Government of the People's Republic of Bangladesh

Ministry of Water Resources

Bangladesh Water Development Board

Blue Gold Program

Final Report

on

Environmental Impact Assessment (EIA) on Rehabilitation of Polder 43/2D

June 2015

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CEGIS gratefully acknowledges the contributions of all the above mentioned officials/personnel and also others not named here, in conducting the EIA of Polder 43/2D.

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Abbreviations and Acronym

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

ERD	Economic Relations Division
FAO	Food and Agriculture Organization
FCD	Flood Control and Drainage
FCD/I	Flood Control Drainage/ Irrigation
FCBO	Fisheries Community Based Organization
FES	Fishing Effort Survey
FGD	Focus Group Discussion
FGs	Functional Groups
FMD	Foot and Mouth Disease
FS	Frame Survey
FPCO	Flood Plan Co-ordination Organization
GIS	Geographic Information System
GoB	Government of Bangladesh
GoN	Government of Netherlands
GPA	Guidelines for Project Assessment
GPWM	Guidelines for Participation of Water Management
GSB	Geological Survey of Bangladesh
GW	Ground Water
Ha	Hectare
HH	Household
HTW	Hand Tube Well
HYV	High Yielding Variety
ICM	Integrated Crop Management
IEC	Important Environmental Component
IEE	Initial Environmental Examination
IESC	Important Environmental and Social Component
IRRI	International Rice Research Institute
IPM	Integrated Pest Management
IPSWAM	Integrated Planning for Sustainable Water Management
IS	Institutional Survey
ISC	Important Social Component
IUCN	International Union for Conservation of Nature
IWM	Institute of Water Modeling
IWMP	Integrated Water Management Plan
Kg	Kilogram
KII	Key Informant Interview
LCS	Labor Contracting Society
LGED	Local Government Engineering Department
LGIs	Local Government Institutions
LGRD	Local Government and Rural Development
Lpc	Litre per capita
MoEF	Ministry of Environment and Forest

MoWR	Ministry of Water Resources
MP	Murate of Potash
MSL	Mean Sea Level
MT	Metric Ton
MW	Mega Watt
NCA	Net Cultivable Area
NCS	National Conservation Strategy
NDVI	Normalized Difference Vegetation Index
NEMAP	National Environmental Management Action Plan
NGO	Non-Governmental Organization
NIR	Near- Infrared
NOCs	No Objection Certificates
NWRD	National Water Resources Database
O and M	Operation and Maintenance
OHP	Occupational Health and Safety Plan
PCM	Public Consultation Meeting
PCP	Public Consultation Process
PD	Project Director
PP	Project Proforma
PPM	Parts per Million
PPR	Pest Des Pititis Ruminants
PRA	Participatory Rural Appraisal
PSF	Pond Sand Filter
PWD	Public Works Department
RL	Reduced Level
RRA	Rapid Rural Appraisal
RS	Remote Sensing
SAAO	Sub Assistant Agriculture Officer
SIA	Social Impact Assessment
SIS	Small Indigenous Species
SRDI	Soil Resource Development Institute
STW	Shallow Tube Well
SW	Surface Water
SWAIWRPMP	South West Area Integrated Water Resources Planning and Management Project
SWAT	Soil and Water Assessment Tools
T. Aman	Transplanted Aman
ToR	Terms of Reference
TSP	Triple Super Phosphate
UFO	Upazila Fisheries Officer
UNDP	United Nation Development Program
UNO	Upazila Nirbhahi Officer

WARPO	Water Resources Planning Organization
WMA	Water Management Association
WMC	Water Management Committee
WMF	Water Management Federation
WMGs	Water Management Groups
WMIP	Water Management Improvement Project
WMO	Water Management Organizations

Glossary

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

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

Executive Summary

Background

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

Objective

The objective of the Environmental Impact Assessment (EIA) study is to ensure environmental sustainability, as well as social viability of the consequences of proposed interventions under the Blue Gold program to be implemented in Polder 43/2D, by assessing the potential environmental and social impacts and their magnitudes, and providing mitigation/ enhancement/ compensation/ contingency measures where necessary.

Approach and Methodology

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

Project Description

Polder 43/2D is located in Patuakhali Sadar Upazila and adjacent to the Patuakhali town. It is surrounded by Gulishakhali (on the West) ,Lohalia (on the East) and Gorai (on the east and south) rivers (map 1.1). The Polder covers an area of 9,270 ha, with a Net Cultivable Area (NCA) of 6,440 ha (69%).

The polder is bounded by 42.3 km embankment that was built to protect against tidal waves and salinity intrusion. There are 16 drainage sluices, 3 drainage outlets and 60 flushing inlets constructed by BWDB within the polder. These structures need repairing as almost all of these are not functioning up to the desired level. A number of the gates do not operate smoothly due to damages in the wheels and shafts used to elevate gates. The internal

drainage channels of the polder consist of 243 km lengths in total. Topsoil erosion, and other land filling activities have resulted in gradual decrease of water courses within the polder over the years.

Existing problems and works under the proposed interventions

The Polder was constructed in 1990-95, and later on was rehabilitated under the IPSWAM project from 2003 to 2011. However, a number of the gates do not operate smoothly due to damages in the wheels and shafts used to elevate gates. Functionally, the drainage outlets cannot drain out water properly after heavy rainfall events, especially during post monsoon. The sluice gates are not able to provide full protection against salinity intrusion. Poor maintenance is another issue in the polder, which results in damages in water control structures as well as peripheral embankments. Tidal flooding (at Hajikhali, Hajikhali Abad, Gerakhali and Tafalbaria mauzas) and low water availability for irrigation are other issues affecting the local people. Most of the khals is found in good flow condition but the hydrological connectivity is found disrupted at some locations where water from low lying lands does not carry into the khals, a situation which generates drainage congestion.

Blue Gold Program has taken some interventions like re-sectioning of embankment, repairing of water control structures, construction of water control structures, re-excavation of khals considering the existing problems and need of the local residents to mitigate the existing water management problems.

Environmental and Social Baseline

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). The highest and lowest values of rainfall are observed during the months of July (590 mm) and December (7 mm) respectively. It shows an increasing trend from April to July and after that decreasing pattern was observed. The relative humidity shows an increasing trend from April to July and after that decreasing pattern was observed.

Polder 43/2D is 56 km away from the Bay of Bengal and undergoes diurnal tidal influence. The polder is surrounded by a number of tidal rivers namely, Gulishakhali River on the West, Gorai River on the South and South-East, and Lohalia River along the East and North-East directions. There is a narrow tidal water course named as Bahalgacia khal that connects Lohalia River with Gulishakhali River and is situated along the immediate North of the polder. tidal influence governs within the polder, with the occurrence of diurnal tidal shifts (a high tide followed by a low tide, and then another high tide) at about 6 hour intervals in each day.

Total cropped area is about 11,334 ha of which 66% is covered with rice and the rest 34% is occupied by non-rice crops. The cropping intensity is about 176%. Recently, Integrated Crop Management (ICM) is practiced in some areas of the polder. The estimated total fish production of the polder area is about 275 tons. Bulk of the fish production (about 84%) is coming from culture fisheries and the rest is contributed by the capture fishery. In the polder area, tidal flood and drainage congestion are the main threats for ecosystem sustainability. A huge amount of vegetation including homesteads and crop fields are damaged. Damages of vegetation severely impact on dweller wildlife like local birds, mammals, reptiles etc due to habitat destruction.

There are 15, 715 households in the polder area having a total population of 71,840 of which 34,631 are male and 37,209 are female (BBS, 2011). The female population is found to be higher than the male population. The average literacy rate in the study area is 52% which is

slightly better that national level (51%). The polder area is comprised of different occupations. Agriculture is still is still the mainstay of the economy in the polder area. Most of the population of polder is engaged in agriculture sector (75%). These occupational groups are mainly farmer, agricultural labor, fishers, day labors etc. About 19% population is engaged in salaried service sector and only 6% is engaged in industry, petty trade, handicrafts and other manual sectors. In case of sanitation, 30%households have hygienic sanitation facility (water-sealed), 50 % have not water-sealed sanitation facility, 19% have non-sanitary sanitation facility and 2%have no sanitation facility. Overall status of drinking water in the area is satisfactory. On an average, 98% people can collect drinking water from tube well and rest of the 2% can collect drinking water from other sources.

Prediction and Evaluation of Potential Impacts

The proposed interventions will affect many environmental and social components either positively or negatively. The proposed interventions would reduce the tidal flooded areas considerably. It is expected that flood free area would be 80% from the existing impacted areas. The project would have a positive impact on agricultural resources especially in crop production. The increased water depth as well as improved water quality would create congenial environment for habitation of different type of fish species at the excavated khals. The productivity of capture fish habitat may be increased significantly. Existing trend of vegetation loss due to natural disaster will be reduced for flood protection by re-sectioning of embankment. Existing khal bank side and crop field vegetation will be improved by reducing drainage congestion due to construction of water control structures. The households of the polder area will be benefitted since they will have access and sharing open water bodies which would ensure social use of water. Moreover, this would enhance their social bonding and cohesion in every aspects of life.

The cumulative and induced effects of the proposed interventions in Polder 43/2D have been investigated based on qualitative assessments. The study infers positive long term cumulative effects in Polder 43/2D due to other proposed regional and local projects. The proposed Ganges Barrage may largely change the surface water salinity frontier of the area in the future. On the other hand, the proposed Ganges Barrage would have positive impact especially in 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 livelihood would shift towards enhanced farming practices. The rehabilitation works in Polder 43/2D may generate some minor induced effects in connection with river siltation, employment generation and food security. The reciprocal impacts of climate change on the polder have also been assessed. Impacts of climate change have been evaluated through advanced applications of hydrological (SWAT) and hydrodynamic (Delft 3D) modelling tools. The study infers that water level and surface water salinity in adjacent areas may increase in the future due to climate change, whereas dry season water availability may decrease. The climate resilience of local people in Polder 43/2D has also been found to have become enhanced due to the implementation of many capacity development initiatives.

Environmental Management Plan

Based on the EIA study the following recommendations are made to improve performance and sustainability of the project:

- A good water management plan should be prepared for proper utilization of surface water for agriculture cultivation;
- Crop rotation with leguminous crops, application of more organic materials, organic manure, and green manuring and soil management should be practiced to improve soil fertility in the polder area;
- Training from DAE and DoF for local people should be arranged to enhance sustainable crop production and tree plantation;
- Re-excavation during fish migration period e.g. month of May to August should be avoided;
- Re-excavation should be implemented segment wise to reduce indigenous fishes and other aquatic life ;
- Implement plantation along the slopes of embankment after completing the earth works;and
- Employment opportunities that local skilled man power get chance in work before construction period should be ensured.

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

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

1 Introduction

1.1 Background

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

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

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

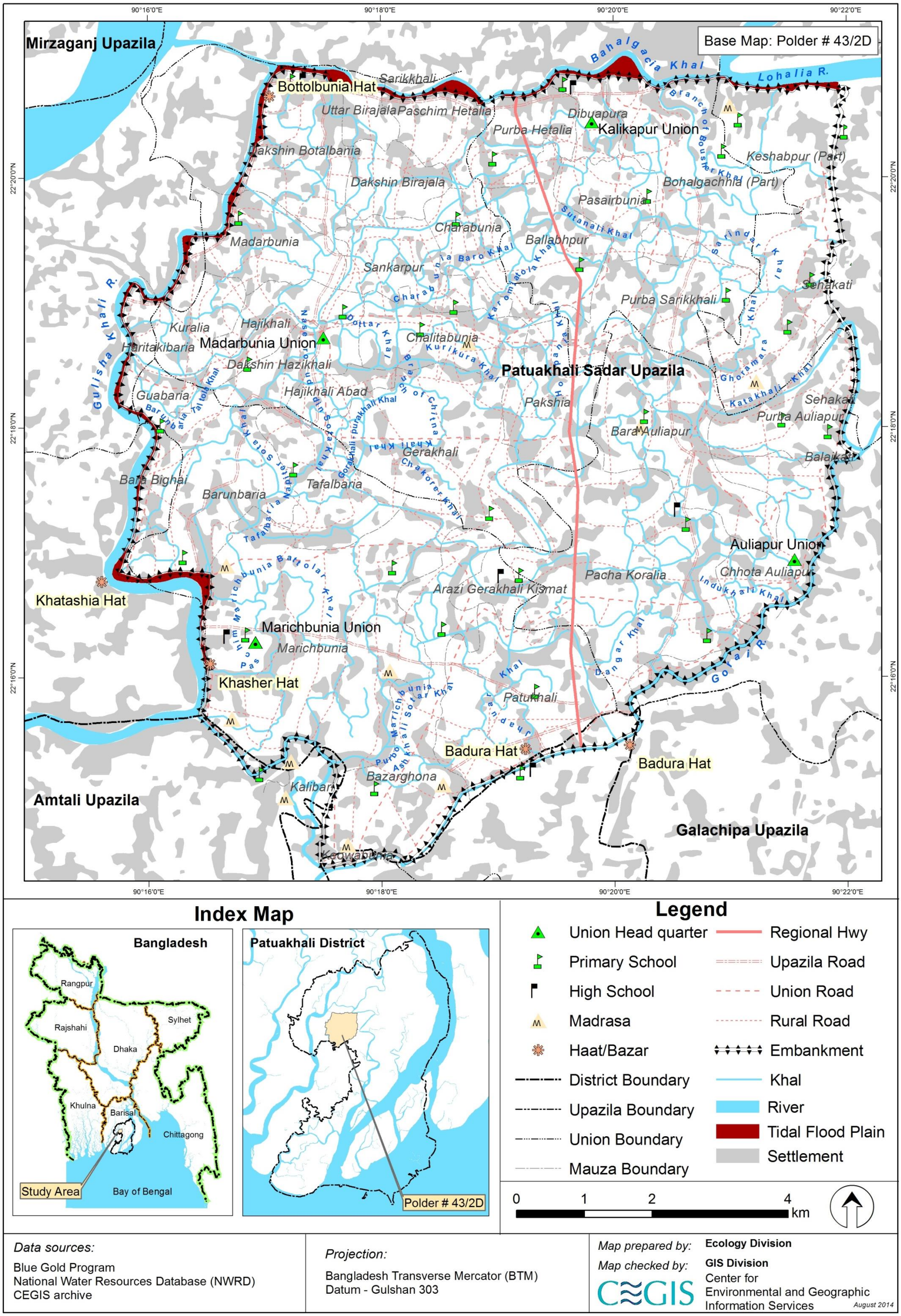
in Table 1.1. All 9 IPSWAM polders are included in the program as well as 2 polders for which water management assessment has taken place already. The final

4 Selection of the other polders will be done in accordance with the established selection criteria and project objectives.

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

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

5 The main implementing partners of the program are the BWDB and the Department of Agriculture Extension (DAE). The program will cooperate closely with the related ministries, local Government institutions, knowledge institutes and the private sector including NGOs. 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 (component ii) and the food security and agricultural production component (component iii) need to be taken into special consideration. Accordingly, the Blue Gold Authority engaged CEGIS for carrying out Environmental Impact Assessment (EIA) study of five initially selected polders under component two which mainly includes fine- tuning and some rehabilitation of water management infrastructures in selected polders. As the interventions are relatively smaller in size, the EIA study of these five polders is combined into a single study project titled “Environmental Studies for Blue Gold Program”.



Map 1.1: Study Area of Polder 43/2D

1.2 Rationale of the study

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

7 Component two (ii) of Blue Gold Program includes rehabilitation of water resources management infrastructure in selected polders. The rehabilitation works inside the polders include re-sectioning of embankments, repair and/or improvement of drainage outlets and irrigation inlets, re-excavation of internal canals and improvement of on-farm water management. These interventions must be subjected to EIA to obtain an environmental clearance from the Department of Environment (DOE) prior to implementation. To fulfill the obligation, CEGIS was engaged by the client to conduct the EIA study.

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

1.3 Study area

9 The study area of the EIA study of Rehabilitation of Polder 43/2D is located in the South-Central hydrological region of Bangladesh, with administrative jurisdiction lying within the Patuakhali O&M Division, BWDB, Patuakhali.

1.4 Objectives of the study

10 The objective of the EIA study included the following:

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

1.5 Scope of work

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

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

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

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

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

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

vi. Preparation of landuse map and ground truthing.

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

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

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

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

1.6 Limitations

12 Time allocated for the EIA study of Rehabilitation of Polder 43/2D was the major limitation which had to be overcome by employing more resources from CEGIS than the allocation of the TOR.

1.7 EIA study team

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

Mr. Sarfaraz Wahed, Water Resources Engineer/ Team Leader

Mr. Md. Ebrahim Akanda, Soil and Agriculture Specialist

Dr. Ashraful Alam, Fishery Specialist

Mr. Md. Amanat Ullah, Ecologist

Mr. Mobsher Bin Ansari, Socio-economist

Mr. Mohammad Saidur Rahman, GIS/RS Specialist

Mr. Fahad Khadim Khan, Junior Engineer

Ms. Laila Sanjida, GIS/RS Analyst

Mr. Md. Azizur Rahman, Field Researcher

Mr. Md. Shahadat Hossain, Field Researcher

Mr. Md. Shahidur Rahman, Enumerator

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

Mr. Mujibul Huq, Environmental Advisor

Mr. Syed Ahsanul Haque, Disaster Management Specialist

Ms. Anushila Mazumder, Environmentalist

Ms. Sarazina Mumu, Urban Planner

Ms. Tahmina Tamanna, Civil Engineer

Mr. Tanvir Ahmed, Water Resource Modeller

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

Ms. Mashuda Parvin, Junior Ecologist

1.8 Report format

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

Chapter 1: ***Introduction*****:** This chapter describes the background of the project, study area, objectives, scope of work in addition to presenting the list of the multi-disciplinary EIA study team members.

Chapter 2: ***Policy, Legal and Administrative Framework*****:** This chapter contains the brief of the relevant national rules and regulations which relevant for the EIA study

Chapter 3: ***Approach and Methodology*****:** This chapter presents the detail procedures followed for conducting 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 and Social baseline condition in respect of meteorology, seismicity, water resources, land resources, agriculture, livestock, fisheries, ecological resources are discussed in this chapter

Chapter 6: ***Socio-economic Condition:*** socio-economic condition chapter presents the demography, livelihood, quality of life, common resource properties etc. in the polder area

Chapter 7: ***Public Consultation and Disclosure:*** This chapter gives an overview of the public consultations held in the project sites as well as disclosure and results including methodology, public opinion and suggestions derived from the consultations

Chapter 8: ***Identification, Prediction and Evaluation of Potential Impacts:*** The possible impacts of proposed intervention s on the environmental and social components are discussed Assessment of the impacts of the proposed

interventions on the environmental and social components pertaining to water resources, land resources, agriculture, livestock, fisheries, ecological resources and socio-economic condition.

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) with EMP and Monitoring cost.

Chapter 11: ***Conclusions and Recommendations*****:** Conclusions and recommendations summarize the key findings of the EIA study before making specific recommendations for implementation of the EMP.

2 Policy, Legal and Administrative Framework

16 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 proponent before actual execution of a program or plan. The proponent has to be well aware of these requirements and comply with the provisions as applicable and necessary. 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 program are described in this chapter.

2.1 National Policies and Legislations

2.1.1 The National Environment Policy, 1992

17 The National Environment Policy was adopted by the Government of Bangladesh in 1992, with the aim to maintain ecological balance and overall development through protection and improvement of 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 and need an initial environmental examination (IEE) and environmental impact assessment (EIA) before initiation of the project. The Policy delineates the DoE, as the approving agency for all such IEE/EIAs to be undertaken in the country.

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

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

2.1.2 National Environmental Management Action Plan (NEMAP) 1995

20 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.

21 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.

2.1.3 The National Water Policy, 1999

22 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.

23 Sub-clause (b) of Section 4.5 states that planning and feasibility studies of all projects (relevant to water resources management or development or cause have interference in the 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 National Biodiversity Strategy and Action Plan for Bangladesh 2004

24 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.

2.1.4 Bangladesh Climate Change Strategy and Action Plan (BCCSAP)

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

i. Food security, social protection and health to ensure that the poorest and most vulnerable in society, including women and children, are protected from climate change and that all programs focus on the needs of this group for food security, safe housing, employment and access to basic services including health;
ii. Comprehensive disaster management to further strengthen the country's already proven disaster management system to deal with increasingly frequent and severe natural calamities;
iii. Infrastructure to ensure that existing assets are well maintained and fit-for-purpose and that urgently needed infrastructure is put in place to deal with the likely impact of climate change;

iv. Research and knowledge management to predict the likely scale and timing of climate change impacts on different sectors of the economy and socio-economic groups, to underpin future investment strategies and to ensure that Bangladesh is networked with the latest global thinking on science and best practices of climate change management;
v. Mitigation and low carbon development to ensure low carbon development options and implement these as the country's economy grows over the coming decades and the demand for energy increases; and
vi. Capacity building and institutional strengthening to enhance the capacity of government ministries and agency, civil society and the private sector to meet the challenges of climate change and mainstream them as part of development action.

2.1.5 Proposed National Wetland Policy (draft 1998)

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

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

27 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

28 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.

29 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

30 The Coastal Development Strategy (CDS) focuses on the implementation of the coastal zone policy. The CDS was approved at the second meeting of the Inter-Ministerial Steering Committee on ICZMP held 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

2.2 Legal Framework

2.2.1 Water Resource Management Legislation

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

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

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

32 This Act provides power to the government to:

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

The Embankment and Drainage Act 1952

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

34 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.

35 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.

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

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

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

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

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

38 An Ordinance to consolidate and amend the law related to the imposition of a water rate for the supply, regulation or storage of water for irrigation or drainage purposes. Imposition of water rate - (I) Whenever the government is of the opinion that lands within any area is benefited or is likely to be benefited by water supplied or regulated by the government or the Board or the Corporation through any canal during any financial year. The Government may, by notification, declare its intention to impose in such area, hereinafter referred to as the notified area, a water rate for such financial year provided that the water rate so specified for a crop season shall not exceed such rate as may be prescribed and provided further that the water rate intended to be imposed may vary from one notified area to another.

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

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

The Protection and Conservation of Fish Rules (1985)

40 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”.

Panishampad Parikalpana Ain (Water Resource Planning Act, 1992)

41 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.

National Water Act, 2013

42 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.

43 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.

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

45 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.

46 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

47 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.

48 The Act provides provisions for punishment and financial penalty for non-compliance with the Act, 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 Tk.10, 000 (Ministry of Law, Justice and Parliamentary Affairs, 2013).

2.2.2 Environmental Legislation

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

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

- This Act provides power to the government to declare areas as game reserves, wild life sanctuaries and national parks to protect the country's wild life. This Act also provides legal definitions of the protected areas as follows:
  - "Game reserve" means an area declared by the government as such for the protection of wild life and increase in the population of important species wherein capturing of wild animals shall be unlawful;
  - "National park" means comparatively large areas of outstanding scenic and natural beauty with the primary objective of protection and preservation of scenery, flora and fauna in the natural state to which access for public recreation and education and research may be allowed;
  - "Wild life sanctuary" means an area closed to hunting, shooting or trapping of wild animals and declared as such under Article 23 by the government as undisturbed breeding ground primarily for the protection of wild life inclusive of all natural resources, such as vegetation, soil and water.
- Under this law hunting, killing, 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.

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

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

51 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.

52 The main objectives of ECA '95 are:

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

53 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.

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

The Environment Conservation Rules, 1997

55 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).

56 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.

57 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.

58 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.

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

Bangladesh Environment Conservation Act (Amendment 2000)

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

Environment Court Act, 2000

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

Bangladesh Environment Conservation Act (Amendment 2002)

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

2.3 Procedure for Environmental Clearance

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

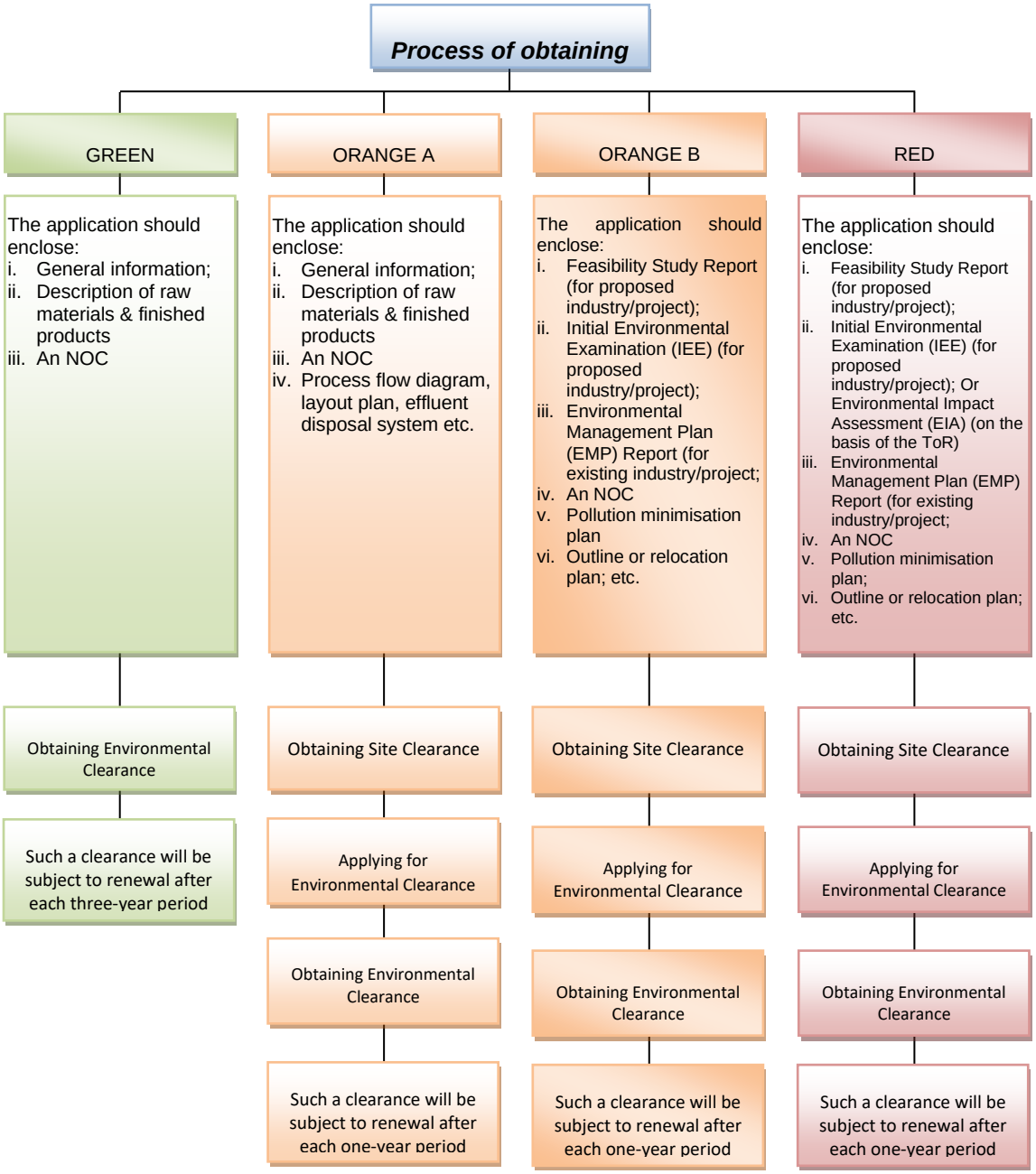


Figure 2.1: Steps Involved in Environmental Clearance following DoE Guidelines

64 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.

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

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

2.4 Environmental Quality Standards

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

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

Sl. No.	Area	Suspended Particulate Matters (SPM)	Sulfur Dioxide (SO_2)	Carbon Monoxide(CO)	Oxides Nitrogen(NO_x)
1	Industrial and mixed	500	120	5000	100
2	Commercial and mixed	400	100	5000	100
3	Residential and rural	200	80	2000	80
4	Sensitive	100	30	1000	30

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

Note:

1. At national level, sensitive area includes monuments, health center, hospital, archeological site, educational institution, and government designated areas (if any).
2. Industrial units located in areas not designated as industrial areas shall not discharge pollutants which may contribute to exceeding the standard for air surrounding the areas specified at sl. no. c and d above.
3. Suspended Particulate Matter means airborne particles of a diameter of 10 micron or less.

Table 2.2: Bangladesh Standards for Noise

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

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

Note:

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

2.5 Administrative Framework

67 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.

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

3 Approach and Methodology

3.1 EIA Process

69 The guideline for environmental impact assessment of water sector projects, developed by the Flood Plan Co-ordination Organization (FPCO) in 1992 and updated by the Water Resources Planning Organization (WARPO) in 2003 (WARPO, 2005) was followed for conducting the 'Environment Impact Assessment of Rehabilitation of Polder 43/2D.

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

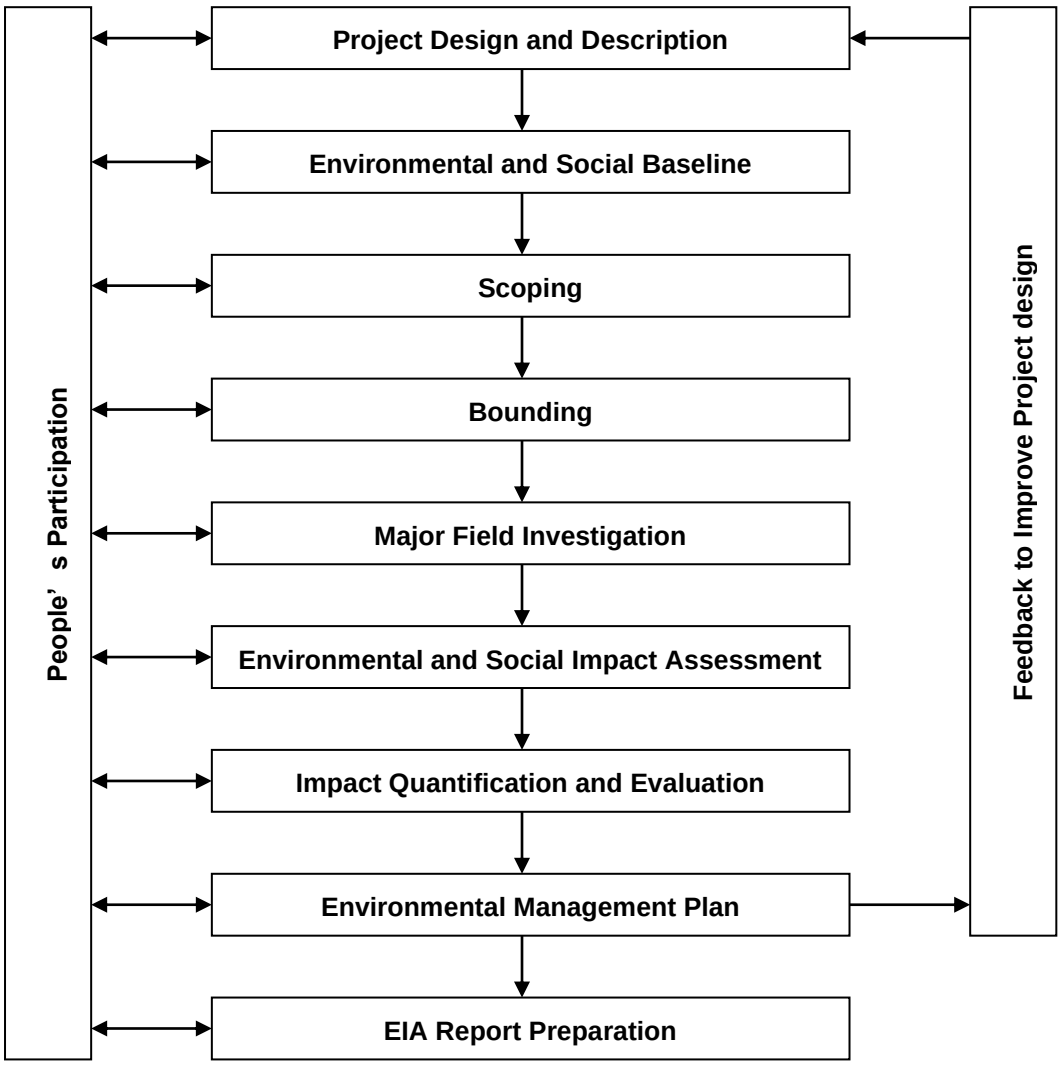


Figure 3.1: The EIA process

3.2 Project Design and Description

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

3.3 Environmental and Social Baseline

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

3.3.1 Source and methodology of data collection/ analysis

3.3.2 Climate and Meteorology

73 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 600m from Polder 43/2D) was selected. The data were collected from National Water Resources Database (NWRD) of the Water Resources Planning Organization (WARPO) that contains long time series of temporal data showing daily values for meteorological stations. The rainfall measuring station of BWDB is located almost a similar distance away (to that of the Patuakhali BMD station) from the polder and as such no further rainfall analysis has been carried out. The BMD station in Patuakhali does not measure evaporation, and as no other BMD stations were located nearby, discussions on evapo-transpiration has been omitted for Polder 43/2D. The issue of climate change has been discussed on a regional scale. Through a review of existing literatures on different climate change scenarios for the South-Central hydrological region (which is relevant to the Patuakhali district), an understanding has been obtained regarding probable climate change consequences in the future.

Topography and Seismicity

74 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). Topographical data were collected from the GSB and (NWRD) of (WARPO).

Water Resources (both surface water and ground water)

75 Water resource data under the headings of river hydrology, river morphology, ground water availability, drainage pattern, ground and surface water quality and water use were collected from secondary sources and primary observation. The professionals from multidisciplinary study team received feedbacks from local people during their field investigations. 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 river-khal-beel network, water availability, drainage pattern, water quality (surface and ground water), flash flood, risk of erosion or sedimentation etc.

76 Field visits were made to the study area and primary data on water resources components were collected through discussion with stakeholders. A checklist was used to obtain information on the different resources. Local knowledgeable persons and community representatives were also interviewed. During the field visits, the multidisciplinary EIA team members made professional observations pertaining to their individual areas of expertise. The impact of the 'Rehabilitation of Polder 43/2D' on water resources components were assessed by analyzing collected data, community knowledge and through professional justification of water resource managers. The management plan for water resources components was incorporated to assess impact magnitude and water resources status using the stakeholders' requirements and experts' judgment.

77 The specific data on different events of water resources were collected from the different sources. There are two surface water stations of BWDB in the vicinity of the polder namely Station 185 at Patuakhali (at Lohalia River and situated 2 km away from polder) and Station 19 at Mirjaganj (at Payra River and situated within 5 km distance from polder). Information from Patuakhali station could be more relevant, but the station collected data upto 1987 only and as such, the station at Mirjaganj was considered for analyzing surface water levels in this study. The monthly variations in Groundwater Table (GWT) from 1978 to 2013 was collected from the observation well of BWDB designated as PAT002 (6.5 km distance from polder). Data on water quality were measured at site by collecting surface and ground water samples from different locations within the polder. Surface water salinity was measured from different locations during high tide (mostly near the high water slack period). Furthermore, information on different water resources functions; problems and uses were collected through intensive local level consultations.

Land Resources

78 The Agro-ecological Region of the proposed study area was identified using secondary sources (FAO/UNDP). Land use, land type, soil texture data were also 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 level during field visit through physical observations as well as in consultation with the local people and officials of the DAE

Agricultural Resources

79 Data on agricultural resources included farming practices, crop production constraints, existing cropping patterns, crop variety, crop yield, crop damage and agricultural inputs used. Agriculture data were collected from primary sources through extensive field survey by using a developed questionnaire and in consultation with local people as well as relevant agricultural officials. Agricultural resources data were also collected from secondary sources from the DAE office. Crop production was determined using the formula: Total crop production = damage free area × normal yield + damaged area × damaged yield. The crop damage (production loss) was calculated using the formula: Crop production loss = Total cropped area ×normal yield-(damaged area ×damaged yield+ damage free area × normal yield). Crop damage data for the last three years were collected from the field.

Livestock Resources

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

Fisheries Resources

81 **Data collection methods:** The fisheries data were collected for the EIA study by considering the seasonal variance of dry and wet seasons. Prior to undertaking data collection, a checklist and a questionnaire were developed. The checklist included all kinds of information of existing and potential structures of the project. A combination of survey techniques was used for data collection. The survey techniques included sampling site selection, data collection, data analysis and reporting. The sequential steps of the methodological approach were as follows:

82 **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 the intervened and non-intervened areas to find out the difference between them in terms of fisheries impact.

83 **Data Collection:** Data were collected in multiple ways which can be broadly divided into two classes, for instance, (i) primary data collection and (ii) secondary data collection. Primary data were collected from the fishermen community, fisher households and local key informants and secondary data were collected from upazila fisheries office during field visits.

84 **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, and floodplain, borrow pit and beel. The culture fish habitats included homestead culture fish pond, commercial fish farm etc.

85 **Capture & Culture Fish habitats:** Capture fish habitat assessment was carried out through Fishing Effort Survey (FES), Frame Survey (FS), micro- scale Catch Assessment Survey (CAS), habitat based species diversity & composition. The habitat

based species diversity & composition survey included identification of species of conservation significance, identification of potential fish habitat prescribing to for fish conservation, fish migration survey and habitat identification for fish conservation. Culture fish habitat assessment was carried out through homestead culture fish pond survey and commercial fish farm survey.

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

87 **Secondary Data Collection:** Relevant secondary data were collected from the upazila fisheries office from their annual report as well as from various literatures/studies.

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

Ecological Resources

89 Information on bio-ecological zones and their characteristics was collected from the publications of the International Union for Conservation of Nature (IUCN). For ecological baseline, data were collected on terrestrial and riverine ecology including flora, birds, reptiles, amphibians, mammals, and migratory birds. The field activities included collecting ecosystem and habitat information, sensitive habitats ecological changes and potential ecological impacts.

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

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

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

92 Field investigation methods included physical observation; transect walk, habitat survey and consultation with local people. Field visits were carried out for delineating the ecological baseline condition. Public consultation was carried out through FFGD and KII methods. An inventory of common flora and fauna was made based on field survey and the data base of the IUCN.

Socio-economic condition

93 Socio-economic baseline information including the study area, demographic information, occupation and employment, literacy rate, drinking water, sanitation, electricity facilities etc. was collected from secondary sources, i.e. BBS, 2011. Data the income expenditure of local people inside the polder area, land ownership pattern, poverty status, migration, social overhead capitals and quality of life, disasters, conflicts of the study area, information on NGOs, and cultural and heritage features of the study area were collected mainly from primary sources through PRA and FGDs as well as public consultations.

94 The steps taken for collecting socio-economic data were as follows:

a) Data collected from BBS, 2011;

b) Reconnaissance field visit and discussion with BWDB officials and local stakeholders for primary data collection;

c) PRA /RRA, FGDs, KII for primary data collection; and

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

3.4 Scoping

95 A scoping process was followed for selecting Important Environmental and Social Components (IESCs) which are likely to be impacted by the proposed interventions of 'Rehabilitation of Polder 43/2D'. Scoping was done in two stages. Individual professionals of EIA study team made a preliminary list of the components pertaining to their disciplines, which could be impacted by the project. The second stage included village scoping sessions where stakeholder perceptions were obtained about those environmental and social components. Professional judgment of the EIA team members as well as the stakeholder opinions obtained in the scoping sessions was considered in selecting the IESCs.

3.5 Bounding

96 The area likely to be impacted by 'Rehabilitation of Polder 43/2D' was delineated in consultation with the Blue Gold Authority and feedback received from the local people during baseline consultation. In addition, processed RS tools were also used for this purpose.

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

3.6 Major Field Investigation

98 The EIA study team members collected intensive data on possible impact of the project after obtaining a detailed rehabilitation plan from the project authority. Intensive data on

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

3.7 Environmental and Social Impact Assessment

99 Environmental and social impacts of the proposed interventions 'Rehabilitation of Polder 43/2D' on the IESCs have been assessed through several sets of activities. Impacts are caused as a result of interaction of specific project activities with the existing environmental settings. The impacts of the proposed interventions were estimated on the basis of difference between the future-without-project (FWOP) condition and the future-with-project (FWIP) condition. FWOP conditions were generated through trend analysis and consultation with the local people. This reflected 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 condition. Comparison and projection methods were used for impact prediction. This included both positive and negative impacts which were considered in the preparation of the environmental management plan.

100 The sequence of assessment of environmental and social impacts was as follows:

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

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

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

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

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

3.8 Impact Quantification and Evaluation

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

3.8.1 Assessment Methodology

102 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.

103 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.

3.8.2 Magnitude

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

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

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

Table 3.1: Parameters for determining magnitude

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

3.8.3 Sensitivity

106 The sensitivity of a receptor has been determined based on review of the population (including proximity / numbers / vulnerability) and presence of features on the site or the surrounding area. Criteria for determining receptor sensitivity of the project's potential impacts are outlined in Table 3.2.

Table 3.2: Criteria for determining sensitivity

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

3.8.4 Assessment of Residual Impacts

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

3.9 Environmental Management Plan

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

3.10 EIA report preparation

109 At the end of the process, the present report on "Environmental Impact Assessment of Rehabilitation of Polder 43/2D" was prepared incorporating all the findings of the EIA study.

4 Project Description

4.1 Background

110 The Blue Gold Program covers many aspects of development in Polder 43/2D, concentrating on five components i.e. (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. As the EIA investigation only entails Component-II namely, water resources management. As such, the description of interventions provided in this chapter only attempts to discuss the rehabilitation of water resources management infrastructures in the polder. To make the polder effective against emerging challenges of erosion and sedimentation, increased salinization of groundwater, and cyclone surges and climate change; innovative and effective solutions have been suggested in connection with increasing infrastructure sustainability and stability. Capacity building of the BWDB officers and other responsible persons to ensure participatory water resources development involving the community as well with other stakeholders, high quality standards of design and implementation, introduction of innovative concepts and technical solutions are the salient features of the project.

4.2 Objective

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

- Ensure sustainability of the development of the polder through effective community participation.
- Improve protection against tidal flooding through increasing embankment stability.
- 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 as well as irrigation, and rainwater storage to enhance water use.

4.3 Present Status of Water Management Infrastructures

112 Polder 43/2D covers Auliapur, Kalikapur, Madarbunia, Marichbunia and some portion of Jainkati union of Patuakhali Sadar upazila, Patuakhali district. The polder was constructed in 1990-95, 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 Division, BWDB, Barisal (Map 1.1). Two Water Management Associations (WMAs) are functioning within the polder namely, Madarbunia-Kalikapur WMA and Auliapur-Marichbunia WMA.

4.3.1 Water Management Infrastructures

113 Water Management Infrastructures are the physical interventions that are used to ensure sustainable management, optimal use and equitable sharing of water resources.

In Polder 43/2D, there are some typical water management infrastructures i.e. peripheral embankments, sluices, drainage outlets, flushing inlets. Based on field investigation carried out in May 2014, the study team perceived the following information regarding the status of existing infrastructure.

Embankments

114 The Embankment is of 42+370 km length, with top width varying from 2.2 m to 4.0 m, and crest levels of around 3.75 m above Mean Sea Level (MSL). Existing side slopes varies over a wide range (from 2.8 to 5 m as hypotenuse), with low setback distance (less than 15 m on most cases). The existing situation of the embankment at most parts is good, offering protection against tidal and storm surges and salinity intrusion. In dry season, the embankment remains dry and various modes of transportations are found through it. A significant portion of the peripheral embankment is paved, which allow heavy vehicular movements during all seasons. However during wet seasons, the unpaved portion of embankment surface becomes slippery and unsuitable for vehicular movements. There are some locations along the peripheral embankment where the sluice gates walls are situated at around 7~8 feet apart on each side of the road (Koyer khal sluice), which does not allow free passage of heavy vehicles. Overall, significant damages have occurred on some portion of the embankment for which vehicular movements are at stake.

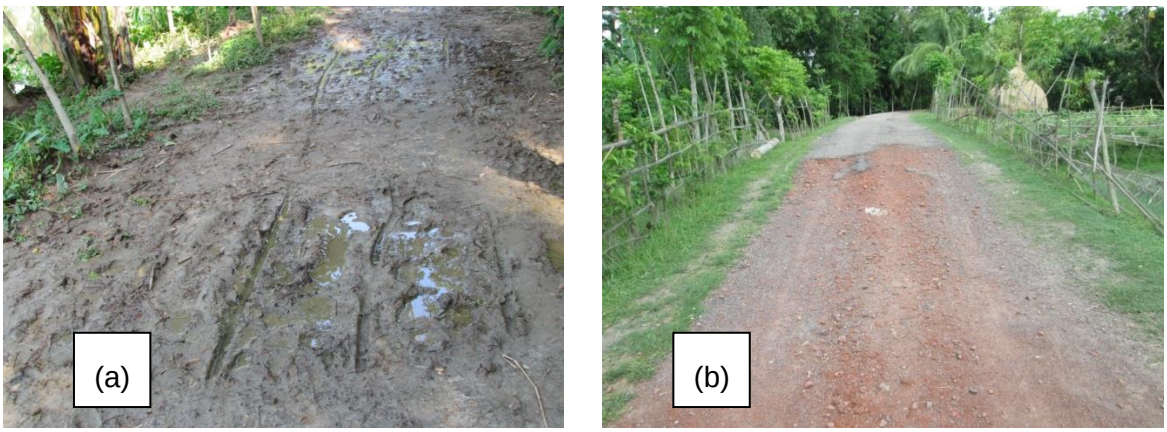


Photo 4.1: Existing Status of Embankments

*[(**a**) unpaved road surface becoming wet and slippery following rainfall, (b) damages along the concrete works of paved road surface]*

Water Control Structures and Culverts

115 There are 16 drainage sluices, 3 drainage outlets and 60 flushing inlets constructed by BWDB within the polder. These structures need repairing as almost all of these are not functioning up to the desired level. A number of the gates do not operate smoothly due to damages in the wheels and shafts used to elevate gates. Some 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. Functionally, the drainage outlets cannot drain out water properly after heavy rainfall events, especially during post monsoon. The sluice gates are not able to provide full protection against salinity intrusion. There are also severe mismanagement issues regarding the water control structures.

116 During the field visit in May 2014, the study team found that most of existing sluice gates and outlets have been subjected to structural damage in recent years and are not maintained properly by local people. The sluice gate at Nilkhola was found to have severe damage, as the Barrel underneath cannot be operated mechanically using wheels and shafts. The damage occurred during Sidr in 2007.The Gate of Nilkhola sluice needs to be replaced and a new hoisting system has to be installed.

117 The structures at Koyer khal, Katakhali, Taktakhali,Idukhali, and Chatua were also found functionally damaged; with severe mismanagement issues observed at some locations. The hoisting system needs reinstallation at both Idukhali and Chatua sluices. Gate openings at Taltola and Taktakhali need to be cleaned from debris as well as water hyacinths which hamper the natural flow through the structures. The other water control structures were found with more or less limitations in functionality.

Photo 4.2: Existing Status of Sluice Gates

*[(**a**) Fultola Sluice with decent operation and functionalities,(**b**) An inlet at Keshabpur requiring gate replacement, (**c**) Severely damaged Nilkhola sluice requiring major repairing,(**d**) Opening of Hetalia sluice covered by uncontrolled existence of water hyacinths]*

4.4 Present Status of Drainage Khals

118 The internal drainage channels of the polder consist of 243 km lengths in total. 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 at the North West region of the polder (Naserouddin Sota khal, Dottar khal, Charabunia khal etc.) have become very shallow (as low as 5 feet wide) at some locations. Most of the khals were found in good flow condition, as observed by the study team during their field

investigation. 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. Following heavy rainfall events local people have to pump water out from their own areas into the adjacent drainage khals.

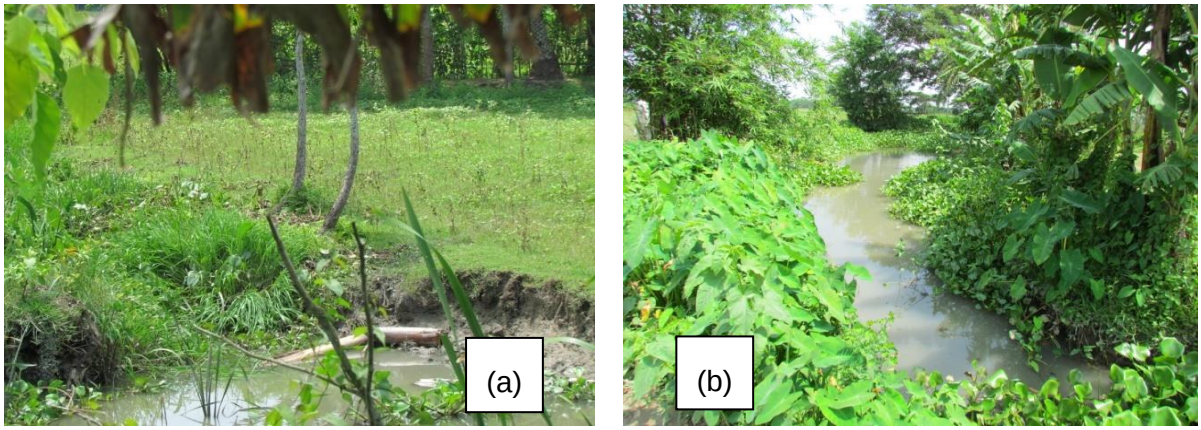


Photo 4.3: Drainage Khals within the polder

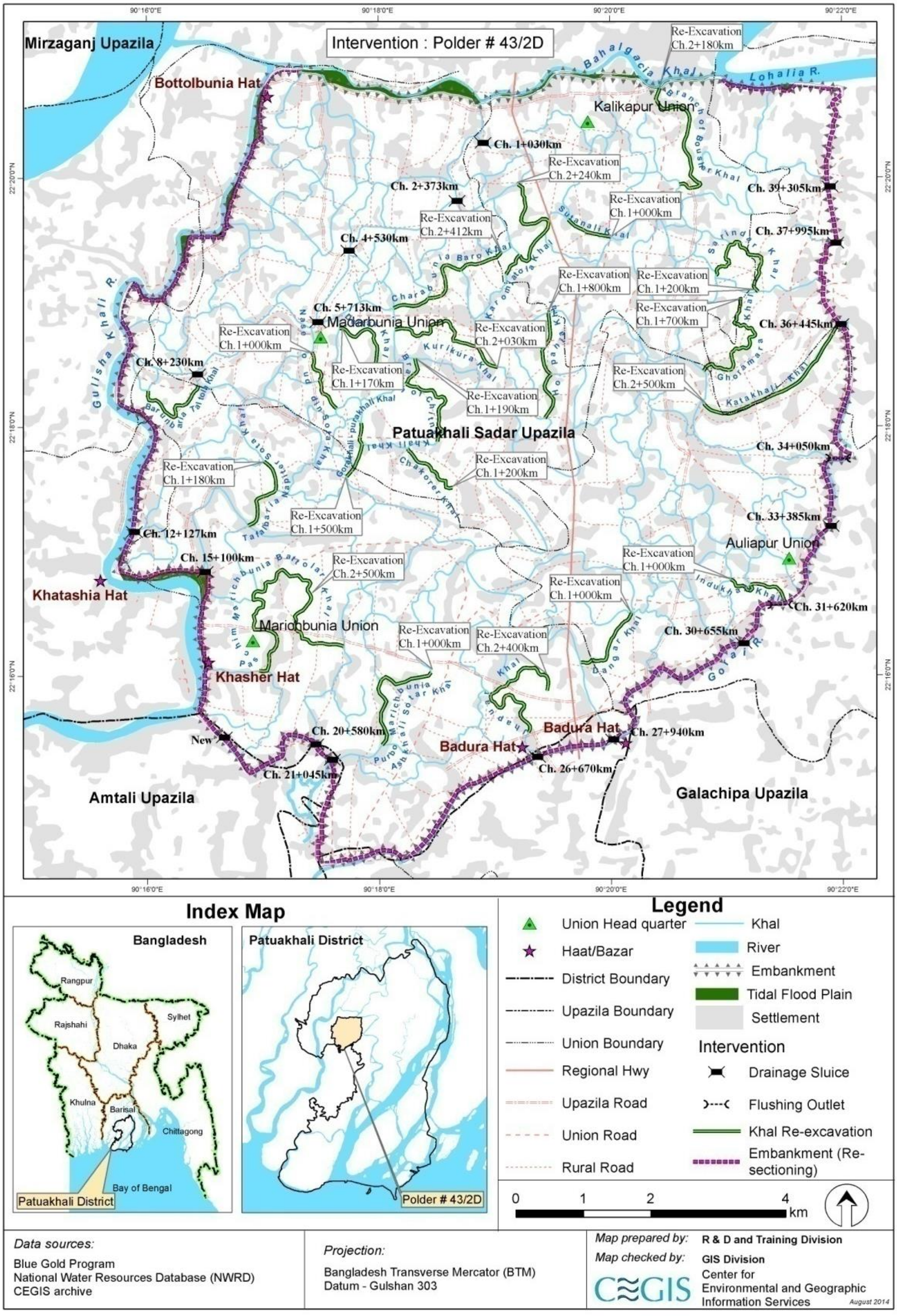
*[(**a**) Very narrow opening of Naseruddon Khal which merely exists, (**b**) Narrow course of Sutanalir khal]*

4.5 Problems and Issues in the Polder

119 A number of problems and issues are hindering the development potential of Polder 43/2D at the moment. During field investigations in May 2014, local people opined that around 45% of the total length of water courses inside the polder is affected from drainage congestion issues, of which only 30% khals have been taken into the re-excavation program. Poor communication is another major problem. The existing road network is damaged at some places, and the unpaved portion become unusable for heavy vehicles during wet season. Poor maintenance is another issue in the polder, which results in damages in water control structures as well as peripheral embankments. Tidal flooding (at Hajikhali, Hajikhali Abad, Gerakhali and Tafalbaria mauzas) and low water availability for irrigation are other issues affecting the local people.

4.6 Proposed Interventions in Polder 43/2D

120 Taking the status of existing infrastructures into account, and the problems resulting from their damaged state, the Blue Gold Program has the following category of interventions in Polder 43/2D. The locations of interventions have also been shown in Map 4.1.



Map 4.1: Location of proposed interventions

4.6.1 Re-sectioning of Embankment

121 Re-sectioning works along the peripheral embankment is proposed to be carried out at locations where damages exist. The proposed crest width is 4.27m, with side slopes of 1(V): 2(H) on both river and country sides, with the exception of 1(V): 3(H) R/S slope from Chainage 41+000 to 42+370. The design elevation of the crest of the embankment is at 4.27 m +PWD (above Mean Sea Level). The cross sections of the proposed re-sectioned embankments at different chainages are provided in appendix 2.

4.6.2 Repairing of Water Control Structures

122 All existing sluices, inlets and outlets of BWDB will be repaired within the polder. Some sluices would require new shafts and wheels, whereas some (Nilkhola, Idukhali, Chatua) would require replacements of barrels and gates. The drainage outlets and flushing inlets would also require repairing. The sizes of each vent for all the sluices are 1.5m x 1.8m, and the pipe diameters for the two outlets are 900 mm.

4.6.3 Construction of Water Control Structures

123 One new 1-vent sluice gate at Raja Baria khal (N: 22016'02.6", E: 90016'20.3") has been proposed and approved for implementation. Furthermore, one new drainage outlet at Akubia khal; and four new irrigation inlets at Thengai (1), South Auliapur (1) and Barunbaria (2) have been proposed by the WMA.

4.6.4 Khal Re-excavation

124 A total number of 21 khals are under the re-excavation plan of Blue Gold program in polder 43/2D. The total length to be re-excavated is around 34 km. Charabunia khal, Naseruddin Sota khal, Dontar khal, Hopania khal, Sutanalir khal etc. are to be re-excavated under the Madarbunia Kalikapur WMA, whereas Jhapuar khal, Taltalar khal, Katakhali khal, Idukhalir khal etc. are to be re-excavated under the Auliapur Morichbunia WMA. Some relevant long and cross sections of each khal under the re-excavation plan are shown in Annex 2.

125 Table 4.1 below provides a summary of proposed interventions discussed above; along with their locations and geometric specifications.

Table 4.1: Summary of proposed interventions in Polder 43/2D

Sl	Name of Intervention	Location	Proposed dimensions
1	Re-sectioning of Embankment	Entire embankment	✓ 330 meters length ✓ Crest width is 4.27m ✓ Side slopes of 1(V): 2(H) ✓ Side slopes of 1(V): 3(H) (except Chainage 41+000 to 42+370) ✓ Crest elevation 4.27 m, PWD
2	Repairing of Water Control Structures	All existing sluices, inlets and outlets of the BWDB within the polder will be repaired (location shown in Map 4.1)	✓ Sizes of all sluice gates are 1.5m x 1.8m ✓ Pipe diameters for two outlets are 900 mm
3	Constreuction of Water Control	-One new sluice gate at Raja Baria khal (N: 22016'02.6", E:	✓ 1-vent

	Structures	90016'20.3")	
		One new drainage outlet at Akubia khal	✓
		Four new irrigation inlets at Thengai (1), South Auliapur (1) and Barunbaria (2)	✓
4	Re-excavation of khals	21 khals under the re-excavation plan (location shown in Map 4.1)	✓ Total length of re-excavation is 21 km ✓ Average depth of khal is 1~2 m ✓ Average top width of khal is 4~9 m

Source: Blue Gold Program, 2014

4.7 Construction Details

126 The following sections provide a comprehensive discussion on the activities under component two, construction schedule, man power and material requirement, requirements for labour shed and construction camps as well.

4.7.1 Description of Activities

127 *Re-sectioning of Embankment*

128 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 fertilizing will also be provided.

Re-excavation of khals

129 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 be started from the upstream portion of the channel. Cross dams are to be provided at the starting and final locations of the reach, and then soil from the channels will be excavated and removed upto 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.

Repairing and Construction of Drainage Sluices and Outlets

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

Repairing and Construction of Flushing Inlets

131 A suitable site for the construction material of the structure 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 make the flow to be channeled through the flushing gate.

132 To summarize, a list of activities under each phase is shown in Figure 4.1 below.

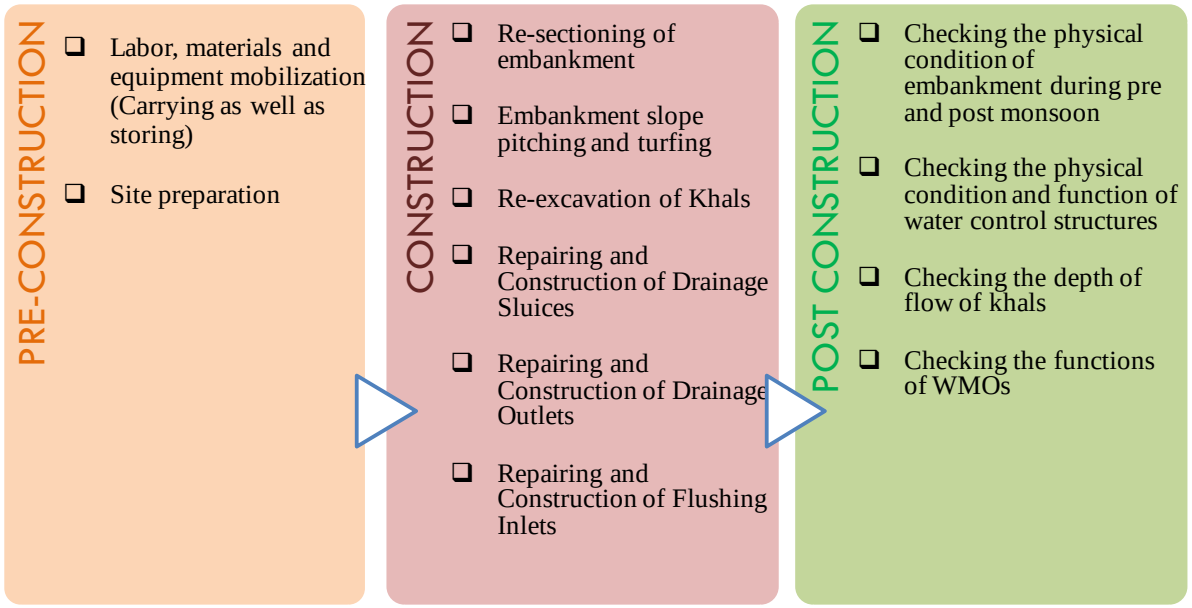


Figure 4.1: Phase wise list of activities in Polder 43/2D

4.7.2 Construction Schedule

133 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 during the entire year. The interventions proposed in Polder 43/2D are likely to be completed by June 2015.

Table 4.2: Construction Schedule in Polder 43/2D

Key Activities	2013				2014				2015			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Screening, hiring and orientation of Community Organizers (COs)												
Community mobilization for Water Management Planning (Fine tuning works)												
In-depth information dissemination/ campaigns on Blue Gold Goals, Objectives, Components and Initial discussions with WMGs												
Assessment of WMO Functionality												
Strengthening/ capacity building of WMO based on outcome of Assessment												
Community Mobilization for Village Development Plan (VDP) and Polder Development Plan (PDP) Firm-up water management development options Firm-up Sustainable Environmental Management Plan (SEMP)												
Implementation of Water Management fine tuning works with active participation of the WMGs/ WMA through the Quality Control/ Block Committee												

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

4.7.3 Materials Requirement

134 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 4.3 below.

Table 4.3: Construction Materials Requirement in Polder 43/2D

Sl	Description	Quantity	Sources
Re-sectioning of embankment			
1	Materials for Earthwork	379,090 m^3	From the set back location and other khas lands
2	Hoe(or Shovel) and Baskets	600 nos. each	To be procured
3	Compactor	100 nos.	To be procured
Repairing of sluices and flushing inlets			
4	Lift Gate	4 (1.5 m x 1.8 m)	To be procured
5	Flap Gate	4 (1.5 m x 1.8 m)	To be procured
6	Barrel	2 (1.5 m x 1.8 m)	To be procured

Sl	Description	Quantity	Sources
7	Pipe	5 (dia: 0.90 m)	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, 2014

4.7.4 Manpower Requirement

135 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 (Labor Contracting Society) and Contractors, on 50-50 basis. Several LCS will be engaged under the 28 existing WMGs, each involving 60 members, to carry out the construction works of Polder 43/2D. The LCS would entail 60% male and 40% female, and all of them would be engaged from the local area.

4.7.5 Construction Camps and Labour shed

136 There are two WMAs in the polder, which will circulate the monitoring of the project. Moreover, the project works will be carried out by the local people, and therefore no labor shed would be required. Labors will come from their respective houses and will return back there after working at project sites.

4.8 Project Management and Implementation

137 The project will be implemented in a participatory manner, ensuring local community based participation at all stages of the project. The issues considered for implementation of the project, the responsibilities of different stakeholders and actors, and the status of WMOs/ CBOs functioning within Polder 43/2D are discussed in the following sections.

4.8.1 Implementation Considerations

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

139 The main objective of TA-consultant is to create community participation through creating cooperatives which will be in the drivers' seat for economic development. Furthermore, they will facilitate creation of enabling environment, supportive towards these cooperatives and the overall sustainable development; thereby realizing increased rural income and poverty alleviation. All interventions/ contributions by actors and stakeholders will be planned and coordinated by the TA-consultants, and the interventions concerned with the Government institutions will be done in close coordination with the concerned Government Departments and Local Government

Institutions (LGIs). If and where needed, on-the-job training will be provided to the Government staff as to further reinforce their capacity.

140 The Water Management component of Polder 43/2D will be integrated through BWDB, as the BWDB staff will be directly responsible for the overall implementation process: from planning to approval of the works to be completed and O&M of the main infrastructures. Technical assistance will be mainly deployed in fields where BWDBs capabilities are not sufficiently developed.

141 District Commissioners, and the elected chairpersons of the upazilas and Unions will be regularly be informed about the progress. For implementation, TA-consultant will call upon the Union chairman/ councilor to actively participate during the mobilization phase of the cooperatives. Table 4.4 below shows the list of major actors and stakeholders, as well as their responsibilities to be involved in the implementation of Blue Gold program of Polder 43/2D.

Table 4.4: Major actors and stakeholders for project implementation of Polder 43/2D

Type	Organization/ Agency	Roles and Responsibilities
Development Partner	Embassy of the Kingdom of the Netherlands	Program approval, monitoring and supervision. Initiation/approval of innovations.
National Agencies	Planning Commission/ ERD	Program approval, monitoring and supervision
	Inter-Ministerial Steering Committee	Coordination of contributions of involved GoB agencies at national level.
	BWDB	Overall management, implementation of component two in Polder 43/2D.
	Ministry of LGRD and Cooperatives; LGED	Registration of WMO under Cooperative Law and training and supervision of annual audits. Coordination of Construction and maintenance work
	National Agricultural Research System	Obtaining information on potentially relevant agricultural production practices for on farm trials.
	WMIP/ SWAIWRPMP/ CDSP/ CEIP	Exchange of experiences and harmonization of approaches
LGIs	DDCC	Coordination of BG interventions with District level development agencies. Participation of BG representatives in coordination meetings
	UDCC	Coordination of BG interventions with Upazila level development agencies.
	Union Parishad	Coordination of interventions. Participation of BG representatives in coordination meetings

142 The project has also perceived research contributions from different organizations namely IWM, CEGIS, IFI, Technical UN Agencies, BUET, BAU, IRRI, CGIAR, BANCID, Delft Hydraulics, and Dutch private enterprises.

4.8.2 Community Participation through WMO/ CBO

143 It is needed to ensure sustainable operation of the project, participation of Water Management Organization (WMO) and Community Based Organizations (CBOs). Therefore, a three tier organizational structure comprising of Water Management Groups (WMG) at the lowest level, Water Management Associations (WMA) at the mid-tier and Water Management Federation (WMF) at the apex would be in place. These groups, associations and federations in a particular sub-project is together termed as the Water Management Organizations (WMOs) which has been considered in this project. Polder 43/2D comprises of 30 WMGs and 2 WMA, under Blue Gold Program. All WMA and WMGs are already registered through Bangladesh Water Development Board (BWDB).

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

145 The Following CBOs have been recommended for this polder under Blue Gold Program.

Water Management Committee (WMC)

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

Labor Contracting Society (LCS)

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

4.9 Operation and Maintenance Plan

148 Since construction, Polder 43/2D has been playing a vital role in safeguarding the polder 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 to the diversified 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 43/2D has been proposed.

4.9.1 Operational Plan

149 Operational plan involves setting out the schedule of activities related to operation of gates of structures by the users' organization to control water levels best suited to water management and agricultural needs. The activities given below have been recommended for the operation plan of Polder 43/2D.

Regulation of Gates

150 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 in June, which is considered as the starting period for fish breeding and migration. 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 sectors i.e. farmer, fisher etc. Operation of outlets and inlets should also undergo similar practices with maximum involvements of different beneficiaries' organizations. The O&M section, WMOs and BWDB staff will assist local stakeholders in effective management of water inside the polder.

Frequent Monitoring of Embankments and Structures

151 This is a typical monitoring activity, to be carried out by the BWDB O&M staff. It is intended mainly to detect weak sections, gullies, slips at abutments, damage of protective works, wing walls, periodic damage 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

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

4.9.2 Maintenance Plan

153 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 43/2D, only those works which directly serve water management should be regularly maintained.

Preventive or Routine Maintenance

154 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 by LCSs.
- Cleaning, greasing, and painting of structures by LCSs;

Periodic Maintenance

155 Periodic Maintenance works are also 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.

156 Minor Periodic Maintenance Works

- Minor earth works on the embankments by LCSs, i.e., shaping and minor fillings including repair of access ramps;
- Minor repair of protective works by LCSs i.e. re-positioning of the displaced blocks;
- Minor repair of structures by LCSs i.e. small patching of brick works, replacing rubber seals; and
- Major Periodic Maintenance Works
- Major earth works by LCSs i.e. re-sectioning of embankments including turfing;
- Major repair of structures i.e. repair or replacement of metal works / hinges, lifting mechanisms, gates, block works, head / wing walls;

Emergency Maintenance

157 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 requiring immediate attention includes the closure of an embankment breach, the repair and replacement of flap gates, or the construction of cross dams over canals if structure fails.

4.10 Expected Benefits and Outcome

158 The foreseeable benefits which are likely to occur due to the implementation of Blue Gold program in Polder 43/2D are listed in Table 4.5 below.

Table 4.5: Expected benefits and outcome of proposed interventions

Interventions	Benefits
Re-sectioning of Embankment	✓ Protection of tidal flooding ✓ Protection against salinity intrusion. ✓ Increased side slopes will enhance the stability of the embankment. ✓ Communication facilities may improve.
Construction of Retired Embankment	✓ Protection of tidal flooding ✓ Protection against salinity intrusion. ✓ 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.
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.

4.11 No Objection Certificate

159 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 3.

5 Environmental Baseline

5.1 Physical Environment

The physical environment of the study includes sound quality, water quality, seismicity and topography, land, water resources etc. The following sections discuss the physical environment within the polder area:

5.1.1 Meteorology

160 The following sections provide analysis on meteorological information (temperature, rainfall, humidity) of the polder area. Values have been collected from the Patuakhali station of Bangladesh Meteorological Division (BMD).

Rainfall

161 The average monthly rainfall variation at Patuakhali (from 1973 to 2013) is shown in Figure 5.1. The hyetograph shows that the highest and lowest values of rainfall are observed during the months of July (590 mm) and December (7 mm) respectively.

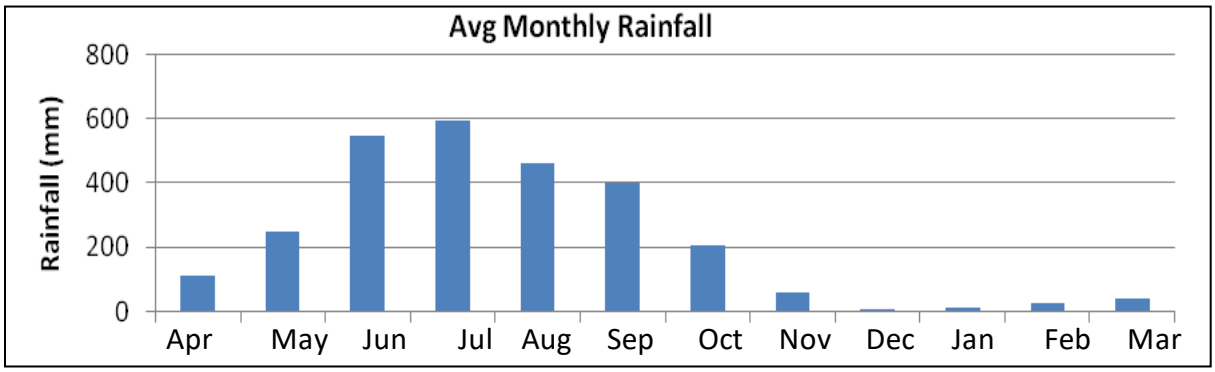


Figure 5.1: Average monthly rainfall at Patuakhali BMD

162 The BMD station at Patuakhali is very close to the polder (within 600 m). The rainfall station of BWDB at Patuakhali is almost a similar distance away and from the Thiessen's Polygon considered around the rainfall stations of BWDB it is observed that the entire polder falls inside the Patuakhali polygon. Therefore assumptions have been made that rainfall data from the BMD station at patuakhali is significant enough for the polder and no analyses have been carried out with the rainfall stations of BWDB for Polder 43/2D.

Temperature

163 Figure 5.2 below shows the variations in average maximum and average minimum temperatures at 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).

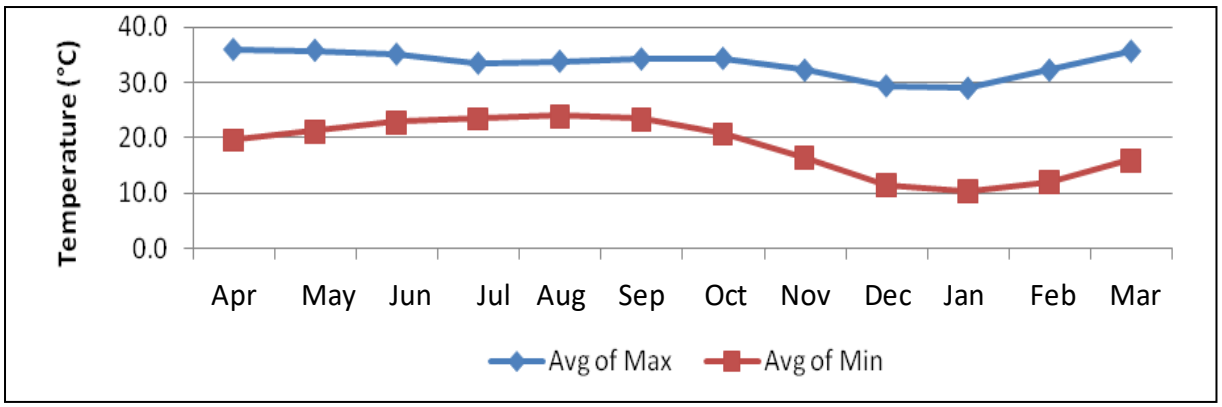


Figure 5.2: Average of Maximum and Minimum Temperatures at Patuakhali BMD station

Relative humidity

164 Relative humidity is the ratio of the partial pressure of water vapor in an air-water mixture to the saturated vapor pressure of water at a prescribed temperature. The value depends on temperature and the pressure of the system of interest. As the temperature of the atmosphere increases, vapor carrying capacity in water increases, and thus the atmospheric vapor pressure also increases. Figure 5.3 below shows the variation of monthly relative humidity, as recorded by the Patuakhali BMD station (1973~2013). It shows an increasing trend from April to July and after that decreasing pattern was observed. A significant fluctuation has been observed as relative humidity values start to increase from April (start of summer) due to the increase in atmospheric water vapors coupled with temperature rise.

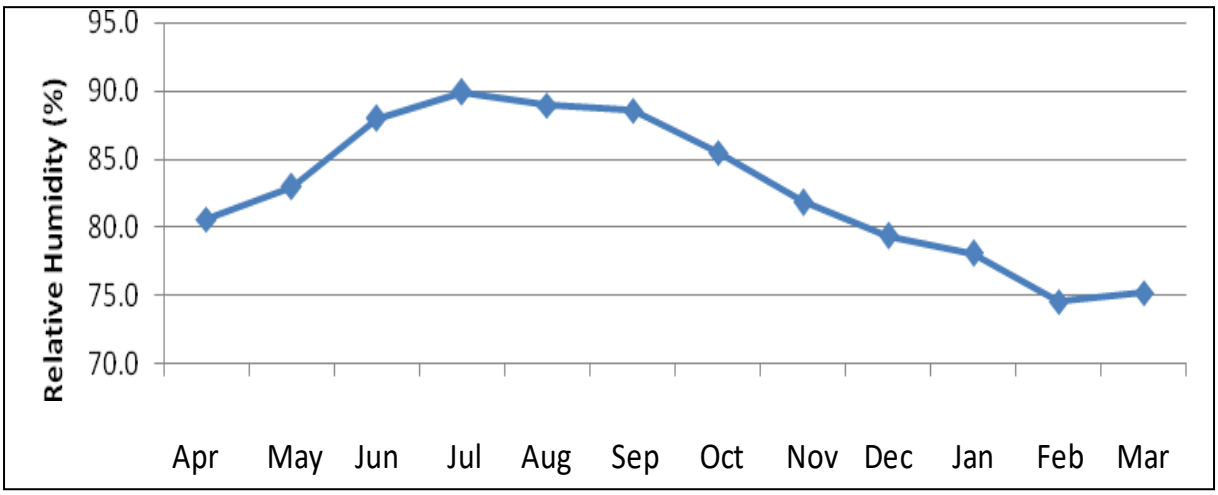


Figure 5.3: Average Relative Humidity at Patuakhali BMD station

Wind speed

165 Figure 5.4 below shows the distribution of average monthly wind speeds; 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, the former one created devastating impacts due to the high wind speed whereas the later one is more related to the increased storm surge.

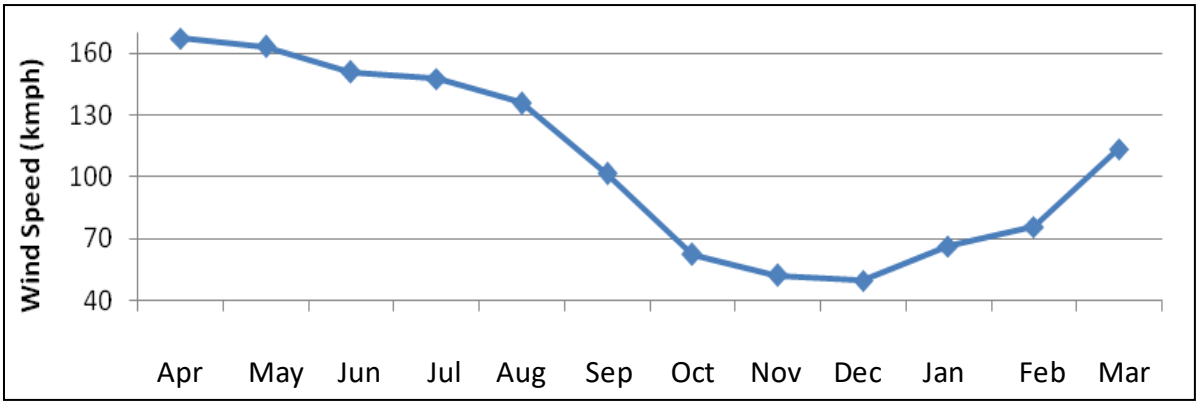


Figure 5.4: Variation of Average Wind Speed at Patuakhali BMD station

Sunshine hour

166 The average sunshine hour data has also been collected from Patuakhali BMD station (1985-2013). Figure 5.5 shows that from August to March it shows an increasing trend and the daily average sunshine hours are higher than almost 6 hours, but a decreasing trend is observed from April to July because of some monsoon cloud available at that time.

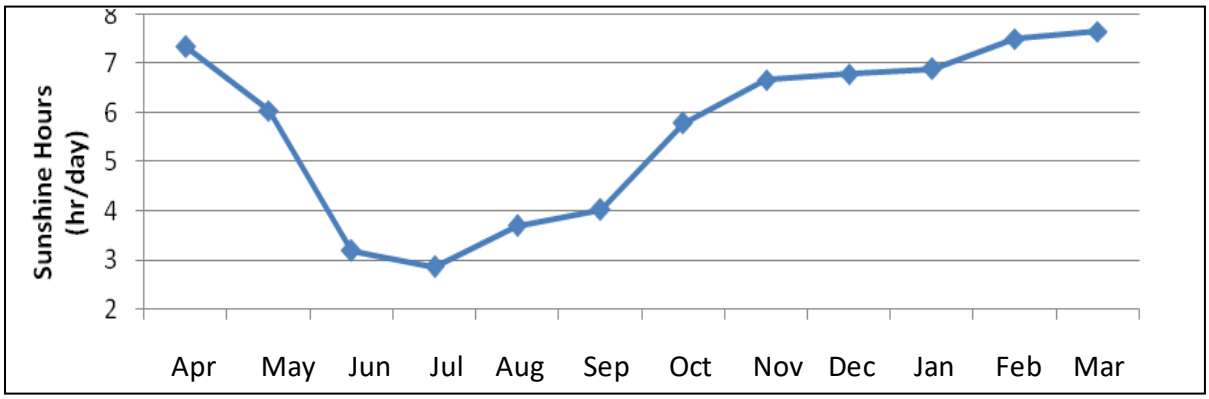


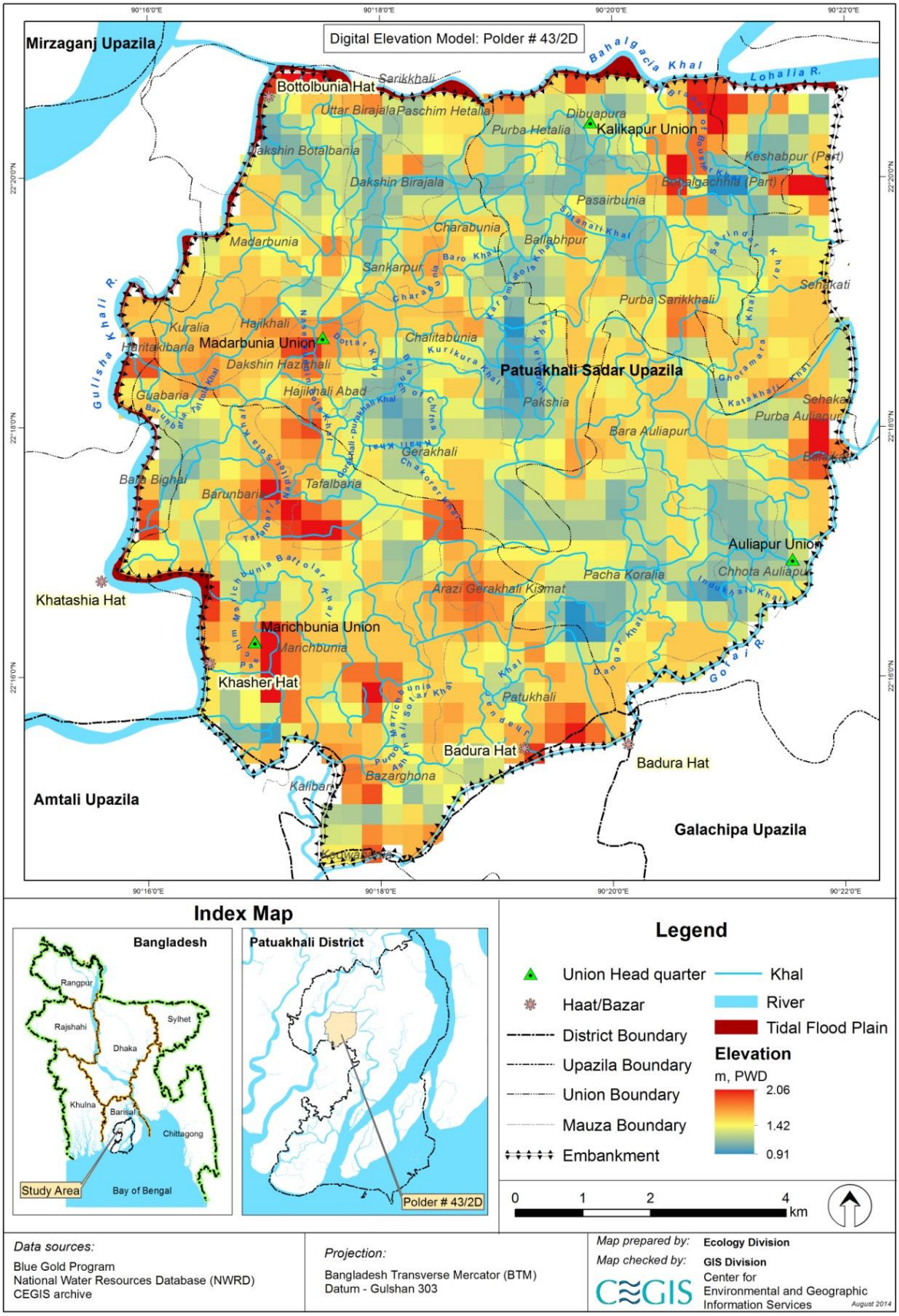
Figure 5.5: Monthly Variation of Average Sunshine Hours at Patuakhali BMD station

5.1.2 Topography

167 The study area is located in the Southern central hydrological zone of the country, with very low average elevations. Re-sampled 500m × 500m grid reduced levels (RLs) 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 called Digital Elevation Model (DEM), produced by CEGIS in 1997 (Map 5.1). DEM analysis infers that the Reduced Levels inside the polder vary from 1.3 to 2.0 m +PWD (from Mean Sea Level), with average elevations of around 1.46 m +PWD. The entire portion of Polder 43/2D is higher than the low tidal water levels observed in Mirjaganj (Payra River). On the other hand in monsoon water levels at Mirjaganj are observed higher than the maximum elevations of the polder.

168 From the DEM it is found that 80% land areas of the polder have elevations between 1.3 to 1.5 m +PWD. There are some occasional low lying lands at Auliapur, Gerakhali, Koralia (around 1.3 m), whereas the peripheral locations are usually higher. The flow direction is tidal, and during high tide, water from outside of the polder flows towards the inside and during low tide moves backwards towards the Bay of Bengal through Payra

and Lohalia rivers. Map 5.1 below shows the topography of the study area, identifying the rivers and water bodies as well as categorizing land elevations.



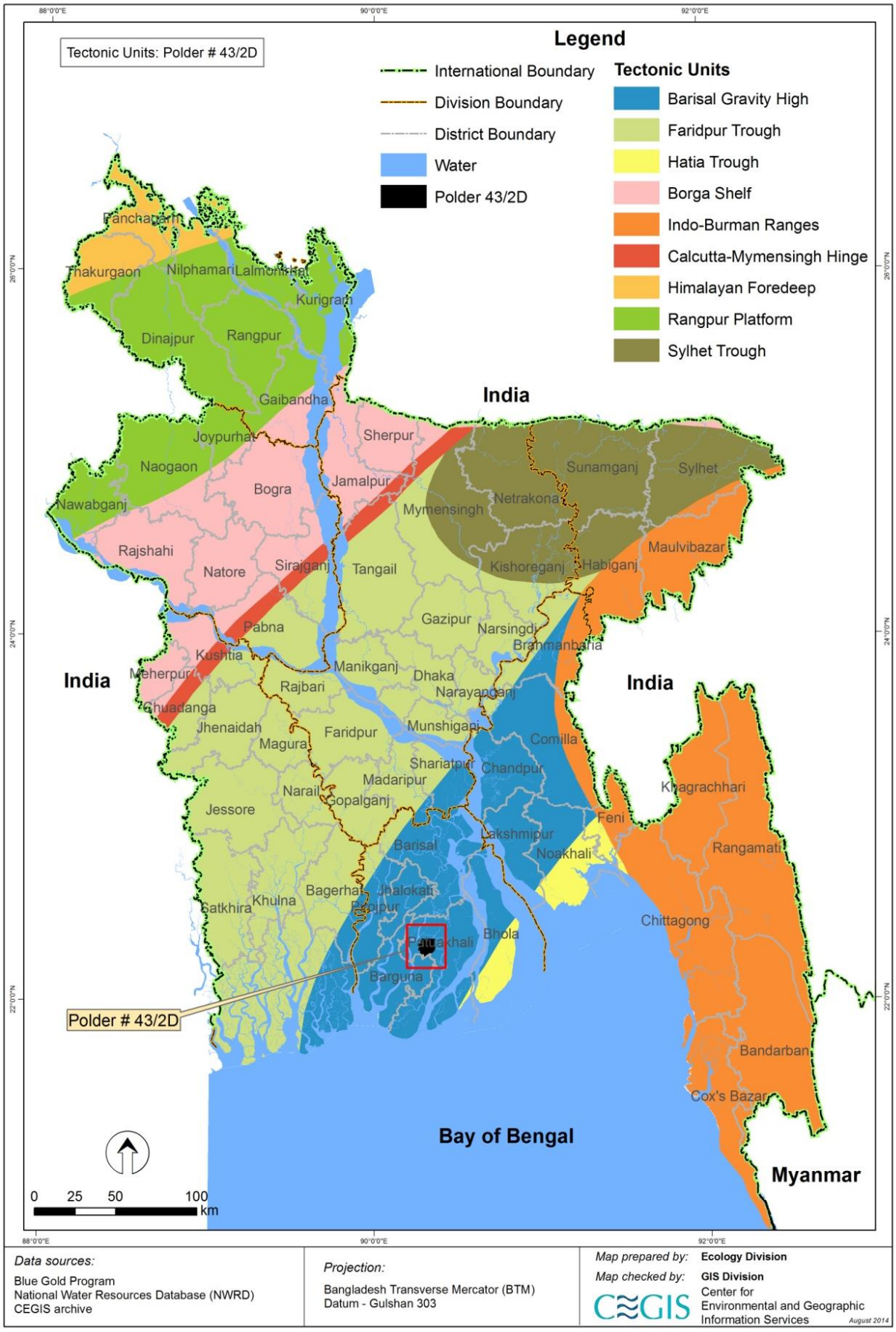
Map 5.1: Digital Elevation Model (DEM) Map of Polder 43/2D

5.1.3 Seismicity

169 Bangladesh is one of the seismically active regions of the world, experiencing numerous severe earthquakes in the past 200 years Major active fault zones of the country have been delineated through geological trenching and dating methods. On the basis of distribution of earthquake epicenters and tectonic behavior of different tectonic blocks, a seismic zoning map of Bangladesh was proposed in 1979 by Geological Survey of Bangladesh (GSB) dividing the country into three seismic zones: zone-I, zone-II, and zone-III (Map 5.2). Later, a new updated seismic zoning map and detailed seismic design provisions have been incorporated in Bangladesh National Building Code (BNBC), 1993 (Department of Disaster Management, GoB). The study area falls under Zone-I which situated in the southwest portion of Bangladesh which is seismically quiet zone with Bask coefficient 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 5.3 below shows the seismic location of Polder 43/2D.

170 It is observed that both in consideration of seismicity and stratigraphy, Polder 43/2D falls on a relatively safer (seismically quiet and tectonically stable) side.

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



Map 5.3: Tectonic units Map of the Polder area

5.1.4 Agro-ecological zone

171 Thirty agro-ecological zones 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. These layers are: 1) Physiography (land forms and parent materials), 2) Soils, 3) Depth and duration of seasonal flooding and 4) Agro-climatology [It comprises four elements: length of kharif and rabi growing seasons, length of pre-kharif transition period, number of days below certain winter critical temperatures (<15^{0}C) and number of days with extremely high summer temperature (>40^{0}C).

172 Agro-ecological zones and sub-zones are very broad units. Fertility status of these zones varies greatly. Individual farmers have fragmented the land into small pieces causing wide variation in the management of each and every piece of land. This leads to the large variation in the fertility levels even between adjacent plots. Realizing the difficulties of agro- ecological zones is given here which serves as a ground for AEZ based fertilizer recommendations for cropping patterns (FAO/UNDP, 1988). For detailed information about physical and chemical properties of soils, respective Upazila Nirdeshika may be consulted. However, for fertility data of a specific area soil sample should be collected for detailed analysis (BARC, 2012).

173 Total Polder 43/2D area is under Ganges Tidal Flood Plain (AEZ-13). The polder area is situated in nine unions at Patuakhali sadar and Amtali upazilas of Patuakhali and Borguna districts.

(a) AEZ-13: Ganges Tidal Floodplain

174 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, noncalcareous, heavy silty clays in the extensive basins. Non-calcareous Grey Floodplain soil is the major component of General Soil Types. Soils of the Sundarbans area are alkaline. General fertility level is high with low to medium organic matter content and very high CEC and K status. There are limitations of high exchangeable Na and low Ca/Mg ratio. The Zn status is low to medium and the B and S status is medium to optimum.

Table 5.1: Some physic-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	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

5.1.5 Fertility status of soils in the polder area

175 Soil fertility is an important factor for crop production. In general the coastal regions of Bangladesh organic matter content of the soil is pretty low (Haque, 2006). Thus in addition to salinity, plant nutrients in soils affect plant growth. Farmers reported that the soils are in general poor in organic matter content. Soil sample were collected from six locations in three depths (0-10 cm, 10-20 cm and 20-30 cm)) inside the polder area in the month of late May, 2014, but in the month of March-April salinity may be high. To

know the present fertility status of the soil in the polder was analysed from Soil Resource Development Institute (SRDI). Table 5.2 shows the detailed analysed results and status of soil fertility in the polder area. From the table, salinity level is ranges from 2.41 to 7.31 in top soil in all locations. The pH ranges from 4.5-8.4 in AEZ 13 and we observed that, pH ranges from 4.8-6.9 in three depths of all locations of the polder. It indicates that, pH ranges within the limit. OM content ranges from 0.28-2.40 in all locations in three depths. But OM status in the AEZ is low to medium. It indicates that, soil of the polder area is quite suitable for crop production. K, ranges from 0.14 to 0.33 in all locations of the soil. But, it was found in the soils of AEZ is ranges from medium to optimum. It is suitable from 0.17-3.30 for crop production. N level is low in the AEZ. We found from the table that, N ranges from 0.02 to 0.13 in all locations of the polder area and ranges from 0.07 to 0.15 are not good for crop production. P level is very low to low in the overall AEZ area and 0.01-0.20 is suitable for crop production. On the other hand, it ranges from 2.04 to 6.11 in three locations of the polder area. However, the polder areas soil is good for crop production. In case of the quality of S in the soils of AEZ is medium to optimum. But it was observed, S ranges from 7.03 to 109.11 in all locations of the polder (Table 5.2).

Table 5.2: Fertility status of soils in the polder area

Number of the polder	Location	GPS reading	Depth (cm)	EC	pH	OM	K	N	P	S
43/2D	Hazikhali	E-90° 17′20.4″ N-22° 18′36.6″	0-10	4.91	5.5	1.79	0.20	0.10	2.49	7.28
			10-20	5.65	4.8	2.40	0.22	0.13	2.04	7.03
			20-30	5.46	5.8	1.34	0.18	0.08	3.17	70.25
	Hetalia (East)	E-90° 18′52.4″ N-22° 20′30.9″	0-10	2.41	6.7	1.12	0.20	0.06	6.11	34.84
			10-20	2.75	5.4	2.03	0.20	0.12	3.40	72.72
			20-30	4.49	5.2	1.95	0.21	0.11	3.42	9.50
	Awoliapur	E-90° 20′22.7″ N-22° 16′51.7″	0-10	2.44	4.9	1.89	0.33	0.11	3.29	27.95
			10-20	2.61	5.5	1.79	0.24	0.10	3.40	46.44
			20-30	3.76	6.0	1.28	0.33	0.07	2.61	81.08
	Patukhali	E-90° 18′43.8″ N-22° 16′20.8″	0-10	4.64	4.9	2.29	0.26	0.13	2.52	97.45
			10-20	4.08	5.9	1.90	0.25	0.11	2.69	109.11
			20-30	4.49	5.6	1.10	0.30	0.06	3.15	41.99
	Gorakhali	E-90°18′50.7″ N-22° 17′49.1″	0-10	3.84	4.9	1.22	0.14	0.07	3.25	10.08
			10-20	5.21	6.6	1.72	0.16	0.10	4.82	1.23
			20-30	4.50	5.5	1.52	0.16	0.08	3.44	3.16
	Sarikhali (West)		0-10	7.31	6.3	0.28	0.20	0.02	3.54	33.77
			10-20	2.61	6.9	0.83	0.25	0.04	4.15	30.69

Number of the polder	Location	GPS reading	Depth (cm)	EC	pH	OM	K	N	P	S
			20-30	3.26	6.8	1.28	0.16	0.07	5.22	6.28

Source: Laboratory analysis report, 2014

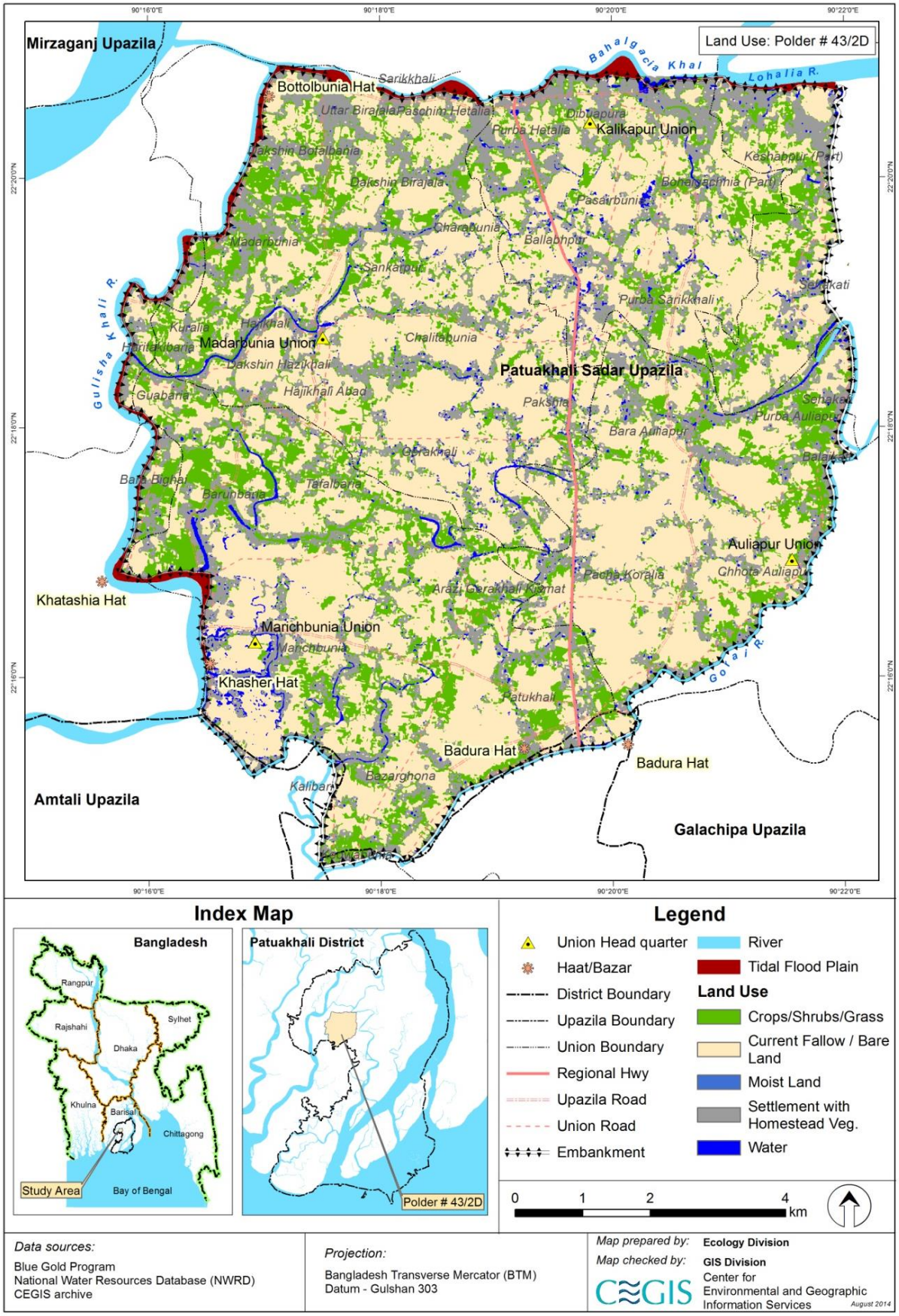
5.1.6 Landuse

176 The gross area is about 9,270 ha of which about 69% of net cultivable area (NCA). Settlements, road and water bodies constitute about 28%, 2% and 1% respectively of the total area of the polder. Detailed of landuse of the polder area is presented in Table 5.3 and Map 5.4.

Table 5.3: Present detailed landuse of the polder area

Land use	Area (ha)	Total area (%)
NCA	6,440	69
Settlements	2,570	28
Road	150	2
Water bodies(khals)	110	1
Gross Area	**9,270**	**100**

Sources: CEGIS estimation from SOLARIS-SRDI, 2006



Map 5.4: Landuse of the polder area

5.1.7 Land Type

177 Land type classifications are based on depth of inundation on agriculture land during average monsoon season. In terms of depth of flooding, the five classes of land type are recognized by SRDI, (1988). The entire polder area is under medium highland (F_1) which normally is flooded between 0 - 90 cm deep of water continuously more than two weeks to few months during the monsoon season.

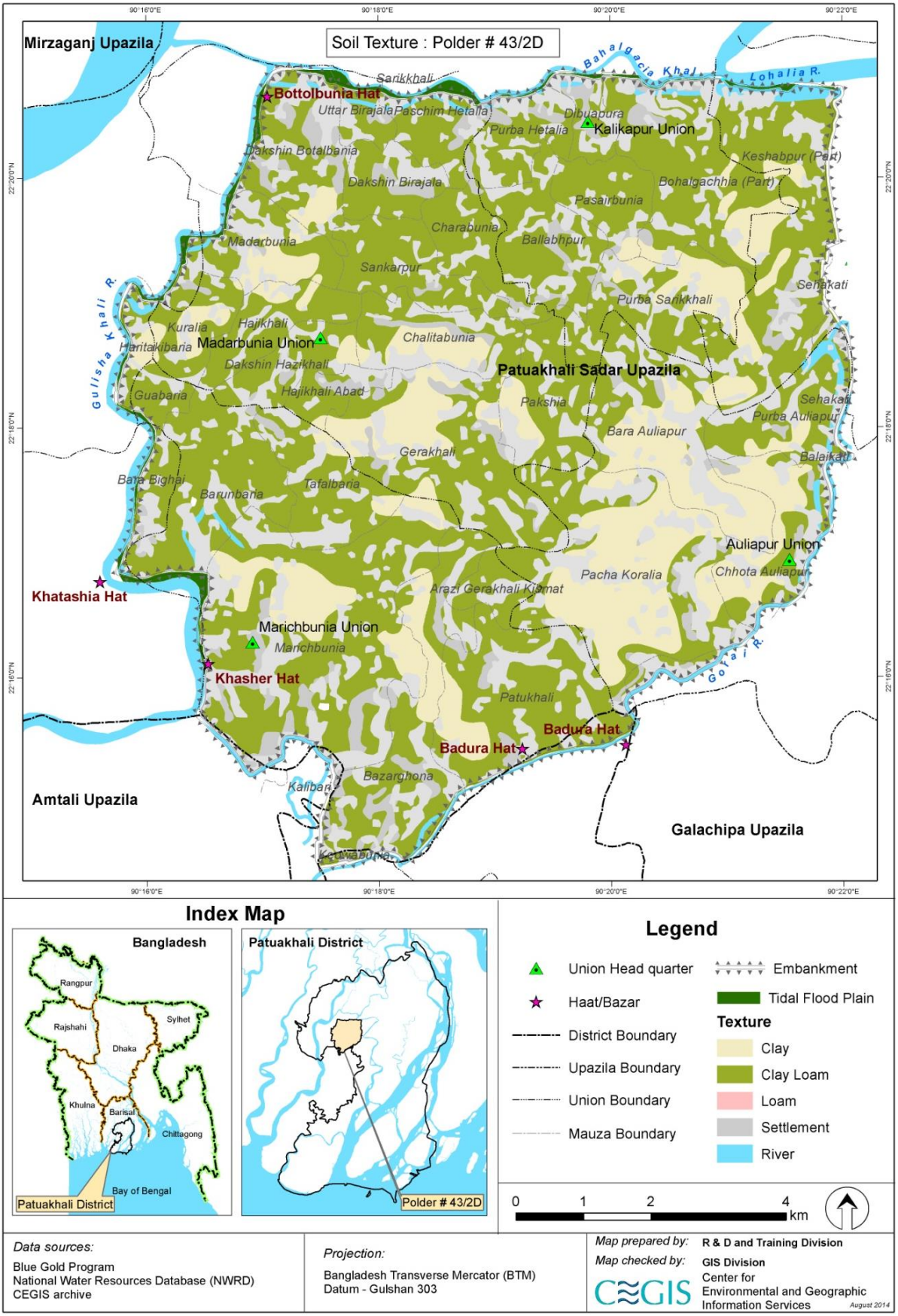
5.1.8 Soil Texture

178 Soil texture is the relative proportions of sand, silt and clay. The polder is covered with clay texture (32%) and clay loam texture (68%). Detailed soil texture is presented in Table 5.4 and Map 5.5.

Table 5.4: Detailed Soil texture of the surface soil (0-15 cm) in the polder area

Texture	Area(ha)	% of NCA
Clay	**2065**	**32**
Clay Loam	**4375**	**68**
Total	**6,440**	**100**

Sources: CEGIS estimation from SOLARIS-SRDI, 2006



Map 5.5: Soil texture in the polder area

5.1.9 Soil Salinity

179 The soils of the polder area become very slightly saline to slightly saline in the dry season (Jan-May). There is no change in water salinity in 1973, 2000 and 2009 inside the polder area. Polder area is suffered by very slightly saline with some slightly saline which is (100%). Detailed soil salinity of the polder area is presented inTable 5.5.

Table 5.5: Detailed Soil salinity of the polder area

Soil Salinity class (EC=ds/m)	Description	Location (Union/ Mouza)	Area (ha) 1973	% of NCA	Area (ha) 2000	% of NCA	Area (ha) 2009	% of NCA
4.1 - 8.0	Very slightly saline with some slightly saline	Jainkathi, Madarbunia, Chhota Bhigai, Kalikapur, ,Auliapur, Marichbunia, Baro Bighai, Amkhola, Atharogachia, Kukua and Gulishakhali	105	2	6,440	100	6,440	100
Total			**105**	**2**	**6,440**	**100**	**6,440**	**100**

Sources: CEGIS estimation from SOLARIS-SRDI, 2006.

Note: In 1973, 6,335 ha of land, salinity data was not available

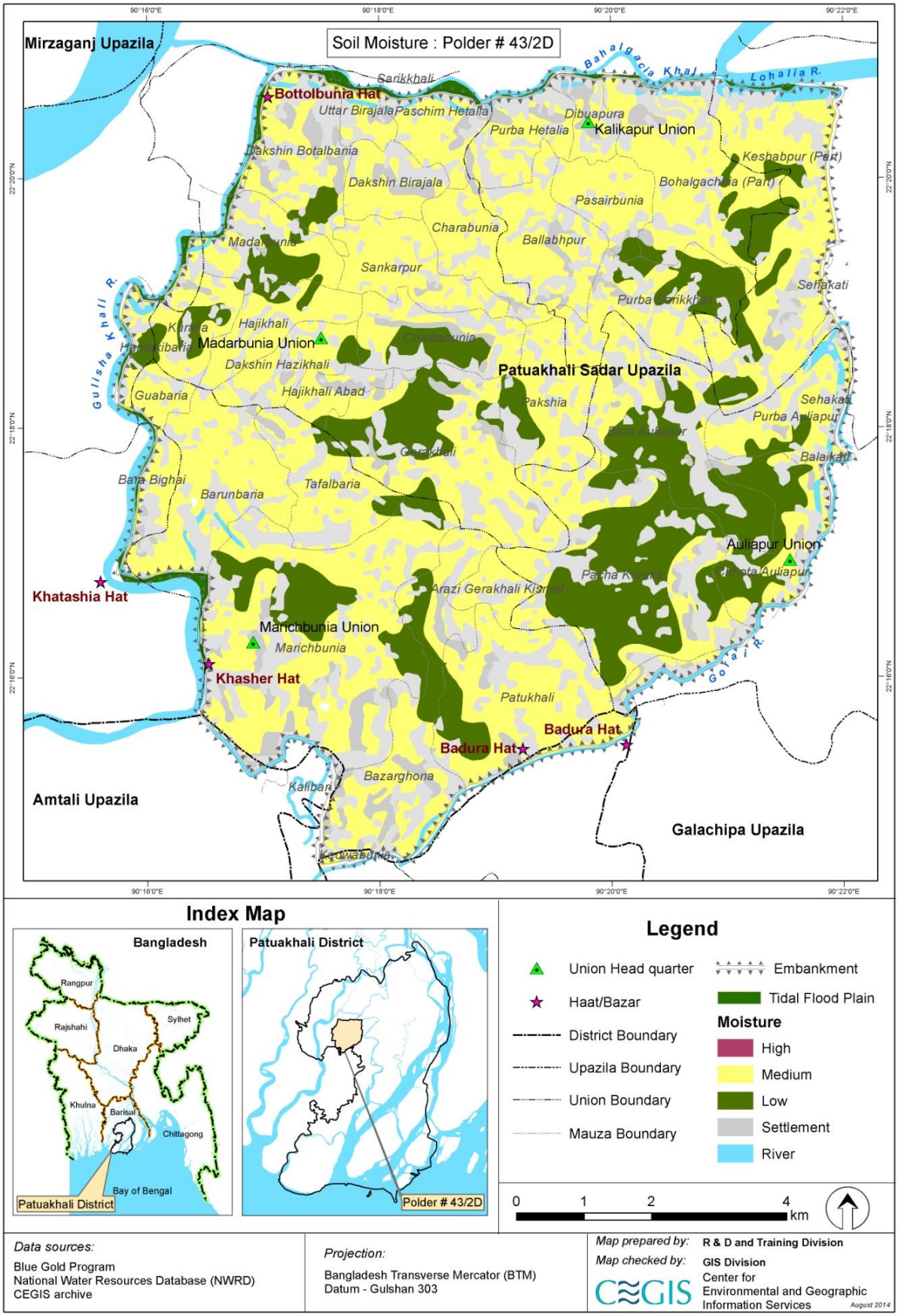
5.1.10 Available Soil Moisture

180 The available soil moisture is very important for the cultivation especially in rabi crops. The maximum area (77%) is covered with low level of available soil moisture and the rest is medium (23%) level in the polder area. Detailed distribution of available soil moisture is presented in Table 5.6 and Map 5.6.

Table 5.6: Detailed distribution of available soil moisture in the polder area

Moisture	Characteristics	Area (ha)	Moisture (%)
Medium	Plant extractable soil moisture remained in field level from one to two months	1,482	23
Low	Plant extractable soil moisture remained in the field level less than one month	4,958	77
Total		**2980**	**6,440**

Source: CEGIS estimation from SOLARIS-SRDI, 2006



Map 5.6: Distribution of available soil moisture

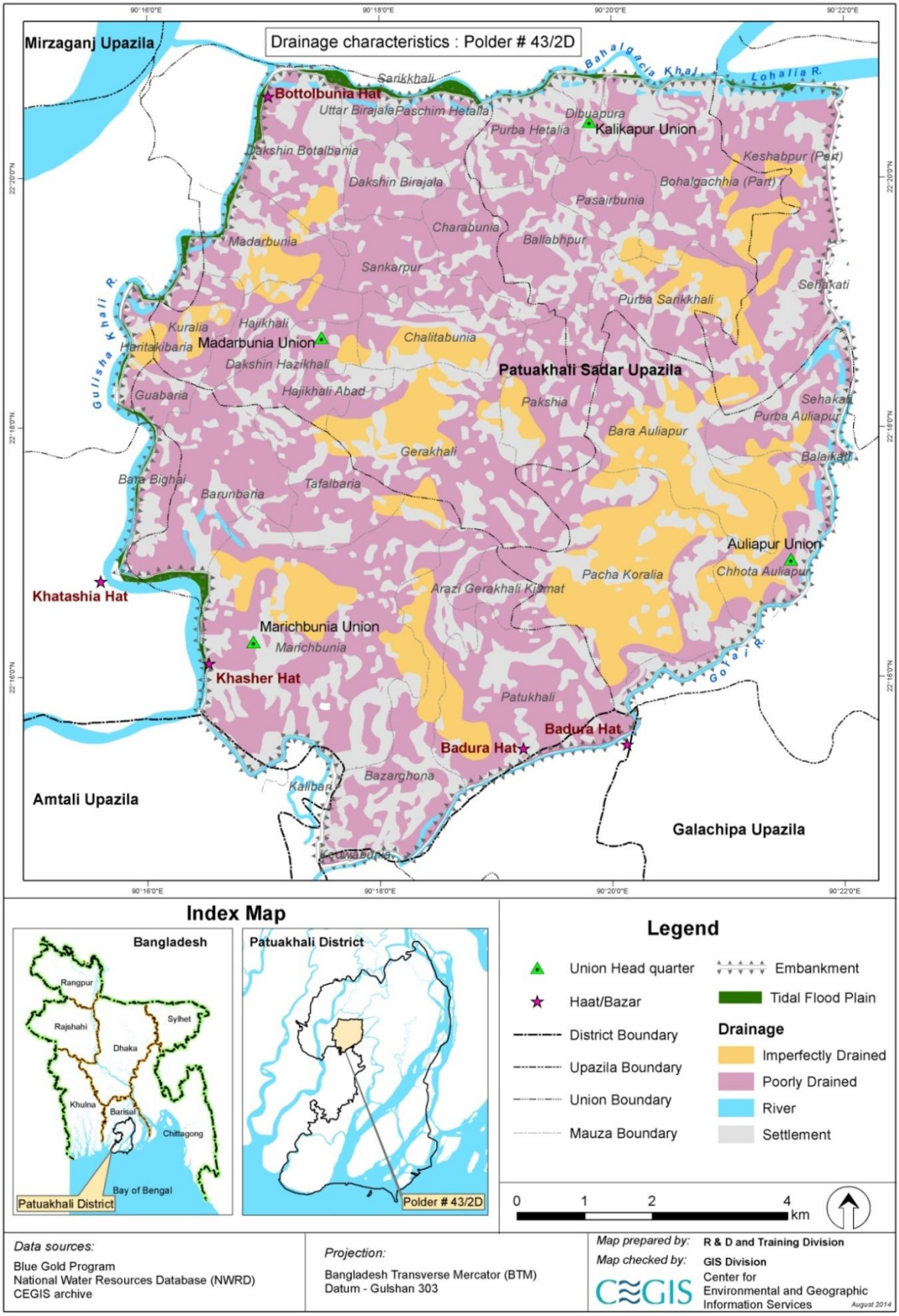
5.1.11 Drainage Characteristics

181 Drainage plays a vital role in the management of soil in the polder area. As per the SRDI (1988), the drainage characteristics have been divided into six classes from the agricultural point of view. In the polder area, 77% of the NCA is under poorly drained condition and the rest 23% is imperfectly drained condition. The dominance of poorly drained soil of the polder area indicates that the removal of water in rainy/ monsoon season is the main constraint for growing dry land crops in the polder area. Detailed drainage characteristics along with area are presented in Table 5.7 and Map 5.7.

Table 5.7: Detailed drainage characteristics of the polder area

Drainage classes	Drainage characteristics	Area (ha)	Percent of NCA
Imperfectly Drained	Water drained from soil badly or slowly. This soil often remains wet in rainy season due to rainfall. In normal situation, water does not stand on land more than 15 days at a stretch. In rainy season, groundwater stands within one meter at least for some time.	1,482	23
Poorly Drained	The soil remains under water from 15 days to 7/8 months. Water is drained from the soil slowly. In most cases, the land remains wet/water logged for a considerable period of time after the rainy season.	4,958	77
Total		6,440	100

Source: CEGIS estimation from SOLARIS-SRDI, 2006



Map 5.7: Drainage characteristics along with area

5.1.12 Farming Practices

182 Farming practices in the polder area are largely controlled by physical, biological, climatologic and socioeconomic factors. Agricultural crops are grown according to the cropping seasons. There are two distinct cropping seasons in a year. They are the Kharif and the 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 adaptability and crop culture, the kharif season has been further sub-divided into kharif-I (March-June) and Kharif-II (July-October) seasons.

183 The Kharif-I season is characterized by high temperature, low humidity, high evaporation, high solar radiation and uncertainty of rainfall of low alternating dry and wet spells. In this season, most of the polder area remains fallow. However, local transplanted aus (Lt Aus) are grown in this season. Few vegetables are grown in the homestead and bank of the khals area mainly.

184 The Kharif-II season is characterized by high rainfalls, lower temperatures, high humidity, low solar radiation and high floods that recede towards the end of the season. Rice is the predominant crop grown during this season due to the submergence of soil. Excessive soil moisture also restricts other crops suitable for a high temperature regime. Local transplanted Aman (Lt. aman) rice is grown in kharif-II season in the polder area.

185 During Rabi season, crops are favored with high solar radiation, low humidity and temperature, but lack of adequate soil moisture restricts the crop yield because of very low or evens no rainfall throughout the season. Wide ranges of crops can be grown in this season. Major crops grown in this season of the polder area are Sesame, Mungbean, Khesari, Chilli, Sweet Potato, Ground nut and HYV boro etc. However, there are occasional overlaps such that kharif-I season crops (Lt. aus) are harvested in kharif-II season, kharif-II season crops (t.aman) are harvested in Rabi season and rabi season crop (HYV Boro, Sesame, Mungbean, Khesari, Groundnut, Chilli and Sweet Potato) are harvested in kharif-I season.

5.1.13 Crop Production Constraints

186 The following crop production constraints have been identified through our visit and group discussions with the local farmers:

i) Drainage congestion during transplanting period in Aman season;
ii) Due to impact of climate change the level of sea water increase which is caused to natural calamities such as tidal surge, cyclone etc.
iii) Severe scarcity of irrigation water during dry season especially for rabi crops cultivation; and
iv) The siltation caused raise of bed of different internal drainage khals.

187 Above situations are unfavorable for crop production

5.1.14 Cropping Pattern by Land Type

188 In the polder area, land status is medium high. Farmers are growing crops like Lt aus, Lt.aman, sesame, mungbean, khesari, chilli, sweet potato, groundnut and very few amount of HYV boro. The dominant cropping pattern is Fallow – Lt. Aman–Sesame which is 22% of the NCA. The next dominant cropping pattern is Fallow –Lt. Aman - Fallow which is occupied about 21% of the NCA. Detailed cropping pattern is presented in Table 5.8.

189 In the Kharif-I season; Lt. Aus is cultivated in 13% of the NCA and 87% of the NCA remains fallow. In the kharif-II season, only Lt. Aman is grown. In rabi/boro season, pulses, oilseed, sweet potato and boro are grown in 63% of the NCA and rest 37% of the NCA remains fallow. Department of Agriculture Extension (DAE) started demonstration in last boro season with rice BRRI dhan 28 and groundnut. Farmers are growing vegetables not as a pattern, but growing in the homestead area. Local farmers informed that about 60% area was under aus before 10-12 years back. Now farmers are cultivating Lt aus in small scale because of crop damage due to siltation of drainage khals.

Table 5.8: 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	Fallow	Lt. Aman	Fallow	1,352	21
	Lt. Aus	Lt. Aman	Mung bean	580	9
	Fallow	Lt. Aman	Sesame	1,417	22
	Fallow	Lt. Aman	Fallow	1030	16
	Fallow	Lt. Aman	Khesari	644	10
	Fallow	Lt. Aman	Chilli	515	8
	Fallow	Lt. Aman	Sweet potato	451	7
	Fallow	Lt. Aman	Groundnut	193	3
	Lt. Aus	Lt. Aman	HYV Boro	258	4
			Total	6,440	100
Cropping intensity 176%					

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

Photo 5.1: View of land preparation in the polder 43-2D area

Photo 5.2: View of chilli field in the polder 43-2D area

Photo 5.3: View of sunflower damage field in the polder 43/2D area

Photo 5.4: ICM practice in Lt Aus field in polder 43/2D area

5.1.15 Cropped Area and Cropping Intensity

190 Total cropped area is about 11,334 ha of which 66% is covered with rice and the rest 34% is occupied by non-rice crops (Table 5.13). The single, double and triple cropped area is 37%, 50% and 13% of the NCA respectively. The rest 87% of the NCA is remained fallow. In kharif-II season, the coverage of local aman is about 100% of the total NCA. After implementation of the project it is possible to grow HYV aman. In Rabi/ boro season, the coverage of pulses, oilseed, spices and HYV boro are about 63% of the NCA. The rest 37% of the NCA is remained fallow. Fallow land may be utilized by growing summer and winter vegetables and cropping intensity may be 215%.

5.1.16 Crop Damage

191 Generally crop damage occurs almost everywhere i.e., inside and outside the polder area. Inside the polder area crop damage by drainage congestion, heavy rainfall and partially salinity etc. was reported by the local farmers. Total loss of rice production is about 1,219 tons in 770 ha and loss of non-rice production is about 170 tons in 213 ha (Table 5.13). Causes of crop damage in the polder ara shown in Table 5.9.

Table 5.9: Crop damage in the polder area

Crop name	Location	% of damage area	Timing	Causes of damage
Lt. Aus	Pocket area	15	July-August	Heavy rainfall & drainage congestion,
Lt. Aman	Entire polder area	10	July-August	Heavy rainfall drainage congestion,
Sesame	Entire polder area	15	April-May	Heavy rainfall & drainage congestion

Source: Based on field information (FGD); 2014

5.1.17 Agricultural Inputs

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

Seed

193 The role of seeds is very important for growing crops. Selection of seeds should be considered on the basis of more than 85% germination rate, free from disease infestation, good shape and size and high yield potential. According to land zone (AEZ 13) the recommended seed rate (BARI 2011-2012 and BRRI, 2011) is presented in Table 5.10. The seed rate used by the farmers in the polder area is also presented in the same (Table 5.10). In case of rice, farmers are using more seed than recommended as they normally use more seedlings per hill. Most of the cases, seedlings are affected by monsoon flood and salinity. Sometimes, they are forced to re-transplant due to damage by heavy rainfall during monsoon season. The seed rate of vegetables generally depends on the size and viability of the seed.

Labor

194 In the polder area, almost 60% of the cultural practices for crop production are being done manually. So, agricultural labor is considered as one of the essential inputs for crop production. The labor requirement is not uniform throughout the year. The number of labor requirement varies from crop to crop and season to season. Local farmers reported that females are involved mostly in pulses, oilseed and spices crops harvest and post harvest works for all crops. The average number of labor (male and female) used per hectare in the polder area is presented in Table 5.10.

Fertilizer

195 The rate of fertilizer use per hectare varies considerably from farmer to farmer depending on soil fertility, cropping pattern and financial ability. The major fertilizers used in this area are Compost, Urea, TSP, MP and Gypsum. Farmers are using less chemical fertilizer than the recommended dozes in all crops. According to local farmers, there are three fertilizer dealers near the upazila head quarter; they said farmers are not aware about recommended doze. On the other hand they don't have enough money to buy fertilizer too. About 50-60% household has compost pit in there homestead area. Compost is mainly used in pit crops. Fertilizer recommendation rate as developed by BARC, 2012 on the basis of agro-ecological zone (AEZ-13) is presented in Table 5.10.

Pesticides

196 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, pulses, oilseeds, spices and tuber crops cultivation. Melathion and BARI trap used in bitter gourd and other gourd for prevention of pest infestation where farmers are growing vegetables in the homestead area. Detailed information of pesticides used is presented in Table 5.10.

Table 5.10: Seed, labor, fertilizer and pesticides application of the polder area

Crop name	Seed		Labor	Farmers using fertilizer (Kg/ha)						Recommended fertilizer (kg/ha)						Pesticides	
	Farmers used (Kg/ha)	Recommended seed (kg/ha)	(No./ha)	Compost	Urea	TSP	MP	Gypsum	Zn	Compost	Urea	TSP	MP	Gypsum	Zn	No. of application	Liq. (ml/ha) approx.
Lt Aus	40	40	150	0	30	20	10	0	0	0	97	14	17	0	0	0	0
Lt Aman	45	40	130	0	40	30	0	0	0	0	97	14	17	0	0	0	0

Crop name	Seed		Labor	Farmers using fertilizer (Kg/ha)						Recommended fertilizer (kg/ha)						Pesticides	
	Farmers used (Kg/ha)	Recommended seed (kg/ha)	(No./ha)	Compost	Urea	TSP	MP	Gypsum	Zn	Compost	Urea	TSP	MP	Gypsum	Zn	No. of application	Liq. (ml/ha) approx.
HYV Boro	40	40	175	0	125	50	50	0	0	0	272	44	58	17	4	0	0
Khasari	50	40	100	0	15	0	0	0	0	0	21	17	20	0	0	0	0
Sesame	5*	7	70	0	30	20	0	0	0	0	170	60	31	0	1.3	0	0
Chilli	0.600	0.230	120	1,000	30	10	10	0	0	1,000	70	42	53	14	1.3	4	2000
Mungbean	16*	25	150	0	45	25	15	0	0	0	45	67	20	0	0	3	1500
Groundnut	90*	100	150	0	40	20	10	1	0	0	25	160	85	160	0	3	1500
S.potato	65,000 C	56,000 C	160	1,000	40	40	20	0	0	8,000	140	120	160	0	0	1	400
Red Amaranth	2	2	100	500	30	0	0	0	0	5,000	59	13	17	4	0	1	200
Stem Amaranth	2	2	100	500	30	0	0	0	0	5,000	150	44	25	0	0	1	200
Indian spinach	0.6	0.5	100	400	60	20	10	0	0	5,000	163	29	25	0	0	1	200
Bottle gourd	4.5	5	50	0	50	20	10	0	0	5,000	141	80	33	0	1	1	200
Ash gourd	4.5	5	60	0	50	20	10	0	0	5,000	141	55	25	0	0	0	0

*Source: CEGIS field survey, 2014 and secondary data from UAO. * Fertilizer varied land to land.* Seed may vary.*

Note: Farmers grow some vegetable crops in the homestead area which is mentioned in the above Table

5.1.18 Integrated Crop Management (ICM)

197 Recently, Integrated Crop management (ICM) is practiced in some of the polder. DAE has taken active part on ICM. In this system, insects are controlled biologically. Farmers of the ICM areas use branches of trees, bamboo and jute sticks etc to make favorable perches for birds in fields with standing crops. The birds eat the insects which help control infestation. In this process, the crops are protected without applying pesticides. Trap is another technique for controlling pests under ICM. This system is used in the agriculture fields especially on watermelon and vegetables for attracting insects. At the base of the trap, there is a sheet generally made of steel that slopes downward. Thus, it is possible to control the harmful insects without the application of pesticides. In the polder areas the ICM technique is mainly applied on mungbean crops. Field information (Farmers, SAAO of DAE) indicates that ICM is being practiced in the fields covering about 15-20% of the cultivated areas in the polder area and the impact has been found very encouraging. On-farm research division of BARI is doing some ICM work in the polder area.

5.1.19 Irrigated area by crops

198 According to the local farmers, total irrigation coverage of the polder area is about 7% (450 ha) of the total NCA during the dry season in three crops. The source of irrigation water is surface water. Irrigation is lifted with the help of low lift pumps (LLPs). According to UAO and SAAO there are 32 LLPs in the polder area of them 12 LLPs are functioning. According to local farmers, once light irrigation was given after sowing groundnut and planting of sweet potato and three times in HYV boro. The cost of

irrigation is about taka 4,000 - 5,000/ha. Lt. Aus and Lt. Aman are generally practiced under rain fed condition. 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)
HYV Boro	258	4	4,500
Groundnut	64	1	2,500
Sweet potato	128	2	2,500

Source: CEGIS estimation on field information based on farmers interviewed; 2014

5.1.20 Crop yield level (Normal and damaged)

199 Drainage congestion and partial soil salinity is the major constraint to crop production inside the polder area. Normally, crops are being damaged due to drainage congestion, for siltation of drainage channels, partial salinity, and natural calamities etc. In addition, early rain causes damage of some pulses crops, Aman seedbed and Aman crops at early growing stages. This causes reduction of average yields. Crop yield data of local DAE, farmers yield and damaged yield of crops are presented in Table 5.12 Local DAE demonstration yield proves that it is possible to increase crop production in the polder area.

Table 5.12: Crop Yield level by different crops

Crop name	Yield (ton/ha)			
	Local demonstration by DAE	Farmers (about)	Damaged (about)	Damage free (about)
Lt. Aus	2.2*	1.70*	0.30*	1.40*
Lt. Aman	2.5*	2.20*	0.60*	1.60*
HYV Boro	3.4*	3.00*	-	3.00*
Sesame	1.0	1	0.2	0.8
Khesari	0.8	0.7	0	0.7
Chilli	1.0	0.8	0.6	0.2
Mungbean	1.2	1	0.1	0.9
Sweet Potato	17-20	15	-	15
Groundnut	1.5	1.2	0.5	0.7

*Sources: Based on field information 2014; *Indicates cleaned rice*

5.1.21 Crop Production

200 Total crop production is about 27,877 tons of which rice is about 15,312 tons (55%) and non-rice is about 12,565 tons (45%). Detailed crop production and crop production loss are presented in Table 5.13.

Table 5.13: Existing crop production and crop production loss of the polder area

Crop Name	Crop Area (ha)	Damage Free		Damaged		Total Production (ton)	Production loss(ton)	Production (%)	Production loss (%)
		Area (ha)	Yield (ton/ha)	Area (ha)	Yield (ton/ha)				
Lt. Aus	837	712	1.9	126	0.4	1,402	188	12	20
Lt.Aman	6,440	5,796	2.2	644	0.6	13,137	1030	84	80
HYV Boro	258	258	3	-	-	773	-	4	-
Total rice	7,534	6,765		770		15,312	1,219	100	100

Crop Name	Crop Area (ha)	Damage Free		Damaged		Total Production (ton)	Production loss(ton)	Production (%)	Production loss (%)
		Area (ha)	Yield (ton/ha)	Area (ha)	Yield (ton/ha)				
Sesame	1,417	1,204	1	213	0.2	1,247	170	9	100
Khesari	644	644	2	-	-	1,288	-	9	-
Chilli	515	515	1.5	-	-	773	-	6	-
Mungbean	580	580	1.3			753	-	16	-
Sweet potato	451	451	18	-	-	8118	-	58	-
Groundnut	193	193	2			386	-	3	-
Total non-rice	3,800	3,587	-	213	-	12,565	170	100	100
Total	11,334	10,352	-	983	-	27,877	1,389	-	-

Source: CEGIS field estimation, 2014, UAO, DAE

5.1.22 Water Resources System

201 The water resource system is the source of water supply, and plays a crucial role in assimilating and diluting waste, attenuating and regulating flood, drainage, recharge aquifer, and maintaining the environment for aquatic habitats. The following sections discuss the water resources system within Polder 43/2D.

5.1.23 River System

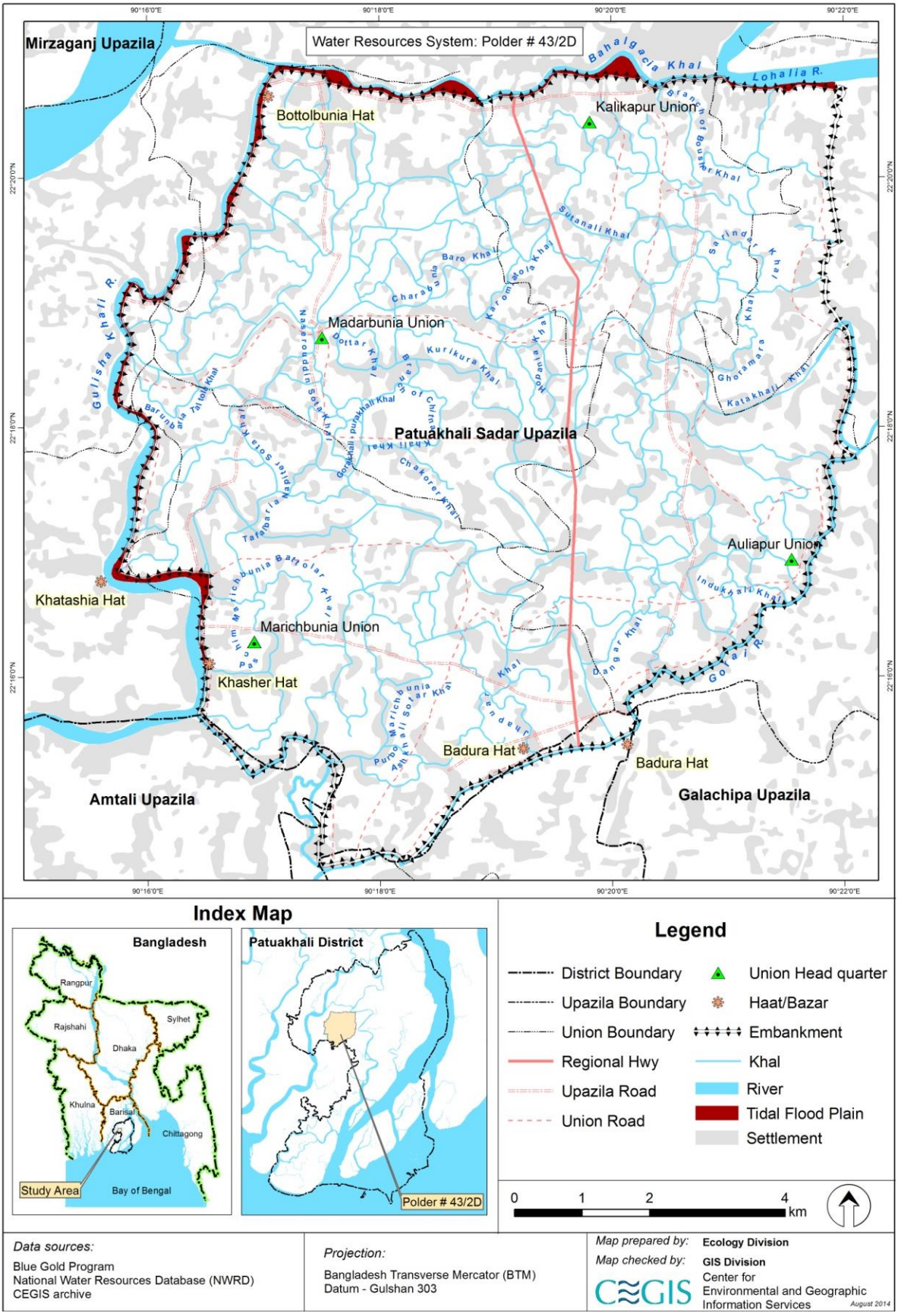
202 Polder 43/2D is 56 km away from the Bay of Bengal and under goes diurnal tidal influence. The polder is surrounded by a number of tidal rivers namely, Gulishakhali River on the West, Gorai River on the South and South-Eest, and Lohalia River along the East and North-East directions. There is a narrow tidal water course named as Bahalgacia khal that connects Lohalia River with Gulishakhali River and is situated along the immediate North of the polder. The river Gorai meets the Gulishakhali River along the South-West corner of the polder, which eventually meets the Payra River at 9 km downstream. Both Lohalia and Payra rivers separately fall into the Bay of Bengal. Apart from these peripheral rivers, there are approximately around 243 km water courses within the polder, in the form several drainage and irrigation canals (Charabunia khal, Naseuddin khal, Dontar khal, Hopania khal, Jhapuar khal, Idukhalir khal, Shingkhalir khal etc.). The river system of the area is shown in Map 5.8.

Photo 5.5: Gulishakhali River (near the Raja Baria Khal Sluice)

Photo 5.6: Lohalia River (near Lohalia Bridge)

5.1.24 Hydrological Connectivity

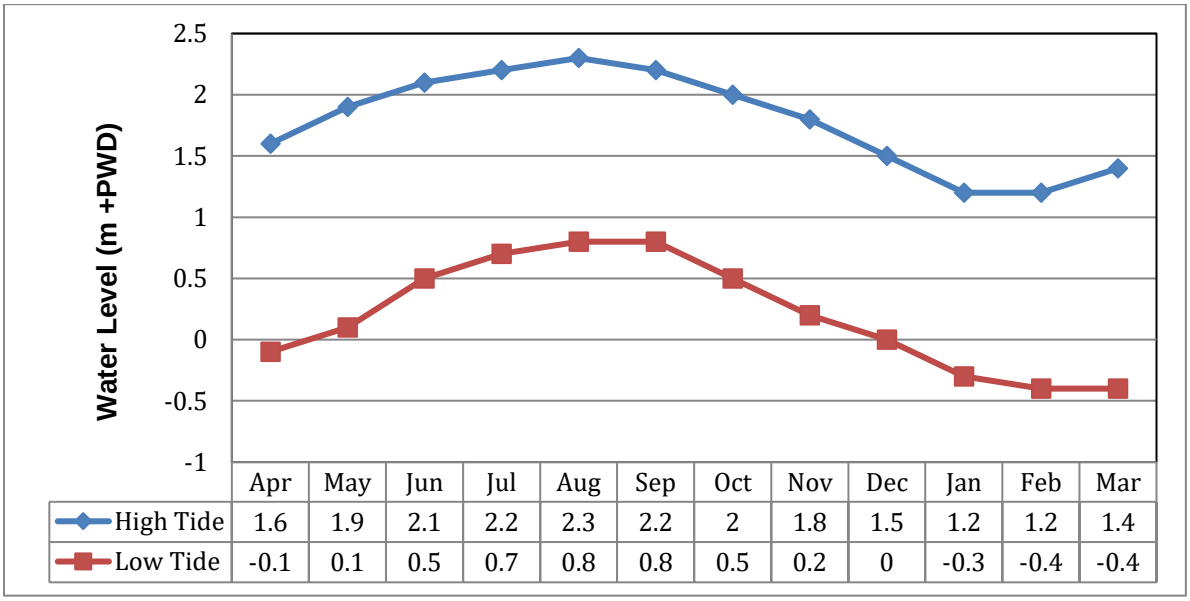
203 As already discussed, tidal influence governs within the polder, with the occurrence of diurnal tidal shifts (a high tide followed by a low tide, and then another high tide) at about 6 hour intervals in each day. As the sluice gates are closed during dry season, most portion of the tidal water cannot enter into the polder during high tide. However during monsoon and post-monsoon, the gates are kept open and free circulation of tidal water within the polder takes place. During high tide, water from the peripheral rivers push towards the Polder area and the opposite takes place during low tide. A number of khals exist within the polder i.e. Charabunia khal, Naseuddin khal, Dontar khal, Hopania khal, Jhapuar khal, Idukhalir khal, Shingkhalir khal etc. which circulate the flow of water within the polder. These khals also drain the internal water out of the polder through the peripheral sluice gates. The flow direction within the polder is shown in Map 5.8 below.



Map 5.8: Water Resources System of the area

5.1.25 Surface Water Level

204 The surface water levels have been analyzed (Figure 5.6) from 1990 to 2009. Water levels during high tide range from 1.14 m +PWD to 2.22 m +PWD (above MSL), whereas the low tidal water levels range from 0.1 to 0.3 m below the MSL.



	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
High Tide	1.6	1.9	2.1	2.2	2.3	2.2	2	1.8	1.5	1.2	1.2	1.4
Low Tide	-0.1	0.1	0.5	0.7	0.8	0.8	0.5	0.2	0	-0.3	-0.4	-0.4

Figure 5.6: Surface water level at Mirjaganj (Payra River)

5.1.26 Ground Water

205 The variation pattern shows that the Ground Water Table (GWT) is the highest during September and the lowest in March.

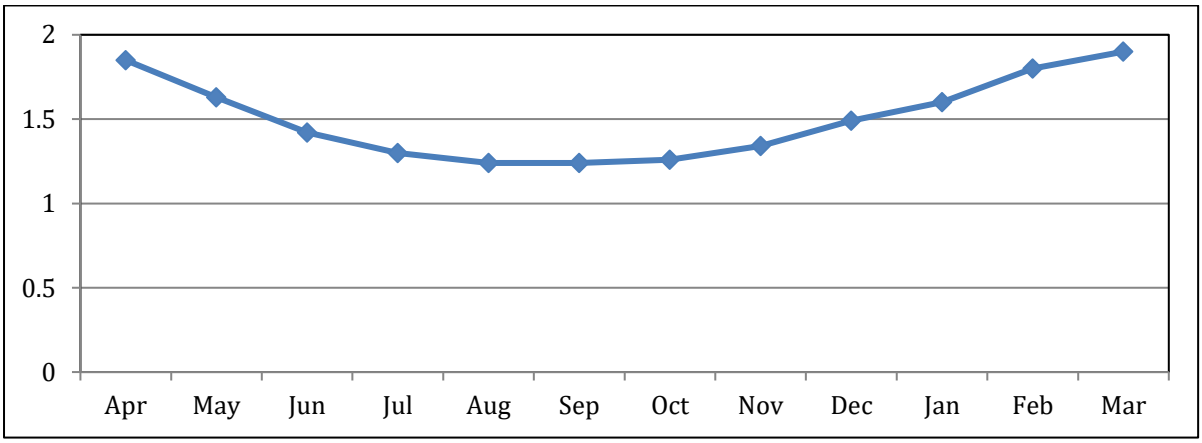


Figure 5.7: Average monthly variations of GWT

206 Analyses have also been carried out to understand the annual variations of GWT at PAT002 station for March and September (from 1980 to 2012). The values show a decreasing trend in both cases (Figure 5.7 and 5.9).

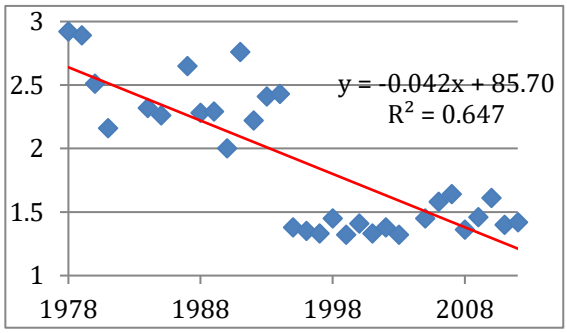


Figure 5.8: Variation of GWT at PAT002 in March (1980-2012)

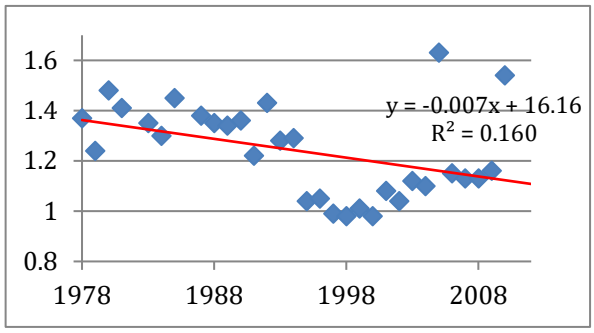


Figure 5.9: Variation of GWT at PAT002 in September (1980-2012)

Source: NWRD, 2013

5.1.27 Water Resources Problems

207 The function and problems of the water resources in the polder are discussed in the following sub-section.

Tidal and Storm Surge Flooding

208 Local people in Polder 43/2D opined that the peripheral embankment at most locations effectively offer protection from regular tidal flooding. However there are some low lying areas along the central portion of the polder which are flooded at regular intervals. Analysis made using a 2-D hydrodynamic model (Sobek) for the polder, coupled with information obtained from stakeholder consultations during the major field investigations have inferred that around 230 ha lands near Hajikhali, Hajikhali Abad, Gerakhali and Tafalbaria are subjected to regular tidal flooding. Particularly in monsoon, water inundate a significant portion of agricultural lands in these locations up to a height of 2 ~ 2.5 feet. The risk of storm surge induced flooding in the polder is relatively low, with the polder being located in an area (besides city centre and far from the Payra river) which is geographically less harmful to direct storm surge consequences.

Drainage Congestion and Water Logging

209 From field investigation it was found that the polder suffers from drainage congestion issues at several low lying places. GIS based spatial analysis and field investigations have inferred approximately 113 km water courses within the polder suffer from drainage congestion issues. Around 20 km khals at Choto Auliapur, Arazi Gerakhali Kismat and Pacha Koralia mauzas suffer from high drainage congestion problems, whereas 56 km khals along Gerakhali, Hetalia, Chharabunia, Botolbunia mauzas suffer from medium drainage congestion problems. A significant portion (approximately 37 km) of the khals at Marichbunia, Boro Bighai etc. mauzas face low drainage congestion problems. During field investigation in May 2014, multiple reasons were identified for the existing drainage congestion issues by the study team. At some cases the lower drainage capacity of silted up khals has been causing drainage congestion whereas in some khals it is the lower depth and flow of the peripheral rivers which is causes drainage congestion following any major rainfall events. For example, the low depth and flow of Gorai River are the reason behind the poor drainage system in the Sothern and Eastern portions of the polder (where high and low drainage congestion exists respectively). But in the Northern parts of the polder, some of the internal khals of the polder have been heavily silted up (due to top soil erosion and other anthropogenic activities) for which water

cannot be drained out in time following heavy rainfall occurrences, resulting in medium drainage congestion problems.

210 Moreover, the field investigations revealed that despite of the aforementioned multi-level drainage congestion phenomenon in Polder 43/2D, no water logging problems exists inside the polder. Local people opined that even though it takes some time for rainwater to be drained out of the polder, but usually no such portion of rainwater remains entrapped in post-monsoon or dry seasons, which means there are no water logging issues in the polder.

5.1.28 Warer Resources Fuctions

Domestic Use

211 The average daily demands of water for domestic and drinking purposes in rural areas are considered as 50 lpc (Ahmed and Rahman, 2010). In Polder 43/2D, the field investigations found that average daily use of water is around 30 lpc. Therefore for the total number of 36,250 people living in the polder (BBS, 2011), around 2,870 m^3 water is consumed per day. The domestic demands are mostly met using surface water sources whereas ground water sources are used to meet up the drinking water requirements.

Irrigation Use

212 The local farmers in Polder 43/2D practice Lt. Aus in Kharif-I (March-June) season, Lt. Aman in Kharif-II season (July-October) and HYV Boro in Rabi (November-February) season as cereal crops. From previous CEGIS studies it has been found that around 300 mm water is required for each ha of Lt. Aus and Lt. Aman cultivation whereas for HYV boro, the amount of water required is relatively high (approximately 1500 mm water per ha area for clay soil). Local farmers opined that they use rainwater for irrigation in Kharif-I and Kharif-II seasons and surface water irrigation during the Rabi season. For irrigation in HYV boro, approximately 3.87 Mm^3 water is used each year (Table 5.14). This amount of is taken from the existing surface water system of Polder 43/2D, using several irrigation canals as well as LLPs.

Table 5.14: Irrigation water requirements in Polder 43/2D

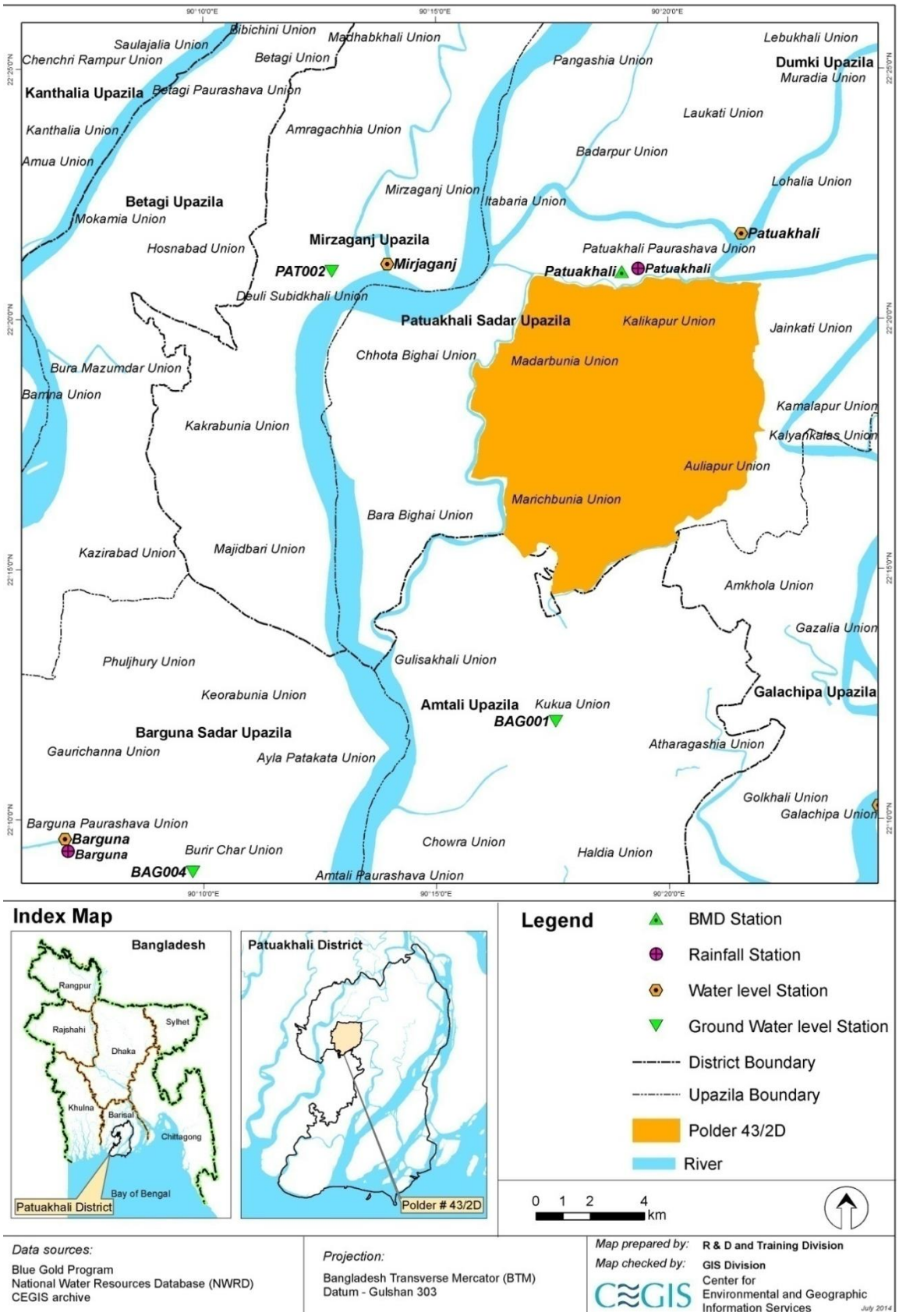
Season	Lt. Aus (ha)	Lt. Aman (ha)	HYV Boro (ha)	Water requirement (mm/ ha)	Water Used (Mm^3)	Source of Irrigation
Kharif-I	838	-	-	300	2.51	Rain Water
Kharif-II	-	6,440	-	300	19.32	Rain Water
Rabi	-	-	258	1,500	3.87	Surface Water

Source: CEGIS Estimation

Navigation

213 The Lohalia River along the Eastern periphery of Polder 43/2D is predominantly used for waterway navigation. The other peripheral rivers (Gulishakhali and Gorai) also offer navigation for small boats as well as large streamers and trawlers. Some small boats also navigate through the Bahalgacia khal on the North. However, very little navigation takes place inside the polder area. Only small fishing boats were found to navigate through the khals inside the polder during monsoon.

214 Map 5.9 below is a reference map, showing the locations the stations used for collected secondary data on water resources (both surface and ground water); and the thiessens polygons used for spatial distribution of rainfall.

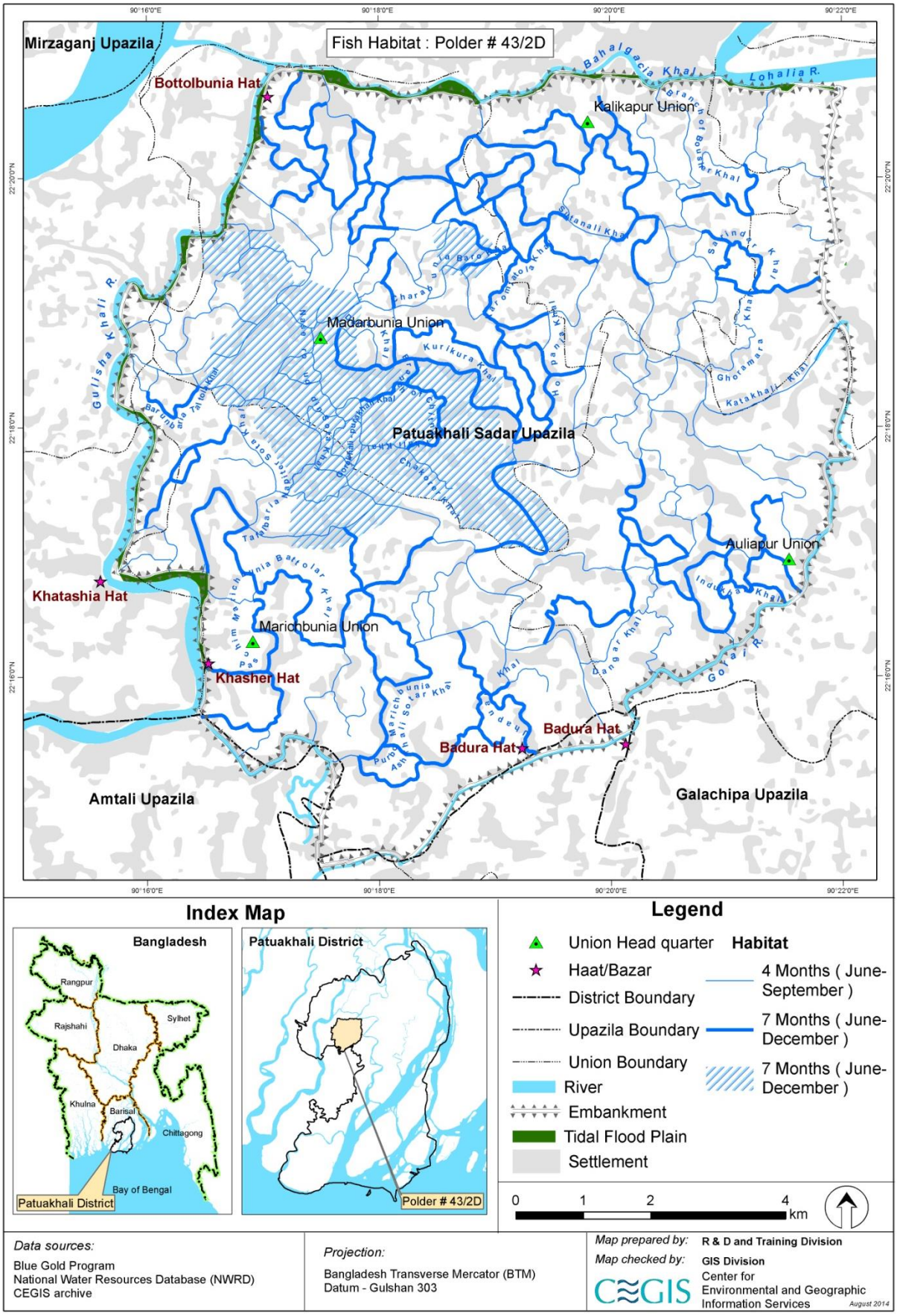


Map 5.9: Map showing the locations of BMD stationsPolder 43/2D

5.2 Biological Environment

5.2.1 Fish Habitat

215 Fish habitats of the polder area are primarily classified under two broad categories, such as capture and culture fishery. Capture fisheries habitats include Peripheral River, tidal floodplain, intertidal floodplain and internal khals (Map 5.10). The open water fish habitats of the area are khals and floodplain which are acting as major arteries of fish migration into the polder area. These are playing vital role in maintaining fisheries productivity of the open water fish habitats inside the polder area. The culture fishery of the polder area is dominated by culturable fish pond. The periphery river Gulishakhali is located on the west part of the polder. Moreover, a small part of Lohalia River has touched on the north - east corner of the polder. These rivers are tidal in nature and having potentials habitats for saline and brackish water fish species. Numbers of seasonal and perennial khal exist within the polder area. These khals act as open water fisheries connectivity between polder and adjacent rivers. Therefore, fisheries resources of the area are diversified with different fresh and brackish water fish habitats.



Map 5.10: Fish habitat in the study area

Capture Fisheries

216 The estimated fish habitat area is 520 ha where culture fishery contributes the major share (340 ha) and the capture fish habitat shares the rest. The open water fish habitat is represented by khal alone as shown in the following Table 5.15. In the study, the peripheral rivers has not been considered for fish production estimation of the polder area.

Table 5.15: Fish habitat status in the polder area

Sl.	Category	Habitat Types	Area (Ha)
1	Capture	Khal	110
		Floodplain	230
		Sub-total	*340*
2	Culture	Cultural pond	*150*
		Cultured pond	30
		Sub-total	*180*
		Total	520

Source: CEGIS estimation based on field data and FRSS, 2011-12

217 Among the khals Katakhali Khal, Idukhali Khal, Charabunia Boro khal, Hopania khal, are playing important role. The depths of these internal khals range from 0.28 to 1.85 m (Table 5.16) which is found suitable for the habitation of medium sized fish species particularly during dry season in the low tide situation. Some of the khals are encroached by the local people and practicing culture fishery by developing barriers through net. Photo 5.11shows the internal khals in the polder area.

Perennial khal

Silted up khal (Kuri kurar khal)

Photo 5.7: Open water fish habitat (khal) in the polder area

Table 5.16: Detailed information of important khals in the Polder area

Sl.	Khal Name	Average Width (m)	Average Depth (m)	Nature of Water bodies
1	Jhapuar Khal	5.74	0.73	Seasonal
2	Katakhali Khal	9.32	1.85	Seasonal
3	Dangar Khal	6.13	0.74	Seasonal
4	Idukhali Khal	6.93	1.52	Seasonal
5	Hopania Khal	4.69	0.75	Seasonal
6	Dontar Khal	4.84	0.92	Seasonal
7	Naseroddir Sota Khal	6.31	0.28	Seasonal
8	Chakorer Khal	4.55	0.85	Seasonal

Sl.	Khal Name	Average Width (m)	Average Depth (m)	Nature of Water bodies
9	Branch of Chitnakhali Khal	6.91	0.96	Seasonal
10	Gerakhali Khal	5.78	0.69	Seasonal
11	Sutanali Khal	4.10	1.12	Seasonal
12	Marich bunia Askhali Suta Khal	5.06	0.66	Seasonal
13	Paschim Marich bunia Bottolar Khal	6.33	0.85	Seasonal
14	Barunbunia Taltolar Khal	5.58	1.31	Seasonal
15	Tafalbaria Napiter Sota Khal	6.55	1.20	Seasonal
16	Koromjatola Khal	6.42	1.25	Seasonal
17	Branch of Bousher Khal	6.07	1.36	Seasonal
18	Charabunia Baro Khal	4.96	0.90	Seasonal
19	Kuri kurar Khal	5.19	0.79	Seasonal
20	Ghoramarar Khal	3.89	1.05	Seasonal
21	Sarindar - Monair Khal	5.20	0.44	Seasonal

Sources: GIS data, CEGIS, 2014

218 Siltation is found one of the major problems of the khals to make the habitat unsuitable for fishes. This phenomenon is more pronounced at the mouth of sluice gate and impedes the fish migration. For this reason, this habitat cannot function as spawning ground of the resident fish species and thus capture fishery is declining day by day.

Culture Fisheries

219 Aquaculture practice is expanding gradually in the polder area. But main constraint of aqua culture development are mal functioning of water control structures, overtopping of fish ponds due to extreme tidal effect and resultant intrusion of saline water. Nevertheless, various types of fish culture systems are practiced by the local people including mono-, poly-, and mix-culture. It is reported that almost every household have pond which is used as fresh water reservoir cum fish culture. Culture fish pond in the polder area is shown in the following photo 5.8.

Photo 5.8: Culture fish pond in the polder area

5.2.2 Fish Habitat Quality

220 Aquatic environmental quality is satisfactory in the study area though some pollutants are released from crop fields and are s causing damage of fish. However, some surface water quality parameters that are related to fish habitat suitability was measured Table 5.2 in Baseline Chapter of water resource).From the data it is observed that pH values

little higher but within the limit of usable for fisheries. Dissolved oxygen concentrations of 5 mg O_2/L or more are acceptable for most aquatic organisms (Stickney, 2000). The measured DO values are found within the permissible limit for fish and aquatic biota habitation. The salinity value of both river and khal is nil (in monsoon) It is suitable for fresh and brackish water biota. Turbidity is the term for the amount of dissolved, suspended dirt and other particles in the water, which give the water a brown color. High turbidity of water can decrease fish productivity, as it reduces light penetration into the water and thus oxygen production by the water plants. Dissolved, suspended solids also cause clog filters and injure fish gills (Eira et al, 2008). However, Total dissolved suspended (TDS) or turbidity in all water bodies is recorded as higher (>2000 ppm) than the permissible limit for fish. Standard values of different parameter of water quality for fisheries are given in following table 5.17.

Table 5.17: Standard values of different parameter of water quality

Sl.	Parameters					
	P^H	EC (mmhos / cm)	TDS (ppm)	Temp (ºC)	DO (mg/l)	Salinity (ppt)
	(6.5-8.5)*	(800-1000)*	1000*	(28-34)**	4.0-6.0*	(0-4) for prawn and (5 - 35) for shrimp**

*Source - *M AMazid 2002 ** Jack M. et al, 2002*

Aquatic vegetation

221 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. 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. Moreover, Shapla (*Nymphaea nouchali / N. stellata*) , Chandmala (*Nymphoides* sp.) are top frequent rooted floating plants available in all the floodplains. 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 included Dhol kolmi (*Ipomoea aquatic*), Kochu (*Colocasia* spp.) and Helencha (*Enhyra flactuans*) etc. These types of submerged and floating with leafs are usedas habitat and spawning ground of fisheries as well as other insects and crustaceans in the polder area.

5.2.3 Fish Production

222 The estimated total fish production of the polder area is about 307 tons. Bulk of the fish production, about 75% is coming from culture fisheries and the rest is contributed by the capture fishery. Fish production trend of the capture fishery is downward in the polder area. The downturn of the production is caused due to obstruction to fish migration, unsuitability of the khals for fish habitation, siltation in internal khal and the mouth of regulators, less availability of nutrients, indiscriminate catch of fishes. Fish production in the polder area is shown in Table 5.18.

Table 5.18: Fish production from different habitats of the study area

Sl.	Category	Habitat Types	Fish Production (Ton)
1	Capture	Khal	19
		Floodplain	58
		Sub-total	**76**
2	Culture	Culturable pond	210
		Cultured pond	21
		Sub-total	**231**
		Total	**307**

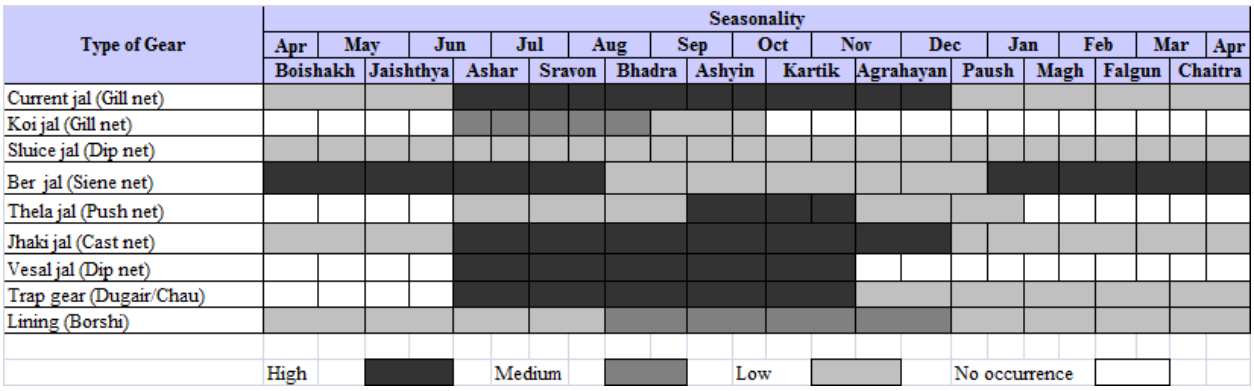
Source: CEGIS estimation based on field data and FRSS, 2011-12

5.2.4 Fishing Effort

Fishing Season

223 Fishing in the khals and the peripheral rivers goes almost round the year but more catch of fishes starts in April / May and continues up to December. The seasonality of major fishery is furnished in the Table 5.19.

Table 5.19: Fishing seasonality in the polder area



Source: Field Survey, 2014

Fishing Crafts and Location

224 The commercial fishermen of the polder area catch fish in the peripheral rivers and internal khals by using mechanized boat, Jala Nouka and Dingi fishing boats. Fishing boat in the polder area is shown in the following photo 5.9.

Photo 5.9: Fishing boat in the polder area

Fishing Gears

225 Different types of nets/gears are used for fishing: (a) Mono filament net, locally known as Current jal and Koi jal, which is used to catch poa, chingri, tengra, gulsha, and koi fish; (b) Seine net which is used to catch all types of small and big fishes; (c) Cast net, locally known as Jhaki jal, which is used to catch puti, bagda, golda, phasa etc. (d) Push net, locally known as thela jal, which is used to catch puti, tengra, chingri, etc; (e) Sluice/Dip net locally known Sluice jal is found at the mouth of sluice gate to catch all types of fishes. Around 5% of fishermen have fishing boats and around 80% fishermen have fishing gears/nets. Traditional fishing gears of the polder area cast net (Jhaki jal) is shown in the following photo 5.10.

Photo 5.10: Fishing gear in the polder area

5.2.5 Fish Migration

226 The riverine and polder resident fish species migrate through regulated khals to some extent during the period of late June to August. Perennial Khals along with other seasonal internal khals are used as feeding and nursing ground of most of the open water fishes. Fish species such as Chingri, Puti, Boal, Pairsa, Tengra, Gulsha, Khorsula, Baila migrate through mal-functioned regulators to these water bodies as part of their life cycle. Fish hatchling moves from river to khal through regulators during wet season. Peripheral rivers along with internal khals of the polder area have been silted up naturally cause the reduction of the length of successive migratory routes. Siltation and water control structures hamper the migration of fish and other aquatic biota. Fish migration status is found poor to moderate in the study area due to following reasons like improper management and mal-functioning of the water regulatory structures, fishing by net, inactive of the Water Management Organizations (WMOs).

5.2.6 Fish Biodiversity

227 The study area is moderate in fish biodiversity though the biodiversity of fishes has the declining trend over the years. Local people reported that about 100 of fish species are available in the area. The study area comprises an assemblage of both fresh and brackish water fish species (photo 5.11). Checklist of the fishes of different habitats reported by local fishermen is analyzed to draw an indicative scenario of the local fish biodiversity of the study area. Among the fish species *Puti, Chingri, Bele, Chanda, Mola, Shol, Taki, Puti, Koi, Shing* etc are dominant fresh water fish species. And the dominant cultured fish species include Tilapia, Rui, Catla, Pungus, Bighead, Silver carp, Magur, Puti etc.

Photo 5.11: Composition of fish catch in the polder area

List of fishes of different habitat in the study area are presented in Table 5.20.

Table 5.20: Indicative fish species diversity of different fish habitats in the study area

Scientific Name	Local Name	Habitat type		
		Peripheral River	Khal and Seasonal beel	Pond
Brackish water fish species				
Metapenaeus monocerus	Horina Chingri	H	L	NA
Penaeus monodon	Bagda chingri	M	L	L
Harpodon nehereus	Lottiya	L	NA	N/A

Scientific Name	Local Name	Habitat type		
		Peripheral River	Khal and Seasonal beel	Pond
Lates calcarifer	Koral/Bhetki	M	L	N/A
Setipinna paasa	Phasa	M	L	N/A
Trypauchen vagina	Sada Cheowa	H	L	NA
Apocryptes bato	Chiring	M	M	NA
Tenualosa ilisha	Ilish	H	NA	NA
Mystus gulio	Guila Tengra	H	L	L
Sillaginopsis panijus	Tular Dandi	M	NA	NA
Liza parsia	Pairsa	M	NA	NA
Pangasius pangasius	Pungus	L	NA	NA
Pama pama	Poa	L	NA	NA
Polynemus paradiseus	Topsa	L	NA	NA
Macrobrachium rosenbergii	Golda chingri	L	L	L
Scylla serrata	Kankra	L	M	L
Fresh water fish species				
Puntius chola	Chola puti	L	M	M
Channa punctatus	Taki	NA	H	L
Glossogobius giuris	Baila	H	M	L
Channa striatus	Shol	NA	M	L
Mystus vittatus	Tengra	M	H	L
Mastacembelus pancalus	Chirka baim	M	M	NA
Macrognathus aral	Tara baim	NA	M	L
Chanda spp	Chanda	NA	M	NA
Wallagu attu	Boal	L	L	NA
Clarius batrachus	Magur	NA	L	NA
Aorichthys seenghala	Guijja Ayre	L	NA	NA
Puntius sophore	Jat puti	L	M	L
Eutropiichthys vacha	Bacha	M	NA	NA
Lepidocephalus guntea	Gutum	NA	M	L
Channa marulius	Gojar	NA	N	NA
Culture fish species				
Labeo rohita	Rui	L	M	M
Catla catla	Catla	L	M	M
Oreochromis nilotica	Telapia	NA	L	H
Puntius sarana	Sharputi	NA	M	H
Pangasius suchi	Pungus	L	NA	H
Hypophthalmichthys molitrix	Silver Carp	NA	L	M
Hypophthalmichthys nobilis	Brig head	NA	L	M

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

5.2.7 Species of Conservation Significance

228 Fish species variety those are locally unavailable for last (10-15) years or become rare reported by the local fishermen and concerned elderly people are given in the following Table 5.21.

Table 5.21: List of species of conservation significance

Scientific Name	Local Name	Local Status	
		Rare	Unavailable
Colisa faciatus	Kholisha	√	
Lates calcarifer	Koral	√	

Scientific Name	Local Name	Local Status	
		Rare	Unavailable
Nandus nandus	Veda / Roina	√	
Ompok pabda	Pabda	√	
Labeo bata	Bata	√	
Notopterus notopterus	Foli	√	
Clarius batrachus	Magur		√
Macrobrachium rudis	Shola chingri		√
Wallago attu	Boal		√

Source: Field Survey, 2014

5.2.8 Area of Conservation Significance

229 The Katakhali Khal, Idukhali Khal, Charabunia Boro khal, Hopania khals are used as feeding and spawning ground of most of the open water fishes. Moreover, Marichbunia Uttar Beel (seasonal beel) is used as feeding ground of Small Indigenous Species (SIS) fish and medium size fish species.

5.2.9 Fisheries Management

230 There is no active Community Based Fishers Management (CBFM) in the polder area. Department of Fisheries (DoF) has taken a project namely IAPP (Integrated Agricultural Productivity Project) funded by World Bank for ensuring food security in the polder area. The main objective of this project is to ensure food security through motivation of culture fisheries adopting advanced culture system both in mono-sex Tilapia and mix culture of carp species. There is no community based fisherman association. Fisherman association for working along with WMA/WMO of the polder, the activities of this association is not functioning. The fishermen have full fishing right on existing fish habitats. Department of Fisheries (DoF) has limited activity for fisheries resource conservation and management in this area. Every year, they arrange an upazila and union level training program for the fish farmers on modern fisheries. Some NGOs Grameen Bank, ASA, BRAC, RDF (Rural Development Forum) etc. are working, but they are very much limited in micro credit rather than extension services and aquaculture training. Enforcement of fisheries regulation is weak inside the polder area.

5.2.10 Bio-ecological zones

231 IUCN-The World Conservation Union has identified 25 bio-ecological zones (2002) in Bangladesh based on physiographic, climate, soil type, flooding depth and biodiversities characteristics. These bio-ecological zones can be classified as major ecosystems of the country. The polder area is situated in nine unions at Patuakhali sadar and Amtali upazilas of Patuakhali and Borguna districts. The polder area encompasses one of these bio-ecological zones, namely the Ganges Floodplain. A brief ecological description of the bio-ecological zone is presented below.

(a) Ganges Floodplain

232 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, and eroding depositing large areas of charlands in each flooding season. Both plants and animals move and adapt with the pattern of flooding (Brahmer, 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. Beels and other water bodies support good amount of free floating aquatic vegetation. Homesteads forest prominent with both 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. Moreover, Grasses are more abundant in 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.

233 Major groups of oriental birds are presented in this zone by one or more species. In addition, a large number of migratory birds are found here during the winter. Beside this, different species of freshwater tortoise and turtles are found in the rivers and ponds. Among the amphibian species, the area found toads, frogs and tree frogs are well known. Foxes, Jackals, rats, mice, squirrels, bats etc are common mammals of this zone.

(b) Floodplain Area

234 A floodplain is an area near a river or a stream which floods when the water level reaches flood stage.

235 Floodplains can support particularly rich ecosystems, both in quantity and diversity. A floodplain may contain 100 or even 1,000 times as many species as a river. Wetting of the floodplain soil releases an immediate surge of nutrients: those left over from the last flood, and those that result from the rapid decomposition of organic matter that has accumulated since then. Microscopic organisms thrive and larger species enter a rapid breeding cycle. Opportunistic feeders (particularly birds) move in to take advantage. The production of nutrients peaks and falls away quickly; however the surge of new growth endures for some time. This makes floodplains particularly valuable for agriculture.

5.2.11 Terrestrial Ecosystem

a) Terrestrial Flora

Settlement/Homestead vegetation

236 Homestead vegetation is the important plant community in polder area. Homestead vegetation generally includes two types of plants: those which are cultivated for their economic value and those which are self propagating. In the polder area, ecosystem services of homestead vegetation are good. Most of the homestead consists of fruit yielding plant, medicinal plants, vegetables and timber trees. According to the vegetation survey, homestead vegetation of this polder is exclusively dominated by Narikel (*Cocos nucifera*), Supari (*Areca catechu*), Tal (*Boassus flabelifer*) and Babla (*Acacia nilotica*) trees. The same species occupied top canopy of the vegetation layers. Among the other species, Aam (*Mangifera indica*), Kola (*Musa* sp), Mahogoni (*Swietenia mahagoni*), Khejur (*Phoneix sylvestirs*), Sil Koroi (*Albizia procera*) etc. are also common. Eucalyptus (*Eucalyptus* sp) and Akashmoni (*Acacia auriculiformes*) are the common exotic species. Shrubs and herbs occupy lower canopies. Bamboo bushes are commonly found in each homestead and contribute a big source of earning also. The homestead vegetation is important place for wildlife dwelling.

237 Many species of wild plants are found in homestead vegetation and village groves. Among this type, Swetkan (*Euphorbia thymifolia*), Bhui amla (*Phylanthus niruri*), Nata (*Caesalpinia bonduc*), Dudhikalmi (*Ipomoea alba*) are common. Sezi (*Euphorbia*

antiquorum) and Jiga (*Lennea coromandelica*) are indicative fencing plants used for homestead boundaries of this polder area. Major homestead plants including their status and importance are presented in Table 5.22.

Table 5.22: Major tree species within the homestead in the polder area

Tree species name	Family name	Abundance
Kola *(Musa* sp*)*	Musaceae	H
Narikel *(Cocos nucifera)*	Palmae	H
Suparee*(Areca catechu)*	Palmae	H
Aam *(Mangifera indica)*	Anacardiaceae	M
Kathal *(Artocarpus heterophyllus)*	Moraceae	M
Peyara *(Psitium guajava)*	Myrtaceae	H
Jambura(*Ciitrus grandis)*	Rutaceae	H
Khajur*(Phonix sylvestris)*	Palmae	H
Amra *(Spondias dulcis)*	Anacardiaceae	H
Tal *(Boassus flabelifer)*	Palmae	H
Bash *(Bamboosa sp)*	Gramineae	H
Sil Koroi *(Albizia procera)*	Leguminosae	H
Nim *(Azadirachta indica)*	Meliaceae	M
Jamrul *(Syzygium samarangense)*	Myrtaceae	M
Siso *(Dalbergia sissoo)*	Fabaceae	M
Kadom (*Anthochephalous kadamba*)	Rubiaceae	L
Chalta*(Dillenia indica)*	Dilleniaceae	M
Amra*(Spondias dulcis)*	Anacardiaceae	M
Akasmoni *(Acacia moniliformis)*	Mimosaceae	H
Eucalyptus *(Eucalyptus citriodora)*	Elaeocarpaceae	M
Rendi Koroi *(Albizia saman)*	Leguminosae	H
Raintree *(Albiza saman)*	Leguminosae	H
Mahogoni *(Swietenia mahogoni)*	Meliaceae	H
Bot(*Ficus benghalensis)*	Moraceae	M
Assawath (*Ficus religiosa)*	Moraceae	M

(Note: Rank, H= High, M= Medium, L= Low) *(Source: CEGIS field survey, 2014)*

Photo 5.12: Coconut trees on a homestead platform

Photo 5.13: Homestead with banana plants

Crop field vegetation

238 The net cultivated area in the polder area is more than 6,400 ha. Land is used mainly for Lt Aman in rain feed condition in kharif –II season, in kharif-I season there are few Lt Aus, HYV Boro and in rabi season farmers grow sesame, mungbean, , Chilli, Khasari,

Groundnut, Sweet potato and vegetables. Verities of crops and cropping patterns have been discussed in the agricultural section of this report.

239 A part of crop fields being seasonal (March-June) remains fallow for 3-4 months of a year. The seasonal fallow lands have also important roles in ecosystem functioning as support for grazing of cattle, feeding and breeding habitats of many arthropods, reptiles and avifauna.

Seasonal fallow land	Area
kharif-I	5602 ha
rabi season	2382 ha

240 In cropland, some floras which are found along with crops and which are not cultivated, called agricultural weeds. The weeds have important roles in terms of ecosystem those contribute to the ecosystem functionality. The dominant cropland's wild species in this polder area are Hatisur (*Heliotropium indicum*), Bothua Shak (*Chenopodium album*), Durba Gash (*Cynodon dactylon*), Biskantali (*Polygonum* Sp.), Thankuni (*Centella asiatica*), etc.

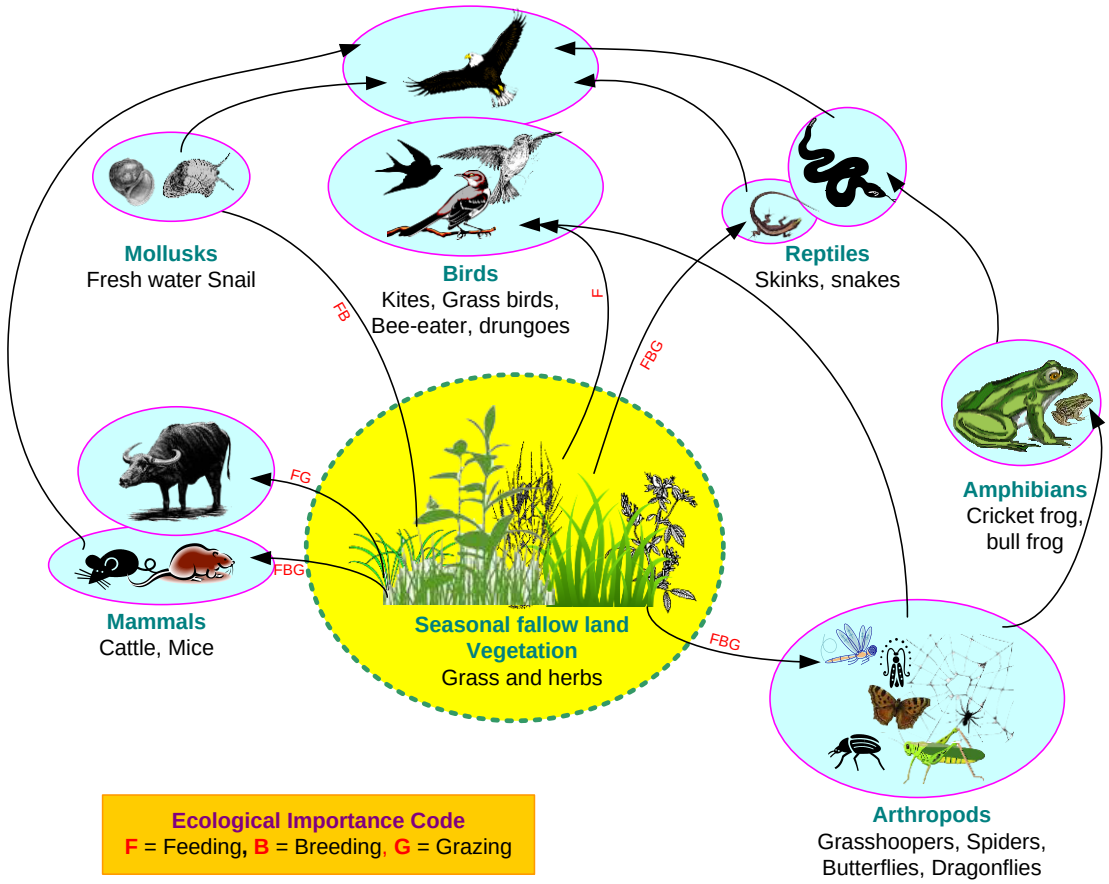


Figure 5.10: Ecological importance of seasonal fallow land's vegetation for different faunal communities along with partial food web

Photo 5.14: Hatisur *(Heliotropium indicum),* common wild herbs in the polder

Embankment /Village road and bank side vegetation

241 Major species found along the village road are: Sirish (Albizia odoratissima), Babla (Acacia nilotica), Tal (*Boassus flabelifer*), Narikel (*Coccos nucifera*), Suparee (*Areca catechu*), Khejur (*Phoenix sylvestris*), Kola (*Musa* sp), etc. Jiga (*Lennea coromandelica*), Akand (*Calotropis procera*), Vaant (*Clerodendron viscossum*), sech/sezi (*Euphorbia grandialata*) and Hatisur (*Heliotropium indicum*) are common wild shrubs and herbs sighted along most of the roadsides.

242 Embankment is exclusively dominated by Babla (*Acacia Arabica*), Sirish (*Albizia odoratissima*) Narikel (*Coccos nucifera*), Suparee (*Areca catechu*), and Kola (*Musa* sp). These plants are mostly planted by villagers for harvesting of timber and fuel wood. Vegetation of this type supports good habitats for local avifauna.

243 There is another type of vegetation found along river and khal bank side of the polder area. Different types of marginal herbs like Dholkolmi (*Ipomoea aquatic*), Bishkatali (*Polygonum* sp.), Mutha gash(*Cyperus* sp), Kasorti (*Eclipta* sp),etc are dominant in the lower slope and swamp trees like Pitali (*Trewia nudiflora*), Baroon (*Crataeva nurvala*) etc are found at upper slope of the river and khal banks.

Photo 5.15: Vegetation along road cum embankment sides

Photo 5.16: A village road beside homesteads followed fencing trees

Photo 5.17: khal bank side vegetation

Photo 5.18: A part of river bank side vegetation

b) Terrestrial fauna

Amphibians

244 Amphibian species favor wetland areas and the marginal dried areas. Common Toad (*Bufo melanostictus*), Bull Frog (*Hoplobactruchus crassus*), Cricket Frog (*Rana cyanophlyctis*) and Tree Frog (*Rana temporalis*) are commonly found in the polder area. Presence of small ditches, homesteads ponds and marginal areas of internal canals favor all of these amphibian species.

Reptiles

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

Mammals

246 Common mammals are concentrated in village grooves, road and embankment sides and crop fields. Small mammals, such as Jackal (*Canis aureus*), Grey mask shrew (*Suncus murinus*) and small Indian civet (*Viverricula indica*), Common Mongoose (*Herpestes edwardsii*), Jungle Cat (*Falis chaus*), Bengal Bandicot Rat (*Bandicota bengalensis*), Common House Rat (*Rattus rattus*), Squirrel (*Cllosciurus pygeryhrus*) and bats like Short-nosed Bat (*Cyynopterus sphinx*) are found in dense vegetation or crop fields of the polder area.

Avifauna

247 Terrestrial birds can be divided into two major groups: birds observed in floodplains and wetland, and birds observed in dry habitat such as homestead, open woodland, scrub and grass land. Birds of prey survive well in the area. Common bird of prey species found in the polder area are Brahminy Kite (*Heliastur indus*). Other common bird species in the 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*), Large-billed crow (*Corvus macrohynchos*).

5.2.12 Aquatic ecosystem

a) Wetlands

248 There are more than 340 ha of wetland inside the polder. Wetlands' of this area provide 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.

249 Seasonal wetland holds water for 3-4 months and is usually flooded during rainy season. Seasonal wetland creates mainly floodplains and an important fishing ground Perennial wetland contains water for whole of the 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 wet lands.

Aquatic flora

250 Wetlands contain plenty of aquatic floras, such as free floating, submerged, sedges and meadows.

251 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.

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

253 Submerged plants exist in both perennial and seasonal wetland. Such as, Jhangi (*Hydrilla verticillata*), Ghechu (*Aponogeton natans*), Bicha (*Vallisneria spiralis*) etc are found.

254 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 included Dhol kolmi (*Ipomoea aquatic*), Kochu (*Colocasia* sp.) and Helencha (*Enhyra flactuans*).

255 Throughout the intertidal plains are exclusively dominated by Hogla (*Typha elephantalis*), and local brackish grasses species like Chaila gash (*Hemarthria protensa*). In addition, patches of Hijal (*Barringtonia acutangula*), Ora (*Sonneratia caseolaris*), Borun (*Cratava nurvala*) trees are observed sporadically on the torus and along riverside toe of the embankment.

Photo 5.19: Common Floating hydrophytes : Kochuripana (*Eichhornia crassipes*)

Photo 5.20: A homestead pond dominated by *Lemna* sp

Photo 5.21: Hogla (Typha elephantalis), a brackish aquatic plant is very common in the polder area

Aquatic fauna

256 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

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

Reptiles

258 Snakes are the main type of aquatic reptiles of the polder area. The population of Bengal grey monitor (*Varanus bengalensis*) is well. Common aquatic snakes include the checkered keel back (*Xenocrophis piscator*) and smooth water snake (*Enhydris enhydris),* Glossy marsh Snake (*Gerardia prevostiana*) and Common wolf snake (*Lycodon aulicus*) are found in all types of wetlands. Turtle species are rare and maximum abundance occurred during monsoon. Spotted pond turtle (*Geoclemys hamiltoni*) is a common species inside the polder.

Avifauna

259 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*) are frequently found along mudflats, canal systems and seasonal wetlands throughout of the year. Local people reported that migratory birds are found here during the winter.

260 Fresh water Snail and Oyster are also commonly found in all floodplains and even in perennial water bodies. Their abundance is high during rainy season.

5.2.13 Ecosystem services

a) Output of ecosystem services

261 Ecosystem services are the benefits which 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.

A Table below represents ecosystem goods and services from different common plants of the polder.

Item	Source	Goods/Services
Food	Supari *(Areca catechu),*Narikel *(Cocos nucifera),*Aam*(Mangifera indica),*Jam *(Syzygiumsp),*Kola (*Musa* sp*),* Safeda *(Manilkara zapota),* Piyara (*Psidium guajava)*, etc	Fruit
	Ghechu (*Aponogeton sp*.)	Rootstock
	Helencha (*Enhydra fluctuans)* and Kolmishak (*Ipomoea aquatica*)	Leaf and stem
Fodder	Kochuripana, (*Eichhornia crassipe*), Phutku (*Hygroryza aristata*) etc.	Leaf and stem
Wood, timber	Aam *(Mangifera indica),*Jam *(Syzygiumsp),* Babla *(Acacia nilotica),* Mahogany (*Swietenia mahagoni),*	Trunk
	Borun (*Cratava nurvala*)	In tannery and for making drums, combs etc.
	Hijal (*Barringtonia acutangula*)	Boat and cabinet-making, construction
Medicine	Mahogany (*Swietenia mahagoni),* Tulshi *(Ocimum americanum),* Sezi *(Euphorbia antiquoram),* Bel *(Agle marmelos),*Nim *(Azadirachta indica)*	Roots, Leaf, Stem
Thatching and mat making	*Cyperus platystylis*, Supari *(Areca catechu),*Narikel *(Cocos nucifera),*Bash (*Bamboosa* sp.), Bel *(Agle marmelos),*Tal *(Boassus flabelifer),* Hogla (*Typha elephantalis*),	Thatching and fencing for huts and as protective screen in homestead.
Fuel	Babla *(Acacia nilotica),* Akashmoni *(Acacia auriculiformis),* Boroi*(Zizyphus* sp*),*Gab*(Diospyros perigrina),* etc*.*	Brunches, Leaf
Bio-fertilizer	Kochuripana	As compost
Hydroponics	Kochuripana to make baira (floating platforms)	to grow seedlings and vegetables
Bio-gas	Kochiripana, Khudipana and other aquatic plants.	All parts of the pant
Fishery	Hijal	To make Katha for fish.
Erosion Protection	Dholkolmi, Hijal, Chaila gash (*Hemarthria protensa*)	Against wave action, erosion and storm

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

5.2.14 Present threats on ecosystem

262 In the polder area, tidal flood and drainage congestion are the main threats for ecosystem sustainability.

263 Most of the wetlands, especially khals were found silted up. Non-functioning of water control structures like regulators, causes insufficient drainage facilities which arises drainage congestion to khal surrounding areas (Hajikhali, Hajikhali abad, Garakhali, Tafalbaria village) during heavy rainfall. In addition, the existing embankment cannot protect tidal surge as well as saline water intrusion in country side when cyclonic storms occurred. As a result huge amount of vegetation including homesteads and crop fields are damaged. Damages of vegetation have severe impact on dweller wildlife like local birds, mammals, reptiles etc due to habitat destruction.

5.2.15 Status of livestock and poultry

264 A large number of populations of the polder area earn their livelihood through work associated with raising livestock / poultry. About 60% of households are rearing cows/ bullock, 35% of household are rearing goat, 10% of household are rearing sheep, 75% of household are rearing chicken, 70% of household are rearing duck, 25% of household are rearing pigeon. In addition to that there are about 200 small poultry farms. Detailed status of livestock and poultry is presented in Table 5.23.

Table 5.23: Status of Livestock/Poultry in the polder area

Live stock/Poultry	% of household	Number of Livestock/Poultry in the polder area
Cattle/cow/bullock	60	18,840
Goat	35	10,990
Sheep	10	3,140
Chicken	75	70,650
Duck	70	76,930
Pigeon	25	15,700

Source: Based on field information, 2014 and Upazila Livestock Office.

Photo 5.22: View of grazing land in the polder 43-2D area

Photo 5.23 : View of small poultry firm in the polder 43-2D area

5.2.16 Feed and Fodder of Poultry

265 The owners of the livestock population are facing problems in respect of availability of fodder and feeds during the monsoon season due to non-availability of grazing land.

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

5.2.17 Livestock and poultry diseases

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

5.3 Environmental Quality

Sound Quality

267 A number of suitable sites were selected inside the polder to measure the sound levels and establish a comparison between the standard levels and the in situ values. The Environmental Conservation Rules 1997, of Department of Environment, Bangladesh has defined standard noise levels as 50 dB during day time for Residential Zones, and comparisons have been made between the observed sound levels and the standard value (Table 5.24).

Table 5.24: Sound Levels for different locations in the study area

Location	GPS	Sound (dB)	Standard level	Deviations from standard
Chalk Khan's Pond at Auliapur	22º16'53.1''N 90º20'26.8''E	41	50 dB (Residential Zone)	Within limit
Kongsor khal at Patu khali	22º16'18.5''N 90º18'40.9''E	43		Within limit
Yousuf Sikder's Pond at Gerakhali	22º17'46.3''N 90º18'46.4''E	49		Up to 20%
Pond at Purba Sarikhali	22º18'51.1''N 90º19'59.3''E	52		Up to 30%

Source: CEGIS field survey, May 2014

N.B.: All values were collected during day time

Water Quality

268 Four major water quality parameters (pH, TDS, Temp., and DO) have been measured at site in May 2014, from seven different locations of the polder (Table 5.25). The pH values were higher than neutral scale (pH=7) which means that the water in these locations is alkaline in nature during May. Values of TDS were found within a lower

range inside the polder, as the tidal water could not enter into it. Values of DO were mostly found close to the standards set by DoE for both irrigation (5 to 6 mg/l) and fishing (5 mg/l).

269 Temperature values varied within a typical range for different locations as samplings were made in different periods of the day.

Photo 5.24: In-situ measurement of TDS in Polder 43/2D

Table 5.25: Water Quality Parameters

Location	GPS coordinates	P^H	TDS (ppm)	Temp. (ºC)	DO (mg/l)
Lohalia Bridge, Lohalia River, Keshabpur	22º20'47.6''N 90º21'29.1''E	7.6	716	29.9	5.9
Rajarkhali New Sluice, Gorai River, Marichbunia	22º16'02.6''N 90º16'20.6''E	7.3	858	32.6	5.2
Paler Hota Khal, Auliapur	22º16'45.8''N 90º20'22.6''E	7.9	765	29.4	6.2
Gerakhali Khal, Auliapur	22º17'46.6''N 90º18'46.4''E	7.7	503	33.4	4.8
Sarikhali khal, Purba Sarikhali	22º18'50.0''N 90º19'59.8''E	7.5	616	31.2	5.2
Pond at Patukhali, Marichbunia	22º16'18.5''N 90º18'40.9''E	7.9	152	32.7	5.3
Pond at Gerakhali, Madarbunia	22º17'46.9''N 90º18'46.4''E	7.8	116	33.7	4.8

Source: CEGIS field survey, May 2014

270 Salinity levels in five locations have been measured at site (Table 5.26). All of the samples were found having zero salinity. The local people claimed that no surface water salinity exists within the polder, even though minor surface water salinity is found along the peripheral rivers i.e. Payra River and Kala Nadi. The reason for this lower salinity is the increased amount of freshwater discharge from the upstream Meghna River system towards the rivers of South Central hydrological region.

Table 5.26: Salinity Level in Different Locations

Location	Sampling water Source	GPS readings	Salinity (ppt)
Lohalia Bridge, Lohalia River, Keshabpur	Surface Water, Outside Polder	22º20'47.6''N 90º21'29.1''E	0

Location	Sampling water Source	GPS readings	Salinity (ppt)
Rajarkhali New Sluice, Gorai River, Marichbunia	Surface Water, Outside Polder	22º16'02.6''N 90º16'20.6''E	0
Nilkhola Sluice, Nilkhola Khal	Surface Water, Inside Polder	22º15'31.7''N 90º17'14.3''E	0

Source: CEGIS field survey, May 2014

Note: SW: Surface Water

5.4 Climate Change

271 The following sub-sections provide climate change issues including climatic trends, climate change projections and cyclone and storm surges in the polder area.

5.4.1 Climatic trends

272 There have been very few studies on the climatic trends for Patuakhali BMD station. This section contains information extracted for Patuakhali (the region of Polder 43/2D) from another CEGIS study on national and sub-national climate change modeling using PRECIS model (CEGIS, 2014).

(a) Temperature

273 Analyzing the change of average temperatures in the existing hydrological regions of Bangladesh, it is found that the temperature of south central region (the region containing Polder 43/2D) shows a decrease of 0.73° C per 100 years, whereas temperature of other regions shows an increasing trend (Figure 5.11).

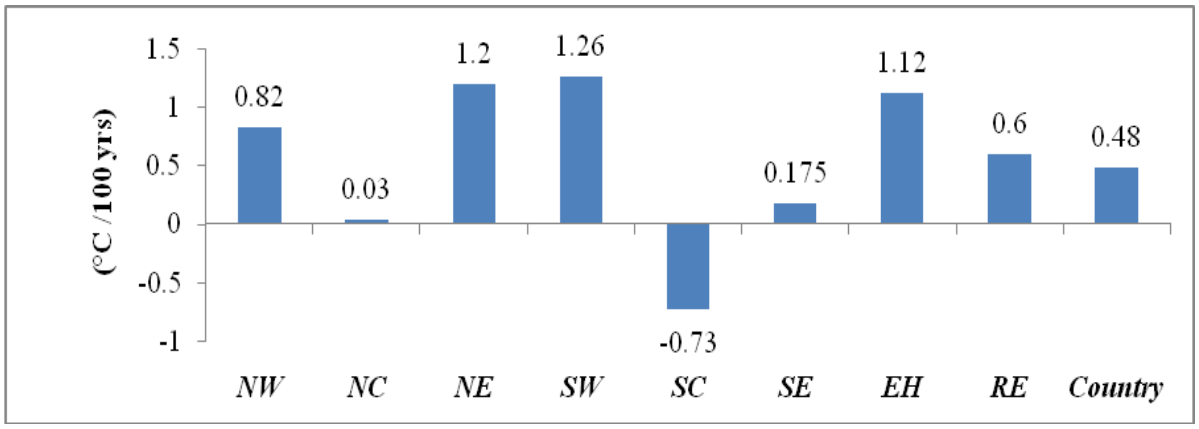


Figure 5.11: Change in average temperature in different regions (CEGIS, 2014)

274 Table 5.27 below provides a comprehensive comparison on variation of temperatures for each BMD stations within the south central hydrological region. In addition the country average values have also shown. The Table shows that the average temperature has decreases 0.9 ^{0}C per hundred years in Patuakhali, against a rise in country average values of 0.48 ^{0}C per hundred years.

Table 5.27: Trend analysis for temperature of South Central Region

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

Region	Station	Temperature Change, °C per 100 years				
		Max	Avg. Max	Min	Avg. Min	Avg.
	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
	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, 2014

(b) Rainfall

275 The variation of rainfall in pre monsoon, monsoon and post monsoon seasons of different representative districts (from different hydrological regions) are shown in Figure 5.12 below. The pre-monsoon and post-monsoon rainfall patterns show increasing trends for all the selected stations. Barishal, one of the representative location of the south central region, however has very negligible change. It can be concluded that also in Patuakhali, the long term seasonal variations of rainfall is very negligible.

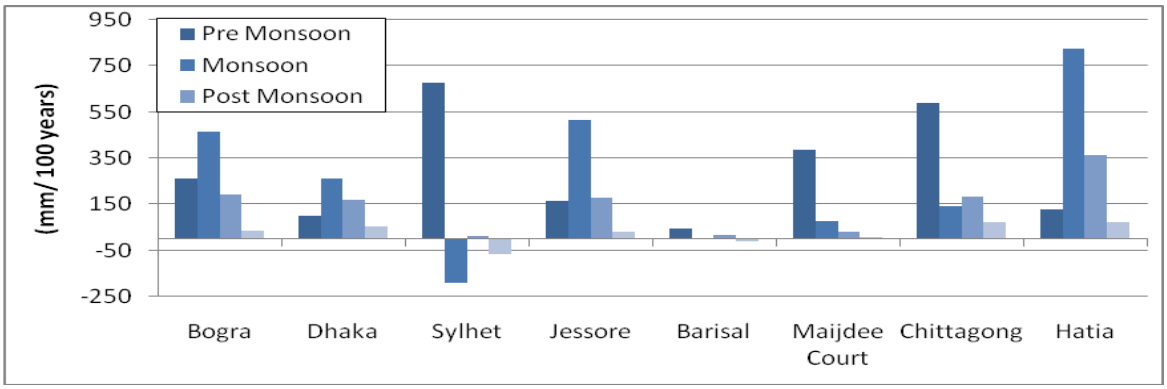


Figure 5.12: Long term seasonal variation of rainfall for selected stations (CEGIS, 2014)

5.4.2 Climate Change Projection

276 Two greenhouse gas emission scenarios, A2 and A1B, from the Special Report on Emissions Scenarios by the Intergovernmental Panel on Climate Change (IPCC) were used for investigating different scenarios. A2 is the business-as-usual scenario, a very heterogeneous, market-led world, with high population growth slow economic development, and slow technological change. A1B, however, is the scenario which has been developed putting balanced emphasis on all potential energy sources (here balanced is defined as not relying too heavily on one particular energy source, on the assumption that similar improvement rates apply to all energy supply and end-use technologies) (Table 5.28).

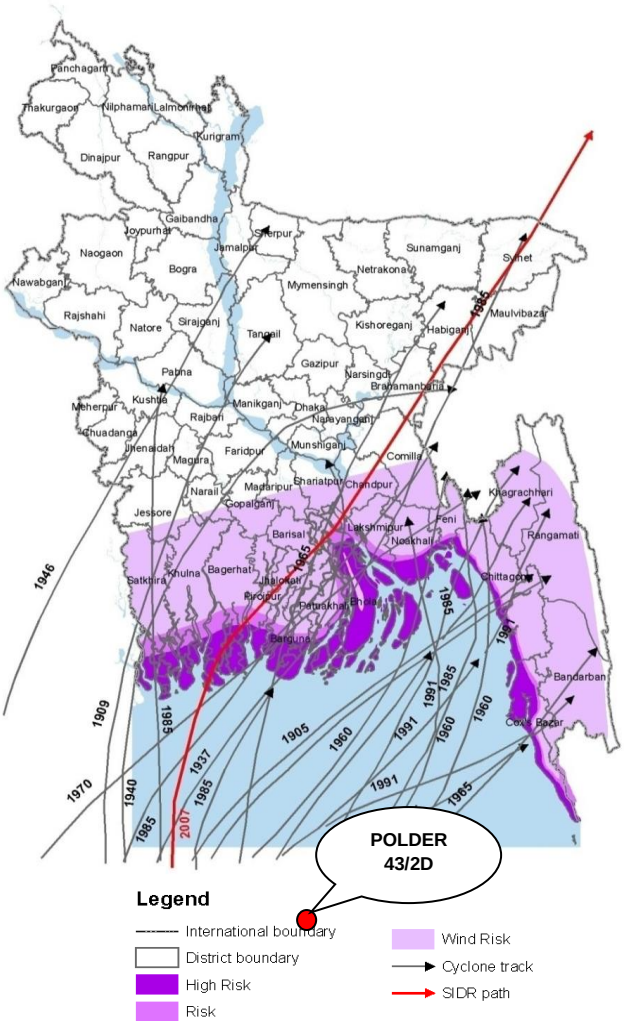
Table 5.28: Summary Features of Climate Projections (of 2050) for Patuakhali (CEGIS, 2014)

Parameter	Scenarios							
	A1B				A2			
Maximum	The	average	monthly	maximum	The	average	monthly	maximum

Parameter	Scenarios	
	A1B	A2
Temperature	temperature may increase by 1.5^{0}C in March-May and 2^{0}C in December-February.	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 2^{0}C in March-May and 3^{0}C in December-February.
Seasonal Rainfall	The seasonal rainfall may increase up to 100 mm in June-August	The seasonal rainfall may increase up to 100 mm in June-August

5.4.3 Cyclones and Storm Surges in Polder 43/2D

277 Tropical cyclones from the Bay of Bengal accompanied by storm surges are one of the major disasters in the coastal regions in Bangladesh. The high number of casualties is due to the fact that cyclones are always associated with storm surges, sometimes with surge heights of even more than 9m. 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). Observing the tracks of different cyclones affecting the country, the countries southward portion has been classified into three risk zones namely, high risk zone, risk zone, and wind risk zone (Map 5.11). Polder 43/2D falls in the wind risk zone which possesses some vulnerability due to the strong winds, and surge heights associated with cyclones.



Map 5.11: Cyclone tracks in Bangladesh and risk areas

278 From field observations it was found that the polder suffered minor damages during Sidr (2007) and Aila (2009). Sidr damaged a number of water control structures of the polders (at Nilkhola, Chatua) which were not repaired under the IPSWAM project. However, as the polder is not located along the Payra River, it faced less devastation than the other adjacent polders (Polders 43/2A and 43/2F).

6 Socio-economic condition

6.1 Demography

279 The 15, 715 households in the polder area have a total population of 71,840 of which 34,631 are male and 37,209 are female. The female population is found to be higher than the male population. The average male-female sex ratio is 94 of which means there are 94 males per 100 females which is lower than the national figure of 100.3 (BBS, 2011). The average density of population is about 681 persons per sq. km which is also lower the national density of 1,015 populations per sq. km. About 96% of total populations in the polder area are Muslim while rests of them are Hindu and Christian. The key demographic data of the Polder is presented in Table 6.1.

Table 6.1: Demographic data of polder

Districts	Upazillas	Unions	Total HHs	Population			Sex Ratio	Population density [sq. km]
				Both	Male	Female		
Barguna	Amtali	Atharagashia	53	235	114	121	94	514
		Gulisakhali	65	284	136	148	92	506
Patuakhali	Patuakhali sadar	Bara Bighai	179	752	356	396	90	632
		Chhota Bighai	211	979	490	489	101	693
		Auliapur	3101	14487	6928	7559	92	715
		Jainkati	909	4203	2064	2139	96	692
		Kalikapur	2797	13285	6569	6716	98	988
		Madarbunia	4407	20551	9879	10672	93	733
		Marichbunia	3992	17064	8095	8969	90	651
Total/Average			**15,715**	**71,840**	**34,631**	**37,209**	**94**	**681**

Source: Population Census 2011, BBS

6.1.1 Age composition

280 About 36% of the population is less than 15 years, 54% is between 15 to 59 years and 10% are over 60 years of age. It is observed that 24% of total population is still belonging between 30-49 years age category and they are the main working force for development of society. Details of this age composition are shown in the following table (Table 6.2)

Table 6.2: Age distribution at polder 43/2D

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+
Atharagashia	11	14	12	6	7	8	24	8	4	6
Gulisakhali	10	13	13	7	7	8	25	8	4	6
Bara Bighai	10	13	13	7	7	8	25	8	3	6
Chhota Bighai	10	13	14	9	7	8	23	7	4	6
Auliapur	10	14	14	8	8	8	22	7	4	6
Jainkati	10	14	13	7	8	8	24	7	4	6

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+
Kalikapur	10	13	13	8	8	9	23	7	3	6
Madarbunia	10	14	13	8	7	8	23	8	4	6
Marichbunia	10	14	12	7	7	9	24	8	3	6
Average	10	13	13	8	7	8	24	7	4	6

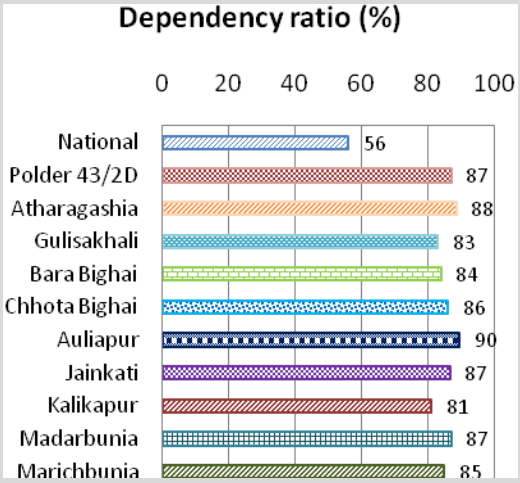
Source: Population Census 2011 ,BBS

6.1.2 Dependency ratio

281 In demography the dependency ratio is an age-population ratio of those typically not in the labor force (the dependent part) and those typically in the labor force (the productive part). It is used to measure the pressure on productive population (Wikipedia, 2014). Here, 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). The data shows that around 47 percent of the population depends on the 53 percent of the earning members of their households. Hence the dependency ratio for polder 43/2D is 87 which is higher than national rate 56. BBS data also shows each of the union comprises almost similar ratio whereas Auliapur union comprises the highest dependency ratio than other unions within the polder (Table 6.3).

Table 6.3: Categorical distribution of population by union

Unions	0-14 Children (%)	15-59 Active workforces (%)	60+ Old (%)
Atharagashia	37	53	10
Gulisakhali	36	55	9
Bara Bighai	37	54	9
Chhota Bighai	37	54	10
Auliapur	37	53	10
Jainkati	37	54	10
Kalikapur	35	55	9
Madarbunia	37	53	10
Marichbunia	37	54	9



Source: Population Census 2011, BBS

6.1.3 Marital status

282 According to BBS, around 69% people are ever married where as 29% people are never married (it includes children). There has been discrepancy seen for male population is (35%) and female counterpart (23%) in terms of never married persons. It indicates that young people are gradually becoming interested to be involved in business and entrepreneurial activities. Among all population, 3% are widow and 1% is divorced or separated. Following table (Table 6.4) shows the marital conditions at polder area.

Table 6.4: Male-female marital status at polder area

Unions	% of Male				% of Female			
	Never married	Married	Widowed	Divorced/ Separated	Never married	Married	Widowed	Divorced/ Separated
Atharagashia	32.8	66.3	0.8	0.1	20.4	70.9	8.1	0.6
Gulisakhali	33.3	65.8	0.8	0.1	21.1	70.3	8.0	0.6
Bara Bighai	34.5	64.8	0.7	0.0	22.1	70.8	6.9	0.2
Chhota Bighai	38.9	60.5	0.5	0.1	23.9	69.4	6.3	0.4
Auliapur	35.8	62.7	1.3	0.2	23.8	68.0	7.6	0.6
Jainkati	33.6	65.7	0.6	0.1	21.2	70.9	7.4	0.4
Kalikapur	36.9	62.0	0.9	0.2	24.6	67.6	7.1	0.8
Madarbunia	35.3	63.7	0.9	0.1	23.4	68.7	7.5	0.5
Marichbunia	32.6	66.5	0.8	0.1	22.0	68.8	8.8	0.4
Average	34.9	64.2	0.8	0.1	22.5	69.5	7.5	0.5

Source: Population Census 2011, BBS

6.2 Household size and types of family

283 The average household size is 4.57, which is similar to the national household size of 4.50 (HIES 2010[1]). According to local people, household size is still considered as gift in some cases and curse in another case. If most of the household members become able to contribute in household income they are considered as gift, on the other hand, if most of the members appeared as only consumers are considered as curse for the family (Table 6.5).

Table 6.5: Distribution of household members at polder area

Unions	Percentage of Households comprising							
	1 person	2 persons	3 persons	4 persons	5 persons	6 persons	7 persons	8+ persons
Atharagashia	11	14	12	6	7	8	24	8
Gulisakhali	10	13	13	7	7	8	25	8
Bara Bighai	10	13	13	7	7	8	25	8
Chhota Bighai	10	13	14	9	7	8	23	7
Auliapur	10	14	14	8	8	8	22	7
Jainkati	10	14	13	7	8	8	24	7
Kalikapur	10	13	13	8	8	9	23	7
Madarbunia	10	14	13	8	7	8	23	8
Marichbunia	10	14	12	7	7	9	24	8
Average	**10**	**13**	**13**	**8**	**7**	**8**	**24**	**7**

Source: Population Census 2011, BBS

284 Therefore, In terms of the types of family, most of the households (66%) are live in either a nuclear or a conjugal family while only 34% live in extended or joint family (Figure 6.1). Local people opined that within the process of modernization, development of communication, growth of education, closeness to Patuakhali or Barishal cities, now they are being conscious about nuclear family and declining structure of kinship is observed all over the polder.

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

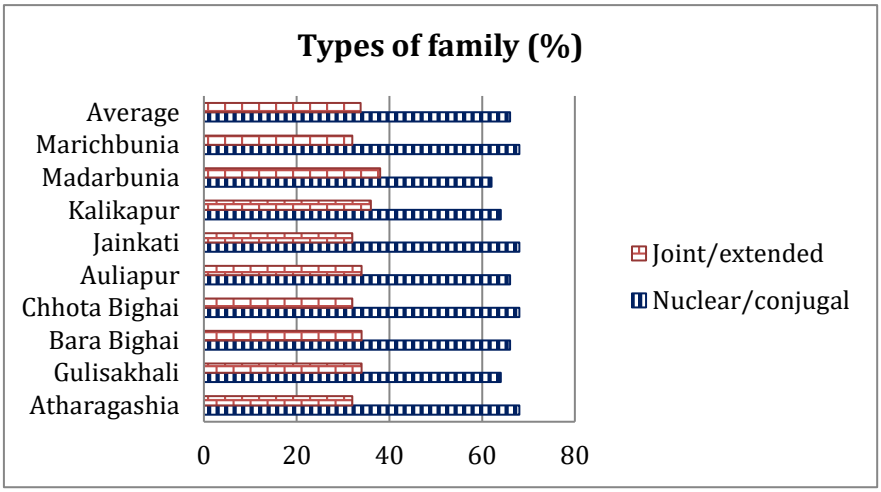


Figure 6.1: Distribution of population by the types of family

Source: CEGIS fieldwork, 2014

6.3 Livelihood

6.3.1 Employment and occupation

285 In the polder area, about 35% of total population is employed, 49% is engaged in household work, only one percent is looking for work and about 16% of total population is not working (it includes children and physically challenged population). At present, there are 5 brick fields and significant portions of labor are working in these brick fields. Table 6.6 shows the employment status of the people in the Polder area.

Table 6.6: Distribution of employment status by unions

Unions	Employed	Looking for work	Household work	Do not work
Atharagashia	32.7	3.0	46.8	17.5
Gulisakhali	36.8	1.1	43.1	19.0
Bara Bighai	33.4	0.6	48.2	17.8
Chhota Bighai	36.4	0.5	41.3	21.8
Auliapur	32.0	0.5	43.0	24.5
Jainkati	34.5	0.5	49.3	15.7
Kalikapur	39.8	0.7	38.9	20.6
Madarbunia	32.8	0.9	42.1	24.2
Marichbunia	32.9	0.8	47.5	18.8
Average	**34.6**	**1.0**	**44.5**	**20.0**

Source: Population Census 2011, BBS

286 The polder area is comprised of different occupations. Although agriculture is still the mainstay of the economy, the area provides varied sources of livelihood which are not commonly observed in other parts of Bangladesh. At present, most of the population is engaged in agriculture sector (75%). These occupational groups are mainly farmer, agricultural labor, fishers, day labors etc. About 19% population is engaged in salaried service sector and only 6% is engaged in industry, petty trade, handicrafts and other manual sectors (Table 6.7).

Table 6.7: Distribution of population by field of activity

Unions	Agriculture	Industry	Service
Atharagashia	87	3	10
Gulisakhali	84	5	11
Bara Bighai	80	7	13
Chhota Bighai	78	10	12
Auliapur	70	7	23
Jainkati	65	4	31
Kalikapur	50	4	46
Madarbunia	79	9	11
Marichbunia	85	4	11
Average	**75**	**6**	**19**

Source: Population Census 2011, BBS

Photo 6.1: Different modes of livelihood activities at polder 43/2D

6.3.2 Availability of labor and wage rate

287 Filed findings shows, there have been a growing tendency that people trying to cultivate their own land rather depends on sharecropping system. About 12-15% of total household hire labor for agricultural production. The wage rate varies between 400 Tk. to 350 Tk. /day for male whereas women wage rate is about 250 Tk. to 200 Tk. and they can work 20 days continuously in a month. Women participation in agricultural or any other occupation is negligible. They only work in household level for their necessity.

6.4 Population Migration

288 Migrations scenario is found in the studied area. Few of households have found tendency to migrate permanently in both type of migration (In/Out migration). However, seasonal labor migration is common. People from the polder area tend to migrate to Patuakhali, Barishal, Khulna, Dhaka for better livelihood and lack of employment opportunity over the polder (12-15%) from April to June. Very few of the households are migrating into city only for work in garments sector. On the other hand, a considerable number of labors (20-25%) migrate to the polder area during cropping period from August- October (Table 6.8).

Table 6.8: Migration status in the polder area

Type of Migration	Out Migration		In Migration	
	Place of destination	% of total population	Place of origin	% of total population
Seasonal labor migration	Patuakhali, Barishal, Khulna, Dhaka	12-15	Periphery of the polder	20-25
Permanent household migration	Barishal, Khulna, Dhaka	20-25 HHs	-	-

Source: CEGIS fieldwork 2014

289 In terms of in migration most of the migrants are male in sex, aged between 15 to 49 years and they are from economically impoverished segment of the society. On the other hand, out migrants from the polder area is both male and female and from both socially deprived segments is reported.

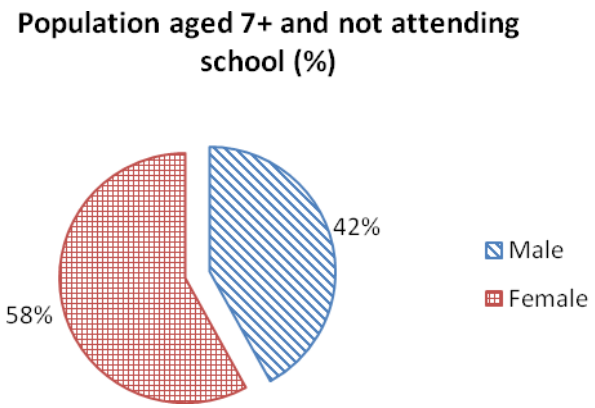
6.5 Education

290 The average literacy rate in the study area is 52% which is slightly better that national level (51%). It is observed like other part of Bangladesh that the male population (55%) is more educated than their female counterpart (50%) and here the difference is significant (Table 6.9). Besides, about 58% of female from total population aged 7+ are still not attending school whereas 42% are male. Local people opined that, unemployment and lack of facilities are the main hindrance behind the development of education among women. But now they perceived that they have to find out the way to overcome this present situation but only education can lead them towards emancipation. At present, girls are trying to complete their secondary level and some of them are also going Patuakhali or Barishal for higher study.

Table 6.9: Literacy rate at polder 43/ 2D area

Unions	Literacy Rate (%)		
	Both	Male	Female
Atharagashia	44	49	40
Gulisakhali	53	57	50
Bara Bighai	52	55	50
Chhota Bighai	51	53	48
Auliapur	54	57	51
Jainkati	48	51	45
Kalikapur	65	68	63
Madarbunia	55	57	53
Marichbunia	49	52	46
Average	**52**	**55**	**50**

Source: Population Census 2011, BBS



6.5.1 Educational Institutions

291 According to the field findings there are 101 primary schools, 38 high schools and 32 ebtedaye/ Dakhil Madrashas in the polder area (Table 6.10 & Photo 6.2). There are 6 colleges in the polder area (Source: CEGIS field work, 2014). Local people opined that numbers of high schools are still not sufficient in response to population. They demand more educational institutions in every union of the polder area.

Table 6.10: Academic Institutions at polder

Union Name	No of Primary School	No of Madrasha	No of High School	No of Collage
Atharagashia	4	2	2	-
Gulisakhali	10	4	5	1
Bara Bighai	15	7	4	1
Chhota Bighai	14	6	2	1
Auliapur	12	1	5	-
Jainkati	7	5	5	-
Kalikapur	08	4	3	-
Madarbunia	17	5	3	2
Marichbunia	14	4	3	1
Total	**101**	**38**	**32**	**6**

Source: CEGIS field work, 2014

Photo 6.2: Local educational institution at polder area

6.6 Health Condition

6.6.1 Disease prevalence

292 The health profile of the local people living in the Polder is presented in the Table 6.11. According to the ranking, the incidence of Influenza/Common fever is the most prevalent ailment for dry season whereas cough/cold, skin diseases are also common for winter season in the Polder area.

Table 6.11: Disease profile in the polder

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

Source: CEGIS fieldwork, 2014

6.6.2 Health services and facilities

293 Field findings show that no upazila health complex was found in the polder. Besides, there are 9 union health complexes and 19 community clinics. These health services are not adequately functioning (Table 6.12). As a result, local people are to receive health service and facility from peripheral hospitals i.e. Barguna, Patukhali sadar. However, it is observed that communication between polder areas to upazila is not good and some

parts of the road network are under threats of erosion. Nevertheless, they are going to upazila or district hospitals when patient reach in a severe condition. Local people opined that, it is need to repair the damaged road networks as early as possible.

Table 6.12: Health service facilities in the study area

Unions	Upazila Health Complex	No of Union health complex	No of Community Clinic	Outside of Polder health facilities
Atharagashia	-	1	2	Barguna, Patuakhali sadar
Gulisakhali	-	1	2	Barguna, Patuakhali sadar, Barguna sadar
Bara Bighai	-	1	4	Patuakhali Sadar
Chhota Bighai	-	1	2	Patuakhali Sadar
Auliapur	-	1	1	Patuakhali Sadar
Jainkati	-	1	2	Patuakhali Sadar
Kalikapur	-	1	2	Patuakhali Sadar
Madarbunia	-	1	3	Patuakhali Sadar
Marichbunia	-	1	2	Patuakhali Sadar
Total	-	9	19	

Source: CEGIS fieldwork, 2014

294 From the field, it is also found that about 45 percent people receive health services from quack doctors and 30 percent from paramedic/ diploma physicians and only 10 percent from trained physicians. It is noteworthy that about 5 percent do not receive treatment facility due to their impoverishment and lack of consciousness.

6.7 Landownership and land price

295 Landownership pattern can be an indicator to understand the poverty incidence in a given area. Statistics shows that there are 71% small land holders, 26% medium and only 4% large landholders. In the study area, arable land is mainly used for crop production. Generally small and medium holders cultivate variety of crops at those lands. The large farmers are mostly from absentee category. They usually live in Patuakhali sadar or Hetalbunia and appoint caretaker to take care of their land.

Table 6.13: Landownership pattern in polder

Unions	Land ownership pattern (%)		
	Small	Medium	Large
Atharagashia	75	20	5
Gulisakhali	68	30	2
Bara Bighai	70	25	5
Chhota Bighai	72	20	8
Auliapur	70	22	8
Jainkati	75	22	3
Kalikapur	72	22	6
Madarbunia	68	28	4
Marichbunia	70	26	4
Average	**71**	**24**	**5**

Source: BBS, Agriculture Census, 2008

296 Land price in the study area is increasing day by day in the polder area. According to the local people, agricultural land prices are relatively lower. The land price of homestead land is the highest in comparison to other land. The details of lands price is shown in the Table 6.14.

Table 6.14: Sell value of land at polder 43/2D

Land type	Sale value	Year
Homesteads land	3.5-4 lacks per decimal (depends on location)	2014
Agricultural land	10000-15000 Tk. Per decimal	2014
Commercial land	2-2.5 lacks per decimal (depends on location)	2014

Source: CEGIS fieldwork, 2014

6.8 Household income and expenditure

297 The income and expenditure at the household level within the Polder area is shown in Table 6.15. It is found that income and expenditure of most of the people belong to Tk. 24,001 taka to 60,000 taka. It is assumed that due to lack of alternative sources of livelihood operation within the polder, their income and expenditure status is quite poor.

Table 6.15: Annual income and expenditure level

Range in Taka	Percentage (%) of Households	
	Income	Expenditure
Up to 12,000	15	10
12,001to 24,000	21	24
24,001to 60,000	52	54
60,001to 108,000	7	6
108,001 to 240,000	5	5
More than 240,000	3	3

Source: CEGIS fieldwork, 2014

6.9 Sectors of income and expenditure

298 Field findings shows that most of the income comes mainly from two sectors i.e. agriculture (45%) and fishing (32%). On the other hand, most of the expenditure costs for household consumption 50% (it includes everyday food, clothing and other necessary things) and education purpose (20%). In to some extent, they are now feeling discomfort due to current price hike in every sector of expenditure. In most of the cases, expenditure is becoming two times greater than income. Some of them are lending money from NGOs for well being of their family or livelihood (Figure 6.2 and 6.3).

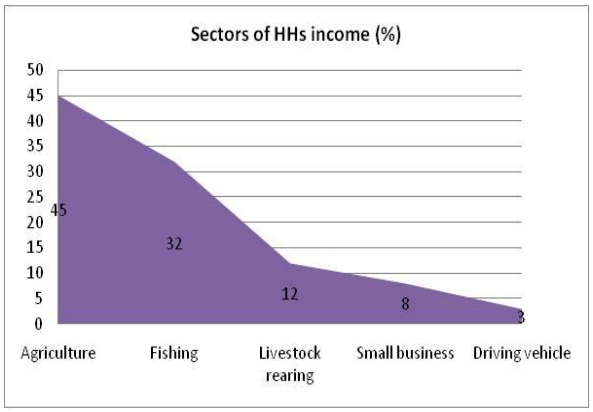


Figure 6.2: Proportionate Distribution of Household income.

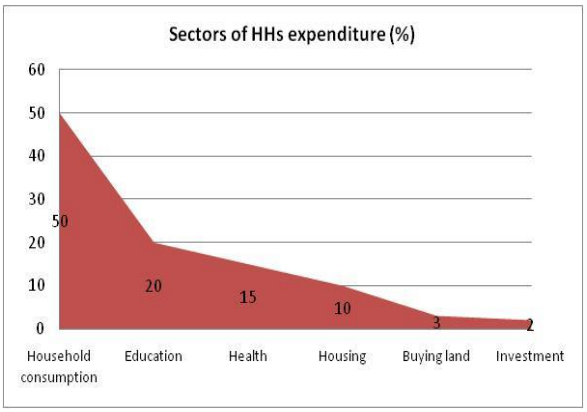


Figure 6.3: Proportionate Distribution of Household expenditure.

Source: CEGIS fieldwork, 2014

6.10 Susceptibility to disasters

299 The local inhabitants of Polder 43/2D have identified tidal flooding, erosion, water logging and cyclones as the major hazards in the area and these natural disasters are frequently affecting them. They can only recall the cyclone SIDR and AILA that occurred in 2007 and 2009. The most impact of the cyclones reported by local people was loss of livelihood opportunities, standing crops, fisheries and other household assets for both long and short term. The loss and damage inflicted as a result of cyclone AILA and SIDR had lasting effects. The decreased availability of food led to malnutrition and school drop-out rates increased in that time as some people were forced to migrate and children had to take jobs in order to contribute the household income. Furthermore, drainage congestion in certain part has gradually increased and crop production, the income source village from homestead gardening, livestock rearing and wage labour has been hampered. They feel risk due to such kind of vulnerable factors and mentioned necessary mitigation measures to risk reduction from GOs or NGOs level. Details about the disasters and their affects on their livelihood in the area are presented in table (Table 6.16)

Table 6.16: Effects of recent natural disaster within the polder

Disaster	Affected Year	Affected Area (%)	Affected House Holds (%)	Crop Damaged (%)	Major Damaged Crop
Tidal Flood	2007	40	30	30	Rice, water melon, mug bean etc.
Erosion	2007, 2009, 2014	5	2	8	Rice, water melon etc.
Cyclone	2007 (Sidr), 2009 (Aila)	40	30	30	Rice, water melon, mug bean etc.

Source: CEGIS fieldwork, 2014

6.11 Quality of life

300 Housing tenancy and housing condition in the study area, most of the people are dwelling2 in their own household. Contractually dwellers are insignificant who came from another location due to job purposes and or having no own homestead land. Almost 98% people possessed own household within the polder area whereas around 0.8% people are living without rent free and rest of 1.2% are living in rented house.

301 Overall housing condition[3] is not satisfactory. On an average only 1% of houses are Pucka,4% houses are semi-pucka and 2% houses are Jhupri whereas 93% 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. It can be concluded that the people living in the study area belong to poor category in terms of housing type. Statistics show that Bara Begghai and Kalikapur union comprises the highest pucka household (1 & 3.5%) whereas Choto Beghai union comprises the highest kutcha households (96 %). Table 6.17 and photo 6.3 shows housing types of the polder.

Table 6.17: Types of housing structure by union at polder 43/2D

Unions	Type of Structure (%)			
	Pucka	Semi-pucka	Kutcha	Jhupri
Atharagashia	0.9	7.7	86.5	4.9
Gulisakhali	1.1	2.3	94.1	2.4
Bara Bighai	1.1	3.5	94.5	0.9
Chhota Bighai	0.4	2.6	96.3	0.7
Auliapur	0.6	3.2	94.3	1.9
Jainkati	0.8	4.2	93.6	1.4
Kalikapur	3.5	7.3	88.6	0.7
Madarbunia	0.9	2.2	95.8	1.1
Marichbunia	0.6	5.0	92.6	1.8
Average	**1.1**	**4.2**	**92.9**	**1.8**

Source: Population Census 2011, BBS

[2]BBS distinguishes tenancystatus ofdwellingunits into three classes such as- i) **Owner:**Dwellingunitfoundoccupiedandused byhousehold owningit; ii)**Rented:**Dwellingunitfoundoccupiedandusedunderarrangementofcontractually rented; and iii) **Rent free:** Dwelling unit found occupied and used without rent.

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


Photo 6.3: Housing structure at polder area

6.11.1 Sanitation

302 The sanitation facilities[4] adopted by households of the polder area are presented in Table 6.18 & Photo 6.4. It shows that about 30%households have hygienic sanitation facility (water-sealed), 50 % have not water-sealed sanitation facility, 19% have non-sanitary sanitation facility and 2%have no sanitation facility. Sanitation facility is moderate in Bara Bighai and Madarbunia unions (43% and 40% water-sealed sanitary) whereas in Gulisakhali union it is only 22%.

Table 6.18: Sanitation facilities by union at polder 43/2D

Union	Toilet Facility (%)			
	Sanitary (water-sealed)	Sanitary (non water-sealed)	Non-sanitary	None
Atharagashia	9.7	40.1	43.3	7.0
Gulisakhali	22.3	48.5	25.1	4.1
Bara Bighai	42.7	46.5	9.8	1.0
Chhota Bighai	28.8	60.8	10.0	0.4
Auliapur	6.7	76.7	14.7	2.0
Jainkati	36.4	41.6	20.9	1.1
Kalikapur	59.6	27.5	12.5	0.4
Madarbunia	40.1	46.1	12.6	1.2
Marichbunia	20.0	60.2	17.6	2.2
Average	**29.6**	**49.8**	**18.5**	**2.1**

Source: Population Census 2011, BBS

303 People stated that non water sealed (ring slab) is gradually replacing the non sanitary (kutcha) and hanging latrines since several NGOs and governmental departments are distributing ring slab as free of coast and or at little cost. Additionally, people are being cognized using hygienic sanitation through continuous promulgation of mass media popularly TV and radio.

[4] BBS defined four types sanitation in Bangladesh such as **(i) Sanitary (water-sealed):** A water sealed latrine is simply a pit latrine that has a water barrier to prevent odors. These latrines are simply pits dug in the ground in which human waste is deposited. **(ii) Sanitary (not water-sealed/ring slab),** latrine with a slab or other secure cover over the drop hole, or a polyethylene flap preventing 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

6.11.2 Drinking water

304 Overall status of drinking water in the area is satisfactory. On an average, 98% people can collect drinking water from tube well and rest of the 2% can collect drinking water from other sources such as ponds, PSF (Pond Sand Filter); rain water etc. Database also shows that, Atharagashia union comprises highest (99.6%) user tube well for collecting drinking water whereas Marichbunia union comprises lowest percentage (95%) about tube well users. It is notable that, there is very few use of tap as sources of drinking water within the polder. The detail is presented in Table 6.19, which shows that percentage of tube-well coverage is significant.

Table 6.19: Sources of drinking water in polder by union

Unions	Source of Drinking Water (%)		
	Tap	Tube-Well	Other
Atharagashia	0.1	99.6	0.2
Gulisakhali	-	97.1	2.8
Bara Bighai	-	99.3	0.7
Chhota Bighai	0.2	98.8	1.0
Auliapur	-	99.1	0.9
Jainkati	-	98.8	1.1
Kalikapur	0.1	98.1	1.8
Madarbunia	0.1	97.4	2.5
Marichbunia	-	94.9	5.1
Average	**0.1**	**98.1**	**1.8**

Source: Population Census 2011, BBS

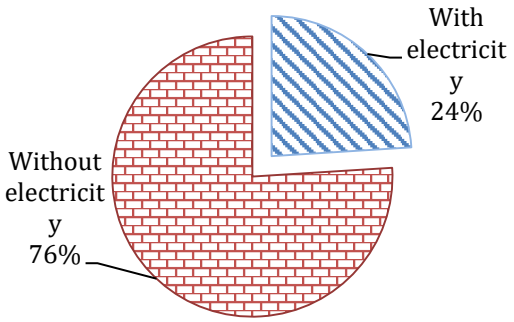
Photo 6.5: Domestic level tube well

6.11.3 Electricity and fuel consumption

305 Electrification as reported in the Population Census is not satisfactory in the polder area. On an average, only 21% households are under electricity coverage. BBS data shows Bara Beghai union comprises highest (25%) electricity coverage whereas Chhota Beghai and Gulishakhali union comprises lowest (17%) coverage. Moreover, almost 25% households now use solar electricity in the polder area (CEGIS fieldwork, 2014). Traditional fuels such as wood, cow dung, chips etc. are usually used by the households. Cow dung sticks are stored for wet season use. People also collected naturally produced herbs and shrubs and dried up for using as fuels.

Table 6.20: Distribution of electricity connection by union at polder area

Unions	Electricity Connection (%)
Atharagashia	12.8
Gulisakhali	17.5
Bara Bighai	25.3
Chhota Bighai	17.1
Auliapur	18.8
Jainkati	34.7
Kalikapur	44.7



6.12 Social amenities

Roadways

306 Road networks and communication system is not better in the polder area. Local people communicate through both roadways and waterways. There are some roadways cum embankments along the polder which are often threatened to river bank erosion and homestead damage (Table 6.21 and Photo 6.6). The peripheral roads of the polder are of different types such as paved, brick soling and earthen road.

Table 6.21: Road network in polder

Destination	Status	Length (km)
Titkata to Khatashiya bazaar to Patuakhali sadar	Paved	24
Titkata to Uttar Bara Beghai	Semi paved	4
Titkata to Dakkhin Titkata	Earthen	4
Chhota Beghai to kajir hat to Patuakhali Sadar	Paved	15
Hajikhali to Botolbunia	Paved	5
Hajikhali to Patuakhali	Paved	12
Hajikhali to Madarbunia	Earthen	8
Auliapur to Sharifbari	Paved	4
Siyakathi to Bodura bazar	Paved	6
Musirpul to Badura bazar	Paved	7
Fotulla to hasher Mirza's House	Paved	2
Mukul to Peda bari	Paved	1.5
Masuakhali to Kazibari	Paved	1
Total		**93.5**

Source: CEGIS field work, 2014

Photo 6.61: Soling and paved road in the polder

Markets and growth centers

307 The current status regarding market and growth center at polder area is not satisfactory. There are only three growth centers and 30 markets/bazaars are observed in polder 43/2D area. According to local people, these facilities are not enough to serve all necessary purpose in their day to day life.

6.13 Socio cultural capital

6.13.1 Social safety nets

308 A number of local, national and international NGOs are working in the polder area. The main activities of these NGOs are operating micro credit programs among the rural poor and landless women/men. The major NGOs working in the area include BRAC (Bangladesh Rural Advancement Centre), ASA (Association for Social Advancement), Space Bangladesh, Ahsania Mission, CCDA (Centre for Community Development Assistance), Heed Bangladesh (Table 6.22 and Photo 6.7). These NGOs are serving with micro credit while BRAC working for non-formal education, Health, human rights, water and sanitation, gender and children development programs. About 45% of households are found to benefit from the NGOs interventions. After disasters (Sidr and Aila) the Nobolok has become one of the most important NGO for the local people.

Table 6.22: NGOs and their programs in polder area

NGOs	Type of Programs						
	Credit	Education	Water and Sanitation	Health	Seeds	Gender	Children
BRAC	✓	✓	✓	✓	✓	-	-
ASA	✓	-	-	-	-	-	-
Ahsania mission	✓		-	-	✓	-	-
Space bangladesh	✓	-	-	-	-	-	-
Grameen Bank	✓	-	-	-	-	-	-
Heed Bangladesh	✓	-	-	-	-	-	-
CCDA	✓	-	-	-	-	-	-

Source: CEGIS fieldwork, 2014

Photo 6.7: Some glimpses of social safety net programs

6.13.2 Rituals and festivities

309 Muslims are the dominant inhabitants (95%) of the polder area followed by Hindus and a very few Christians. In terms of rituals and festivities, there exists good social bonding and cohesion between the Muslims and Hindus. Muslims mainly gather for their largest religious festivals as Eid-ul Fitr, Eid-ul Azha, amid much fanfare and festivity during occasion. On the other hand Hindus and other religions group take part their rituals and festivities simultaneously in a peaceful way (Photo 6.8).

Photo 6.8: Mosque and graveyard at polder area

6.13.3 Common Property Resources

310 The common property places/resources of the area are different social amenities e.g. mosques, graveyards, temples, crematorium, playgrounds and Eidgahs (place for offering Eid prayers). These are used frequently by the local people for the purposes of religious, social and cultural gathering. Besides these, the BWDB embankment is also used very commonly for different livelihood purposes of the local inhabitants.

311 There are 158 mosques, 31 temples, 18 Eidgah, 15 graveyards and 9 crematoriums in the polder area. Besides there are 15 cyclone shelters among them 7 are under construction (Table 6.23). However, there are no known historical and archeological sites declared by government in the Polder area.

Table 6.23: Common property places/resources in polder 43/2D

Unions	No of Mosque	No of Temple	Eidgah	No of Graveyard	No of Crematorium	No of Cyclone Salter	
						Functional	Under construction
Atharagashia	33	2	8	6	2	3	-
Gulisakhali	32	10	10	5	2	4	2
Bara Bighai	64	10	2	4	2	4	2
Chhota Bighai	44	6	2	3	2	3	2
Auliapur	46	2	6	10	3	2	1
Jainkati	16	4	5	12	2	3	-
Kalikapur	14	2	5	6	2	2	-
Madarbunia	18	5	4	3	3	4	1
Marichbunia	15	5	3	4	3	3	1
Total	158	31	18	15	9	15	7

Source: Union website, 2014

6.13.4 Conflict of interest

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

6.14 Poverty Situation

Self-assessed poverty

313 Poverty profile has been prepared by the participants of the RRA themselves through a self-assessment exercise. The assessment is based on the year-round income along with the food consumption of the inhabitants within three different categories (Figure 6.4). It is observed that about 45% of the households in average are in the 'deficit' category, 8% are surplus and rest of 47% households are in balance situation. These households have been identified in the RRA as the poor households of the Polder area. Considering the standard consumption of food (three meals in a day), the deficit group was usually taking two meals in a day in the lean period since they could not afford three full meals.

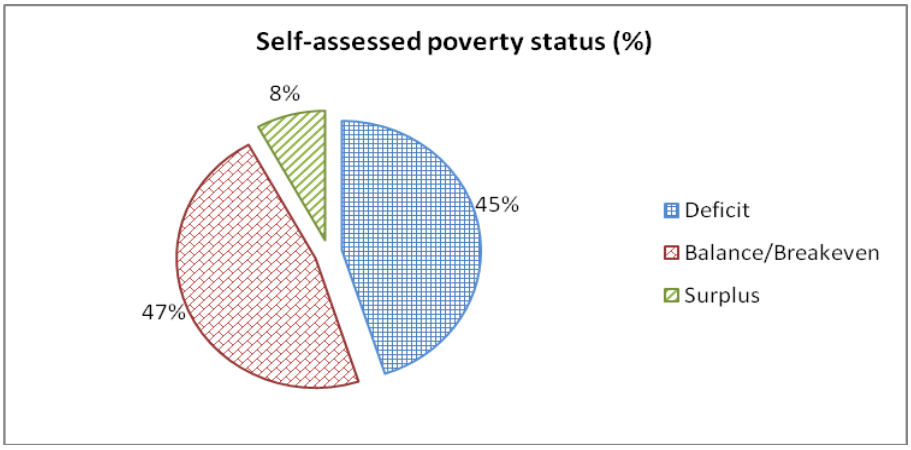


Figure 6.4 Self-assessment of poverty status

Source: CEGIS fieldwork, 2014

6.15 Gender issue

a. Education enrolment

314 Enrolment in education shows the difference regarding attending and not attending school for both sexes. In terms of attending school both male and female rate of education for 6 to 10 years and 11 to 14 years is almost similar while this situation is very awful for higher studies. It is clear that women are still backward than the male counterpart to become educated. This tradition has now been changing and people of the area are now concentrating on female education.

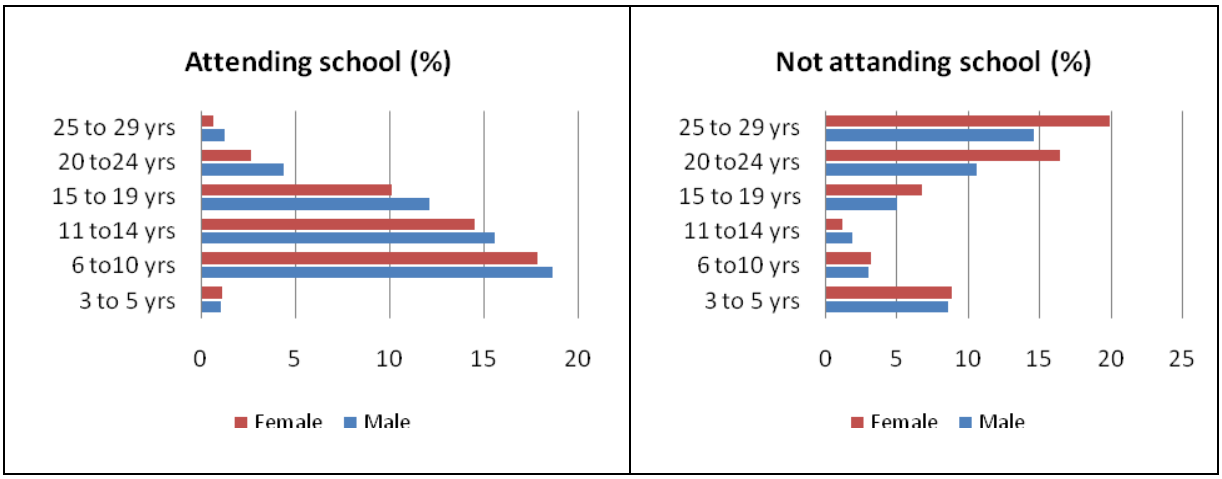


Figure 6.5: Male-female education enrolment at polder area

Source: Population Census 2011, BBS

b. Health

315 About 18 % women are living with good health condition and the rest are suffering from various diseases such as low blood pressure and premature delivery. About 15% women are getting proper nutrition and about 10% have access to the health centers. Mortality rate of the pregnant mother during delivery period has reduced over times which are mainly due to the growing consciousness among the local people as well as the health services provided by the public and other health centers including the programs of NGOs (CEGIS fieldwork and union office, 2014).

c. Employment

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

d. Empowerment

317 In the polder, women's status has changed greatly during the last few decades. Many of the Hindu women have come out of the kitchens. They are working hand in hand with men in all spheres of work i.e. earthwork, tailoring, teaching etc. Like other part of the country, Muslim women are little bit restricted to household works. They mostly stay at home except when going for medical treatment, fetching water and visiting relatives.

e. Vulnerable communities

318 In the Project area, three types of people could be considered as vulnerable. These include marginal farmers having less than monthly income Taka 6,000, fishermen, and women headed households. Local economy is mostly agriculture based and most of the land owners cultivate their land by themselves. Some of the land lords give their land for sharecropping to the marginal farmers and other vulnerable groups. Some people of the polder depend on fishing from the open water bodies. According to local people, about 10% male population and 5 percent female population is involved in fishing or fish culture. Besides, almost all households catch fish for their daily use during monsoon.

7 Public Consultation and Disclosure

7.1 Introduction

319 The GoB as well as development partners place great importance on involving primary and secondary stakeholders for determining the environmental and social impacts associated with project implementation. Participation of stakeholders is an integral part of the EIA process. It is required to gather local knowledge for baseline conditions, understand perceptions of the community regarding impact significance, and propose meaningful mitigation measures. During the present EIA, an attempt has been made to consult with a full range of stakeholders to obtain their views on Project interventions. According to the EIA Guidelines of the DoE, public participation is obligatory for the EIAs of the Red Category projects. Public participation through consultations in the water sector project is also mandated according to the Guidelines for the Participatory Water Management (GPWM) of the BWDB.

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

7.2 Objectives of stakeholder consultation

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

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

7.3 Identification of stakeholders

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

7.3.1 Primary Stakeholders

323 Primary stakeholders are people who would be directly benefited or impacted by a certain project intervention. In case of the proposed Project in Polder 43/2D, 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, fishermen, 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.

7.3.2 Secondary Stakeholders

324 This category of stakeholders pertains to those who may not be directly affected but have interests that could contribute to the study, play a role in implementation at some stage, or affect decision making on Project aspects. Secondary stakeholders for the Project include local government institutions (LGI), Bangladesh Water Development Board, the Ministry of Water Resources, Department of Forest, other government agencies, academia, NGOs, the Blue Gold officials at Patuakahli, the Netherlands govt. officials and general public at large.

7.4 Approach and Methodology

325 Participatory approach was followed in conducting the public consultation meetings in the Polder 43/2D. The consultants discussed first with the BWDB officials and then the Upazila Parishad Chairman (UZPC) and/or the Upazila Nirbahi Officers (UNOs), the Blue Gold officials, the Project Implementation Officers (PIOs) of the polder area to share the Feasibility and EIA process of the Blue Gold program. The BWDB and local government officials/representatives were consulted to identify the potential stakeholders at the Polder level.

326 Focus group discussions (FGDs) were carried out during in the public consultation process. In order to conduct the FGD and consultation meetings, five checklists were prepared covering the aspects including an overview of the proposed Blue Gold program, information on the ongoing EIA process, and seeking information on the problems of the area with their potential solutions, the local needs and demands have been discussed by giving equal opportunity to all participants attending in the meeting. During consultation meeting all relevant issues within the water resources, land resources, socio-economic resources, and disaster aspects were discussed in detail.

327 During the FGDs and consultation meetings, the EIA team displayed maps of the Project area, shared the initial concepts on proposed interventions and facilitated the response of the participants. The stakeholders of the Polder 43/2D were asked to share their needs, problems, possible sustainable solutions, and their views on the Project interventions. The stakeholders' perceived views on important environmental and social components (IESCs) and Project's impacts on them, along with perceived benefits, risks, threats and demand from the Project were identified during discussions.

7.4.1 Consultation Process

328 A PCM and number of consultation meetings and FGDs were conducted at different locations of the Polder 43/2D. The details of these meetings and FGDs are presented in Table 7.1 and some photographs of these meetings are given in Photo 7.1 to 7.2.

Table 7.1: Consultation Details

Sl	District	Upazila	Union	Meeting venue	Type of consultation	Meeting date	Time
1	Patuakhali	Sadar	Sadar	Blue Gold office	Sharing meeting with Blue gold officials	25/05/2014	10:00
2	,,	,,	Madarbunia	Chatua sluice gate	FGD	26/05/2014	10:00
3	,,	,,	Kalikapur	Kalikapur UP office	,,	26/05/2014	12:00
4	,,	,,	Auliapur	Auliapur UPP office	,,	26/05/2014	13:30
5	,,	,,	Morichbuina	Morichbunia UP office	,,	26/05/2014	15:30
6	,,	,,	Madarbunia	Madarbunia UP Hall Room	PCM	18/11/2014	10:00
7	,,	,,	Morichbunia	Morichbunia UP Hall Room	PCM	19/11/2014	10:00

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

Photo 7.2: Meeting at BWDB office; Patuakhali

Photo 7.3: Meeting with Chairman, Kalikapur

7.4.2 Consultation Participants

329 The main participants of these consultation meetings included Blue Gold officials, local representative, farmer, trader, members of WMO and daily-wage laborers of the Polder 43/2D and nearby areas. A total of 80 participants attended these consultations. The participant details are provided in Table 7.2 and Photo 7.4 to Photo 7.7 below.

Table 7.2: Participant details

Sl	Meeting venue	Type of consultation	Type of Participants	No. of participants
1	Blue gold office	Consultation	Secondary stakeholders	10
2	Chatua sluice gate	FGD	Primary stakeholders	20
3	Kalikapur UP office	"	,,	15
4	Auliapur UP office	"	,,	20
5	Morichbunia UP office	"	,,	15
6	Madarbunia UP Hall Room	PCM	Both primary and secondary stakeholders	43
7	Morichbunia UP Hall Room	PCM	Both primary and secondary stakeholders	45

Photo 7.4 Consultation with local people at Murichbunia

Photo 7.5: Consultation at Chatua sluice gate, Madarbunia

Photo 7.6: Consultation at Hajikhali, Fatulla


Photo 7.7 Consultation at Auliapur UP

Photo 7.8 A View of PCM at Madarbunia UP Hall Room

Photo 7.9 A View of PCM at Morichbunia UP Hall Room

7.5 Issues discussed in FGDs and meetings

330 At the outset of these meetings and FGDs, an overview of the proposed Project including the ongoing activities of the implementing agencies and the EIA process was shared with the participants. Subsequently, the key environmental, social, and socioeconomic aspects listed below were discussed.

- **Water resources:**
    - Surface water (tidal flooding, drainage, salinity, siltation)
    - Water management (flood control, drainage, irrigation)
- **Land resources:**
    - cropping practice,
    - production and yield,
    - water logging and drainage congestion
    - Crop damage.

- **Socio-economic aspects:**
    - Occupation and Employment (unemployment/joblessness)
    - Migration (temporary/permanent out-migration)
    - Poverty (food and income poverty)
    - Education (poor literacy rate, non-schooling, less female education, drop out etc)
    - Health and nutrition (illness, diseases, poor nutrition)
    - Quality of life (poor housing and sanitation facilities, scarcity of drinking water, fuel and fodder)
- **Disasters**:
    - Cyclones
    - River erosion
    - Associated damages
- **The sustainable and integrated solutions of the main problems being faced in the Polder:**
    - Water 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 their water resources and to make these resources more productive.

7.6 Community Concerns and Suggested Solutions

331 The outcomes of the FGDs and consultation meetings in terms of concerns and the suggested solutions were noted and organized according to themes are presented in the Table 7.3 below.

Table 7.3: Community concerns and suggested solutions

Themes/Topics	Concerns/Issues/Problems	Suggested Solution/Remedies
Overall	Drainage congestion due to siltation at certain parts of the polder and poor communication system are the main community concerns in the polder area.	Comprehensive rehabilitation of the polder should be taken up at the earliest with the active involvement of the local community.
Water resources	- Drainage Congestion is the most prominent water related concern of the polder, with nearly 45% of the khals within the polder suffering from it - Tidal Flooding is another issue. Around 230 ha areas in Hajikhali, Hajikhali Abad, Gerakhali etc. suffer from regular tidal flooding in the area - Water Availability is another concern. With very low flow in some of the silted up khals, the local people suffer from surface water shortage at some places for their domestic use	- Khal re-excavation - Repairing of sluice and re-excavation of khals - Khal re-excavation - Use of net jal should be prohibited to remove the canals from water hyacinth
Agriculture resources	- Drainage congestion during transplanting period in Aman season; - The level of sea water increases due to impact of climate change which is responsible for natural calamities such as tidal surge, cyclone etc. - Scarcity of irrigation water in dry season especially for rabi crops cultivation; - The siltation caused raise of bed of different internal drainage khals; and - Repair of embankment to control outside water.	- Repair of sluice gates - Re-excavation khals - Repair of embankments. - Training for WMAs
Fishery resources	- Reducing depth of internal khals and habitat quality degradation due to siltation - Fish and hatchling movement disrupted due to properly operation of water control structures. - Indiscriminate fishing by Sluice net	- 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
Ecological resources	- In the polder area, tidal flood and drainage congestion are the main threats for sustainability of ecosystem. - Most of the wetlands, especially khals were found silted up. Non-functioning of water control structures like regulators, causes insufficient drainage facilities which arises drainage congestion to khal surrounding areas (Hajikhali, Hajikhali abad, Garakhali, Tfalbaria	- Re-sectioning and repairing of embankment, - Repairing water control structure along the embankment to protect settlement, road, inter tidal floodplain area and crop fields from existing problem.

Themes/Topics	Concerns/Issues/Problems	Suggested Solution/Remedies
	village) during heavy rainfall. In addition, the existing embankment cannot protect tidal surge as well as saline water intrusion in country side when cyclonic storms occur. As a result huge amount of vegetation including homesteads and crop fields are damage. Damages of vegetation are severely impacted on dweller wildlife like local birds, mammals, reptiles etc due to habitat destruction.	
Socio-economic resources	- Some of the road networks of the polder are damaged which, creates problems in regular communication system. - The proposed khals which will be excavated are basically occupied by local elites. The local elites used the water of these khals for fish culture or other purposes and create disruption to mass people. - 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. - Strengthening of WMGs so that mass people can access to open water bodies easily. - It is needed to ensure sustainable operation of the project, participation of Water Management Organization (WMO) and Community Based Organizations (CBOs) and also manage properly water control structures i.e. embankment, sluice gate, regulator, inlets, culverts etc and growing of consciousness among the community in the polder. - The Government should rehabilitate the affected farmers who are affected by salinity intrusion; - Need awareness building about water management among the communities. - The payment of the labors should be paid in time;

7.7 Perceptions towards proposed interventions

332 The intervention 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 43/2D.

7.8 Participant list

333 The name of the participants of different meetings, their age, occupation and address including cell phone number (if any) are provided in Table 7.4. The list of participant of the PCM are presented in Appendix 5.

Table 7.4: Name of participants

SL	Name	Gender	Occupation	Age	Address/Mobile No
1	Tanvir Ahmed	M	Chairman, Kalikapur UP	44	01731-129004
2	Md. Rubel Mridha	M	Chairmand, Murichbunia UP	42	01713-952371
3	Omar Faruk	M	Secretary, Murichbunia UP	45	01714-598027
4	Altaf Hossain	M	Chairman, Auliapur UP	50	01748-934852
5	Abdur Razzak Mirza	M	Service	42	01713-961649
6	Md. Siddiqur Rahman	M	Member, Auliapur Up	35	01838-948935
7	Md. Faruk Azam	M	President, WMA	56	01768-955316
8	Kazi Nazrul Islam	M	President, WMG	60	01718-832592
9	Tahmina Akhter	F	Sociologist, Blue Gold Program	48	01712-818720
10	Md.Khalil Sikdar	M	Agriculture	45	01721-809296
11	Md. Jakir Hossain	M	Business	25	01725-439065
12	Habibur Rahman	M	Agriculture	30	01747-696808
13	Md. Chan Miya	M	Business	60	01743-378682
14	Nakib Matobbor	M	Agriculture	70	-
15	Md. Shanu Hawladar	M	Business	40	01621-610019
16	Mijanur Rahman	M	Business	30	01834-817194
17	Md. Rasel	M	Business	18	01777-494637
18	Rafik Gazi	M	Agriculture	35	-
19	Kabir Matobbor	M	Agriculture	40	01740-496426
20	Md. Yusuf	M	Agriculture	28	01739-620491
21	Md. Hemayat Uddin	M	Student	20	01774-949585
22	Nur Mohammad	M	Agriculture	25	01830-643465
23	Md. Ismail	M	Business	50	01773-433937
24	Md. Forkan	M	Teacher	50	01732-057671
25	Md. Ruhul Amin	M	Business	43	-
26	Md. Zahirul Islam	M	Agriculture	40	01721-186429
27	Md. Abul Khayer	M	Agriculture	24	01751-172882
28	Saidul Islam	M	Business	38	01914-720409
29	Md. Abul Kalam	M	Agriculture	28	01915-896197
30	Md. Zakir Hossain	M	Agriculture	41	01717-808981
31	Md. Shah Alam	M	Agriculture	43	01712-262675
32	Md. Bashir Ahmed	M	Agriculture	38	01710-021733
33	Md. Atahar Uddin	M	Business	59	01743-412971
34	Md. Mossarraf Hossain	M	Business	38	01714-572579

8 Identification, Prediction and Evaluation of Potential Impacts

8.1 Identification of IESCs and Rationale

334 The proposed interventions will not affect all environmental and social components. Some environmental and social components will be impacted while others will be independent of the interventions. Environmental and social components likely to be impacted by the project interventions are termed as Important Environmental and Social Components (IESCs). The IESCs have been selected based on the rationale are presented in Table 8.1 below

Table 8.1 Identification of IESCs and Rationale

IESCs	Rationale
Water Resources	
Drainage Congestion and Water Logging	The re-excavation works in the khals may improve the drainage status of the area, and diminish the risk of emergence of water logging problems at some portions of the polder. Therefore, drainage congestion and water logging has been considered as another IEC.
Surface Water Availability	Due to khal re-excavation works, the availability of surface water in Polder 43/2D may be increased and this might facilitate the multi-purpose use of water. As such, Surface Water Availability has been selected as an IEC.
Land and Agricultural Resources	
Cropping intensity	The Project intervention may change the hydrologic regime inside the project area, which may encourage the farmers to change their cropping patterns. This may increase the cropping intensity in consideration of which cropping pattern has been selected as an IEC
Crop production	Agricultural crop production is expected to be increased due to the improvement of drainage congestion due to excavation of Khals. The crop damage would be reduced due to repairing of embankments. The re-excavation of khals would help to drain out excess water from crop field. Repairing of sluice gate might prevent the intrusion of saline water. The Excess rain water inside the polder would be drained out through regulators that might help to cultivate the HYVs rice. Moreover, the surface water may be stored in the re-excavated khals which would be used as 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 project area due to water lodging in the pre-monsoon and rainy season, drainage congestion, drought, etc. which are expected to be reduced through implementation of the proposed interventions. Reduction in crop damage would be reflected in aerial extent in consideration of which crop damage has been selected as an IEC.
Tidal Flooding	At present, some of the sluice gates and drainage outlets are not functioning up to the desired level. If the sluice gates are repaired, surplus entry of tidal water may be regulated. Furthermore, better control on drainage is to be expected. Moreover, the khal re-excavation works would facilitate the water courses with more water

IESCs	Rationale
	carrying capacity, which might impact on the regular tidal flooding phenomenon. Therefore, tidal flooding has been considered as an IEC.
Irrigated area	Surface water is more preferable over ground water for irrigation use because of its low cost and sediment content contributing towards maintaining the soil nutrient status. The proposed interventions are expected to increase the availability of surface water for irrigation use in consideration of which irrigation has been selected as an IEC.
Fisheries Resources	
Fish Habitat	The proposed interventions of the project are likely to alter the fish habitat as well as habitat quality in the polder area. Increased water depth may support different fish species. In this context, fish habitat quality has been considered as an IEC of the study.
Hatchling and fish Movement	A numbers of khals are connected with the peripheral rivers. Most of the khals are silted up but till there is a scope of hatchling as well fish movement from river to khal and tidal area especially in monsoon. The proposed interventions like repair of regulators and re-excavation of khals may have considerable change in fish hatchling movement in the polder area. Thus hatchling and fish movement has been considered as an IEC.
Fish Biodiversity	The polder area is tidal in nature and comprises both of fresh and brackish water fish species. More than100 of fish species are reported in the study area. The brackish and fresh water fish species are declining due to habitat losses, obstruction of migration routes, degradation of fish habitat quality etc. Moreover, the proposed intervention may change the fish migration which might change in fish species diversity in the polder area. So, fish diversity has been considered as IEC of this study.
Capture Fisheries Productivity	Culture fisheries still contribute significantly on fish production in the polder area. The proposed interventions especially culture fisheries may change the fish abundance which ultimately may increase the fish productivity of fisheries in this area. Due to increased depth and improved water quality for re-excavation of khal, it is expected that capture fisheries productivity inside the polder may be changed. So, fish productivity has been considered as an IEC of this study.
Ecological Resources	
Embankment and inter-tidal Vegetation	Embankments slopes and inter-tidal area of khals and river banks possess vegetation which is an important component of the existing ecosystem. This type of vegetation provides habitat for wildlife animals. 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, embankment and inter-tidal vegetation has been identified as an IEC.
Aquatic habitat	Aquatic habitat condition of an area mainly relies on water quality, depth, velocity, salinity as well as abundance of, aquatic flora and fauna. Poor drainage capacity of internal silted khals and non-functionality of water control structures also create drainage congestion at surrounding area in rainy season. Repair of water control structures and khal re-excavation may change water quality which may impact on aquatic habitat condition. Impacts can be both positive and negative in the long run. Hence, Aquatic habitat is considering as an IEC.

IESCs	Rationale
Socio-economic Condition	
Access to open water bodies	All the khals are recognized as one of the sources for surface water bodies at the polder. At present, mass people has limited access to open water body for instance, khals which are to be excavated in the proposed interventions. In most of the cases, local power elites occupied these khals for culture fish or any ohter purposes. Thus, it can be said that, if the proposed khals are reexcavated, it may change the pattern of social use of water and accessof mass to the khals. Therefore, access to open water bodies is regarded as an ISC.
Communication	The unhappiness in certain part of the study area prevails due to the condition of the existing communication system. The poor and damaged communication system keeps 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. Thus, communication has been regarded as an ISC.
Women empowerment	In polder area, most of the people are living under poor condition. Specially, women and widow who are dependent on others and do not have any definite sources of income are mostly vulnerable. It is proposed that about 40% of labour under total local constructing society (LCS) will be women. Thus, the employment opportunity for women in the construction works and during operation/maintenance phase can promote them into better life and livelihood. Thus, women empowerment is considered as an ISC.
Employment opportunity	The construction work will generate a significant amount of employment over its construction period to local people and other associated professionals. People will also be involved to carry put operation and maintenance related jobs to operate the hydraulic structures. It is expected that proposed intervention will create employment opportunities for different occupational groups. Hence, employment opportunity has been considered as an ISC.

8.2 Prediction and Evaluation of Potential Impacts

335 This section identified the prediction and evaluation of potential environmental and social impacts that may be caused due to various project activities during pre-construction, construction, and post-construction stages of already identified IESCs. Potential Proposed interventions which may cause potential environmental impacts during pre-construction, construction, and post-construction stages have been identified in Chapter 4. The following detailed investigations have been carried out to assess the magnitude of these prioritized impacts:

- RRA survey to assess the loss of vegetation, occupation, income and poverty levels of the affected households, etc.
- Environmental quality baseline monitoring of noise, surface water, groundwater and soil,
- Ecological surveys comprising vegetation, wildlife and fisheries covering both terrestrial and aquatic ecosystem,
- Land surveys in the Polder area comprising socio-economic status and environmental settings,
- Expert consultations, focus group discussions, and public consultation

8.3 Impact screening

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

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

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

Table 8.2: Screening Matrix

Project Phases and Activities	Water Resources			Land & Agriculture				Fisheries				Ecological		Socio-Economic			
	Drainage congestion & water logging	Tidal flooding	Surface water availability	Cropping intensity	Crop production	Crop damage	Irrigated area	Fish Habitat & quality	Hatchling and fish movement	Fish biodiversity	Fisheries Productivity	Embankment and inter-tidal Vegetation	Aquatic Habitat	Access to open water bodies	Communication	Women empowerment	Employment opportunity
Pre-construction																	
Labor, materials and equipment mobilization	-	-	-	-	-	-	-	-	-	-	-	-	-	-	I	-	MP
Site preparation	-	-	-	-	-	-	-	-	-	-	-	MN	I	-	-	MP	I
Construction																	
Re-excavation of khal	MN	-	MN	-	-	-	-	HN	HN	MN	MN	-	HN	MN	I	I	HP
Re-sectioning of embankment	-	-	-	-	-	-	-	-	-	-	-	MN	-	-	MN	MP	HP
Construction of retired embankment	-	-	-	I	I	I	-	-	-	-	-	MN	-	-	I	MP	MP
Embankment slope pitching and turfing	-	-	-	-	-	-	-	-	-	-	-	MN	I	-	-	MP	HP
Repairing of Drainage sluices	MN	I	I	-	-	-	-		MN	I	-	-	MN	-	I	I	I
Repairing of Drainage Outlets	I	-	I	-	-	-	-	-	MN	-	I	I	MN	-	-	I	I
Repairing of Flushing Inlets and Culverts	I	-	I	-	-	-	-	-	MN	-	I	I	MN	-	-	I	I
Post-construction																	
Checking the physical condition	-	HP	-	-	-	-	-	-	-	-	-	-		-	-	-	-

Project Phases and Activities	Water Resources			Land & Agriculture				Fisheries				Ecological		Socio-Economic			
	Drainage congestion & water logging	Tidal flooding	Surface water availability	Cropping intensity	Crop production	Crop damage	Irrigated area	Fish Habitat & quality	Hatchling and fish movement	Fish biodiversity	Fisheries Productivity	Embankment and inter-tidal Vegetation	Aquatic Habitat	Access to open water bodies	Communication	Women empowerment	Employment opportunity
of embankment during pre and post monsoon																	
Checking physical condition and function of water control structures	HP	HP	HP	HP	HP	HP	HP	HP	MN	-	-	-		-	-	-	-
Checking the functions of WMOs	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-

No Impact (-), Highly negative (adverse) impact (HN); Moderately negative impact (MN); Insignificant impact (I); Highly positive (beneficial) impact (HP); Moderately positive impact (MP).

8.4 Impact during Pre-construction Phase

338 There would be no significant impact on environmental and social components during this phase. The materials required for carrying out the proposed works would mostly be managed from the polder. On the other hand, some construction materials may be procured, which would be transported through water ways into construction site. This may generate some impacts, but are very minor in extent and may therefore be considered as negligible. There will be no movements of heavy vehicles or construction machineries, as all the associated works would be carried out through manual labor. No labor shed would constructed as all the manpower required to be involved in the project would be hired from inside the polder (local people would be engaged, in the form of LCS, WMC etc.). Considering these issues, a significant positive impact has been foreseen on the socio-economic condition during pre-construction phase of the project as described in the following Table 8.3.

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

IESC	Location	Baseline Condition	Impact	Impact (+/-)/ Magnitude (1-10)
Socio-economic Condition				
Activity: (i) Labor, materials and equipment mobilization (carrying as well as storing (ii) Site preparation				
Employment opportunity	Periphery and inside of the polder 43/2D where different activities will be initiated.	Most of the HHs income comes mainly from two sectors i.e. agriculture (45%) and fishing (32%). Both male and female are working here simultaneously	Local unemployed labors will be recruited in pre-construction of intervention work i.e. carrying and storing of materials, site preparation. Thus, the income of labor will increase temporarily	+2

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

8.5 Impact during Construction Phase

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

Table 8.4: Location Specific Impact Assessment Matrix during Construction phase

IESC	Location	Baseline Condition	Impact	Impact (+/-)/ Magnitude (1-10)
Water Resources				
There will be no impact during the construction phase.				
Land and agricultural resources				
There will be no impact during construction phase as excavated spoil materials will be used on existing embankment and non agriculture land.				
Fisheries Resources				
Activity: Re-excavation of khals				

IESC	Location	Baseline Condition	Impact	Impact (+/-)/ Magnitude (1-10)
1.Fish Habitat 2. Hatchling and fish movement	Mentioned in section 4.7.4 (Chapter 4)	All khals are seasonal. Average depths of these khals are (0.44-1.52) m is suitable for fish habitation. But habitat quality is degrading day by day. More than 100 fish species (both brackish and fresh water fish) are present.	Feeding ground of bottom dweller (e.g. eel fish, baila, crabs etc) fishes and habitat quality will be impacted temporary. But after one (01) year the habitat quality will improve. Fish production will be reduced temporarily about 0.8 ton per year.	-2
Activity: Repairing and Construction of Drainage Sluices				
Hatchling and fish movement	All existing sluices Construction of one new 1-vent sluice gate at Raja Baria khal (N: 22016'02.6", E: 90016'20.3")	Fish hatchling and some brackish water fish species move through the mal-functioned of regulator during high tide.	Movement of Fish hatchling and fish species like *Puti, Chingri, Baila, Pairsa, Chingri, Tengra* etc movement would be obstructed because of implementation of proposed intervention.	-1
Ecological Resources				
Activity: Re-sectioning of embankment				
Embankment and inter-tidal vegetation	Both sides of the embankment and at re-sectioning reaches.	Embankment side vegetation is dominated by medium sized trees, shrubs and herbs e.g. Kola, Tal Khejur,Babla, Shirish, Akand, Bhat, Hatisur etc which provide feeding ground for mammals, birds, reptiles and amphibians. Vegetation is facing risk due to tidal flooding, natural disaster and human activities	Temporary damages of herbs, shrubs, various type of grass and bushes due to soil dumping for re-sectioning work.; Relocation of wildlife due to loss temporarily of habitat	
Activity: Re-excavation of khal				
Aquatic habitat	All the khals which are proposed to be re-excavated	Vegetation 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 (i.e. Egrets) and fishese.g. Egret. 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 the both side of the khal. Different types of local avifauna roam here for their feeding. Reduced water area for siltation		
Activity: Construction of drainage sluice and outlet				
Aquatic habitat	One new 1-vent sluice gate site at Raja Baria khal one new drainage outlet site at Akubia khal;	Moderate in condition Composed of free floating plants, like Kochuripana Kutipana, Dhol kolmi, etc, which support habitat for fishes and Kingfisher, Egret, Snake, etc. Durba Gash *(Cynodon dactylon)*, Biskantali (*Polygonum* Sp.) and different types of marginal herbs like Dholekolmi (*Ipomoea aquatic*), Kasorti (*Eclipta* Sp),etc. are dominant along the both side of the khal. Different types of local avifauna roam here for their feeding. Reduced water area for siltation	Temporary reduction of habitat quality due to obstruct khal flow and connectivity with main river	
Socio-economic Condition				
Activity: (i) Re-sectioning of embankment (ii) Embankment slope pitching and turfing (iii) Re-excavation Khals (iv) Repairing and construction of drainage outlets (v) Repairing and construction flushing inlets				

IESC	Location	Baseline Condition	Impact	Impact (+/-)/ Magnitude (1-10)
Employment Opportunity	Periphery and inside of the polder 43/2D where different activities will be initiated.	About 35% of total population is employed, 49% is engaged in household work, only one percent is looking for work and about 16% of total population is not working	A lot of local labor will be needed in earth work, re-sectioning of embankment and afforestation, soil dumping and compaction and different repair works	+2
Women empowerment	Periphery and inside of the polder 43/2D where different activities will be initiated.	About 52% of female are working at household level whereas few of them are working here as a day labor or earth worker	According to the project work, the LCS entail 60% male and 40% female, all of whom would be engaged from the local area. Thus, employment access to women in the construction works and during operation/ maintenance phase will be promoted significantly and they can take part in different decision making processes.	+3
Communication	Different parts of the polder i.e. Nilkhola, Idukhali, Chatua, Auliapur, Kalikapur, Madarbunia	Road networks and communication system is not good in the polder area. Local people communicate through both the roadways and waterways.	Road network system may deteriorate or remain in same condition during construction period	-1

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

8.6 Impact during Post-construction phase

340 During post-construction phase, possible impacts of the proposed interventions on the selected IESCs have been assessed comparing the Future-without-Project (FWOP) condition with the Future-with-Project (FWIP) condition. The impacts on the IESCs under different resources are presented in the following sections and summary in of impact are presented in a tabular form.

8.6.1 Water Resources

a) Drainage congestion and water logging

Future without Project

341 The khals proposed for re-excavation need to drain out a large volume of water after any major rainfall events. At present, around 20 km of the khals suffer from high drainage congestion problems and 56 km khals face moderate drainage congestion. Another 37 km of the khals suffer from low congestion problems. If the re-excavation works are not carried out, around 12 km khals at Gerakhali, Pakshia and Chalitabunia mauzas with moderate drainage congestion problems will be subjected to high drainage

congestion problems and an additional length of 5 km khals with low drainage congestion problems near Auliapur might be converted to having moderate drainage congestion problems.

Future with Project

342 If the existing khals are re-excavated, drainage congestion problems in the khals with moderate drainage congestion problems (at Charabunia, Madarbunia, Hetalia etc.) would be diminished to a considerable extent. Rain water would be drained out properly from the area into the outfall river. However, around 15 km khals with high drainage congestion problems at Auliapur and Pacha Koralia; and 30 km khals with low drainage congestion problems at Marichbunia and Patukhali would still be affected by the problem.

Impacts

343 Considering the 'future without project' and the 'future with project' scenarios, it can be said that around 68 km khals (60%) would be benefited. the existing drainage congestion problems will be reduced significantly.

b) Surface water availability

Future without Project

344 At present, people from Polder 43/2D are suffering from water availability concerns.. Due to surface water scarcity , irrigation for HYV Boro during Rabi season cannot be provided at some locations. If the khal re-excavation works are not carried out under the Blue Gold program in Polder 43/2D, the entire polder community would suffer from water scarcity for different uses. The top-soil erosion and other anthropogenic activities in connection with land development may cause further siltation in the khals, and the water carrying capacity might further deteriorate. Water availability would be restricted and use of water could be constrained. The study team infers that around 30% of the people in Polder 43/2D might be suffering from water scarcity concerns if the re-excavation works are not carried out.

Future with Project

345 If the project is implemented, additional volumes of 94,586 m^3 of water would be made available in the water courses of the polder. Assuming 60% flow probability on an average in this additional volume of re-excavated khals, it can be said that the percentage of population under water deficiency would be reduced upto approximately around 10-12%. The khals to be re-excavated within the administrative jurisdiction of Madarbunia-Kalikapur WMA would bring in major benefits in water use as most of the khals in this portion of the polder are at severely deteriorated state.

Impacts

346 From the spatial distribution of Settlements it is observed that around 5,000 people (7%) in Madarbunia and Kalikapur unions would be guaranteed sufficient surface water availability, and this would result in immense benefits in water use. Domestic purposes of water would be served, and water for irrigation would also be available substantially.

c) Tidal flooding

Future without Project

347 At present around 230 ha area near Hajikhali, Hajikhali Abad, Gerakhali and Tafalbaria are subjected to regular tidal flooding. If the project is not implemented, more

area would come under the tidal flooding extent in future. The study infers that about 20 ha of additional area in Charabunia and Madarbunia mauzas would be flooded in future, if the proposed interventions (both khal re-excavation works and sluice gate repairing) are not carried out.

Future with Project

348 If the proposed interventions are carried out, the tidal flooded areas would considerably reduce. A significant portion of areas in Hajikhali, Hajikhali Abad, Gerakhali, and Tafalbaria would be improved. Furthermore, some area in Charabuina and Madarbunia might also be protected from any probable flooding events. The study infers that if the proposed interventions are carried out, the flooding extent would considerably be reduced to a value of about 50 ha.

Impacts

349 Flooding would be improved at around 80% existing impacted areas. Flooding would be reduced by around 200 ha areas in Hajikhali, Hajikhali Abad, Gerakhali, Tafalbaria, Charabunia and Madarbunia.

8.6.2 Agriculture Resources

a. Cropping intensity

Future without Project

350 Presently, cropping intensity is about 176%. The situation would be same or might decrease under FWOP condition. This may occur due to Land fallow land in Kharif-I and rabi season.

Future with polder

351 Cropping intensity would be increased due to implementation of interventions (re-sectioning of embankment, repair of sluice, re-excavation of khals etc. and its proper management). Therefore, this intervention would have positive impact i.e fallow land will become cropped area under the FWIP condition. It is expected that, cropping intensity would be about 215% in FWIP.

Impacts

352 It is expected that, cropping intensity would be increased about 39% under FWIP over FWOP.

b) Crop production

Future without Project

353 Presently, total crop production is 27,877 tons of which, rice production is about 15,312 tons and non-rice crop production is about 12,565 tons. The contribution of rice production is about 55% and non-rice is about 45% of the total crop production. Under the FWOP condition, the situation would be aggravated and the crop production would be about 24,207 tons due to increase of siltation of khals, drainage congestion etc.

Future with Project

354 The successful implementation of the interventions would have positive impact on crop production. The crop production would be boosted up significantly under the FWIP condition. The total rice production would be about 17,914 tons which would be about 30% higher than the production of FWOP. About 14,496 tons of non-rice crops would

also be produced under the FWIP condition which would be about 40% higher than that of FWOP (Table 8.4). The production of rice would be increased due to introduction of HYV Aman, Increased the area of HYV Boro and reduction of Lt. Aman and Lt. Aus rice area. Non-rice production would be decreased due to decrease of non-rice cropped area.

Impacts

355 Additional 4,088 tons rice and 4,115tons non-rice would be produced under FWIP as compared with FWOP (Table 8.5).

Table 8.5: Major Cropping Patterns under FWOP and FWIP Condition

Sl No.	Crop Name	Production (ton)				% of Change
		Baseline	FWOP	FWIP	Impact (FWIP-FWOP)	
1	Lt. Aus	1,402	1,101	2,102	1,001	91
2	Lt. Aman	13,137	11,978	13,326	1,348	11
3	HYV Aman	-	-	1,173	-	-
4	HYV Boro	773	747	1314	567	76
Total rice		**15,312**	**13,826**	**17,914**	**4,088**	**30**
5	Sesame	1,247	1,256	2,047	791	63
6	Khesari	1,288	1,507	1,037	-470	-31
7	Chilli	773	451	1,095	644	143
8	Mungbean	753	618	966	348	56
9	Sweet potato	8,118	6,182	9,016	2,834	46
10	Groundnut	386	367	335	-32	-9
Total non-rice		**12,565**	**10,381**	**14,496**	**4,115**	**40**
Total crop production		**27,877**	**24,207**	**32,410**	**8,203**	**34**

Source: Field information, 2014

c) Crop damage

Future without Project

356 Presently, total crop production loss is 1,361 tons of which rice is 1,218 tons and non-rice is 170 tons due to drainage congestion/water logging etc. The situation would be aggravated under FWOP condition i.e. crop damage would be increased by about 722 tons over baseline situation.

Future with Project

357 Crop damage would be reduced due to implementation of interventions and its proper management. Therefore, these interventions would have positive impact in reducing crop damage area as well as crop production loss. The total crop production loss would 589 tons of which 511 tons rice and 78 tons non-rice under the FWIP condition.

Impacts

358 It is expected that loss of crop production would be reduced by 1,324 tons rice and 196 tons non-rice crops under FWIP over FWOP (Table 8.6).

Table 8.6: Impact on Crop damage in the Polder Area

Sl No.	Crop Name	Production loss (ton)				% of Change
		Baseline	FWOP	FWIP	Impact (FWIP-FWOP)	
1	Lt. Aus	188	290	62	-228	-79
2	Lt. Aman	1,030	1,546	449	-1,096	-71
Total rice		**1,218**	**1,836**	**511**	**-1,324**	**-72**
4	Sesame	170	274	78	-196	-72
Total non-rice		**170**	**274**	**78**	**-196**	**-72**
Total crop production		***1,388***	**2,110**	**589**	**-1,520**	**-72**

Source: Field information, 2014

8.6.3 Agricultural Resources

d) Irrigated Area

Future without Project

359 Presently, irrigated area is about 450 ha. The situation would be aggravated under FWOP condition i.e. irrigated area would reduce to about 300 ha. This likely to occur due to siltation of existing khlas.

Future with Project

360 Irrigated area would be increased due to implementation of interventions (Re-excavation of khals and its proper management). Therefore, this intervention would have positive impact i.e. water would be preserved for supplementary irrigation under the FWIP condition. It is expected that, irrigated area would be about 578 ha in FWIP.

Impacts

361 It is expected that, irrigated area would be increased about 278 ha under FWIP over FWOP.

8.6.4 Fisheries Resources

a) Fish Habitat

Future without Project

362 Internal khals of Polder 43/2D is seasonal and most of them are silted up due to top soil erosion and silt transportation. Silts from the peripheral rivers enter into the polder through the water control structures. As a result, suitability for fish habitation are declining day by day. If the water control structures are not repaired, in future the siltation situation might be further aggravated. But floodplain fish habitat would be increased by 20 ha from the base condition (Map 5.3).

Future with Project

363 Water depth and surface water availability would be increased for re-excavation of khals in FWIP condition. The increased water depth as well as improved water quality would create congenial environment for habitation of different types of fish species at the excavated khals. Besides, repairing of water control structures would prevent saline water intrusion inside the polder area which would increase the habitat quality. Due to properly drainage of water from the polder area through theregulators and re-excavated

khals, the duration and water depth of seasonal beel as well as floodplain would be reduced. It is expected that floodplain area would be 50 ha (Map 8.3). Culture fisheries practices would be increased significantly due to reduction of flood risk and prevention of salt water intrusion. Many culturable ponds would be converted into cultured pond.

Impacts

364 The floodplain are would be decreased by 200 ha from the base condition. The area of khal would remain same. Water depth as well as water quality will be improved. The improved habitat quality will support different types of aquatic vegetation which would be helpful for fish feeding and habitation.

b) Hatchling and Fish Movement

Future without Project

365 Some particular brackish and freshwater fish species move from river to khal through malfunctioned sluice gate and drainage inlets. In FWOP condition, hatchling and fish movement would be facilitated round the year. Beyond this, the disruption of fish movement routes include substantially progressing khal bed siltation leading to reduced water depth, more in-stream barriers like cross fish pata etc.

Future with Project

366 The movement of hatchling and brackish and fresh water fish from river to polder area would be obstructed / regulated due to repairing of sluices and drainage inlets and outlets. Movement of brackish water fish species like Puti, Chingri, and Baila Pairsa, etc which moves on the regular basis during high tide would be impacted. But internal fish migration would improve for the re-excavation of khals. Beside these, construction of one sluice (at Raja Baria khal) and four new inlets (1 at Thengai, 1 at South Auliapur and 2 at Barunbaria)will facilitate the fish movement inside the polder area.

Impacts

367 Hatchling movement from river to polder area through water control structures would be obstructed / regulated. Some brackish water fish species include Pairsa, Chingri, and Baila etc migrates on the regular basis during high tide would be impacted. But construction of new inlets would further facilitate to move a number of small fishes inside the polder area.

c) Fish Biodiversity

Future without Project

368 Fish biodiversity in the polder area is moderate. More than 100 species is reported to exist in the polder area. Due to continuous siltationof the khals and saline water intrusion through water control structures, brood stock at perennial khals are being disappearing. If the siltation continue, some fish species like Tengra, Koi, Shol, Taki , Puti, Shing, Baim would become rare or disappear from this area due to habitat deterioration. Besides, some rare and unavailable fish species like, Boal, Roina, Shing, Magur may disappear from the polder area. The fish species composition would be dominated by brackish water fish species.

Future with Project

369 The fish habitat both at khal and floodplain would become suitable for fresh water fish species. Thus capture fish species richness would be increased particularly by the small

indigenous species (SIS) of fish. Locally rare and unavailable fish species like Boal, Roina, Magur would be increase along with their abundance. In contrast, brackish water fish species like Bhetki, Pairsa, Chingri, and Baila etc which are commonly found in the internal khal would decrease from the polder area.

Impacts

370 Fresh water fish species including small indigenous species (SIS) and their composition would be increased. Brackish water fish diversity would be decreased.

d) Capture Fisheries Productivity

Future without Project

371 Due to ongoing process of siltation in the khals as well as saline water intrusion through malfunctioned regulators would cause less suitability for fish habitation in future. It is suspected that many of fresh water fish species may disappear from the habitat and feeding ground may also be disturbed. Hence, capture fisheries productivity from the internal khal would be reduced about 10% from the base condition.

Future with Project

372 In FWIP condition, the capture fisheries productivity would increase due to re-excavation of khal and repairing of regulators. On the other hand, improved drainage channel would reduce the flood duration in the polder area which would decrease the floodplain fish productivity. It is expected that the capture fisheries productivity from khal would be increased by about 15% from the base scenario.

Impacts

373 Habitat quality and productivity will improve. It is expected that about 15 % of fish production would increase when compared with base condition.

8.6.5 Ecological Resources

a) Embankment and inter-tidal Vegetation

Future without Project

374 Embankment and inter-tidal vegetation will be continuing to be at risk due to tidal flooding, natural disaster and human activities. Thus embankment and intertidal vegetation as well as dweller wildlife like local birds, mammals, reptileswould be impacted .

Future with Project

375 Existing trend of vegetation loss due to natural disaster will be reduced due to flood protection and re-sectioning of embankment. Due to construction of water control structures, existing khal bank side and crop field vegetation will be improved due to reduced drainage congestion.

Impacts

376 Embankment side and inter-tidal vegetation will be improved.

b) Aquatic Habitat

Future without Project

377 . Composition of aquatic vegetation may change slightly due to long time inundation of floodplain. Dominance of free floating plants will increase whereas decrease sedges and meadows will decrease. But in the long run, excess growth of these aquatic plants may tightly cover on the water surface and get rotten. For this reason, habitat quality will be deteriorating.

Future with Project

378 Aquatic habitat condition is expected to improve due to increased khal depth, regulated water flows. The temporary deterioration of habitat quality will diminish within 2-5 years by regenerating all existing aquatic plants. But vegetation composition will be change due to change of khal depth and velocity. Abundance of free floating species will be low during monsoon for regular flow velocity and high during dry season. On the other hand there is little scope to grow rooted floating plants inside the khal for the same causes.

Impacts

379 Aquatic habitat will be improved due to improvement of plant diversity as well as khal depth and flow velocity.

8.6.6 Socio-economic Condition

a) Access to open water bodies

Future without Project

380 Mass people cannot use open water bodies i.e. khals for bathing, washing and other purposes due to monopolization of these khals by local power elite. They often use these khals for culture fish or other purposes. In this situation, the percentage of medium access to open water bodies is 94% whereas 6% has poor access to water bodies (Map 8.4). Without project situation, salinity condition may increase and it creates more disturbances to mass people.

Future with Project

381 With the intervention, numbers of families will be benefited. They can use water in different social aspects. After implementation of the proposed project, 15% of the total household will have good access to water bodies and 79% will have medium access to open water bodies. A few percentages (6%) will have poor access to water bodies. Moreover, this would enhance social bonding and cohesion among them.

Impacts

382 The standard of living of the households of the polder will be benefitted since they will have access and sharing open water bodies which would ensure social use of water. Moreover, this would enhance their social bonding and cohesion in every aspects of life.

b) Communication

Future without Project

383 At present, road networks at some parts of the polder i.e. Hajikhali to Madarbunia, Auliapur to Sharipur, Musirpul to Badua, Nilkhola, Idukhali, Chatua, Auliapur, Kalikapur,

Madarbunia and many other places are very poor. In without project situation, communication system may deteriorate further into severe condition.

Future with Project

384 In with project situation, road networks system will be improved and ensure better communication facilities within the periphery of polder.

Impacts

385 Road communication will be improved which is likely to cause better economy by expanding business option to Patuakhali sadar to national level.

c) Women empowerment

Future without Project

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

Future with Project

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

Impacts

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

d) Employment opportunity

Future without Project

389 Employment opportunities are still not good. Because they are living under poor economic condition and they have very few options to develop or adapt this condition. Under the future without project situation, these sufferings may remain same or will be aggravated in future.

Future with Project

390 Proposed intervention can ensure improve quality of life. More income opportunity and employment in construction and maintenance of different interventions can ensure better life and livelihood of stakeholder of the polder.

Impacts

391 Creating new employment opportunities will increase income generation of the people which will ensure betterment and wellbeing as well as standard of life.

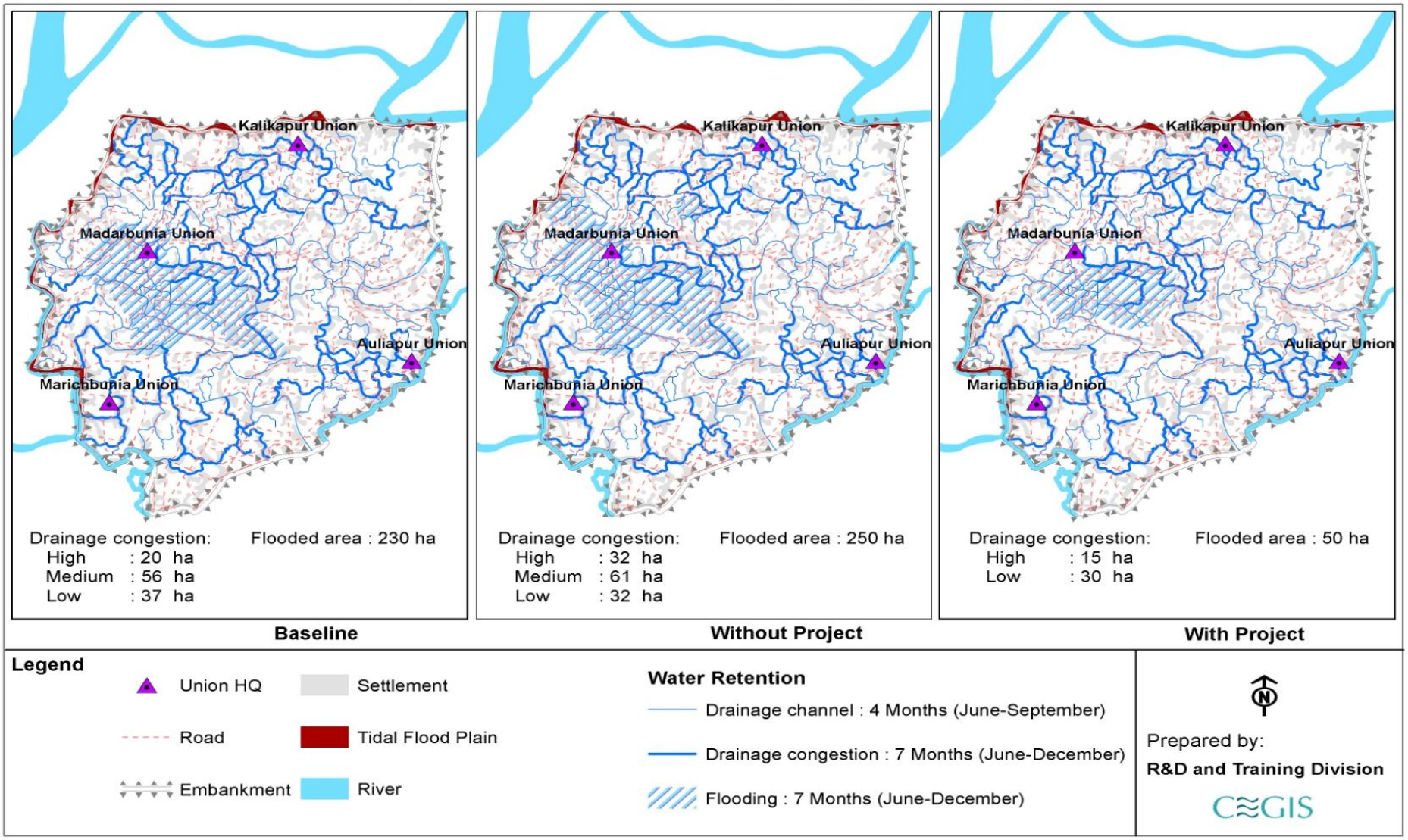
Table 8.7: Location Specific Impact Assessment Matrix under Post Construction Phase

IESC	Baseline	Future without Project	Future with Project	Impact (+/) / Magnitude 1-10
Water Resources				
Drainage congestion and water logging	Around 20 km of the khals suffer from high drainage congestion problems and 56 km khals face moderate drainage congestion. Another 37 km of the khals suffer from low congestion problems.	Around 12 km khals at Gerakhali, Pakshia and Chalitabunia mauzas with moderate drainage congestion problems will be subjected to high drainage congestion problems and an additional length of 5 km khals with low drainage congestion problems near Auliapur might be converted to having moderate drainage congestion problems.	Around 30 km khals would have low drainage congestion problems at Marichbunia and Patukhali and around 15 km khals would have high drainage congestion problems at Auliapur and Pacha Koralia; and	+5
Surface Water Availability	More than 20% population are suffering from domestic and irrigation water scarcity	Around 30% people might suffer from water scarcity concerns	Water deficiency for both domestic use and irrigation would remain at approximately around 10-12%.	+4
Tidal Flooding	Around 230 ha areas near Hajikhali, Hajikhali Abad, Gerakhali and Tafalbaria are subjected to regular tidal flooding.	Around 250 ha of areas in Hajikhali, Hajikhali Abad, Gerakhali, Tafalbaria Charabunia and Madarbunia mauzas would be flooded	Flooding extent would considerably be reduced to a value of around 50 ha.	+5
Agricultural Resources				
Cropping intensity	Cropping intensity is about 176%	Same or might decrease	Cropping intensity would be about 215%	+3
Crop production	Total crop production is about 27,877 tons of which rice crop is about 15,312 tons and non-rice is about 12,565 tons respectively.	Total crop production would be about 24,207 tons of which rice crop would be about 13,826 tons and non-rice would be about 10,381 tons respectively.	Expected that crop production would be increased by about 34% in FWIP over FWOP.	+4

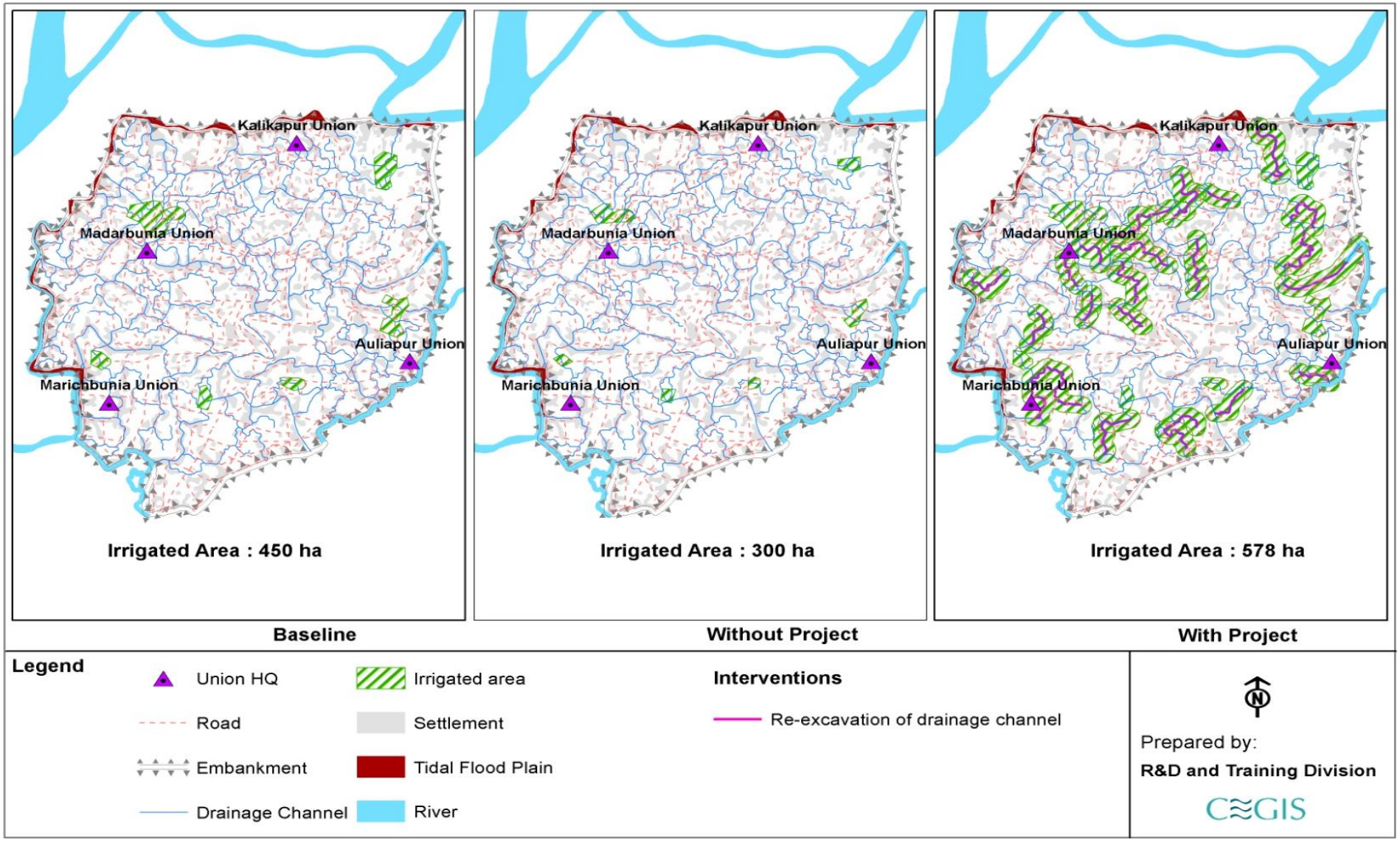
IESC	Baseline	Future without Project	Future with Project	Impact (+/) / Magnitude 1-10
Crop damage	Total crop damage is about 1,388 tons of which rice production damage is about 1,218 ton and non-rice production loss is about 170 tons.	Total crop damage would be about 2,110 tons of which rice production damage would about 1,836 ton and non-rice production loss is about 270 tons.	Expected that crop n damage would by decreased by about : Rice: 72% Non-rice:72% in FWIP over FWOP.	+6
Irrigated area	Irrigated area is about 450 ha.	Irrigated area would be about 300 ha.	Irrigated area would be about 578 ha	+4
Fisheries Resources				
Fish habitat	Floodplain fish habitat is 230 ha	Floodplain fish habitat would be 250 ha due to increasing of drainage congestation	-Floodplain habitat would be about 50 ha. It is expected that about 200 ha floodplain habitat would be reduced from the existing condition due to improved drainage network. -Habitat quality would be improved.	-2
Hatchling and fish movement	Some particular brackish and freshwater fish species move from river to khal through malfunctioned sluice gate and drainage inlets	Same as base condition	Hatchling migration would be hampered but internal fish movement would be increased	-1
Fish biodiversity	Moderate and 100 nos. of fish species is present.	Decline from the base situation	Richness of fish diversity will be improved.	+2
Capture fisheries productivity	Capture fisheries productivity is 165 kg/ha	Productivity would be decreased upto 148 kg/ha	Productivity would be increased up to 172 kg/ha	+1
Ecological Resources				
Embankment and inter-tidal vegetation	Moderate	Increase threats on surrounding vegetation due to drainage congestion, tidal flood, natural disaster and human activities. Most of the terrestrial faunal species are displaced due to	Vegetation loss will be reduced and floral species will be increased due to protection of area from existing flooding problems.	+3

IESC	Baseline	Future without Project	Future with Project	Impact (+/) / Magnitude 1-10
		vegetation damaged by existing problem.		
Aquatic habitat	Moderate	Aquatic habitat quality would be deteriorating due to death of aquatic plants.	Improved aquatic habitat due to improvement of plant diversity as well as khal depth and water velocity	+2
Socio-economic Resources				
Access to open water bodies	People can not use water for taking shower, washing and other purposes due to monopolization of khals by local power elite. They often use these khals for culture fish or other purposes.	Production of culture fish may increase and which eventually may create conflict with agriculture. As a result people's quality of life may be deteriorated.	With the intervention, numbers of families will be benefited. They can use water in different social aspects. Moreover, it will enhance social bonding and cohesion among them.	+2
Communication	Different parts of the polder i.e. Nilkhola, Idukhali, Chatua, Auliapur, Kalikapur, Madarbunia is good	Communication system may deteriorate into severe condition.	Road networks system will be improved and ensure better communication facilities within the periphery of polder.	+2
Women empowerment	In the polder area only 3 % women are working whereas 97 male members are engaged in income generating activities.	Women especially, the mostly vulnerable to distressed and widow who are dependent on will be more vulnerable and become burden to society.	The employment opportunity for women in the construction works and during operation/maintenance phase can promote them into better life and livelihood.	+3
Employment opportunity	At present, people of the Polder 43/2D are living under poor economic condition and they have very few options to develop or adapt with this condition.	The sufferings may remain same condition or will be deteriorated further	Proposed intervention would improve quality of life. More income opportunity and employment in different interventions would ensure better life and livelihood for stakeholder of the polder.	+2

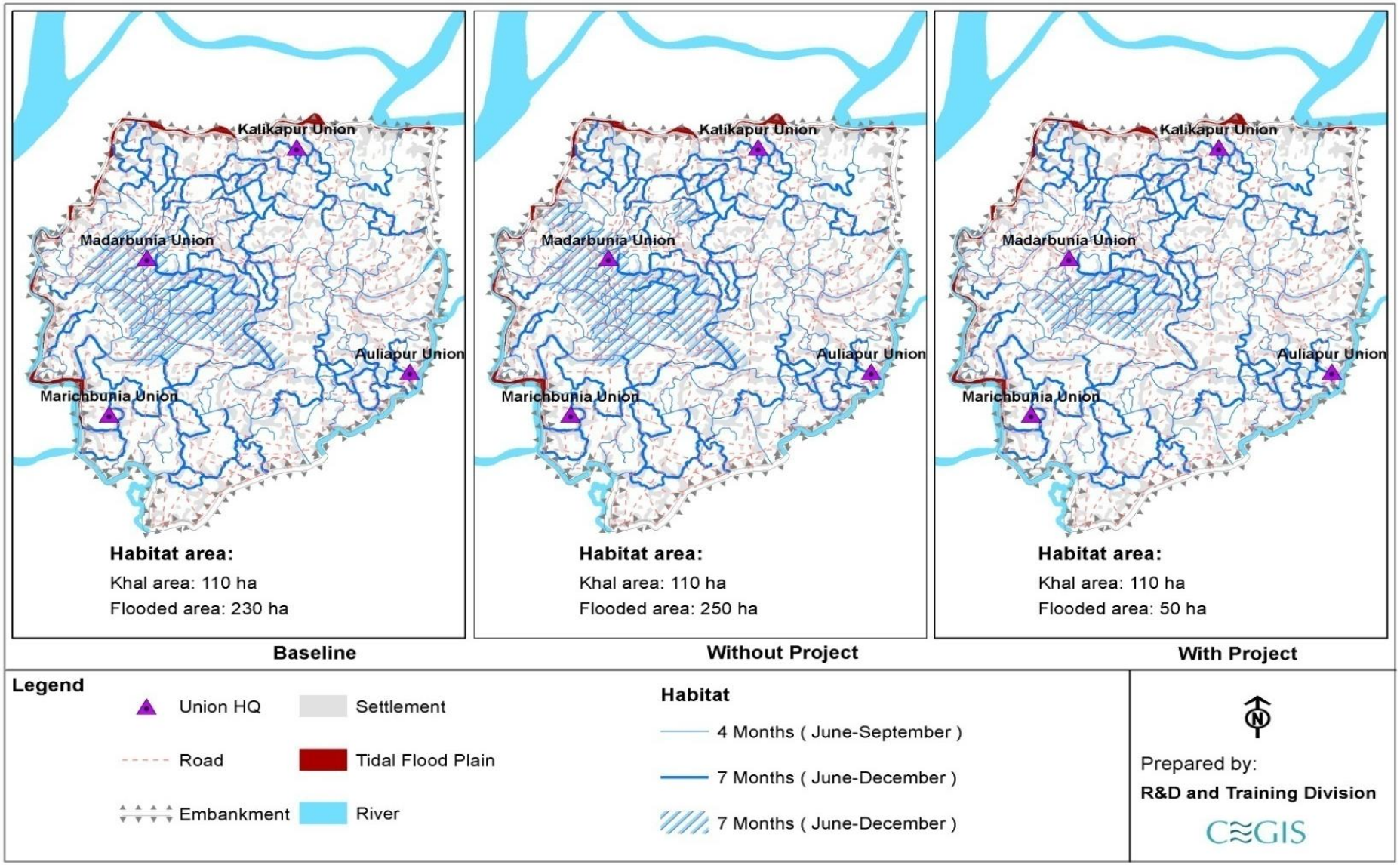
** Low impact (1-3); Medium impact (4-6); High impact (7-10)*



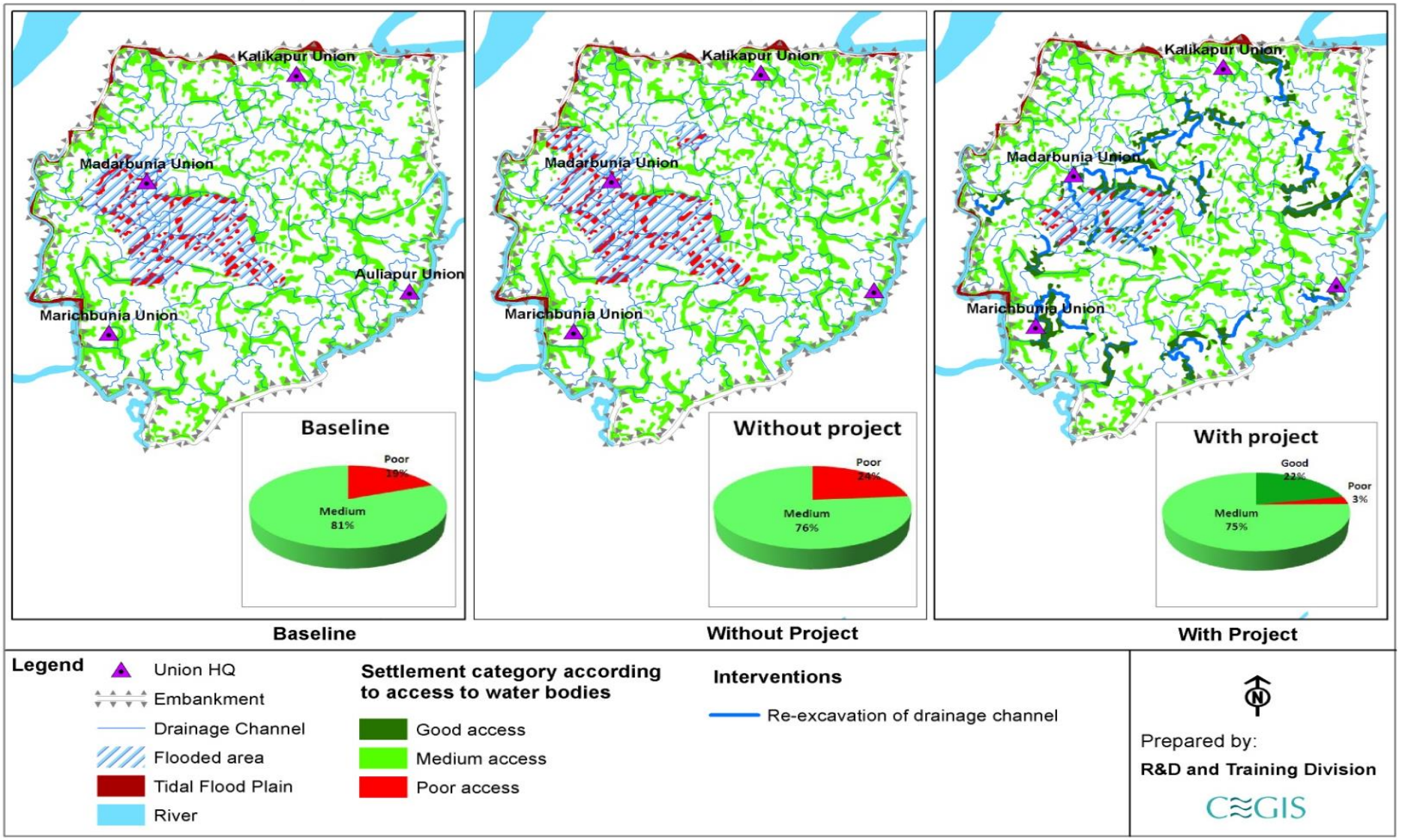
Map 8.1: Impacts on water resources : Drainage congestion and flooding



Map 8.2: Impacts on water resources : Irrigated area



Map 8.3: Impacts on fisheries resources : changes in fish habitat



Map 8.4: Impacts on access to open water bodies in future without project and future with project condition

9 Assessment of Cumulative, Induced and Reciprocal Impacts

9.1 General

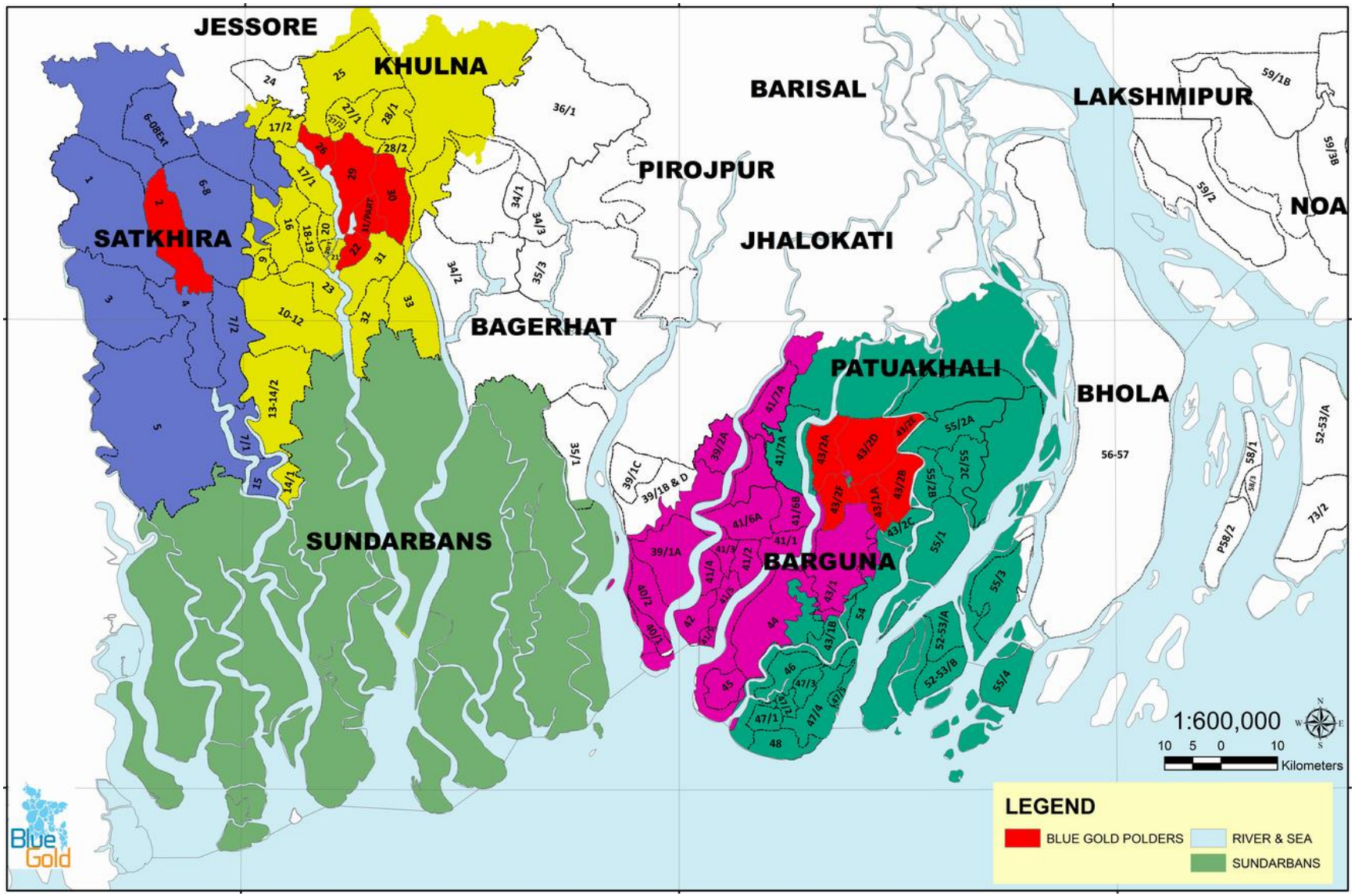
392 This Chapter attempts to analyze several indirect effects regarding the implementation of different interventions proposed under Blue Gold Program in Polder 43/2D. These effects include cumulative and induced impacts of Polder 43/2D, and the reciprocal impacts of climate change and polder. Cumulative impacts entail the total of all impacts to a particular resource that have occurred, or occurring, or may occur as a result of any action or influence in the surrounding area. In the vicinity of Polder 43/2D, a number of other projects also exist apart from the Blue Gold polders. Such projects are affecting the life and livelihood of people, environmental quality, natural ecosystem, flora-fauna etc. Induced impacts, on the other hand are the indirect effects caused for implementation of any project, but occur later in time or at a distance far away from the polder. The reciprocal impacts of climate change and polder include long term effects of climate change induced phenomena into the polder, and the climate change resilience developed in the particular polder due to implementation of Blue Gold Program.

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

393 A total number of 12 polders in Satkhira, Khulna and Patuakhali districts have been selected for implementation of the program in the first phase. The selected polders are shown in Map 9.1 below. Among these, five polders (Polders 43/2A, 43/2F, 43/1A, 43/2B and 43/2E) are located adjacent to Polder 43/2D and therefore may generate some impacts in future. The existing crest levels of Polder 43/2A ranges from 3.2 to 4.0 m above MSL, Polder 43/2F ranges from 3.70 to 4.10 above MSL, Polder 43/1A is around 3.30 m above MSL, Polder 43/2B ranges from 3.00 to 4.00 m above MSL, and 43/2E ranges from 3.80 to 3.90 above MSL. Rate of river sedimentation may increase along the peripheral rivers of Polder 43/2D, if embankment re-sectioning works are carried out along the adjacent polders. This is because when the crest levels of the adjacent polders would be raised up to an elevation of 4.27 m above MSL and some of the water control structures would be repaired and reconstructed, river flow may not enter the polders, and the sediments will be confined within the Gulishakhali and Gorai river systems. With reduced river sections along the Gulishakhali and Gorai rivers, tidal flow velocity might increase, which would create more pressure at some certain corners of Polder 43/2D and increase river erosion in future. Furthermore, storm surge and tidal inundation risks may increase for Polder 43/2D. Such risks would be transferred from the adjacent polders, as storm surge and tidal water levels may not be able to overtop the adjacent polders once the peripheral crest levels have been elevated (under the Blue Gold program).

9.2.1 Synopsis of projects around Polder 43/2D

394 Apart from Blue Gold interventions, there are some other programs and projects nearby Polder 43/2D, 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 43/2D, undertaken by different line agencies in Khulna.



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

Table 9.1: List of water management projects

Agency	Project Name	Duration	Location	Sensitivity	Remarks
National					
MoWR, BWDB	Construction of Ganges Barrage	Proposed but not implemented	Pangsha, Ganges River	High	
MoDMR	Comprehensive Disaster Management Program (CDMP), Phase II	2010- ongoing	Entire country (40 districts with direct interventions)	Low	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	Negligible	No ECRRP polder located adjacent to Polder 43/2D
BWDB	Coastal Embankment Improvement Project (CEIP)	2012- ongoing	Coastal zone	Negligible	No CEIP polder located adjacent to Polder 43/2D
	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	
	Construction of 464.75M PC Girder Bridge over Lohalia river	2013-ongoing	Patuakhali	Moderate	
DoF	Fisheries extension project	1994-2004	Patuakhali, Barguna	Negligible	
DPHE	Water Supply, Sanitation, Drainage and Waste Disposal Project	1996-2007	Noakhali, Feni, Lakshmipur, Patuakhali and Barguna districts	Negligible	
DAE	Small Holder Support Project	1999-2005	Barisal, Patuakhali, Jhalokati, Barguna	Negligible	

395 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 43/2D are briefly discussed in the following sections.

9.2.2 Cumulative Impacts of proposed Ganges Barrage

396 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 socio-economic development in equitable fashion, and to recover the existing environmental degradation. GoB already finalized the feasibility level investigation of the project. The selected site at Pangsha is situated at the lower stretch of the river, at 32 km upstream of the Jamuna-Ganges confluence. The main function of the 2116.50 m long barrage would be to store water for dry season through flow control.

397 Sufficient dry season flow may cause great hydrological changes in the Ganges and adjacent river systems. The Barrage will meet up the demand of utilizing Ganges water of different sectors, leading to sustainable development of the Ganges Dependent Area (GDA). Diversion of Ganges water from the upstream of the barrage through the Hisna-Mathabhanga-Kopotaksha system, the Gorai- Modhumati-Nabaganga system and the Chandana-Barasia system will rejuvenate 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.

398 Polder 43/2D is located within the GDA, and bears significant sensitivity towards the proposed Ganges Barrage. The most significant impact of the barrage on Polder 43/2D would be the reduction of surface water salinity in its adjoining river system. At present, the peripheral Gulishakhali and Gorai rivers carry minor salinity concentrations during dry season, which hampers the agricultural water use during the period. 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 livelihood would shift towards enhanced farming practices. More regional and local developments are expected, and the environment surrounding the polder woul be be benefited as a whole.

9.2.3 Cumulative Impacts of Other Projects

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

Water Management Improvement Project (WMIP)

400 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 41/7, 41/6B and 41/1 are adjacent to Polder 43/2D 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 43/2D. The local people are more comfortable in forming and actively maintaining WMOs and as such, water management initiatives under the Blue Gold program are being benefited.

Projects under Climate Change Trust Fund (CCTF)

401 Considering Bangladesh's vulnerability to climate change, GoB decided to finance climate change adaptation initiatives from its own revenue budget as Climate Change Trust Fund (CCTF), for implementing more projects on climate change adaptation and mitigation. Up until now feasibility level investigations have been completed for a total number of 30 projects of BWDB, some of which are being implemented throughout the country. The second phase of CCTF is in the pipeline for implementation, with a number of newly proposed projects. Among all the CCTF projects, the geographic extent of one scheme (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 43/2D. The interventions proposed under the project are localized within the polder, and will not have any large scale impacts on Polder 43/2D. However, there may still be some social impacts regarding labor harnessing, employment opportunities etc.

Capital Dredging of River system

402 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 43/2D. 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 43/2D may slightly be benefited. In future, if more similar dredging works are initiated nearby, Polder 43/2D may be further benefited.

9.3 Induced Impacts of Polder 43/2D

403 The interventions in Polder 43/2D may cause some spatial and temporal effects to a number of environmental and social components near the polder. The following sections descrobes in detail on such components which are to be indirectly impacted. It is to be mentioned here that Polder 43/2D 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

404 The proposed interventions in Polder 43/2D will safeguard the polder against direct intrusion of tidal water. Therefore, water from Gulishakhali and Gorai rivers carrying sediments will move further downstream or upstream and may cause induced

sedimentation. As a result, the river system may be subjected to increased floodplain siltation.

Tidal and Storm Surge Flooding

405 Polders 43/1A, 43/2B and 43/2E are located adjacent to Polder 43/2D. As per design, the crest level of Polder 43/2D would be raised up to 4.27 m above MSL, which may impose tidal and storm surge inundation risks to the adjacent polders (Polders 43/1A, 43/2B and 43/2E) during extreme events. Tidal water may not be able to enter Polder 43/2D during such events, and will be diverted elsewhere. This may increase the risk of flooding in the aforementioned nearby polders. Table 9.2 below shows the existing average existing crest levels in Polders 43/1A, 43/2B and 43/2E.

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

Polder	Existing crest level (m +PWD)
Polder 43/1A	3.3
Polder 43/2B	3.0~4.0
Polder 43/2E	3.8~3.9

Affect on water quality

406 The interventions in Polder 43/2D 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 might increase in the peripheral Gulishakhali and Gorai Rivers. Furthermore, due to expansion of agricultural area, more agriculture practices and industrialisation are expected, which might pollute surface water system near the polder.

Changes in aquatic habitat, species migration and biodiversity

407 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 Gulishakhali-Gorai River system.

Employment opportunities and Livelihood improvement

408 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 43/2D, new employment opportunities would be created. This may encourage people from outside the polder to visit the polder for work and improve their livelihood status.

Enhanced local and regional food security

409 The proposed interventions would drive agro-economic development inside the polder. Thus, the area may provide enhanced food security to the surrounding areas. In future, Polder 43/2D would not only be able to resist the damage of cyclonic hazards or flooding, but may also provide safety against food crisis of the nearby areas undergoing probable damage. In greater context, the agro-economic development of the polder would contribute to the regional food security as well.

9.4 Reciprocal Impacts of Climate Change and Polder

410 In order to investigate the reciprocal impacts of Climate Change and Polder 43/2D, 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

411 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)

412 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 considered good better enough for identification of internal rivers and regulator locations.

River Bathymetry Data

413 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

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

Land Use Data

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

Soil Data

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

Weather Data

417 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

418 The present study utilizes the statistically downscaled climate projection data from "Climate Wizard" developed by Washington University 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 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 - 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 for the climate change scenario A1B with 50% ensemble of 16 GCM results by 2050s for polder 43/2D.

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

Sea Level Rise

419 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

Scenarios	Sea Level Rise (m)
A1B	0.21 – 0.48
A2	0.23 – 0.51
A1FI	0.26 – 0.59

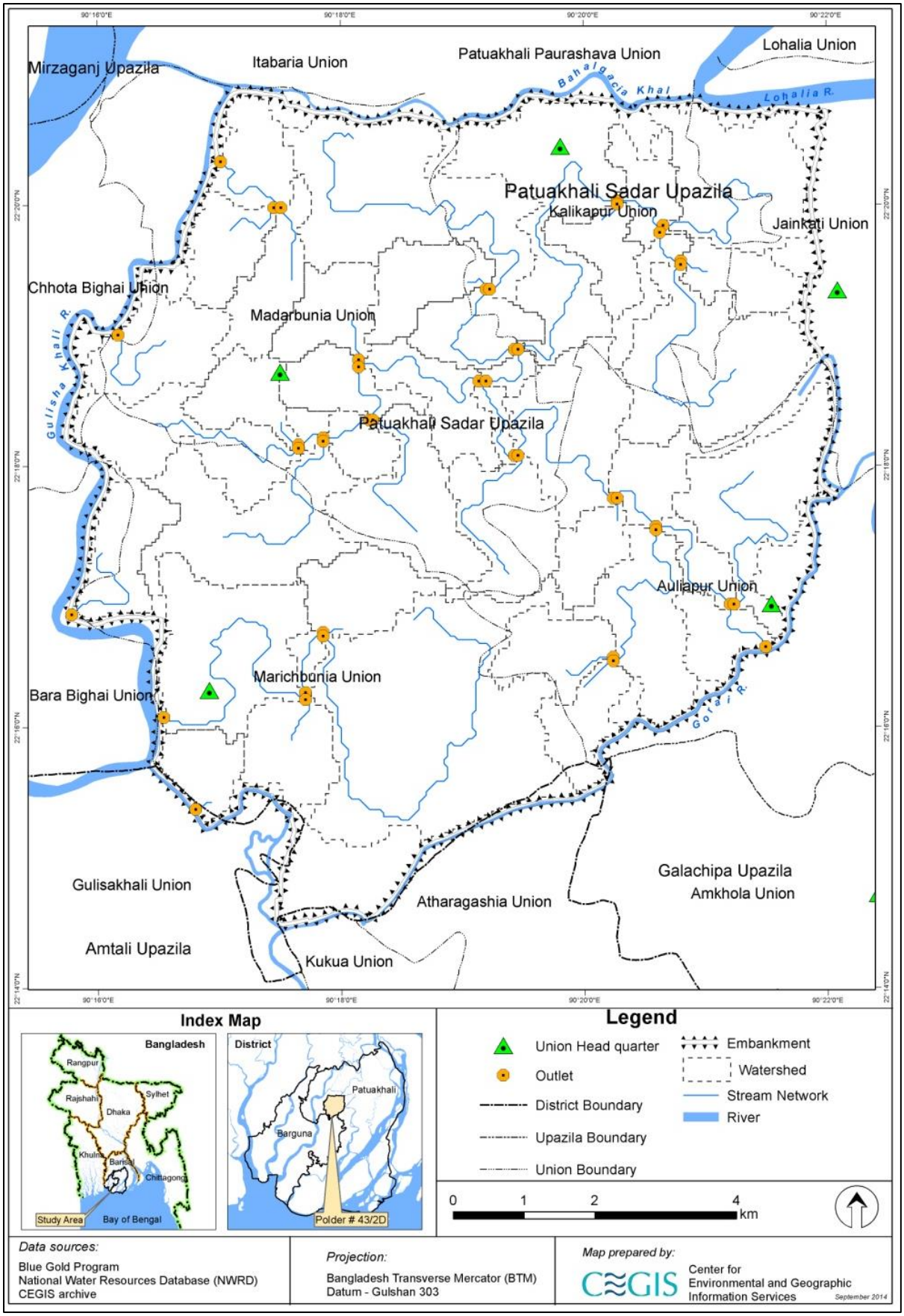
Source: IPCC AR4, 2007

9.4.2 Model Schematization

420 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

421 Five sequential steps were followed to schematize the SWAT model: watershed delineation, Hydrological Response Unit (HRU) definition, weather data definition, assembling and editing SWAT inputs, and the actual simulation run. The watershed delineation was performed with the automatic delineation tool of SWAT 2012 using the DEM and the river network. All the watershed delineation steps such as filling sink, defining flow direction and accumulation have been done automatically through the user interface. The watershed delineation results 42 watersheds for the entire polder area. The delineated watershed for polder 43/2D is shown in Map 9.2. Afterwards, 298 numbers of HRUs were generated with four land classes, five soil classes and 42 watersheds.

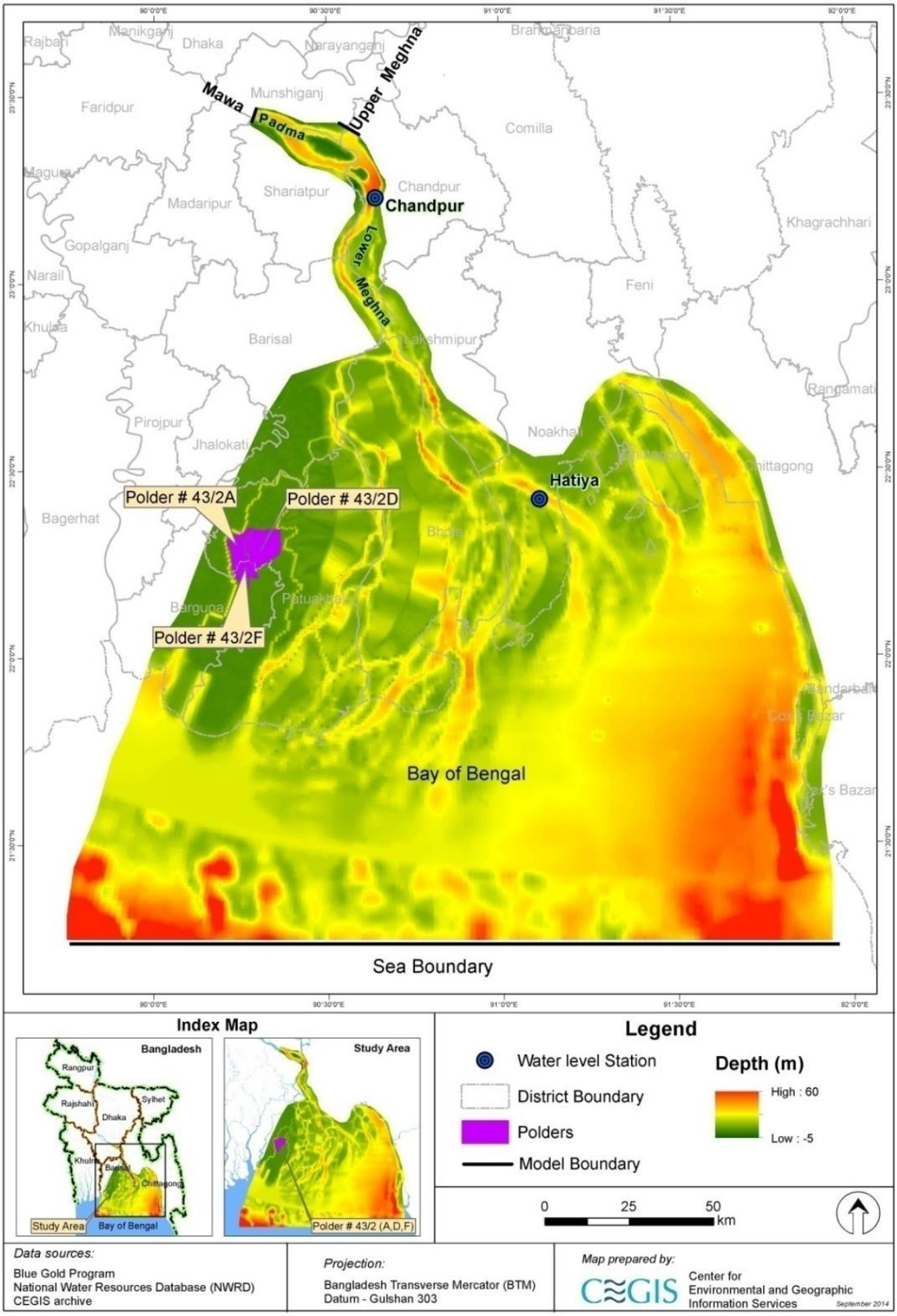


Map 9.2: Delineated watershed during model schematization using SWAT for Polder 43/2D

Delft 3D model Setup and Calibration

422 A 2-D hydrodynamic model was setup for the Padma and Lower Meghna river system using the Delft 3D modeling tool. The schematization of the model is shown in Map 9.3. The model starts from the Padma River to the Bay of Bangal. The bathymetry of the river has been generated from the interpolation of available cross-sections at a distance of 100 m using the HEC-RAS model. Daily discharge data of BWDB at 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.

423 The model has been calibrated using Manning's n 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.



Map 9.3: Schematization of hydrodynamic model using Delft 3D

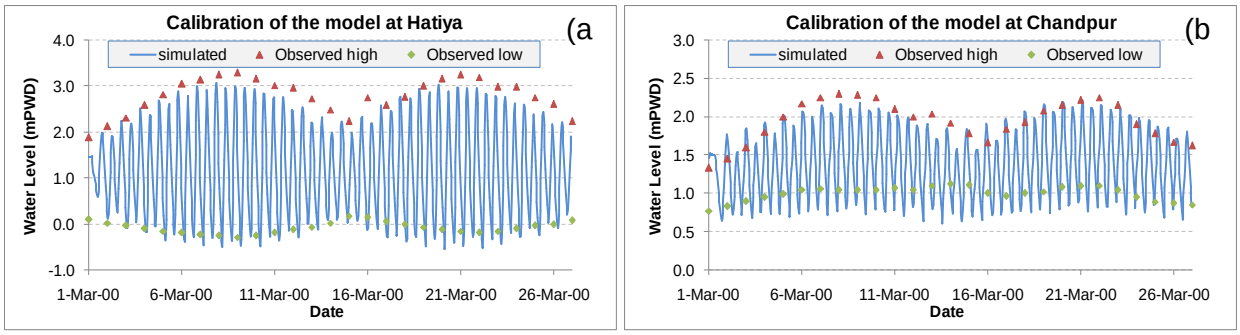
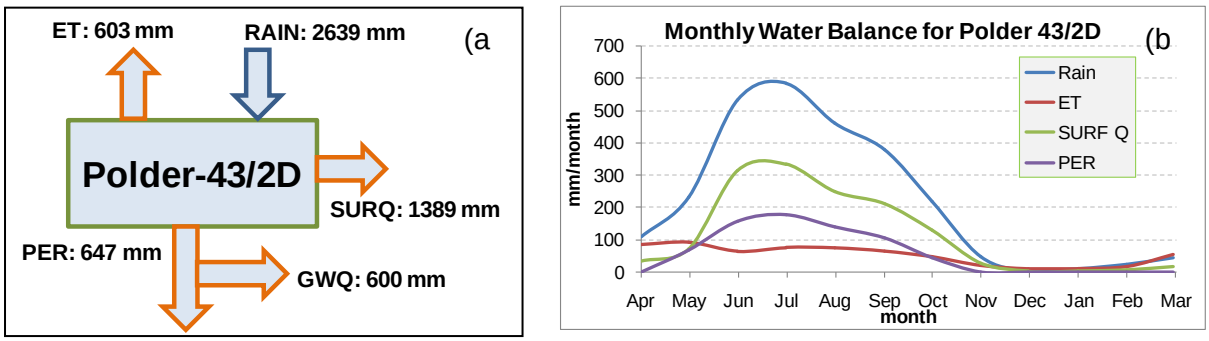


Figure 9.1: Calibration of model results at (a) Hatiya and (b) Chandpur for March, 2000

Water Balance of the Study Area

424 Water balance is the assessment of water resources and its use in the system. The model has been simulated for the period of 1981 to 2008 to estimate the availability of water during base period (1981 to 2012). The annual water balance for the polder 43/2D is shown in Figure 9.2.



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

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

425 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.

426 Input to the water balance is rainfall while losses occur through evapo-transpiration and percolation and as water contributing to stream flow through surface runoff. The annual actual evapo-transpiration of the area is 603 mm which is 23% of the annual rainfall. The evapo-transpiration is maximum during April and May and which is about 100 mm per month. The evapo-transpiration rate is minimum during December to January. The percolation rate for the polder area is 647 mm per year which is 25% of the annual rainfall. The percolation rate follows similar trend like rainfall and the maximum rate is 180 mm per month. After the losses of water through evapo-transpiration and percolation, the remaining water contributes to stream flow as overland flow and lateral (subsurface) flow. About 53% (1389 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

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

428 The climate change impact on annual water balance for the Polder 43/2D is given in Table 9.5 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 also increases as there is an increase in annual rainfall. There is a little increase in annual evapo-tranpiration (7 mm/year) which is mainly due to the increase of temperature. There is also a bit increase in annual percolation due to climate change.

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

Climate parameter	Amount (mm)	
	During base (1981-2012)	CC_2050s
Rainfall	2639	2694
Surface Runoff	1389	1435
Evapo-transpiration	603	610
Percolation	647	649
Base flow	600	600

429 The generated water yields were estimated and compared with base condition to assess the impact of climate change on water availability. Water yield is the net amount of water that leaves the polder and contributes to stream flow in the reach during the period (water yield = surface runoff +lateral flow + base flow- total loss- abstraction). The monthly water yield for the base and climate change condition is given in Figure 9.3.

430 The availability of water will increase during May to October as there is an increase in rainfall during that period. During the dry period (Dec-Feb), the water availability will decrease due to climate change by 2050s. The increase in around 4-12 mm and decrease is around 3 mm per month.

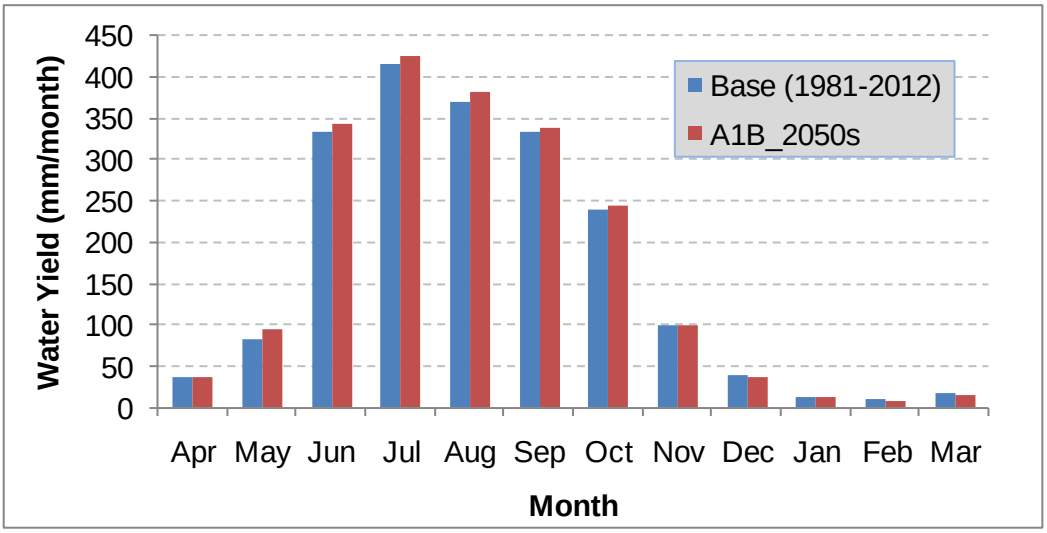


Figure 9.3: Climate change impact on monthly water yield for climate scenario A1B by 2050s

431 Table 9.6 below show the changes in seasonal water yield due to climate change by 2050s for scenario A1B. The Table shows increase in seasonal water yield during monsoon (2.3 %) and decrease in dry seasonal water yield (7%). Minor seasonal water yields during pre-monsoon and monsoon would also occur.

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

Season	Water Yield during base (mm)	Change in water yield due to CC (%)
Pre-monsoon (Mar-May)	117	11.3
Monsoon (Jun-Sep)	1457	2.3
Post-monsoon (Oct-Nov)	338	1.8
Dry (Dec-Mar)	77	-7.0

9.4.4 Climate Change Impact on Water Level

432 The sea level supposed to be increased due to the climate change by 2050s. Sea level rise during the 21st century is projected to have substantial geographical variability. The patterns from different models are not generally similar in detail, but have some common features, including smaller than average sea level rise in the Southern Ocean, larger than average in the Arctic, and a narrow band of pronounced sea level rise stretching across the southern Atlantic and Indian Oceans. The rise in sea water level will affect the increase of the river water level outside of the polder area. In Bangladesh, the impact of sea-level rise may be worsened by other effects of global warming, such as variable precipitation, more frequent droughts and floods, and shrinking of the glaciers that supply water to the rivers of the delta. The rainfall during the monsoon will be increased due to climate change which will result the increase in extreme flow during monsoon which ultimately result the increase in flood water level. Recently CEGIS conducted a study on climate change impact on stream flow for the GBM 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 Ganges basin. For the Meghna basin, the increase of monsoon flow is about 10% due to climate change by 2050s.

433 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 Meghna River has been assumed respectively for the model setup. The model has been simulated for the combination of above two scenarios and the simulated maximum water level during the monsoon has been compared with the base year (2000) to assess the impact of climate change and sea level rise on flood level.

434 From the model simulation, it has been found that the flood level adjacent to the polder area will increase by 50 cm due to only the increase of sea level. 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 43/2D. The increase in flood water level might be a threat for the embankment and it also interrupt the drainage from the inside polder area. The climate change and sea level rise may increase the drainage congestion and flood risk for the polder.

9.4.5 Climate Change Impact on Salinity

435 Sea level rise can cause saline water to migrate upstream to points where freshwater previously existed or can intensify the salinity. Several studies indicated that sea level rise would increase the salinity in estuaries, which would result in changes in stratification and estuarine circulation. Salinity migration could cause shifts in salt-sensitive habitats and could thus affect the distribution of flora and fauna. In addition to sea level rise, the decrease in flow during dry season can increase the salinity of rivers through encroaching seawater that moves upstream during periods of low flow.

436 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 43/2D 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 43/2D

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

10 Environmental Management Plan

438 Environmental management plan together with necessary monitoring program are presented in the following sections for pre-construction, construction and post-construction phases against the impacts on the IESCs pertaining to water resources, land and agriculture resources, fisheries resources, ecological resources and socio-economic condition.

10.1 Water resources

10.1.1 Pre-construction and Construction Phases

439 No significant positive or negative impacts on water resources have been foreseen during the both pre-construction and construction phases for the implementation of proposed interventions in Polder 43/2D. As such, no activities under the proposed EMP have been recommended in this phase.

10.1.2 Post-construction Phase

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

Table 10.1: EMP Matrix for Post-Construction Phase on Water Resources

Impact	Mitigation measure	Enhancement/ Contingency/ compensation	Residual Impact (+/-)/ Magnitude (1-10) with EMP	Responsible agency
Around 68 km affected khals (60% of total affected) would be benefited from the existing drainage congestion problems.		Around 1 km re-excavation works should be carried out from the opening portion of each of the Taltola, Taktakhali, Patukhali, Baktana and Marichbunia khals	+6	-
Around 5,000 people (7%) in Madarbunia and Kalikapur unions would be guaranteed sufficient surface water availability, and this would result in immense benefits in multifaceted water use.	Not required	Not required	-	-
Flooding would be reduced by around 200 ha areas (80% of total affected) in Hajikhali, Hajikhali Abad, Gerakhali, Tafalbaria, Charabunia and	Not required	Not required	-	-

Impact	Mitigation measure	Enhancement/ Contingency/ compensation	Residual Impact (+/-)/ Magnitude (1-10) with EMP	Responsible agency
Madarbunia mauzas.				

10.2 Agricultural Resources

10.2.1 Pre-construction and Construction Phases

441 No significant positive or negative impacts on agricultural resources have been foreseen during the both pre-construction and construction phases for the implementation of proposed interventions in Polder 43/2D. As such, no activities under the proposed EMP have been recommended in this phase.

10.2.2 Post-construction phase

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

Table 10.2: EMP Matrix for Post-construction Phase on Agricultural Resources

Impact	Mitigation measure	Enhancement/ Contingency/ compensation	Residual Impact (+/-)/ Magnitude (1-10) with EMP	Responsible agency
Cropping pattern would be changed significantly so that cropping intensity would be increased about 39%.	-	• Crop diversification with HYV under irrigated condition should be increased. • Improved land type and creation of irrigation facilities would increase cropping intensity.	+3	BWDB, DAE and WMOs
It is expected that crop (rice) production would increase by 34% in FWIP over FWOP.	-	• Organic manure should be applied for the restoration of soil fertility. • Farmers group should have close contact with DAE for adaptation of various measures on IPM/ICM. • Irrigation should be provided in optimum level with minimum conveyance loss from Khals. • Involvement of WMGs/WMA/WMF in polder activities would enhance crop production. • Introduction of HYV/Hybrid crops cultivars along with crop diversification need to be practiced. • It is likely that the farmers of the polder areas would be very much encouraged to grow more agricultural production, as they would	+5	BWDB, DAE, BADC and WMGs/WMA /WMF

Impact	Mitigation measure	Enhancement/ Contingency/ compensation	Residual Impact (+/-)/ Magnitude (1-10) with EMP	Responsible agency
		have quick marketing facilities in the local markets. In this case farmers need good support from the Govt. for timely supply of inputs e.g fertilizers, pesticides, seeds, credits etc.		
It is expected that crop production loss would decrease as follows: Rice 72% Non-rice: 72% in FWIP over FWOP.	-	• The constructing materials like sand, cement, concrete, block, etc. should be placed in non-agricultural land. • The WMGs/ WMA/ WMF should be involved in the construction and post construction phase which might reduce crop damage. • WMGs/WMA/WMF should be given orientation training to protect their crops from re-excavation of Khal and re-sectioning/ repair of embankment /protection work of embankment and development of on farm water management etc.	+7	BWDB, DAE, BADC and WMGs/WMA/WMF
It is expected that irrigated area would be expanded about 278 ha in FWIP over FWOP.	-	• Training of "Integrated water management" and "on farm development" of WMGs would help to increase the expansion of irrigated area • The WMGs/WMAs/ WMFs should be involved in the integrated water management through proper maintenance of regulators (sluice gate, inlets and outlets) for the expansion of irrigated area. • The irrigation water should be used at optimum level so that the area might be increased with limited scale of water.	+5	BWDB, DAE, BADC and WMGs/WMA/WMF

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

10.3 Fisheries Resources

10.3.1 Pre-construction Phase

443 There will be no impact during pre-construction phase. No EMP is need during this phase.

10.3.2 Construction phase

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

Table 10.3: EMP Matrix for Construction Phase on Fisheries Resources

Impact	Mitigation Measures	Enhancement/ Compensation/ Contingency	Residual Impact (+/-) Magnitude (1-10) with EMP	Responsible Agency
• Feeding ground bottom dweller (e.g. eel fish, baila, crabs etc) and habitat quality will be impacted temporary. But after one (01) year the habitat quality will improve. • Fish production would loss temporally about 0.8 ton per year. • Fish hatchling and fish species like *Puti, Chingri, Baila, Pairsa, Chingri, Tengra* etc movement would be obstructed because of implementation of proposed intervention.	• Avoid re-excavation during fish migration period e.g. month of May to August • Earth spoils to be dumped outside the khal area. • To protect the indigenous fishes and other aquatic lives, re-excavation should be implemented segment wise and one after another. • At least 100 m of each khal should be (about) 0.5 m deeper than the normal design section of other reaches	• N/A	-1	Contractor, BWDB, Department of Fisheries (DoF)

10.3.3 Post-construction Phase

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

Table 10.4: EMP Matrix for Post-Construction Phase on Fisheries Resources

Impact	Mitigation Measures	Enhancement/ Compensation/ Contingency	Residual Impact (+/-) Magnitude (1-10) with EMP	Responsible Agency
The floodplain are would be decreased by 200 ha from the base condition. The area of khal would remain same. Water depth as well as water quality will be improved. The improved habitat quality will support different types of aquatic vegetation which would be helpful for fish feeding and habitation.	• Awareness development on natural resources, camping against indiscriminate fishing and reinforcement of fisheries laws and regulation in the polder area. • For protection of capture fish habitat quality, apply IPM in agricultural field • Encourage culture fish practices		-1	Department of Fisheries in coordination with WMC
Hatchling movement from river to polder area through water control structures would be obstructed / regulated. Some brackish water fish species include *Pairsa, Chingri, and Baila* etc migrates on the regular basis during high tide would be impacted. But construction of new inlets would further facilitate to move a number of small fishes inside the polder area.	• Properly and timely gate operation will have to be carried out to allow the entrance the fish hatchling in the months of May to July • Water Management Committee should be formed including fishers representati		0	Department of Fisheries in coordination with Water Management Committee

Impact	Mitigation Measures	Enhancement/ Compensation/ Contingency	Residual Impact (+/-) Magnitude (1-10) with EMP	Responsible Agency
	ve.			
Fresh water fish species including small indigenous species (SIS) and their composition would be increased. Brackish water fish diversity would be decreased. fish species composition would be changed	Not required	Not required	-	-
Capture fish production from khals would increase about 15 % from the base condition.		• For brood fish protection, 100 m (Deeper area) of each re-excavated khal should be kept as non fishing zone.	+2	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).*

10.4 Ecological Resources

10.4.1 Pre-construction phase

446 There will be no impacts in this phase. As such, no EMP is required.

10.4.2 Construction phase

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

Table 10.5: EMP Matrix for Construction Phase on Fisheries Resources

Impact	Mitigation measure	Enhancement/ Contingency/ compensation	Residual Impact (+/-)/ Magnitude (1-10) with EMP	Responsible agency
• Temporary damages of herbs, shrubs, various type of grass and bushes due to soil dumping for re-sectioning work.; • Temporary relocation of wildlife due to habitat loss	• 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
• Damage of existing aquatic vegetation would cause habitat degradation for aquatic birds and fishes • Damages of existing bank line vegetations due to dumping of soil along both sides of the khal	• Keep untouched the deepest points of the khal as much as possible; • The works should be completed in scheduled time to minimize habitat disturbance to wildlife	N/A	-2	Contractor and BWDB
Temporary reduction of habitat quality due to obstruction of khal flow and connectivity with main river	The works should be completed in scheduled time	N/A	-2	Contractor and BWDB

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

10.4.3 Post-construction phase

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

Table 10.6: EMP Matrix for Construction Phase on Ecological Resources

Impact	Mitigation measure	Enhancement/ Contingency/ compensation	Residual Impact (+/-)/ Magnitude (1-10) with EMP	Responsible agency
Improve embankment side and inter tidal vegetation.	N/A	Plant native mixed trees along the embankment slopes wherever possible to enhance green coverage.	+4	BWDB, FD and local stakeholder.
Improve Aquatic habitat due to improvement of plant diversity as well as khal depth and velocity	N/A	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)*

10.5 Socio-economic condition

10.5.1 Pre-construction

449 The implementation of proposed interventions may generate some temporary impacts on socio-economic condition, as discussed in Chapter 8. Some of the impacts would require different levels of mitigation for negative impact, enhancement for positive impacts, compensation or contingency measures as shown in following Table 10.7.

Table 10.7: EMP Matrix for Pre- 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 before construction period	+3	Blue gold and BWDB

10.5.2 Construction

450 The implementation of proposed interventions may generate some temporary impacts on socio-economic condition, as discussed in Chapter 8. Some of the impacts would require different levels of mitigation for negative impacts, enhancement for negative impacts, 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	-	Local labor should be recruited for the construction work of the project area.	+3	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. If possible, maximum labor should be recruited from locally.	+2	BWDB
Women empowerment	-	According to the project works, the LCS entail 60% male and 40% female, all of them would be engaged from the local area. Thus, ensure more gender promotion activities for women in future.	+3	BWDB

10.5.3 Post-construction

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

Table 10.9: EMP Matrix for Post-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 and BWDB
Access to open water bodies	-	- About 17537 number of 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	BWDB
Communication	-	Existing rural road is required to repair and carpeting properly at every locations of damaged road networks.	+3	BWDB
Women empowerment	-	At least 40% of total labor will be recruited for these interventions	+3	BWDB

Impact	Mitigation measure	Enhancement/ Contingency/ compensation	Residual Impact (+/-)/ Magnitude (1-10) with EMP	Responsible agency
		work and ensure more gender promotion in different sectors of present interventions of the polder.		

10.6 Spoil Management Plan (SMP)

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

10.6.1 Proposed SMP

453 Polder 43/2D of Blue Gold program entails excavation of a number of khals which would generate a volume of around 93,860 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, especially in earthworks for embankment rehabilitation. The volume of earthwork required for rehabilitation of embankment (around 379,000 m^3) is more than the excavated spoil; therefore no spoil dumping along the re-excavated canals would be required. 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.

10.6.2 Phase wise activities of Spoil Management

454 A number of activities are proposed to be carried out during different phases associated with the efficient management of re-excavated spoil (Figure 10.1). 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.

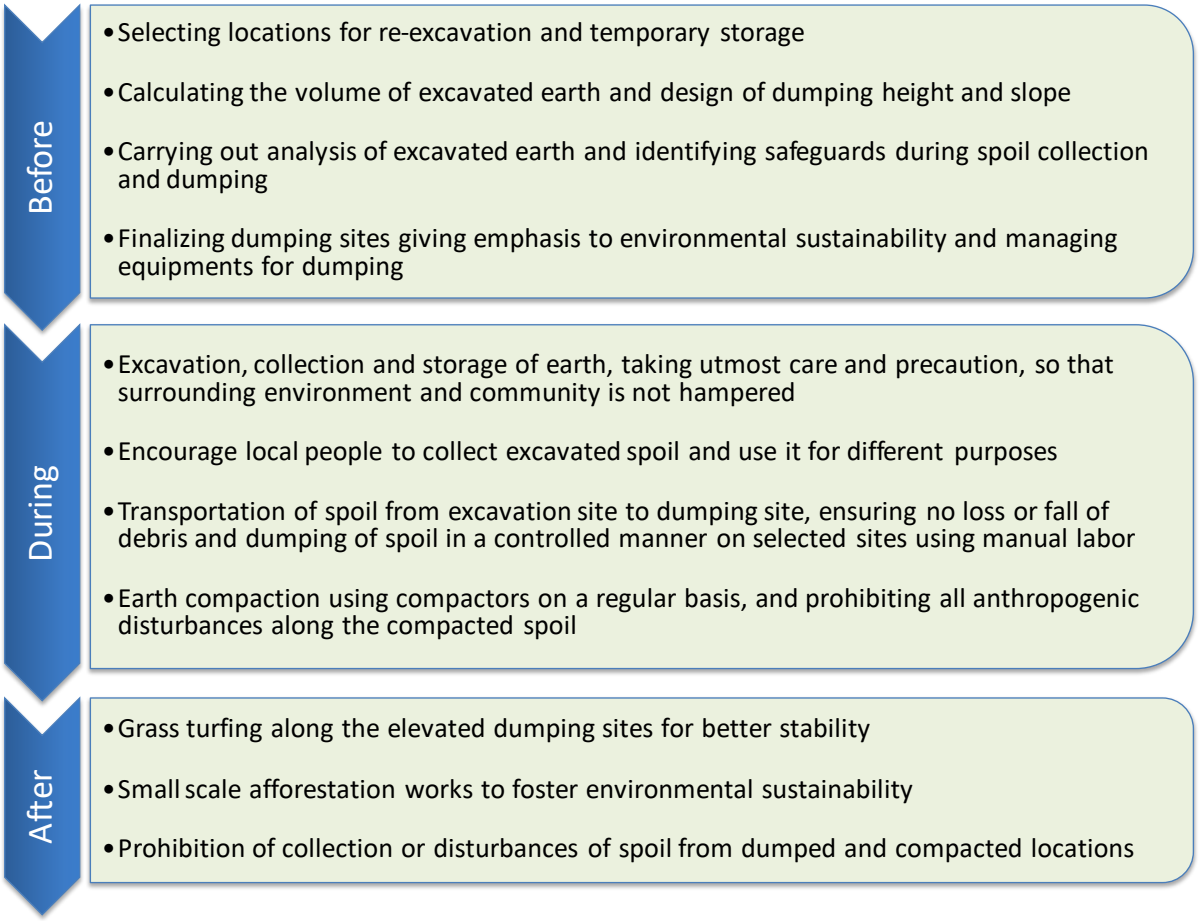


Figure 10.1: Phase wise activities of Spoil Management

10.6.3 Safety Measures and Precautions

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

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

10.7 Environmental Monitoring

10.7.1 Monitoring plan for pre-construction phase

456 No specific monitoring plan is required to be followed during the pre-construction phase of the water resources management component of the project in Polder 43/2D.

10.7.2 Monitoring plan for construction phase

457 A typical checklist have been prepared for monitoring during construction phase. The checklist will be followed at the proposed construction sites. The monitoring report are to be submitted concerned authorities as mentioned in the following checklist.

Bangladesh Water Development Board

Blue Gold Program: Component II

EMP IMPLEMENTATION

Book No. _____ Monitoring Report No._____

Date:_____ Time:_____

Contract:_____

Contractor:_____

Work Sites (s):_____

A	DAILY EHS CHECKLIST	Yes	No	Score Yes=+5 No=-5	A	DAILY EHS CHECKLIST	Yes	No	Score Yes=+5 No=-5
1	Correct dumping of spoil				4	Any threat caused to river bank area			
2	Inconsistencies or mismanagement in embankment re-sectioning works				5	Use agriculture land for spoil dumping			
3	Compaction of earth materials on embankment				6	Obstruct fish migration route			
4	No pollution from construction site				7	Hamper route communication			
5	Inconsistencies in water control structures repairing works				8	Presence of child labour in construction work			

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

C.NON COMPLIANCE:

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

D.CIRCULATION

1)**PD**, Blue Gold Program 2) **DG**, DoE 3) **DG**, BWDB 4) **EE**, Local BWDB 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.**	

10.7.3 Monitoring plan for post construction phase

The following environmental and social parameters will be monitored in the proposed site during post-construction phase.

10.7.4 Water Resources

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

Mismanagement of water management infrastructures	Field observation	Throughout the polder	Every day (as per requirements)	Local People and WMOs

10.8 Agricultural Resources

Indicator	Method	Location	Frequency	Responsible agency
Construction phase				
Re-excavation of Khals and dumping of spoil earth materials on the existing embankment and re-sectioning/ repair of embankment works/ protection work of embankment	Field observation	Entire polder area	7 days interval during construction period	WMGs and BWDB
Post- construction phase				
Crop production	Focus Group Discussion (FGD) and individual discussion with farmers should be followed.	Entire polder area	At harvest time of each cropping season (Will continue for two years).	DAE and WMGs
Crop damage	Focus Group Discussion (FGD) and individual discussion with farmers should be followed.	Entire polder area	At harvest time of each cropping season (Will continue for two years).	BWDB, DAE and WMGs
Irrigated area	Focus Group Discussion (FGD) and individual discussion with farmers should be followed.	Entire polder area	During Rabi season (Will continue for two years).	BWDB, DAE, BADC and WMGs/WMA/WMF

10.9 Fisheries Resources

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

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

10.10 Ecological Resources

Indicator	Method	Location	Frequency	Responsible agency
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

10.11 Socio-economic Condition

Indicator	Method	Location	Frequency	Monitoring Cost (Lac Tk.)*	Responsible Agency
Employment opportunities	RRA and observation	Whole polder area	Twice in a year	2.0	BWDB
Women empowerment	Village wise RRA/FGD	Periphery within the polder	Every year	0.50	LGI, BWDB
Communication	Observation	Different parts of the polder i.e. Nilkhola, Idukhali, Chatua, Auliapur, Kalikapur, Madarbunia	Once in a year	1.0	LGED, BWDB
Sub-total				**3.50**	

10.12 EMP cost

Sl. No	EMP measure	Cost (Lakh Tk.)	Sl. No	Monitoring item	Cost (Lakh Tk.)
1	• Formation of WMGs/ WMA/ WMF (GPWM-2002), strengthening of WMGs through imparting training on re-excavation of Khals. • Embankment management Group (EMG), landless	2.00	1	Re-excavation of Khals and disposal of spoil earth materials for spoil management and re-sectioning/ repair/ protection	0.75

Sl. No	EMP measure	Cost (Lakh Tk.)	Sl. No	Monitoring item	Cost (Lakh Tk.)
	Contacting Society (LCS), on farm water management and development etc. • Involvement of WMGs in polder activities.			work of embankment etc	
2	• Organic manure should be applied for the restoration of soil fertility. • Farmers group should have close contact with DAE for adaptation of various measures on IPM/ICM. • Irrigation should be provided in optimum level with minimum conveyance loss. • Involvement of WMGs in polder activities. • Introduction of HYV/Hybrids crops with crop diversification need to be practiced.	2.50	2	Crop production	0.75
3	• The constructing materials like sand, cement, concrete, block, etc. should be placed in non-agricultural land as far as possible. • Dumping of spoil earth materials on non-agricultural land. • WMGs/WMA/WMF should be involved in the construction and post construction phases. • Quick marketing facilities in the local markets. • Farmers need good support from the Govt. for timely supply of inputs e.g fertilizers, pesticides, seeds, credits etc.	1.50	3	Crop damage	0.50
4	• Training of "Integrated water management" and "on farm development" of WMGs would help to increase the expansion of irrigated area. • The WMGs/WMAs/WMFs should be involved in the integrated water management through proper maintenance of regulators (sluice gate, inlets and outlets) for the expansion of irrigated area. • The irrigation water should be used at optimum level so that the area might be increased with limited amount of water.	1.50	4	Irrigated area	0.50
	Sub-Total	**7.50**		**Sub-Total**	**2.50**

Sl. No	EMP measure	Cost (Lakh Tk.)	Sl. No	Monitoring item	Cost (Lakh Tk.)
Total Cost for EMP & Monitoring for land and Agriculture = 10.00 Lakh Taka					
Fisheries Resources					
1	Awareness development on natural resources and dissemination of the knowledge about importance in one daily life through observation of several national and international days like Fish Week, Environment Day, Earth day, water Day Rally, Discussion etc. (for Two year in the polder area).	1.50	1	Fish hatchling movement in three khals (Two year).	0.5
2	Transfer of improved fish culture technology to the pond owner and demonstration of pond on improved fish culture in the polder area. Number of pond would be 7 or 8 with about 100 decimal areas.	3.0	2	Species diversity through Fish Catch Assessment/ observation in three khals. Three market survey once in a week (for two years).	1.5
Sub-Total		**4.5**	**Sub-Total**		**2.0**
Total Cost for EMP & Monitoring for Fisheries= 6.5 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 been estimated yet	0.5 (Gross amount)	1	Habitat suitability	3.00
			2	Wildlife diversity	4.00
	Sub-Total	0.50		Sub-Total	7:00
Total Cost for EMP & Monitoring for Ecology= 7.50 Lakh Taka					

458 The total EMP and monitoring cost is BDT 24, 00,000 of which EMP cost is BDT 12, 50,000 and monitoring cost is BDT 11, 50,000 only. The cost may be spent by the Blue Gold Program. It is to be mentioned here that the costs for executing the measures identified in the EMP have not directly been included in the Development Project Proforma (DPP) of Blue Gold Program. However, the program has substantial fund allocated within budget approved for the Technical Assistance (TA) team. As per the opinion of the Blue Gold Program, the costs incurred in the form of EMP implementation will be spent from the TA budget.

11 Conclusions and Recommendations

11.1 Conclusions

459 This project aims 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. Local people opined that around 45% of the total length of water courses inside the polder is affected from drainage congestion issues, of which only 30% khals have been taken into the re-excavation program. The structural interventions proposed for Polder 43/2D includes re-sectioning of embankment, repairing of water control structures, construction of new water control structures and re-excavation of khals. There would be no impact during construction phase due to excavated spoil materials would be used on existing embankment and non agriculture land. Cropping intensity would be increased due to implementation of interventions. The capture fisheries productivity would increase due to re-excavation of khals and repairing of regulators. On the other hand, improved drainage channel would reduce the flood duration in the polder area which would decrease the floodplain fish productivity. Aquatic habitat condition is expected to improve for increased khal depth and controlling water passing systems During re-sectioning of embankment, temporary damages of herbs, shrubs, various type of grass and bushes are apprehended due to soil dumping for re-sectioning work. Proposed intervention can ensure improve 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 opportunity for both man and woman in different interventions can ensure better life and livelihood of stakeholder of the polder.

11.2 Recommendations

460 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 crop cultivation.
- Crop rotation with leguminous crops, application of more organic materials, organic manure, and green manuring and soil management should be practiced to improve soil fertility in the polder area.
- Introducing crop diversification with multi-crops for improving condition of the soil to be considered
- Improved land type and creation of irrigation facilities would increase cropping intensity.
- Avoid re-excavation during fish migration period e.g. month of May to August.
- Re-excavation should be implemented segment wise to reduce indigenous fishes and other aquatic lives.

- Plantation should be made along the slopes of embankment after completion of the earth works.
- Plant native mixed trees along the embankment slopes wherever possible to enhance green coverage.
- Ensure employment opportunities that all local skilled man power gets chance in work before construction period.
- Proper O&M of the infrastructures has to be ensured and proper monitoring is to be performed

461 The interventions will bring about positive impacts in the polder area. There are some negative impacts as well some of which may be overcome through appropriate mitigation measures and timely monitoring. As such, the project may get necessary clearance from appropriate authorities for implementation.

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Appendix 1: Data Collection Checklist

Water Resources

Baseline Data Collection Form

Environmenal Studies for Blue Gold Program

Name of Data Collector: Date:

Project Name:

A. Administrative Information

BWDB Division:	BWDB Circle:
BWDB Zone:	Hydrological Zone:
District(s):	Upazila(s):
Union(s):	Mouza(s):

B. Secondary data (to be obtained before going to the field)

Field	Source	Station(s)	Year(s)	Analysis		
				Max.	Min.	Avg.
Rainfall						
Temperature						
Humidity						
Evaporation						
Wind speed						
Sunshine hours						
Climate change						

C. Primary data (To be collected during field visit)

1. River system & flow direction (inside and outside the project)	
2. Name and location of beels and connectivity with rivers and khals	
3. Name of canals/khals and connectivity with rivers and beels	
4. Topography and Drainage pattern	
5. Location specific drainage congestion (% of extent, and delineate boundary in field map)	
6. Location specific water logging (% of extent, and delineate boundary in field map) in the month of February	
7. Flooding (depth, % of	

extent, onset, pick and recession)				
8. River/ khal erosion	River/khal	Area (ha) eroded	Length (m)	Reason
9. Accretion	River/khal	Area (ha) accreted	Reason	
D. Water Quality (people's perception/measurement)				
	People's Perception	Measurement		
1. Ground water: (Arsenic/Iron/Salinity)		Arsenic: Iron: Salinity:		
2. *Surface water: (Salinity, pH, DO, TDS, BOD, COD)		Salinity: pH: DO: TDS: BOD: COD:		
*Note: It can be extended according to Client demands				
E. Pollution status (people's perception)				
1. Source of pollution				
2. Type of effluent				

F. Water Use

Sources	Domestic	Agriculture	Fisheries	Others (industry…)
Surface water				
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						
6						
..						
..						

Location of labor shed with their water and sanitation facilities system
Number of labor (foreign labor or local labor)
Area of land acquisition and requisition with name of place, if necessary
Carrying system of spoil earth
Time period of construction/earth works
Activities involved in re-excavation

Phase	Name of activities	Remarks
Pre-construction phase		
During construction		
Post-construction		

Stockyard information during construction time:

Baseline data collection for EIA study: Land, Agriculture and Livestock Resources

Land Resources: Secondary information: SRDI/SOLARIS/NWRD/GIS database

Agro-ecological regions

Name of AEZ	Area (ha)	%	Soil characteristics

Land use

Land use	Area (ha)	Percent of gross area
Gross area		
Net Cultivated Area (NCA)		
Settlements		
Water bodies		
Rivers/ Khals		
Forest		
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			
Salinisation			
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:	Beel (Leased/non leased)																
Culture Fisheries:																		
	d. No. of Days spend annually in fishing by CFHHs:																	
Indiscriminate Fishing Activities:	SFHHs:																	

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
	e. Hrs/Day spend in fishing by CFHHs: 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. 5.						Live fish				
											Other fish				
											Shrimp/prawn				
											Hilsa/Bombay duck/Indian salmon				
											Pomfret				
Important breeding, feeding and over wintering ground											Jew fish				
											Sea cat fish				
											Shark/Skates/ Rays				
											Rui				
											Catla				
Horizontal Migration pattern	Species: 1. 2. 3. 4. 5.	Season (Months):	Routes:	Significant areas	1. 2. 3.						Mrigal				
											Koi				
											Sarputi				
											Large shrimp				
											Small shrimp				
Vertical Migration	Species: 1.	Season (Months):	Habitats:	Species of Conservation	Rare:						Silver carp				
											Carpio				

Fish Migration				Fish Biodiversity		Species List					Species Composition				
						River	Khal	Beel	Pond	Other	Group	River	Khal	Beel	Pond
Pattern	2.			Significance							Grass carp				
	3.										Tengera				
	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 community structure (Traditional/Caste/Religion)	
Landing center, whole sale market, other district markets, etc.:		Traditional fishermen vulnerability (Occupation change/others):	
Storage facility (number, location and name):		Existing Fisheries Management	
Fish market (Number, location and name):		Fishermen Community Based Organizations (FCBOs):	

Post Harvest Activities		**Fishermen Lifestyle**	
Marketing problems:		WMOs activity:	
Fish diseases (Name, Host species, Season, Syndrome, Reason, etc.):		Fishing right on existing fish habitats (Deprived/Ltd. access/Full access):	
Other backward and forward linkages (Number, location and name):		Leasing system:	
Transport facility (Mode of fish transportation, cost, other involvements)		Enforcement of fisheries regulation (Weak/strong):	
Dry fish industries (Number, location and name):		Department of Fisheries (DoF) activity:	
Others information:		NGOs activities:	

Note: 1. Major Carp - Rui, Catla, Mrigal, 2. Exotic Carp - Silver Carp, Common Carp, Mirror Carp, Grass Carp, 3. Other Carp - Ghania, Kalbasu, Kalia, 4. Cat Fish - Rita, Boal, Pangas, Silon, Aor, Bacha, 5. Snake Head - Shol, Gazar, Taki, 6. Live Fish - Koi, Singhi, Magur, 7. Other Fish - Includes all other fishes except those mentioned above.

Marine: Hilsa/Illish, Bombay Duck (Harpondon nehereus), Indian Salmon (Polydactylus indicus), Pomfret (Rup_Hail_Foli Chanda), Jew Fish (Poa, Lambu, Kaladatina etc.), Sea Cat Fish (Tachysurus spp.), Sharks, Skates & Rays, Other Marine Fish.

Beels: Rui (Labeo rohita), Catla (Catla catla), Mrigal (Cirrhinus mrigala), Kalbasu (Labeo calbasu), Ghonia (Labeo gonius), Boal (Wallago attu), Air (Mystus aor / Mystus seenghala), Shol/Gazar (Channa spp.), Chital/Phali (Notopterus chitala / N. notopterus), Koi (Anabas testudineus), Singi/Magur (Heteropneustes fossilis /Clarias batrachus), Sarpunti (Puntius sarana), Large Shrimp (Macrobrachium rosenbergii /M. malcomsonii), Small Shrimp, Silver Carp (Hypophthalmichthys molitrix), Carpio (Cyprinus carpio), Grass Crap (Ctenopharyngodon idellus), Pabda (Ompok pabda), Punti (Puntius spp.), Tengra (Mystus spp.), Baim (Mastacembelus spp.), Chapila (Gudusia chapra), Others.

Pond: Rui (Labeo rohita), Catla (Catla catla), Mrigal (Cirrhinus mrigala), Kalbasu (Labeo calbasu), Mixed Carp, Silver Carp (Hypophthalmichthys molotrix), Grass Carp (Ctenopharyngodon idellus), Mirror Carp (Cyprinus carpio var. specularis), Tilapia (Oreochromis mossambicus / O. niloticus), Shrimp, Aor (Mystus aor / Mystus seenghala), Boal (Wallago attu), Shol/Gazar & Taki (Channa spp.), Chital/Foli (Notopterus chitala / N. notopterus), Koi (Anabas testudineus), Singi/Magur (Heteropneustes fossilis / Clarias batrachus), Sarpunti (Puntius sarana), Thai Sarpunti (Puntius gonionotus), Punti (Puntius spp.), Others.

Ecological Data Collection Form for ESIA Study

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 Wetland5	Area in ha		Flooding depth (m)	Connectivity with river		Importance6
		Seasonal	Perennial		from	to	

1= Open water wetlands, 2= Rivers, 3= Estuarine and mangrove forest, 4= Beels and haors, 5= Floodplains, 6= Closed water wetlands,
7= Ponds, 8= Baors (oxbow lake), 9= Brackish water farms
2 1=Fish; 2= migratory bird; 3= other wildlife; 4=aquatic flora;

Aquatic flora

Ecology and plant community (depending on water depth and flooding)

Species name	Type1	Abundance2	Growing period	Utilization7

1 1=Submerged, 2=Free floating, 3=Rooted floating, 4=Sedges, 5=Marginal
2 1= High, 2= Moderate, 3= Low
31=food; 2=fuel; 3=medicinal; 4=fiber/thatching; 5=Bio-fertilizer 6=others (specify if any)

Aquatic Fauna

Species name	Status1	Species name	Status1
Amphibians			
Reptiles			
Birds			

[5] 1= Open water wetlands, 2= Rivers, 3= Estuarine and mangrove forest, 4= Beels and haors, 5= Floodplains, 6= Closed water wetlands, 7= Ponds, 8= Baors (oxbow lake), 9= Brackish water farms

[6] 1=Fish; 2= migratory bird; 3= other wildlife; 4=aquatic flora;

[7] 1=food; 2=timber; 3=fuel; 4=medicinal; 5=fiber/thatching; 6=others

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

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	

Type of Conflict	
conflict	
Proposed solutions	

Miscellaneous

Particulars	Number	Name	Brief Description
Ethnic Community			
Vulnerable Community			
Cultural Heritage Site			
Common Property Resources			

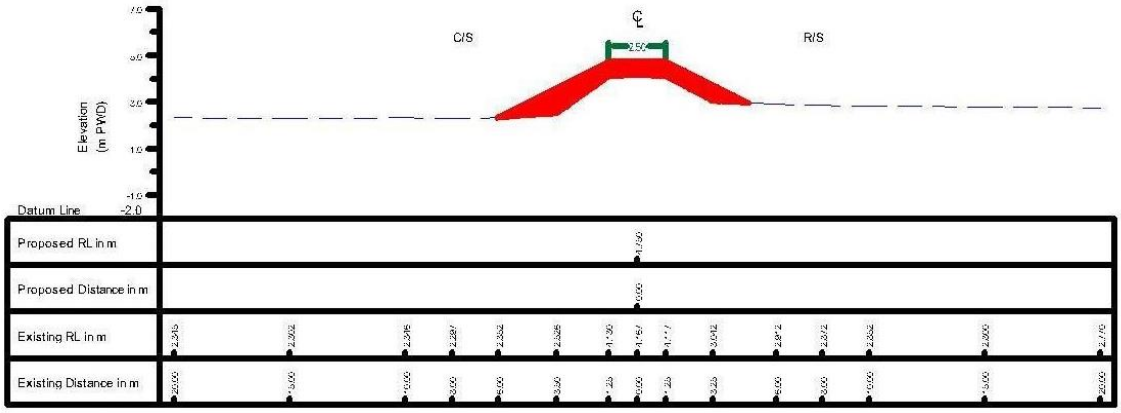
Profile of RRA Participants

Name	Age	Occupation	Address/ Mobile no.

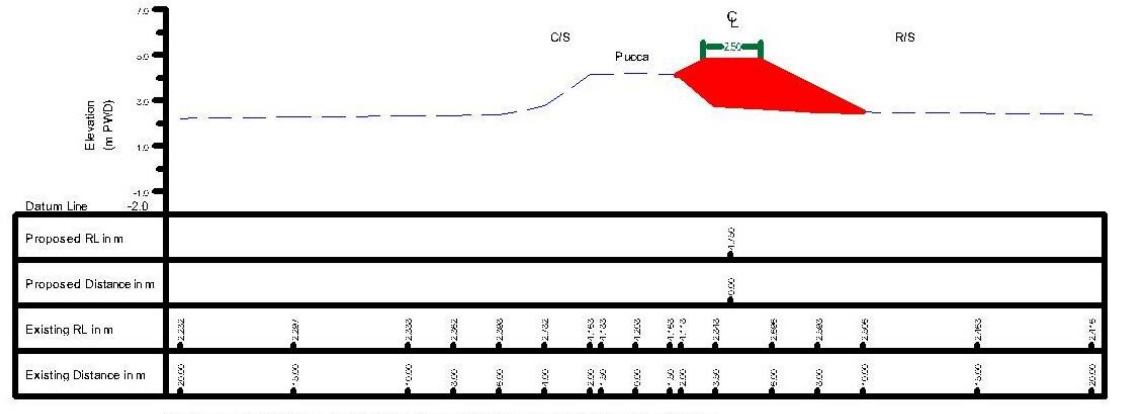
Required Photographs: Educational Institutions, Housing Pattern, Water-Sanitation Facilities, Solar/Biogas Plant, Health Facilities, Transportation/Communication Network, Markets, Adverse Affects of Disasters etc

Appendix 2: Cross Section of Embankment and Re-excavtion Khal

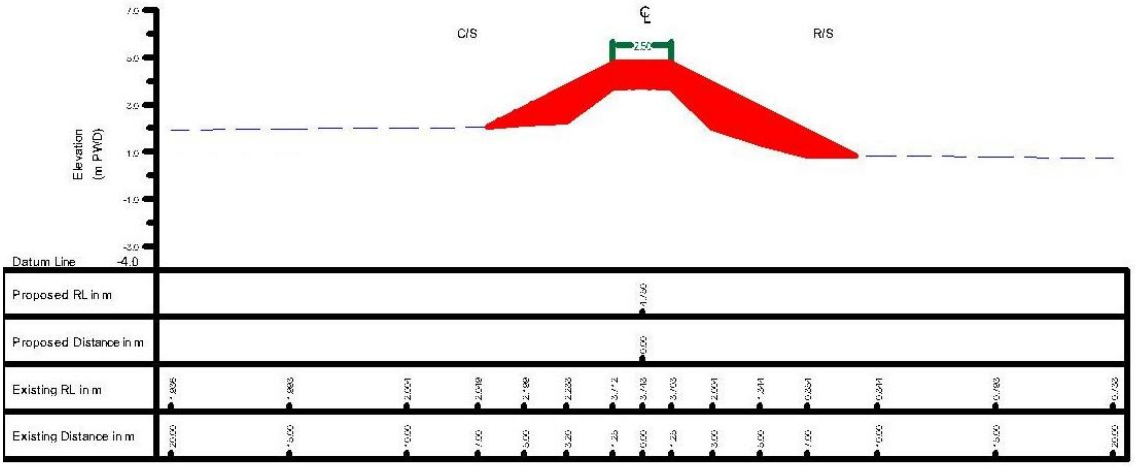
(a)Some cross sections along the length of the peripheral embankment of Polder 43/2D has been shown below:



Chainage 10+400 km

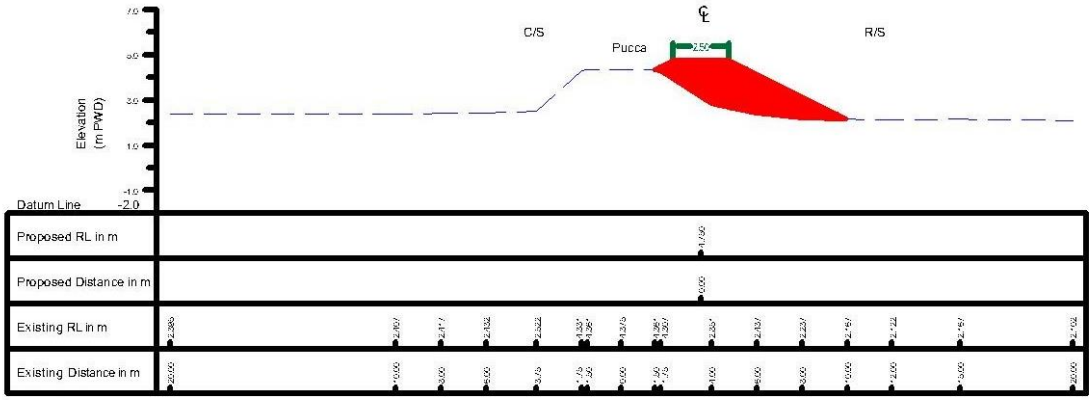


Chainage 19+000 km



Chainage : 30+000 km., Earth Filling Area : 17.050 sq.m, Turfing Length : 15.700 m.

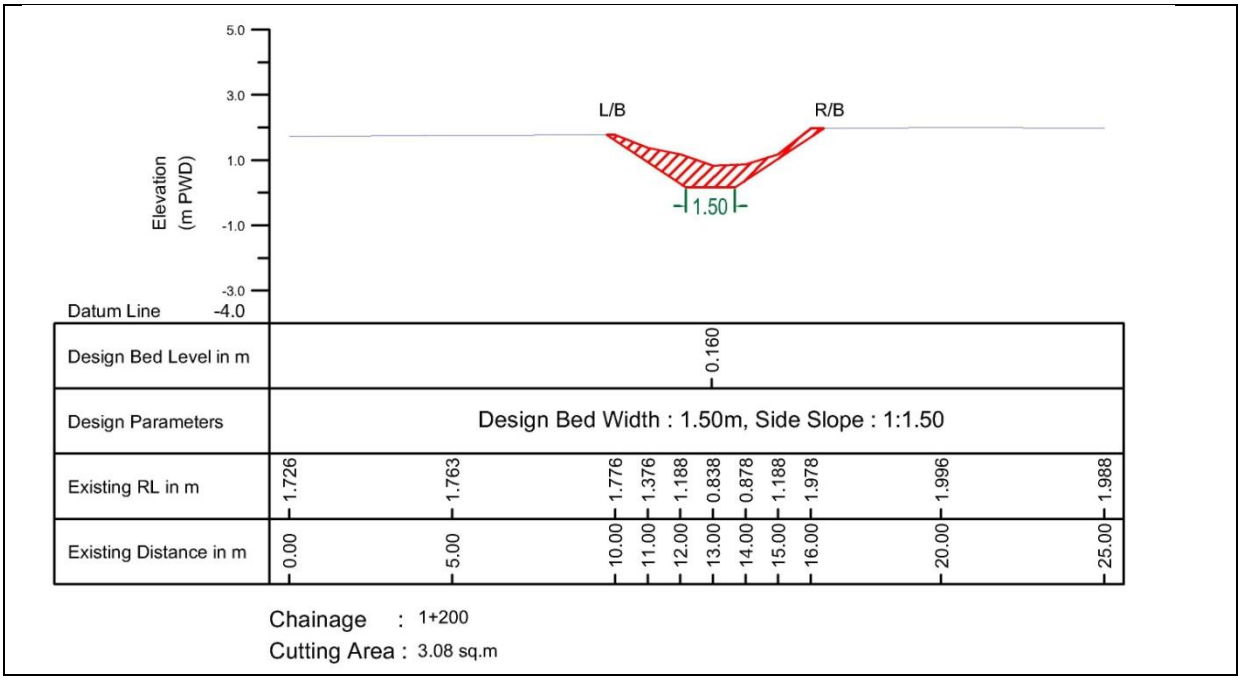
Chainage 30+000 km



Chainage : 39+800 km., Earth Filling Area : 9.900 sq.m, Turfing Length :7.640 m.

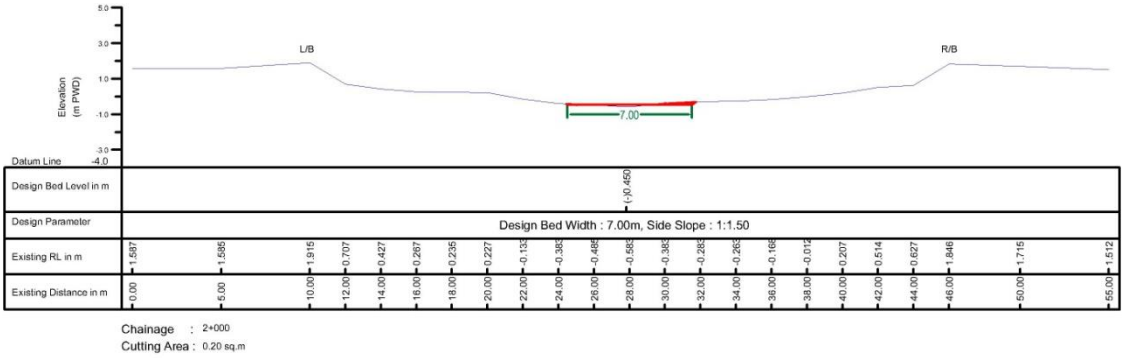
Chainage 39+800

(b) Some cross sections of khals to be re-excavated are show below:



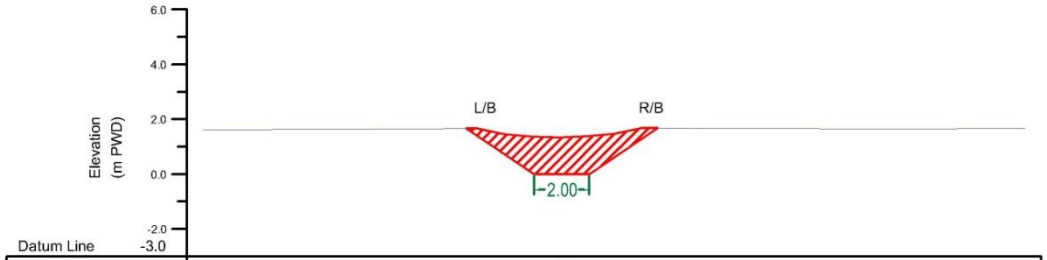
Chainage : 1+200
Cutting Area : 3.08 sq.m

Jhapuar Khal: Chainage 1+200 km



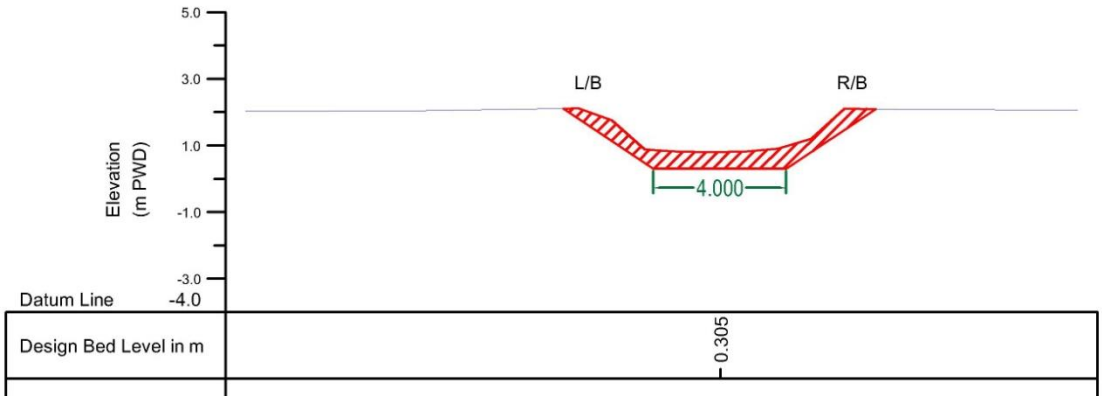
Chainage : 2+000
Cutting Area : 0.20 sq.m

Katakhali Khal: Chainage 2+000



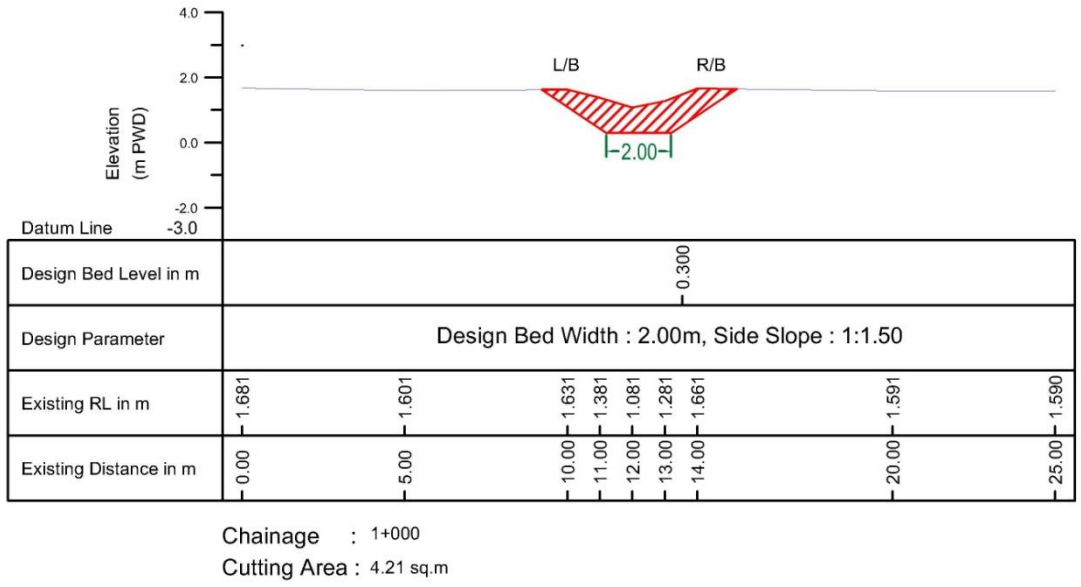
Chainage : 1+000
Cutting Area : 6.17 sq.m

Dangar Khal 1+000

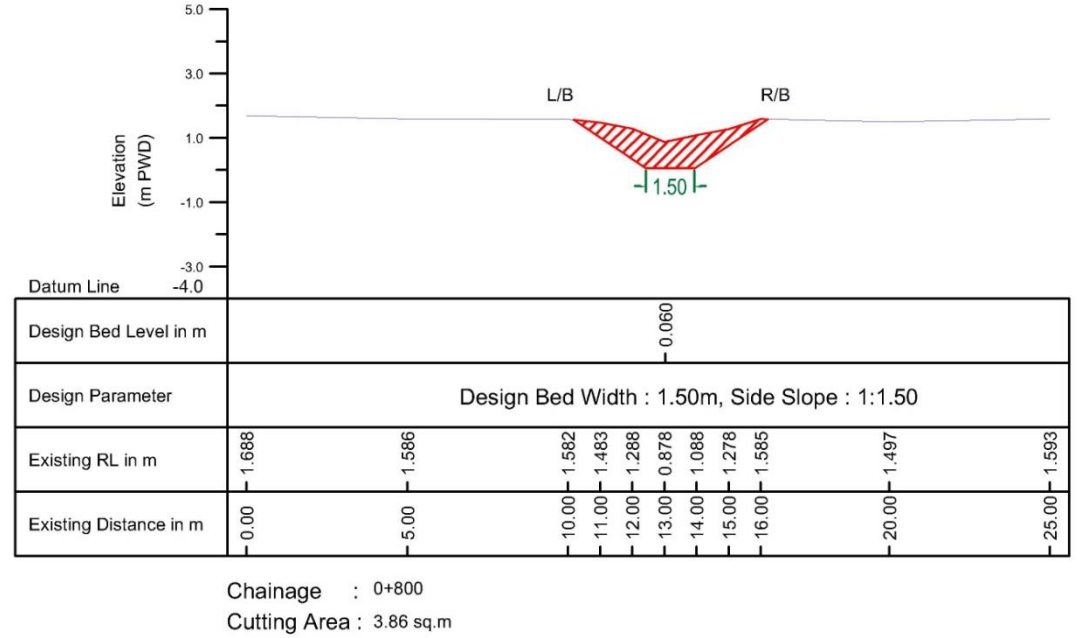


Chainage : 1+000
Cutting Area : 4.55 sq.m

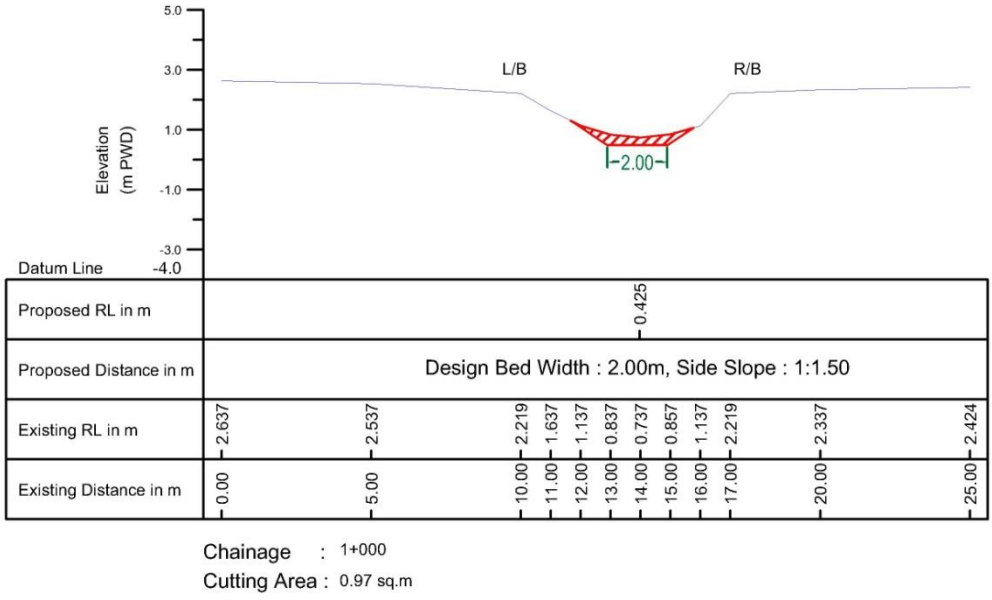
Idukhali Khal: Chainage 1+000



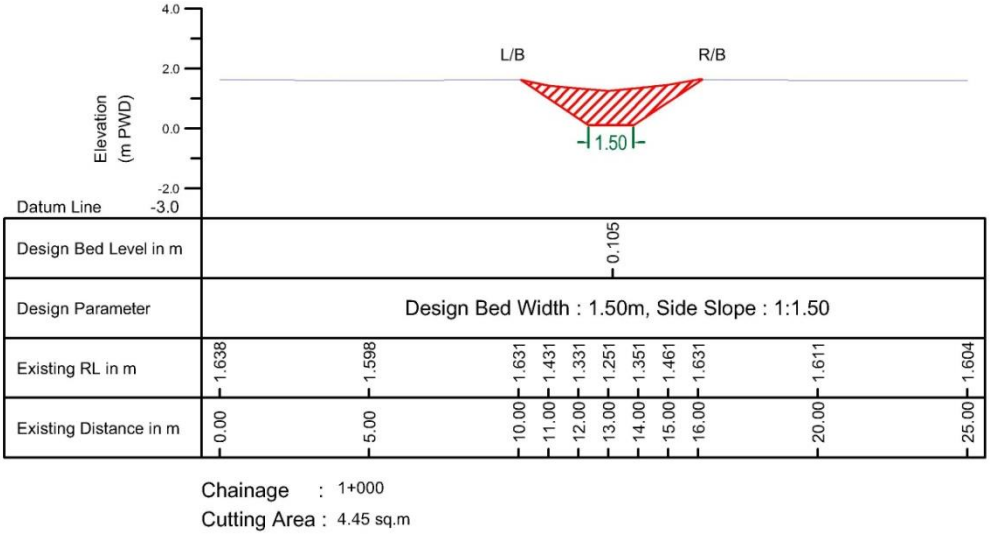
Hopania Khal: Chainage 1+000



Dontar Khal: Chainage 0+800

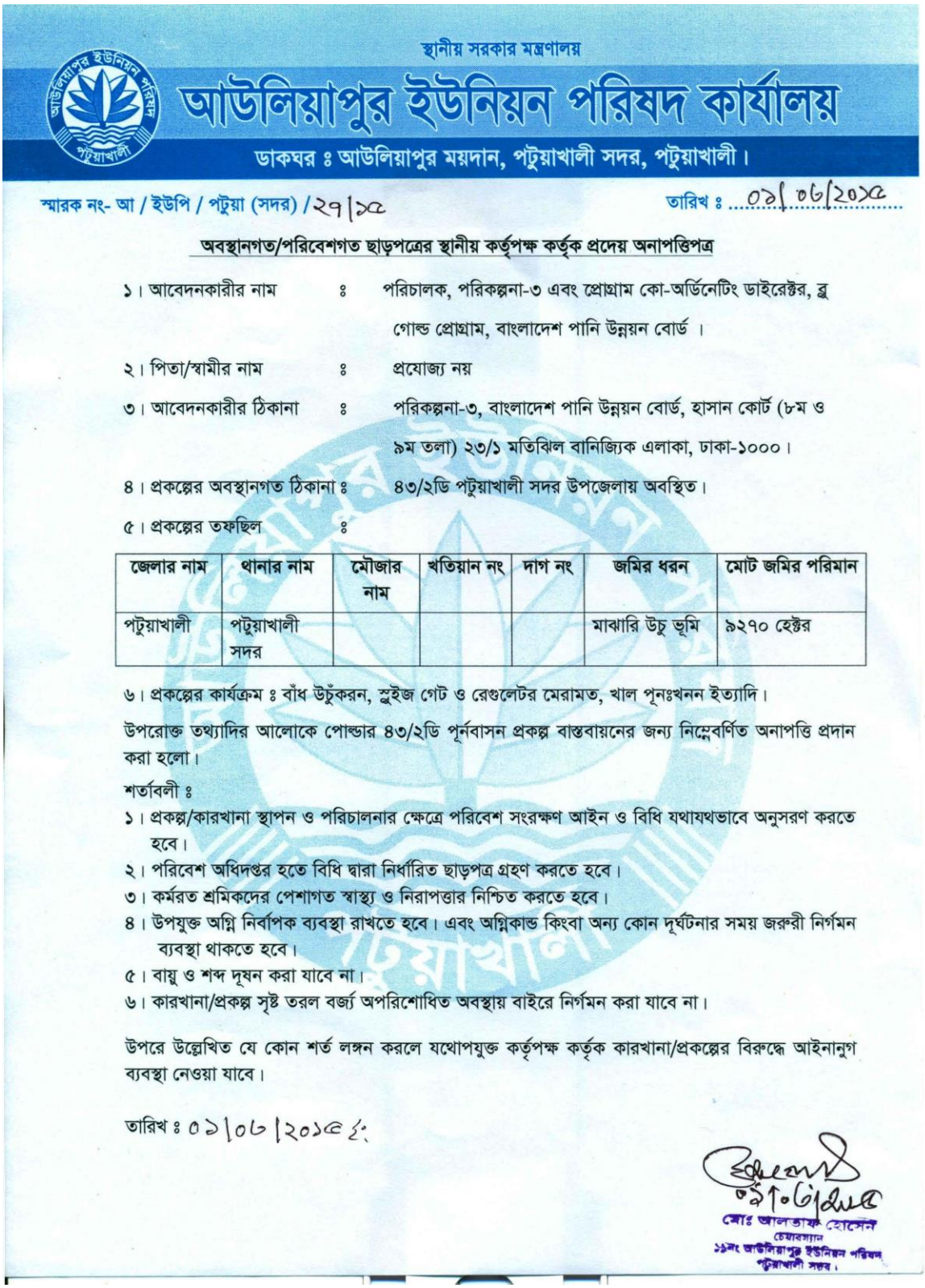


Sutanali Khal: Chainage 1+000



Murichbunia Khal: Chainage 1+000

Appendix 3: No Objection Certificate



স্থানীয় সরকার মন্ত্রণালয়

আউলিয়াপুর ইউনিয়ন পরিষদ কার্যালয়

ডাকঘর ঃ আউলিয়াপুর ময়দান, পটুয়াখালী সদর, পটুয়াখালী।

স্মারক নং- আ / ইউপি / পটুয়া (সদর) /২৭/১৫ তারিখ ঃ ০২/০৬/২০১৫

অবস্থানগত/পরিবেশগত ছাড়পত্রের স্থানীয় কর্তৃপক্ষ কর্তৃক প্রদেয় অনাপত্তিপত্র

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 ঃ ৪৩/২ডি পটুয়াখালী সদর উপজেলায় অবস্থিত।

৫। প্রকল্পের তফছিল ঃ

জেলার নাম	থানার নাম	মৌজার নাম	খতিয়ান নং	দাগ নং	জমির ধরন	মোট জমির পরিমান
পটুয়াখালী	পটুয়াখালী সদর				মাঝারি উচু ভূমি	৯২৭০ হেক্টর

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

উপরোক্ত তথ্যাদির আলোকে পোল্ডার ৪৩/২ডি পূর্নবাসন প্রকল্প বাস্তবায়নের জন্য নিম্নেবর্ণিত অনাপত্তি প্রদান করা হলো।

শর্তাবলী ঃ

১। প্রকল্প/কারখানা 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। কারখানা/প্রকল্প সৃষ্ট তরল বর্জ্য অপরিশোধিত অবস্থায় বাইরে নির্গমন করা যাবে না।

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

তারিখ ঃ ০২/০৬/২০১৫ ইং

০২/০৬/২০১৫

মোঃ আলতাফ হোসেন
চেয়ারম্যান
১৯নং আউলিয়াপুর ইউনিয়ন পরিষদ
পটুয়াখালী সদর।

মাদারবুনিয়া ইউনিয়ন পরিষদ কার্যালয়

ডাকঘরঃ গেড়াখালী, উপজেলাঃ পটুয়াখালী সদর, জেলাঃ পটুয়াখালী।

http://madarbuniaup.patuakhali.gov.bd

স্মারক নং-৮৮২৫ তারিখঃ ২১/১২/১৫

অবস্থানগত/পরিবেশগত ছাড়পত্রের স্থানীয় কর্তিপক্ষ প্রদেয় অনাপত্তিপত্রের ছক

১।আবেদন কারীর নামঃ পরিচালক, পরিকল্পনা-৩ এবং প্রোগ্রাম কো-অর্ইডনেটিং ডাইরেক্টর, ব্লু গোল্ড প্রোগ্রাম, বাংলাদেশ পানি উন্নয়ন বোর্ড।

২।পিতা/ স্বামীর নামঃ প্রযোজ্য নয়।

৩।আবেদনকারীর ঠিকানাঃ পরিকল্পনা-৩, বাংলাদেশ পানি উন্নয়ন বোর্ড, হাসান কোর্ট(৮ম ও ৯ম তলা)২৩/মতিঝিল বানিজ্যিক এলাকা, ঢাকা-১০০০।

৪।প্রকল্পের অবস্থানগত ঠিকানঃ ৪৩/২ডি পটুয়াখালী সদর উপজেলায় অবস্থিত।

৫।প্রকল্পের তফছিলঃ

জেলার নাম	থানার নাম	মৌজার নাম	খতিয়ন নং	দাগ নং	জমির ধরন	মোট জমির পরিমান
পটুয়াখালী	পটুয়াখালী সদর	-	-	-	মাঝারি উচু ভূমি	৯২৭০ হেক্টর

৬।প্রকল্পের কার্যক্রমঃ বাঁধ উচুঁকরন, স্লুইজ গেট ও রেগুলেটার মেরামত, খাল পূনঃখনন ইত্যাদি।

উপরোক্ত তথ্যাদির আলোকে পোল্ডার ৪৩/২ডি পূর্নবাসন প্রকল্প বাস্তবায়নের জন্য নিম্নেবর্নিত আনাপত্তি প্রদান করা হলো।

শর্তাবলীঃ

১।প্রকল্প/কারখানা স্থাপন ও পরিচালনার ক্ষেত্রে পরিবেশ সংরক্ষন আইন ও বিধি যথাযথভাবে অনুসরন করতে হবে।

২।পরিবেশ অধিদপ্তর হতে বিধি দ্বারা নির্ধারিত ছাড়পত্র গ্রহন 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 যাবেনা।

৬।কারখানা/প্রকল্প সৃষ্ট তরল বর্জ্য অপরেশোধিত অবস্থায় বাইরে নির্গম করা যাবেনা।

উপরে উল্লেখিত যে কোন শর্ত লঙ্গন করলে যথোপযুক্ত কর্তৃপক্ষ কর্তৃক কারখানা/ প্রকল্পের বিরুদ্ধে আইনানুগ ব্যবস্থা নেওয়া হবে।

স্থানীয় কর্তৃপক্ষের স্বাক্ষর ও সীলঃ

চেয়ারম্যান

মাদারবুনিয়া ইউনিয়ন পরিষদ

চেয়ারম্যান
মাদারবুনিয়া ইউনিয়ন পরিষদ
পটুয়াখালী সদর।

Appendix 4: Terms of Reference

Government of the People's Republic of Bangladesh
Department of Environment
www.doe.gov.bd
Head Office, Paribesh Bhaba
E-16 Agargaon, Dhaka-1207

Memo No: DoE/Clearance/5309/2014/ 158 Date: 10/07/2014

Subject: Approval of Terms of Reference for EIA of the Proposed Rehabilitation and Improvement of Infrastructure of Five Coastal Polders under Blue Gold Program.

Ref: Your Application dated 20/04/2014.

With reference to the above, the undersigned is directed to convey the approval of the Terms of Reference (TOR) for Environmental Impact Assessment (EIA) of the proposed Rehabilitation and Improvement of Infrastructure of five coastal Polders under Blue Gold Program.

I. The project authority shall submit a comprehensive Environmental Impact Assessment (EIA) considering the overall activity of each polder in accordance with the TOR and time schedule submitted to the Department of Environment (DOE) and additional suggestions provided herein..

II. The EIA report should be prepared in accordance with following indicative outlines:

1. Executive summary
2. Introduction: (Background, brief description, scope of study, methodology, limitation, EIA team, references)

Legislative, regulation and policy consideration (covering the potential legal, administrative, planning and policy framework within which the EIA will be prepared)

4a. Project activities:

- A list of the main project activities to be undertaken during site clearing, construction as well as operation
- Project Plan, Design, Standard, Specification, Quantification, etc.

4b. Project schedule: The phase and timing for development of the Project

4c. Resources and utilities demand: Resources required to develop the project, such as soil and construction material and demand for utilities (water, electricity, sewerage, waste disposal and others), as well as infrastructure (road, drains, and others) to support the project.

4d. Map and survey information

Location map, Cadastral map showing land plots (project and adjacent area), Topographical map, Geological map showing geological units, fault zone, and other natural features.

5. Baseline Environmental Condition should include, inter alia, following: (Identification and Quantification of Physical Situation that has been proposed to be changed)

- Physical Environment : Geology, Topology, Geomorphology, Land-use, Soils, Meteorology, and Hydrology
- Biological Environment : Habitats, Aquatic life and fisheries, Terrestrial Habitats and Flora and Fauna
- Environment Quality : Air, Water, Soil and Sediment Quality
- Relate baseline in both Quantitative and Qualitative term with the anticipated outcomes, achievement of goals, objectives and changes due to project interventions

6. Socio-economic environment should include, inter alia, following:

- Population: Demographic profile and ethnic composition
- Settlement and housing
- Traffic and transport
- Public utilities: water supply, sanitation and solid waste

1

- Economy and employment: employment structure and cultural issues in employment
- Fisheries: fishing activities, fishing communities, commercial important species, fishing resources, commercial factors.

7. Identification, Prediction and Evaluation of Potential Impacts (identification, prediction and assessment of positive and negative impacts likely to result from the proposed project).

   In identification and analysis of potential impacts'-the 'Analysis' part shall include the analysis of relevant spatial and non-spatial data. The outcome of the analysis shall be presented with the scenarios, maps, graphics etc. for the cases of anticipated impacts on baseline. Description of the impacts of the project on air, water, land, hydrology, vegetation-man maid or natural, wildlife, socio-economic aspect shall be incorporated in detail.

8. Management Plan/Procedures:

   For each significant major impact, proposed mitigation measures will be set out for incorporation into project design or procedures, impacts, which are not mitigable, will be identified as residual impacts Both technical and financial plans shall be incorporated for proposed mitigation measures.

   An outline of the Environmental Management Plan shall be developed for the project.

   In Environmental Monitoring Plan, a detail technical and financial proposal shall be included for developing an in-house environmental monitoring system to be operated by the proponent's own resources (equipments and expertise).

9. Consultation with Stakeholders/Public Consultation (ensures that consultation with interested parties and the general public will take place and their views taken into account in the planning and execution of the project)

   Beneficial Impacts (summarize the benefits of the project to the Bangladesh nation, people and local community and the enhancement potentials)

10. Conclusion and Recommendations

III. Without approval of EIA report by the Department of Environment, the project authority shall not be able to open L/C in favor of importable machineries.

IV. Without obtaining Environmental Clearance, the project authority shall not be able to start the physical activity of the project.

V. The project authority shall submit the EIA along with a filled-in application for Environmental Clearance in prescribed form, the applicable fee in a treasury chalan, the no objection certificates (NOCs) from the local authority, NOCs from forest department (if it is required in case of cutting any forested plant, private or public) and NOC from other relevant agencies for operational activity etc. to the concerned divisional office of DOE with a copy to the Head Office of DOE in Dhaka.

ডায়েরী নং ৬২৫ তারিখঃ ১৫/৭/১৪

10.07.2014

(Syed Nazmul Ahsan)
Deputy Director (Environmental Clearance)
and
Member Secretary
Environmental Clearance Committee
Phone # 02-8181778

Project 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 5: List of Participants

Environmental Study for Blue Gold Program

EIA and SIA study conducted by CEGIS

Participant list of PCM

Venue: মাদারবুনিয়া ইউপি, Date: ২৮/১১/২০১৮

SL	Name	Occupation	Age	Address	Mobile No.
০১	মুহাম্মদ ফারুক আলম	সভাপতি	৫০	সভাপতি ৪৬১২ বি- WMA	01768-955316
০২	আঃ খালেক মন্ডল	ব্যবসায়ী	৫৪	[illegible]	01712436471
০৩	মোঃ হযরত মুন্সী	কোষাধ্যক্ষ	৬২	[illegible]	01749187019
০৪	কাজী নজরুল ইসলাম	সদস্য	৫৮	[illegible]	01718892392
০৫	মোসাঃ মনোয়ারা বেগম	সহ-সভাপতি	৪৫	গোবরাখালী	01723519546
০৬	মোঃ আবুল কালাম [illegible]	সদস্য	৫০	দঃ হরিখালী	01731768909
০৭	[illegible]	সদস্য	৪০	[illegible]	01799933571
০৮	মোঃ রফিকুল ইসলাম	সদস্য		মাদারবুনিয়া	
০৯	বশির নুর	সদস্য, WMA	৫০	সহকারী মাদারবুনিয়া	01725487372
১০	মোসাঃ শামসুন্নাহার	ইউপি সদস্য	৩৭	[illegible]	01724005975
১১	নাছির [illegible]	সহ সভাপতি, WMA	৪৫	হরিখালী	~~01725487372~~
১২	শামিমা নাসরিন	সদস্য	৩০	হরিখালী	01725962157
১৩	উর্মিলা রানী	দুঃস্থ	৪৬	[illegible]	01743393938
১৪	ফিরোজা বেগম	কোষাধ্যক্ষ WMG	৫০	দঃ হরিখালী	017199388[illegible]
১৫	আনিছুর রহমান	C.O	৪৫	ব্লু গোল্ড প্রোগ্রাম	01712201899
১৬	মোঃ মিলন [illegible]		৩৩	[illegible]	01754071824
১৭	মিসেস রাহিমা বেগম	ইউপি সদস্যা	৩৫	মাদারবুনিয়া	01726-79898
১৮	মোঃ মোসাদ্দেক [illegible]	[illegible]	৪০	চরাবুনিয়া	01712535306
১৯	[illegible]	কৃষক	৬০	[illegible]	

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Environmental Study for Blue Gold Program

EIA and SIA study conducted by CEGIS

Participant list of PCM

Venue: মাদারবুনিয়া, ইউপি,   Date: ১৫/১১/২০১৮

SL	Name	Occupation	Age	Address	Mobile No.
২০	মো: ছত্তার সরদার	ইউপি সদস্য	৫২	মাদারবুনিয়া	০১৭৪৫৩৬৭৫ ৮৪৪
২১	মো: ইউনুস খান	ইউপি সদস্য	৩৮	"	01718433515
২২	মো: নোহজাহান [illegible]	ই. উ. সদস্য	৬০	নলিতাবুনিয়া	01716028652
২৩	[illegible]	[illegible]	৪৬	[illegible]	01724385123
২৪	মো: [illegible] মিয়া	কৃষক	৩২	হরিণঘাটা	
২৫	মো: [illegible] খান	[illegible]	৫৮	দ: হরিণঘাটা	[illegible]
২৬	বীথিকা হালদার	Socio Economist	39+	Blue Gold	[illegible]
২৭	[illegible] আহমেদ	Service	28	CEGIS	01914434168
২৮	[illegible]	কৃষক	৩৫	হরিণঘাটা	
২৯	মোসা: মোমেনা বেগম	সদস্য, WMA	৪৫	চালিতাবুনিয়া	01824421645
৩০	আলো তারা	গৃহিনী	৪২	হরিণঘাটা	
৩১	[illegible]	চেয়ারম্যান	৩৬	[illegible]	01712895907
৩২	মো: [illegible]	[illegible]	২৯	[illegible]	01797476819
৩৩	মো: সেলিম মাতব্বর	ব্যবসা	৪০	চালিতাবুনিয়া	01749938898
৩৪	আবুল কাদের	ব্যবসা	৪৮	[illegible]	0
৩৫	মো: [illegible]		২৬	হরিণঘাটা	
৩৬	মো: [illegible]	[illegible]	২৭	[illegible]	[illegible] 01733124663
৩৭	মোসা: [illegible]	[illegible]	৩৫	[illegible]	01721851220
৩৮	মো: রায়হান			হরিণঘাটা	01773343328

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Participant list of PCM

Venue: মাদারবাড়িয়া ইউনিয়ন **Date:** 26.11.2018

SL	Name	Occupation	Age	Address	Mobile No.
৩১	মো: রাকিব হোসেন			শাহিখালী	
৪০	দ্বীন ইসলাম			উ: শাহিখালী	
৪১	নাইম ইসলাম			শাহিখালী	
৪২	মো: সাইফুল			ঐ	
৪৩	মো: তাজুল সাহা			ঐ	

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Participant list of PCM

Venue: মাঝিরা বুনিয়া ইউ: পি: **Date:** ২২/১১/২০১৪

SL	Name	Occupation	Age	Address	Mobile No.
১	মো: আনোয়ার হাওলাদার	কৃষি	৪৬	~~[illegible]~~	01723474483
২	মো: হোসাইন সাত্তী	ইউ: পি:	৬৬	পূর্ব মাঝিরবুনিয়া	01710149853
৩	মো: রফিকুল ইসলাম	ইউ: পি:	৪৫	বকুলবাড়ীয়া	01768987554
৪	মো: মজিবুর রহমান	ইউ: পি:	৩৫	দ: কালাপুরহোন্দা	01719971973
৫	মো: হাবিবুর রহমান	WMG	৪৬	উ: মাঝির বুনিয়া	01725522160
৬	মো: আবুল কালাম	WMG	৪৫	দ: মাঝির বুনিয়া	01992625986
৭	মো: নিজাম উদ্দীন	"	৪০	"	০১৭৪৫০৭৯২২২
৮	মো: হাবিবুল্লাহ	ইমাম	২৪	মাঝিরবুনিয়া	01712455762
৯	মো: মজিবুর রহমান	ব্যবসা	৪০	মাঝির বুনিয়া	০১৭২৭৯৬২৬৫৯
১০	মো: হুমায়ুন কবির	ইমাম	৫০	মাঝির বুনিয়া	01735866423
১১	আবদুল মালেক হাং	কৃষি	৭৮	মাঝির বুনিয়া উ:	
১২	মো: সাত্তার	ব্যবসা	৫৫	মাঝিরবুনিয়া	01713956160
১৩	মো: হানিফ হাং	মাঝি	৫০	"	01712905778
১৪	মো: দেলোয়ার	ব্যবসা	৪৪	উ: মাঝিরবুনিয়া	
১৫	মো: জামাল	জেলে	৪২	উ: মাঝির বুনিয়া	
১৬	মোস্তফা	[illegible]	৪০	উ: মাঝির বুনিয়া	
১৭	মো: কাদের আলি	[illegible]	৩২	[illegible]	
১৮	মো: কবির সিকদার	সভাপতি উ: মাঝি বুনি:	৪৪	উ: মাঝিরবুনিয়া	
১৯	বিউটি বেগম	সহসভাপতি	৪২	উ: মাঝির বুনিয়া	

Center for Environmental and Geographic Information Services

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Environmental Study for Blue Gold Program

EIA and SIA study conducted by CEGIS

Participant list of PCM

Venue: [illegible] ইউ. পি.

Date: ২২/১১/২০১৪

SL	Name	Occupation	Age	Address	Mobile No.
২০	মোসা: সাহিনুর বেগম	[illegible]		[illegible]	01727980860
২১	মোসা: সেলিনা বেগম	[illegible]		[illegible]	
২২	রাশিদা খানম				রাশিদা
২৩	আমেনা বেগম				আমেনা
২৪	ডা: সালমা	[illegible]	50	[illegible]	01719620666 01718907003
২৫	মোসা: হোসনেয়ারা	W.M.A U.P.	২৮	[illegible]	01739556808
২৬	মোসা: কহিনুর বেগম	U.P	৩০	[illegible]	01823974923
২৭	মো: সাদের [illegible]	Chairman	80	"	01750102760
২৮	মো: মোহরাব খান			[illegible]	01843332210
২৯	হাসান	ব্যবসা	২৮	[illegible]	01728195743
৩০	মো: আবুল	কৃষক	৩০	কাজারবোনা	
৩১	ড. মো: [illegible] হোসেন	[illegible]	৪৫	[illegible]	0171597470

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Environmental Study for Blue Gold Program
EIA and SIA conducted by CEGIS
Participant list of PCM

Venue: সাবিচবুনিয়া ইউপি **Date:** ১৯/১২/২০১৪

SL	Name	Occupation	Age	Address	Mobile no:
1	মোঃ রফিকুর রহমান	ব্যবসা	৪৬	সাবিচবুনিয়া	০১৯২-৫৫২১৬০
2	মোঃ মনোরঞ্জন সিকদার	ইউপি, সদস্য	৩৮	বকুলতলিয়া	০১৭১৩৯৫১৪১৩
3	মোঃ জোবায়ের	গ্রাম পুলিশ	৪৫	বাজারগোলা	০১৭৩৯৩৬৪৭৮৭
4	মোঃ আনিকুর	ব্যবসা	৪৫	তালতলাবড়ুয়া	০১৭২১৯০২৭৮২
5	মোঃ কালাচাঁদ	কৃষি	৬১	সাবিচবুনিয়া	০১৭৫৯০৭৭৫৩
6	আনিছুর রহমান	চাকুরী	৪৫	Blue Gold Programme	০১৭১২২০১৪৯৯
7	মোঃ তোফাজ্জল	কৃষক	৫০	সাবিচবুনিয়া	০১৭৮৪২৬৫৪৫
8	মোঃ সুলতানা মমিতা	কৃষি	৩৫	সাবিচবুনিয়া	০১৭৬১৫২৯৮৫৭
9	তৈয়বা	কৃষি	৩০	বাজারগোলা	০১৮৬২৫৩৫৯৭৩
10	মোছাঃ জাহেদুর	সদস্য, WMA	২৫	সাবিচবুনিয়া	
11	মোঃ ছত্তার মুন্সী	কৃষি	৫০	সাবিচবুনিয়া	০১৭৩৪৪৬৯৫৯
12	সাফিয়া	গৃহিণী	৫০	তালতলাবড়ুয়া	০১৭৪২৬১৯৫৩৩
13	মোঃ ইউছুপ সরোয়ার	কৃষক	৫২	সাবিচবুনিয়া	০১
14	মোঃ ফরিদুল	গ্রাম পুলিশ	৩০	সাবিচবুনিয়া	০১৭৫২১৫৭৬৬
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Appendix 6: Comments and Responses

Sl.	Comments	Response	Reference No.
1.	Summarize the proposed interventions and include them in one table, with other necessary information (length, width and dimension).	The issue has been dealt with a Table on summarized proposed intervention has been included in the Final EIA report.	Chapter 4, Page 37, Paragraph 125 and Table 4.1
2.	Mention if all the interventions proposed under the Blue Gold Program are sufficient, especially as remedy measures for the prominent water management problems of the area.	The issue was previously discussed with local people during PCM but the findings were perhaps not properly reflected in the draft report. In view to this, a new article has been added in the Final EIA report (Article 7.8: Perceptions towards proposed interventions)	Chapter 7, Page 128 Paragraph 330
3.	Describe the status of existing water management organizations (WMOs)/ water management groups (WMGs); and mention if they are registered entities or not.	The comment has been incorporated in the Final EIA report (Article 4.8.2)	Chapter 4, Page 43, Paragraph 143
4.	Mention the source of financing (provision in DPP or other potential sources?) for implementing the proposed EMPs, which have been suggested in the EIA study.	The source of financing of measures suggested in the EMP has been mentioned in the Final EIA report (Article 10.10)	Chapter 10, Page 192, Paragraph 457