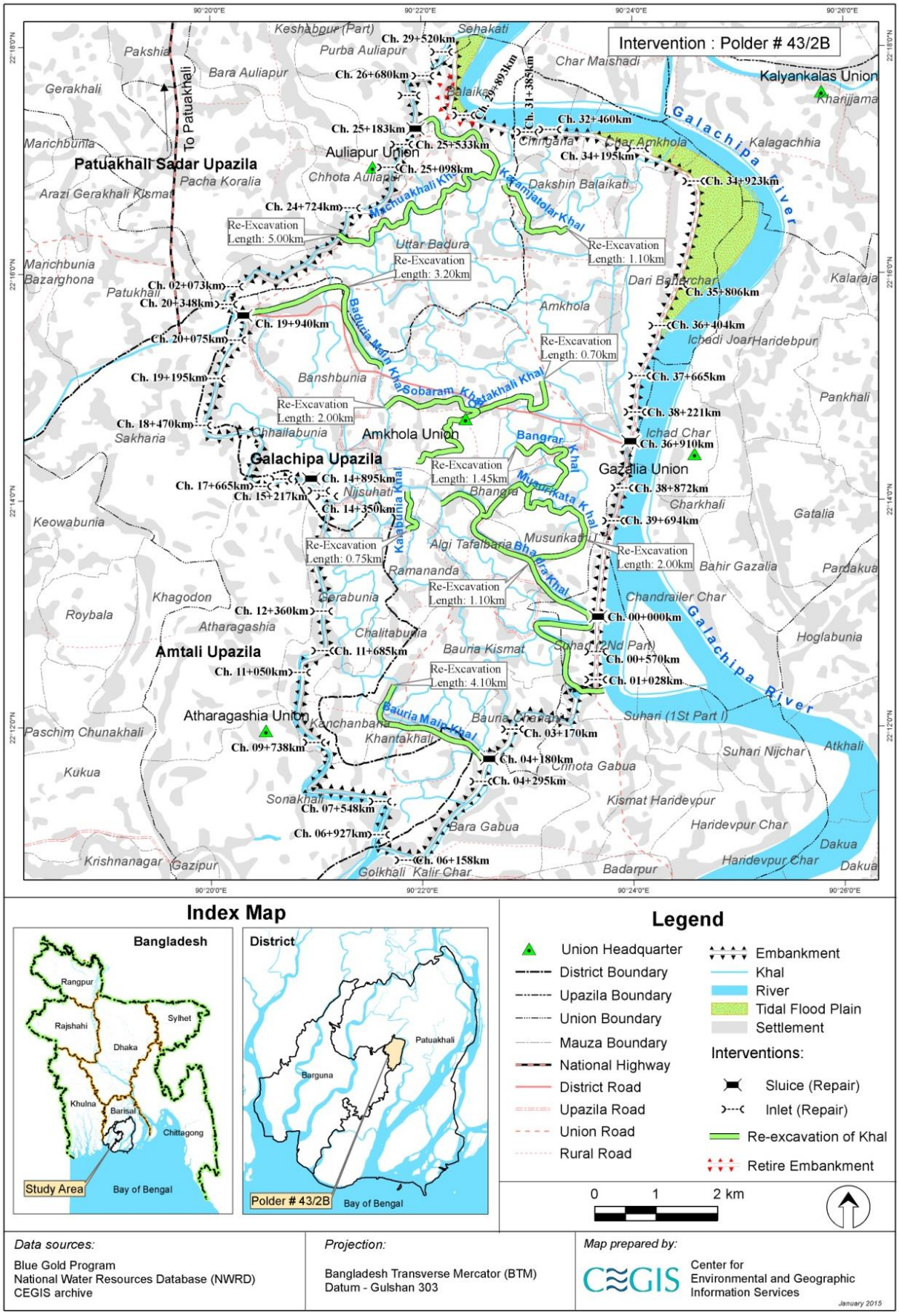
4.10 Khal Re-excavation

123. A total number of 13 khals are under the re-excavation plan of the Blue Gold program in polder 43/2B. The total length to be re-excavated is around 26.9 km. The names of the proposed khals with lengths to be re-excavated are shown in Table 4.3.

Table 4.3: Detail information on proposed re-excavation of Khals

Sl. No.	Name of khals	Approximate length (km)
1	Bauria Khal	4.10
2	Badrar Khal	1.10
3	Bangrar Khal	1.45
4	Karmjatala Khal	1.10
5	Ostakhali Khal	0.70
6	Sobaram Khal	2.00
7	Kalabunia Khal	0.75
8	Badura Khal	3.20
9	Masuakhali Main Khal	5.00
10	Musurikati Khal	2.00
11	Bastalar Khal	1.50
12	Tulabaria Khal	2.00
13	Luhit bari Khal	2.00

Source: Blue Gold Program Office, 2015



Map 4.1: Proposed Intervention Map of Polder 43/2B

4.11 Details of Construction

124. The following sections provide a comprehensive discussion on the detail activities, construction schedule, manpower and material requirement and construction camps as well.

4.11.1 Description of Activities

Re-sectioning of Embankment

125. After validating the final design, soil will be excavated or carried earth will be brought and 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 fertilization will also be ensured. The earth required for re-sectioning of the embankment will mainly be collected from the borrow pit of the Polder. Dredging spoils from re-excavation of drainage channels will also be used for the re-sectioning of embankment.

Repairing of Drainage/ Flushing Sluices and Outlets

126. Before starting the repairing of drainage sluices, *Ring bundh* and diversion channel will have to be constructed as required. Approach roads, fitting and fixing of gates will be implemented as needed and hoisting devices will be carried out afterwards. The intake and outfall of the gate will be constructed as per design.

Repairing of Irrigation Inlets

127. A suitable site for storage of construction material will be selected and prepared accordingly. Alternative diversion channels will be constructed before the starting of construction works. 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 ensure the flow to be channeled through the flushing gate.

Re-excavation of khals

128. At first the required tools will have to be procured for re-excavation of the drainage channels. A schematic diagram showing centerline 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 start 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 required depth and width. The excavated soil/ sludge should be disposed along the sides of khals. Proper compaction would be made on khal banks, and after finalizing the 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. To summarize, a list of activities under each phase is shown in Figure 4.1 below.

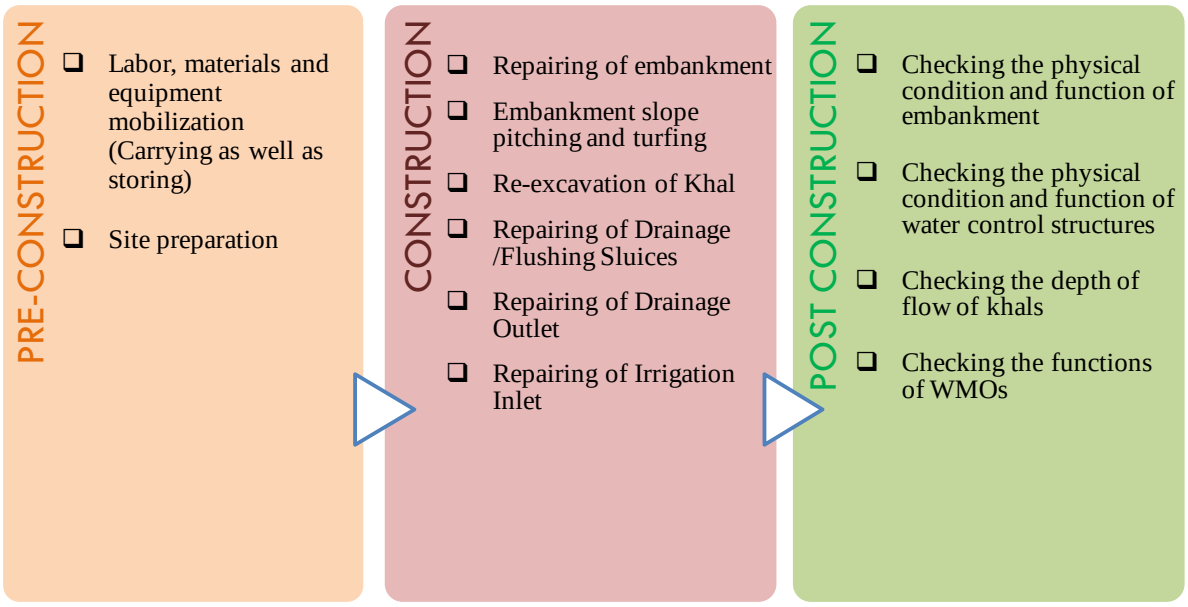


Figure 4.1: Phase wise list of activities in Polder 43/2B

4.11.2 Construction Schedule

129. 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 during the entire year. The interventions proposed in Polder 43/2B are likely to be completed by June 2016.

Table 4.4: Construction Schedule in Polder 43/2B

Key Activities	2014				2015				2016			
	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's Functionality						▬	▬	▬	▬			
Strengthening/ capacity building of WMO based on the outcome of Assessment						▬	▬	▬	▬			
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)							▬	▬	▬	▬		

Key Activities	2014				2015				2016			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Implementation of Water Management fine tuning works with active participation of the WMOs												

Source: Inception Report 2013, Blue Gold Program and CEGIS field investigations 2015.

4.11.3 Materials Requirement

130. The construction materials required for re-sectioning and retired embankment, water regulators and flushing inlets, and bank protection work will include soil, cement, steel, and sand. Estimated quantities of these materials are presented in Table 4.5 below.

Table 4.5: Construction Materials Requirement in Polder 43/2B

Sl	Description	Quantity	Sources
Re-sectioning of embankment			
1	Materials for Earthwork	100,000 m^3	From the set back location and other khas lands
2	Hoe (or Shovel) and Baskets	300 nos. each	To be procured
3	Compactor	40 nos.	To be procured
Repairing of sluices and flushing inlets			
4	Lift Gate	2 (1.5 m x 1.8 m)	To be procured
5	Flap Gate	2 (1.5 m x 1.8 m)	To be procured
6	Barrel	2 (1.5 m x 1.8 m)	To be procured
7	Pipe	4 (dia: 0.45 m and 0.60)	To be procured
8	Wheel and Shaft	4 sets	To be procured
9	Materials for Plastering, Slope Filling, Railing and other repairing works	As per requirement	To be procured

Source: CEGIS Estimation, 2015

4.11.4 Manpower Requirement

131. Technical and nontechnical manpower will be required for the construction works. This will include engineers, technicians, supervisors, surveyors, mechanics, foremen, machinery operators, drivers, skill and un-skilled labors. The implementation of the project would be carried out by both LCS (Landless Contracting Society) and Contractors, on 50-50 basis. Several LCS will be engaged under the 14 existing WMGs, each involving 60 members, to carry out the construction works of Polder 43/2B. Of all the LCS that will be engaged in the construction works, 60% will be male and 40% female, all from the local area.

4.11.5 Construction Camps and Labor Shed

132. The project works will be carried out by the local people, and therefore no labor shed would be required. Laborers will come from their respective houses and will return back home after working at project sites.

4.12 Project Management and Implementation

133. The project will be implemented in a participatory manner, ensuring local community's 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 43/2B are discussed in the following sections.

4.13 Community Participation through WMO/ CBO

134. To ensure sustainable operation of the project, participation of Water Management Organization (WMO) and Community Based Organizations (CBOs) will be of crucial importance. 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 federation are termed as the Water Management Organizations (WMOs) in the context of this project. During the field visit in January 2015, the study team observed that formation of WMGs and WMAs were in the process. The Following CBOs within locally formed WMGs have been recommended for this polder under Blue Gold Program.

Water Management Committee (WMC)

135. For operation of water control structures i.e. irrigation inlets, drainage outlets and drainage sluices a separate group would be acting locally, termed as Water Management Committee (WMC). The responsibilities of maintaining water control structures at their best condition are vested on the WMCs. Each WMC would comprise of 5 to 11 members, depending on the significance of the intervention.

Landless Contracting Society (LCS)

136. LCSs are groups of selected landless people. On average each LCS will have approximately 60 members. They are responsible to carryout earthworks under a single contract. During formation of LCS and other CBOs women participation will have to be ensured.

4.14 Operation and Maintenance Plan

137. The Polder 43/2B, since its construction has been playing a vital role in safeguarding the empoldered area, enhancing agricultural production, improving livelihoods, and mitigating environmental damages. However, the area remains vulnerable to storm surges, tidal flooding, river bank erosion; drainage congestion etc. As it was observed, some of the structures within the area were not adequate to cater the multiple needs of local people. Changes in land use pattern also created social disputes at some places and newer dimensions for the existing structures were proposed as such, to allow flows of water both ways. Therefore, maintaining the polder system with embankments and structural elements built and rehabilitated over there has become a permanently 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 43/2B has been proposed.

4.15 Operational Plan

138. Operational plan involves setting out the schedule of activities related to operation of gates and other structures by the users' organization to control water levels best suited to water management and agricultural needs. The following activities are recommended for the operation of water control structures of Polder 43/2B.

Regulation of Gates

139. In the past BWDB employed the Gate Operators from its own; but due to budget cuts this position has been discontinued. Currently the responsibilities of gate operation are given to beneficiaries in the polders where agricultural activities are of main concern.

140. During the pre-monsoon period (March to May), the gates of each sluice should remain closed for retention of water for irrigation and other use. During monsoon (July to September), the vertical lift gates should normally remain closed, but may be opened to drain out water from the polder if required. In addition to that, the gates should also remain open during May to June, which is considered as the pick period for fish breeding, migration of brood fish and offspring. During the 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 carried out with beneficiaries of all occupational groups i.e. farmer, fisher, fish farmer etc because agricultural practices, crop varieties; and cropping pattern, fish spawning and migration changes with over time.

141. Operation of flushing sluices and inlets should also undergo similar practices with maximum involvements of different beneficiary organizations. The O&M section, WMOs and BWDB staff will assist local stakeholders in effective management of water inside the polder.

Frequent Monitoring of Embankments and Structures

142. 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 to flap gates, fall boards, sign of squatter settlements, cuts in the embankments to accommodate homesteads, embankment subsidence and erosion, and settlement of protection works. The functional WMOs in the polder will assist in the problem detection process.

Supervision of Preventive Maintenance Works

143. 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.

4.16 Maintenance Plan

144. Maintenance of embankments and structures is necessary because it helps keeping the infrastructure in good and functional condition so as to protect investments, and prevent high rehabilitation costs. Under the ‘component II’ of Blue Gold program in Polder 43/2B, only those works which directly serve water management should be regularly maintained.

Preventive or Routine Maintenance

145. 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 and small earthworks on the embankment.
- Cleaning, greasing, and painting of structures ; and
- Cleaning of khals and outfall drains.

Periodic Maintenance

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

147. 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 structures by LCSs i.e. small patching of brick works, replacing rubber seals;
- Re-excavation of Khals and removal of earthen cross dams by LCSs.

148. Major Periodic Maintenance Works

- Major earth works by LCSs and contractors i.e. re-sectioning of embankments including turfing;
- Major repair of structures by LCS and contractors 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

149. Emergency works cover unforeseen interventions that 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 which would require immediate attention includes the closure of an embankment breach, repair and replacement of flap gates, and construction of cross dams over canals if structure fails.

4.17 Project Cost

150. As per the approved Development Project Proforma (DPP) of the Blue Gold Program, the project cost for implementation of fine-tuning works in Polder 43/2B has been estimated as 100 € per hectare. According to that rate, the total project cost is 57000 € i.e. BDT 4.95 crore (1€ =89 Taka, on 6 September, 2015).

4.18 Expected Benefits and Outcome

151. The foreseeable benefits which are likely to occur due to the implementation of Blue Gold program in Polder 43/2B are listed in Table 4.6 below.

Table 4.6: Expected benefits and outcome of proposed interventions

Interventions	Benefits
Re-sectioning of Embankment	✓ Providing continued protection of tidal flooding. ✓ Protection against the adverse effect of salinity intrusion. ✓ Embankment stability will be enhanced by the increased side slopes. ✓ Communication facilities may improve.
Repairing of Water control structures	✓ Sluices will functional properly, agricultural activities during dry and pre-monsoon seasons may be improved. ✓ Drainage situation would improve; salt water intrusion may be prevented.
Re-excavation of Khals	✓ 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 boost up.

4.19 No Objection Certificate

152. There are no archeological sites or any cultural heritage in the polder area that 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 structures. The No Objection Certificates (NOCs) from the union chairmen have been obtained and are attached in **Appendix-2**.

5. Environmental Baseline

153. The existing environmental and social baseline condition of the study area was established for the ESIA study of the Blue Gold Program by collecting data from secondary and primary sources. RRAs, FGDs, KIIs and other public consultation methods were used for collecting primary data whereas secondary data were collected from different sources like Bangladesh Bureau of Statistics (BBS), Bangladesh Water Development Board (BWDB), Water Resources Planning Organization (WARPO), Soil Resources Development Institute (SRDI), Bangladesh Meteorology Department (BMD), Department of Agricultural Extension (DAE), Department of Fisheries (DoF) and International Union for Conservation of Nature (IUCN).

5.1 Physical Environment

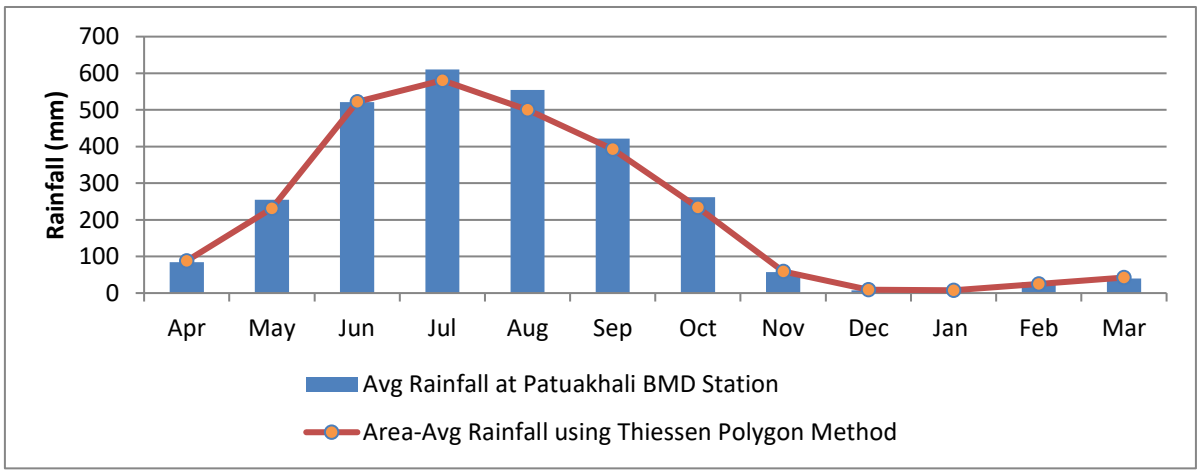
154. The physical environment of the study includes information on meteorology, sound quality, water quality, seismicity and topography. The physical environment within the polder area is briefly discussed in the following sub-sections:

5.1.1 Meteorology

155. This section provides an analysis on meteorological parameters (temperature, rainfall, wind speed and humidity) of the polder area, based on the data collected from Patuakhali station of Bangladesh Meteorological Division (BMD).

Rainfall

156. The average monthly rainfall variation at Patuakhali BMD station (from 1973 to 2014) is shown in Figure 5.1. The hyetograph shows that the highest and lowest values of rainfall are observed during the months of July (610 mm) and December (7.6 mm) respectively. For higher accuracy, a separate area-averaged hyetograph was also determined using Thiessen's polygon method, considering the rainfall stations of Bangladesh Water Development Board (BWDB) (Figure 5.1). Rainfall values obtained by using Thiessen's polygon method are almost identical to the BMD stations' monthly average values.

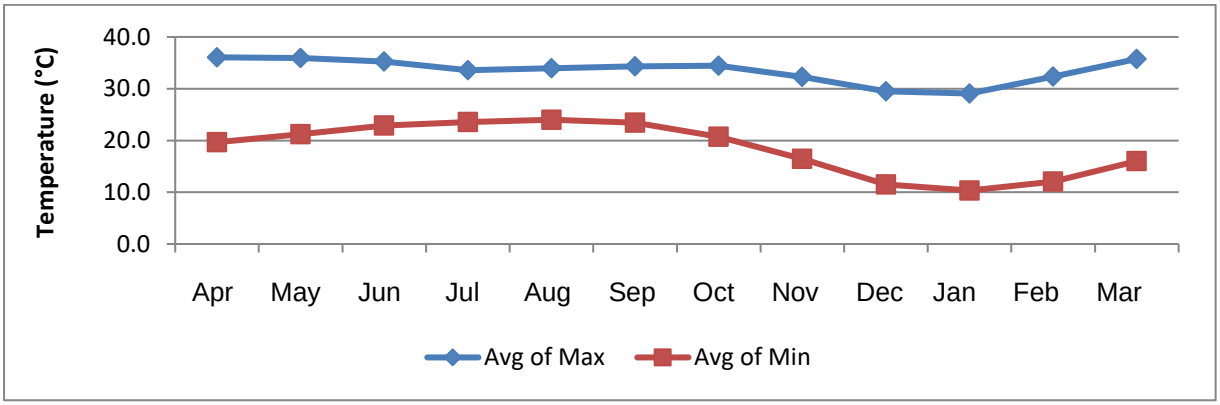


Source: BMD, 2014 and BWD, 2014B

Figure 5.1: Average monthly rainfall at Polder 43/2B

Temperature

157. Figure 5.2 below shows the variations of average maximum and average minimum temperatures at the Patuakhali BMD station (from 1973 to 2013). The average maximum temperature values range from around 29°C (January) to around 36°C (April). Significant fluctuations in average minimum temperatures have been found, which varies from 10.3°C (January) to 24°C (August).

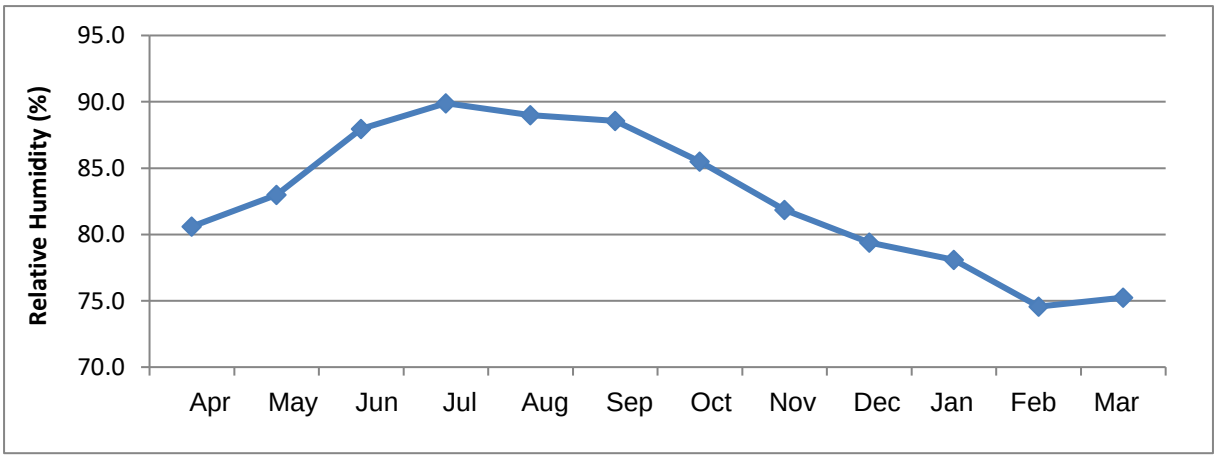


Source: BMD, 2014

Figure 5.2: Average of maximum and minimum temparature at Patuakhali BMD station

Relative Humidity

158. Figure 5.3 below shows the variation of monthly relative humidity, as recorded by the Patuakhali BMD station (1973-2013). Significant fluctuation is 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. An increasing trend is observed from April to July, after which a decreasing pattern is found.

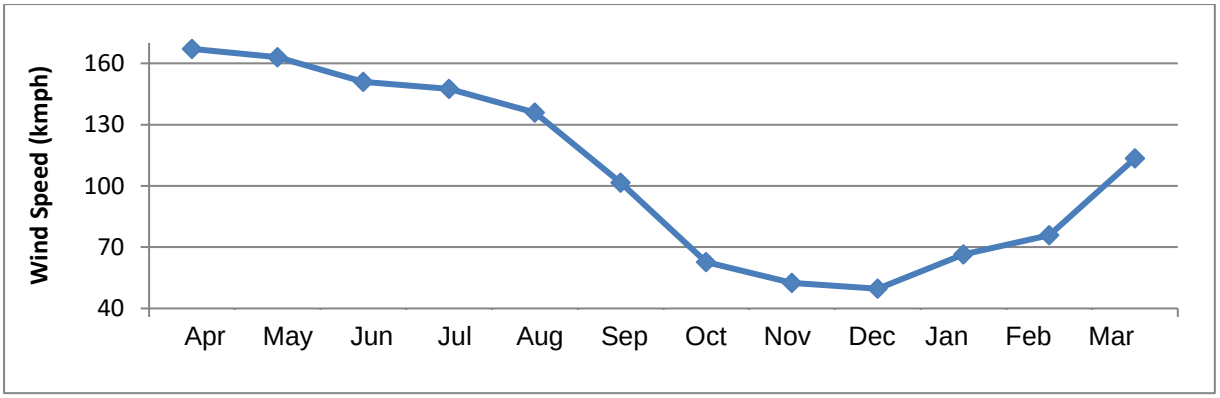


Source: BMD, 2014

Figure 5.3: Average relative humidity at Patuakhali BMD station

Wind speed

159. Figure 5.4 below shows the distribution of average monthly wind speed at Patuakhali BMD station (from 1973 to 2013). Wind speed is the highest in April (around 167 kph) and the lowest in December (around 49.7 kph). During cyclone SIDR (2007) and AILA (2009), 1 minute sustained wind speeds were recorded as 260 kph and 120 kph respectively. SIDR caused more damage due to its high wind speed.

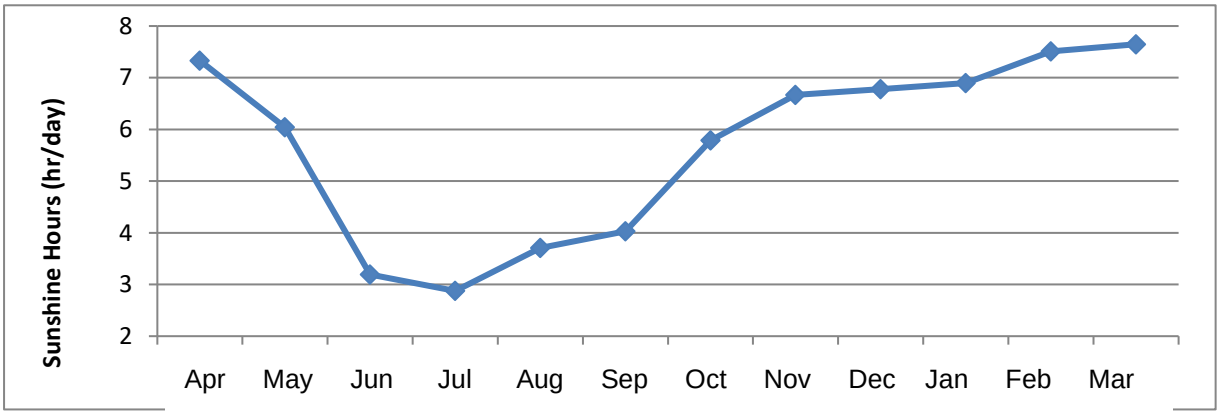


Source: BMD, 2014

Figure 5.4: Variation of average wind speed at Patuakhali BMD station

Sunshine Hour

160. Figure 5.5 presents the monthly variation of sunshine hours. The figure shows an increasing trend from August to March. Maximum sunshine hour is found in March (7.65 hrs/ day). However, a decreasing trend is observed from April to July. Sunshine hours were very low in June (3.2 hrs/ day) and July (2.9 hrs/ day) due to the presence of monsoon cloud.

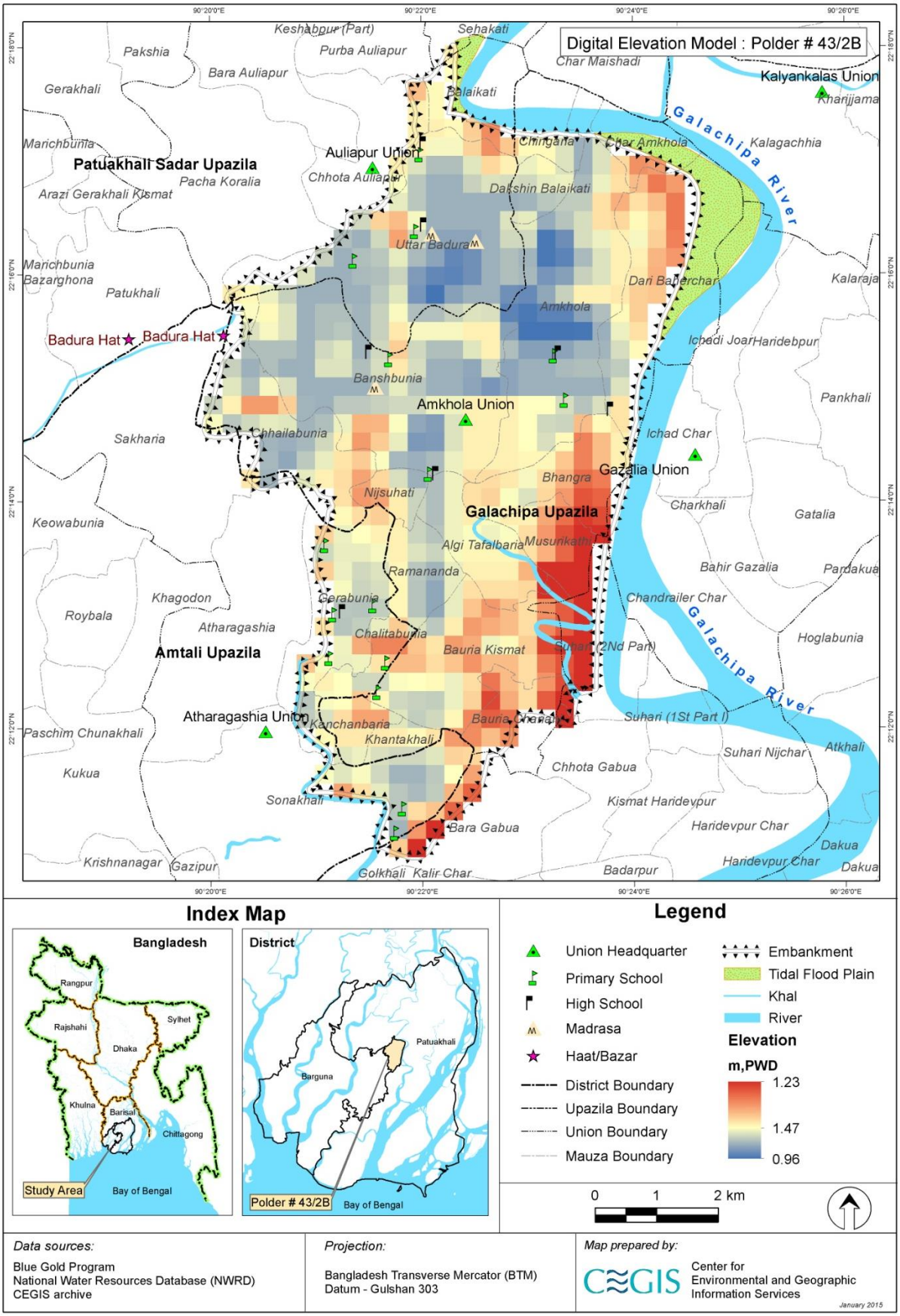


Source: BMD, 2014

Figure 5.5: Monthly variation of average sunshine hours at Patuakhali BMD station

5.1.2 Topography

161. From topographic analysis using the Digital Elevation Model (DEM) concept it has been found that the Reduced Levels (RLs) inside the polder are low, varying from 0.96 to 2.23 m, PWD (a surface which is 0.46 m below the Mean Sea Level), with average elevations of around +1.60 m, PWD. The ground level of the entire polder is higher than the low tidal water levels observed in Mirjaganj (Payra River). The DEM analysis also indicates that the peripheral locations are slightly higher than most of the inner portions of the polder. Map 5.1 shows the topography of the study area, identifying the rivers and water bodies as well as categorizing land elevations.



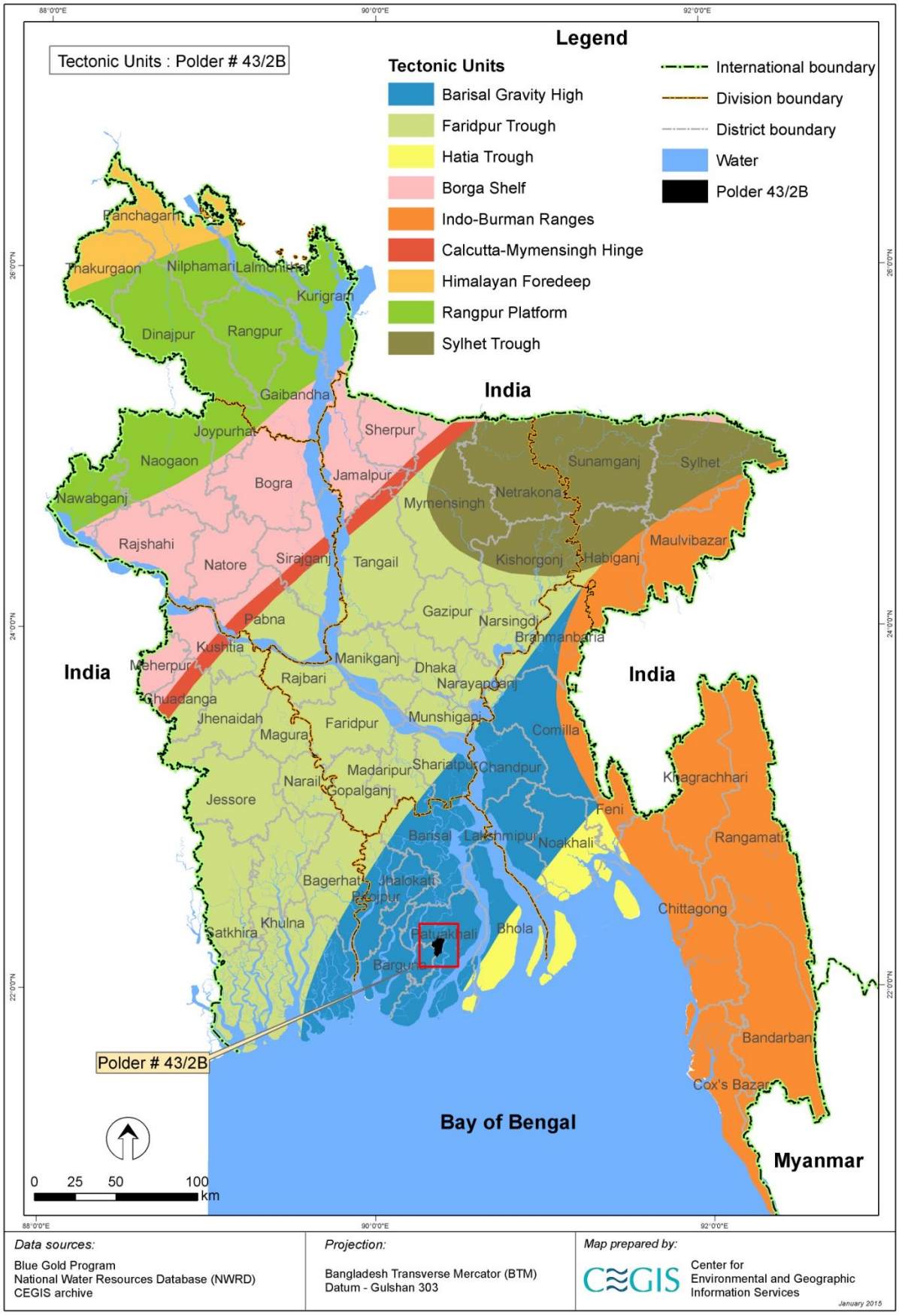
Map 5.1: Digital Elevation Model (DEM) around Polder 43/2B

5.1.3 Seismicity

162. Polder 43/2B falls under *Zone-III* seismic zone, which is a seismically quiet zone with seismic zone coefficient of 0.04. Seismic zone coefficient is a dimensionless number which represents the maximum earthquake acceleration as a fraction of the acceleration due to gravity. Map 5.2 shows the seismic location of Polder 43/2B.

163. Map 5.3 presents the tectonic units available in Bangladesh and the location of Polder 43/2B. The map shows that the polder is located in the Barisal Gravity High tectonic unit. The 60 km wide zone is located between the Faridpur trough and Hatiya trough of the Bengal Foredeep, and is relatively stable. It can therefore be concluded that both in consideration of seismicity and stratigraphy, Polder 43/2B falls on a relatively safer (seismically quiet and tectonically stable) side.

Map 5.2: Earthquake zones of Bangladesh and location of Polder 43/2B



Map 5.3: Map of tectonic units of the polder area

5.1.4 Agro-ecological Zone

164. Thirty agro-ecological zones (AEZ) and 88 sub-zones have been identified by adding successive layers of information on the physical environment which are relevant for land use and assessing agricultural potential. The polder 43/2B area is in the Ganges Tidal Flood Plain (AEZ-13). These layers are:

- Physiography (land forms and parent materials)
- Soils
- Depth and duration of seasonal flooding and
- Agro-climatology [It comprises four elements: length of kharif and rabi growing seasons, length of pre-kharif transition period, number of days below certain critical winter temperatures (<15^{0}C) and number of days with extremely high summer temperature (>40^{0}C)].

Ganges Tidal Floodplain AEZ-13

165. This region occupies an extensive area of tidal floodplain land in the south-west of the country. The greater part of this region has smooth relief having large area of salinity. There is general 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 soils also occupy significant part of the area where it is very strongly acidic during dry season.

5.1.5 Land type

166. Land type is a system of classifying cultivated land based on the seasonal inundation depth in normal flooding year. According to Soil Resource Development Institute (SRDI, 1988), five land types (High land, Medium highland, Medium lowland, Lowland and Very lowland) have been classified in terms of depth of flooding on agriculture land. The entire polder area is under medium highland (F1) which is normally flooded between a depth of 0 to 90 cm continuously for more than two weeks to few months during the monsoon season.

5.1.6 Physico- chemical properties of soil

In general, most of the top soils are acidic and sub-soils are neutral to slightly alkaline. Soils of the Sundarbans area are alkaline. General fertility level is high with low to medium organic matter content and very high Cation Exchange Capacity (CEC) and Potasium (K) status. There are limitations of high exchangeable Sodium (Na) and low Calsium/Magnesium (Ca / Mg) ratio. The Zinc (Zn) status is low to medium and the Boron (B) and Sulphur (S) status is medium to optimum.

Table 5.1: Some Physico Chemical Properties of Soils of AEZ-13

Major Land Type	Soil pH	Soil OM	Nutrients Status								
			N	P	K	S	Ca	Mg	Zn	B	Mo
Medium highland 78%)	4.5-8.4	L-M	L	VL-L	M-Opt	M-Opt	Opt-H	M-Opt	L-M	M-Opt	Opt

OM=Organic matter; VL=Very low; L=Low; M=Medium; Opt=Optimum;

Source: Fertilizer Recommendation Guide - 2012, BARC.

5.1.7 Soil fertility

167. Soil sample were collected from three locations in three depths (0-10 cm, 10-20 cm and 20-30 cm) inside the polder area in the month of January, 2015. Collected soil samples

were analyzed by Soil Resource Development Institute (SRDI), Dhaka. Results of the analysis are presented in the Table 5.2.

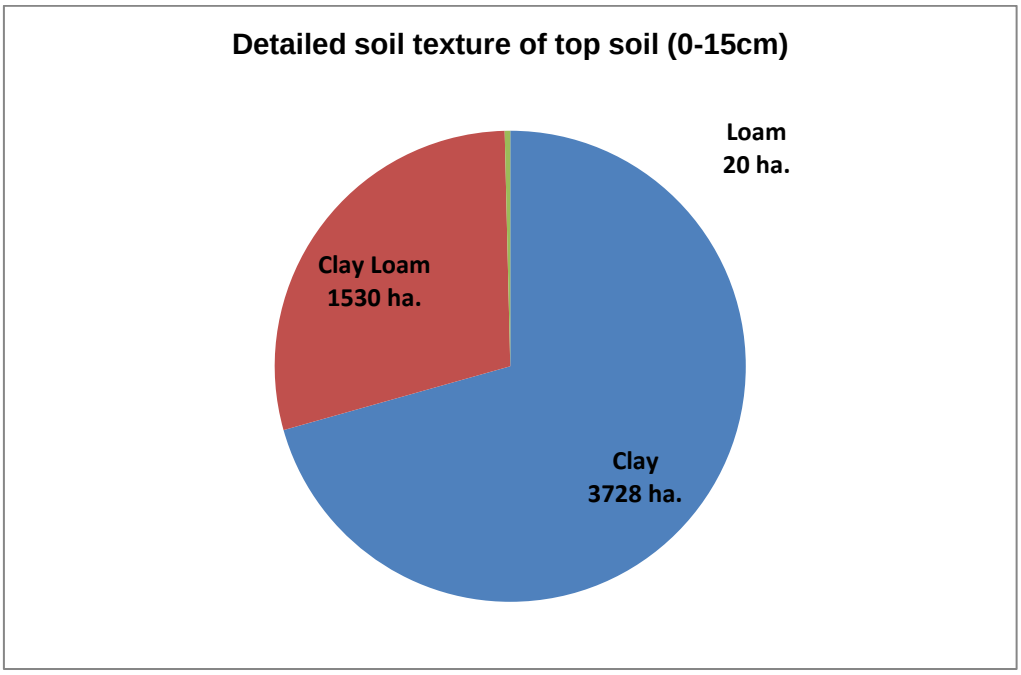
Table 5.2: Chemical properties of soil on agriculture land

Number of the polder	Location	GPS reading	Depth (cm)	EC	pH	OM	N	K	P	S
						%		Meq/ 100g	µg/gm	
43/2B	Bauria Kismat	E-90°22" 14′15″ N-22° 13" 8′18″	0-10	1.57	6.0	1.81	0.10	0.26	7.01	110.60
			10-20	0.77	7.2	1.03	0.06	0.20	13.20	50.44
			20-30	0.73	7.8	1.09	0.06	0.15	4.06	40.42
	Midda Amkhola	E-90°21" 58'67″ N-22° 15" 5′05″	0-10	5.94	4.8	3.71	0.18	0.14	5.11	143.00
			10-20	1.11	6.2	1.45	0.08	0.09	4.59	150.10
			20-30	1.16	6.5	0.52	0.03	0.08	3.56	149.00
	Dakshin Balakatia	E-90°22"52'3′95″ N-22° 16" 34′63″	0-10	0.69	5.6	1.04	0.06	0.10	10.61	157.53
			10-20	0.49	6.5	1.04	0.06	0.13	6.72	146.73
			20-30	0.45	7..2	1.09	0.06	0.13	2.78	142.92

Source: SRDI laboratory analysis, 2015

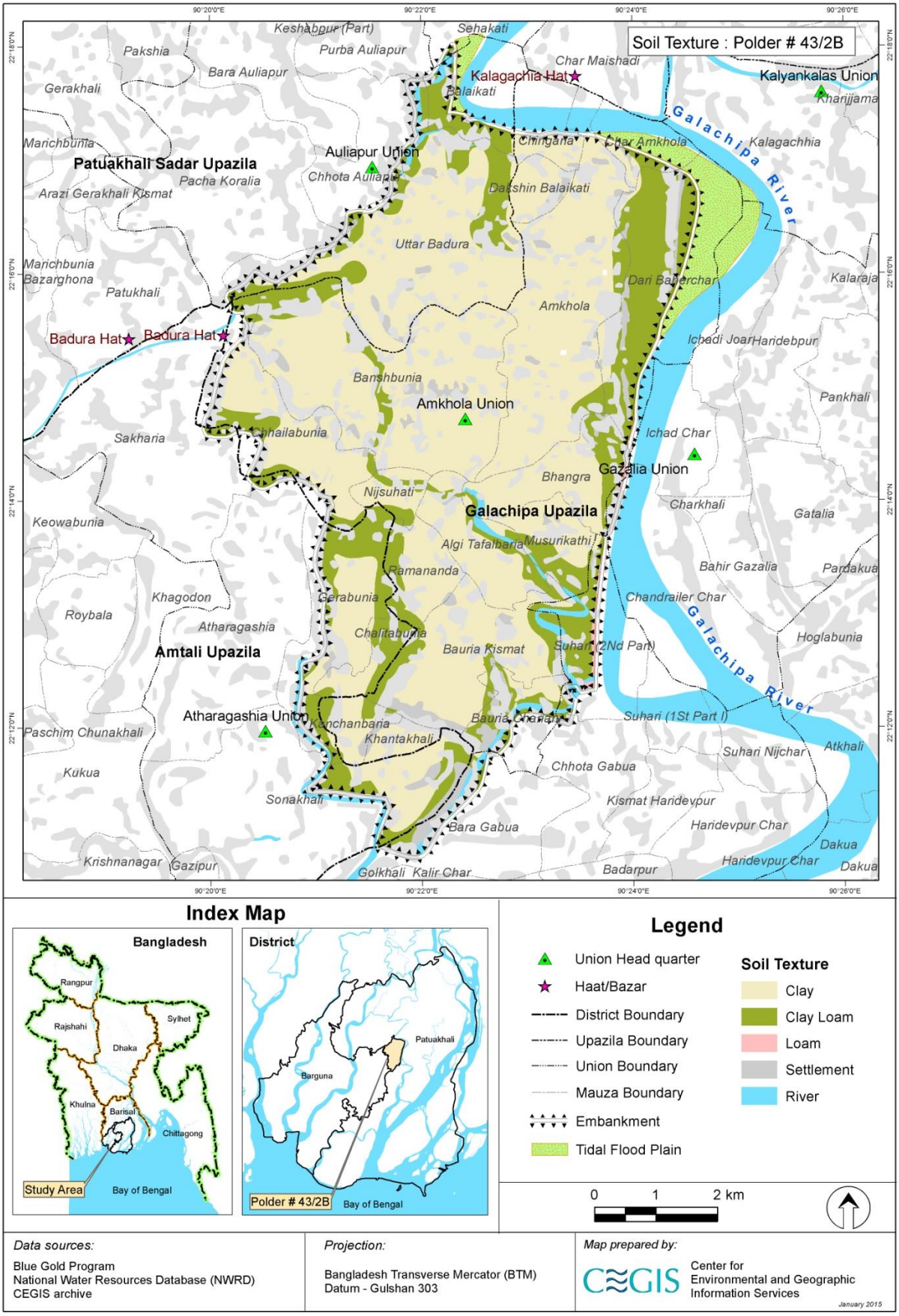
5.1.8 Soil texture

168. Soil texture is the relative proportions of sand, silt and clay. Soil texture is an important soil characteristic that guides crop selection, crop production and also field management. Soil can be classified as one of four major textural classes: a) sands b) silts c) loams and d) clays. Detailed distribution of soil texture is presented in Figure 5.6 and Map 5.4.



Source: CEGIS estimation from SOLARIS-SRDI, 2006

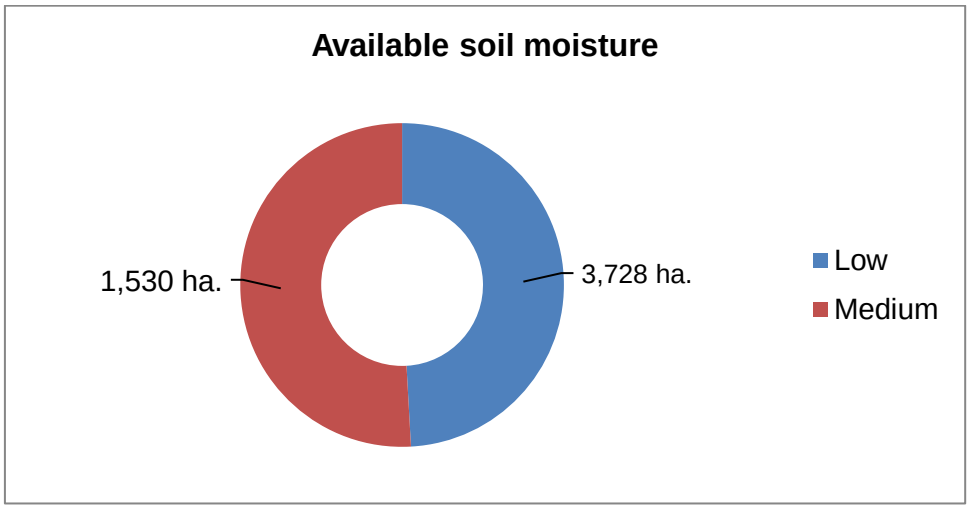
Figure 5.6: Detailed soil texture of top soil (0-15 cm)



Map 5.4: Detailed soil texture of top soil (0-15 cm)

5.1.9 Available soil moisture

169. The availability of soil moisture varies depending on the soil characteristics. According to SRDI, the available soil moisture has been classified into four (Low, Medium, High and Very high) categories. The distribution of available soil moisture is presented in Figure 5.7 and Map 5.5.

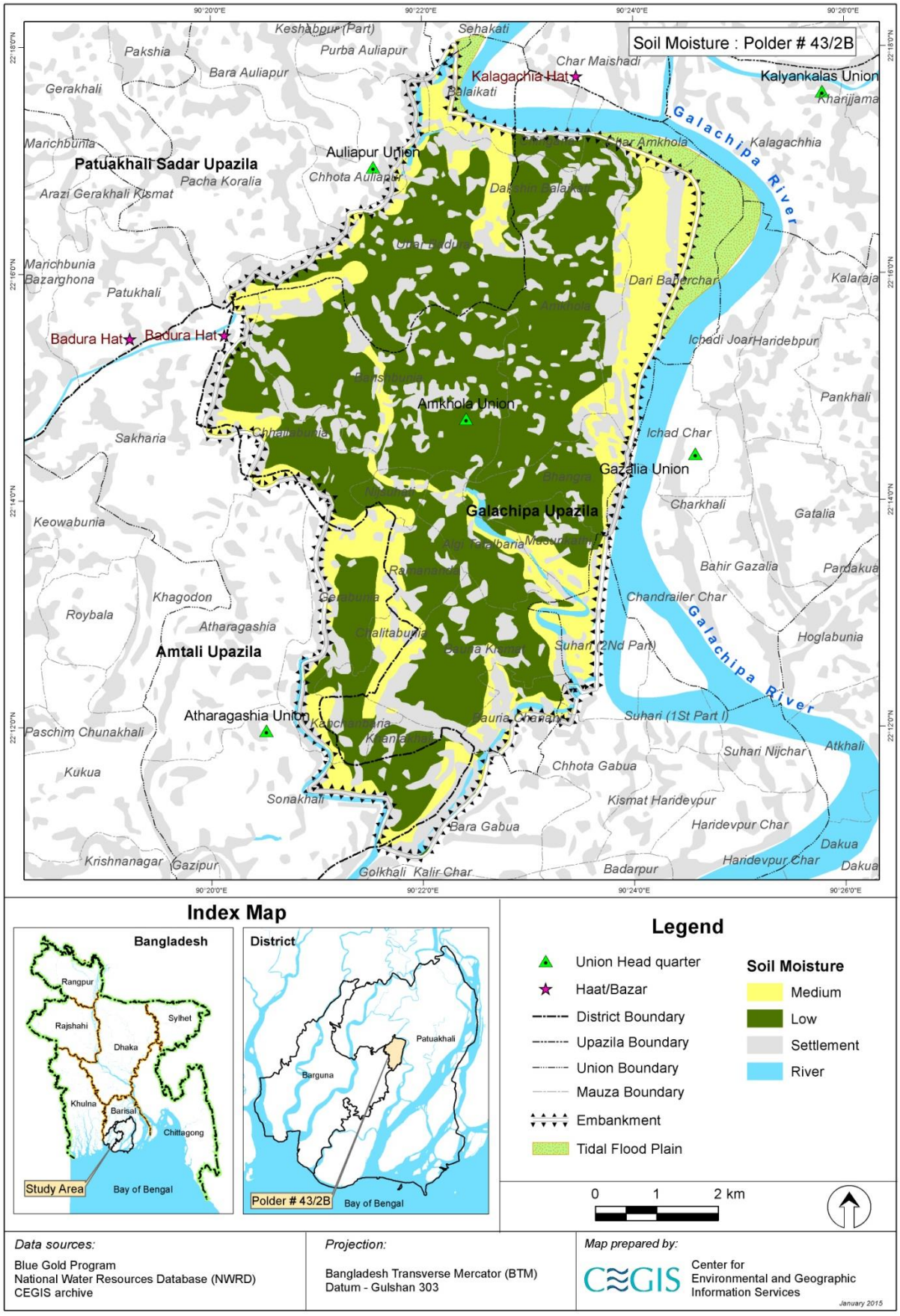


Sources: CEGIS estimation from SOLARIS-SRDI, 2006

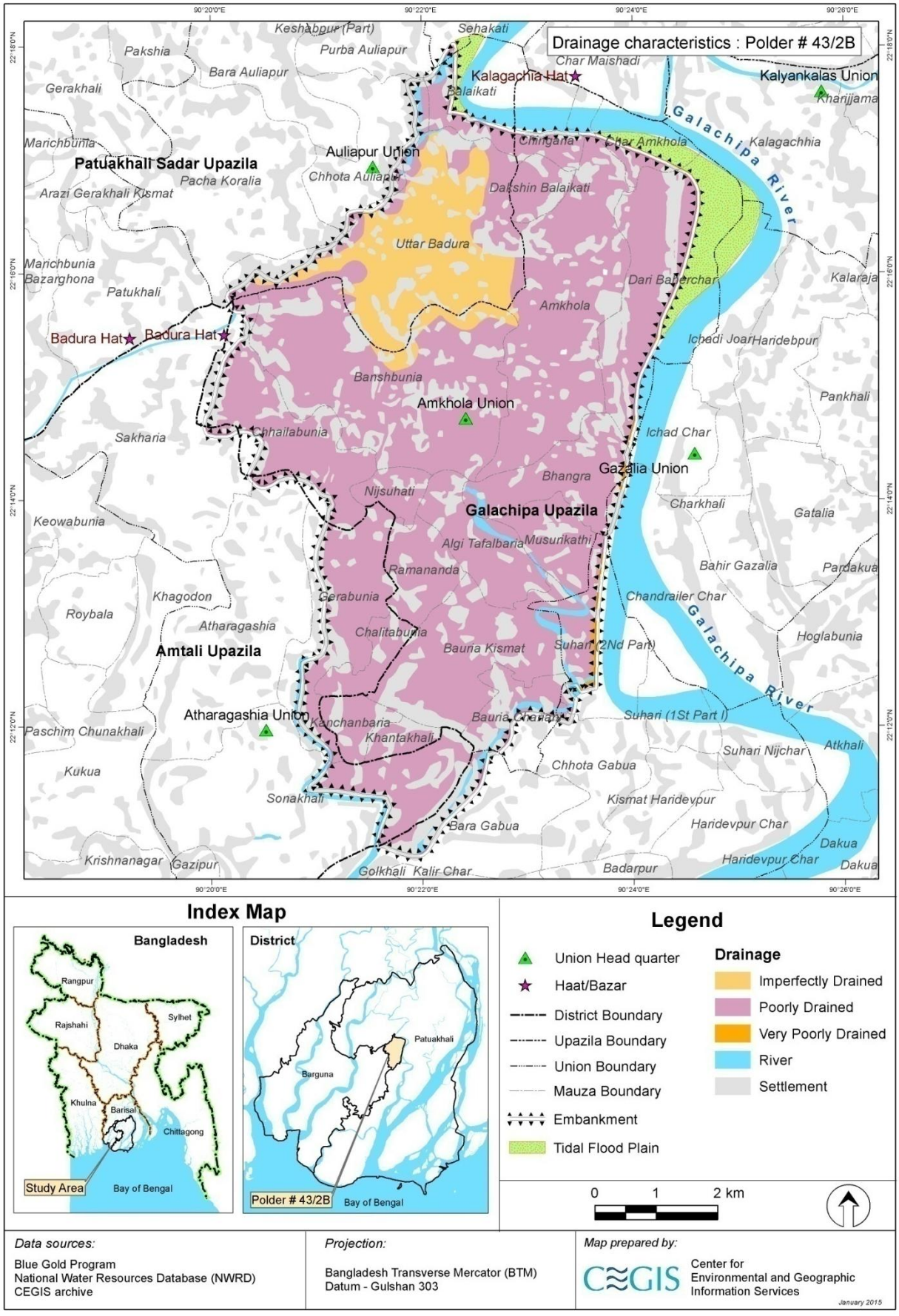
Figure 5.7: Available soil moisture

5.1.10 Drainage characteristics

170. Drainage plays a vital role in the management of soil (salinity, soil health) in the polder area. According to SRDI (1988), the drainage characteristics have been divided into six classes (excessively drained, well drained, moderately well drained, imperfectly drained, poorly drained and very poorly drained) from the agriculture point of view. Total area of the net cultivable area (NCA) is under poorly drained condition i.e, land which normally is flooded between a depth of 0 to 90 cm continuously for more than two weeks to few months during the flood season. Timely drainage of water in rainy/monsoon season is the main constraint for growing rabi/dry land crops in the polder area. Poorly drained area with few other soil characteristics is presented in Map 5.6.



Map 5.5: Available soil moisture of the polder



Map 5.6: Drainage characteristics of the Polder Area

5.1.11 Soil salinity

171. CEGIS estimation from SOLARIS-SRDI, 2006, reveal that over the period soil salinity of the area inside the polder increased gradually. Local farmers reported that most of the water control structures are not functioning properly, and cannot restrict intrusion of saline water inside the polder. This is reported to be the major cause of the salinity increse inside specifies area of the polder.

172. According to Sub-Assistant Agriculture Officers (SAAOs) of DAE the soil and water salinity gradually increases with dryness from January and reached maximum level in the month March-April and then decreases due to onset of monsoon rainfall.

173. Detailed soil salinity of 1973, 2000 and 2009 of the polder area are presented in Table 5.3 and Map 5.7.

Table 5.3: Detailed soil salinity in the polder area

Soil Salinity Class	EC (dS/m)	Area (ha) 1973	Area (ha) 2000	Area (ha) 2009
Non saline with some very slightly saline	2.0 - 4.0	3496	00	2240
Very slightly saline with some slightly saline	4.1 - 8.0	00	5700	3460
Data not available		2210		

Sources: CEGIS estimation from SOLARIS-SRDI, 2006

5.1.12 Land use

174. The polder area is about 5,700 ha of which about 4,078 ha (71%) is net cultivable area (NCA). Settlement area is 1240 ha (22%), water bodies (river/khals) 340 ha (6%) and road coverage comes to 42 ha (1%) of the total polder area. Detailed of land use/land cover of the polder area is presented in Figure 5.8 and Map 5.8.

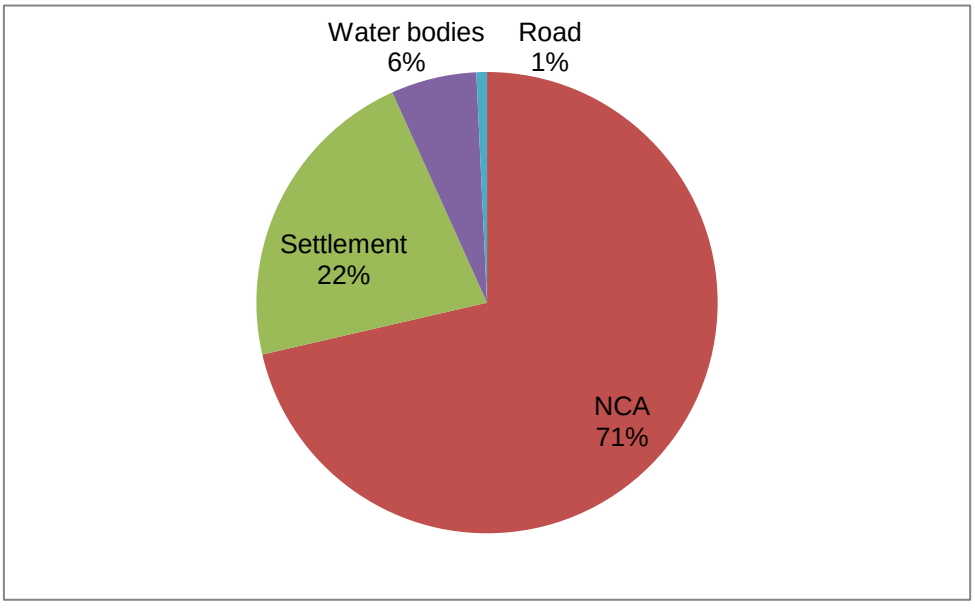
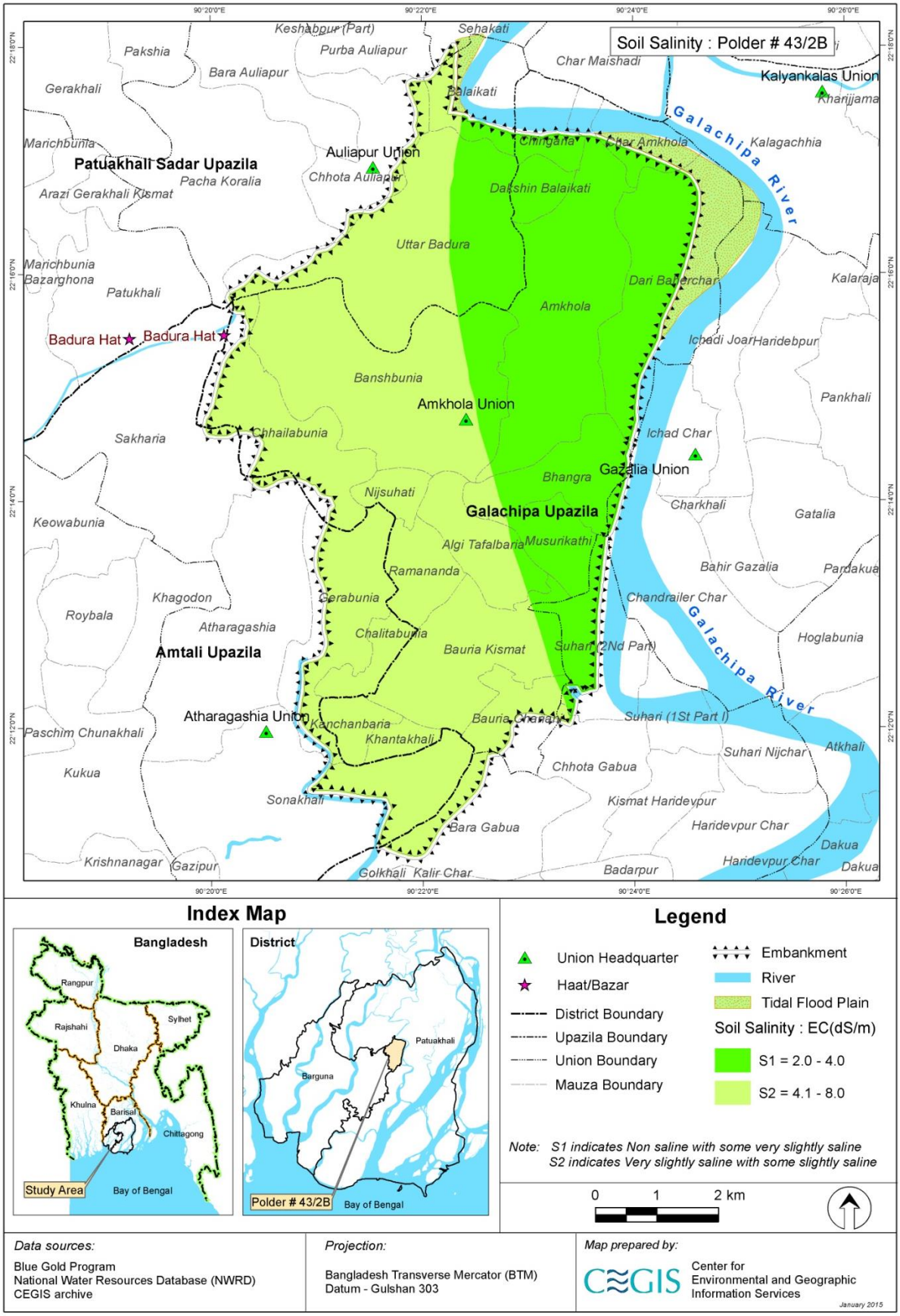
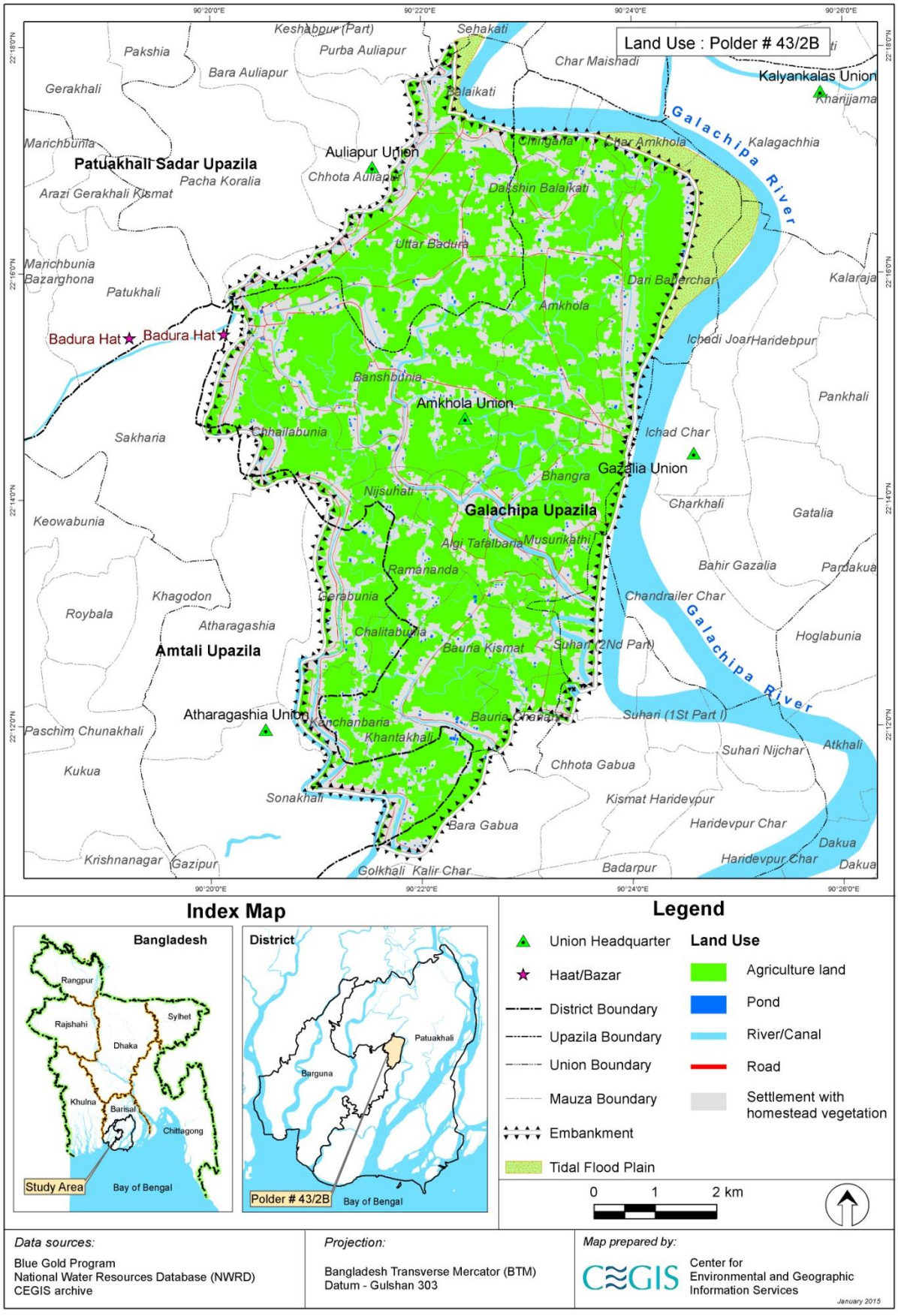


Figure 5.8: Present of land use in the polder area



Map 5.7: Soil Salinity of the Polder Area



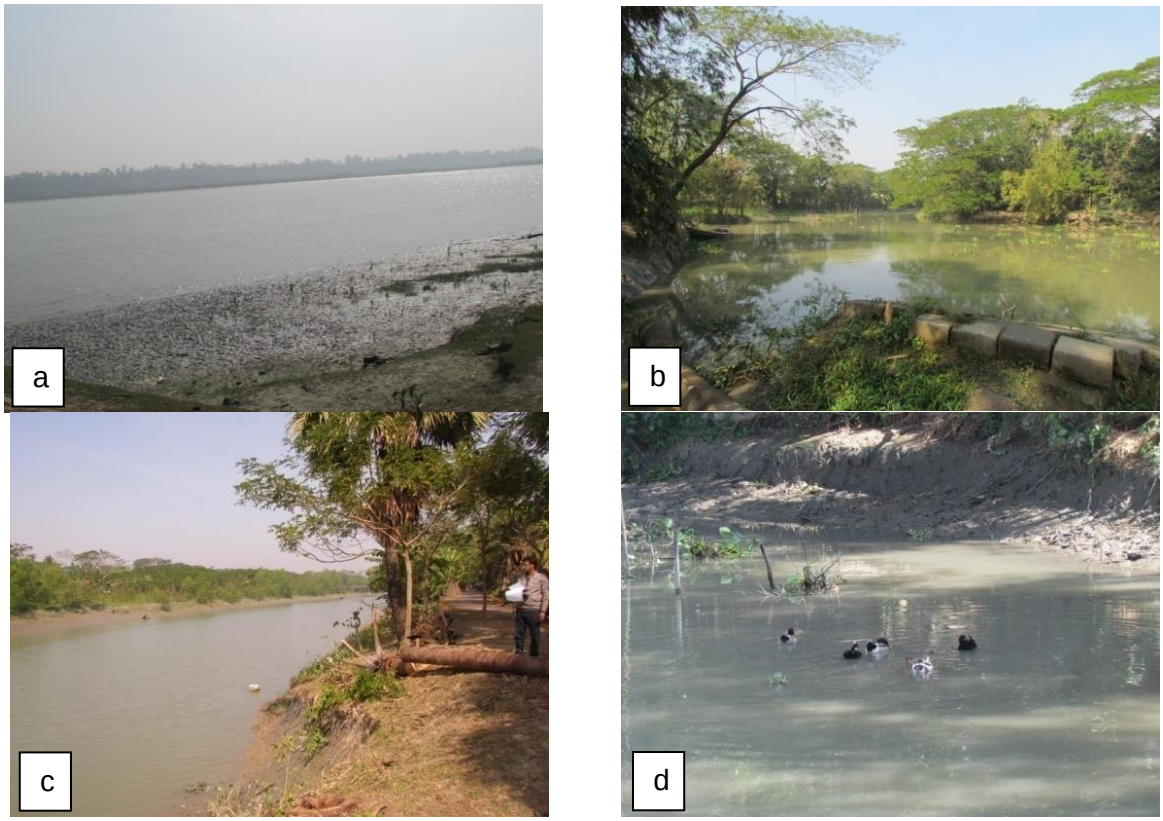
Map 5.8: Land use of the polder area

5.1.13 Water Resources System

175. Water resources system is the source of water supply, and plays a crucial role in assimilating and diluting wastes, attenuating and regulating vital water resources functions such as flood, drainage, recharge aquifer, and maintaining the environment for aquatic habitats. The following sections discuss the water resources system of Polder 43/2B.

River Systems

176. Polder 43/2B is within an aerial distance of 39 km from the coast (Bay of Bengal), and undergoes diurnal tidal influence. The polder is surrounded by Lohalia River on the north and east directions. The western periphery of the polder is surrounded by Golkhali khal. Another important coastal river namely, the Payra River (Buriswar) is located at around 12 km west from the polder. The river Lohalia is originated from the off take of Payra, at about 18 km north from the polder. Apart from these rivers, there are approximately 136 km of drainage and irrigation canals (khals) within the polder (Badura Khal, Athargasia Khal, Bouria khal, Tafalbaria Khal, Bhangra Khal, Mushurikata Khal etc.). The river system of the area is shown in Map 5.9.

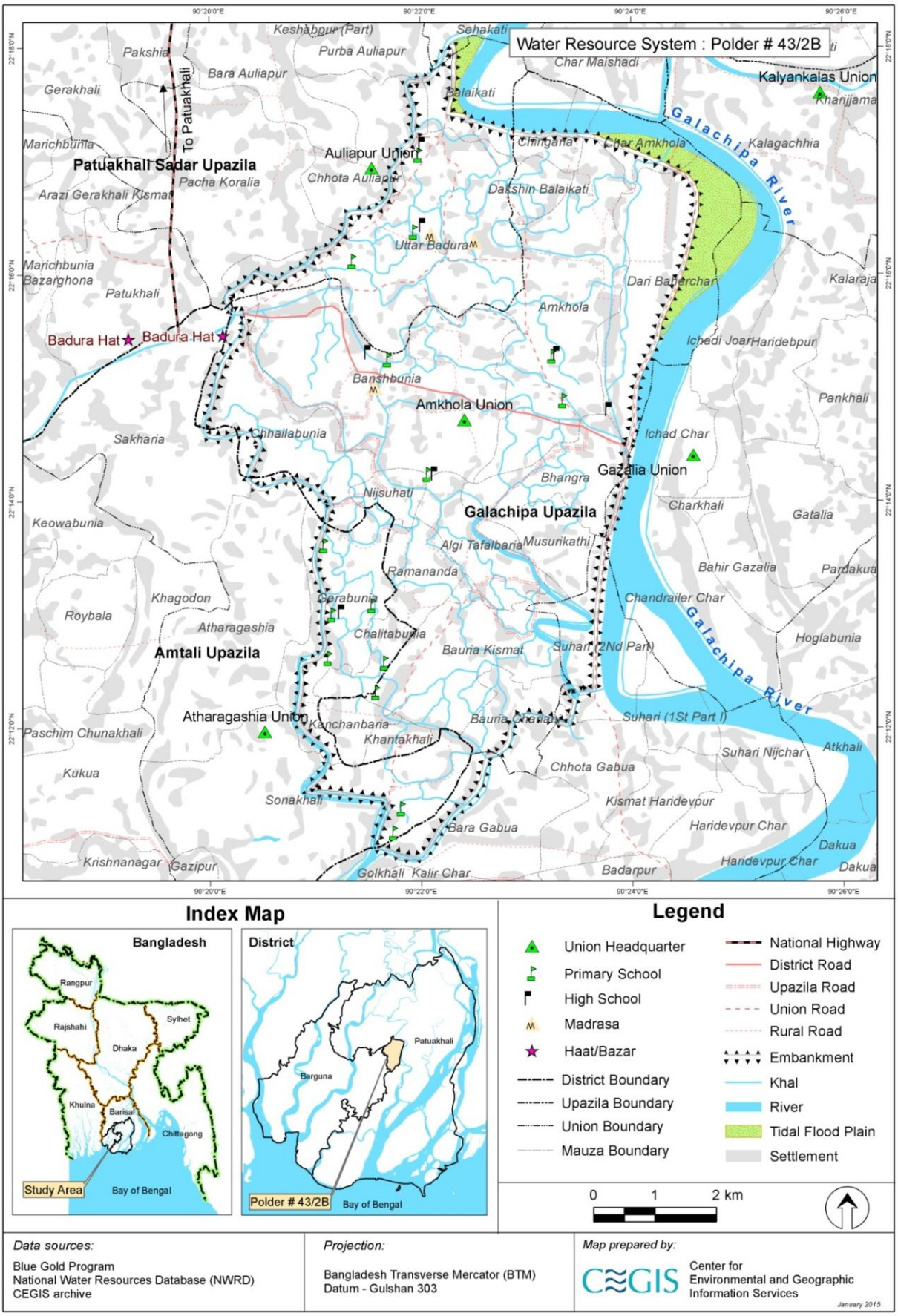


[(a) Lohalia (Golachipa) River, (b) Talbaria river, (c) Sakhariya Khal, (d) Masuakhali Khal]

Photo 5.1: Major rivers and khals in and around Polder 43/2B

Hydrological Connectivity

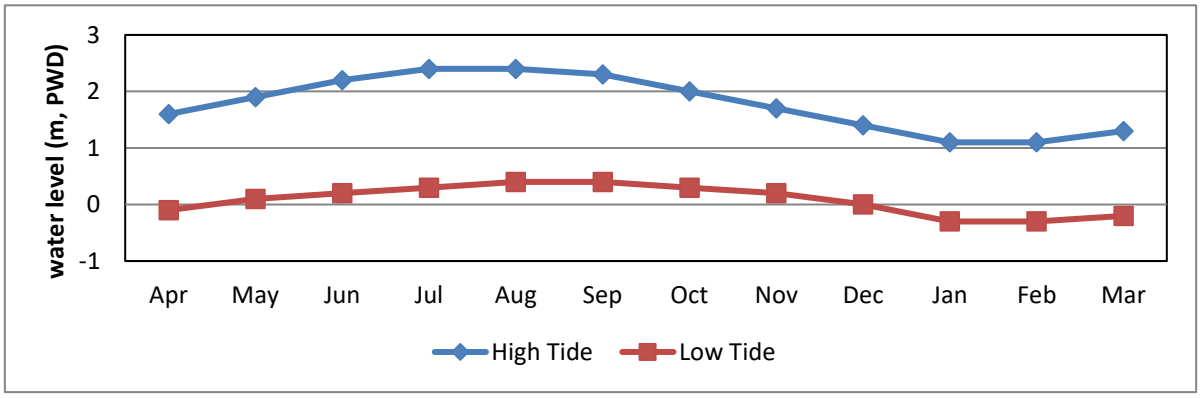
177. Water from peripheral rivers and khals intrude the polder are during high tide while the opposite situation takes place during low tide. The sluice gates and outlets around the polder are not operated and maintained properly, which impeds free circulation of tidal water. A number of distributaries of Lohalia River and Golkhali khal (badura khal, athargasia khal, bouria khal, bhangra khal, mushurikata khal etc.) contribute to the tidal water flowing into the polder, whereas some other internal khals (banshbunia khal, tafalbaria khal etc.) ensure flow circulation within the polder. The water courses also help to drain the surplus water out of the polder through peripheral water control structures (sluice gates, inlets and outlets).



Map 5.9: Water resources system of the study area

Surface Water Level

178. The surface water level is an important dimension of the water resources system. Figure 5.6 shows the monthly variation of average water levels at Amtali (Payra River). The figure shows that the high tidal water ranges from 1.1 m PWD to 2.4 m PWD, whereas low tidal water level ranges from -0.3 m,PWD to 0.4 m,PWD.

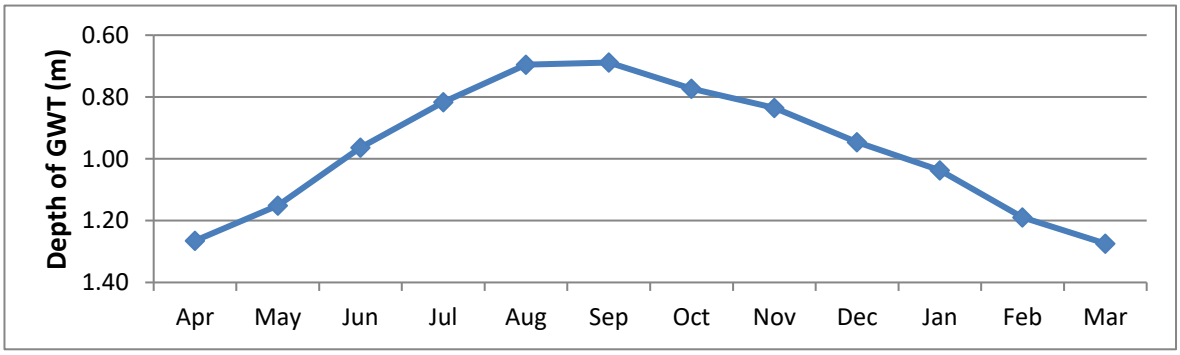


Source: BWDB, 2014

Figure 5.8: Monthly average surface water levels at Payra river (1990-2009)

Ground Water

179. For ascertaining monthly variations in groundwater table (GWT), the monthly variation of GWT for BWDB's observation well at Galachipa (PAT001 station) has been analyzed and shown in Figure 5.7. The variation pattern shows that GWT is highest during August-September and drop to its lowest level in March.



Source: BWDB, 2014

Figure 5.9: Average monthly variations of GWT at Galachipa (1977-2013)

180. Analyses have also been made to understand the long term annual variations of GWT from 1977 to 2013 at PAT001 station, which shows that March is the driest period and August-September is the wettest period. The values are presented in Figure 5.8 and 5.8. A mild decreasing trend of annual GWT variation is observed in both cases.

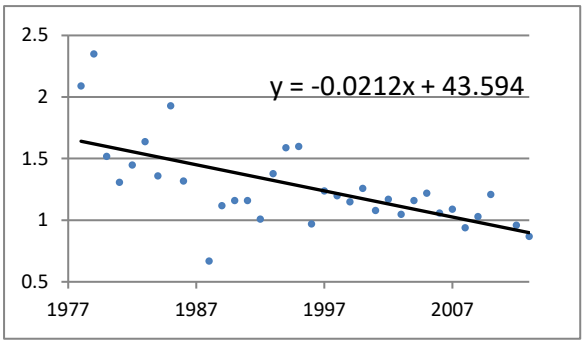


Figure 5.10: Variation of GWT at PAT001 in March (1977-2013)

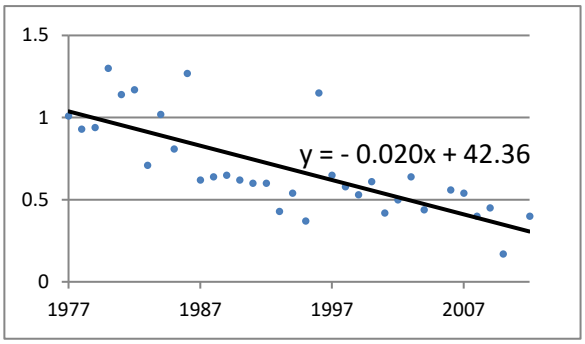


Figure 5.11: Variation of GWT at PAT001 in September (1977-2013)

Source: BWDB,2014

5.1.14 Water Use

Domestic use

181. The standard value of average daily demand of water for domestic and drinking purposes in rural areas is considered as 50 lpc (Ahmed and Rahman, 2010). However, the actual status of drinking water in some of the coastal polders is very poor. During the field survey in Polder 43/2B, it was found that the average daily domestic use of water was around 30 lpc, which is slightly better than those of the other adjacent coastal polders covered under the Blue Gold program. The study found that around 1,275 m^3 of water is consumed daily by the total number of 36,425 people living in the polder. Local people opined that they prefer Deep Tube Wells (DTWs) as drinking water sources to meet up their daily requirements. For other domestic uses, surface water sources are used. Overall, water availability in Polder 43/2B is not a major concern. During field work local people confirmed that they have access to sufficient surface and groundwater sources to meet up their daily need of drinking and domestic purposes.

Irrigation Use

182. The local farmers in Polder 43/2B practice Lt. Aus in Kharif-I (March-June) season, HYV Aman and Lt. Aman in Kharif-II season (July-October) and some other crops (mungbean, sunflower, sesame, khesari, watermelon and groundnut) in Rabi (November-February) season. The rain fed irrigation is sufficient during Kharif-I and Kharif-II seasons for Lt. Aus, HYV Aman, and Lt. Aman crops; whereas surface water irrigation is provided around 95% area of watermelon and groundnut crops during Rabi season. Irrigation is not required in some areas for groundnut for having high soil moisture, and for watermelon which are practiced by the sides of rivers or khals. Water is also required for other rabi season crops (sunfloer, sesame, khesari etc.) but no supplementary irrigation is needed for these crops as sufficient soil moisture is available during the season.

183. Based on expert opinions, it has been assumed that around 300 mm of water is usually required for each ha of land for Aus and Aman cultivation. For groundnut, khesari, watermelon and other rabi season crops water requirement comes to around 200 mm per ha. Using these standards of water requirement, the study infers that approximately 1.8 Mm^3 of water would be required during h Rabi season to ensure effective supplementary irrigation. The surface water irrigation coverage is around 40% of the NCA in Polder 43/2B. Local people claim that the low water availability marked by the reduced water carrying capacity of khals and poor functioning of water control structures are the major reasons for low irrigation coverage during the Rabi season. Irrigation through LLPs is a very costly

intervention (average cost is Take 5,000 to 5,500 per ha), and therefore cultivation of boro crops is not common. It is worth noting that boro crop requires almost 10 times more water than of watermelon and groundnut cultivation.

Table 5.4: Irrigation water requirements in Polder 43/2B

Season	Lt. Aus (ha)	Lt. Aman (ha)	HYV Aman (ha)	Sunflower, Sesame, Khesari and Mungbean (ha)	Watermelon and Groundnut	Water requirement (mm/ ha)	Water Used (Mm3)	Type of irrigation
Kharif-I (March - June)	480	-	-	-	-	300	1.44	No supplementary irrigation is required as rainwater is sufficient
Kharif-II (July - October)	-	3,798	280	-	-	300	12.23	No supplementary irrigation is required as rainwater is sufficient
Rabi (November – February)	-	-	-	2,348	-	200	4.7	No irrigation is provided as existing soil moisture is sufficient
	-	-	-	-	1,730 (*1,050+680*)	200	3.46	Surface water irrigation provided by using LLP and other traditional methods for 1,000 ha watermelon and 650 ha groundnut (95% of the total 1730 ha)

Source: CEGIS Estimation, January,2015

5.1.15 Water Resources Functions and Problems

184. The following sections point out the different water resources functions and problems in the polder. The water resources functions and problems were identified by the study team during their field investigation in January 2015.

Tidal Flooding

185. The peripheral embankment of Polder 43/2B is damaged in some locations. There are some discrete damages in Jainkathi (up to 0.5 km) and Bauria (upto 3.0 km). A more severe damage was observed in Dari Baherchar, where the embankment had a breach of around 0.5 km length. This creates tidal flooding in a significant area of Dari Baherchar. Almost every day, the high tidal water enters into the polder and causes massive sufferings for the local people. The tidal floodplain outer side the polder is also flooded during high tide. During public consultation meeting held in Dari Baherchar, the local people reported about their sufferings from regular tidal flooding in various words.

Drainage Congestion and Water Logging

186. The polder suffers from minor drainage congestion issues. There are some water courses namely, bauria khal, badrar khal, bangrar khal, tulabiara khal etc. which are connected with the external rivers. These water courses have been silted up over the years, especially at their confluence points with the rivers. The situation has further aggravated for the improper maintenance of sluice gates, which sometimes allow tidal water to remain trapped at the openings of the khals. Local people opined that water which accumulates into the polder from rainfall usually does not drain out properly through the aforementioned khals, and remain stagnated for unusual duration (2~3 weeks). However, in spite of the drainage congestion, no water logging was found inside the polder.

Navigation

187. The peripheral rivers and Khals (Lohalia and Golkhali) of Polder 43/2B are used as waterway communication. In addition to peoles' report, during field visits small trawlers carrying passengers and sand were seen navigating through the river. However, very little navigation takes place inside the polder as only small fishing boats were found to navigate through the internal khals.

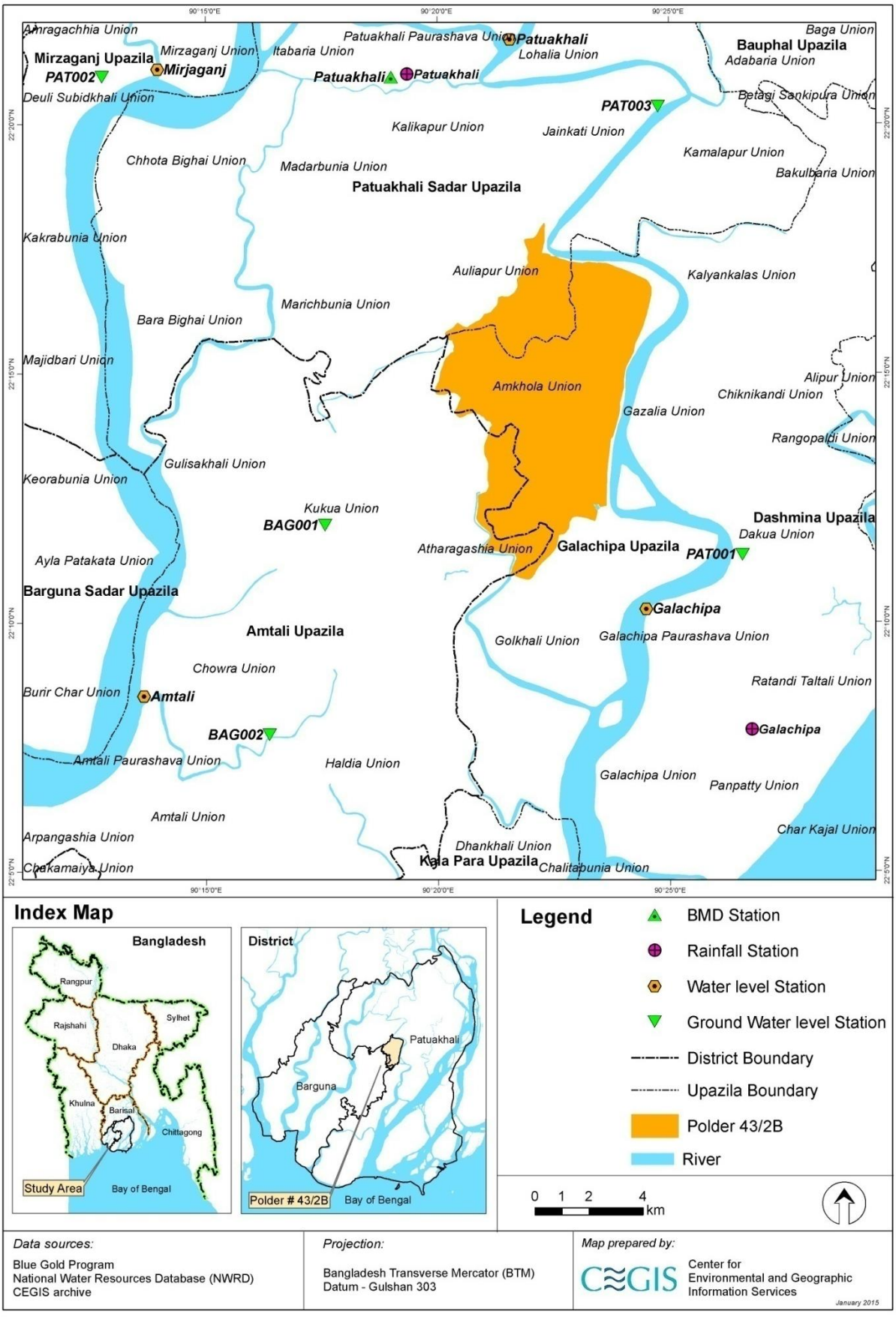
Photo 5.2: A trawler carrying sand navigating through the Lohalia river

Photo 5.3: A boat carrying passengers navigating through the Lohalia river

Erosion and Accretion

188. During field visit, the study team inspected entire peripheral embankment and found a breach of about 0.5 km at the north-east corner along Lohalia River where the process started during past couple of years. This breach may allow more tidal water inside the polder, and eventually may cause severe river erosion in near future. To ascertain the trend analysis has been carried out using Remote Sensing (RS) technology, with satellite images of 1997 and 2014. The RS-based analysis shows that during last 17 years the plan forms of Lohalia River at Dari Baherchar have been changed due to erosion and a very significant portion of lands (20 ha in total) at Boloikati village has been eroded.

Photo 5.4: Vulnerable hotspot for river erosion at Dari Baherchar (Boloikati Village)



Map 5.10: BWDB stations of rainfall, water levels and GW observation wells

5.2 Biological Environment

5.2.1 Farming practices

189. Farming practices in the polder area are largely controlled by physical, biological, climatological and socio-economic 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 further been sub-divided into the kharif-1 (March-June) and the kharif-II (July-October) season.

190. The climatic condition in *kharif-I* season is characterized by high temperature, low humidity, high evaporation, high solar radiation. The season also characterized by uncertain rainfall, which means low alternating dry and wet spells. In this season land remains fully fallow due to high salinity of soil. Salinity level goes beyond the tolerance level of crop, that is usually grown in this season e.g., aus. Scarcity of irrigation water is also another limiting factor. The *kharif-II/monsoon* cropping season is characterized by high rainfalls, lower temperatures, high humidity, and low solar radiation. Rice is the predominant crop grown during this season due to the submergence of soil. Excessive soil moisture and higher temperature restricts cultivation of other crops in the area. Local transplanted aman (Lt Aman) and very few High Yielding Varieties (HYV) of transplanted aman are also grown during this season in the polder.

191. The *Rabi* (winter) cropping season starts from November to ends in February. During this period, crops are favored with high solar radiation, low humidity and temperature. But due to inadequate soil moisture, the crop yield is low in this polder area. Major crops grown in this season are watermelon, sesame, mungbean, groundnut, khesari and sunflower. However, there is occasional overlapping when *kharif-II* season crops (aman rice) are harvested in *Rabi* season and some Rabi season crops (watermelon, groundnut, and mungbean) are harvested in kharif-I season.

5.2.2 Cropping pattern by land type

192. The most prominent cropping pattern is Fallow - Lt Aman - watermelon and Fallow - Lt. Aman - Fallow which are practices in 22% (each) of the NCA. The next dominant cropping pattern is Fallow - Lt *Aman* - Groundnut which is practices in 17% of the NCA. For HYV aman, BR-23 is the only variety practiced by farmers. Among the Rabi crops and varieties farmers are using Sesame-BARI Sesame-2, mungbean-Mubarik, watermelon-Local, chilli-Local, khasari-Local sunflower: Kironi). Khasari and mungbean are grown as a relay crop. Detailed cropping patterns by land type are presented in Table 5.5.

Table 5.5: Detailed existing major cropping pattern by land type

Land Type	Kharif-I (March-June)	Khartif-Ii (July-Oct)	Rabi (Nov-Feb)	Area (ha)	% of NCA
Medium High Land (F_1)	Fallow	HYV Aman	Sunflower	280	7
	Fallow	Lt. Aman	Sesame	278	7
	Lt Aus	Lt Aman	Mungbean	320	8
	Lt Aus	Lt aman	Watermelon	160	4
	Fallow	Lt Aman	Khasari	580	14
	Fallow	Lt Aman	Watermelon	890	22
	Fallow	Lt Aman	Groundnut	680	17

Land Type	Kharif-I (March-June)	Khartif-Ii (July-Oct)	Rabi (Nov-Feb)	Area (ha)	% of NCA
	Fallow	Lt. Aman	Fallow	890	22
			Total =	**4,078**	**100**
			Cropping Intensity (%)	***190***	

Source: CEGIS field survey, 2015 and secondary data from SAAO, DAE

Table 5.6: Varieties cultivated

Sl No.	Aus		Aman	
	Local	HYV	Local	HYV
1	Kalishaitta	Nil	Balashar mota	BRRI dhan 30 and BRRI dhan 31
2	Kalamota		Kutiadani	
3			Kalamadari	
4			Dudkalam	
5			Haitta	

Source: CEGIS field survey, 2015 and secondary data from local SAAO, DAE.

Photo 5.5: View of watermelon seed sowing

Photo 5.6: View of relay mungbean with rice

5.2.3 Cropping intensity

193. Total cropped area is about 7,746 ha of which the coverage of rice is 59% and non rice 41% respectively. The single, double and triple cropped area is 22%, 66% and 12% of the NCA respectively. The cropping intensity of the project is about 190%.

5.2.4 Crop production

194. The annual total crop production in the polder area is about 20,764 tons of which rice and non-rice 5,562 tons and 15,202 tons respectively. The contribution of rice crops is about 27% and non-rice 73% of total crop production. Among the rice crops, the contribution of Lt Aus, HYV aman and Lt Aman are about 12%, 10% and 78% respectively.

195. Some crops in the polder area get damaged by drainage congestion, heavy rainfall etc. as reported by local farmers and the SAAO. Normally, Lt *Aman*, sesame, watermelon and groundnut damage is about 10%, 20%, 15% and 10% respectively. Main causes of the damage are heavy rainfall and drainage congestion. Total loss of rice production is about 224 tons in 380 ha and loss of non-rice production is about 215 tons in 281 ha due to drainage congestion, siltation of khals and drainage channels, natural calamities. Detailed information on crop production and crop production loss is presented in Table 5.7.

Table 5.7: Existing Crop Production and Production Loss of the Polder Area

Crop Name	Crop Area (ha)	Damage Free		Damaged		Total Production	Production	Production (%)
		Area (ha)	Yield (ton/ha)	Area (ha)	Yield (ton/ha)	(ton)	loss(ton)	
Lt.Aus	480	480	1.4	-	-	672	-	12
HYV Aman	280	280	2	-	0.9	560	-	10
Lt.Aman	3,798	3,418	1.2	380	0.6	4330	228	78
Total rice	4,558	**4,178**		**380**		**5,562**	**228**	**27**
Sunflower	280	280	0.92	-	-	258	-	
Sesame	278	222	0.99	56	0.2	231	44	
Mungbean	320	320	1.1	-	-	352	0	
Watermelon	1050	892.5	13	157.5	12	13493	158	
Groundnut	680	612	0.7	68	0.5	462	14	
Khesari	580	580	0.7	-	-	406	0	
Total non-rice	3,188	**2,907**		**281**		**15,202**	**215**	**73**
Total	**7,746**	**7,085**		**661**		**20,764**	**443**	**100**

Source: CEGIS field estimation, 2015, UAO, DAE. Clean rice*

5.2.5 Inputs use

196. Seed, labor, fertilizer, pesticide and irrigation are the main inputs for crop production.

Seed

197. 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. The seed rate used by the farmers in the polder area is presented in Table 5.8. For rice, farmers use more seeds than recommended as they normally use more seedlings per hill. Often, seedlings are affected by monsoon flood. According to farmers, last year (2014) they had to re-transplant their land as the fields were damaged by heavy monsoon rain. The seed rate of vegetables generally depends on the size and viability of the seed. In the local market good quality seeds are available.

Table 5.8: Seed use in the polder area

Name of crops	Seed use (kg/ha)	
	Farmers use	Recommended rate
Lt Aus	55	40
HYV Aman	45*	40
Lt Aman	50	40
Sesame	6*	7
Mungbean	23*	25
Watermelon	1.1	0.8
Sunflower	12*	12
Groundnut	110*	100
Khesari	60	55

*Source: Based on field information; 2015, SAAO, DAE. * Supplementary irrigation*

Labor

198. Almost 60% of the crop production related activities in the polder area are manually done. Use of labor for agriculture is mainly for seed sowing, intercultural operations, harvesting and post harvest activities. The labor requirement is however, not uniform throughout the year. The number of labor requirement varies from crop to crop and season to season. Average labor days used per hectare is presented in Table 5.9.

Table 5.9: Labor use in the polder area

Crop name	No. of Labor days
Lt Aus	130
HYV Aman	150
Lt Aman	130
Sesame	70
Mungbean	140
Watermelon	150
Sunflower	110
Groundnut	150
Khesari	80

Source: Based on field information; 2015, SAAO, DAE.

Fertilizers

199. The rate of fertilizer use per hectare varies considerably depending on soil fertility, cropping pattern and financial ability of the farmers. Fertilizers used in this area are Urea, TSP/SSP, MP and Gypsum. During field visit it was found that in watermelon pits SP is applied. Most of the farmers (around 65%) use un-balanced fertilizers in their field. Organic manures are not used by the farmers for field crops. Cowdung is used for watermelon and homestead garden. According to local farmers and DAE officials all most in every local market there are fertilizer dealers. Dealers receive trainings from UAO office. Local farmers also reported that they do not have enough money to buy all types of fertilizer at a time. Detailed information of fertilizer use is presented in Table 5.10.

Pesticides

200. 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 farmer 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 groundnut cultivation. Local professional pesticide sprayers visit farmers' house for pesticide application in different fruit trees and field crops. Detailed information of pesticides use is presented in Table 5.10.

Table 5.10: Fertilizers and Pesticides use in the polder area

Crop name	Farmers practice (Kg/ha)						Recommended dose (kg/ha)						Pesticide use by farmers	
	Compost	Urea	TSP	MP	Gypsum	Zn	Compost	Urea	TSP	MP	Gypsum	Zn	No. of application	Liq. (ml/ha) apx.
Lt Aus	0	55	10	10	0	0	0	97	14	17	0	0	0	800
HYV Aman	0	100	10	20	0	5	0	163	35	21	0	0	2	600
Lt Aman	0	65	10	10	0	0	0	97	14	17	0	0	0	0
Sesame	0	60	20	0	0	0	0	170	60	31	0	1.3	0	0
Mungbean	0	45	20	0	0	0	0	45	67	20	0	0	2	800

Crop name	Farmers practice (Kg/ha)						Recommended dose (kg/ha)						Pesticide use by farmers	
	Compost	Urea	TSP	MP	Gypsum	Zn	Compost	Urea	TSP	MP	Gypsum	Zn	No. of application	Liq. (ml/ha) apx.
Watermelon	300	90	80 SSP	20	10	0	6,000	141	56	30	0	3	3	1100
Sunflower	0	50	30	0	0	5	5,000	160	150	150	0	0	0	0
Groundnut	0	60	20	10	1	0	0	25	160	85	160	0	1/2	400-600
Khesari	0	20	10	-	-	-	0	40	55	20	0	0	0	0

*Sources: Farmers interviewed, January, 2015; *Seed rate varies in different crops*

Photo 5.7: Farmers used SSP instate of TSP

Photo 5.8: Member of a CEGIS field research team talking to a Pesticide sprayer

5.2.6 Integrated Crop Management (ICM)

201. Recently, Integrated Crop Management (ICM) is practiced in many places of the polder area. In this system, insects are controlled biologically. Farmers within the ICM command area use branches of trees, bamboo and jute sticks etc to make favorable perches for birds in fields with standing crops. The birds by eating the insects help to control infestation. In this process, crops are protected without applying pesticides. Trap is another technique for controlling pests in the agricultural fields especially on watermelon and vegetables that attract insects. Through ICM it is possible to control the harmful insects without the application of pesticides. ICM technique is mainly applied on rice, watermelon and vegetables fields. Field information (Farmers and SAAO of DAE) indicates that ICM coverage is about 10-15% of the cultivated areas and the impact has been very encouraging.

5.2.7 Irrigation

202. Surface water is the only source of irrigation as reported by local farmers. Khals and in few cases ponds are the source of surface water for very limited time. Irrigation is provided mainly in watermelon and groundnut field. Occasionally, Low Lift Pumps (LLPs) are being used for surface water irrigation. Farmers and SAAO reported that if the khals are re-excavated then watermelon and groundnut cultivation area may become double and other Rabi cropped areas will also be increased. Farmers also reported that presently the cost of irrigation per hector of land is about Taka 5,000 to 5,500. Detailed information on irrigation is presented in Table 5.11.

Table 5.11: Irrigated area by crop

Crop name	Irrigation (Surface water)		
	Irrigated area (ha)	% NCA	Charge (tk/ha)
Watermelon	1,000	24	5,000
Groundnut	650	1	5,500

Source: CEGIS estimation on field information; 2015

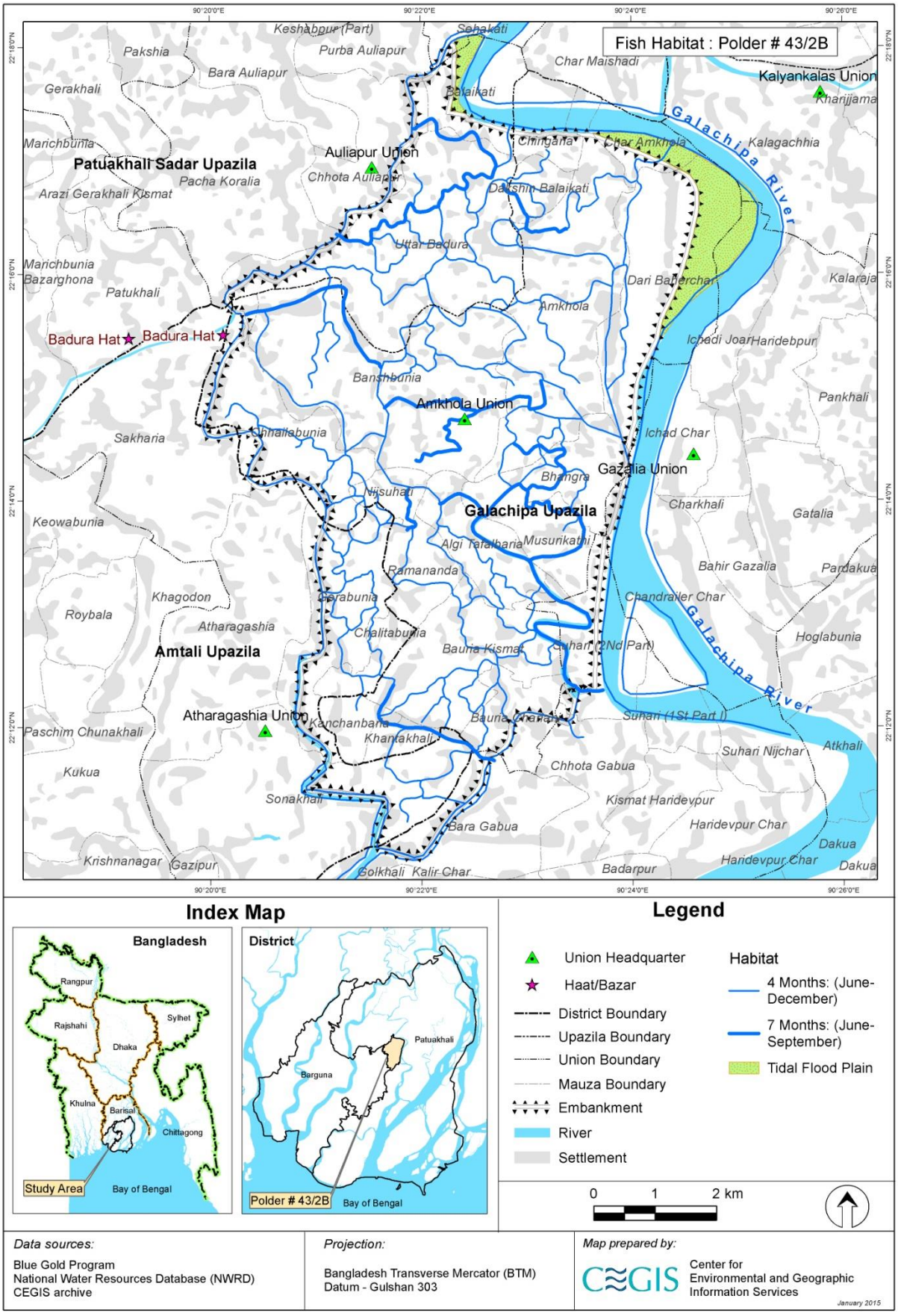
5.2.8 Crop production constraints

203. According to local farmers, the main constraints in the polder area are lack of irrigation water in Rabi season, siltation and drainage congestion. Siltation of different internal drainage channels and partial salinity cause delay in the transplantation of aman in time.

Photo 5.9: Farmers problems for crop production in the polder area

5.2.9 Fish Habitat

204. Fish habitat of the polder area can be classified under two broad categories; capture and culture fishery. Capture fisheries habitats include peripheral piver, intertidal floodplain and internal khals (Map 5.11). The open water fish habitats of the area are khals are acting as major arteries of fish migration into the polder area. Among all the khals, Musurikathi khal, Bauria khal, Noshaishil khal, Badura khal, Mestakhali khal, Amkhola khal are perennial and remaining is seasonal where water retain only wet season. Although slight tidal effect in dry season was found in these khals but the volume of water is not sufficient for fish habitation. The culture fishery of the polder area is dominated by culturable fish pond. The periphery Galachipa River is located on the eastern part of the polder. This river is tidal in nature and is the potential habitat for saline and brackish water fish species. Moreover, a small part of Sonakhali khal has touched on the south-western corner of the polder. The polder area has diversified fisheries resources all depending on fresh and brackish water fish habitats.



Map 5.11: Fish habitat in the study area

Capture Fisheries

205. The estimated fish habitat area is 425 ha where capture fishery contributes the major share (340 ha) and the culture fish habitat shares the rest. The open water fish habitat is represented by khal alone as shown in the following **Table 5.12**. In this study, the peripheral rivers and inter tidal floodplain have not been considered for fish production estimation of the polder area because these habitats are located outside of the polder.

Table 5.12: Fish habitat status in the polder area

Sl. No	Fishery Category	Habitat Type	Area (Ha)	Habitat Status
1	Capture	Khal	340	• Silted up • Encroached for fish culture • Cover with duck weed • Drying up of narrow khal during dry season
		Sub-Total=	**340**	
2	Culture	Culturable pond	60	• Used as water reservoir cum fish culture • No apply supplement feed
		Cultured pond	25	• Increasing trend • Lack of modern training and quality seed and feed
		Sub-Total=	**85**	
		Grand Total=	**425**	

Source: CEGIS estimation based on GIS and Field visit data, 2015

206. The depth of Musurikathi khal, Bauria khal, Noshaishil khal, Badura khal, Mestakhali khal, Amkhola khal is high which is suitable for the habitation of big and medium size fish species particularly during dry season in the low tide situation. Apart from these, remaining khals are seasonal, some of them are encroached by the local people and practicing culture fishery by developing barriers through net. **Photo 5.10** shows the internal khals in the polder area.

a) Perennial khal

b) Seasonal and silted up khal

Photo 5.10: Open water fish habitat (khal) in the polder area

Culture Fisheries

207. Aquaculture practice is increasing in the polder area. Estimated area under cultured pond and culturable pond is about 85 ha (**Table 5.12**). Among the culture fish habitat culturable pond 60 ha and cultured fish pond is 25 ha. Cultured pond is perennial while

culturable fish ponds is seasonal where retain water for six to seven months. Fish pond of the study area is shown in the (**Photo 5.11**)**.** Nevertheless, various types of fish culture systems are practiced by the local people including mono-culture, polyculture, and mix-culture. It is reported that almost every household have a pond which is used as fresh water reservoir cum fish culture. There is no shrimp/prawn gher in the polder area.

Photo 5.11: Fish pond in the polder area

5.2.10 Loss of open water fish habitat

208. The open water fish habitat especially khal habitat is decreasing gradually. Local people reported that about 30% of the perennial internal khal have now become seasonal khal where little water is seen in the dry season. Even some of the seasonal khals seem to be used as agriculture land. The main causes of reducing such fish habitat are siltation, topsoil erosion, decomposition of excessive duck weed, encroachment of khal by the local powerholders for agriculture land and fisheries culture practices. For this reason, spawning and grazing ground of the resident fish species is being damaged and thus capture fishery is declining day by day in the polder area.

Photo 5.12: Present condition of fish habitat

5.2.11 Fish Habitat Quality

209. Some surface water quality parameters that are important for fish habitat suitability were measured in internal khals of the polder area. Table 5.13 presents the measured water quality results of open water fish habitat (internal khal). From the data it is observed that pH values are slightly higher in the khal which means water is alkaline. The salinity in water body (khal) is nil. However, all water quality parameters are within the permissible limit for the development of fisheries resources.

Table 5.13: Water quality parameters of different water bodies in the polder area

Water bodies	Parameters				
	Temp (ºC)	pH	DO (mg/l)	TDS (ppm)	Salinity (ppt)
Internal Khal	24.75	7.76	5.15	154	0
Standard values for fish	(28-34)**	(6.5-8.5)*	(4.0-6.0)*	1000*	(0-4) for prawn and (5 -35) for shrimp**

*Source - *M A Mazid 2002 ** Jack M. et al, 2002*

Aquatic Vegetation

210. Aquatic plants or vegetation play an important role in the structure and function of the aquatic ecosystem. Different types of hydrophytes like emergent, submerged and floating with leafs is used as habitat and spawning ground of fisheries and other insects and crustaceans. So, low abundance of hydrophytes may harm to fish breeding and production. In the wetland, some fishes lay eggs in the body of plants. Beside these, some fishes live on the rotten part of the aquatic plants (Khondker, 2004). Water bodies in the polder area contain different types of aquatic floras such as free floating, rooted floating, submerged and amphibian vegetations like sedges and meadows. Wetlands contain plenty of aquatic floras, such as free floating, submerged, sedges and meadows. Free floating plants especially duck weed are common and their abundance is high in all khals within the polder area. The presence of duck weed has created congenial environment for habitation of snake head (*Taki, Shol, Cheng* etc.) and benthic fishes (mud eels). However, some types of aquatic plants with leafs is using as habitat and spawning ground of fisheries as well as other insects and crustaceans in the polder area.

5.2.12 Fish Productivity and Production

The fish productivity of the polder area is presented in Table 5.14. Net fish productivity of different open water habitats is lower than other areas of the country. The khal productivity rate is 135 kg/ha which is comparatively lower than the national productivity rate (172 kg/ha). The main reasons for low productivity are reduction of water depth due to siltation, fishing by nets close to the sluice gates, obstruction of fish hatchling movement during pre-monsoon and monsoon due to improper management sluice gate. Fish productivity of culturable and cultured pond is low. Low production of culture fishery in the polder area is due to tidal flooding risk for mal-functioning of sluices and regulator, lack of seed and feed, and lack of training of modern fish culture. Nevertheless, aquaculture practice is increasing significantly in the polder area.

Table 5.14: Fish productivity of the Polder area

Fishery Category	Habitat Types	Productivity (kg/ha)
Capture	Khal	135
Culture	Culturable pond	1200
	Cultured pond	2100

Source: Field Survey, 2015 and Professional Judgment

211. The estimated total fish production of the polder area is about 171 tons. Bulk of the fish production (about 81%) is coming from culture fisheries and the remaining from the capture fishery (Table 5.15). Fish production trend of the capture fishery is declining in the polder area.

Table 5.15: Fish Production from Different Habitats of the Polder Area

Sl. No	Fishery Category	Habitat type	Production (MT)
1	Capture	khal	46
		Sub-Total=	**46**
2	Culture	Culturable pond	72
		Cultured pond	53
		Sub-Total=	**125**
		Grand Total=	**171**

Source: CEGIS estimation based on field data, 2015

5.2.13 Fishing Effort

Fishermen number

212. The fishers' household in the polder area can be grouped as commercial, subsistence and part-time fishers. Local people reported that there are about 325 (4% of the total households) fisher households in the polder area. Among the fisher households, 15% are engaged as professional/commercial fishers and they spend around (6-8) hours a day in fishing activities throughout the year. Remaining 85% of the households are involved in part-time fishing, and subsistence level fishing. Most of the fishers are from Muslim community (95% of the total fisher's households). There is no specific "Fishers village" in the polder area. The socio-economic condition of the commercial fishers is poor. The seasonal vulnerability of the fishers starts from late October to April durng the year. The fish catch during this period is hardly recorded. Due to low amount of fish catch during this period, most of the fishers maintain their livelihood through daily labour in or outside the polder. Some fishers are involved in agricultural activities in their own land. In addition to these, they also work against wages to catch fish in the private ponds.

Fishing Season

213. Fishing season in the polder area starts in April / May and continues up to December. Most of the fish catch through use of different gears is during late June to Mid November. It is to be noted that Ber jal and Bendi jal are used in the periphery river round the year. The seasonality of major fishery is presented in the Table 5.16.

Table 5.16: Fishing Seasonality of the Polder Area

Type of Gear	Seasonality												
	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
	Boishakh	Jaishthya	Ashar	Sravon	Bhadra	Ashyin	Kartik	Agrahayan	Paush	Magh	Falgun	Chaitra	
Ber jal (Siene net)													
Current jal (Gill net)													
Bendi/Badhai jal (Siene net)													
Sluice jal (Dip net)													
Dhela jal/net jal (Push net)													
Jhaki jal (Cast net)													
Trap gear (Dugair/Chau)													
Lining (Borshi)													
	High			Medium			Low			No occurrence			

Source: Field Survey, 2015

Fishing Crafts and Location

214. The commercial fishers of the polder area catch fish in the peripheral rivers and internal khals by using both mechanized and traditional boats including *Jala Nouka* and *Kosha, Dingi* fishing boats etc. Fishing boat in the polder area is shown in the following photo **5.13**.

Photo 5.13: Fishing Boats in the Polder Area

Fishing Gear

215. Different types of nets/gear are used for fishing as mentioned in **Table 5.16.** Of the fishing gears used; Seine net (Ber jal/bendi jal) is used to catch all types of small and big fishes; Mono filament net, locally known as Current jal and Koi jal, is used to catch poa, chingri, tengra, gulsha, and koi fish; Cast net, locally known as Jhaki jal, is used to catch puti, chingri, tengara etc. Push net, locally known as Thela jal, is used to catch puti, tengra, chingri etc. Sluice/Dip net locally known as Sluice jal is found to be used at the mouth of sluice gate to catch all types of fishes. Besides, *Katha* is found in the deep pool area of perennial khals inside the polder. The katha is constructed from late October to April to catch all type fishes. Around 5% fishers have fishing boats and around 80% fishers have fishing gears/nets. Jhaki jal (cast net) is a common traditional fishing gear and widely practiced in the polder area (photo **5.14)** in all water bodies.

(a) Common fishing gear (Current Jal) *Fishing Katha*

Photo 5.14: Fishing gear and Trap

5.2.14 Fish Migration

216. The riverine fish species migrate through regulated khals in the polder to some extent during the period of June to August. Perennial khals along with other seasonal internal khals are used as feeding and nursing ground of the fishes. Fish species such as *Chingri, Puti, Boal, Pairsa, Tengra, Gulsha, Baila* migrate through these regulators to these water bodies as part of their life cycle. Fish migration status in the polder area is found to be poor due to successive siltation and mal-functioning of water control structures, inaction of the Water Management Organizations (WMOs) for operation of sluice and regulators. The improper management of regulators hinder the migration of fish hatchling especially carp fry migration during pre-monsoon.

5.2.15 Fish Biodiversity

217. The study area is moderate in fish biodiversity. Biodiversity of fishes is reported to be in a declining trend over the years. Local people reported that about 90 numbers of fish species are available in the area. The study area comprises an assemblage of both fresh and brackish water fish species (photo below). List of fishes of different habitat in the study area are presented in Table **5.17**.

Photo 5.15: Composition of Fish Catch of the Polder Area

Table 5.17: Status of indicative fish species diversity of different fish habitats in the study area

Scientific Name	Local Name	Habitat type		
		Periphery River	Khal	Fish pond
Brackish Fish Species				
Tenualosa ilisha	Ilish	M	NA	NA
Otolithes argentatus	Sada Poa	L	NA	NA
Terapon jarbua	Barguni/Rekha	M	NA	NA
Lates calcarifer	Koral/Bhetki	M	L	NA
Liza parsia	Pairsa	H	L	NA
Liza tade	Bata mach	M	L	L
Mystus gulio	Tengra	M	M	L
Pangasius pangasius	Pangus	L	NA	M
Polynemous paradiseus	Tapasi / Muni	L	L	NA
Sillaginopsis panijus	Tolar dandi	H	L	NA
Scylla serrata	Kankra	H	H	NA
Macrobrachium rosenbergii	Golda chingri	L	L	NA
Metapenaeus monoceros	Horina chingri	H	L	NA
Penaeus monodon	Bagda chingri	M	L	NA

Scientific Name	Local Name	Habitat type		
		Periphery River	Khal	Fish pond
Fresh Water Fish Species				
Puntius sophore	Jat puti	L	NA	NA
Channa punctatus	Taki	NA	H	NA
Channa orientalis	Cheng taki	NA	H	NA
Channa striatus	Shol	NA	H	L
Clarius batrachus	Magur	NA	M	NA
Mystus vittatus	Tengra	M	M	NA
Macrognathus pancalus	Chirka baim	M	H	NA
Macrognathus aral	Tara baim	M	M	NA
Lepidocephalus guntea	Gutum	L	L	NA
Puntius chola	Chola puti	L	M	L
Channa marulius	Gojar	NA	M	L
Wallago attu	Boal	L	L	NA
Aorichthyes seenghala	Ayre	M	L	NA
Gudusia Chapra	Chapila	M	NA	NA
Glossogobius giuris	Baila	M	L	L
Eutropiichthyes vacha	Bacha	M	L	NA
Culture Fish Species				
Telapia nilotica	Telapia	NA	L	H
Hypophthalmichthys molitrix	Silver Carp	NA	NA	H
Puntius suchi	Sharputi	NA	NA	H
Cyprinus carpio	Miror Carp	NA	NA	L
Ctenopharyngodon idellus	Grass Carp	NA	NA	M
Catla catla	Catla	L	L	L
Labeo rohita	Rui	L	L	L

Source: Field Survey, 2015; Note: Abundance Code: H= High; M= Medium; L= Low; NA= Not available

218. Table 5.17 reveal that fish species like *Taki, Shol, Cheng, Puti, Koi, Shing, Puti, chingri* etc are commonly found in the polder area in abundance. These species contribute about 75 % of total fish production. Once brackish water fish species like Koral/Vetki, Pairsa, Topse and fresh water fish species e.g. *Rui, Catla, Ayre* were commonly found in the internal khal. Presently their presence is rather limited. Production of these species has declined almost by 80% due to reducing water depth in the khal and damage of fishing ground due to siltation. According to local people, fish species like *Golda Chingri, Kathali Chingri, Goda Chingri* used to be in plenty during last decade in all habitats. At present they only found in the perennial khal but the quantity is negligible. This could be due to the presence of less salinity in the water bodies, obstruction of fish migration route, indiscriminate fishing by sluice net, and construction of closure. The dominant cultured fish species include Tilapia, Bighead, and Silver carp which contribute 80% of the total culture fish production. Besides, Pungus, Thai sarputi are reared in the fish pond for commercial purposes. Local people stated that the growth rate of those fishes is faster than other cultured fish and they need shallow water which is not the case for carp fishes (e.g. *Rui, Catla, Mrigel* etc.). Therefore, local fish farmers are more interested in shallow water habitat fish culture.

5.2.16 Threatened fish species

219. Threatened fish species, as reported by local fisher population and elderly people, those are becoming locally rare and unavailable over the 10-15 years are noted in Table **5.18**. The *Golda Chingri, Kathali Chingri, Goda Chingri, Pairsa, Koral* has become rare due to decreasing salinity in and surrounding water bodies of polder, obstruction of fish

migration route, indiscriminate fishing by sluice net . Big and depth water habituation fish species like *Boal, Ayre, Mrigel* etc are decreasing due to declining water depth and deteriorating water quality resulting from decomposition of duck weed, pesticides coming from rabi crop (water melon) field; and obstruction of fish hatchling due to improper and irregular operation of water control structures.

Table 5.18: List of threatened fish species

Scientific Name	Local Name	Local Status	
		Rare	Unavailable
Lates calcarifer	*Koral*	√	
Liza parsia	*Pairsa*	√	
Paradise threadfin	*Ramchos/Taposi*	√	
Aorichthyes aor	*Ayre*		√
Ompok pabda	*Pabda*		√
Macrobrachium rosenbergii	*Golda Chingri*		√
Macrobrachium villosimanus	*Kathali Chingri*		√
Macrobrachium dolichodactylus	*Goda Chingri*		√

Source: Field Survey, 2014

5.2.17 Fish Marketing and Post Harvest Facilities

220. Fish edible quality is good for human intake. But local people reported that pesticides coming from agriculture field especially watermelon field and decomposition of duck weed are causing deterioration of habitat quality as well as fish diseases which are not suitable for consumption.

221. Local fisher's sale bulk of their catch either directly in the local fish market at Amkhola, Galachipa or to the fish traders. The fish traders or buyers (Bepari) come from Galachipa Amtoli (Barguna), Patuakhali sadar, Barisal to purchase fishes. No structured fish-landing centers were found in the polder area. There is no ice factory inside the polder area. Ice is collected from Galachipa and Amtoli bazar for icing the harvested fish. No good fish storage facility is reported in the polder or in adjacent vicinity of the polder. Transportation facility at root level is moderately developed. There is no private hatchery inside the polder area. Availability of fish feeds for culture ponds is insufficient. Fish seeds for culture fishery are collected from the hatcheries and nurseries which are situated at Patuakhali. In addition to that fish feeds are also collected from the local market or to the mobile traders who comes from Khulna, Jessore and Barisal district.

5.2.18 Fisheries Management

222. There is no community based fishers association in the polder area. The fishers have full fishing rights and access to existing fish habitats. There is no leased water body in the polder. Department of Fisheries (DoF) has limited activity for fisheries resource conservation and management in this area. Some NGOs are working, but their programs are very much limited to micro credit rather than extension services and aquaculture training. Enforcement of fisheries regulation is weak in and outside the Polder area.

5.2.19 Bio-ecological Zones

223. IUCN has identified 25 bio-ecological zones (2002) in Bangladesh. The zonation is primarily centered based on physiographic, climate, soil type, flooding depth and biodiversity.These bio-ecological zones can be classified as major ecosystems of the country.

224. The polder area is situated at Auliapur, Jainkati, Amkhola, Gazalia, Golkhali and Atharagashia Union of Galachipa, Sadar and Amtali Upazila of Patuakhali and Barguna districts. The polder area encompasses one of the above noted 25 bio-ecological zones; namely the Ganges Floodplain.

The Ganges Floodplain

225. Ganges Floodplain is the active meandering floodplain of the Ganges River. The floodplain mainly comprises a smooth landscape of ridges basins and old channels. The Ganges channel is constantly shifting within its active floodplain, with consequent erosion of large areas of charlands in each flooding season. Both plants and animals move and adapt with the pattern of flooding (Brammer, 1996). The floodplain is characterized by mixed vegetation and support a habitat of rich bio-diversity to some extent for presence of a lot of stagnant water bodies and channels, rivers and tributaries. Homesteads forest is prominent with cultivated and wild plant species. In this zone, the dominant floral types are the Panimorich (*Polygonum orientale*), Jhanji (*Hydrilla verticillata*), Topapana (*Pistia strateotes*), Chechra (*Schenoplectus articulatus*), Sada Sapla (*Nymphaea nouchali*), Keshordam (*Ludwigia adscendens*), Kolmi (*Ipomoea sp*), Tamarind (*Tamarindus indica*), Panibaj (*Salix tetrasperma*) etc. Grasses are more abundant in the Ganges floodplain and begin to grow as soon as the floodwater begins to recede. *Cyperus rotundus, C. deformis, Eleocharis* sp*., Hemarthria* sp*.* etc are the notable grass species.

226. Major groups of oriental birds of different species are found in this zone. Also a large number of migratory birds come to this area during the winter. Additionally, different species of freshwater tortoise and turtles are found in the rivers and ponds. Among the amphibian species found in the area toads, frogs and tree frogs are well known. Foxes, jackals, rats, mice, squirrels, bats etc are common mammals of this zone.

5.2.20 Terrestrial Ecosystem

a. Terrestrial Flora

227. The major types of terrestrial ecosystem found within the polder area are as fallows-

Settlement/Homestead vegetation

228. The homestead vegetation is the important place for wildlife as well as birds. Homestead vegetation is the single most important plant community in polder area. Most of the households are vegetated by local plants. Amon the homestad plants, some are planted for their economic values and some are self propagating. The major tree species of homestead vegetation are shown in Table 5.19. According to the vegetation survey, several tree species are present in different canopy layers and their composition is similar all over the polder area. Common cultivated Plants are Aam *(Mangifera indica)*, Narikel *(Cocos nucifera)*, Supari *(Areca catechu)*, Chambul *(Albizia ricardiana)*, Silkoroi *(Albizia procera),* Raintree *(Albiza saman*), Mahogoni *(Swietenia mahagoni)*, Bamboo/Bash (*Bambusa Spp*.) and etc occupied the top canopy. Other trees, shrubs and herbs occupy lower canopies. Akand (*Calotropis procera*), Vaant/Bhat (*Clerodendron viscosum*), Hatisur (*Heliotropium indicum*), Swetkan (*Euphorbia thymifolia*), Bhui amla (*Phylanthus niruri*), Nata (*Caesalpinia bonduc*), Dudhikalmi (*Ipomoea alba*) Dhol Kolmi (*Ipomoea carnea*) are common species.

Table 5.19: List of plant species found in the homestead of the polder area

Local/English Name	Scientific Name	Abundance
Aam /Mango	*Mangifera indica*	L
Khejur /Date Palm	*Phoenix sylvestris*	H
Khoiya Babla	*Pithocelobium dulci*	M
Peyara/Guava	*Psitium guajava*	M
Raintree	*Samanea saman*	H
Amra	*Spondias dulcis*	M
Mahogoni	*Swietenia macrophylla*	H
Tetul	*Tamarindus indica*	M
Kul	*Ziziphus mauritiana*	L
Jamrul	*Syzygium samarangense*	M
Kodom	*Anthocephalas chinensis*	M
Krisnachura	*Delonix regia*	L
Chalta	*Dillenia indica*	H
Kola	*Musa sp*	H
Akasmoni	*Acacia auriculiformis*	M
Kalo Koroi	*Albizia lebbeck*	H
Sada Koroi /Sil Koroi	*Albizia procera*	H
Chambul/Raj Koroi	*Albizia richardiana*	H
Supari	*Areca catechu*	H
Kanthal	*Artocarpus heterophyllus*	L
Bamboo/Bash	*Bamboosa spp.*	M
Tal	*Boassus flabellifer*	H
Shimul	*Bombax ceiba*	M
Jambura	*Ciitrus grandis*	L
Narikel/Coconut	*Cocos nucifera*	H
Sisoo	*Dalbergia sissoo*	M
Eucalyptus	*Eucalyptus camaldulensis*	L
Kotbel	*Limonia acidissima*	M

Source: CEGIS field survey, 2015 *(Note: Abundance Code, H= High, M= Medium, L= Low)*

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

Photo 5.16: Homestead vegetation in the polder 43/2B

Crop field vegetation

230. A part of crop field also remains fallow during March-June. During thei period, the land gets covred with grassy vegetation and wild herbs. Durba (*Cynodon* sp.*)* is prevalent with *Echinocola, Brachiara, Digiteria, Hemarthrira, cyperus and Paspalum* spp. among the grass species. *Croton, Xanthium, Amaranthus* are also grown sporadically along with grasses. The seasonal fallow lands have important roles in ecosystem functioning namely, support grazing for cattle, feeding and breeding habitats of many arthropods, reptiles and avifauna.

Photo 5.17: View of crop field vegetation in the polder 43/2B

Embankment /Village Road and Bank side vegetation

231. Along the village road major species found are: Tal (*Boassus flabelifer*), Narikel (*Coccos nucifera*), Suparee (Areca catechu), Khejur (Phoenix sylvestris) etc. Akand (Calotropis procera), Vaant (*Clerodendron viscossum*) and Hatisur (*Heliotropium indicum*). Common wild shrubs and herbs are also sighted along most of the roadsides.

232. Riverside embankment is exclusively dominated by Babla *(Acacia Arabica),* Sirish (*Albizia odoratissima),* Chambul/Raj koroi *(Albizia richardiana),* Kola *(Musa sp),* Bash *(Bamboosa spp).* Vegetation of this type supports good habitats for local avifauna.

233. There is another type of vegetation found along river and khal bank side of the polder area. Different types of marginal herbs like Narikel (*Coccos nucifera*), Dholkolmi (*Ipomoea aquatic*), Bishkatali (*Polygonum sp*.), Mutha gash (*Cyperus sp*), Kasorti (*Eclipta sp),* etc are dominant in the river and khal banks.

Photo 5.18: View of embankment side vegetation

Photo 5.19: View of bank side vegetation

Photo 5.20: View of villege road side vegetation

b. Terrestrial fauna

234. The fauna is environmentally interacted in the process of ecosystem. Terrestrial fauna in the polder area are described in accordance with their hierarchy.

Amphibians

235. Amphibian species favor wetland areas and the marginally dry 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 favor all of these amphibian species.

Reptiles

236. Among the reptiles, House Lizard (*Hemidactylus brookii*), Common Garden Lizard (*Calotes versicolor*), Common Kukri Snake *(Oligodon arnenesis*), Buffstriped Keelback (*Amphiasma stolata*), Kal Keotey/ Common Krait *(Bungarus caeruleus),* Rat Snake (*Ptyas mucosus*), Monocellate Cobra (*Naja kaouthia*) and Spotted Pond Turtle (*Geoclamys hamiltonii*) have been seen within polder area. Habitats belongs to these species are homestead, cropland and garden vicinity.

Mammals

237. Common mammals are concentrated in village grooves (homestead forest), wetlands, road and embankment sides and crop fields. Small mammals, such as Pati Shial (*Canis aureus*), Grey Mask Shrew (*Suncus murinus),* Khatash/Bagdash/Small Indian Civet (*Viverricula indica*), Common Mongoose/Beji (*Herpestes edwardsii*), Dharia/Ud/Otter (*Lutrogale perspicillata*), Fish Cat/Mesho Bagh/Jungle Cat (*Perionailurus viverrinus*), Bengal Bandicot Rat (*Bandicota bengalensis*), Common House Rat (*Rattus rattus*), Five stripped palm Squirrel (*Funambulus pennanti*), and Short-nosed Bat (*Cynopterus sphinx)* are found in village grooves or crop fields of the polder area.

Birds

238. 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 grassland. 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 polder 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 Larged-billed crow (*Corvus macrohynchos*).

5.2.21 Aquatic ecosystem

239. There are more than 380 ha of wetland inside the polder. Wetland provides ecosystem sustainability. It contains rich variety of flora and fauna and mostly provides food and habitat to the aquatic fauna. The wetlands are divided into two major categories; seasonal and perennial wetland.

240. Seasonal wetland holds water for 3-4 months and is usually flooded during rainy season. Seasonal wetland creates mainly floodplains and an important grazing ground for fishes.

241. Perennial wetland contains water for during the whole year. Perennial wetlands are good shelter for most of the aquatic flora and fauna. In the polder area, homesteads pond and khal are the perennial wetlands.

a. Aquatic flora

242. Within the polder area ponds and khals contain different types of aquatic floras such as free floating, rooted floating, submerged and amphibian vegetations like sedges and meadows.

243. Free floating plants are also common throughout the polder area. Kochuripana (*Eichhornia crassipes*), Kutipana (*Azolla pinnata*), Topapana *(Pistia stratiotes)*, Kuripana *(Salvina cucullata)*, Khudipana *(Lemna perpusilla)* are most dominant in this type of vegetation.

244. Shapla *(Nymphaea nouchali/ N. stellata)*, Chandmala *(Nymphoides* sp.) are top frequent rooted floating plants available all the floodplains, homesteads ponds and ditches.

245. Submerged plants exist in both perennial and seasonal wetland. Jhangi (*Hydrilla verticillata),* Ghechu (*Aponogeton natans),* Bicha (*Vallisneria spiralis)* are commonly found in the area.

246. Sedges and meadows plants consist of amphibian plants. This type has the highest species diversity and is one of the most important wetland plant communities in the polder area. They include Dhol kolmi (*Ipomoea aquatic),* Kochu (*Colocasia* spp.) and Helencha *(Enhyra flactuans).*

247. The intertidal plains are exclusively dominated by Hogla (*Typha elephantalis*), and local brackish grasses species like Chaila gash (Hemarthria protensa). In addition, patches of Ora *(Sonneratia caseolaris),* Hogla/Patipata (*Typha elephantalis)* trees are observed sporadically on the torus and along riverside toe of the embankment.

Photo 5.21: Internal Khal silted up by Kochuripana

Photo 5.22: Ora *(Sonneratia caseolaris)*, a brackish aquatic plant is very common in the polder area

b. Aquatic fauna

248. 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. A brief description of aquatic fauna is presented below.

Amphibians

249. Among amphibians, the skipper frog *(Euphlyctis cyanophlyctis)* is common and found in all wetland. Bullfrogs *(Hoplobactruchus tigerinus)* are also found frequently during monsoon.

Reptiles

250. Snakes are the main type of aquatic reptiles of the polder area. Common aquatic snakes include the checkered keelback *(Xenocrophis piscator),* smooth water snake *(Enhydris enhydris),* Rat snake *(Ptyas mucosus),* and Common wolf snake *(Lycodon aulicus)* and are found in all types of wetlands.

Avifauna

251. Availabilities 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 *(Casmerodious albus),* Common Kingfisher *(Alcedo atthis),* Little Cormorant *(Phalacrocorax niger*), Grey Heron *(Ardea cinerea),* Indian pond heron *(Ardeola grayii*) are frequently found along mudflats, canal systems and seasonal wetlands throughout of the year. During winter, moderate number of migratory birds roams along the riverside of the polder. Fresh water Snail and Oyster are also commonly found in all floodplains and even in perennial water bodies.

5.2.22 Ecosystem services

252. UNEP defines ecosystem as a dynamic complex of plant, animal, and microorganism communities and the nonliving environment, interacting as a functional unit. Humans are an integral part of ecosystems (http://www.unep.org/dewa/assessments/ecosystems;12 May, 2015). Ecosystem services are the tangible and intangible benefits people obtain from ecosystems. These include provisioning services such as food and water; regulating services such as flood and disease control; cultural services such as spiritual, recreational, and cultural benefits; and supporting services, such as nutrient cycling, that maintain the conditions for life on earth.

253. Healthy ecosystems provide both goods (tangible benefits) and services (intangible benefits) to humanity. Here, goods refer to items given monetary value, whereas the services from ecosystems are valued, but are rarely bought or sold. Ecosystem "goods" includes foods, construction materials, medicinal plants and tourism.

254. On the other hand, ecosystem "services" includes maintaining hydrological cycles, regulating climate, shelterbelt, cleansing water and air, maintaining the gaseous composition of the atmosphere, pollinating crops and other important plants, generating and maintaining soils, storing and cycling essential nutrients, absorbing and detoxifying pollutants; providing aesthetic beauty and recreation.

255. The table below represents few tangible ecosystem goods (but not limited to) from different common plants of the polder areas.

Goods/Services/ Purpose	Name of Plants	Plants Parts used by local people
Food	Supari *(Areca catechu),* Narikel *(Cocos nucifera),* Aam *(Mangifera indica),* Jam *(Syzygium sp),* Kola (*Musa sp),* Safeda *(Manilkara zapota),* Payara (*Psidium guajava)*, Tal *(Boassus flabellifer),* Amra *(Spondias pinnata),* Katbadam *(Terminalia catappa),* Boroi *(Ziziphus jujuba),*	Fruit
	Ghechu (*Aponogeton spp*.)	Rootstock
	Helencha (*Enhydra fluctuans)* and Kolmishak (*Ipomoea aquatica*)	Leaf and stem
Fodder	Kochuripana, (*Eichhornia crassipe*), Ipil Ipil (*Leucaena leucocephala*)	Leaf and stem
Timber	Aam *(Mangifera indica),* Jam *(Syzygium sp),* Babla *(Acacia nilotica),* Mahogany (*Swietenia mahagoni),* Neem *(Azadirachta indica),* Akashmoni *(Acacia auriculiformis),* SadaKoroi /SilKoroi *(Albizia procera),* Chambul/Rajkoroi *(Albizia richardiana),* Sisoo *(Dalbergia sissoo),* Raintree *(Samanea saman),*	Tree Trunk, Bole
Medicine	Tetul (*Tamarindus indica),* Tulshi *(Ocimum americanum),* Sezi/Dudhiya *(Euphorbia antiquoram),* Bel *(Aglemarmelos),* Jat Neem *(Azadirachta indica),* Arjun *(Terminalia arjuna),* Gab *(Diospyros perigrina),*	Roots, Leaf, Bark, fruit
Thatching and mat making	Supari *(Areca catechu),* Narikel *(Cocos nucifera),* Tal *(Boassus flabellifer),* Hogla/Patipata (*Typha elephantalis*), Golpata (*Nypa fruticans*), Bamboo (*Bambusa spp.)*	leave
Fuel	Babla *(Acacia nilotica)*, Raintree *(Samanea saman),* Akashmoni *(Acacia auriculiformis),* Boroi *(Ziziphus jujuba),* Aam *(Mangifera indica),* Khoiya Babla *(Pithocelobium dulci),*	Branches, Leaf
Organic Fertilizer (compost)	Kochuripana (*Eichhornia crassipes*), Topapana (Pistia stratiotes), Khudipana (*Lemna perpusilla*) and other aquatic plants.	All parts of the pant

Sources: CEGIS Field Survey 2015 (Note: Abundance Code, H= High, M= Medium, L= Low)

5.2.23 Present threats on ecosystem

a. Terrestrial flora

256. Local people reported that river erosion, lack of appropriate knowledge about homestead plant biodiversity, improper maintenance of embankment and sluice gates and internal canal bed siltation are the main problem to sustain terrestrial flora in the polder area. Every year (Dari baherchar and Jainkati village) homestead, roadside and mainly riverside vegetation gets affected by river bank erosion. Pests and diseases attack, improper homestead space planning, utilization and natural disaster are other problems also.

b. Terrestrial fauna

257. Local people reported that Mammals' and poisonous snake population is very low in the polder area due to human settlement, development activities and anthropogenic disturbances. Big mammals have already been disappeared, because of changes in land use, jungle cutting and different human activities.

258. Several species listed in the IUCN *Red Data Book and of relevance to polder ecosystem* are given below.

Local/ Common name	Scientific name	Local status	IUCN status	Cause of threat
Pati Shial/Golden Jackal	*Canis aureus*	Rare	Vulnerable	Hunt and habitat loss
Khatash/Small Indian Civet	*Viverrricula indica*	Rare	Vulnerable	Habitat loss
Kal Keotey/ Common Krait	*Bungarus caeruleus*	Common	Endangered	Hunt and habitat loss
Spotted Pond Turtle/Kalo Kachim	(*Geoclamys hamiltonii*)	Rare	Endangered	Hunt and habitat loss

Source: CEGIS Field survey, 2015 and Red Data Book of IUCN Bangladesh.

c. Aquatic fauna

259. The hydrological cycle and the presence of perennial and seasonal wetland provide a diversified habitat for all biota. The life cycle of the aquatic or wetland dependent fauna is dependent on the aquatic ecosystems natural fluctuations and isolation or connectivity with nearby wetlands. In the dry period, most of the wetlands in these areas remain completely or partially dry. Some species have not adapted to the altered environment whilst others have flourished. Common Smooth Water Snake, Dhora shap Aquatic and water-dependent birds are severely affected by the alteration of the natural habitat. Wetland degradation has left very little or no shelter place for waterfowl to roost or nest.

260. On the other hand, numerous kinds of snail and oyster can be found in fresh water of khal and river. A fresh water snail is one kind of fresh water mollusk, the other kind being fresh water clams and mussels. Specifically fresh water is a gastropod that lives in a watery non marine (fresh water) habitat. Gastropods have successfully colonized fresh water environments. Oyster influences nutrient cycling, water filtration, habitat structure, biodiversity and food web dynamics. Oyster feeding and nutrient cycling activities could rebalance in fresh water ecosystems. Benthic species like snails, oyster etc. often gets displaced leading to death due to re-excavation of khal. Deterioration of snail and oyster production, in turn also hampers fish health and production indirectly impact the aquatic ecosystem.

5.2.24 Livestock and Poultry

261. A large number of populations of the polder area earn their livelihood through work associated with raising livestock and poultry. According to local people, there are about 100 small poultry farms in the polder area. Detailed status of livestock and poultry and invlovment of number of households in these activities is presented in Table 5.20

Table 5.20: Status of Livestock/Poultry in the Polder Area

Live Stock/Poultry	% of Household	No. Livestock/Poultry in the Polder Area
Cattle/cow/bullock	65	10,491
Buffalo	22	3,551
Goat	35	5,649
Sheep	5	1,211
Chicken	65	26,228
Duck	40	12,912
Pigeon	2	646

Source: Based on field information, 2015 and Upazila Livestock Office.

Feed and Fodder

262. The owners of the livestock population are facing problems with respect to 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, are used as feed in this polder. But, during the dry season (especially from late December to late April) land is available for grazing, but then there is shortage of grass due to salinity. Poultry population and ducks survive by scavenging and generally no feed supplements are provided.

Photo 5.23: Rice straw for cattle feed

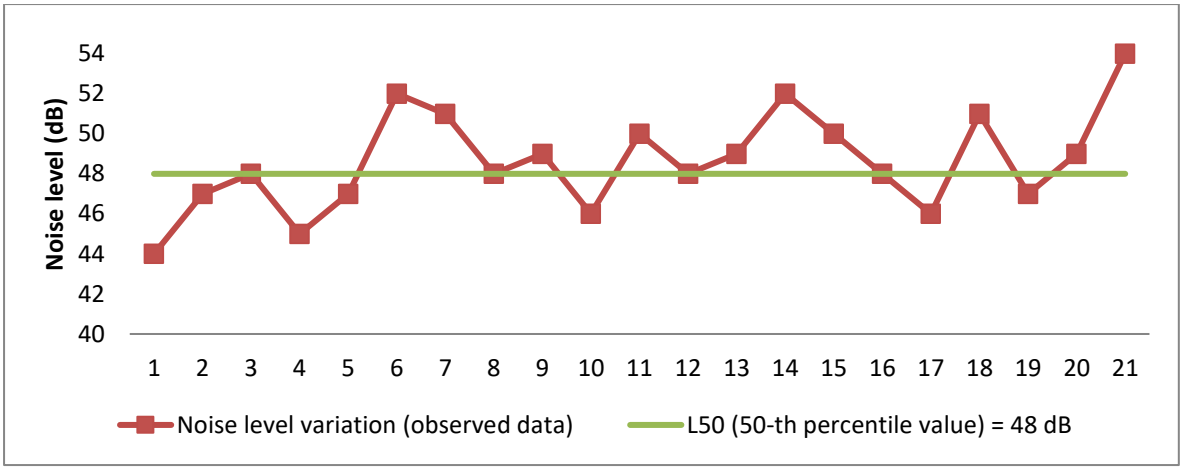
Livestock and Poultry Diseases

263. Rearing of livestock and poultry birds 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 Peste 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.

5.3 Environmental Quality

5.3.1 Sound Quality

264. During field work, sound levels were measured at Amkhola bazaar (near Amkhola Sluice) with 10 minute sampling period. The L_{50} (50-th percentile value) value was computed with the observed sound levels. For a normal time series distribution of sound levels, L_{50} is assumed to be equal to Leq, which is the Equivalent Noise Level. In the study area, the L_{50} value was found as 48 dB, which is lower than the standard Leq value for residential zone set by ECA 1997 (50 dB). As the project implementation works are to be carried out manually i.e. without the use of any typical heavy loaded vehicle, it can be assumed that the sound generation from the construction works would be limited and will have very minor contribution in the overall noise levels of the polder.



Source: CEGIS field survey, January 2015; N.B.: All values were collected during day time

Figure 5.10: Variation of sound levels for 10 minute sampling period at Amkhola bazaar (22º14'20.5''N and 90º23'46.1''E)

5.3.2 Water Quality

265. Five major water quality parameters (pH, TDS, Temp., DO and Salinity) were measured on site in January 2015, from four different sampling locations of the polder. The results of the in-situ water quality measurements are shown in Table 5.21 below.

Photo 5.24: In-situ water quality measurement in Polder 43/2B

Table 5.21: Salinity levels in different locations

Location	Sampling Water Source	GPS readings	pH	TDS (ppm)	Temp. (ºC)	DO (mg/l)	Salinity (ppt)
Bauria Sluice	Tabalbaria river, Outside the polder	22°11'47.0"N 90°22'27.5"E	7.93	164	23.9	5.3	0
Nosaisil sluice	Tabalbaria river, outside the polder	22°14'09.7"N 90°20'49.8"E	7.69	189	27.1	5.7	0
Boloikati, Dari Baherchar	Lohalia river, inside the polder	22°17'38.0"N 90°22'08.1"E	7.51	134	23.2	4.9	0
Amkhola Sluice	Amkhola khal, inside the polder	22°14'33.2"N 90°23'47.8"E	7.92	129	24.8	4.7	0

Source: CEGIS field survey, January 2015

266. The pH values, in the sample sites (see Table 5.21 above) were higher than neutral value (pH=7) which means that the water in these locations is alkaline during January. Values of DO were mostly found close to the standards set by the DoE for both irrigation (5 to 6 mg/l) and fishing (5 mg/l). Temperature values varied within a typical range for different locations as sample tests were carried out at different times of the day. Furthermore, all samples were found with zero salinity. Local people claimed that no surface water salinity exist in the area in dry season (December to February). March and April are only two months where surface water system outside the polder becomes slightly saline. It can be inferred that due to the increased amount of freshwater recharge from the Meghna river system, surface water salinity in the South Central hydrological region is low, and for the local people it is not a major concern.

5.4 Climate Change

5.4.1 Climatic Trends

The following section provides information extracted for the hydrological regions of Bangladesh using the PRECIS model. The downscaled information was produced in a CEGIS study on national and sub-national climate change modeling (CEGIS, 2014).

Temperature

Figure 5.11 below shows the changing trend of average temperature in the existing hydrological regions of Bangladesh. In contrast to the other hydrological regions of the country, the temperature of the South-Central region (the region where the Polder 43/2B is located) shows a decrease of 0.73°C in every 100 years.

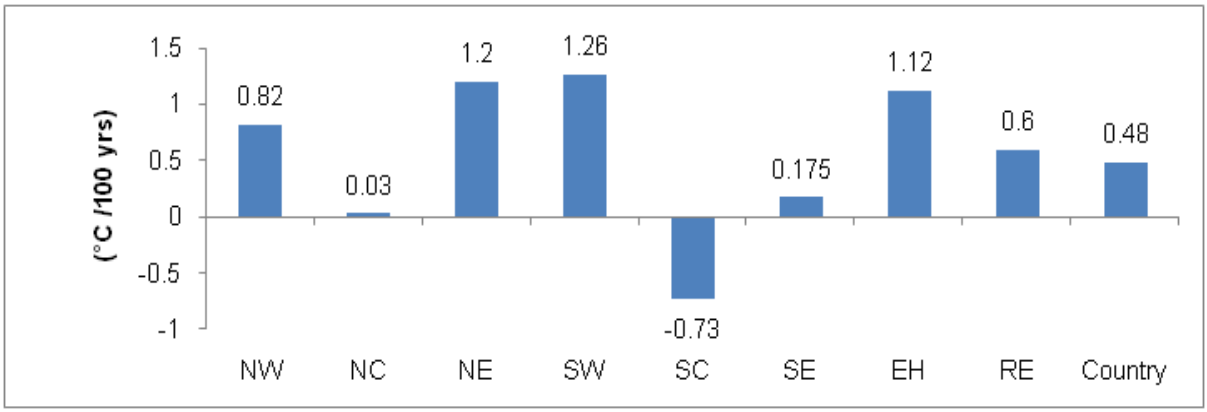


Figure 5.11: Change in average temperature in different regions (CEGIS, 2014)

Table 5.22 represents a comparison of temperature variation for each BMD station located within the South-Central hydrological region. The Table shows that average temperature has decreased by 0.9^0C in hundred years in Patuakhali, whereas the country as a whole observed an increase of average values by 0.48^0C in hundred years.

Table 5.22: Trend analysis for temperature of the South Central Region (CEGIS, 2014)

Hydrological Region	Station	Temperature Change, °C per 100 years				
		Max	Avg. Max	Min	Avg. Min	Avg.
South Central	Faridpur	4.4	2.59	1.7	2.45	0.4
	Madaripur	-0.8	0.43	1.4	4.53	-3
	Barisal	0.7	2.89	-3.8	2.25	-0.5
	Bhola	-0.2	0.8	-0.4	0.9	1.1
	Patuakhali	2.8	4.74	-3.3	-0.96	**-0.9**

Hydrological Region	Station	Temperature Change, °C per 100 years				
		Max	Avg. Max	Min	Avg. Min	Avg.
	Khepupara	1.7	3.0	-5.2	0.8	-1.5
Country Average		*-0.32*	*2.63*	*-0.47*	*1.38*	***0.48***

Source, CEGIS, 2015

Rainfall

The variation of rainfall in pre-monsoon, monsoon and post-monsoon seasons of different representative districts (from different hydrological regions) are shown in Figure 5.10 below. The pre-monsoon and post-monsoon rainfall patterns show increasing trends for all the selected stations. Barisal, one of the representative locations of the South-Central region, however has very negligible change. It can therefore be concluded that the long term seasonal variations of rainfall in Patuakhali will also be very negligible.

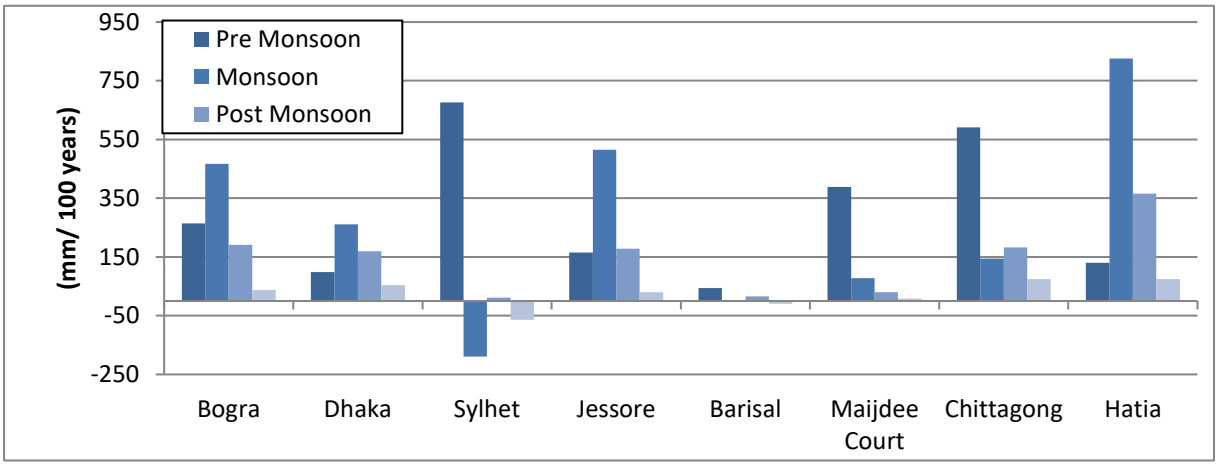


Figure 5.12: Long term seasonal variation of rainfall for selected stations (CEGIS, 2014)

5.4.2 Climate Change Projection

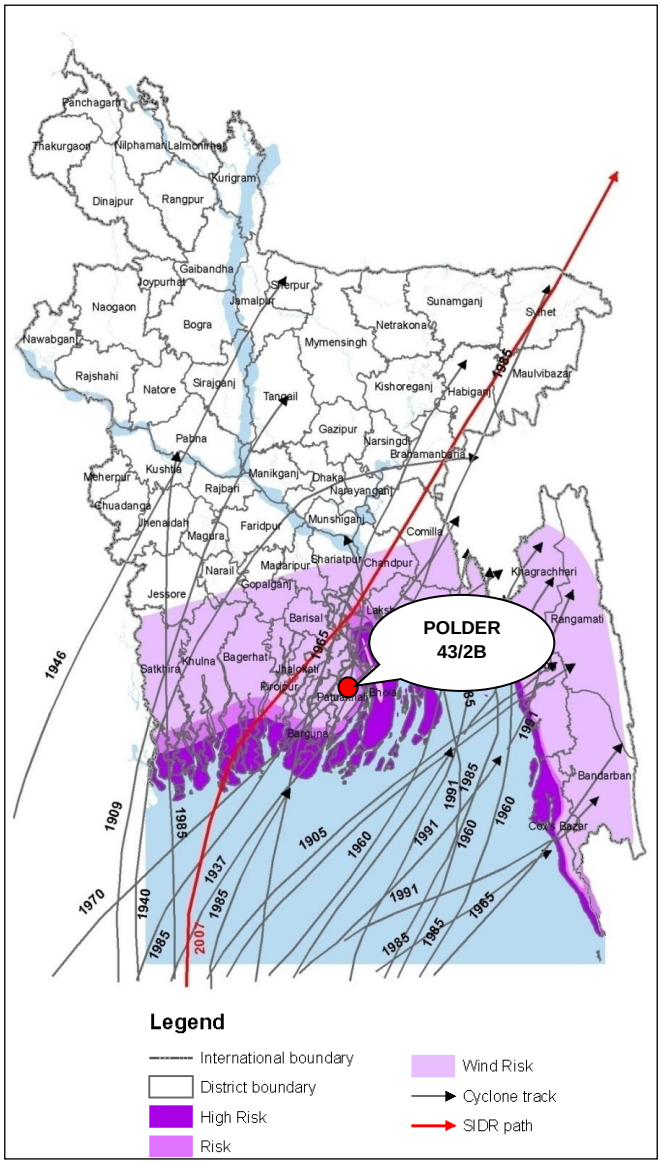
Two greenhouse gas emission scenarios, A1B and A2 were used from the Special Report on Emissions Scenarios by Intergovernmental Panel on Climate Change (IPCC), 2007, for investigating climate change projection. A2 is the business-as-usual scenario, which is a very heterogeneous, market-led world, with high population growth, slow economic development, and slow technological change. A1B on the other hand, is the scenario which has been developed providing balanced emphasis on all potential energy sources (here balanced is defined as not relying too much on one particular energy source, on the assumption that similar improvement rates apply to all energy supply and end-use technologies) (Table 5.23).

Table 5.23: Summary of climate projections for 2050 in Patuakhali (CEGIS, 2014)

Parameter	Scenarios	
	A1B	A2
Maximum Temperature	The average monthly maximum temperature may increase by 1.5^{0}C in March-May and 2^{0}C in December-February.	The average monthly maximum temperature may increase by 1.5^{0}C in March-May and 2^{0}C in December-February.
Minimum Temperature	The average monthly minimum temperature may rise by 1^{0}C in March-May and 1.5^{0}C in December-February.	The average monthly temperature may increase by 2^{0}C in March-May and 3^{0}C in December-February.
Seasonal Rainfall	Seasonal rainfall may increase up to 100 mm in June-August	Seasonal rainfall may increase up to 100 mm in June-August

5.4.3 Cyclones and Storm Surges in Polder 43/2B

267. Tropical cyclones from the Bay of Bengal accompanied by storm surges are one of the major disasters in the coastal region of Bangladesh. The high number of casualties is due to the fact that cyclones are always associated with storm surges, sometimes with surge heights of more than 9m. The 1876 cyclone had a surge height of 13.6 m and in 1970 the height was 9.11 m (Department of Disaster Management, GoB)[1]. Observing the tracks of different cyclones affecting the country, the country's southern portion has been classified into three risk zones namely high risk zone, risk zone, and wind risk zone (Map 5.11). Polder 43/2B falls in the wind risk zone which is vulnerable to strong winds and surge heights associated with cyclones.



Map 5.12: Cyclone tracks in Bangladesh and risk areas

268. Field observations have revealed that the polder suffered massive damages during SIDR (2007) at some locations. A number of places in Dari Baherchar, Bauria along the eastern periphery of the polder were damaged due to high storm surge along the Lohalia river. Local people informed that 12 people died at Mollabari (Gerabunia mauza) during SIDR due to the heavy strike of storm surge along the western side of the polder. Besides, some water control structures (Musurkati sluice outlet, Bauria sluice, Amkhola sluice etc. and some other inlets along the Lohalia River) were heavily damaged.

[1] http://old.ddm.gov.bd/cyclone.php

6. Socio-economic Condition

269. The socio-economic condition of the people living in 'Polder 43/2B EIA' (i.e the study area) is described in this chapter. In doing so, primary data were collected using RRA techniques including Key Informant Interview (KII), Focus Group Discussion (FGD), observation and public consultation. Moreover, relevant secondary information were compiled from the community series of the Population Census 2011 published by the Bangladesh Bureau of Statistics (BBS).

270. The socio-economic baseline situation of the study area is described in following sections.

6.1 The people

6.1.1 Demography

271. The polder is the home of 36,425 people living in 8,070 households. Of the total population 17,620 are male and 17,805 are female. In the polder number of female population is higher than the male. The average male-female sex ratio is 93. This means there are 93 males per 100 females which is lower than the national figure of 100.3 (BBS 2011). The average density of population is 491 persons per sq. km which is nearly half of the national density of 1,015 persons per sq. km. The inhabitants of this polder belong to three religious group; i.e., the Islam, Hinduism and Buddhism. About 96% of total populations are Muslim and the rests are Hindu and Christian. The demographic data of the polder is presented in Table 6.1.

Table 6.1: Distribution of population and households per different unions of the polder

Union	Total HHs	Population			Sex Ratio	Population density [sq. km]
		Both	Male	Female		
Auliapur	1172	5476	2619	2857	92	552
Jainkati	10	25	12	13	96	303
Amkhola	5639	25418	12319	13099	94	540
Gazalia	20	84	39	45	88	486
Golkhali	302	1356	663	693	96	543
Atharagashia	928	4067	1969	2098	94	524
Total/Average	**8,070**	**36,425**	**17,620**	**18,805**	**93**	**491**

Source: Population Census 2011, BBS

Age Structure

272. About 37% of the population is young and are less than 14 years old. 65% belongs to age bracket of 15 to 59 years of age, and 9% are over 60 years of age. However, a disaggregated analysis of population data as per various age groups shows that 31% of total population falls between 30-49 years age category. On the other hand, the data shows that around 47 percent of the population depends on the 53 percent earning members of their households. Hence the dependency ratio[2] is 88 which are higher than national rate 56. BBS data also shows each of the union comprises almost similar ratio. Details of the age structure are shown in the table (**Table 6.2**).

[2] Dependency ratio refers to ratio of dependent population (population aged up to 14 years and above 59 years) to the working age population (population aged between 15 to 59 years).

Table 6.2: Age distribution at polder 43/2B

Union	Percentage of population in the age group									
	0-4	5-9	10-14	15-19	20-24	25-29	30-49	50-59	60-64	65+
Auliapur	10	14	14	8	8	8	22	7	4	6
Jainkati	10	14	13	7	8	8	24	7	4	6
Amkhola	11	14	12	7	7	8	23	7	4	7
Gazalia	11	15	12	6	7	8	23	7	3	7
Golkhali	11	14	12	7	8	9	23	7	3	6
Atharagashia	11	14	12	6	7	8	24	8	4	6
Total/Average	**11**	**14**	**12**	**7**	**8**	**8**	**23**	**7**	**4**	**6**

Source: Population Census 2011, BBS

Household size

273. The following **Table 6.3** gives the distribution of persons per household over various unions of the polder. It is found that 4 memebrs household is the dominant category, and 24% households are in this group. On the otherhand single person household stands to 3%, being the lowest. The average size[3] of household in the study area is 5, which is slightly higher than that of national average of 4.5. When population distribution data is analysed per union it appears that bigger size of the household with an average membership of 4.7 & 4.6 are in Auliapur and Jainkati union. Conversely the smallest household size with average membership of 4.4 is in Gazalia and Atharagashia unions.

Table 6.3: Distribution of household members at polder area

Union	Percentage of Households comprising								Average size of Household
	1 person	2 persons	3 persons	4 persons	5 persons	6 persons	7 persons	8+ persons	
Auliapur	2.5	9.3	17.3	22.6	19.9	12.9	7.2	8.4	4.7
Jainkati	4.2	8.4	16.5	22.3	21.5	12.7	6.4	8.0	4.6
Amkhola	2.2	9.6	17.2	25.5	21.2	11.9	5.8	6.6	4.5
Gazalia	3.0	10.7	19.2	23.8	20.8	11.9	4.8	5.9	4.4
Golkhali	2.0	8.6	17.7	26.7	21.3	12.3	5.9	5.6	4.5
Atharagashia	3.3	10.8	18.1	25.0	20.2	11.3	5.8	5.4	4.4
Total/Average	**3**	**10**	**18**	**24**	**21**	**12**	**6**	**7**	**5**

Source: Population Census 2011, BBS

6.1.2 Education

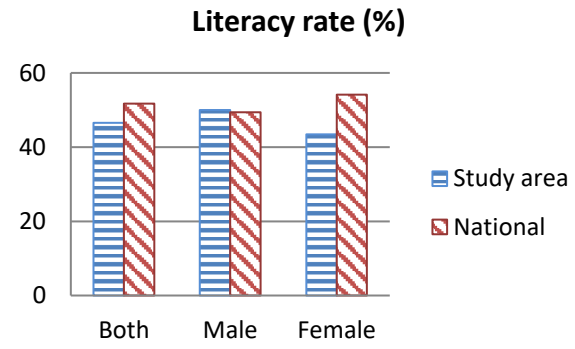
Literacy rate

274. The average literacy rate in the study area is 48% which is slightly lower than the national level (52%) (**Table 6.4**). Data confirms that like the national picture of Bangladesh (Male 54.1% and Female 49.4%), in the study area the male population are more educated than the female counterpart, the rate being 51% for male with 45% for female. Data also shows Amkhola union has the lowest literacy (45%). Local people opined that, unemployment and lack of communication facilities are the main reason for low literacy rate. However, they recognize that they have to overcome this.

[3] HIES 2010 refers to Household Income and Expenditure Survey conducted by the Bangladesh Bureau of Statistics (BBS) in 2010.

Table 6.4: Literacy rate at polder 43/2B area

Union	Both	Male	Female
Auliapur	54	57	51
Jainkati	48	51	45
Amkhola	45	49	41
Gazalia	49	51	48
Golkhali	46	47	44
Atharagashia	44	49	40



Source: Population Census 2011, BBS

Field findings reveals that there are 48 primary schools, 15 high schools and 17 Ebtedaye/ Dakhil Madrashas in the polder area (**Table 6.5 & Photograph 6.1**). There are also five colleges (three intermediate and two degree colleges) in the polder area *(Source: CEGIS field work, 2015).*

Table 6.5: Education Institutions in the Polder

Union Name	No of Primary School	No of Madrasha	No of High School	No of Collage
Auliapur	12	1	5	-
Jainkati	07	5	5	-
Amkhola	10	03	07	01
Gazalia	03	03	02	01
Golkhali	12	04	04	02
Atharagashia	04	01	02	01
Total/Average	**48**	**17**	**25**	**05**

Source: CEGIS field work, 2015

Photo 6.1: Local educational institution at Polder area

6.1.3 Health

Access to health service

275. The there are 6 union health complexes and 22 community clinics. These health centers are not adequately functioning (**Table 6.6 Photograph 6.2**). As a result, for health services, local people visit the hospitals in Barguna or Patukhali. However, it is observed that communication within the polder areas as well as from the polder to the Upazila headquarters is not good and some parts of the existing road network are under threats of erosion. Notwithstanding, the above noted bad road networks, they are tend to go upazila or district hospitals when the patients reach critical conditions. Local people emphasized the need and urgency of repairing the damaged road networks as early as possible.

Table 6.6: Health service facilities in the study area

Union Name	Upazila Health Complex	No of Union Health Complex	No of Community Clinic	Outside of Polder health facilities
Auliapur	-	1	5	Patuakhali Sadar
Jainkati		1	3	,,
Amkhola	-	1	4	,,
Gazalia	-	1	3	Patuakhali Sadar, Barguna sadar
Golkhali		1	3	,,
Atharagashia		1	4	,,
Total/Average	**-**	**6**	**22**	-

Source: CEGIS fieldwork, 2015

276. Field survey also confirmed that nearly 45 percent people receive health services from *quack* doctors and 30 percent from paramedic/ diploma-holder physicians and only 10 percent from trained and qualified doctors**.** It is noteworthy that about 5 percent can not afford to any medical service due to impoverishment. People reported that the previous preference for going to the local healer for treatment has been gradually replaced by visit to registered/trained physicians. Economic wellbeing and level of awareness could be the reasons for this change.

Photo 6.2: Amkhola UP Hospital

Prevalence of diseases

277. The Population Census, 2011 identified six types of disabilities and their proportionate distribution per union is presented in the Table 6.7 below. In the study area 1.5% of the total populations have some kind of disabilities. Among the six types of disabilities, physically challenged ranks high with 0.6%. (**Table 6.7**). Local people opined that the incidence of Influenza/Common fever is the most prevalent ailment during dry season whereas cough/cold, skin diseases are common in r winter.

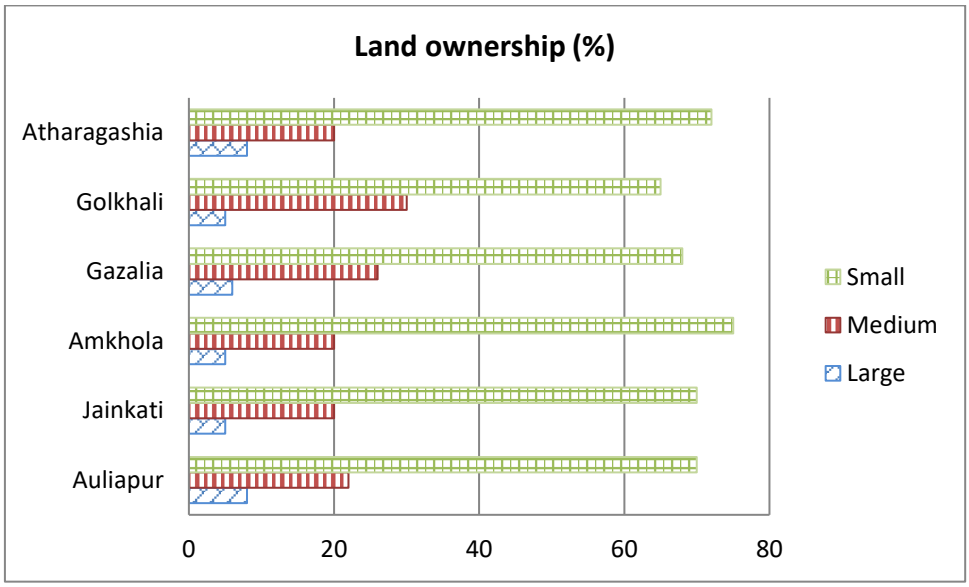
Table 6.7: Proportionate of available disability in polder area

Union	Type of disability (%)						
	All	Speech	Vision	Hearing	Physical	Mental	Autism
Auliapur	1.5	0.3	0.3	0.2	0.5	0.2	0.1
Jainkati	1.4	0.2	0.4	0.2	0.5	0.1	0.0
Amkhola	1.5	0.2	0.3	0.1	0.6	0.2	0.1
Gazalia	1.8	0.2	0.4	0.1	0.7	0.2	0.2
Golkhali	1.2	0.2	0.2	0.1	0.5	0.1	0.1
Atharagashia	1.8	0.2	0.5	0.2	0.7	0.2	0.1
Average	**1.5**	**0.2**	**0.3**	**0.1**	**0.6**	**0.2**	**0.1**

Source: Population Census 2011, BBS

6.1.4 Ownership and utilization of land

278. Landownership pattern[4] can be an indicator to understand the poverty incidence in a given area. Statistics shows that there are 70% smallholders, 23% medium and only 6% large landholders. In the study area, arable land is mainly used for crop production. Generally small and medium landholders cultivate variety of crops in these lands. They however, cannot harvest the full potential from their land due to drainage congestion and siltation of water bodies. (**Figure 6.1**).



Source: BBS, Agriculture Census, 2008

Figure 6.1: Landownership pattern in polder area

279. Land price in the study area is increasing day after day like other parts of Bangladesh. According to the local people, price of agricultural land is relatively low. The price of commercial land is the highest in comparison to homestead or agricultural land. The details on land price are shown in the **Table 6.8**.

[4] Agricultural Census by BBS (2008) defined farm holding into three broad categories such as- a) small: having minimum cultivable land 0.05 acre but operate 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.

Table 6.8: Sell value of land at polder 43/2B

Land type	Sale value	Year
Homesteads land	Taka 3.5-4 lacks per decimal (depends on location)	2015
Agricultural land	Taka 10,000-15,000 per decimal	2015
Commercial land	Taka 2-2.5 lacks per decimal (depends on location)	2015

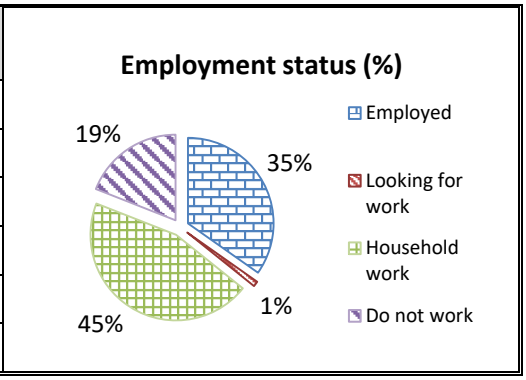
Source: CEGIS fieldwork, 2015

6.1.5 Occupations and livelihoods

280. In the polder area, those who are age 7+ their employment status is about 35%. Of the rest 45% is engaged in household work, only one percent is looking for work and about 19% of total population is not working (it includes children and physically challenged population). **Table 6.9** shows the employment status of the people in the Polder area.

Table 6.9: Distribution of employment status by polder area

Union	Employed	Looking for work	Household work	Do not work
Auliapur	32.0	0.5	43.0	24.5
Jainkati	34.5	0.5	49.3	15.7
Amkhola	35.7	0.7	46.2	17.4
Gazalia	33.1	0.8	44.9	21.1
Golkhali	40.5	0.6	40.9	18.1
Atharagashia	32.7	3.0	46.8	17.5

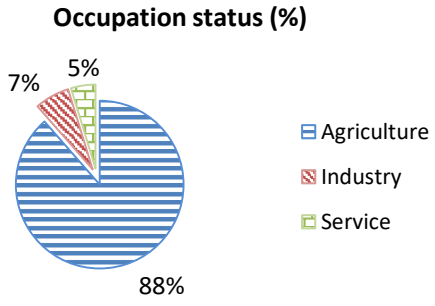


Source: Population Census 2011, BBS

281. In the polder area, employed population is engaged in different occupations. According to BBS 2011, 88% of the populations are engaged in agriculture sector. Here agricultural sector includes farmer, agricultural labor, fishers, day labors etc. About 5% population is engaged in salaried service sector. It includes population who are employing for government, private sector jobs. Lastly, industrial sector employs only 7% population implying that industrialization is still underdeveloped. (**Table 6.10**).

Table 6.10: Distribution of population by occupational group

Union	Agriculture	Industry	Service
Auliapur	83	9	8
Jainkati	88	7	5
Amkhola	90	6	4
Gazalia	89	6	5
Golkhali	91	7	2
Atharagashia	91	6	3



Source: Population census 2011, BBS

Photo 6.3 : Different modes of livelihood activites at polder 43/2B

6.1.6 Labor market

Wage level and labour condition

282. Field findings show, that people tends 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 Taka 350 to Taka 400/day for male whereas for women wage rate varies in the range of Taka 200 to Taka 250/day.

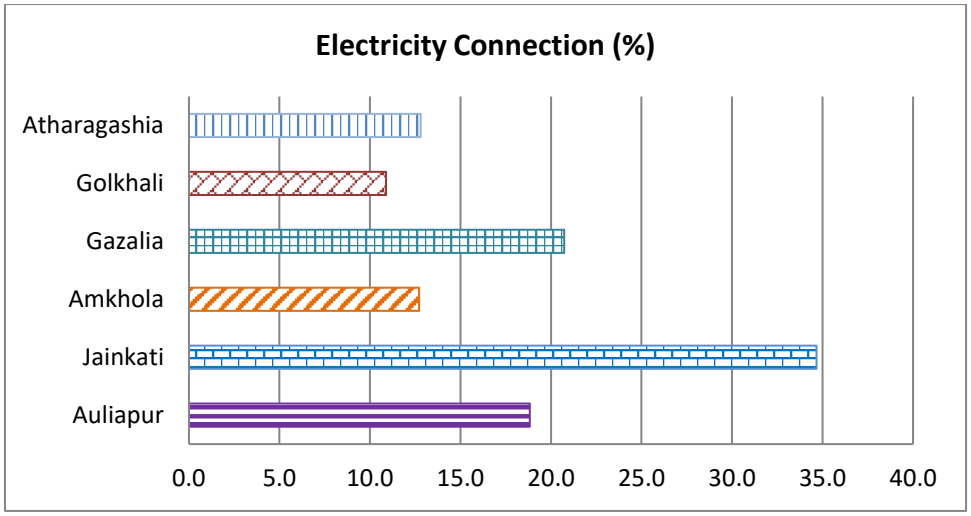
Labor Migration

283. Out migration of labourers is insignifican (4%) and in-migration is almost absent. These out-migrants are mainly agricultural labourers, who travel to neighboring districts (Patuakhali, Barishal, Khulna, and Dhaka) during May to September for plantation and harvesting of crops. Additionally, there is trivial international out migrants (1.5%) who go to Middle East for better livelihood options.

6.1.7 Standard of living

Access to electricity

284. Electrification as reported in the Population Census, 2011 is not satisfactory in the polder area. On an average, only 18% households are under electricity coverage. Data also shows Kukua union has highest electricity coverage with a record of 22% households having access to electricity whereas in Golkhali and Amkhola union this figure stands to 11% and 12% households respectively.



Source: Population Census 2011, BBS

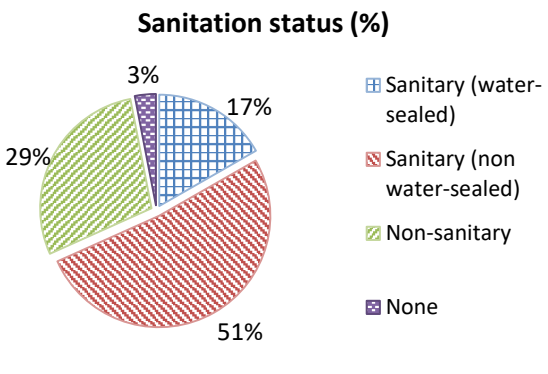
Figure 6.2: Distribution of electricity connection by union at polder area

Sanitation

285. The sanitation facilities[5] used by households of the polder area are presented in **Table 6.11.** It shows that about 17% of households have access to hygienic sanitation facility (water-sealed) and 51 % to non water-sealed sanitation facility. About 29% of households use non-sanitary facilities and 3% have no access to sanitation facility. Statistics shows that sanitation facility is better in Jainkati (36%) than other unions, whereas Atharagashia union has the highest percentage of households (7%) with "no" sanitation coverage.

Table 6.11: Sanitation facilities by union at polder 43/2B

Union	Sanitary (water-sealed)	Sanitary (non water-sealed)	Non-sanitary	None
Auliapur	6.7	76.7	14.7	2.0
Jainkati	36.4	41.6	20.9	1.1
Amkhola	18.2	64.4	16.3	1.0
Gazalia	18.6	52.4	26.5	2.5
Golkhali	10.8	34.1	50.2	4.8
Atharagashia	9.7	40.1	43.3	7.0



Source: Population Census 2011, BBS

[5] 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 in-sects 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.


Photo 6.4: Sanitation facility in the polder area

Drinking water

286. Overall status pertaining to sources of and access to drinking water in the area is satisfactory. On an average, 99% people can collect drinking water from tube-well while only 1% collects drinking water from other sources such as ponds, pond sand filter (PSF); rain water etc. According to BBS, 2011, Atharagashia union has the highest users (99.6%) of tube well whereas Gazalia union got the lowest (98.6%) tube well users. The detail is presented in **Table 6.12.**

Table 6.12: Sources of drinking water in polder by union

Union	Source of Drinking Water (%)		
	Tap	Tube-Well	Other
Auliapur	0.0	99.1	0.9
Jainkati	0.0	98.8	1.1
Amkhola	0.1	98.7	1.3
Gazalia	0.1	98.6	1.3
Golkhali	0.0	99.2	0.8
Atharagashia	0.1	99.6	0.2
Average	**0.1**	**99.0**	**0.9**

Source: Population Census 2011, BBS

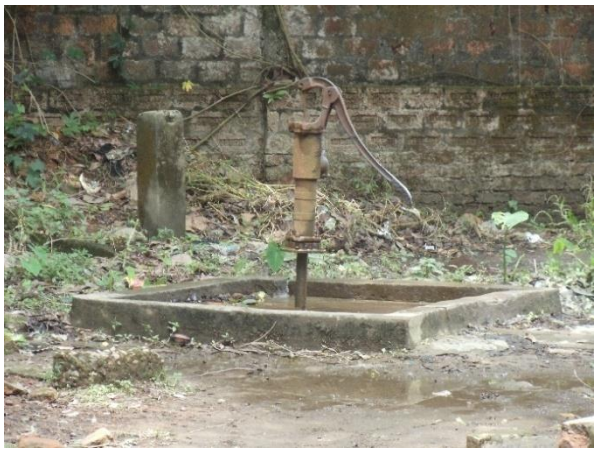



Photo 6.5: Domestic level tube well

Floor of the house

287. The overall housing condition[6] is not satisfactory. Only 1% of houses are Pucka, 3% houses are semi-pucka, 3% houses are Jhupri where 93% percent are kutcha. On the other hand, in 2011 at national level, 25.12% of the households reported to have used brick/cement in the walls of the main dwelling structure. With reference to national statistics it can safely be stated that the large percentage of the households of the study area belong to poor category in term of housing type. Statistics show that Atharagashia union comprises the highest pucka household (1%) whereas Amkhola union has the highest kutcha households (96 %). **Table 6.13** and **photographs 6.6 shows** represent housing types of the polder.

Table 6.13: Types of housing structure by union at polder 43/2B

Union	Type of Structure (%)			
	Pucka	Semi-pucka	Kutcha	Jhupri
Auliapur	0.6	3.2	94.3	1.9
Jainkati	0.8	4.2	93.6	1.4
Amkhola	0.6	1.8	96.2	1.4
Gazalia	0.7	1.5	95.7	2.2
Golkhali	0.6	1.7	93.4	4.3
Atharagashia	0.9	7.7	86.5	4.9
Average	**0.7**	**3.4**	**93.3**	**2.7**

Source: Population Census 2011, BBS

Photo 6.6: Housing structure at polder area

Cooking fuel

288. Almost every household in this area mainly use cow dung sticks as fuel. People also uses wood, chips naturally produced herbs and shrubs etc. to meet up their fuel needs.

[6]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-pucka**: 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) **Pucka**: House which is made by fully concrete, cement, and iron.

6.1.8 Poverty

289. Poverty is often defined by one dimensional measure. However, no one dimension alone can capture the various dimensions of poverty. Therefore multidimensional poverty index (MPI) composed of several factors is considered a better approach to define/understand poverty in other words defining poor and people's experience and extent of deprivation. These are:

- Poor health;
- Lack of education ;
- Inadequate living standard;
- Lack of income;
- Disempowerment;
- Poor quality of work; and
- Threat from violence.

290. The multidimensional poverty index that incorporates a range of indicators is considered more appropriate to capture the complexity of poverty and better inform decision makers for making policy choices to eradicate it. . The MPI has been applied to assess people's poverty status. The detail process and methods of the MPI are given in the **appendix 3.** The summary results are presented in Table 6.14 below.

Table 6.14: Weighted score and status of MPI poor of Polder 43/2B

Poor Category of People	Landless persons work in share cropping and agricultural labour (L)	Day labourers work in Brick Field (DL)	Marginal Grosser sell things in the rural bazar (MG)
Weighted Score (deprivation score)	38.89%	33.33%	22.22%
Status: MPI poor (33.33%)	Greater than MPI poor	Equal to MPI poor	Less than MPI poor

Table 6.15: Results of MPI

Factor H for the Polder	0.667
Factor A for the polder	0.361
MPI	0.241

291. According to **Table 6.15**, headcount ratio (H) about 66% of people live in poor households. In the context of intensity of poverty (A), the average poor person is deprived in 36% of the weighted indicators. Thus the MPI of the polder is 0.241 (in 2014) compared to Bangladesh 0.292 (in 2007)[7] which indicates status of poor HHs have been reducing very slowly.

6.1.9 Institutions and infrastructure

Transport (road/navigation) networks

292. Most of the peripheral roads of the polder are earthen and brick soling. The earthen roads become un-usable during the wet season. Some parts of the road networks are also damaged by river erosion. During field visit it was observed that the road network at

[7] http://en.wikipedia.org/...../Multidimensional_Poverty_Index (web page) p.6.

Boloykathi is at serious risk of river bank erosion along the Galachipa River. According to local people the poor communication system is one of the main hindrances to the development of the polder. Length and status of local roads are shown in the table (**Table 6.16**) and (**Photo 6.7**).

Table 6.16: Road network in polder

Destination	Status	Length (km)
Amkhola to Galachipa	Paved	9
Badura- Amkhola	,,	9
Badura- Masukhali	,,	5
Galachipa-Sonakhali	,,	7
Majhibari School- Amkhola	,,	2
Boubazar- Solaiman Hawladar Bari	,,	2
Badura- Mriddha bari	Brick soling	7
Munshirhat- Algi gram	,,	2
Majhibari- Amkhola	,,	3
Adambridge- Boubazar	,,	2
	Total =	**48**

Source: CEGIS fieldwork, 2015

Photo 6.7: Paved and brick soling road in the polder

6.1.10 Extension services

293. The major social safety-nets and poverty reduction programs currently running 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 for the targeted poor households and vulnerable communities to some extent. **Table 6.17** gives the coverage of households under various safety-net and social services programs in the study area.

Table 6.17: Households Served by Different Social Safety Nets Programs

Social Safety Net Programs	Households/Communities Served (%)
Vulnerable Group Development (VGD)	8
Food/Taka For Work (F/TFW) of PIO	5

Social Safety Net Programs	Households/Communities Served (%)
Food for Education/Cash for Education	12
Rural Maintenance Programme (RMP)	5
Old Age Allowance	3
Freedom Fighter Allowance	2
Integrated Poverty Reduction Program of BRDB	5

Source: CEGIS Fieldwork, 2015

294. A number of local, national and international non-governmental organizations (NGOs) are working in the polder area. NGOs working in the area include BRAC (Bangladesh Rural Advancement Committee), ASA (Association for Social Advancement), Space Bangladesh, Grameen Bank, CODEK, SUSHILON, Khalifa Foundation, Uddipon etc. (**Table 6.18 and Photograph 6.8**). Operation of micro credit program among the rural poor and women/men is one of the main activities of these NGOs. Several NGOs however, implement few 'rural development' programs. Among them BRAC has larger portfolio of programs covering non-formal education, health and nutrition, water and sanitation, development of rural road networks. About 45% of households could be classified as beneficiaries of NGOs interventions.

Table 6.18: NGOs and their programs in polder area

NGOs	Type of Programs						
	Credit	Non-formal Education	Water and Sanitation	Health and nutrition	Road networks	Disaster	Livestock
BRAC	✓	✓	✓	✓	✓	-	-
ASA	✓	-	-	-	-	-	-
Space Bangladesh	✓	-	-	-	-	-	-
Grameen Bank	✓	-	✓	-	-	-	-
Uddipon	✓	-	-	-	-	✓	✓
CODEK	✓	-	-	-	✓	-	-
SUSHILON			✓		✓	-	-
Khalifa Foundation	-	-	-	✓	-	-	-

Source: CEGIS fieldwork, 2015

Photo 6.8: Some glimpses of NGOs' presence

6.1.11 Common property resources and its utilization

295. The common property resources and/or community facilities in the area are different social amenities e.g. mosques, graveyards, temples, cremation grounds, playgrounds, open water bodies and *Eidgahs* (place for offering Eid prayers). These are used by the local people for the purposes of religious, social and cultural gathering. Besides these, the BWDB embankment is also very commonly used for different livelihood purposes i.e. living or takes shelter by the local inhabitants (**Table 6.19)**.

296. It is observed, there are 4 cyclone shelters including one under construction. There are 368 mosques, 13 temples, 53 Eidgah, 14 graveyards, 23 playground and 9 crematoriums in the polder area. However, there are no known historical and archeological sites declared by government in the Polder area.

Table 6.19: Common property places/resources in polder 43/2B

Union	Mosque	Temple	Eidgah	Graveyard	Play ground	Cremation ground	No of Cyclone Shelter	
							Functional	Under construction
Auliapur	42	1	3	4	5	2	1	1
Jainkati	28	4	5	5	4	2	1	1
Amkhola	92	3	6	1	4	3	2	-
Gazalia	55	3	5	2	3	2	1	-
Golkhali	119	1	26	0	3	-	-	-
Atharagashia	32	1	8	2	4	-	1	1
Total	**368**	**13**	**53**	**14**	**23**	**9**	**6**	**3**

Source: extracted from http://amkholaup.patuakhali.gov.bd/http://golkhaliup.patuakhali.gov.bd/http://jainkatiup.patuakhali.gov.bd/http://athrogasiaup.barguna.gov.bd/http://uliapurup.patuakhali.gov.bd//http:// gazaliaup.patuakhali.gov.bd//on January 29, 2015)

7. Public Consultation

7.1 Introduction

297. Public consultation is a regulatory process by which the public's input on matters affecting the local population is sought. It is a part of the EIA process aimed in involving the project stakeholders into the project development and implementation process. A formal meeting comprising of local people who are likely to be impacted was arranged at the polder 43/2B project location. During consultation meeting the proposed project interventions and their associated impacts were discussed following a comprehensive checklist. Such consultations are organized to solicit people's opinion and feed on the project activities and make the project socially acceptable and environmentally sustainable based on their feedbacks. The participants expressed their opinion spontaneously and shared their experiences.

7.2 Objectives of stakeholder consultations

298. Keep in view the following key objectives the consultation process was design and implemented

- To provide key project information and create awareness among various stakeholders about project interventions;
- To have interaction for primary and secondary data collection with project beneficiaries, affected population, and other stakeholders;
- To identify environmental and social issues such as safety hazards, employment, and vulnerable persons;
- To establish communication and evolving a 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 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 Approach and Methodology

299. Participatory approach was followed in conducting the public consultation meeting (PCM). The study team first had meeting with the BWDB officials responsible for the polder to share with them the feasibility and EIA process of the Blue Gold program. The local government officials/representatives were consulted to identify the potential stakeholders at the polder level. With support from the Blue Gold program officials and UP Chairman, the union level public representatives as well as the key persons were contacted over telephone and they were informed about the specific consultation meeting and requested them to be present in the meeting. Accordingly, the venue, date and time of the consultation meetings were fixed. Later, the study team organized the meetings at the local level. Names, occupations and addresses of the meeting participants were noted during the meeting.

300. A number of focus group discussions (FGDs) and several informal discussions were also arranged public consultation process. In order to conduct the FGD and informal

discussions five checklists was prepared covering various 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 providing equal opportunity to all participants attending the meeting. During consultation meeting all relevant issues pertaining to water resources, land resources, socio-economic resources, and disaster aspects were discussed in detail.

301. During FGDs and PCM, the EIA team displayed maps of the project area, shared the initial concepts on proposed interventions and facilitated the discussions to solicit responses from the participants. The stakeholders of the polder 43/2B 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 through these discussions.

7.4 Identification of stakeholders

302. Stakeholders include all those who will be affected and are being affected by the 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. In the context of this study stakeholders are those who are and/or could be affected by the project interventions.

7.4.1 Primary Stakeholders

303. Primary stakeholders are people who would be directly benefited or impacted by a certain project intervention. In case of the proposed project in polder 43/2B, the primary stakeholders include the people living within the project area particularly those who reside within and in the immediate vicinity of the polder. The primary stakeholders of the project include the farmers, fishers, local business community as well as women groups, and caretakers of community properties. Primary stakeholders identified and consulted during the present EIA include communities to be benefitted and/or affected by the project, local leaders, community members and other local representatives.

7.4.2 Secondary Stakeholders

304. This category of stakeholders pertains to those who may not be directly affected but have interests which could contribute to the study, play a role in implementation at some stage, or affect decision making on project aspects. From this perspective, NGOs, concerned government departments, line agencies, Blue Gold program officials fall under this category.

7.5 Consultation meetings

7.5.1 Consultation Process

305. One PCM and a number of FGDs were conducted at different locations of the Polder 43/2B. The details of these FGDs and PCM are presented in Table 7.1 and some photographs of the meetings are given in Photo 7.1 to 7.2.

Table 7.1: Public Consultation Details

Sl	District	Upazila	Union	Meeting venue	Type of consultation	Meeting date	Time
1	Patuakhali	Patuakhali Sadar	Sadar	Blue gold office	Sharing meeting with Blue Gold officials	11/01/2015	10:00
2	Patuakhali	Galachipa	Amkhola	UP Auditorium	PCM	19/01/2015	11:00
3	Patuakhali	Galachipa	Amkhola	Amkhola bazar	Meeting with WMGs	14/01/2015	10:00
4	,,	,,	,,	Bauria Bazar	FGD	14/01/2015	2:00
5	,,	,,	,,	Gerabunia School	,,	15/01/2015	11:30
	,,	,,	,,	Munshir hat bazar	,,	15/01/2015	03:00


Photo 7.1: Knowledge sharing, consultation meeting with Blue Gold program officials and WMG, Patuakhali


Photo 7.2: PCM at Amkhola Union, Patuakhali

7.5.2 Consultation Participants

306. The participants of these consultation meetings included Blue Gold program officials, local representatives, farmers, traders, members of WMO and daily-wage laborers of the Polder 43/2B and nearby areas. A total number of 108 participants attended these consultations. The details participant is provided in **Table 7.2** and **Photo 7.3 and 7.4** below.

Table 7.2: Participant details

Sl	Meeting venue	Type of consultation	Type of Participants	No. of participants
1	BlueGold Program office	Consultation	Secondary stakeholders	10
2	UP Auditorium	PCM	Primary and secondary stakeholders	40
3	Amkhola Bazar	,,	,,	15
4	Bauria Bazar	,,	,,	17
5	Gerabunia School	,,	,,	14
6	Munshir hat Bazar	,,	,,	12

Photo 7.3: FGD at Amkhola Bazar

Photo 7.4: FGD at Gerabunia School

7.6 Issues discussed in FGDs and

307. At the outset of these FGDs and PCM, 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)
  - Education (literacy rate, school enrolment , female education, drop out etc)
  - Health and nutrition (illness, diseases, nutrition)
  - Quality of life (housing and sanitation facilities, status 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 resource 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 water resources and to make these resources more productive.

7.7 Community Concerns and Suggested Solutions

308. The outcomes of the FGDs and PCM in terms of concerns and the suggested solutions were noted. They are organized by themes and presented in the **Table 7.3** below.

Table 7.3: Community concerns and suggested solutions

Themes/Topics	Concerns/Issues/Problems	Suggested Solution/Remedies
Overall	✓ River bank erosion at Boloykathi, Chinguria and drainage congestion at certain parts of the polder are the main community concerns in the polder area.	✓ Comprehensive rehabilitation of the polder should be taken up at the earliest possible time with the active involvement of the local community.
Water resources	✓ Erosion at Galachipa River has damaged some of the water control structures along the river. In local people's view operation of existing water control structures are nearly impossible. ✓ Tidal flooding is an issue in the different portion of the polder. Local people are extremely vulnerable from both tidal and storm surge induced flooding. ✓ Drainage congestion is the most prominent problem in the area. ✓ Surface water scarcity	✓ Temporary protection at Boloykathi, Chinguria ✓ Construction of retired embankment ✓ Re-sectioning of embankment ✓ Re-excavation of khals ✓ Repairing of Sluice gates, inlets and outlets
Agricultural resources	✓ Drainage congestion and water logging during T Aman (Kharif-II season). ✓ Scarcity of irrigation water in Rabi season. ✓ River erosion an endemic problem affecting villages crops, homestead, roadside and riverside crop fields	✓ Repair of sluice gates are expected to decrease siltation which may enhance crop production and may reduce crop damage and creates opportunities for introduction of new crops. ✓ Re-excavation of khals to remove drainage congestion. ✓ Retired embankments to be constructed
Fishery resources	✓ Due to siltation depth of internal khals are getting reduced and that leads to degradation of fish habitat. ✓ Indiscriminate fishing by Sluice net ✓ Pond inundation due to storm surges associated tidal flooding	✓ Re-excavation of khal will help to increase the richness of fish species in the polder area. ✓ Strengthening of WMA/WMO activities ✓ Application of fisheries rules and regulation by the government strongly ✓ Re-sectioning of embankment as well as retired embankment
Ecological resources	✓ Homestead, roadside and mainly riverside vegetation affected and destroyed by river bank erosion ✓ Drainage congestion, water logging and natural disaster are also causal to damage homestead vegetation	✓ Construction of retired embankment, re-sectioning of embankment and repairing water control structure ✓ Re-excavation of khal to remove drainage congestion and water logging.

Themes/Topics	Concerns/Issues/Problems	Suggested Solution/Remedies
Socio-economic resources	✓Some of the road networks (Boloykathi, Chinguria) of the polder are threatened with river bank erosion which creates problems in regular communication system. ✓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 infrastructure.	✓The embankment cum road should be repaired immediately in places where erosion is taking place or are threaten with erosion. ✓Strengthening of WMGs so that mass people can have access to open water bodies easily. ✓ To ensure sustainable operation of the project, participation of Water Management Organization (WMO) and Community Based Organizations (CBOs) is called for in the proper management of water control structures i.e. embankment, sluice gate, regulator, inlets, culverts etc. ✓There should be some programs to raise awareness of CBO members and people at large people on the importance of these. ✓

7.8 Perceptions towards proposed interventions

309. 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 7.3. The solutions opted by the local people are mostly found similar to these propoed 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 43/2B.

7.9 Participant list

310. The name of the participants attending different FGDs, their age, occupation and address including cell phone numbers are provided in **Table** 7**.4**. Similarly, a list of the participants of PCM was maintained in attendance sheet containing their contact numbers. Scanned list of PCM participants is attached in **Appendix 4.**

Table 7.4: Name of participants

SL	Name	Gender	Occupation	Age	Address/Mobile No
1	Anowar Hossain	M	Business	35	01731-866742
2	Md. Dalil Uddin Gazi	M	,,	62	01743-252475
3	Md. Shahjahan Mriddha	M	,,	60	01780-207842
4	Md. Harun Hawladar	M	,,	42	01712-834660
5	Md. Mohsin Gazi	M	,,	42	01770-566980

SL	Name	Gender	Occupation	Age	Address/Mobile No
6	Md. Ibrahim Molla	M	,,	45	01818-486613
7	Md. Abdur Rauf Mriddha	M	Lecturer	40	01726-800530
8	Md. Jewel Ahmed	M	Service	30	01716-142867
9	Md. Sohel Molla	M	Business	30	01737-782564
10	Md. Rafique Mriddha	M	,,	48	01730-184865
11	Abdus Sttar Chowkidar	M	,,	70	-
12	Sushil Chandra Shil	M	Black Smith	55	-
13	Shahjahan Chawkidar	M	Agriculture	50	-
14	Alhaj Sanu Talukdar	M	,,	60	01734-083244
15	Md. Dulal Talukdar	M	UP Member	45	01752-092151
16	Surja Vanu	F	Housewife	50	-
17	Kashem Sikdar	M	Business	40	01718-957035
18	Md. Nowab Miya	M	Agriculture	35	01761-509414
19	Bahadur Talukdar	M	Business	35	01754-257504
20	Shefali Begum	F	Housewife	40	-
21	Sobhan Bepari	M	Fisher	62	01734-129491
22	Most. Shahinur	F	Housewife	28	01725-966584
23	Most. Mukta Begum	F	,,	30	01781-959924
24	Barik Talukdar	M	Business	60	-
25	Md. Gazi	M	Agriculture	50	-
26	Siddique Talukdar	M	,,	40	01718-966907
27	Billal Hossain	M	,,	26	01738-132512
28	Khaleque Ghorami	M	,,	65	-
29	Solaiman Bepari	M	Fisher	65	-
30	Halim Bepari	M	Agriculture	62	-
31	Jaynal Peda	M	,,	45	-
32	Mijanur Khan	M	,,	35	01718-959924
33	Sufia Khatun	F	Housewife	50	-

8. Identification, Prediction and Evaluation of Potential Impacts

311. 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

312. 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). The IESCs under the different resources likely to be impacted by the interventions along with the rationale of their selection are presented in Table 8.1

Table 8.1: Identified IESCs and Rationale

IESCs	Rationale
Water Resources	
Water Availability	The re-excavation of khals within the polder may improve the water carrying capacity and hence allow more surface water to be available. This may improve the different uses of water in the area. Therefore, water availability has been considered as an IEC.
Drainage Congestion and Water Logging	The repairing of sluice gates and drainage outlets might improve the drainage status in some locations of the polder, and might restore the existing water logged areas. Therefore drainage congestion and water logging has been considered as another IEC.
Tidal Flooding	The re-sectioning of embankment at Dari Baherchar may protect the entry of high tidal water into the polder and hence influence tidal flooding. As such, tidal flooding has been considered as another IEC.
Land and Agricultural Resources	
Agriculture land use	It is expected that the present land use might change due to changes of hydrologic regime inside the polder area. Farmers of the polder area would be encouraged cultivating more crops in changing situation. Because of this reason, land use has been considered as one of the IECs.
Cropping pattern and intensity	The proposed interventions will change the hydrologic regime inside polder, which may encourage the farmers to change their cropping patterns and may use more HYV. This may increase the cropping intensity and cropping pattern. Therefore cropping pattern and intensity both are selected as IEC

IESCs	Rationale
Crop production	Agricultural crop production is expected to increase due to improvement of drainage system after repairing of embankment, re-excavation of khals, repairing of drainage/flushing sluices and irrigation inlets. The re-excavation of khals would help to drain out excess water from crop field. Repairing of drainage/flushing sluices and irrigation inlets might prevent the intrusion of saline water. The excess rain water inside the polder area would be drained out through drainage/flushing sluices and this might help to cultivate HYVs rice. Moreover, the surface water might be available in the re-excavated khals which would be used for irrigation purpose. This situation would be favorable for enhanced crop production. As such crop production has been selected as an IEC.
Crop damage	Crops are presently damaged in the polder area due to drainage congestion in the pre-monsoon and rainy season, drainage congestion, partial salinity, drought, etc. These are expected to be checked due to implementations of the proposed interventions. Reduction in crop damage would be reflected in aerial extent as well as increased yield per hectare, all contributing to increase in crop production. In consideration of this 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, the latter contributing in 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 and habitat quality	The proposed interventions of the polder are likely to alter the fish habitat as well as habitat quality in the polder area. Increased water depth due to re-excavation of khals may change the water quality which may support different type of fish species. In this context, fish habitat and habitat quality has been considered as an IEC of the study.
Fish movement and migration	Internal fish movement and migration through khal is still the driving force for capture fisheries of the polder area. A small number of internal khals are connected with the peripheral rivers. The major portion of thees khals are silted up. These khals are covered with water hyacinth which is hampering of fish movement and migration. Proposed interventions especially khal re-excavation may increase water flow and depth of water in turn would facilitate the lateral fish migration. Thus fish movement and migration has been considered as an IEC.
Fish productivity	Open water fisheries contribute a small part of fish production in the polder area. People of the area are mainly dependent on culture fisheries. The implementation of proposed interventions may change the fish abundance which ultimately changes the fish productivity. So, fish productivity has been considered as an IEC under this study.
Ecological Resources	
Terrestrial Vegetation	Terrestrial vegetation is an important component of the existing ecosystem. This type of vegetation provides habitat for wildlife and also offers services to human. Any change of physical environment causes different intensity of vegetation damage. The proposed interventions may cause impacts to vegetation during construction as well as post construction phases. Therefore, terrestrial vegetation has been identified as an IEC.

IESCs	Rationale
Aquatic flora and fauna	Aquatic flora and faunal status relies on wetland water salinity, quality, depth and the flora nad fauna play an important role in the existing wetland ecosystem. Proposed intervention especially khal re-excavation is expected to change water quality as well as fresh water flow which may impact the aquatic flora and fauna. Impacts can be positive and/or negative in the long run. Hence, aquatic flora and fauna is considering as an IEC.
Socio-economic Condition	
Access to open water bodies	All the khals are recognized as open waterbodies int the polder. At present, mass people has limited access to open water bodies i.e., the khals which are to be excavated in the proposed interventions. In most of the case, khals are being silted up. Thus, it can be said that, if the khals are re-excavated, and are put under community management, it will contribute to social use of water and may give mass people access to khals.
Communication	In certain part of the study area the existing communication system is a major social concern. The archaic and damaged communication system keeps the polder people separated them from the developed regions of the district. It negatively affects their economy, politics, and society. Because of the project implementation, communication system of this area may be improved, and thus considered an IESC.
Gender promotion	In polder area, most of the people are living in poor condition. Specially, the females are mostly vulnerable. Widows are dependent on others and do not have any definite sources of income. It is proposed that about 40% of labour under the Labour Contracting Society (LCS) will be females. Thus, the employment opportunity for women in the construction works and during operation/maintenance phase can promote them into better life and livelihood.
Employment opportunity	The construction work will generate significant volume of employment for the local people and other associated professionals. People will also be involved to carry out operation and maintenance related jobs of the hydraulic structures. It is expected that proposed intervention will create employment opportunities for different occupational groups.

8.2 Evaluation of Potential Impacts

8.2.1 Preamble

313. This section identifies the potential environmental and social impacts which may be caused by various project activities during the three stages of construction works: pre-construction, construction, and Operation, on the identified IESCs. Proposed interventions which may cause potential environmental impacts during pre-construction, construction, and Operation stages have been identified in Chapter 4. The following detailed investigations have been carried out to assess the magnitude of these 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

314. As part of the environmental impact assessment process, a tailored made screening matrix was used to asses 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 each of these broad categories were further divided into different aspects. The potential impacts thus predicted were characterized as follows:

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

315. The potential environmental impacts of the proposed intervention on the IESCs, during pre-construction, construction as well as operation phases 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			
	Surface water availability	Drainage congestion	Tidal flooding	Agricultural landuse	Cropping pattern and intensity	Crop production	Crop damage	Irrigated area	Fish habitat quality	Movement of fish hatchling	Capture fish productivity	Terrestrial Vegetation	Aquatic flora and fauna	Access to open water bodies	Communication	Gender promotion	Employment generation
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	MN		NI	I	I	MP
Construction phase																	
Re-sectioning of embankment	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	HN		NI	MN	MP	I
Embankment slope pitching and turfing	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	HN		NI	I	MP	I
Re-excavation of Khal	I	I	NI	MN	NI	NI	I	MN	HN	MN	HN	NI		MN	I	MP	I
Spoil dumping and compaction on the banks of the khals	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	MN		NI	I	NI	NI
Repairing of drainage sluices and outlets	I	I	I	NI	NI	NI	NI	I	I	MN	MN	NI		I	I	I	I
Repairing of flushing inlets and culverts	I	I	I	NI	NI	NI	NI	I	I	MN	MN	NI		I	I	I	I
Operation phase																	
Checking the physical condition of embankment during pre- and post-	-	HP	HP	-	-	-	-	-	-	-	-	-		-	-	-	-
Checking physical condition and function of water control structures	HP	HP	HP	HP	HP	HP	HP	HP	HP	-	-	-		-	-	-	-
Checking the functions of WMOs	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-

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).

8.3 Impact during Pre-construction Phase

316. There would be no significant impact on the IESCs of water resources, agriculture, fisheries, and ecological resources during this phase of the proposed interventions. Some temporary impacts may genarate on social conditions and 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-
Socio-economic Condition				
Activity: *(i) Labor, materials and equipment mobilization (caring as well as storing (ii) Site preparation*				
Employment opportunity	Periphery and inside of the polder 43/2B where different activities will be initiated.	Most of the household income comes mainly from agriculture (45%), small business (20%) and fishing (10%). Source: RRA	Local unemployed laborers (both male and female) will be recruited for the pre-construction activities such as carrying and storing of materials, site preparation. Thus, the income of laborer will increase temporarily.	+2

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

8.4 Impact during Construction Phase

317. There would be no significant impact on IESCs of water resources, agriculture resources during this phase of the proposed interventions. Environmental and social parameters that may be temporary impacted during the construction phase and 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)
Fisheries Resources				
Activity: *Re-excavation of khal*				
➢ Fish habitat and habitat quality ➢ Fish movement and migration ➢ Fish productivity/ production	• Bauria khal (4.1 km) • Badrar khal (1.10 km) • Bangrar khal (1.45 km) • Karimjatala khal (1.10 km) • Ostakhali khal (0.70 km) • Sobaram khal (2.0 km) • Kalabunia khal (0.75 km); • Badura khal (3.2 km); • Masuakhali main khal (5.0 km); • Musurikati khal (2.0 km); Bastalar • khal (1.5 km); • Tulabaria khal (2.0 km); • Luhit bari khal (2.0 km)	Tidal in nature, silted up, water depth is shallow and covered with duck weed, water hyacinth)in most part of a khal.	• Feeding and breeding ground of the bottom dweller fishes will be lost. • Fish movement/migration especially small fishes will be disturbed. • About 9.8 ha fish habitat would be damaged temporarily and fish production loss would be about 1.3 tons/ year from the said khal. But after 1-2 year the habitat quality of fish will be improved.	-2
Activity: *Repairing of Water Control Structure*				

IESC	Location	Baseline Condition	Impact	Impact (+/-)/ Magnitude (1-10)
Fish movement and migration	• Drainage/flushing Sluices (Musurikat sluice, Bauria sluice, Nasaisil sluice, Badura sluice, Masuakhali sluice), • Irrigation Inlets (in total 46 nos locations are mentioned in the section of water resources)	• Fish hatchling and some brackish water fish species like Chingri, Baila, Pairsa and fresh water fish like puti, tengra and boal etc. move through the malfunctioning regulator during high tide round the year.	• Movement and migration of fish species like Chingri, Baila, Pairsa and fresh water fish like puti, tengra, boal etc would be obstructed during repairing of structures. • Fish hatchling movement would also be hampered, if the repairing works is implemented during hatchling period (June-August).	-1
Ecological Resources				
Activity: Repairing of embankment				
Terrestrial vegetation	Both sides of the embankment at re-sectioning points	• Embankment side vegetation is main type. • Embankment side vegetation is dominated by medium sized trees, shrubs and herbs e.g. Kola, Tal, Khejur, Chambul, Shirish, Akand, Bhat, and etc which provide feeding ground for mammals, birds, reptiles and amphibians. • Vegetation is facing risk due to river erosion, natural disaster and human activities	• Temporary damages of herbs, shrubs, various type of grass and bushes due to soil dumping for repairing work.; • Displacement of wildlife due to habitat loss temporarily.	-2
Activity: *Re-excavation of khal*				
Aquatic flora and fauna	All the khals which are proposed to be re-excavated	• Moderate in condition • Composed of free floating plants, like Kochuripana, Kutipana, Dhol kolmi, etc which support habitat for fishes and Kingfisher, Egret, Snake, etc.	• Damages of existing aquatic vegetation would cause habitat degradation for aquatic birds (ie. Egrets) and fishes • Damages of existing bank line vegetations due to dumping of soil along both sides of the khal	-3

IESC	Location	Baseline Condition	Impact	Impact (+/-)/ Magnitude (1-10)
		• Durba Gash *(Cynodon dactylon)*, Biskantali (*Polygonum* Sp.) and different types of marginal herbs like Dholekolmi (*Ipomoea aquatic*), Kasorti (*Eclipta* Sp), etc. are dominant along both side of the khal. • Different types of local avifauna roam here for their feeding. • Reduced water area for siltation		
Socio-economic Condition				
Activity: *(i) Repairing of embankment (ii) Embankment slope pitching and turfing (iii) Re-excavation of Khals (iv) Repairing of drainage outlets (v) Repairing of irrigation inlets*				
Employment Opportunity	Periphery and inside of the polder 43/2B where different activities will be initiated.	About 35% of total population is employed, 45% is engaged in household work, only one percent is looking for work and about 19% of total population is not working	A huge number of laborers will be needed in earth work, re-sectioning of embankment and afforestation, soil dumping and compaction different repair works.	+2
Gender Promotion	Periphery and inside of the polder 43/2B where different activities will be initiated.	About 52% of female are working in the household chores whereas few of them are working as a day labor or earth works in brick fields.	According to the project information, the LCS will have 60% male and 40% female membership, all of them from the local area. . Thus, access to employment for female laborers in the construction works and during operation/ maintenance phase will increase significantly and that may create opportunities for their participation in different decision making.	+3
Communication	Different parts of the polder i.e. Boloykathi, Chinguria, Gerabuina, Buria bazaar etc	Most of the road networks in the study area are earthen. During rainy season, it becomes very difficult to communicate through these roads.	Road networks may temporarily deteriorate or may remain in the same condition during construction period.	-1

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

8.5 Impact during Operation Phase

318. Possible impacts of the proposed interventions on the selected IESCs during the Operation phase 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 of impact are presented in Table 8.7.

8.5.1 Water Resources

a. Surface Water Availability

Future-without-Project

319. People living in Polder 43/2B at present are suffering from water shortage for irrigation as khals are gradually being silted up. Local people cannot fulfill their irrigation requirements up to the desired level due to reduction in the level of surface water sources. If the proposed khals are not re-excavated (along Bauria Khal, Bangrar Khal, Kalabunia Khal, Musurikati Khal etc.) the water scarcity will be more acute in the near future. The study infers that water availability and use may be reduced in future and around 25% people in Polder 43/2B might be suffering from water scarcity.

Future-with-Project

320. If the proposed re-excavation works are carried out, an additional volume of 64,000 m^3 of water would be made available in the water courses within the polder. Assuming 60% flow probability on an annual average, taking account of the seasonal water fluctuation and other water losses, it can be said that around 7% people would still remain under water stress.

Impact

321. From the spatial distribution of khals that are to be re-excavated, it is observed that around 6,500 numbers of people (18% of total population) in Banshbunia, Nijsuhati, Amkhola, and Ramananda Mauzas would have sufficient surface water and access to the same. This would result in immense benefits to these people in terms of access to water for various uses.

b. Drainage congestion and water logging

Future-without-Project

322. At present, minor drainage congestion (around 5 km) is observed along the Bauria khal, Badrar khal, Bangrar khal, Tulabiara khal. As the khals are being silting up gradually, in future approximately 15 km water courses within the polder may face drainage congestion. This may cause other environmental and social problems as well. In spite of the drainage congestion, no water logging has been observed inside the polder.

Future-with-Project

323. If the proposed re-excavation works are carried out and water control structures are fully repaired as suggested, the drainage congestion problems of the entire polder will be improved.

Impact

324. Considering the 'future without project' and the 'future with project' scenarios, it can be concluded that around 15 km khals (11% of total) would provide benefit through reduction of drainage congestion in future, due to the overall improvement in drainage capacity of the re-excavated khals.

c. Tidal Flooding

Future-without-Project

325. At present around 10 ha areas of the polder suffer from tidal flooding due to the existence of breach in the embankment at Dari Baherchar. The existing embankment is vulnerable to further damage or failures if the embankment is not repaired up to the design level as proposed. If the polder is not re-sectioned, tidal flooding extent may further increase up to around 20 ha in future. Areas along the periphery of the polder periphery at Dari Baherchar would be in more risk.

Future-with-Project

326. If the proposed re-sectioning work is carried out, no tidal flooding would occur at Dari Baherchar. Furthermore, the polder as a whole would offer better flood protection. Tidal water would not be able to overtop or enter the polder.

Impact

327. Analyzing the two scenarios mentioned above, it can be concluded that the proposed retired embankment would bring in noticeable positive impacts in the polder. Approximately, 20 ha of land at Dari Baherchar could be protected from probable tidal flooding consequences.

8.5.2 Land Resources

a. Agriculture land use

Future-without-Project

328. Presently, NCA is about 71% of the gross area. Of this net cultivable area single, double and triple cropping is practiced in 22%, 66% and 12% respectively. If the polder is not rehabilitated, utilization of land for single, double and triple crop would be about 27%, 63 % and 10% of the NCA respectively and are shown in Table 8.5.

Table 8.5: Detailed agriculture land use of the polder area

Agriculture land use	Baseline	FWOP	FWIP	Impact (FWIP-FWOP)
	% of NCA	% of NCA	% of NCA	
Single crop	22	27	16	-11
Double crop	66	63	70	+7
Triple	12	10	14	+4
Total =	**100**	**100**	**100**	

Source: CEGIS estimation based on field information, 2015

Future-with-Project

329. The interventions would increase intensity of land use in the polder areas. Drainage congestion is expected to be removed due to implementation of different interventions of the polder. The area under different land types will be improved which would create scope for enhanced land use. It is expected that repairing of embankment, repairing of drainage /

flushing sluices, repairing of irrigation Inlets and re-excavation of khals etc. would contribute to increased land utilization. However, the land utilization for single, double and triple cropped area would be 16%, 70% and 14% of NCA respectively in future with the improvement of the polder infrastructure. Detailed land use has been presented in Table 8.5.

Impact

330. The overall impact of different options on land use would be positive. Double and triple cropped area would increase by 7%, and 4% of the NCA under FWIP condition. Single cropped area would decrease by 11%. Detailed land use is presented in Table 8.5.

8.5.3 Agricultural Resources

a. Cropping pattern and intensity

Future-without-Project

331. Presently, cropping intensity of the polder area is about 190%. If the polder is not rehabilitated, the land type as well as land use would be adversely impacted due to the failure of embankment, non -repairing of existing drainage/flushing sluices and irrigation inlets and siltation of river and drainage channels. Under this condition, there would be negative impact. The cropping intensity would be 183% in future without project **Table 8.6**.

Table 8.6: Major cropping patterns under FWOP and FWIP condition in the polder area

Kharif-I (March-June)	Khartif-II (July-Oct)	Rabi (Nov-Feb)	Baseline % of NCA	FWOP % of NCA	FWIP % of NCA	Impact (FWIP-FWOP)
Fallow	HYV Aman	Sunflower	7	5	10	+5
Fallow	Lt. Aman	Sesame	7	7	7	0
T Aus	Lt Aman	Mungbean	8	6	8	+2
T Aus	Lt aman	Watermelon	4	4	6	+2
Fallow	Lt Aman	Khasari	14	16	11	-5
Fallow	Lt Aman	Watermelon	22	20	25	+5
Fallow	Lt Aman	Groundnut	17	15	17	+2
Fallow	Lt. Aman	Fallow	22	27	16	-11
		Total	**100**	**100**	**100**	**0**
Cropping Intensity %			**190**	**183**	**198**	**15**

Source: CEGIS estimation based on field information, 2015

Future-with-Project

332. The future with improved polder infrastructures would help to change the hydrologic regime inside the polder area which could ceate enabling conditions for the farmers to change their cropping patterns **Table 8.6.** Under FWIP condition, the structures would function properly, drainage of excess water during rainy season will be ensured which probable positive impact on the land. The improved land type condition could influence the farmers to practices multiple cropping in the polder area. After completion of the interventions, the cropping intensity is expected to increase to 198%.

Impact

333. After completion of the interventions, more crops will be cultivated. Farmers will also be able to grow more HYVs. It is anticipated that the cropping intensity would be increased by 15% under FWIP over FWOP.

b. Crop production

Future-without-Project

334. Presently, total crop production is 20,764 tons of which rice is 5,562 tons (27%) and non rice is 15,202 tons (73%). Volume of crop production may get adversely impacted due to siltation of river and drainage channels. The production would decrease from the base situation. Notwithstanding the above, the farmers will continue their efforts to produce more crops under the FWOP condition. A total amount of 4,266 tons of rice and 11,984 tons of non-rice are expected to be produced in the polder.

Table 8.7: Impact on crop production in the polder area

Crop Name	Production(ton)			Impact(FWIP-FWOP)	% Change
	Baseline	FWOP	FWIP		
Lt. Aus	672	490	914	424	87
HYV Aman	560	367	979	612	167
Lt. Aman	4330	3,409	4,991	1,581	46
Total rice	**5,562**	**4,266**	**6,883**	**2,617**	**61**
Sunflower	258	184	408	224	122
Sesame	231	207	274	67	32
Mungbean	352	245	456	211	86
Watermelon	13,493	10,570	18,960	8,390	79
Groundnut	462	453	679	226	50
Khesari	406	326	449	123	38
Total non-rice	**15,202**	**11,984**	**21,226**	**9,242**	**77**
Total	**20,764**	**16,250**	**28,110**	**11,859**	**73**

Source: CEGIS estimation from field information, 2015

Future-with-Project

335. The crop production would boost up significantly under the FWIP condition. The total crop production would be 28,110 tons of which rice would be 6,883 tons and non-rice 21,226 tons. The rice and non-rice production is estimated to be about 61% and 77% higher under FWIP than that of FWOP. Rice production would be increased due to expansion of area for HYV Aman, Lt Aus, and non-rice crop with expanded watermelon cultivation. Additional 2,617 tons of rice and 9,242 tons non-rice would be produced in the polder area (Table 8.7).

Impact

336. Additional production of 2,617 tons (61% higher) of rice and 9,242 tons (77% higher) of non-rice are estimated under FWIP over FWOP (Table 8.7).

c. Crop damage

Future-without-Project

337. Presently, total crop production loss is about 444 tons of which rice is about 228 tons and non-rice is about 216 tons due to drainage congestion, partial salinity and scarcity of irrigation water etc. The situation would be aggravated under FWOP condition. Total 465 tons of rice and 283 tons of non-rice crops production would be lost under FWOP situation (Table 8.8).

Table 8.8: Impact on crop production loss in the polder area

Crop Name	Production(ton)			Impact (FWIP-FWOP)	% Change
	Baseline	FWOP	FWIP		
Lt.Aman	228	465	148	-317	-68
Total rice =	**228**	**465**	**148**	**-317**	**-68**
Sesame	44	50	11	-39	-78
Watermelon	158	196	0	-196	-100
Groundnut	14	37	14	-23	-62
Total non-rice =	**216**	**283**	**25**	**-258**	**-91**
Total =	**444**	**748**	**173**	**-575**	**-77**

Source: CEGIS estimation from field information, 2015

Future-with-Project

338. Crop damage n FWIP scenario, would be reduced by 77% due to implementation of interventions and their proper management. These interventions would have positive impact in reducing crop damage area as well as crop production loss. It is also assumed that the production loss of watermelon will be reduced. The total rice and non-rice production loss would be about 148 tons and 25 tons respectively.

Impact

339. It is expected that loss of crop production would be reduced by 575 tons which would be about 77% less in FWIP over FWOP in Table 8.8.

d. Irrigated area

Future-without-Project

340. Presently, irrigated area is about 1,650 ha. If the interventions would not be implemented, the availability of surface water in the river and khals will decrease due to further siltation of river and khals in the area. The irrigated area would decrease to 1,590 ha in FWIP.

Future-with-Project

341. After implementation of the polder, water will be available in the rivers and khals. Irrigation of *Rabi* crops will be possible using water from different rivers and khals through LLPs up to February. The irrigated area would increase to 1,970 ha in FWIP. The irrigated area would be increased about to 380 ha in FWIP over FWOP.

Impact

342. The irrigated area would be increased about to 380 ha in FWIP over FWOP.

8.5.4 Fisheries Resources

a. Fish habitat and habitat quality

Future-without-Project

343. Fish habitat of Polder 43/2B mainly include internal khals and ponds. Most of the khals are silted up and the shallow water depth is covered with water-hyacinth. Due to continuous siltation water availability as well as flow is decreasing in the internal khals. If this situation continues, perennial khals would be converted into seasonal khal or most portion of the khal would become agriculture land in future. It is assumed that 10-15% area of a khal may turn to seasonal khal. As a consequence duck weed and water-hyacinth will increase and would covered most of the part of a khal. The excessive water-hyacinth would obstract light penetration into the water column and that would hamper photosynthesis activities of fish depending aquatic vegetation. On the hand, decomposition of water-hyacinth would deteriorate the water quality which would cause negative impact on the fisheries resources and aquatic biota. During field visits from the local people it is learned that around 10 ha of area is inundated every day at Dari Baherchar area of the polder due to the exsting breach in the embankment breaching. In FWOP situation, it is expected that tidal flooding habitat may increase up to 20 ha.

Future-with-Project

344. Water depth as well as water availability would be increased due to re-excavation of khal. Duck weed and water hyacinth would also be totally removed. As a result, silted up and seasonal khal would be perennial khals and the water quality would improve. Photosynthesis activity of fish depending aquatic vegetation would be enhanced. After re-excavation of khal, feeding and breading ground of bottom dweller fish species would be damaged. Turbidity of khal's water would be increased. The increased turbidity may reduce primary productivity of fish food organisms. As a consequence, fish production of khal may decrease slightly. This impact on fisheries resources is expected to be temporary. After 1 or 2 year the habitat quality will be improved. In future with project situation, floodplain habitat would be totally lost due to re-sectioning of embankment.

Impact

345. Seasonal khal would become perennial khal again. The improved habitat quality would support different types of fishes as well as aquatic vegetation which would be helpful for feeding and habitation of fisheries and aquatic biota. Floodplain habitat would be totally lost.

b. Fish movement and migration

Future-without-Project

346. Most of the freshwater and brackish water fish species as well as fish hatchling move from river to khal through sluice gate at some stage of their life cycle for nursing and feeding purpose. In FWOP condition, hatchling and fish movement would be facilitated round the year due to existing malfunctioning and mismanagement of water control structures. Moreover, siltation of khal bed would lead to reduce the water depth. Thus fish movement and migration would be hampered from river to khal and vice-versa. On the other hand, duck weed and water hyachinth would also obstruct the movement of surface dweller/pelagic fish species.

Future-with-Project

347. The movement of hatchling as well as brackish and fresh water fish from river to polder area would be obstructed / regulated during the repairing of sluices and drainage inlets and outlets. Brackish water fish species like *Puti, Chingri, Tengra, Baila* and *Pairsa,* etc which moves on regular basis during high tide would thus be adversely impacted duing repairing of sluices/ regulators. But increased water depth and removal of duck weed and water hyacinth due to re-excavation of khal would facilitate the internal fish movement and migration significantly.

Impact

348. Movement of both brackish and fresh water fish species as well as hatchling through water control structures would be slightly hampered. But internal fish movement and migration would be facilitated significantly.

c. Fisheries Productivity

Future-without-Project

349. Due to ongoing process of siltation bed level of the khals continues to rise and making the khals less suitable for fish habitation. The catch per unit area (CPUA) will reduce from the current CPUA under FWOP. Many fish species will disappear from this habitat which ultimately leads to decrease the fish biodiversity in the polder area. But abundance snake head fish species like *Taki, Cheng, Shol, Gojar* etc and benthic species like *Baim, Gutum, Shing, Magur, Meni* etc may be increased due to low water depth and excessive duck weed in future without project situation. However, it is assumed that capture fisheries productivity may be decreased by 5% from the base condition. The estimated capture fisheries productivity would be 122 kg/ha. Moreover, increased tidal floodplain would enhance capture fisheries productivity. But the contribution will be insignificant because water is only available during high tide.

Future-with-Project

350. Implementation of proposed activities especially re-excavation of khal under the project would increase the water depth, water availability as well as water quality of the khals which would play vital role to increase catch per unit area (CPUA) in the polder area under future-with-project situation. The improved fish habitat and habitat quality and enhanced internal fish movement and migration would change fish diversity as well as fish composition. The open water fisheries productivity would be increased. It is expected that the capture fisheries productivity would be increased by 5% (142 kg/ha) compare to baseline situation (135 kg/ha). It is mentionable that fish production from snake head and benthic fishes would be decreased due to improved water quality and removal of duck weed. On the other hand, re-sectioning of embankment and repairing of water control structures would reduce the flood vulnerability of the aquaculture pond. Therefore, area of culture fisheries might be increased which would boost up the culture fisheries productivity.

Impact

351. Capture fisheries productivity would be increased by 20 kg/ha. Culture fish productivity would also increase significantly.

8.5.5 Ecological Resources

a. Terrestrial Vegetation

Future-without-Project

352. Terrestrial vegetation will be continuing to risk due to natural disaster and human activities. On the other hand, every year (Dari baherchar and Jainkati village) homestead, roadside and mainly riverside vegetation gets destroyed by river bank erosion. It is also observed that, settlement density is higher along the polder embankments and lower near the peripheral settlement of the polder.

353. Damages of vegetation will also have impact on dweller wildlife like local birds, mammals, reptiles etc due to habitat destruction.

Future-with-Project

354. Existing trend of vegetation loss due to natural disaster will be reduced for flood protection by re-sectioning of the embankment. Existing vegetation of the khal banks will be improved by reducing drainage congestion due to construction of water control structures.

Impact

355. Terrestrial vegetation will improve.

b. Aquatic flora and fauna

Future-without-Project

356. Deterioration of the aquatic vegetation will due to the reduction of water area in khals and present siltation process. Composition of aquatic vegetation may slightly change due to long time inundation of floodplain. Dominance of free floating plants will increase with decrease of sedges and meadows. In the long run, excess growth of these aquatic plants may tightly cover on the water surface and get rotten. For which, habitat quality will be deteriorating.

Future-with-Project

357. Aquatic habitat condition is expected to improve due to increase in khal depth. The temporary deterioration of habitat quality during construction phase could be restored within 2-5 years by regenerating all existing aquatic plants. But vegetation composition will be changed due to change of khal depth and velocity. Abundance of free floating species will be low during monsoon for increased in velocity during dry season. On the other hand there is little scope to grow rooted floating plants inside the khal for the same reason.

Impact

358. Aquatic habitat will improve due to improvement of plant diversity as well as khal depth and velocity.

8.5.6 Socio-economic Condition

a. Access to open water bodies

Future-without-Project

359. Mass people cannot use open water bodies i.e. the khals for bathing, washing of cloths and other purposes due to siltation. Every year the siltation process is increasing and creating drainage congestion during rainy season. Under the given situation, people can

have medium access to 72% open water bodies and very poor access to 28% water bodies (**Map 8.4**). Without project situation, this situation may further deteriorate and will create more disturbances to the mass people.

Future-with-Project

360. With the implementation of the interventions, numbers of families will be benefited. They will be able to use water for various purposes. After implementation of the project, 21% of the total households will have better access to water bodies and 79% will have medium access to open water bodies (Map 8.4). However, in general terms the improvements would enhance social bonding and cohesion among them.

Impact

361. Peoples' standard life in the polder will improve since they will have access and sharing of open water bodies which could ensure social use of water, with consequent impact on social bonding and cohesion in various aspects of life.

b. Communication

Future-without-Project

362. Presently, the road networks in some parts of the polder i.e. Boloykathi to Amkhola, Gerabunia to Sakhariya bazar, Badura bridge to Mriddha bari and many other places are very poor. Communication system may create harsher condition for people's mobility without project situation.

Future-with-Project

363. Road network system with project situation, will be improved and ensure better communication facilities within the periphery of polder.

Impact

364. Road communication will be improved which will create opportunities for movement of people and goods and give access to market leading to expanding business opportunities.

c. Gender promotion

Future-without-Project

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

Future-with-Project

366. 40% of the total labourforce to be mobilized through the labour contracting society (LCS) will be female. Since some of the earthwork contract will be awarded to the LCS, they will be directly benefited through these interventions.

Impact

367. The employment opportunity for women in the construction works and during operation/maintenance phase can create opportunities for the labouring female population for better life and livelihood.

d. Employment opportunity

Future-without-Project

368. Employment opportunity for people is poor. . They are living under poor economic condition and have very few options to diversify, adapt and develop their economic activities. Under future without project situation, these sufferings may remain same or may further deteriorate in future.

Future-with-Project

369. The proposed interventions can improve peoples' quality of life within the polder. More opportunities for income and employment in different interventions can help them to lead better life and pursue livelihoods.

Impact

370. Creation of new employment opportunities will increase the level of income leading to improved wellbeing better standard of life.

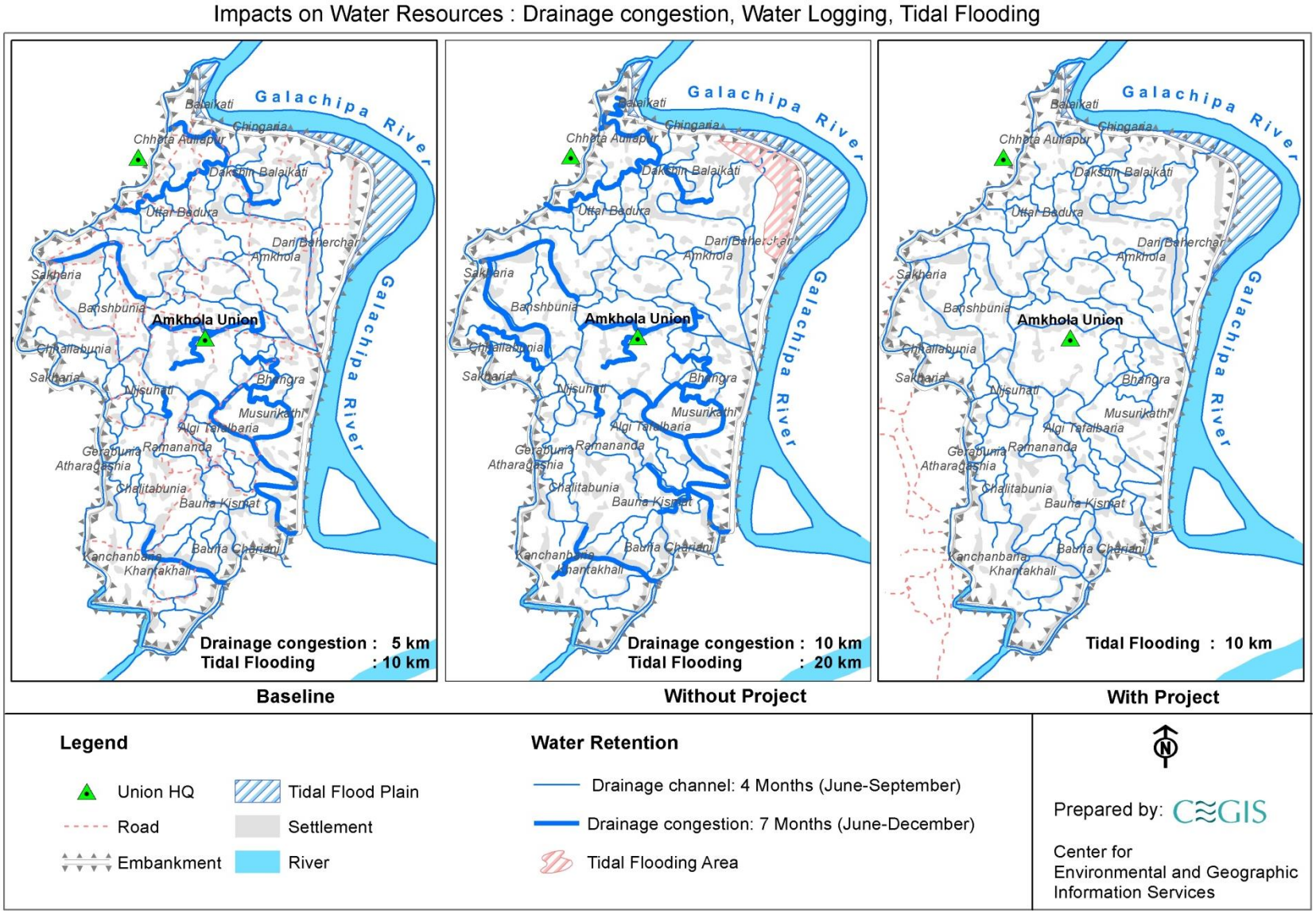
Table 8.9: Location Specific Impact Assessment Matrix under Operation Phase

IESC	Baseline	Future without Project	Future with Project	Impact (+/-) / Magnitude 1-10
Water Resources				
Surface Water Availability	No major water deficit for drinking and domestic purposes, however there is demand of irrigation water.	Approximately 25% of the people in the polder might suffer from irrigation water scarcity.	Around 7% of population would still remain under water stressed condition.	+4
Drainage congestion and water logging	Minor drainage congestion exists inside the polder (up to 5 km) but no water logging exists.	Around 15 km of khals (along Bauria khal, Badrar khal, Bangrar khal, Tulabiara khal Etc.) would face drainage congestion, but no water logging would occur.	No drainage congestion and water logging would occur.	+4
Tidal Flooding	Around 10 ha of areas at Dari Baherchar are subjected to tidal flooding	Tidal flooding extent may further increase upto around 20 ha at Dari Baherchar	No tidal flooding would occur at Dari Baherchar	+4
Land Resources				
Agriculture land use	Presently, net cultivable area (NCA) is about 71% of the gross area. Of this NCA single, double and triple cropped area are about 22%, 66%, 12% respectively.	Utilization of land for single, double and triple cropped would be changed to about 27%, 63%, 10% of the NCA respectively under FWOP condition	Utilization of land for single, double and triple cropped would be changed to 16%, 70%, 14% of the NCA respectively under FWIP condition	+2
Agricultural Resources				
Cropping pattern and intensity	Presently, cropping intensity of the polder area is about 190%.	Cropping intensity would be reduced to183%.	Cropping intensity would be about 198%.	+3
Crop production	Total crop production is 20,764 tons of which rice is 5,562 tons and non rice is 15,202 tons.	The total crop production is expected to decrease to 16,250 tons of which loss of rice would be 4,266 tons and non-rice would be 11,984 tons.	The total production is expected to increase to 28,110 tons of which rice would be 6,883 tons and non-rice would be 21,226 tons.	+4

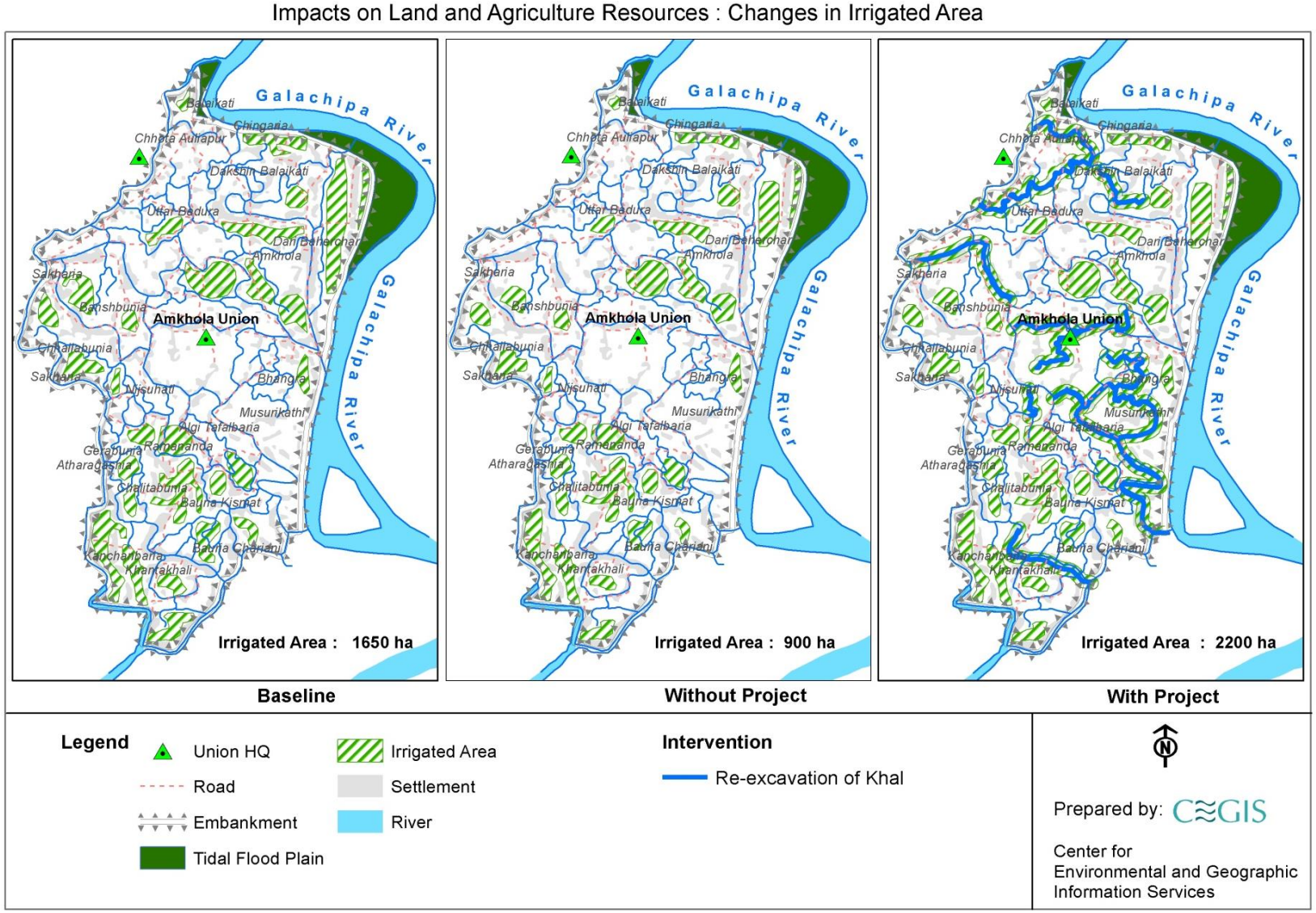
IESC	Baseline	Future without Project	Future with Project	Impact (+/-) / Magnitude 1-10
Crop damage	Total crop production loss is 444 tons of which rice are 228 tons and non-rice 216 tons.	Total crop production loss is expected to increase to 748 tons of which rice is 465 tons and non-rice 283 tons.	Loss of rice production would be reduced to 317 tons and non-rice at 258 tons.	+5
Irrigated area	Irrigated area is about 1,650 ha.	Irrigated area is expected to decrease to 1,590 ha.	Irrigated area would be increased to 380 ha.	+3
Fisheries Resources				
Fish habitat and habitat quality	• Siltation and excessive duck weed (and water hyacinth) are major problems of the khals in the polder area which are causing unsuitable for fish habitation.	• Perennial khal would be converted to seasonal khal • 10-15% area of a khal may become seasonal khal • Habitat quality would be declined along with feeding and breeding ground of bottom dweller would be damaged	• Seasonal khal would be perennial khal • Habitat quality would be improved. • Improved habitat would support growth of different types of aquatic vegetation which would be used as fish feed and habitation.	+3
Fish movement and migration	• Fresh and brackish fish species move and migrate through water control structures on a regular basis during high tide	• Same as base condition	• Movement of fish and hatchling would be restricted but internal movement and migration would improve significantly	+2
Capture fisheries productivity	Capture fisheries production in khal is 135 kg/ha	Capture fisheries production in khal would decrease to 122 kg/ha	Capture fisheries production in khal would increase to 142kg/ha	+2
Ecological Resources				
Terrestrial Vegetation	Moderate	• Increase threats on surrounding vegetation due to natural disaster and human activities. • Most of the terrestrial faunal species are displaced due to vegetation damaged by existing problem.	• Vegetation loss will be reduced and floral species will be increased due to protection of area from existing problem.	+3

IESC	Baseline	Future without Project	Future with Project	Impact (+/-) / Magnitude 1-10
Aquatic flora and fauna	Moderate	• Aquatic habitat quality would be deteriorating due to death of aquatic plants. • Reduced depth due to continuous siltation would deteriorate internal khals habitat condition	• Improve Aquatic habitat due to improvement of plant diversity as well as khal depth and velocity	+2
Socio-economic Condition				
Access to open water bodies	People cannot use water for bathing, washing and other domestic purposes due to siltation of khals.	In without project situation, culture fish may increase and that eventually could create more conflicts over water use and supply water to agricultural land. As a result people's quality of life will deteriorate.	With the intervention, families will be benefited. They will be able to use water for various purposes, and access to water could t enhance social bonding and cohesion.	+2
Communication	Different parts of the polder i.e. Boloykathi to Amkhola, Gerabunia to Sakhariya bazar, Badura bridge to Mriddha bari	Without project situation, communication system may deteriorate and even become more severe	With project situation, road networks system will be improved and provide better communication facilities within the periphery of polder.	+2
Gender promotion	In the polder area only 2 percent 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, the females are mostly vulnerable. Widows 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.	The employment opportunity for women in the construction works and during operation/maintenance phase can give them the opportunities for better life and livelihood.	+3

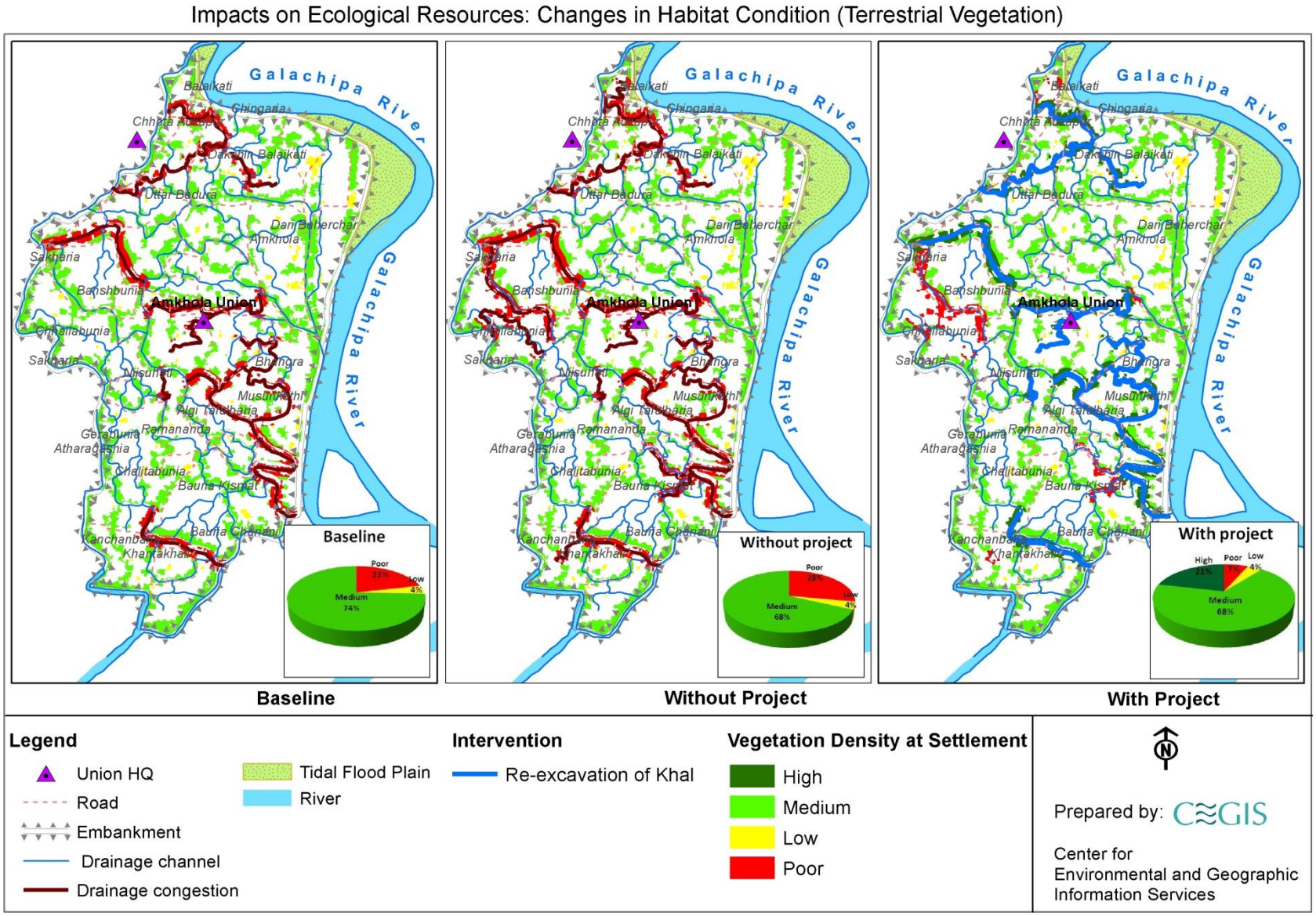
** Low impact (1-3); Medium impact (4-6); High impact (7-10)*



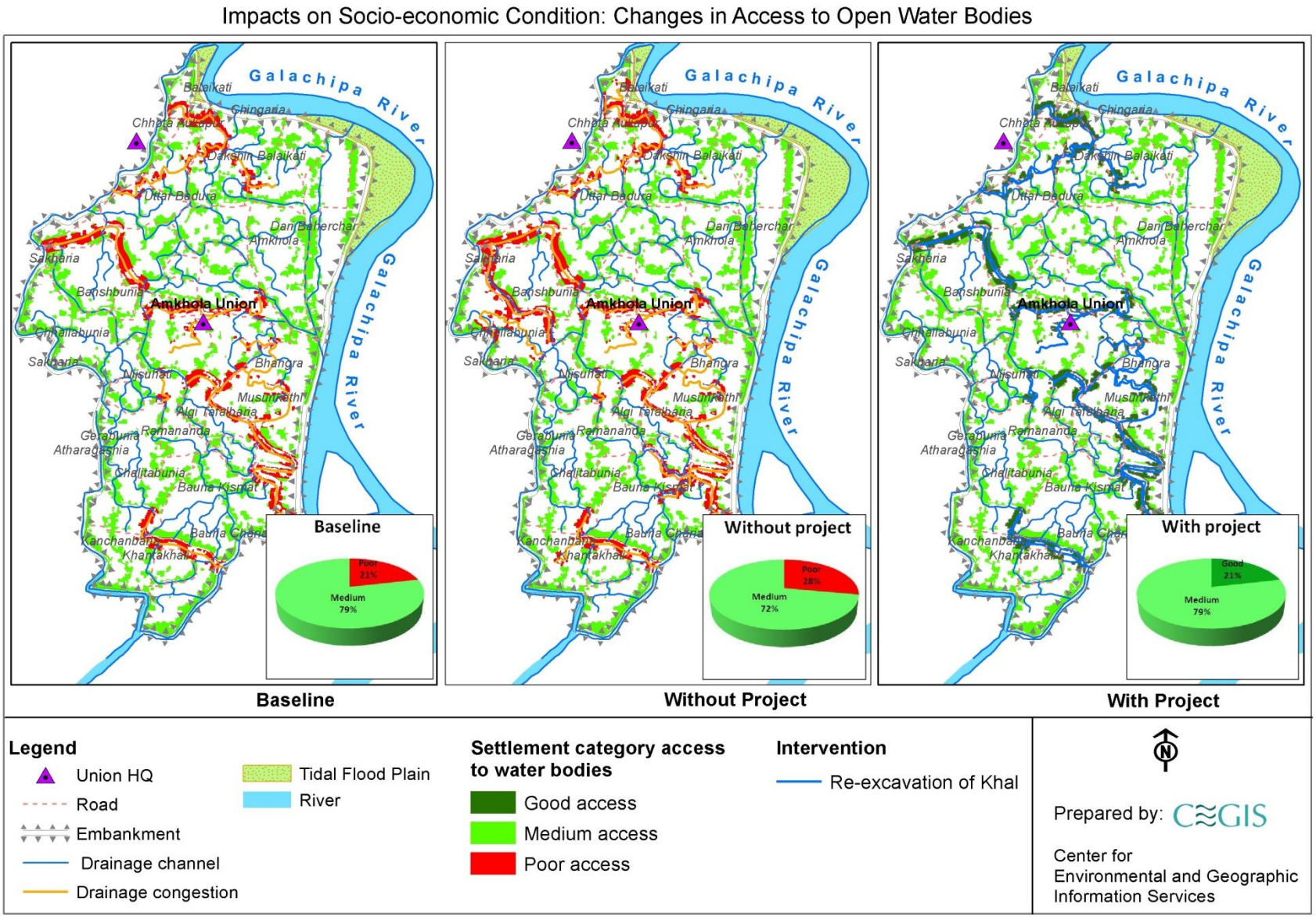
Map 8.1: Impacts on water resources: drainage congestion, water logging, tidal flooding



Map 8.2: Impacts on Land and Agriculture Resources: changes in irrigated area



Map 8.3: Impacts on Ecological Resources: changes in terrestrial vegetation condition



Map 8.4: Impact on socio-economic condition (vulnerability of the settlement to disaster)

9. Assessment of Cumulative, Induced and Reciprocal Impacts

9.1 General

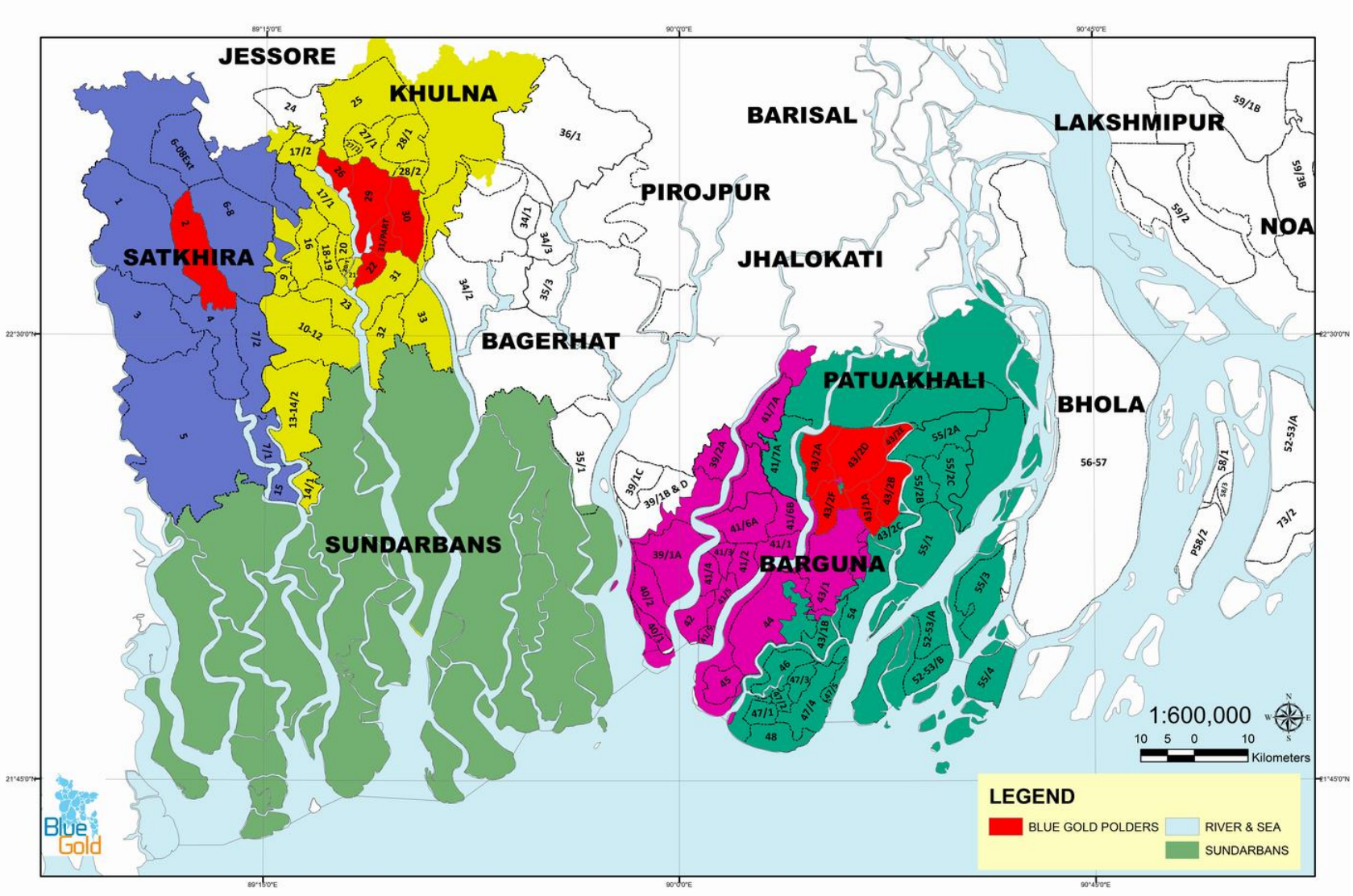
371. This chapter attempts to analyze several indirect effects regarding the implementation of different interventions proposed under the Blue Gold Program in Polder 43/2B. These effects include cumulative and induced impacts in the Polder 43/2B, and the reciprocal impacts of climate change in this polder. 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. Apart from the Blue Gold program, a number of other projects also exist in the vicinity of Polder 43/2B. 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 due to implementation of any project, but occur later in time or at a distance far away from the polder. The reciprocal impacts of climate change in this particular polder 43/2B include long term effects of climate change induced phenomena, and the climate change resilience developed in the polder due to implementation of the Blue Gold program.

9.2 Cumulative Impacts of all Blue Gold interventions on Polder 43/2B

372. A total number of 12 polders in Satkhira, Khulna and Patuakhali districts have been selected for implementation of the Blue Gold program in the first phase. The selected polders are shown in **Map 9.1** below. Among these, two polders (43/1A and 43/2D) are located adjacent to Polder 43/2B and therefore, may generate some impacts in future. The existing crest levels of Polder 43/1A is 3.30 m above MSL and that of Polder 43/2D ranges from 3.65 to 3.86 m above MSL. Rate of sedimentation may increase along the Lohalia River if re-sectioning of the embankment are executed in Polder 43/1A and 43/2D. This is because MSL and some of the water control structures would be repaired and reconstructed, tidal flow from the Lohalia River may not enter the polders, which would confine the river sediments within the Lohalia River system. With reduced river sections along the river, flow velocity might also increase, creating more pressure along the South-East corner of Polder 43/2B. This may increase river erosion in Polder 43/2B in future. Furthermore, storm surge and tidal inundation risks may be increased in Polder 43/2B. Such risks would be transferred from the adjacent polders (43/1A and 43/2D), as storm surge and tidal water levels may not be able to overtop those polders once the crest levels have been elevated (under the Blue Gold program).

9.2.1 Synopsis of projects around Polder 43/2B

373. Apart from the Blue Gold interventions, there are some other development projects in and around the Polder 43/2B, 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 43/2B, undertaken by different line agencies in Patuakhali and Barisal districts.



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	Proposed but not implemented	Pangsha, Ganges River	High	
GoN, BWDB	Bangladesh Delta Plan 2100	2013-ongoing	Entire country	Moderate	
MoDMR	Comprehensive Disaster Management Program (CDMP), Phase II	2010- ongoing	Entire country (40 districts with direct interventions)	Negligible	No schemes in Patuakhali sadar and Amtali upazilas
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	Low	
Regional					
DMB, BWDB, LGED	Emergency 2007 Cyclone Recovery and Restoration Project (ECRRP)	2008- ongoing	Coastal Zone	Moderate	
BWDB	Coastal Embankment Improvement Project (CEIP)	2012- ongoing	Coastal zone	Moderate	
	Coastal Embankment Rehabilitation Project (CERP)	1995-2004	Coastal zone	Negligible	
Local					
LGED	Development of Union Parishad Connecting Roads	1999-2006	Patuakhali and Barguna	Negligible	
	Rural Development Project-16: Infrastructure (Phase-II)	1999-2004	Patuakhali and Barguna	Negligible	
	Participatory Small Scale Water Resources Sector Project	First (1996-2007) and Second (2010-ongoing)	Barisal, Jhalokathi, Patuakhali etc.	Negligible	
DoF	Fisheries extension project	1994-2004	Patuakhali, Barguna	Negligible	
DPHE	Water Supply, Sanitation, Drainage and Waste Disposal Project	1996-2007	Patuakhali and Barguna	Negligible	
DAE	Small Holder Support Project	1999-2005	Barisal, Patuakhali, Jhalokati, Barguna	Negligible	

Source: Integrated Coastal Resources Database, developed and maintained by WARPO and CEGIS

374. The projects (listed in **Table 9.1**) which have or may have **high or moderate sensitivities** on some of the environmental or social components of Polder 43/2B are briefly discussed in the following sections.

9.2.2 Cumulative impacts of the proposed Ganges Barrage

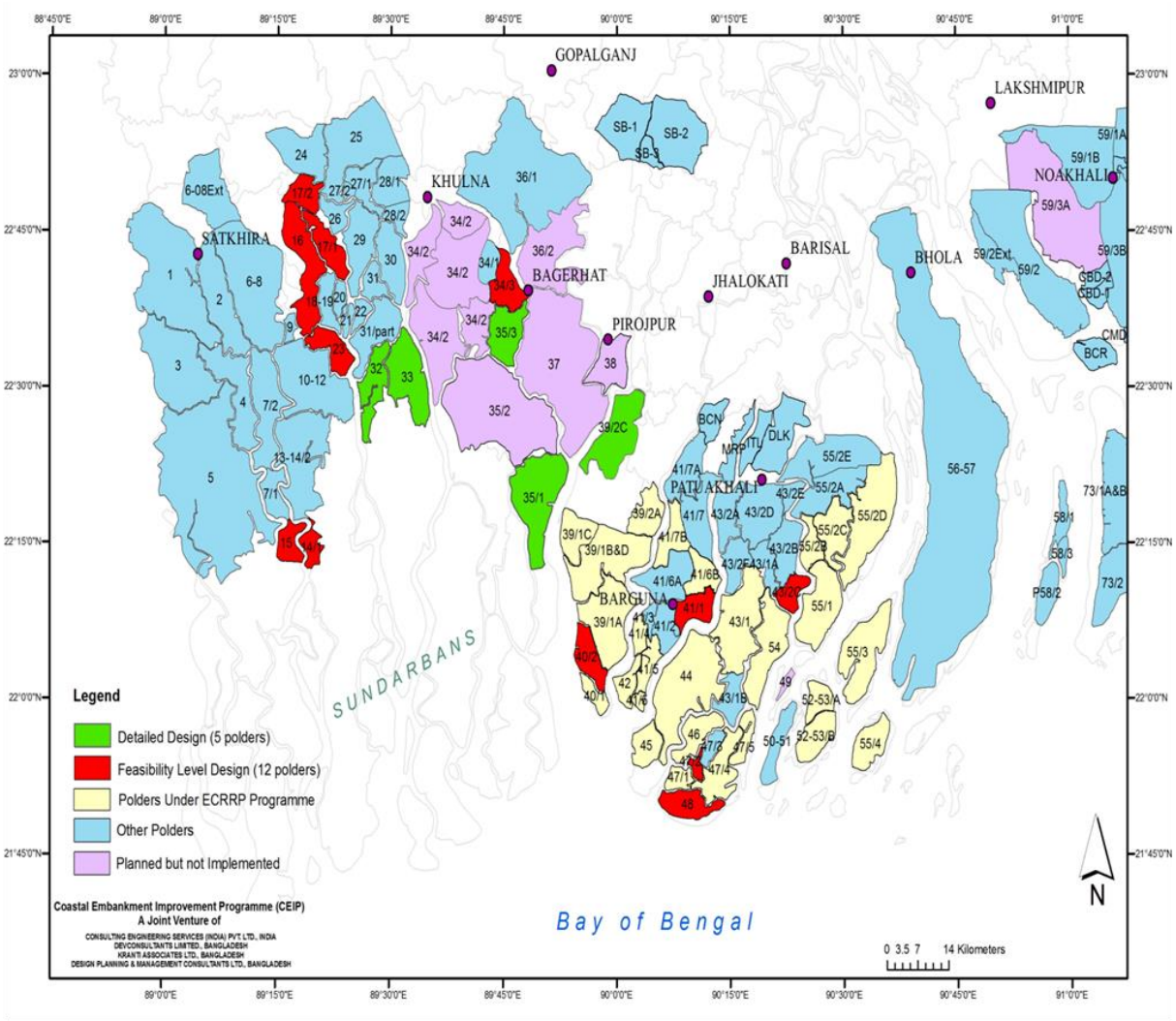
375. The Ganges Barrage Project is perhaps the most significant project for the coastal region of Bangladesh. The project is expected to manage the water resources system, promoting inclusive socio-economic development, and to recover the existing environmental degradation. The Government of Bangladesh (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.

376. 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 the 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.

377. Polder 43/2B is located within the GDA, and bears significant sensitivity towards the proposed Ganges Barrage. The most significant impact of the Barrage on Polder 43/2B would be the reduction of surface water salinity in its adjoining river system. At present, the peripheral Lohalia River carries low salinity concentrations during dry season, which hampers the agricultural water use. The proposed Ganges Barrage will benefit dry season water use; enhancing surface water irrigation practices within the polder. This would eventually enhance 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 the rural livelihoods would shift towards enhanced farming practices. More regional and local developments are expected, and the environment surrounding the polder may be benefited as a whole.

9.2.3 Cumulative Impacts of the Coastal Embankment Improvement Project (CEIP)

378. The 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 being implemented. The other 12 polders have undergone pre-feasibility studies and would be implemented gradually in later phases.



Map 9.2: Location of CEIP polders

379. Polder 43/2C is located along the Lohalia River, which is adjacent to Polder 43/2B. The existing crest levels of the polder ranges from 3.32 to 3.60 m above MSL. Re-sectioning works are proposed in the polder under CEIP, which would increase its crest level up to 5.18 m (in most locations) above MSL. This increase would reduce storm surge to enter into the polder, and additional storm surge may be diverted towards Polder 43/2B. As such, the risk of storm surge inundation may increase in Polder 43/2B. Furthermore, tidal sedimentation may increase the outside Polder 43/2C, along Lohalia River, which may increase flow velocity towards the upstream location during high tide. This may create pressure on the southern portion of Polder 43/2B, along the Lohalia River, and may result in river erosion incidents in future.

9.2.4 Cumulative Impacts of the Emergency 2007 Cyclone Recovery and Restoration Project (ECRRP)

380. In order to facilitate generation of livelihood activities to recovery from the aftermath of cyclone Sidr, and to rehabiliate the infrastructure damaged by this devastation cyclone government decided to build long-term preparedness through strengthened disaster risk management. In this effort the GoB has implemented the 'Emergency 2007 Cyclone Recovery and Restoration Project (ECRRP)' in a total number of 13 districts (Barguna, Bagerhat, Barisal, Khulna, Bhola, pirojpur, Jhalokati, Noakhali, Feni, Chittagong, potualkhali, Sathkhira, Laksmipur) of Bangladesh. A major component of the activities of this project is

rehabilitation of embankments and among the 35 polders considered for rehabilitation under the project, Polders 43/1, 55/1, 55/2B and 55/2C are located near Polder 43/2B, along the downstream of Lohalia River (Map 10.2). The design crest levels of these polders are: up to 5.18 m above MSL for Polder 43/1 and up to 4.27 m above MSL for Polder 55/1, 55/2B and 55/2C. All these polders will tend to divert the flow of Lohalia River further upstream and will transfer storm surge inundation risks. There may also be flood plain sedimentation along the river as a significant portion of tidal water would be prevented from entering those polders, which may reduce the depth of flow of Lohalia River and Golkhali Khal in future. Due to the reduced depth, the probability of the river erosion in Polder 43/2B may increase.

9.2.5 Cumulative Impacts of Other Projects

381. As shown in **Table 9.1**, a number of other projects are under implementation near Polder 43/2B with low sensitivity. Most of the projects have much significance on the coastal region in general, but are located far away from Polder 43/2B. A synopsis of the minor indirect effects of these projects with **low sensitivity** for Polder 43/2B is discussed below.

Water Management Improvement Project (WMIP)

382. Water Management Improvement Project (WMIP) covers 120 completed FCD/FCDI/Town protection schemes of BWDB located in 39 districts throughout the country. The objective of WMIP is to improve national water resources management by involving the local communities to play an expanded role in all stages of the participatory scheme cycle management. Out of the 120 schemes, 67 schemes are under components 1 (System Improvement and Management Transfer) and 2 (O&M Performance Improvement), and 63 schemes are under Component 4 (Flood Damage Rehabilitation). Polders 55/2A and 55/2B are adjacent to Polder 43/2B which include schemes under Component 2 of WMIP. Operation and Maintenance programs are currently ongoing within these polders, entailing several software interventions i.e. scheme selection, WMO formation and planning, implementation, evaluation and management transfer etc. These initiatives have created a widespread perception regarding water management amongst local people, which has somewhat created a social impact in Polder 43/2B. The local people are more comfortable in forming and actively maintaining WMOs and as such, water management initiatives under the Blue Gold program is likely to be benefited.

Projects under Climate Change Trust Fund (CCTF)

383. Considering Bangladesh's vulnerability to climate change, the GoB decided to finance climate change adaptation initiatives from its own revenue budget through the creation of Climate Change Trust Fund (CCTF), for implementing more projects on climate change adaptation and mitigation.Till 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 the CCTF is in the pipeline for implementation, with a number of newly proposed projects. Among all CCTF projects, the geographic extent of one scheme (Re-excavation of Khals in Kalapara and Rangabali Upazila in Patuakhali District for Retention of Rain water to increase Agricultural Production and Removal of drainage Congestion) lies within the vicinity of Polder 43/2B. The interventions proposed under the project are localized within the polder, and will not have any large scale impacts on Polder 43/2B. However, there may still be some social impacts regarding labor harnessing, employment opportunities etc.

Capital Dredging of River system

384. 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 43/2B. The dredging activity proposed 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 43/2B may slightly be benefited. In future, if more similar dredging works are initiated nearby, Polder 43/2B may be further benefited.

Comprehensive Disaster Management Programme (CDMP)

385. Globally Bangladesh is recognized as a country most vulnerable to disasters, both natural and manmade. Several international reports (AR4, IPCC 2007; World Risk Report 2012, UNU-EHS, World Disaster Report 2012, IFRC) have ranked Bangladesh high in terms of disaster damage (loss of life and assets). The Programme (CDMP) was launched by the Government of Bangladesh in 2003 as a key strategy to advance combined risk reduction efforts among all key factors including the government at national and local levels. The overall objective is to achieve significant reduction of death, vulnerabilities and loss from future disasters through improved resilience of the vulnerable communities through a transformational change in the disaster management system in the country that will benefit both the rural and urban communities. The Comprehensive Disaster Management Programme covers 40 districts with direct interventions throughout the country. Furthermore, there are total 18 schemes in Patuakhali district under Doshmina, Golachipa and Kalapara unions. However, there may be negligible impacts on Polder 43/2B.

9.3 Induced Impacts of Polder 43/2B

386. The interventions in Polder 43/2B 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 43/2B 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

387. The proposed interventions in Polder 43/2B will safeguard the polder against direct intrusion of tidal water. Therefore, water from Lohalia river carrying sediments will move further downstream or upstream and may cause induced sedimentation. The river system may be subjected to increased floodplain siltation and new morphological changes (i.e. formation of new lands, river course shifting) may be developed along the Lohalia river.

Tidal and Stor m Surge Flooding

388. Polders 55/2A and 55/2B are located adjacent to Polder 43/2B. As per design, the crest level of Polder 43/2B would be raised up to 4.27 m above MSL, which may impose tidal and storm surge inundation risks to the adjacent polders (Polders 55/2A and 55/2B) during extreme events. Tidal water may not be able to enter Polder 43/2B during such events, and will be diverted elsewhere. This may increase the risk of flooding in the aforementioned nearby polders and Chandrailer Char developed in Lohalia River. **Table 9.2** below shows the existing average existing crest levels in Polders 55/2A and 55/2B.

Table 9.2: Existing Average Crest levels of Polders adjacent to Polder 43/2B

Polder	Existing crest level (m +PWD)
Polder 55/2A	3.00~4.00
Polder 55/2B	3.50~3.80

Affect on water quality

389. The interventions in Polder 43/2B would lead to infrastructural developments, increased settlements and other human induced output in future. This would generate debris/ waste which may reach the peripheral rivers. Pollution phenomena may increase in the peripheral rivers and Khals (Lohalia and Golkhali). Furthermore, due to expansion of agricultural area, more agriculture practices and industrialisation are expected, which may pollute the surface water in terms of chemical composition, through agricultural run-off and discharge of untreated used water from industries.

Changes in aquatic habitat, species migration and biodiversity

390. Due to increased floodplain sedimentation outside the polder, aquatic habitat may slightly be affected. Flow 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 as a consequence of prevention of dry season entry of saline water, for which the salinity tolerant aquatic species may dominate while fresh water aquatic species may decrease. Biodiversity of aquatic life may also decrease in the Lohalia River system.

Employment opportunities and Livelihood improvement

391. 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 43/2B, new employment opportunities may be created. This may as well encourage people from outside the polder to visit the polder for work and improve their livelihood status.

Enhanced local and regional food security

392. The proposed interventions may drive agro-economic development inside the polder. Thus, the area may provide enhanced food security to the surrounding areas. In future, Polder 43/2B 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 may contribute to the regional food security as well.

9.4 Reciprocal Impacts of Climate Change and Polder

393. In order to investigate the reciprocal impacts of climate change in the Polder 43/2B, 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

394. 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 model has been simulated using Delft 3D as modeling tool. All data used in the model setup and calibration (including topography, soil maps, land use maps, and weather data, river network and cross-section, water level, discharge and salinity) were obtained from different sources.

Digital Elevation Model (DEM)

395. 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 effective enough for identification of internal rivers and regulator locations.

River Bathymetry Data

396. Bathymetry of the Padma and Meghna 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

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

Land Use Data

398. The land use data for the study area 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

399. Information on soil data was obtained from the Soil Research Development Institute (SRDI) of the Bangladesh Government. 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).

Weather Data

400. 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

401. The present study utilizes the statistically downscaled climate projection data from “Climate Wizard” with a spatial resolution of around 50 km. 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 the monthly rainfall values may increase from April to October and decrease from November to March. 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 rainfall will increase by 1.5 to 3.5 % during July and September by 2050s. Monthly temperature values will increase by 1.6^{0}C to 2.0^{0}C with an average rise of 1.8^{0}C by 2050s in the polder area.

Table 9.3: Change in monthly temperature and rainfall under climate change scenario A1B with 50% ensemble of 16 GCM results by 2050s for polder 43/2B

Month	Climate Variables	
	Change in Rainfall (%)	Change in Temperature (^{0}C)
Jan	-17.4	1.9
Feb	-8.2	1.9
Mar	-2.7	2.0
Apr	5.8	1.9
May	5.5	1.8
Jun	0.6	1.6
Jul	1.5	1.7
Aug	3.5	1.8
Sep	1.5	1.7
Oct	4.2	1.7
Nov	-3.0	1.7
Dec	-19.5	1.7

Note: the negative (-) value in the table represent the decrease in rainfall or temperature Source: Climate Wizard, Washington University (http://climatewizard.org/)

Sea Level Rise

402. 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

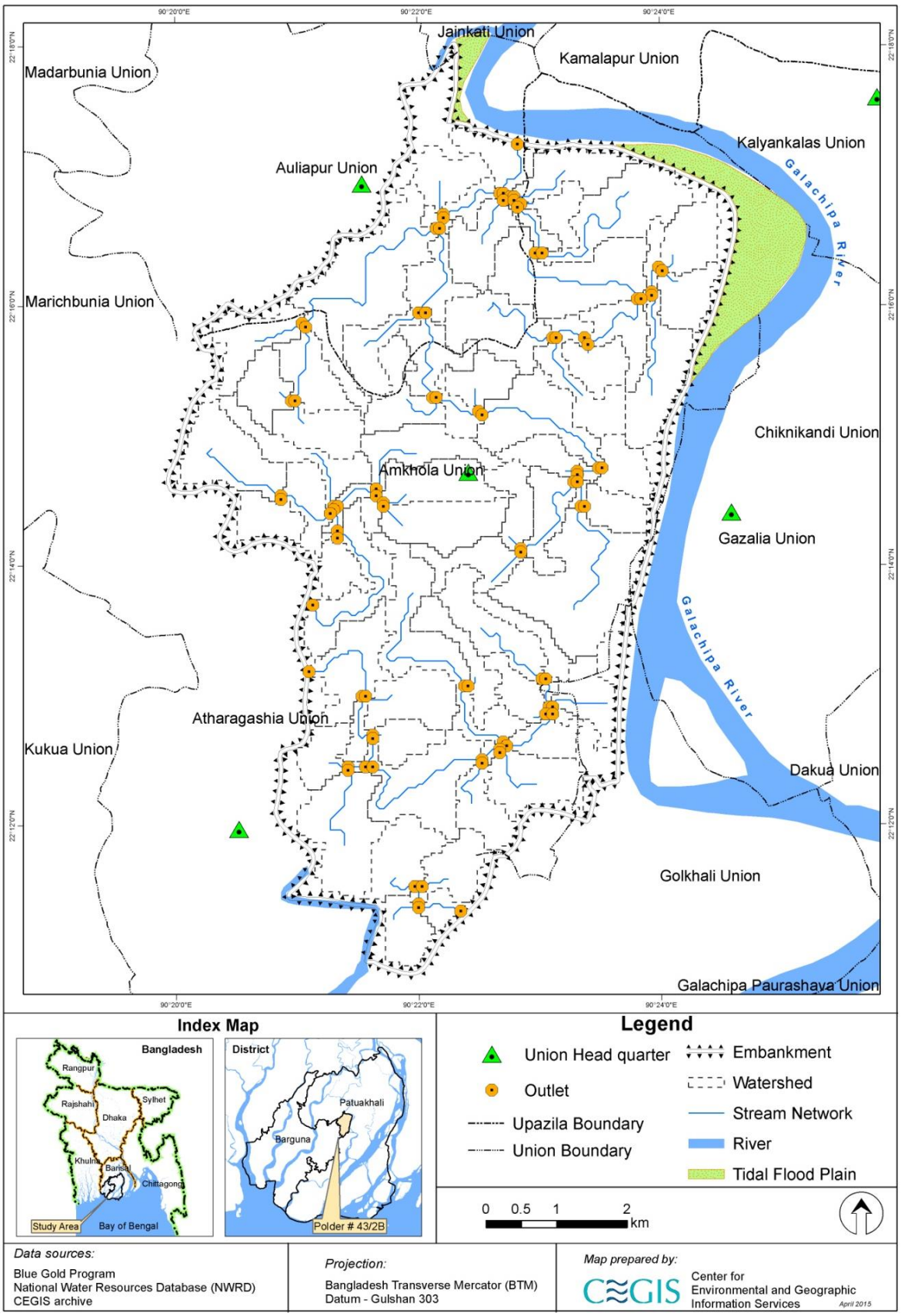
Source: IPCC AR4' 2007

9.4.2 Model Schematization

403. The following sections provide detail discussions on schematization and calibration of both the SWAT and Delft 3D models. The details of the model schematization have been discussed below.

SWAT model Setup

404. Five sequential steps are 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 is 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 automatically been done through the user interface. The watershed delineation results 86 watersheds for the entire polder area. The delineated watershed for polder 43/2B is shown in Map 9.3. Afterwards, 393 numbers of HRUs were generated with four land classes, six soil classes and 86 watersheds.



Map 9.3: Delineated watershed during model schematization using SWAT for Polder 43/2B

Delft 3D model Setup and Calibration

405. A 2-D hydrodynamic model was setup for the Padma and Lower Meghna river system. The schematization of the model is shown in Map 9.4. The model starts from the Padma River to the Bay of Bengal. 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 Mawa has been utilized as upstream flow boundary and astronomical constituent values has been used to generate the tidal boundary at the sea and utilized as downstream boundary condition of the model. The model has been simulated with a time step of 5 min for the year 2000. It has been simulated for water level, discharge and salinity.

406. The model has been calibrated using "Manning's n[8] values" for the rivers, against the water level data at Chandpur and Hatiya as shown in Figure 9.1. The model has been calibrated only for the maximum and minimum water level due to the unavailability of hourly or three hourly time series data. The model shows good agreement with the observed water level for both high and low tides at Hatiya and for the Chandpur, the model can capture the high tide but slightly over-estimate during the low tide. In a word, the model performs well to simulate the tidal fluctuations.

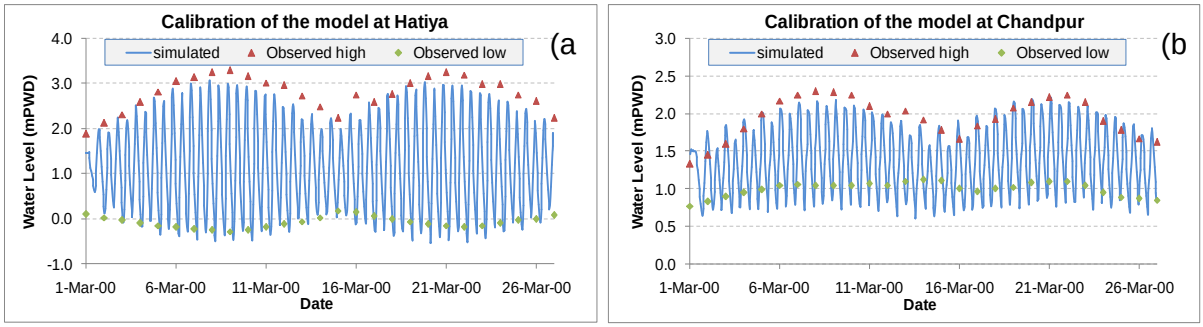
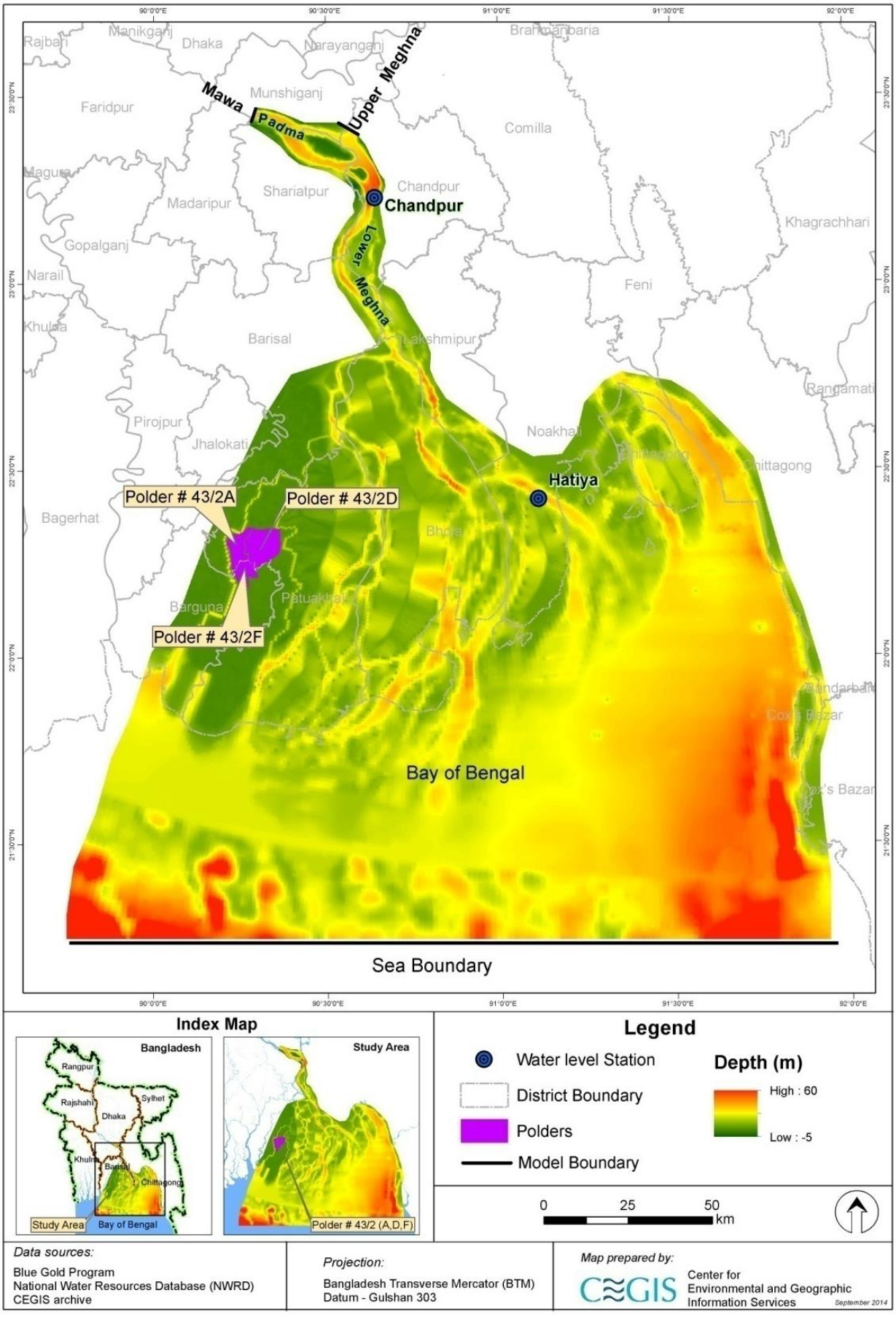


Figure 9.1: Calibration of model results at (a) Hatiya and (b) Chandpur for March, 2000

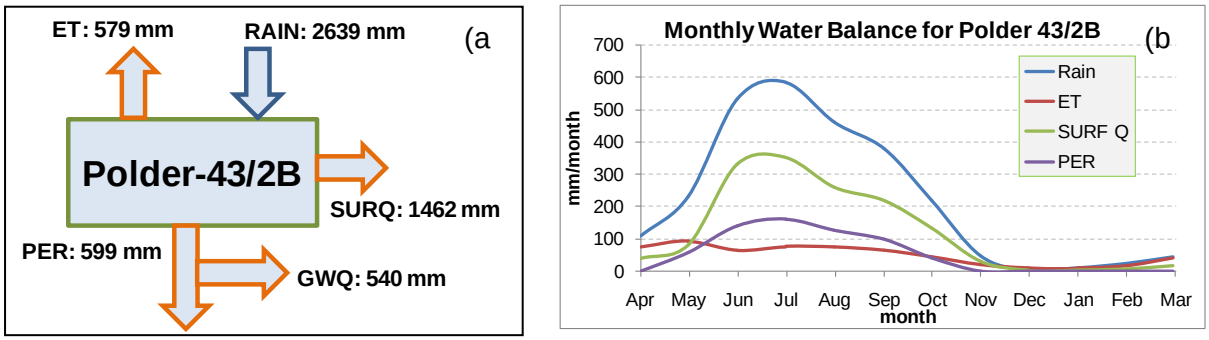
[8] Mannings's Equation is one of the most commonly used equations in Open Channel Flow. It was introduced by the Irish Engineer Robert Manning in 1889. In the equation, a roughness coefficient was introduced and denoted as 'n', which is known as the manings 'n'.
(http://www.fsl.orst.edu/geowater/FX3/help/8_Hydraulic_Reference/Manning_s_Equation.htm)



Map 9.4: Schematization of hydrodynamic model using Delft 3D

Water Balance of the Study Area

407. 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 2012 to estimate the availability of water during base period (1981 to 2012). The annual water balance for the polder 43/2B is shown in Figure 9.2.



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

Figure 9.2: Water balance for polder 43/2B, (a) average annual, (b) average monthly during the period of 1981 to 2012

408. The average annual rainfall of the polder area is 2,639 mm. The monsoon starts from the month of May and reaches its peak in July. The maximum monthly rainfall is about 600 mm.

409. 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 579 mm which is 22% of the annual rainfall. The evapotranspiration is maximum during April and May and is about 100 mm per month. The evapotranspiration rate is minimum during December to January. The percolation rate in the polder area is 599 mm per year which is 23% of the annual rainfall. The percolation rate follows similar trend like rainfall and the maximum rate is 160 mm per month. After losses of water through evapotranspiration and percolation, the remaining portion contributes to stream flow as overland flow and lateral (subsurface) flow. Around 55% (1462 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

410. The precipitation, temperature and other climate parameters are assumed to be changed 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.

411. The climate change impact on annual water balance in the Polder 43/2B is given in Table 10.5 for climate change scenario A1B by 2050s.The annual average rainfall for the polder area will be 2,694 mm which is about 2% more than the base condition. The surface runoff will also increase as there will be an increase in annual rainfall. There will be slight increase in annual evapotranpiration (8 mm/year) which is mainly due to the increase of temperature. There will also be a minor 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	2639	2694
Surface Runoff	1462	1507
Evapotranspiration	579	587
Percolation	599	600
Baseflow	540	540

412. 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 shown in Figure 9.3.

413. The availability of water will increase during May to October as there will be 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 will be around 4.5 to 12 mm and decrease around 2 mm per month.

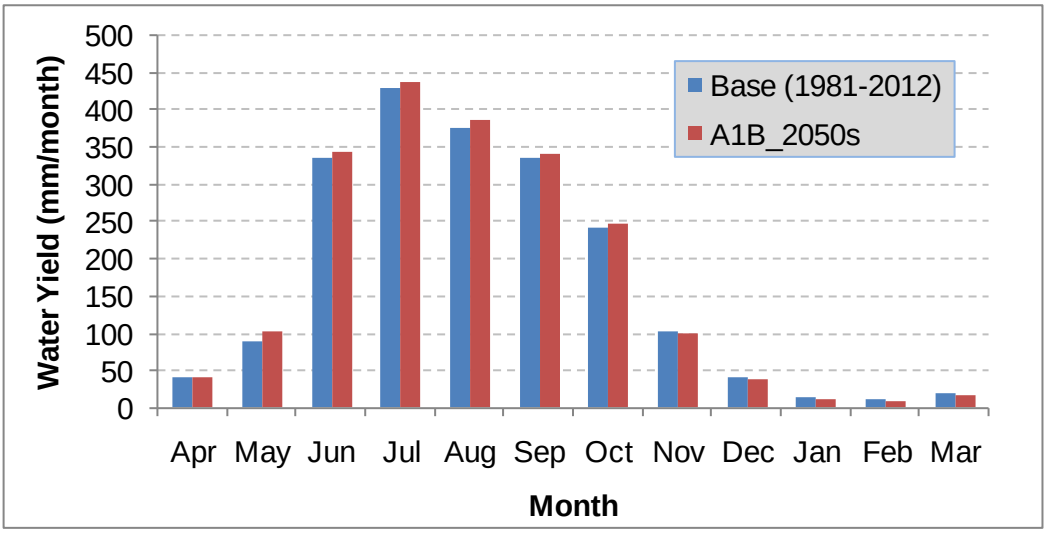


Figure 9.3: Climate change impact on monthly water yield for climate scenario A1B by 2050s

414. Table 9.6 below show the changes in seasonal water yield due to climate change by 2050s for scenario A1B. The Table shows an increase in seasonal water yield during monsoon (2.3%) and decrease during dry season (6.5%). Minor seasonal water yields during pre-monsoon and monsoon would also take place.

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)	131	9.1
Monsoon (Jun-Sep)	1477	2.3
Post-monsoon (Oct-Nov)	343	1.8
Dry (Dec-Mar)	81	-6.5

9.4.4 Climate Change Impact on Water Level

415. The sea level is expected to rise 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 high due to climate change which will result in increase of extreme flow during monsoon which ultimately results to increase in flood water level. CEGIS recently conducted a study on climate change impact on stream flow for the GBM basins and found that the dry season flow will be reduced and monsoon flow will increase. For climate change scenario A1B, there is a 5% reduction of dry season flow and 15% increase of monsoon flow for the combined flow of the Brahmaputra and the Ganges basin. For the Meghna basin, the increase of monsoon flow is about 10% due to climate change by 2050s.

416. The calibrated and validated Delft 3D model for the Padma-Meghna 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 has been assumed for the present study. At the same time, 15 and 10% increase of monsoon flow for the Padma and the Meghna rivers has been assumed respectively for the model setup. The model has been simulated for the combination of the above two scenarios and the simulated maximum water level during monsoon has been compared with the base year (2000) to assess the impact of climate change and sea level rise on flood level.

417. From the model simulation, it has been found that the flood level adjacent to the polder area will increase by 50 cm due to the increase of sea level only. The effect of change in upstream water flow is insignificant for the polder area. The combined effect of sea level rise and increase of upstream water results an increase of 50 cm increase of maximum water level of the rivers surrounding Polder 43/2B. If the water level increases by 50 cm of embankment overtopping will not be happened because the esixting crest level (4.3 m PWD) of embankment is adequate to protect the flood water. On the other hand, if proposed interventions espcailly re-excavation of proposed khals and repairing of drainage sluices is performed properly, there would be no drainage congestion inside the polder area for additional water to be generated due to climate change.

9.4.5 Climate Change Impact on Salinity

418. Sea level rise can cause saline water to migrate upstream to points where freshwater previously existed or can intensify the salinity. Sea level rise may lead to increased salinity in the estuaries, and may affect the 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.

419. 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 Padma River will be reduced by 5% 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 43/2B will increase by 1.7 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 43/2B

420. During field investigations carried out by the study team, it became evident from peoples' responses that they are aware of climate change consequences and events. In recent years they have been the victims of climate change induced natural disasters that frequently hitted the coastal regions causing massive losses of properties and infrastructures. Due to some of the Blue Gold program activities people's resilience capacity to cope and/or adapt to climate change impacts is getting mobilized and started to take actions 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 with better infrastructural support (higher plinth level) against climate change. The local farmers are also more concerned about climate change issues. They regularly follow and take part in the capacity building programs organized by the Blue Gold program, which they believe have enhanced their understanding and preparedness for flood and disaster management.

10. Environmental Management Plan

421. Environmental management plan (EMP) is presented in the following matrix for pre-construction, construction and Operation 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

10.1.1 Pre-construction Phase

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

10.1.2 Construction Phase

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

10.1.3 Operation phase

424. The implementation of the 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 Operation phase on water resources

Impact	Mitigation Measure	Enhancement/Contingency/ Compensation	Residual Impact (+/-)/ Magnitude (1-10) with EMP	Responsible Agency
Around 6,500 people (18% of total) in Banshbunia, Nijsuhati, Amkhola, and Ramananda Mauzas would have sufficient surface water and access to water	Not required	Not required	+4	-
Around 15 km khals (11% of total) would be benefited due to reduction of probable drainage congestion in	Not required	Not required	+4	-

Impact	Mitigation Measure	Enhancement/Contingency/ Compensation	Residual Impact (+/-)/ Magnitude (1-10) with EMP	Responsible Agency
Approximately 20 ha areas at Dari Baherchar would be protected from probable tidal flooding	Not required	As the existing embankment has almost been washed out Dari Baherchar, supplementary temporary protection works (with bamboos and geobags) should be carried out to stabilize the re-sectioned embankment against probable erosion consequences.	+5	Blue Gold Program, BWDB and WMG

No impact (0); Negative Impact (-); Positive Impact (+); Low Impact (1-3); Medium Impact (4-6); High Impact (7-8); Very High Impact (9-10).

10.2 Land Resources

10.2.1 Pre-construction Phase

425. There would be no impact during pre-construction phase. So, no measures are required in this phase.

10.2.2 Construction Phase

426. There would be no impact during construction phase. So, no measures are required in this phase.

10.2.3 Operation Phase

427. After implementation of the project hydrological regime inside the project area will be improved. This might change the agriculture land use of the project area. So, necessary measures may be under taken in this phase.

Table 10.2: EMP Matrix for Operation phase on land resources

Impact	Mitigation Measure	Enhancement/ Contingency/ compensation	Residual Impact (+/-)/ Magnitude (1-10) with EMP	Responsible Agency
Single cropped area would decrease 11% but double and triple cropped area would increase by 7% and 4% of the NCA respectively under FWIP condition.	-	• Formation of WMGs (as per the GPWM-2002). • Strengthening of WMGs through imparting training on proper management of structure and utilization of spoil earth materials which will come up from re-excavation. • Involvement of WMGs in different project activities.	+3	BWDB, DAE and WMGs

No impact (0); Negative Impact (-); Positive Impact (+); Low Impact (1-3); Medium Impact (4-6); High Impact (7-8); Very High Impact (9-10).

10.3 Agriculture Resources

10.3.1 Pre-construction phase

428. There would be no impact during pre-construction phase. So, no measures are required in this phase.

10.3.2 Construction phase

429. In construction phase, crop production loss might not occur due to dumping of re-excavated spoil earth materials on both side of khals and existing embankment. It is noted that repairing activity would be done on existing embankment. So, no impact on agriculture land i.e crop production loss would occur. So, no measures are required in this phase.

10.3.3 Operation Phase

430. The implementation of the 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 Operation Phase on Agricultural Resources

Impact	Mitigation Measure	Enhancement/ Contingency/ Compensation	Residual Impact (+/-)/ Magnitude (1-10) with EMP	Responsible Agency	
Expected that cropping intensity would increase by nearly 15%.	-	• Involvement of WMGs in project activities would enhance cropping pattern and intensity. • Introduction of HYV/Hybrid crop cultivars along with crop diversification need to be practiced.	+4	BWDB, DAE and WMGs	
Additional 2,617 tons (61%) of rice and 9,242 tons (77%) of non-rice would be produced under FWIP scenario over FWOP.	-	• Organic manure should be applied for restoration of soil health and fertility. • Farmers group should have close contact with SAAO of DAE for adaptation of various measures on 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/Hybrid crop cultivars along with crop diversification need to be practiced.	+5	BWDB, DAE and WMGs	
It is expected that loss of crop production would be reduced by 575 tons which would be 77% less in FWIP over FWOP scenario.	-	• The repair of flushing sluice, repair of drainage outlet and irrigation Inlet would help to reduce crop damage situation. • The WMGs should be given orientation training how to protect their standing crops through on-farm water management etc.	+6	BWDB, DAE and WMGs	

Impact	Mitigation Measure	Enhancement/ Contingency/ Compensation	Residual Impact (+/-)/ Magnitude (1-10) with EMP	Responsible Agency	
The irrigated area would be increased by 380 ha in FWIP over FWOP scenario.	-	• Training may be provided to WMGs on "on-farm water management" as well as IWRM to make stakeholders aware about importance of storing available water in the khals/ cannels for different use. • The WMGs should be involved in the integrated water resources management through proper maintenance of khals, irrigation inlets and drainage/flushing outlets for the expansion of irrigated area.	+4	BWDB, BADC, DAE and WMGs	

No impact (0); Negative Impact (-); Positive Impact (+); Low Impact (1-3); Medium Impact (4-6); High Impact (7-8); Very High Impact (9-10).

10.4 Fisheries Resources

10.4.1 Pre-construction Phase

431. There would be no impact during pre-construction phase

10.4.2 Construction Phase

432. The implementation of the 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
• Feeding and breeding ground of the bottom dweller fishes will be lost. • Internal fish movement/migration especially small fishes will be disturbed. Moreover, movement of brackish water fish species like *Chingri, Baila, Pairsa* through regulators would be also be obstructed. • Fish hatchling movement would also be hampered, if the repairing works is implemented during hatchling period (June-August). • About 9.8 fish habitat would be damaged temporarily and fish production loss would be about 1.3 tons/ year from the khals. But after 1-2 year the habitat quality of fish will be improved.	• Re-excavation activity should be done segment wise • Avoid construction activities during fish migration period e.g. month of May to August • Earth spoil should be dumped at setback distance of the khal • Re-excavation should be implemented segment wise and one after another to protect the indigenous fishes and other aquatic creators,	N/A	0	Contractor, BWDB, Department of Fisheries (DoF)

No impact (0); Negative Impact (-); Positive Impact (+); Low Impact (1-3); Medium Impact (4-6); High Impact (7-8); Very High Impact (9-10).

10.4.3 Operation Phase

433. The implementation of the 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 Operation phase on Fisheries Resources

Impact	Mitigation	Enhancement/Compensation/ Contingency	Residual Impact(+/-)	Responsible Agency
Seasonal khal would become perennial khal again. The improved habitat quality would support different types of fishes as well as aquatic vegetation which would be helpful for fish feeding and habitation.	NA	• Re-excavated khal should be kept free from encroachment. • Awareness development on protection and management of natural resources, camping against indiscriminate fishing and reinforcement of fisheries laws and regulation in the polder area. • Practice of IPM in agriculture for protection of capture fish habitat quality.	+4	Department of Fisheries in coordination with WMC
Movement of both brackish and fresh water fish species as well as hatchling movement through water control structures would be hampered slightly. But internal fish migration would be facilitated significantly.	NA	• The sluice gates should be properly and timely opened to ensure entrance of fish hatchling during the period May to July except the tidal surge. • Water Management Committee should be formed with representation of the fisher's community.	+3	Department of Fisheries in coordination with Water Management Committee
Capture fisheries productivity would be decreased by 20 kg/ha. Culture fish productivity would also be increased significantly.		• Construct deep pool in the perennial khals (Musurikathi khal, Bauria khal, Badura khal, Ostakhali khal, Amkhola khal etc) for sheltering of brood fishes. Pool area will be davaloped in the khal which is covered 600 to 700 m^2 and 1.5 m depth below the bed level of khals.	+3	Department of Fisheries in coordination with pond owners.

No impact (0); Negative Impact (-); Positive Impact (+); Low Impact (1-3); Medium Impact (4-6); High Impact (7-8); Very High Impact (9-10).

10.5 Ecological Resources

10.5.1 Pre-construction Phase

434. No EMP is required during this phase

10.5.2 Construction Phase

435. The implementation of the 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 Resource

Impact	Mitigation Measure	Enhancement/ Contingency/ Compensation	Residual Impact (+/-)/ Magnitude (1-10) with EMP	Responsible Agency
Activity: Repairing of embankment				
• Temporary damages of herbs, shrubs, various type of grass and bushes due to soil dumping for repairing work.; • Relocation of wildlife due to habitat loss temporarily.	• Carry out plantation along the slopes of embankment after completing the earth works; • Do not run construction activities at early morning and night to avoid disturbance to wild fauna;	N/A	-1	Contractor and BWDB
Activity: Re-excavation of khal				
• Damages of existing aquatic vegetation would cause habitat degradation for aquatic birds (ie. Egrets) and fishes • Damages of existing bank line vegetations due to dumping of soil along both sides of the khal	• Keep the deepest points of the khal untouched as much as possible; • The works should be completed in scheduled time to minimize habitat disturbance to wildlife	N/A	-2	Contractor and BWDB

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

10.5.3 Operation Phase

436. The implementation of the 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 Operation Phase on Ecological Resources

Impact	Mitigation Measure	Enhancement/ Contingency/ Compensation	Residual Impact (+/-)/ Magnitude (1-10) with EMP	Responsible Agency
Improve terrestrial vegetation	N/A	• Plant mixed species of native trees along the embankment slopes wherever possible to enhance green coverage.	+4	BWDB, Forest Department and local stakeholder.
Improve Aquatic flora and fauna due to improvement of plant diversity as well as khal depth and velocity	N/A	• Ensure regular maintenance/re-excavation of all khals when needed • Ensure proper maintenance of all water control structures.	+2	BWDB and local stakeholder.

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

10.6 Socio-economic Condition

10.6.1 Pre-construction Phase

437. The implementation of the 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
Employment opportunities	-	- Ensure employment opportunities that all local skilled man power get chance in work during pre- construction period	+3	Blue Gold Program and BWDB

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

10.6.2 Construction Phase

438. The implementation of the 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
Employment opportunities	-	- Local laborer should be recruited for the construction work under the project	+3	Blue Gold Program and BWDB
Communication	-	- Action should be taken to improve road network within the polder - During construction works, ensure employment for local people for both technical and non-technical works. Where possible, maximum laborer should be recruited from locally.	+2	Blue Gold Program and BWDB
Gender promotion	-	- According to the project proposal the LCS will be formed with l 60% male and 40% female memberships and all of them would be from the local area and be engaged in project activities of various kind. This would create gender promotion activities for female in future.	+3	Blue Gold Program and BWDB

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

10.6.3 Operation Phase

439. The implementation of the 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
Employment opportunities	-	- Ensure/arrange training from DAE and DOF for local people.	+3	Blue Gold Program and BWDB
Access to open water bodies	-	- People will be benefited from current intervention i.e. they can use sweet water in different social sectors. - Concentration should have to pay to re-excavate rest of Khals for ensuring equity and share of open water bodies.	+4	Blue Gold Program and BWDB
Communication	-	- Existing rural roads to be repaired and carpeting properly at every location of damaged road networks.	+3	Blue Gold Program and BWDB
Gender promotion	-	- At least 40% of total labor will be recruited for these interventions work and ensure more gender promotion in different sectors of present interventions of the polder.	+3	Blue Gold Program and BWDB

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

10.7 Spoil Management Plan (SMP)

440. 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 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

441. Polder 43/2B of Blue Gold program entails excavation of a number of khals which would generate a volume of around 2, 79,760 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 10.1** provides a framework which includes the major components of the proposed Spoil Management Plan for rehabilitation of Polder 43/2B 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.

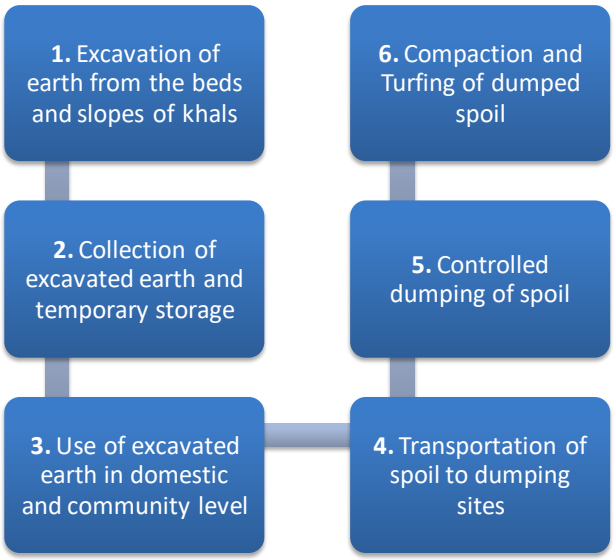


Figure 10.1: Framework for Spoil Management Plan

442. **Table 10.10** below provides a tentative account of the volume of excavated earth, and its multifaceted uses proposed in the Spoil Management Plan. Around 40% of the excavated earth (100,000 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 schools, mosques, community clinics etc. It is expected that around 42,000 m^3 spoil would be collected by for different uses. The residual portion (around 1,38,000 m^3) of spoil may then be disposed on both in a controlled manner.

Table 10.11: Tentative volume calculation and distribution of excavated spoil

Khals to be Excavated	Excavated Volume (m^3)	Uses of Excavated Soil	Volume (m^3) to be Used
Bauria Khal	42,700	Embankment Re-sectioning	1,00,000
Badrar Khal	11,500	Societal uses (uses in household, schools, mosques, or other shelters)	42,000
Bangrar Khal	15,100		
Karmjatala Khal	11,440		
Ostakhali Khal	7,300		
Sobaram Khal	20,800		
Kalabunia Khal	7,800	Dumping	138,000
Badura Khal	33,300		
Masuakhali Main Khal	52,000		
Musurikati Khal	20,800		
Bastalar Khal	15,400		
Tulabaria Khal	21,000		
Luhit bari Khal	20,860		
Total excavation	**2,80,000**	**Total Use**	**2,80,000**

10.7.2 Phase wise activities of Spoil Management

443. 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.

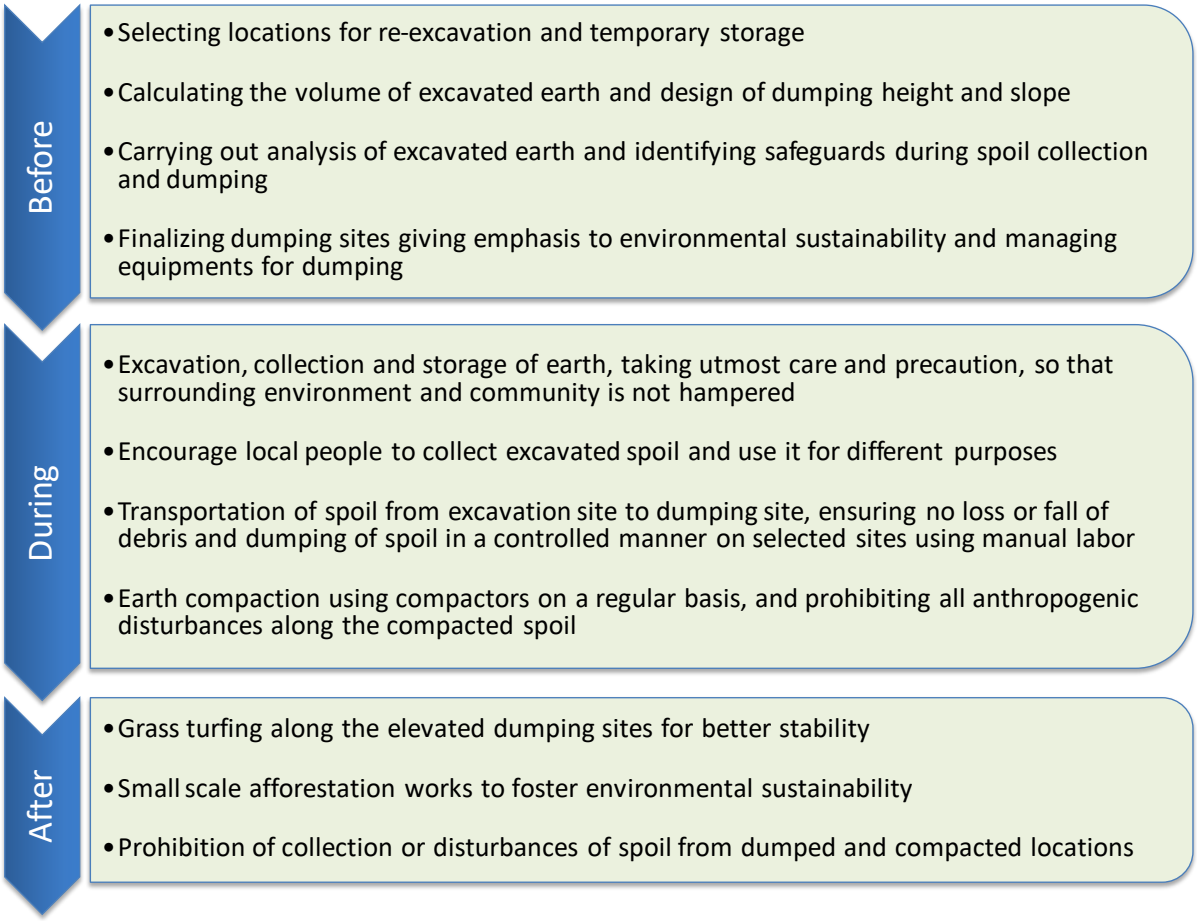


Figure 10.2: Phase wise activities of Spoil Management

10.7.3 Method of Spoil Dumping

444. The proposed re-excavation works for the Polder would require dumping of a significant amount of spoil (around 1, 38,000 m^3). For a 2.5 meter wide and 1.25 meter thick wedge, this equivalents to around 44.16 km length of dumped spoil. Polder 43/2B includes 26.9 km of re-excavation of khals, and if the residual spoil (1,38,000 m^3) is dumped on both sides of the excavated khals up to a height and width of 1.25 m and 25 m respectively, around 22.08 km lengths can be used on both sides. **Figures 10.3** and **10.4** below show the conceptual layouts of proposed dumping technique.

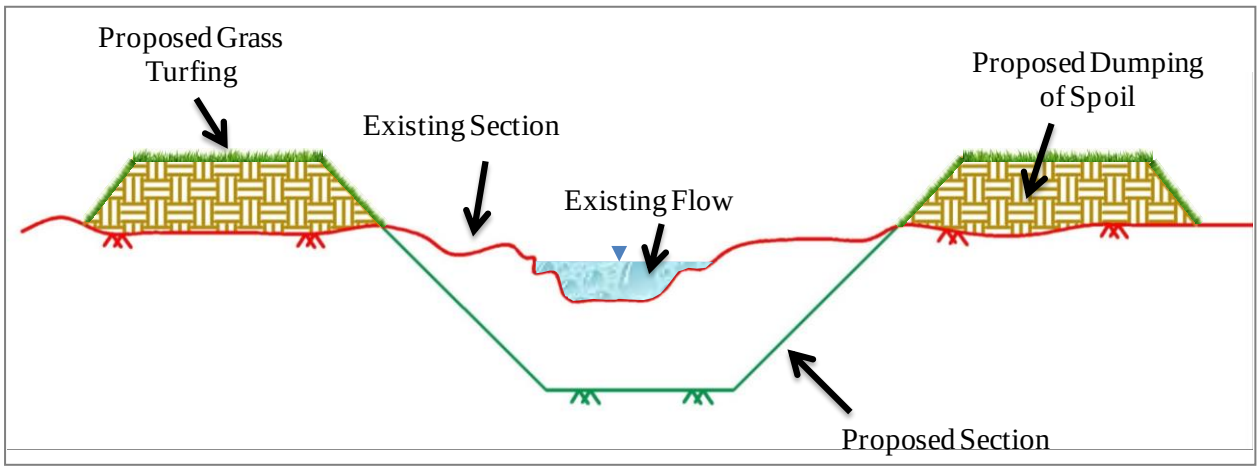


Figure 10.3: Conceptual Cross Section of a typical khal to be re-excavated

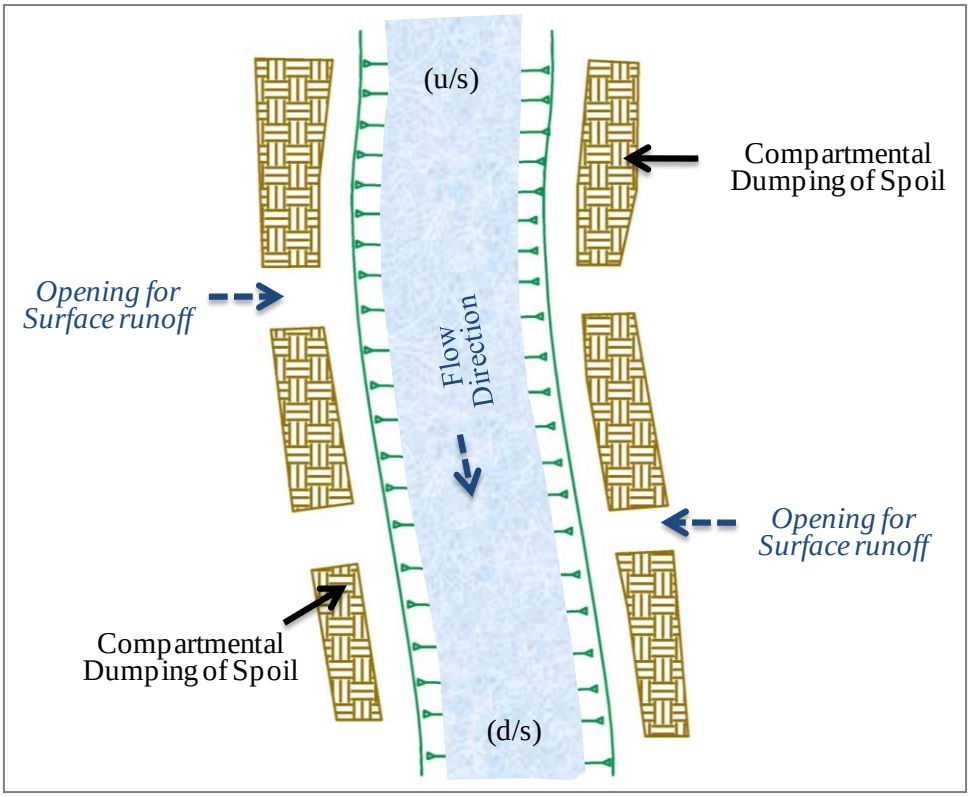


Figure 10.4: Plan form of a typical khal to be re-excavated

445. **Figure 10.3** 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 bank sides of the khals are government owned khas lands which fall within the actual width of the khals. Spoil earth would be dumped on bank 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 10.4** shows a plan of the khal which is to be re-excavated. The figure shows that compartmental dumping spots could be created along the sides of the excavated khals, so that surface runoff after any rainfall can flow into the excavated khals and drain out properly.

10.7.4 Safety Measures and Precautions

446. 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 undertaken, to get rid of possible social and environmental bottlenecks and hence safeguard the environmental sustainability. The safety measures and precautions recommended to be undertaken during implementation of khal re-excavation works are listed below:

- ✓ The laborers used for collection, carriage and dumping of spoil should properly aware of about the health and hygienic aspects.
- ✓ Sufficient washing and cleaning arrangements are to be in place for the LCS laborers
- ✓ Dumped spoil needs to be compacted thoroughly, after disposal upto a certain height (e.g. 6~8 inches)

- ✓ The works when are not in operation, the dumping locations may be covered with plastic or other water proof substances to avoid weather or moisture effects, which 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 wastes 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 of agricultural interests

10.8 Environmental Monitoring

10.8.1 Monitoring Plan for Pre-construction Phase

447. No specific monitoring plan is required to follow during the pre-construction phase for any of the sectors in Polder 43/2B.

10.8.2 Monitoring Plan for Construction Phase

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

Blue Gold Team and Bangladesh Water Development Board

Blue Gold Program: Component two

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	Proper dumping of spoil				4	No pollution from construction site			
2	Inconsistencies or mismanagement in embankment re-sectioning works				5	Compaction of earth materials on embankment			
3	Inconsistencies in water control structures repairing works.								

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) Concerned official designation**, Donor name** 2) **DG**, DoE 3) Concerned official designation, Client 4) **Concerned official designation**, 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.**	

10.8.3 Monitoring Plan for Operation Phase

Water Resources

Indicator	Method	Location	Frequency	Responsible Agency
Depth of khals	Field survey (e.g. boat and led method)	All khals inside the polder.	Once in a dry season and once in a wet season.	WMOs and BWDB
Drainage Congestion and Water	Field observation	Inside the polder.	Once in dry season and once in post-monsoon.	WMOs and BWDB
Operation of Sluice Gates	Field observation	All sluice gates in Polder 43/2B.	Once in a week (dry and pre-monsoon seasons).	WMOs and BWDB
Tidal Flooding	Field observation	Inside the polder.	Once in a month during wet season.	WMOs and BWDB

Land and Agriculture Resources

Indicator	Method	Location	Frequency	Responsible Agency
Crop production and damage	Focus Group Discussion (FGD) and individual discussion with farmers	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 individual discussion with farmers	Entire project area	During Rabi season (Will continue two years).	BWDB, DAE, BADC and WMGs

Fisheries Resources

Indicator	Method	Location	Frequency	Responsible Agency
Species diversity and richness of fish	Catch monitoring/ observations and local fish market survey.	Perennial khals and adjacent floodplain in inside the polder area.	Twice per month in each location and continue for two year.	DoF in cooperation with water management committee and local fishers.

Indicator	Method	Location	Frequency	Responsible Agency
Fish hatchling movement	Savar netting	Near sluice gate in major khals.	Once per week during fish migration period (June – August)	DoF in cooperation with Water management committee and local fishers.

Ecological Resources

Indicator	Method	Location	Frequency	Responsible
Habitat develop	Direct observation	At proposed construction sites	Once before earthworks and half-yearly basis for 5-year monitoring plan	BWDB and DoE
Wildlife occurrence	Direct observation and public discussion	At proposed construction sites	Once before earthworks and half-yearly basis for 5-year monitoring plan	BWDB and DoE

10.9 EMP Cost Estimate

Sl. No	EMP measure	Cost (LakhTk.)	Sl. No	Monitoring Item	Cost (LakhTk.)
Land and Agriculture Resources					
1	• Formation of WMGs/ WMA/ WMF (GPWM-2002), strengthening of WMGs through imparting training on re-excavation of khals, embankment management group (EMG), landless contacting society (LCS), on farm water management and development etc.	1.00	1	Re-excavation of khals, disposal of spoil earth materials for spoil management and repairing of embankment etc.	0.75
2	• Organic manure should be applied for the restoration of soil fertility. • 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.	2.00	2	Crop production and damage	1.25
3	• Training of "Integrated water management" and "on farm development" of WMGs would help to increase the expansion of irrigated area. • The WMGs should be involved in the integrated water management through proper maintenance of 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	3	Irrigated area	0.50
	EMP Cost =	***4.00***		***Monitoring Cost =***	***2.50***

Sl. No	EMP measure	Cost (LakhTk.)	Sl. No	Monitoring Item	Cost (LakhTk.)
Total Cost for EMP & Monitoring for Land and Agriculture = 6.50 Lakh Taka					
Fisheries Resources					
1	Construct fish sanctuary in the deep pool of perennial khals *(0.3 x 6= 1.8 Tk for six number of sanctuary)*	1.8	1	Fish hatchling movement in six khals (Two year).	0.9
2	Awareness development on natural resources mnagment and disseminate the knowledge about the importance of fishery resources in our daily life through several national and international days like Fish Week, Environment Day, Earth day, water Day Rally, Discussion etc. Two year in the polder area.	1.0	2	Species diversity through Fish Catch Assessment/ observation in three khals. Three market survey once in a week (two year).	1.5
3	Training on fish culture and pond demonstration and monitoring (first year demonstration and next year monitoring) (*Training 1.5 Tk and demonstration pond 0.5 Tk)* *(Number of pond :4 pond area: about 100 decimal)*	2.0	3	-	-
	EMP Cost =	***4.8***		***Monitoring Cost***	***2.4***
Total Cost for EMP & Monitoring for Fisheries= 7.2 Lakh Taka					
Ecological Resources					
1.	Embankment would facilitate to enhance habitat quality as well habitat size through tree plantation program but the area for re-sectioning has not estimated yet. However here is mentioned the plantation cost for each 39.08 km length of embankment	17.69	1	Habitat develop	7.00
			2	Wildlife diversity	7.00
	EMP Cost =	***17.69***		***Monitoring Cost =***	***14.00***
Total Cost for EMP & Monitoring for Ecology= 31.69 Lakh Taka					
Grand Total EMP and Monitoring Cost: 45.39 Lakh Taka					

449. The total EMP and monitoring cost is BDT 45.39 lakh of which EMP cost is BDT 26.49 lakh and monitoring cost is **BDT 18.9** lakh.

10.10 EMP Updating

The study infers that EMP has been developed assessing the impacts of interventions on the basis of baseline and prediction information. But monitoring has to be carried out to collect information on the impacts at actuality resulted due to construction of interventions. Furthermore, actual information due to implementation of EMP measures need to be collected for updating the EMP to make the development more environmental friendly as because EMP is not an one time plan rather it is a plan which needs updating continuously.

11. Conclusions and Recommendations

11.1 Conclusions

450. The aim of the project is to improve the existing status of water management, by rehabilitation and fine-tuning of infrastructures. The existing situation of the embankment at most parts is good, offering protection against tidal surges and salinity intrusion. The water control structures need repairing as almost all of these are not functioning upto the desired level. The polder suffers from minor drainage congestion. There are some water courses namely, Bauria khal, Badrar khal, Bangrar khal, Tulabiara khal etc. which are connected with the external rivers. About 26 km of khals will be re-excavated under this project which will resolve the drainage contestation problem in the polder area. The structural interventions proposed for Polder 43/2B includes re-sectioning of embankment, repairing of water control structures, repairing of irrigation inlets and re-excavation of khals. There would be no impact during construction phase as the excavated spoil materials would be used on existing embankment and non agriculture land. Cropping intensity would increase due to implementation of interventions. The capture fisheries productivity would increase due to re-excavation of khals and repairing of regulators. Aquatic habitat condition is expected to improve for increased khal depth and better management of the water controlling infrastructures. During re-sectioning of embankment, temporary damages of herbs, shrubs, various types of grass and bushes are apprehended due to soil dumping for re-sectioning work. Proposed intervention can lead to improvement in the quality of life. The road network system will be improved and ensure better communication facilities within the periphery of polder. More income generation and employment opportunities for both man and woman in different interventions can contribute to better life and livelihoods of the polder population.

11.2 Recommendations

451. 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 agricultural use.
- Crop rotation with leguminous crops, application of more organic materials and green manure to improve soil health and soil fertility in the project area.
- Introduce crop diversification with multi-crops for improving soil condition.
- Monsoon period should be avoided for implementation of the proposed interventions, especially from May to July as this period is crucial for fish migration.
- Re-excavation should be implemented segment- wise to protect indigenous fishes and other aquatic creatures.
- Native mixed deep rooted trees should be planted along the embankment slopes and toes wherever possible to enhance green coverage
- Local communities should be involved in operation and maintenance of the structure for ensuring sustainability of the interventions.
- A significant portion (no less than 50%) of all earthworks should be awared to LCS, and to ensure LCS female participation in the work, necessary logistical and physical facilities (e.g., toilet for women labourers) should be put in place.

452. The interventions will bring long term positive impacts in the polder area. There will be some negative impacts during construction phase as well some of which may be overcome by adopting appropriate mitigation measures (as provided in EMP) and timely monitoring. As such, the project may be undertaken 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

CEGIS, 2014, Development of National and Sub-National Climate Change Model for Long Term Water Resources Assessment

DoE, 2001. State of Environment. Department of Environment, Ministry of Environment and Forest, Dhaka, Bangladesh.

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

SRDI (Soil Resource and Development Institute), 1988, Guideline for land and soil resources use. Soil Resource and Development Institute, Thana Nirdashika, Farmgate, Dhaka

BARI, 2011-2012, Handbook of Agricultural Technology, Bangladesh Agricultural Research Institute, Joydevpur, Gazipir

BRRI 2011, *Adhunik Dhaner Chash*. Bangladesh Rice Research Institute, Joydevpur, Gazipur

SOLARIS (Soil and Land Resources Information System), 2006, SOLARIS Model developed by Center for Environmental and Geographic Information Services (CEGIS) for Soil Resource and Development Institute (SRDI)

BARI 2013. *BARI Developed Crop Varieties*, Bangladesh Agricultural Research Institute, Joydevpur, Gazipur

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

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

Khondker, M. 2004 (edited). *Limnology*. University Book Publishers. Dhaka, Bangladesh

Brammer, H. 1996. *The geography of the Soils of Bangladesh*. University Press Ltd., Dhaka. 287 pp.

Niahat, 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

BBS, 2011, Statistical Yearbook of Bangladesh, Bangladesh Bureau of Statistics, Government of people's Republic of Bangladesh, Dhaka, Bangladesh

BBS, *2008*. *Preliminary Report of Agriculture Census 2008*, Bangladesh Bureau of Statistics (*BBS*), Government of the People's Republic of 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

Carballo, E., A. Assiah van Eer, Ton van Schie, A. Hilbrands, 2008. *Small-scale freshwater fish farming* (Third revised edition), Digigrafi, Wageningen, the Netherlands.

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.

Haque S. A. 2006, *Review article, salinity problems and crop production in coastal regions of Bangladesh.* Department of Soil Science, Bangladesh Agricultural University, Mymensingh, Bangladesh. 38(5): 1359-1365

IPCC, 2007. Global Climate Projections. In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK and New York, NY, USA.

IUCN, 2000. *Red List of Threatened Animals of Bangladesh.* Eds, Islam, M. A. Ameen, M., and Nisha.A. The World Conservation Union, Dhaka, Bangladesh.

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.

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 (BCCSAP), 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

Pak. J. Bot., 2006, Salinity problems and crop production in coastal Regions of Bangladesh, 38(5): 1359-1365

Stickney, R. R. 2000. Encyclopedia of Aquaculture. John Wiley and Sons, New York.

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: Data Collection 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)	
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				
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						
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		
Operation		

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		
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

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			
Sali-sation			
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:	River																
	b. %/No. of CFHHs:																	
	c. %/No. of SFHHS:																	
Culture Fisheries:	d. No. of Days spend annually in fishing by CFHHs: SFHHs:	Beel (Leased/non leased)																
Indiscriminate Fishing Activities:	e. Hrs/Day spend in fishing by CFHHs:																	

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:	Khal																
		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. 2. 3.				Reasons of increase or decrease	1. 2. 3. 4.						Live fish				
												Other fish				
												Shrimp/prawn				
												Hilsa/Bombay duck/Indian salmon				
												Pomfret				
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:		Sig-ficant areas	1. 2. 3.						Mrigal				
												Koi				
												Sarputi				
												Large shrimp				
												Small shrimp				
Vertical Migration Pattern	Species: 1. 2. 3.	Season (Months):	Habitats:		Species of Conservation Significance	Rare:						Silver carp				
												Carpio				
												Grass carp				
												Tengera				

Fish Migration					Fish Biodiversity	Species List					Species Composition				
						River	Khal	Beel	Pond	Other	Group	River	Khal	Beel	Pond
	4.				Unavailable:						Chapila				
	5.										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:	
Seasonal vulnerability:		Other conflict (with muscle men/ agriculture/ other sector/laws):	
Ice factory (Number, location and name):		Fishermen commu-ty 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):	

Post Harvest Activities		Fishermen Lifestyle	
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

Center for Environmental and Geographic Information Services (CEGIS)

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
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 Wetland9	Area in ha		Flooding depth (m)	Connectivity with river		Importance10
		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	Utilization11

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)

Aquatic Fauna

Species name	Status1	Species name	Status1
Amphibians			
Reptiles			
Birds			

[9] 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

[10] 1=Fish; 2= migratory bird; 3= other wildlife; 4=aquatic flora;

[11] 1=food; 2=timber; 3=fuel; 4=medicinal; 5=fiber/thatching; 6=others

Species name	Status1	Species name	Status1
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, WaterSanitation Facilities, Solar/Biogas Plant, Health Facilities, Transportation/Communication Network, Markets, Adverse Affects of Disasters etc

Appendix-2: No Objection Certificate

আমখোলা ইউনিয়ন পরিষদ কার্যালয়

ডাকঘর: আমখোলা, উপজেলা: গলাচিপা, জেলা: পটুয়াখালী।

স্মারক নং-০৭/২৫ তারিখ- ২৯/০৭/২৫

অনাপত্তি পত্র

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 ঃ ৪৩/২বি পটুয়াখালী জেলা গলাচিপা উপজেলায় অবস্থিত।

৫। প্রকল্পের তফছিল ঃ

জেলার নাম	থানার নাম	মৌজার নাম	খতিয়ান নং	দাগ নং	জমির ধরন	মোট জমির পরিমান
পটুয়াখালী	গলাচিপা				মাঝারি উচু ভূমি	হেক্টর

৬। প্রকল্পের কার্যক্রম ঃ বাঁধ উচুঁকরন, স্লুইজ গেট ও রেগুলেটর মেরামত, খাল পূনঃখনন ইত্যাদি।

উপরোক্ত তথ্যাদির আলোকে পোল্ডার ৪৩/২বি 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 নিরাপত্তার 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।

উপরে উল্লিখিত যে কোন শর্ত লঙ্ঘন করলে যথোপযুক্ত কর্তৃপক্ষ কর্তৃক কারখানা/প্রকল্পের বিরুদ্ধে আইনানুগ ব্যবস্থা নেওয়া যাবে।

তারিখ ঃ ২৯/০৭/২০২৫

স্থানীয় কর্তৃপক্ষের স্বাক্ষর ও সীলঃ

মোঃ আলোয়ার হোসেন
চেয়ারম্যান
১নং আমখোলা ইউনিয়ন পরিষদ
গলাচিপা, পটুয়াখালী।

Appendix-3: Analysis of Multidimensional Poverty Index for Polder 43/2B

Background

Poverty is often defined by one dimensional measure. However, no one dimension alone can capture the various dimensions of poverty. Multidimensional poverty is composed of several factors that constitute poor people's experience of deprivation- These are:

- Poor health;
- Lack of education ;
- Inadequate living standard;
- Lack of income;
- Disempowerment;
- Poor quality of work; and
- Threat from violence.

A Multidimensional measure can incorporate a range of indicators to capture the complexity of poverty and better inform policies to relieve it.

Objective

The main objective of Multidimensional Poverty Index (MPI) is to:

- Identify multiple deprivations at the household level in education, health and standard of living dimensions.
- Measure the MPI with the values of ten indicators of the above three dimensions.

On realization of the objectives, policy maker can take the decisions for get rid of poverty towards reduce of income inequality among the people of the Polders.

Method and Process of the MPI

Multidimensional Poverty Index (MPI) was developed in 2010 by the Oxford Poverty and Human Development Initiative (OPHI) and United Nations Development Programme (UNDP). Different factors have been used in MPI to determine poverty beyond income. The MPI is an index of acute multidimensional poverty. It shows the number of people who are multidimensional poor (suffering deprivation in 33.33% of weighted indicators) and it is threshold between poor and non-poor people. The MPI uses the dimensions and indicators[12] are given below:

Table A3.1: Dimension and Indicators of poverty measurement

Dimension	Indicators
Education	Each indicator is weighted equally at 1/6. • Year of schooling (up to class V) • Children enrolled (up to class VIII)
Health	Each indicator is weighted equally at 1/6.

[12] http://en.wikipedia.org/...../Multidimensional_Poverty_Index (web page).

Dimension	Indicators
	• Child Mortality • Nutrition (WHO indicators13: reduced immunity, increase susceptibility of disease, impaired physical and mental development, and reduced productivity).
Standard of living	Each indicator is weighted equally at 1/18. • Electricity • Drinking Water • Toilet • Floor • Cooking fuel • Assets

The values of the deprivation on each of the above indicators for the poor households (HHs) are given based on the field experiences and perception. The deprivation values are '0'% and 100%. '0' indicates No deprivation and 100% indicates deprivation to the indicator. The MPI value is the product of two measures, which are multidimensional poverty headcount ratio (H) and the intensity of poverty (A). Formula of the Index is given below:

$MPI = H \times A$

Where headcount ratio, H, is the proportion of the multi-dimensionally poor in the population, A is the intensity of poverty.

$H = \frac{q}{n}$,

Where q is the number of people who are multi-dimensionally poor and n is the total poor population in this case. Where A represents the intensity of poverty, which is the proportion of the weighted component indicators wherein, on average, poor people are deprived. In the analysis poor households simply (deprivation score greater than or equal to 33.33%), the deprivation scores (weighted scores) are added up and divided by the total number of poor people:

$A = \sum_{iq} \quad ci \div q$,

Where *c* is the deprivation score of a poor person can be expressed as the sum of deprivations in each dimension. The MPI poor assessment using the above method has been used and applied for the Blue Gold Polders of BWDB. The poor people of the polders are categorized in three groups, which are prevalent in the polders. These are:

- Landless people (male and female);
- Day Labourer;
- Marginal Grosser.

Conclusions

The Blue Gold Polders are going to be a sustainable water management project. Thus MPI poor assessment is required for every polder. This analysis will be useful for assessing the productivity of the labourers (both male and female) and will help to support policy maker for overall human development of the poor people.

[13] http://www.who.int/...../nutrition/...(web page).

Table A3.2: Multidimensional Poverty Index for the Polder 43/2B

Sl. No.	Indicator	Weight	Three households considered as major category of the people as seen poor in the Polder					
			Landless persons work in share cropping and agricultural labour (L)	Weighted score	Day labourers work in Brick Field (DL)	Weighted score	Marginal Grossers sell things in the rural bazar (MG)	Weighted score
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
	Household size		5		5		5	
	Education (33.33)							
1	Years of Schooling: deprived if no household member has completed five years of schooling.	0.167	0%	0.000	0%	0.000	0%	0.000
2	Child school attendance: deprived if any school-aged child is not attending school up to class 8.	0.167	0%	0.000	0%	0.000	0%	0.000
	Health (33.33)							
3	Child mortality: deprived if any child has died in the family.	0.167	0%	0.000	0%	0.000	0%	0.000
4	Nutrition: deprived if any adult or child for whom there is nutritional information is malnourished.	0.167	100%	0.167	100%	0.167	100%	0.167
	Standard of living (33.33)							
5	Electricity: deprived if the household has no electricity	0.056	100%	0.056	100%	0.056	0%	0.000
6	Sanitation: deprived if the household's sanitation facility is not improved, or it is improved but shared with other households.	0.056	100%	0.056	100%	0.056	100%	0.056
7	Drinking Water: deprived if the household does not have access to safe drinking water or safe drinking water is more than a 30 minute walk from home roundtrip.	0.056	0%	0.000	0%	0.000	0%	0.000
8	Floor: deprived if the household has a dirt, sand or dung floor.	0.056	100%	0.056	0%	0.000	0%	0.000
9	Cooking fuel: deprived if the household cooks with dung, wood or charcoal.	0.056	0%	0.000	0%	0.000	0%	0.000

Sl. No.	Indicator	Weight	Three households considered as major category of the people as seen poor in the Polder					
			Landless persons work in share cropping and agricultural labour (L)	**Weighted score**	**Day labourers work in Brick Field (DL)**	**Weighted score**	**Marginal Grossers sell things in the rural bazar (MG)**	**Weighted score**
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
10	Assets ownership: deprived if the household does not have access to information: own more than one radio; TV, telephone, and not having at least one bike, motorbike, refrigerator, arable land, livestock and does not own a car or truck.	0.056	100%	0.056	100%	0.056	0%	0.000
	Weighted Score (deprivation score)	**1.000**		**38.89%**		**33.33%**		**22.22%**
	Status: MPI poor (33.33%)			**Greater than MPI poor**		**Equal to MPI poor**		**Less than MPI poor**
	0% indicates no deprivation in that indicator, while '100%' indicates deprivation in that indicator.							
	Factor H for the Polder is 0.667							
	Factor A for the polder is 0.361							
	MPI is 0.241							

Appendix-4: List of Participants of PCM

Environmental Study for Blue Gold Program

EIA and SIA conducted By CEGIS

Participation list of Public Consultation Meeting (PCM)

Place: [illegible] Date: ১৯.০২.২০১৫

Sl	Name	Address/Designation	Mobile No	Signature
১	[illegible]	[illegible]	০১৯২৬৬৬০০	[illegible]
2	[illegible]	[illegible]	01728254644	[illegible]
৩।	[illegible]	[illegible]	01726942472	[illegible]
৪।	[illegible]		01734686981	[illegible]
৫।	[illegible]		01734686556	[illegible]
৬।	[illegible]			
৭	[illegible]	[illegible]	01724023782	[illegible]
৮।	[illegible]	[illegible]	01729647864	[illegible]
৯।	[illegible]	[illegible]	01729477063	[illegible]
১০।	[illegible]	[illegible]	01714597215	[illegible]
১১	[illegible]	[illegible]	01783329[illegible]	[illegible]
১২	[illegible]	[illegible]	01781828533	[illegible]
১৩।	[illegible]	[illegible]	01751569[illegible]	[illegible]
১৪	[illegible]	[illegible]	01731510775	[illegible]
১৫	[illegible]	[illegible]		[illegible]
১৬	[illegible]	[illegible]		[illegible]
১৭	[illegible]	[illegible]	01728253958	[illegible]
১৮	[illegible]	[illegible]	01713953089	[illegible]
১৯	[illegible]	11	01725490548	[illegible]
২০	[illegible]			[illegible]
২১	[illegible]	[illegible]	01713954932	[illegible]
২২				
২৩				
২৪				
২৫				

CEGIS

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, 8817644-52 Fax: 880-2-8850935, 8823138 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
Head Office, Paribesh Bhaba
E-16 Agargaon, Sher-e-Bangla Nagar, Dhaka-1207
www.doe.gov.bd

Memo No: DoE/Clearance/5403/2015/ 8 3 Date: 15 /02/2015

Subject: Exemption from Initial Environmental Examination (IEE) and Approval of Terms of Reference (ToR) for Environmental Impact Assessment (EIA) in favor of the Proposed Rehabilitation and Improvement of Infrastructure of Seven Coastal Polders (Polder Nos. 2, 26, 29, 31-Part, 43/1A, 43/2B and 43/2E) under Blue Gold Program.

Ref: Your Application dated 22/12/2014.

With reference to your application dated 22.12.2014 for the subject mentioned above, the Department of Environment hereby gives exemption from IEE and approval of ToR for Environmental Impact Assessment (EIA) of the proposed Rehabilitation and Improvement of Infrastructure of seven coastal Polders (Polder Nos. 2, 26, 29, 31-Part, 43/1A, 43/2B and 43/2E) 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 & 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

1

- Settlement and housing
- Traffic and transport
- Public utilities: water supply, sanitation and solid waste
- Economy and employment: employment structure and cultural issues in employment
- Fisheries: fishing activities, fishing communities, commercial important species, fishing resources, commercial factors.

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 plants/trees of private or public) and NOC from other relevant agencies for operational activity etc. to the concerned divisional offices of DOE with a copy to the Head Office of DOE in Dhaka.

15.02.2015

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

Program Co-ordinating Director
Blue Gold Program
Bangladesh Water Development Board
Planning-III, Hasan Court (7th and 8th Floor)
23/1, Motijheel C/A, Dhaka-1000.

Copy Forwarded to :

1) Director, Department of Environment, Khulna/Barisal Divisional Office, Khulna/Barisal.
2) Assistant Director, Office of the Director General, Department of Environment, Head Office, Dhaka.

2

Appendix-6: Gate Operation Plan (Bengali)

†cvìv‡ii ¯øyBm ‡MU cwiPvjbvi †ÿ‡Î wbqgvejx

AZx‡Z cvwb Dbœqb †ev‡W©i Kg©Pvixi gva¨‡g ¯øyBm †MU¸‡jv cwiPvwjZ n‡Zv| ev‡RU ¯^íZvi Kvi‡Y †m c`¸‡jv GLb ¯’wMZ Kiv n‡q‡Q| eZ©gv‡b †MU¸‡jv cwiPvjbvi `vwqZ¡ myweav‡fvMx‡`i Dci Ac©b Kiv n‡q‡Q| cÖwZwU †cvìv‡I G Rb¨ cvwb e¨e¯’vcbv ms¯’v (WMG, WMO, WMA) MVb Kiv nq| K…wl Dbœqb I grm¨ m¤ú‡`i K_v we‡ePbv K‡i †cvìvi 43/2B Gi ‡MU cwiPvjbvq cvwb e¨e¯’vcbv ms¯’v¸‡jv‡K wb‡¤œev³ welq¸‡jv we‡ePbv Ki‡Z n‡e:

- **K…wl I grm¨ m¤ú` e¨e¯’vcbvi mv‡_ mvgÄm¨ †i‡L GKwU wbw`©ó wbq‡gi ga¨ w`‡q cÖwZwU †i¸‡jU‡ii †MU Aek¨B wbqwš¿Y Ki‡Z n‡e ;**
- **cÖK„Z cvwb e¨e¯’vcbv we‡kl K‡i K…wl I grm¨ m¤ú‡`i cÖ‡qvRbxZvi wfwË‡Z cvwb Dbœqb ‡ev‡W©i cwiPvjbv I iÿYv‡eÿY kvLv myweav‡fvMx ms¯’v, K…wl m¤úªmviY Awa`ßi Ges grm¨ Awa`ß‡ii gvV Kg©x‡`i ‡hŠ_ civgk©µ‡g †MU cwiPvjbv Ki‡Z n‡e;**
- **ïaygvÎ †givgZ I d¬¨vwks e¨ZxZ ‡i¸‡jU‡ii d¬¨vc GKwU wbw`©ó ¯’v‡b me mgq GKB Ae¯’v‡b ivL‡Z n‡e;**
- **Lv‡j cvwb msiÿY K‡i K…wl Kv‡R †m‡Pi Rb¨ el©vi c~‡e© (gvP© - †g) †MU eÜ ivL‡Z n‡e;**
- **el©vi mgq (RyjvB -‡m‡Þ¤^i) †MU mvaviYZ eÜ _vK‡e Z‡e †cvìv‡ii wfZi I evwn‡ii cvwbi ¯Íi GKwU wbivc` †j‡f‡ji evB‡i hv‡Z P‡j bv hvq †mw`‡K jÿ¨ ivL‡Z n‡e| G‡ÿ‡Î, cÖwZw`‡bi e„wócvZ, b`xi Ae¯’v, b`xi Ges †cvìv‡ii wfZ‡ii cvwbi ‡j‡fj we‡ePbv K‡i h_vh_ wm×vší wb‡Z n‡e;**
- **gv‡Qi m‡e©v”P cÖRb‡bi mgq wWgmn gv gvQ (eyªW gvQ) I gv‡Qi †cvbv AwfMg‡bi welq we‡ePbv K‡i †g n‡Z Ryb gvm ch©šÍ ‡MU †Lvjv ivL‡Z n‡e;**
- **el©v cieZ©x mgq (A‡±vei-b‡f¤^i) †MU Ggbfv‡e cwiPvjbv Ki‡Z n‡e hv‡Z Lv‡j ï®‹ †gŠmy‡gI ch©vß cvwb _v‡K| G‡ÿ‡Î jÿ¨ ivL‡Z n‡e †hb Lv‡ji cvwb Zxi Dc‡P bv hvq Ges K…wl Kvh©µg e¨vnZ bv nq;**
- **d¬¨vwks ¯øyBm I cvBc Bb‡jU cwiPvjbvi †ÿ‡ÎI GKB wbqg AbymiY Ki‡Z n‡e;**
- **K…wl Kvh©µg, k‡l¨i bgybv I aiY, gv‡Qi cÖRbb mgq I AwfMgb BZ¨vw` cwieZ©bkxj weavq mg‡qi mv‡_ myweav‡fvMx ms¯’vi (K…lK, grm¨Rxwe, grm¨Pvwl) mv‡_ wbqwgZ civgk© Ki‡Z n‡e;**

- **K…wl I grm¨ Dfq m¤ú` we‡ePbvq wb‡q cvwb e¨e¯’vcbv ms¯’v¸‡jv‡K (WMG, WMO, WMA) mgwš^Z cvwb e¨e¯’vcbvi Dci cÖwkÿY cÖ`vb Ki‡Z n‡e|**

Appendix-7: Comments and Responses

The responses and actions taken against the valuable comments and suggestions made by the Department of Environment (DoE) in its 396th meeting on the EIA report of "Polder 43/2B" under the Blue Gold Program are given below:

Sl	Comments	Response	Action
1	Prepare Bangla Operation plan of regulators for ensuring the connectivity of rivers and khals for migration of fish during breeding period and annexed it with this report.	An operation plan for regulation of gates has already been discussed in the report (section 4.15). Accordingly, a short operation plan in Bangla has been prepared.	Bangla operation plan has been appended in Appendix -6
2	Incorporate mitigation/enhancement measure in the EIA report- demarked the deep pools area for sheltering of brood fish in the khals under the polder area considering the width of the khals.	The deep pools area for sheltering of brood fish in the khals under the polder area have been demarked and mentioned in the report (section 10.4.3 and Table 10.5)	The deep pools area have been shown in the Map attached in the report
3	Prepare A1 map incorporating surrounding physical features of the polder area, location of mitigation measures, existing interventions and rehabilitations works.	A1 size map has been prepared incorporating all as suggested	Map is attached with the report
4	Describe the baseline line scenarios before polderization of the area in a short form.	During construction of the polder, baseline survey was not been carried out by the project proponent. As such, it was not possible to provide the baseline scenarios before the polderization of the area.	
5	Submit three reports to the Head office, DoE with letter and CC to Barisal regional office.	Agreed and implemented	
6	Delete the column (column number 3) from the Table 4.2	Agreed and performed	
7	Drainage capacity of regulators and canals should be checked considering climate change issues through the modeling.	Drainage capacity of regulators under the polder has been checked on the basis of the modelling results. As per modelling results, drainage capacity of the polder is sufficient to drain out additional water to be generated for climate change.	

Appendix-8: Development Project Proforma (DPP)