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on

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

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CEGIS Center for Environmental and Geographic Information Services
House 6, Road 23/C, Gulshan-1, Dhaka-1212, Bangladesh. Tel: 8817648-52, Fax: 880-2-8823128

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Table of Contents

List of Tables

List of Figures

List of Photographs

List of Maps

Abbreviation and Acronyms

AEZ	Agro -Ecological Zone
ASA	Association for Social Advancement
BAU	Bangladesh Agricultural University
BCCSAP	Bangladesh Climate Change Strategy and Action Plan
BCSAP	Biodiversity Conservation Strategy and Action Plan
BG	Blue Gold
BMD	Bangladesh Metrological Department
BOD	Biochemical Oxygen Demand
BUET	Bangladesh University of Engineering and Technology
BWDB	Bangladesh Water Development Board
CAS	Catch Assessment Survey
CBO	Community Based Organizations
CDSP	Char Development and Settlement Project
CEGIS	Center for Environmental and Geographic Information Services
CEIP	Coastal Environmental Improvement Project
COD	Chemical Oxygen Demand
COs	Community Organizers
DAE	Department of Agricultural Extension
dBA	DecciBel
DC	District Commissioner
DEM	Digital Elevation Model
DG	Director General
DO	Dissolved Oxygen
DoE	Department of Environment
DoF	Department of Fisheries
DPHE	Department of Public Health Engineering
DPP	Development Project Proforma
EA	Environmental Assessment
ECA	Environmental Conservation Act
ECR	Environmental Conservation Rules
EIA	Environmental Impact Assessment
EKN	Embassy of the Kingdom of Netherlands

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

KII	Key Informant Interview
LCS	Labor Contracting Society
LGED	Local Government Engineering Department
LGIs	Local Government Institutions
LGRD	Local Government and Rural Development
Lpc	Litre per capita
MoEF	Ministry of Environment and Forests
MoWR	Ministry of Water Resources
MP	Murate of Potash
MPI	Multidimensional Poverty Index
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	Pestedes Petits Ruminants
PRA	Participatory Rural Appraisal
PSF	Pond Sand Filter
PWD	Public Works Department
RL	Reduced Level
RRA	Rapid Rural Appraisal
RS	Remote Sensing

SAAO	Sub Assistant Agriculture Officer
SIA	Social Impact Assessment
SIS	Small Indigenous Species
SRDI	Soil Resource Development Institute
STW	Shallow Tube Well
SW	Surface Water
SWAIWRPMP	South West Area Integrated Water Resources Planning and Management Project
SWAT	Soil and Water Assessment Tools
T. Aman	Transplanted Aman
ToR	Terms of Reference
TSP	Triple Super Phosphate
UAO	Upazila Agriculture Officer
UFO	Upazila Fisheries Officer
UNDP	United Nations Development Programme
UNO	Upazila Nirbhahi Officer
WARPO	Water Resources Planning Organization
WMA	Water Management Association
WMC	Water Management Committee
WMF	Water Management Federation
WMGs	Water Management Groups
WMIP	Water Management Improvement Project
WMO	Water Management Organization

Glossary

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

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

Unit Conversion

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

Executive Summary

Background

Bangladesh, the largest river delta in the world, has about 710 km of coast line along the Bay of Bengal. There are 38.5 million peoples live in the coastal area. About 38% of the population in the coastal region live below the poverty line and face high vulnerabilities in terms of access to food, employment, income, water and health service. Integrated and participatory water resources management has the potential to contribute significantly to food security, safety, income level, health and economic growth. In this context, the Government of the Netherlands (GoN) as a development partner of Bangladesh has been supporting water resources management projects in Bangladesh since 1975. These projects are mostly operated by the Bangladesh Water Development Board (BWDB).The Blue Gold Program (BGP), is one of such initiative that will cover 26 polders in three coastal districts of Bangladesh. This program, initiated in January 2013 and expected to end in December2018, is built on the results and lessons learnt in managing water resources from previous programs and projects. The explicit objective of Blue Gold Program is to reduce poverty and increase people's income through value chain development in an integrated approach. Initially, in the selected polders of the coastal districts all water control structures will be rehabilitated and fine tuned in line with project objectives. However, to proceed with implementation, the BGP needs environmental clearance from the Department of Environment. This is due to the fact that under the Environment Conservation Rules (ECR, 1997), construction/reconstruction/expansion of flood control embankments, polders, dikes, etc. are classified as **'red'** category projects, and are subject to mandatory to Environmental Impact Assessment (EIA) study. In view of this, the Blue Gold Program management authority entrusted CEGIS to carry out the EIA study of seven selected polders (Polder 2, 26, 29, 31-part, 43/1A, and 43/2B and 43/2E) in its first phase. This document is the Final EIA study report of Polder 43/2E.

Objective of the study

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

Approach and Methodology

The guidelines for environmental impact assessment of water sector projects, developed by the Flood Plan Co-ordination Organization (FPCO) in 1992 and updated by the Water Resources Planning Organization (WARPO) in 2003 (WARPO, 2005) is followed to conduct this EIA study.

Project Description

Polder 43/2E covers most of the areas of Jainkati union of Patuakhali Sadar Upazila in Patuakhali District. The polder was constructed in 1989-90, 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 Patuakhali O&M Division, BWDB, Patuakhali. The polder is surrounded by the tidal river namely, the Lohalia River on the east and north, the Shuddurbaria khal on the south and the Naotana khal along the north direction.

Existing Problems and Proposed Interventions

The polder is enriched with embankment having a length of about 20 km and providing protection against tidal and storm surges and salinity intrusion. There are seven drainage sluices, two drainage outlets and 55 flushing inlets within the polder and are constructed by the BWDB.

The existing condition of the embankment is good in most of the portion; a significant part of the peripheral embankment is paved, which allow heavy vehicular movements. Most of the structures are not functioning upto the desired level and fail to drain out excess water during heavy rainfall causing drainage congestion. The structure at Naotana, Katakhali, Gogonkhali, Piprabunia and Katurataluk is found in an undesirable condition; with severe mismanagement issues observed at some locations. The sluice gate at Dholkhali is severely damaged and found to be tied with ropes and logs. Among the inlet pipes, 3 are completely damaged and most of the other inlets need repairing. The internal drainage channels of the polder consists a total length of 38.997 km. Over the years, siltation, topsoil erosion and other land filling activities have resulted gradual decrease of water courses within the polder.

Considering the existing problems and needs of local residents, the Blue Gold program has considered the following interventions for improvement of Polder 43/2E:

- **Re-sectioning along the existing embankment** with crest width of 4.27m, with side slopes of 1(V): 3(H)in the river sides while 1(V):2(H) in the country sides, with an exception of 1(V): 2(H) on both river and country side from Chainage 15+000 to 19+950;
- **Repairing of 7 numbers of drainage/flushing sluices** at Natuar, Naotana, Katakhali, Gogonkhali, Dholkhali, Suddurbaria and Moubaria khals;
- **Repairing of drainage outlets** at Katurataluk and Piprabunia; reparing of 55 numbers of irrigation inlets at different locations;
- **Re-excavation** of 9 khals inside the polder and new construction of a drainage outlet at Durlob khal.

Environmental and Social Baseline

The project area experiences tropical climate. The average maximum temperature ranges from 29°C (January) to 36°C (April). Significant fluctuations in average minimum temperatures have been observed, which varies from 10.3°C (January) to 24°C (August).The maximum rainfall ever recorded in the area is 547 mm in the month of July and lowest in the month of January which is 7 mm. The monthly average relative humidity of the Patuakhali BMD station varies from 74% to 90%. Daily average sunshine hours are higher than 6 hours (August-March) which reduces to 3 hours from April to July. Wind speed of the polder area is highest in April (around 167kph) and lowest in December (around 50 kph).

The water quality of different water bodies has been measured. The pH values were higher than the neutral value (pH=7) which means that water in these locations are alkaline in nature during January. The polder is situated beside Galachipa River, which is directly connected with the Bay of Bengal. However, the polder is not directly connected with any river. This eventually results in reduced sediment transportation near the polder, for which the values of TDS found are very low. The Values of DO are mostly found close to the standard values set by the DoE for both irrigation (5 to 6 mg/l) and fishing (5 mg/l). Temperature values varied within a typical range for different locations as samplings were made in different time of the day. Furthermore, all samples were found with zero salinity.

About 81% of the land in the area has elevation between 1.4 and 1.61 m +PWD. The study area falls under Zone-III, which is characterized by low earthquake prone sites. In consideration with the seismicity and stratigraphy, Polder 43/2E falls under a relatively safer (seismically quiet and tectonically stable) site.

Polder 43/2E is within around 45 km aerial distance from the coast of the Bay of Bengal, undergoing diurnal tidal influence. The polder is surrounded by a tidal river namely, the Lohalia River on the east and north direction, the Shuddurbaria khal on the south portion and the Naotana khal along the north direction. Apart from these rivers, there are approximately 35.2 km of drainage and irrigation canals (khals) within the polder. The variation of monthly water levels shows that water level during high tide ranges from +1.1 m, PWD to +2.4 m, PWD, whereas low tidal water level ranges from -0.3 m, PWD to +0.4 m, PWD. From the study found that around 280 m^3 of water is consumed daily by the total number of 9,350 people living in the polder. Local people opined that they prefer Deep Tube Wells (DTWs) as drinking water sources to meet up their daily requirements. Average daily use of water is around 35 lpc for domestic use. The existing surface water irrigation coverage is only 5% of the Net Cultivable Area (NCA) of the polder.

Agriculture is the mainstay of livelihood in this polder. The net cultivable area (NCA) of the polder is 1160ha which is 67% of the total polder area. The most prominent cropping pattern is Fallow - HYV Aman - watermelon and Fallow - Lt. Aman - Fallow which comprises 37% and 19% of the total NCA respectively. Total cropped area is about 2,401ha of which 61% is covered with rice and the rest 39% is occupied by non-rice crops. Watermelon, khasari, mungbean, wheat and sesame are mainly cultivated in the Rabi season. The annual total crop production in the polder area stands at about 9,330 tons of which 2,503 tons are rice and 6,827 tons are non-rice is produced. The contribution of rice crops is about 27% and non-rice is about 73% of total crop production. No HYV Boro is cultivated. The cropping intensity of this polder is 207%. Fisheries habitat in Polder 43/2E is about 123 ha which is characterized by both fresh and brackish water fish habitat. The peripheral rivers, tidal and inter tidal floodplains and internal khals are important fish habitat for capture fisheries where internal khals play an important role in fish migration. Culture fisheries are not very widespread here. Although the water quality is good for fisheries, fisheries biodiversity shows a declining trend as most of the water bodies are seasonal in nature. The terrestrial flora and fauna are very rich here although the density of vegetation is not uniform throughout the polder. There are about 88 ha of wetland inside the polder which is very rich in aquatic flora and fauna.

The populations of Polder 43/2E is about 11,965 of which 5,877 are male and 6,088 are female. The average literacy rate in the study area is 48% which is slightly lower than the national level (52%).Most of the population in the polder area is engaged in agriculture sector (65%) followed by service and day labors etc. Sources of drinking water in the area are satisfactory. On an average, 99% people can collect drinking water from tube-wells while only 1% collects drinking water from other sources such as ponds, Pond Sand Filter (PSF); rain water etc. About 36% households have access to hygienic sanitation facility (water-sealed), 42 % non water-sealed sanitation facility and 21% non-sanitary facilities in the polder area. The common property resources and/or community facilities in the area are different social amenities and include mosques, graveyards, temples, cremation grounds, playgrounds, open water bodies and *Eidgahs* (place for offering Eid prayers which are used by the local people for the purposes of religious, social and cultural gathering.

Prediction and Evaluation of Potential Impacts

The proposed interventions will affect a number of environmental and social components either positively or negatively. It is expected that around 8 km khals would be benefited from drainage congestion in future, due to the overall improvement in drainage capacity of re-excavated khals. Moreover, 850 people (7% of total population) in Purba Jainkati, Sehakati and adjacent mauzas would have sufficient surface water. This would result in immense benefits in water use for domestic purposes and for irrigation during dry season. Single cropped area would decrease by 14% but double and triple cropped area would be increase by 7%, 7% of the NCA respectively after implementation of the proposed interventions. It is expected that additional amount of 984tons (47%) of rice and 3,380 tons (67%) of non-rice would be produced more over irrigated area would be increased by 106 ha in the polder area. Seasonal khal would be turned into perennial khal again. The improved habitat quality would support different types of fishes as well as aquatic vegetation which would be helpful for feeding and habitation of fisheries and aquatic biota. However, the open water fish production would be increased and habitat quality will also be improved. In addition, movement of fishes and hatchling of brackish and fresh water fish like *Bhetki, Pairsa, Chingri,* and *Bele* etc. from river to polder area would be hindered due to the repair of regulators/sluices. Culture fish productivity will also be increased due to reduction of flood risk for re-sectioning of the embankment.

Terrestrial vegetation will be benefitted due tore-sectioning of embankment and construction of retried embankment which will enhance plant succession at river levees that would ultimately improve their habitat suitability. Embankment re-sectioning will reduce the vulnerability of livelihoods to natural disasters especially to cyclonic storm surge. The road communication will be developed for re-sectioning of embankment.The standard of living of from 850 people (7%) in Purba Jainkati, Sehakati and adjacent mauzas of the polder will be benefitted.

The cumulative and induced effects of the proposed interventions in Polder 43/2E have been investigated based on qualitative assessments. The study infers positive long term cumulative effects in Polder 43/2E 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. Moreover, Re-sectioning works for Polder 43/2C has been proposed under CEIP, which would increase its crest level up to 5.18 m (at most locations) above MSL. This increase would reduce storm surge to enter into the polder, and additional storm surge may be diverted towards Polder 43/2E. As such, the risk of storm surge inundation may increase in Polder 43/2E.

The improvement works in Polder 43/2E may generate some minor induced effects in connection with river siltation, employment generation and food security. The reciprocal impacts of climate change on the polder have also been assessed. Impacts of climate change have been evaluated through advanced applications of hydrological (SWAT) and hydrodynamic (Delft3D) modelling tools. The study infers that water level and surface water salinity in adjacent areas may increase in the future due to climate change, whereas dry season water availability may decrease.

Environmental Management Plan

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

- Formation of WMGs (GPWM-2002).
- Strengthening of WMGs through imparting training on proper management of structure and utilization of spoil earth materials which will be generated from re-excavation.
- Introduction of HYV/Hybrid crop cultivars along with crop diversification need to be practiced.
- The repair of flushing sluice, repair of drainage Outlet and irrigation Inlet would help to reduce crop damage situation.
- Spoil earth should be dumped at a setback distance of the khal
- To protect the indigenous fishes and other aquatic creators, re-excavation should be carried out in segment wise and one after another.
- Fish sanctuary should be constructed in the deep pool of perennial khals.
- Implement plantation along the slopes of embankment after completing the earth works;
- Avoid construction activities in the early morning and night to evade disturbance to wild fauna;
- Plant mixed species of native trees along the slopes of the embankment as and where possible to enhance green coverage.
- According to the project work, the LCS entail 60% male and 40% female, all of them to be engaged from the local area. Thus, ensure more gender promotion activities for female in future
- Involving local communities in operation and maintenance of the structure for ensuring sustainability of the interventions.

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

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

1. Introduction

1.1 Background

1. Bangladesh, the largest river delta in the world has about 710 km of coast line along the Bay of Bengal (DoE, 2001).The three major river systems of the country mark its physiography and the lives of its people. Effective management of this immense natural resource remains a continuing challenge and at the same time offers tremendous opportunities. About 38.5 millions of people live in the coastal areas (BBS, 2011). About 38% of the population in the coastal region lives below the poverty line and faces high vulnerabilities in terms of insecurity in 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 sustainable environment and provide security and well-being to the present and future generations.

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

3. Blue Gold Program builds on the results and lessons learned in managing water resources from previous programs and projects in Bangladesh. The explicit objective of the Blue Gold Program is to reduce poverty in the coastal areas by enhancing productivity of crops, fisheries and livestock in an integrated way and increase people’s income by creating opportunities for improved processing and marketing of agricultural commodities with value chain development. The project started in January 2013 and will end in December 2018. Its operations are limited to selected polders of three coastal districts: Satkhira, Khulna and Patuakhali which are part of the South-west and South-central hydrological zones.

4. The total land area of the three districts is 11,463 km² and the total population is 5.6 million. This gives an average population density of 493 people per km² and an average household size of 4.3 persons (BBS, 2011). These districts are chosen because of having (i)

higher incidence of poverty, (ii) ineffective coordination between the local administration and private sector and (iii) prevalence of water-related challenges like sedimentation, storm surges and salt water intrusion. Initially, it was anticipated that 26 polders from these three districts will be included in the program, as illustrated in Table 1.1.

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

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

Source: Inception Report, Blue Gold Program, 2013

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

6. The Blue Gold Program has five distinct and interlinked components: (i) community mobilization and institutional strengthening, (ii) water resources management, (iii) food security and agricultural production, (iv) business development and private sector involvement, and (v) cross-cutting issues. From the environmental point of view, the activities of two components i.e. the water resources management component (component (ii) and the food security and agricultural production component (component (iii) needs special consideration. Accordingly, CEGIS has been engaged to undertake Environmental Impact Assessment (EIA) studies of the component (ii) of Blue Gold Program, for a total number of seven polders (Polder 2, 26, 29, 31-part, 43/1A, 43/2B and 43/2E), selected from the nine IPSWAM polders

1.2 Rationale of the Study

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

8. Component (ii) of the Blue Gold Program includes rehabilitation of water resources management infrastructures in the selected polders. Polder 43/2E is one of them. The rehabilitation works of the polder includes re-sectioning of embankments, repair and/or improvement of drainage outlets and irrigation inlets, re-excavation of internal canals and improvement of on-farm water management. To proceed with these interventions, the Blue Gold Program needs environmental clearance from the DoE. To fulfill the obligation, the Blue Gold Program, engaged CEGIS to conduct the EIA study

1.3 Study Area

9. The Polder 43/2E, covered under this EIA study is located in Jainkati union of Patuakhali Sadar Upazila under Patuakhali District.The polder covers an area of 1,720 hectare. Map 1.1 shows the base map of the Polder.

1.4 Objectives of the Study

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

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

1.5 Scope of Work

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

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

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

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

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

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

vi. Prepare a landuse map and ground truthing.

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

viii. A small section in the EIA (EMP) will indicate occupational health and safety measures to be undertaken for implementation of the work, 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 a detailed Environmental Management Plan (mitigation and enhancement plan, compensation and contingency plan as well as monitoring plan).

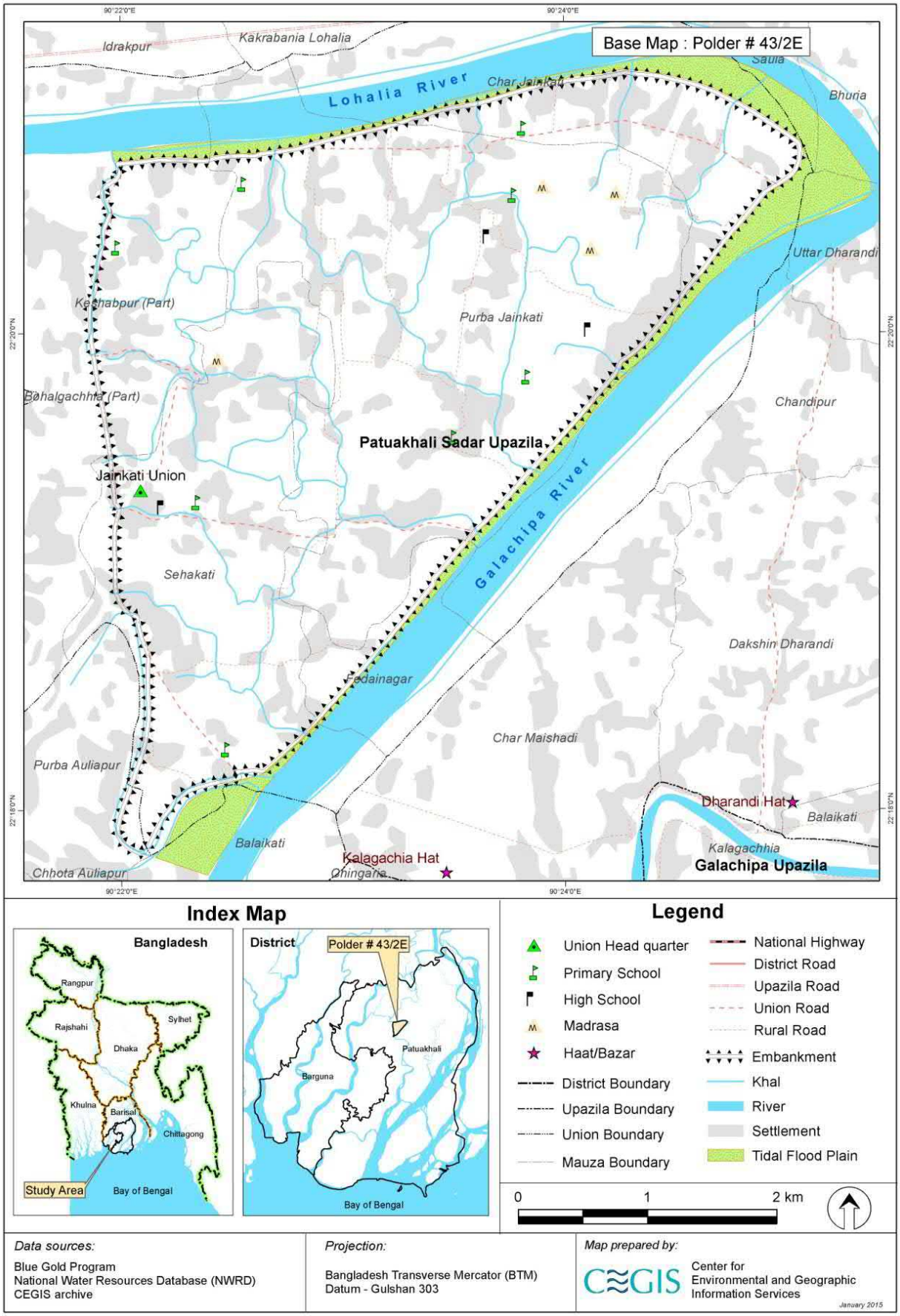
1.6 Limitations

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

1.7 EIA Study Team

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

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



Map 1.1: Base map of Polder43/2E

1.8 Report Format

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

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

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

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

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

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

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

Chapter 7: ***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 opinions and suggestions derived through the consultations.

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

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

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

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

2. Policy, Legal and Administrative Framework

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

2.1 National Policies and Legislations

2.1.1 The National Environment Policy, 1992

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

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

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

2.1.2 National Environmental Management Action Plan (NEMAP) 1995

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

20. NEMAP has the following broad objectives:

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

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

2.1.3 The National Water Policy, 1999

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

22. Sub-clause (b) of Section 4.5 states that planning and feasibility studies of all projects (relevant to water resources management or development or have interference on water sector) will follow the Guidelines for the Project Assessment (GPA), the Guidelines for Peoples Participation (GPP), the Guidelines for Environmental Impact Assessment (EIA), and all other instructions that may be issued from time to time by the Government. Giving importance on the navigation sector, sub-clause (a) of section 4.10 states that if a project may cause disruption to navigation, adequate mitigation measures should be taken. The draft describes the importance of wetlands to the environment of Bangladesh and makes cross-references to the various recent government policy issues that relate to wetland management. In its draft form, it provides a series of recommendations as found in other policies (MoEF, 1999).

2.1.4 The National Biodiversity Conservation Strategy and Action Plan for Bangladesh 2004

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

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

2.1.5 Bangladesh Climate Change Strategy and Action Plan (BCCSAP), 2009

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

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

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

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

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

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

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

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

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

2.1.7 Coastal Zone Policy, 2005

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

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

2.1.8 Coastal Development Strategy, 2006

28. The Coastal Development Strategy (CDS) focuses on the implementation of the coastal zone policy. The CDS was approved by the Inter-Ministerial Steering Committee on

ICZMP on 13 February 2006. Nine strategic priorities, evolved through a consultation process, guide interventions and investments in the coastal zone:

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

2.1.9 National Conservation Strategy (NCS) 1992

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

2.2 Legislation, Act and Rules

2.2.1 National Water Act, 2013

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

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

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

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

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

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

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

2.2.2 The Embankment and Drainage Act 1952

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

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

39. The section 56 (1) states that, persons will be subject to penalty (500 Taka or imprisonment… if he erects, or causes of willfully permits to be erected, any new embankment, or any existing embankment, or obstructs of diverts, or causes or willfully permits to be obstructed or diverted, any water course. This section could be applied to the person causing damage to the protective works.

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

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

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

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

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

42. An Ordinance to consolidate and amend the law related to the imposition of a water rate for the supply, regulation or storage of water for irrigation or drainage purposes. Water rate can be imposed, whenever the government is of the opinion that lands within any area is benefited or is likely to be benefited by water supplied or regulated by the government or the Board or the Corporation through any canal during any financial year. The Government may, by notification, declare its intention to impose in such area, hereinafter referred to as the notified area, a water rate for such financial year provided that the water rate so specified

for a crop season shall not exceed such rate as may be prescribed and provided further that the water rate intended to be imposed may vary from one notified area to another.

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

43. This is an Ordinance to manage ground water resources for agricultural production. This Act authorizes the Thana Parishad to grant license for installing tube wells in its jurisdiction. The Thana Parishad may grant the license if the Parishad is satisfied that the installation of the tube well applied for

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

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

c) is otherwise feasible.

2.2.7 The Protection and Conservation of Fish Rules (1985)

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

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

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

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

46. The Bangladesh Wild Life Preservation (Amendment) Act 1974 provides the power to the government to declare areas as game reserves, wild life sanctuaries and national parks to protect the country’s wild life. This Act also provides legal definitions of the protected areas as follows.

> "Game reserve" means an area declared by the government as such for the protection of wild life and increase in the population of important species wherein capturing of wild animals shall be unlawful;
>
> "National park" means comparatively large areas of outstanding scenic and natural beauty with the primary objective of protection and preservation of scenery, flora and fauna in the natural state to which access for public recreation and education and research may be allowed;
>
> "Wild life sanctuary" means an area closed to hunting, shooting or trapping of wild animals and declared as such under Article 23 by the government as undisturbed breeding ground primarily for the protection of wild life inclusive of all natural resources, such as vegetation, soil and water.

Under this law hunting, killing, capture, trade and export of wild life and wild life products are regulated. The Act also designates a list of protected species and game animals.

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

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

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

49. The main objectives of ECA '95 are:

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

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

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

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

2.2.11 The Environment Conservation Rules, 1997

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

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

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

requirement for IEE and EIA according to categories of industrial and other development interventions.

55. The Rules are not explicit for water development projects. Rather, this is covered under the broader heading of “exploration, extraction and distribution of mineral resources” under the ‘Red’ category projects.

2.3 Procedure for environmental clearance

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

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

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

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

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

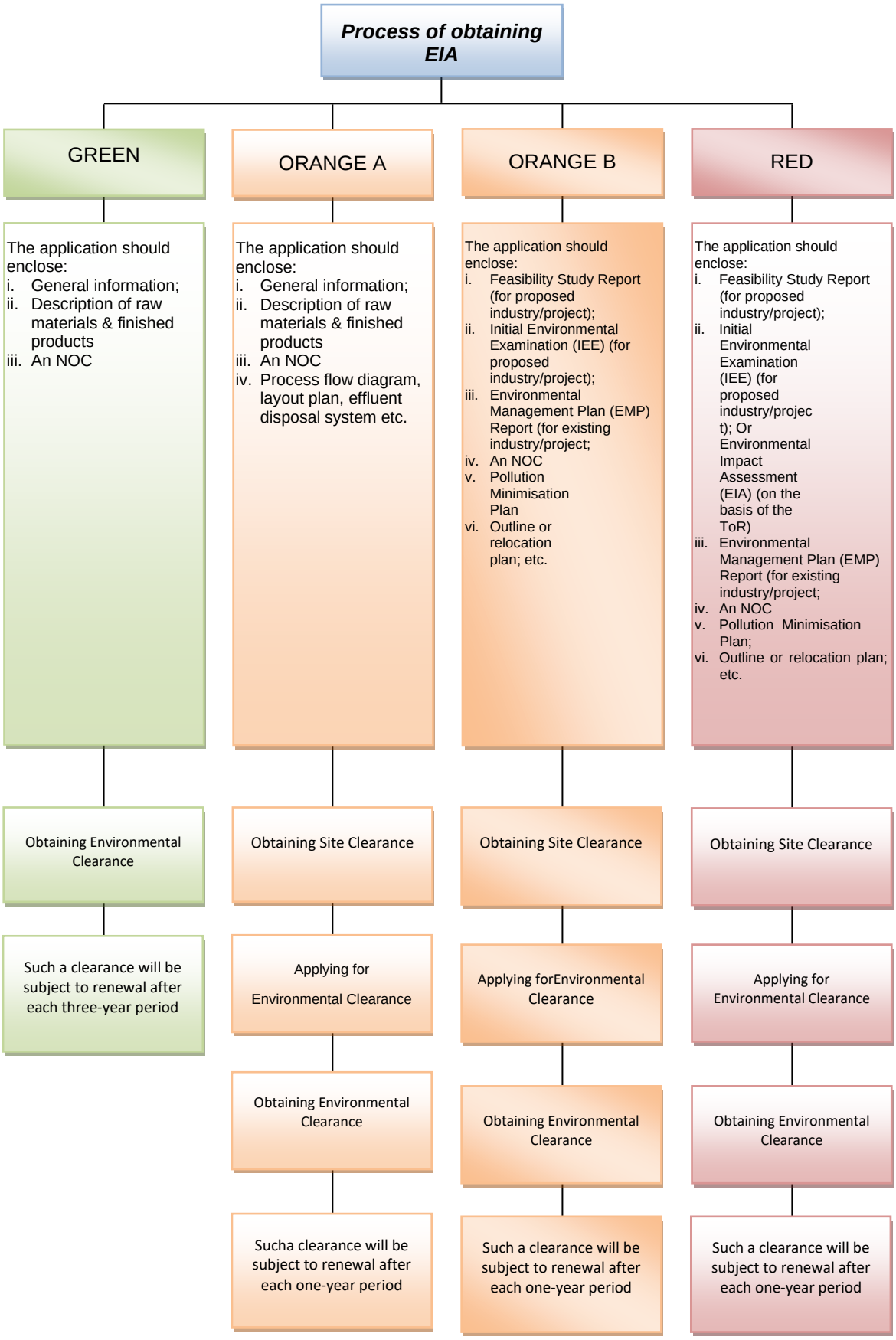


Figure 2.1: Steps Involved in Environmental Clearence folllowing DoE Clearence

2.4 Administrative Framework

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

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

3. Approach and Methodology

3.1 EIA Process

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

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

Figure 3.1: The EIA process

3.2 Project Description

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

3.3 Environmental and Social Baseline

65. Baseline data were collected as a pre-requisite for this EIA study. The baseline condition of the project area was drawn according to the information collected from secondary and primary data sources through literature review, field investigations and consultation with different stakeholders through using comprehensive baseline-checklist (Appendix-1). During field visits, the multidisciplinary EIA team members made professional observations pertaining to their individual areas of expertise. The baseline condition was established in respect of meteorology, seismicity, water resources, land resources, agriculture, livestock, fisheries, ecosystems and socio-economic conditions including identification of problems in respect of the proposed project site and adjoining areas. The baseline data collection methodology is presented in the following section:

3.3.1 Climate and Meteorology

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

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

3.3.2 Topography and Seismicity

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

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

3.3.3 Water Resources

70. Water resource data in connection with river hydrology, morphology, groundwater availability, water related problems, functions and use were collected from the polder area during field visits and from secondary sources. The major river systems were identified for hydrological and morphological investigations through historical and current data collection and analysis. Specific areas or points of interest were selected for collecting data on special hydrological and morphological events such as hydrological network, water availability, drainage issues, erosion, navigation or sedimentation etc.

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

3.3.4 Land Resources

72. The agro-ecological region of the proposed study area has been identified using secondary sources (FAO/UNDP). The land use, land type and soil texture data were collected from the Upazila Land and Soil Resources Utilization Guide (Upazila Nirdeshika) of the Soil Resources Development Institute (SRDI). Secondary data on these parameters were verified at field during field visits through physical observations as well as in consultation with the local people and officials of the Department of Agricultural Extension (DAE).

3.3.5 Agricultural Resources

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

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

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

3.3.6 Livestock Resources

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

3.3.7 Environmental Quality

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

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

3.3.8 Fisheries Resources

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

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

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

82. **Habitat Identification:** Fish habitat are classified on the basis of physical existence and were categorized into capture and culture fish habitats. The capture fish habitats included river, khal, tidal floodplain and borrow pit. The culture fish habitats included homestead culture fish pond, commercial fish farm etc.

83. **Capture and Culture Fish Habitats:** Capture fish habitat were assessed through Fishing Effort Survey (FES), habitat based species diversity and composition, identification of species of conservation significance, identification of potential fish habitat prescribing to restore fish conservation, fish migration survey, and habitat identification for fish conservation. Culture fish habitat assessment was performed through homestead culture fish pond survey and commercial fish farm survey.

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

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

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

3.3.9 Ecological Resources

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

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

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

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

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

3.3.10 Socio-economic Conditions

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

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

a) Data collated from BBS, 2011;

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

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

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

3.4 Scoping

93. A scoping process was followed for selecting IESCs which are likely to be impacted by the proposed interventions of 'rehabilitation of Polder 43/2E'. Scoping was performed in two stages. Individual professionals of the EIA study team made preliminary lists of the components pertaining to their disciplines, which could be impacted by the project. The second stage included village scoping sessions where stakeholder's perceptions were obtained about those environmental and social components. Professional judgment of the EIA team members as well as the stakeholders opinions obtained in the scoping sessions are considered in selecting the IESCs.

3.5 Bounding

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

3.6 Major Field Investigation

95. The EIA study team members collected intensive data on possible impact of the project after obtaining the detailed rehabilitation plan from the project authority. The study team carried out a number of comprehensive field investigations during 10 to 19 January, 2015 in order to collect primary data and solicit feedback from local people. Intensive data on Baseline and IESCs were collected from the field during this stage. I Information on the IESCs were collected through a mixed method including RRA, PRA and KII using checklists for water resources, land resources, agriculture, livestock, fisheries, ecosystem and socio-economic components. Intensive consultations with the local people were carried out for their feedback on the key parameters. This process helped the multidisciplinary EIA study team to qualify their professional observations. In such exercise attention was given to understand the historical status of the IESCs and the possible condition of the same against the proposed interventions.

3.7 Environmental and Social Impact Assessment

96. Environmental and social impacts on the IESCs for the proposed interventions i.e. for Rehabilitation of Polder 43/2E' have been assessed through several sets of activities. Impacts are generated for the interaction of specific project activities with the existing environmental settings. The impacts of the proposed interventions were estimated on the basis of the difference between the future-without-project (FWOP) conditions and the future-with-project (FWIP) conditions. FWOP conditions are generated through trend analysis and consultation with the local people. This reflected the conditions of IESCs in absence of the proposed interventions. Changes expected to be brought about due to the proposed interventions are assessed to generate the FWIP conditions. Comparison and projection methods are used for impact prediction. This included both positive and negative impacts which are considered in preparation of the environmental management plan.

97. The sequence of assessment of environmental and social impact are as follows:

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

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

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

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

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

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

3.7.1 Impact Quantification and Evaluation

99. At this stage, attempts were made to quantify the impacts of the proposed interventions on the IESCs. However, it was not possible to quantify all impacts, especially the impacts on some of the environmental and social components. In such cases, impacts were assessed in qualitative terms, and scores are assigned with plus (+) sign for positive

impacts and minus (-) sign for negative impacts. The magnitude of both positive and negative impacts is indicated in a scale of 1 to 10 on extent, magnitude, reversibility, duration and sustainability considerations.

3.7.2 Assessment Methodology

100. 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 are 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.

101. The criteria for determining significance are generally specific for each environmental and social aspect, but generally the magnitude of each potential impact is defined along with the sensitivity of the receptor. The generic criteria for defining magnitude and sensitivity used for the project are summarized below:

Magnitude

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

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

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

Table 3.1: Parameters for determining magnitude

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

Parameter	Major	Moderate	Minor	Negligible/Nil
		guidelines in one or more parameters		
Likelihood of potential impacts occurring	Occurs under typical operating or construction conditions (Certain)	Occurs under worst case (negative impact) or best case (positive impact) operating conditions (Likely)	Occurs under abnormal, exceptional or emergency conditions (occasional)	Unlikely to occur

Sensitivity

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

Table 3.2: Criteria for determining sensitivity

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

Assessment of Residual Impacts

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

3.8 Environmental Management Plan

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

3.9 EIA Report Preparation

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

4. Project Description

4.1 Background

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

4.2 Objective

109. The objective of the Blue Gold Program are to

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

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

- Repair the existing water control structures such as sluice gate, outlet and inlet to allow better control on drainage and flushing, and hence improve agricultural production.
- Construct an additional outlet to facilitate better drainage system throughout the polder area.
- Conduct re-sectioning of embankment to increase embankment stability and peripheral communication.
- Conduct re-excavation of khals primarily to drain out high peak flow away and rainwater storage to meet up the increasing demand of water use for irrigation.

4.3 Present Status of Water Management Infrastructures

111. Polder 43/2E covers more than half of Jainkati union of Patuakhali Sadar upazila, Patuakhali district. The polder was constructed in 1989-90, 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 with the Patuakhali O&M Division, BWDB, Patuakhali (Map 1.1).

4.4 Water Management Infrastructures

112. Water Management Infrastructures are the physical interventions which ensure sustainable management and optimal use of water resources. In Polder 43/2E, there are some typical water management infrastructures i.e. peripheral embankment, sluices, drainage outlets, flushing inlets. Based on field investigation carried out in January 2015, the study team gathered the following information regarding the status of existing infrastructure.

Embankment

113. The length of the Embankment is 20 km with top width varying from 2 m to 4m. The crest level is 3.9 m above Mean Sea Level (MSL). Existing side slopes varies from 3.00m to 4.8 m as hypotenuse on the riverside and a low range of 3.4 m to 3.5 m on the countryside. A part of the embankment has a comparatively lower setback distance of 5 to 20 m, while the rest of the embankment has a setback distance of 40 to 200 m. The existing situation of the embankment is good at most portions, 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. But in wet seasons the unpaved portion of embankment surface becomes slippery and unsuitable for vehicular movements.

[(**a**)paved road surface at Sehakathi, suitable for various modes of transportation in all season, (b)unpaved road surface at Purba Jainkathi, which becomes slippery and unsuitable for communication in wet season]

Photo 4.1: Existing Status of Embankments

Water Control Structures and Culverts

114. There are 7 drainage sluices, 2 drainage outlets and 55 flushing inlets constructed by BWDB within the polder. These structures need repairing. A number of the gates can not be operated smoothly due to damages in the wheels and shafts used to elevate gates. Some of the gates were found fully been damaged and non-functioning. Functionally, the drainage outlets cannot drain out water properly after heavy rainfall events, especially during post monsoon. An additional outlet will play an effective role in this situation. There are some structures which have attached fishing nets, for which the natural flow is often hampered. Some routine works and practices (establishment of navigation ghats, construction of shops or houses near the gates etc.) of the local people also harm the structural condition of the gates.

115. During field visit in January 2015, the study team found that some of the existing sluice gates and outlets have been subjected to structural damage in recent years and are not maintained properly by the local people. The sluice gate at Dholkhali was severely damaged and found to be tied with ropes and logs. The Gate needs to be replaced and a new hoisting system has to be installed.

116. The structures at Naotana, Katakhali, Gogonkhali, Piprabunia and Katurataluk were also found in undesirable condition; severe mismanagement issues are observed at some locations. The hoisting system needs reinstallation for both Gogonhali and Dudhkhali sluices. Gate openings at Katakhali, Suddurbaria and Moubania are to be cleaned from debris as

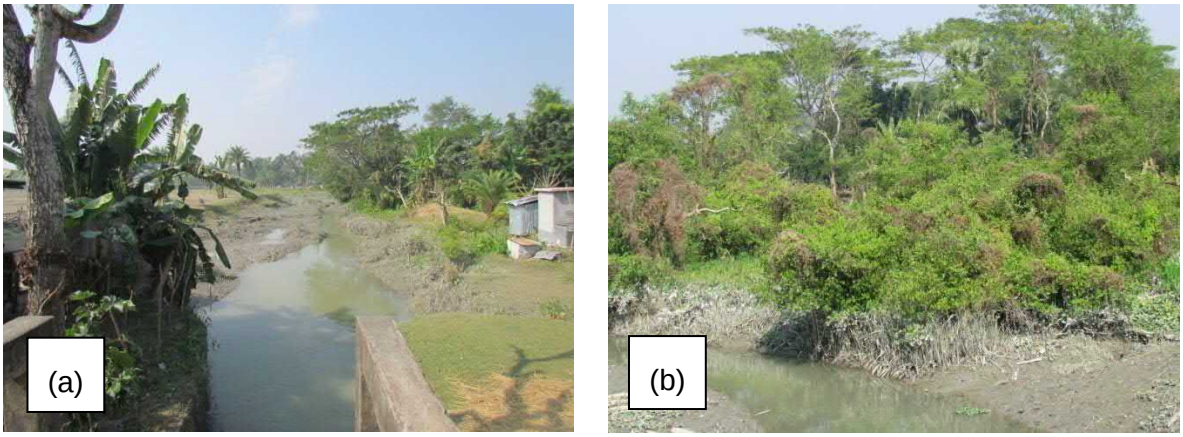
well as water hyacinths which hamper the natural flow through the structures. The other water control structures were found more or less function. Among the inlet pipes, 3 are completely damaged and most of the remaining inlets need repair.

*[(**a**)Severely damaged Dholkhali sluice requiring major repairing, (**b**)Non-functionaing sluice gate at Katakhali,(**c**)Poorly maintained sluice gate at Gogonkhali, (**d**)Opening of Suddurbaria sluice covered by uncontrolled existence of water hyacinths]*

Photo 4.2: Existing Status of Sluice Gates

4.5 Present Status of Drainage Khals

117. The total length of the internal drainage channels of the polder is 38.997 km. Over the years, siltation, topsoil erosion and other land filling activities have resulted gradual decrease of water courses within the polder. Some of the khals at the North West and South West region of the polder (Naotana khal, Natua main khal, Moubaria khal, Shuddurbaria main khal, Piprabunia khal etc.) have became very shallow and narrow in some locations. Most of the khals were flowing in good condition, as observed by the study team during their field investigation. But it is observed that the number of outlets were insufficient compared to the number of khals. An additional outlet at Durlob khal is expected to make the situation better.



*[(**a**)Narrow course along the Jugal Dhopar Barir khal, (**b**)Very Narrow course of Shib Bari khal]*

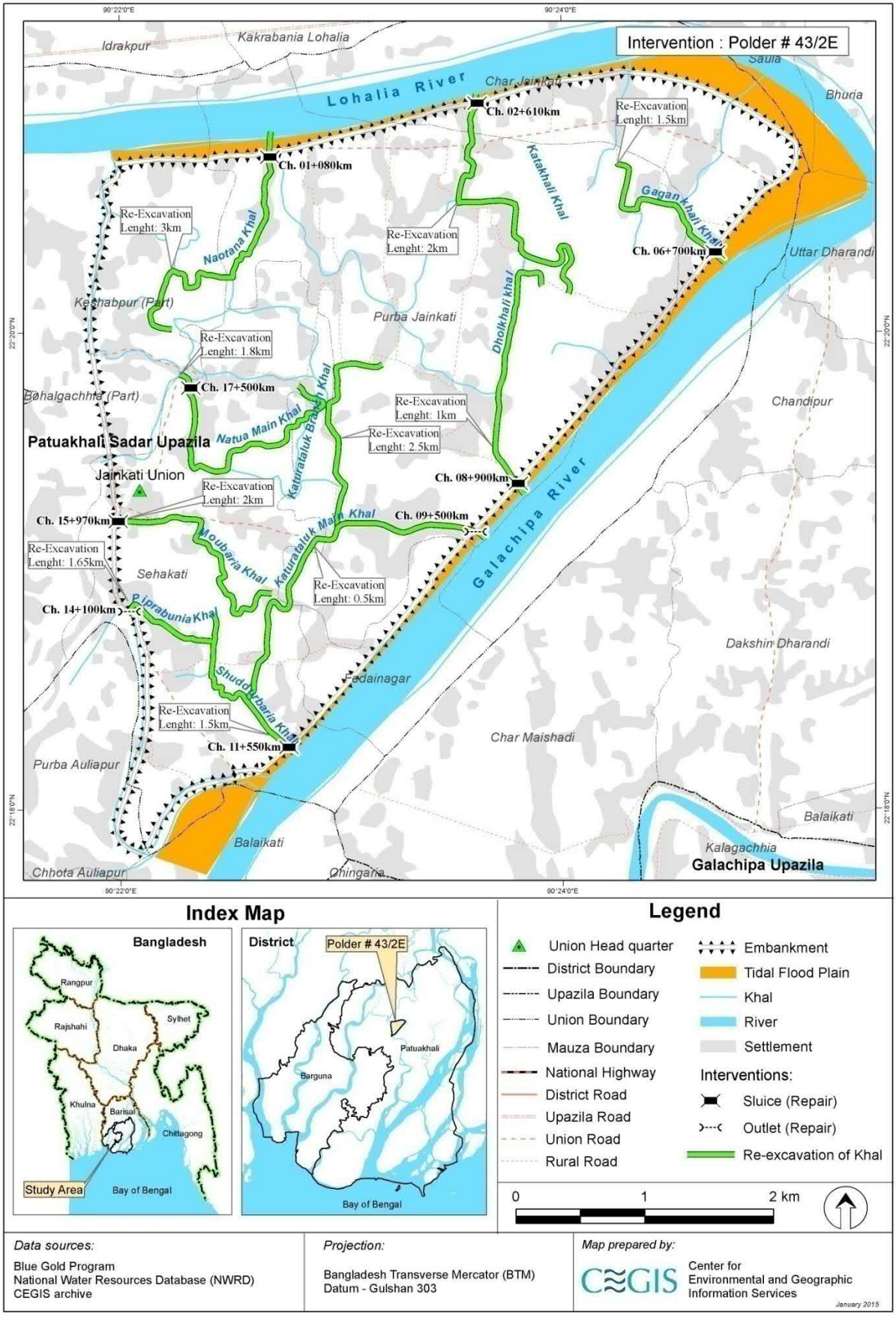
Photo 4.3: Drainage Khals within the polder

4.6 Problems and Issues in the Polder

118. A number of problems and issues are hindering the development potential of Polder 43/2E at the moment. Mismanagement, being one of the primary issues, resulting various damages in water control structures as well as peripheral embankment. Poor communication is another major problem. The unpaved portion becomes unusable for heavy vehicles during wet season.

4.7 Proposed Interventions in Polder 43/2E

119. Considering 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 43/2E. The locations of interventions have been shown in Map 4.1.



Map 4.1: Location of proposed interventions

4.7.1 Re-sectioning of Embankment

120. Re-sectioning works along the peripheral embankment is proposed to be carried out some locations where they are found damaged. The proposed crest width is 4.27m, with side slopes of 1(V): 3(H) on river side and 1(V):2(H) on country sides, with exception of 1(V): 2(H) on both river and country sides from Chainage 15+000 to 19+950. The design elevation of the crest of the embankment is at 4.30 m +PWD (above Mean Sea Level).

4.7.2 Construction/ Repairing of Water Control Structures

121. All existing sluices of BWDB within the polder will be repaired. Some sluices would require new shafts and wheels, whereas some sluices would require replacements of barrels and gates. A number of inlets and outlets also require repairing. Furthermore, one new drainage outlet has been proposed for re-excavation of Durlob khal (*$22^0$21'08.0"N; $90^0$24'08.4"E*). Details of all interventions to be undertaken are presented is Table 4.1 to Table 4.3:

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

Sl. No.	Local Name of Sluice	Number of Vent	Vent Size (m)	Chainage (km)
1	Natuar Khal Pipe Sluice	1-V	0.9m dia	17+500
2	Naotana Sluice	1-V	1.5 ×1.8	01+080
3	Katakhali Sluice	1-V	1.5 ×1.8	02+610
4	Gogonkhali Sluice	1-V	1.5 ×1.8	06+700
5	Dholkhali Sluice	1-V	1.5 x1.8	08+900
6	Suddurbaria Sluice	1-V	1.5x1.8	11+550
7	Moubaria sluice	1-V	1.5x1.8	15+970

Source: Blue Gold Program Office, 2015

Table 4.2: Detail information on proposed repairing of Drainage Outlets

Sl. No.	Local Name of Outlets	Number of Vent	Dia (mm)	Chainage (km)
1	Katurataluk Outlet	1-V	900	09+500
2	Piprabunia Outlet	1-V	900	14+600

Source: Blue Gold Program Office, 2015

Table 4.3: Detail information on proposed Repairing of Irrigation Inlets

Sl. No.	Local Name of Inlets	Size (mm)	Location
1	Pirtala	300	West side of Mannan Chairman House
2	Pirtala	600	West of Sundar Gazi House
3	Pirtala	300	Baside Ananda Sukul Primary School
4	Pirtala	450	North Side of Razzaque Molla's House
5	Joinkati	450	North side of Chandu Sardar's House
6	Chor Joinkati	450	North side of Mokbul Hawladar's House
7	East Char Joinkati	450	Near Chandu Fakir's House
8	East Katakhali	600	Near Nur Hawladar's House
9	Middle Char Joinkati	450	Near Abdul Mazid Bhuiyan's House
10	Char Joinkati	450	Near the House of Sharif Bar
11	East Char Joinkati	300	Near Ratan Bari's House
12	Middle Char Joinkati	450	Near Faiz Bhuyain's House
13	Char Joinkati	450	Near Shamsul Haque's House

Sl. No.	Local Name of Inlets	Size (mm)	Location
14	East Char Joinkati	450	North side of Sohrab Munshi's house
15	East Char Joinkati	450 (Damaged)	Near Nur Mohammad Molla's House
16	East Char Joinkati	450	Near Mosharraf bhuiyan's House
17	East Char Joinkati	450	Near Abdul Haque Munshi's House
18	East Char Joinkati	450	Near Abdul Haque Hawladar's House
19	East Char Joinkati	450	Beside the house of Kader Mollah
20	East Char Joinkati	450	Beside the house of Rawshan Mollah
21	Char Joinkati	450	Near Shamim Akon's House
22	Char Joinkati	450	South Side of Gagonkhali Sluice
23	Char Joinkati	450	Beside the house of Ashraf Gazi
24	Char Joinkati	450	North side of Primary School
25	Char Joinkati	450	Beside the house of Rob Master
26	East Char Joinkati	450	Near Jalal Munshi's House
27	Char Joinkati	450	South side of Fakir Bari's House
28	East Char Joinkati	450	Near Mulai Sikdar's House
29	East Char Joinkati	450	North side of Dholkhali Sluice
30	Katurataluk	450	South Side f Dholkhali Sluice
31	Purbo Joinkathi	450	Beside the house of Abu Bakar
32	Fedai Nagar	450	South side of Katurataluk Bazar
33	Fedai Nagar	450	Beside the House of Salam Talukdar
34	Fedai Nagar	450	Beside the house of Salam Gazi
35	Fedai Nagar	450	Fedai Nagar
36	Fedai Nagar	450	Near Bashir Molla's House
37	Fedai Nagar	450	Near Majid Molla's House
38	Dakkhin Sehakati	600	South side of Suddurbaria Sluice
39	Sehakati Bazar	450	Adjacent to Dakkhin
40	Sehakati Bazar	450	South Side of Insan Ali Chowdhury
41	Dakkhin Sehakati	450	South side of Swapan Akon's House
42	Dakkhin Sehakati	450	Near or falls on Shamsul Haque Hawladar's
43	Dakkhin Sehakati	450	Near or falls on Jafor kon's Land
44	Dakkhin Sehakati	450	Near Zabbar Khan's House
45	Dakkhin Sehakati	450	Near Kala Krishna's House
46	Dakkhin Sehakati	450	South side of Dulal Munshi's House
47	Dakkhin Sehakati	450	Beside the house of Akbar Ali Chowkidar
48	Maddhya Sehakati	450	Beside the House of Mostafa Chowkidar
49	Moubaria Bazar	450	Inside the Moubaria Bazar
50	North Sehakati	450	Beside the House of Mannan Sardar
51	North Sehakati	450 (Damaged)	Near the house of Abdur Rashid Fakir
52	Talbaria	450	East Side of Kalam Pada's House
53	Talbaria	450	North side of Arua Pool Bazar
54	Pirtala	300	North side of west Joinkati Primary school
55	Talbaria	450	Near Chandan Baria Bridge

Source: Blue Gold Program Office, 2015

4.7.3 Construction of Outlet

122. One new drainage outlet at Durlob khal (N: 22°21'8.0", E: 90°24'8.4") has been proposed and approved for implementation. It will be situated exactly at the offtake point of Durlob khal.

4.7.4 Khal Re-excavation

123. A total number of 9 khals are under the re-excavation plan of Blue Gold program in polder 43/2E. The total length to be re-excavated is around 16.425 km. The names of the khals proposed to be re-excavated with their lengths are shown in Table 4.4.

Table 4.4: Detail information on proposed re-excavation of Khals

Sl. No.	Name of Khals	Approximate Length (Km)
1	Gagankhali Khal	1.500
2	Dholkhali khal	1.000
3	Moubaria main khal	2.000
4	Suddurbaria Main khal	1.500
5	Naotana khal	3.000
6	Katakhali khal	2.000
7	Natua Main khal	1.800
8	Piprabunia khal	1.025
9	Ponditer khal	2.600

Source: Blue Gold Program Office, 2015

4.8 Construction Details

124. 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.

4.8.1 Description of Activities

Re-sectioning of Embankment

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

Repairing and Construction of Drainage Sluices and Outlets

126. Before starting the repairing activities of drainage sluices, Ring bundh and diversion channels 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 of Flushing Inlets

127. A suitable site for the construction material of the structure will be selected and prepared accordingly. Alternative diversion channels will be developed before starting of construction works. After completion of all activities, the 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.

Re-excavation of khals

128. At first the required tools will have to be procured for re-excavation of the drainage channels. A schematic diagram showing the 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.

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

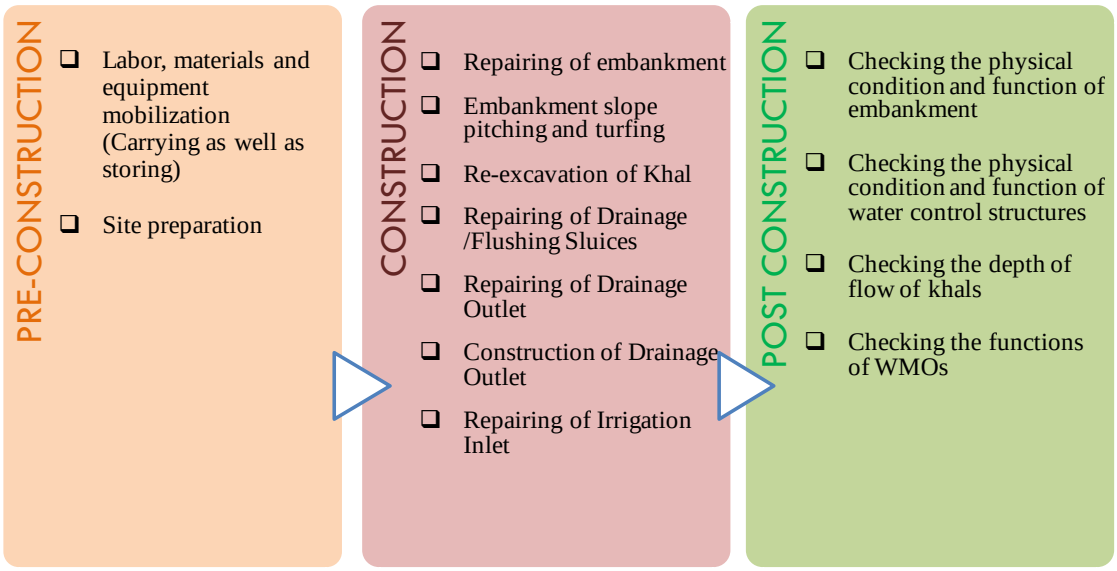


Figure 4.1: Phase wise list of activities in Polder 43/2E

4.8.2 Construction Schedule

130. 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 43/2E are likely to be completed by June 2016.

Table 4.5: Construction Schedule in Polder 43/2E

Key Activities	2014				2015				2016			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Screening, hiring and orientation of Community Organizers (COs)					▬	▬	▬	▬				
Community mobilization for Water Management Planning (Fine tuning works)					▬	▬	▬					
In-depth information dissemination/ campaigns on Blue Gold Goals, Objectives, Components and Initial discussions with WMGs						▬	▬	▬	▬	▬		
Assessment of WMO Functionality						▬	▬	▬	▬			

Key Activities	2014				2015				2016			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
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 WMOs												

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

4.8.3 Materials Requirement

131. The construction materials required for re-sectioning and retired embankment, water regulators, flushing inlets, and bank protection work will include soil, cement, steel, and sand. Estimated quantities of these materials are presented in **Table 4.6** below.

Table 4.6: Construction Materials Requirement in Polder 43/2E

Sl	Description	Quantity	Sources
Re-sectioning of embankment			
1	Materials for Earthwork	50,000 m^3	From the set back location and other khas lands
2	Hoe(or Shovel) and Baskets	150 nos. each	To be procured
3	Compactor	20 nos.	To be procured
Repairing of sluices and flushing inlets			
4	Lift Gate	2(1.5 m x 1.8 m)	To be procured
5	Flap Gate	2 (1.5 m x 1.8 m)	To be procured
6	Barrel	2 (1.5 m x 1.8 m)	To be procured
7	Pipe	1 (dia: 0.90 m) 3 (dia: 0.45 m)	To be procured
8	Wheel and Shaft	2 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

4.8.4 Manpower Requirement

132. Technical and nontechnical manpower will be required for the construction works. This will include engineers, technicians, supervisors, surveyors, mechanics, foremen, machinery operators, drivers, skill and un-skilled labors. The implementation of the project would be carried out by both LCS (Landless Contracting Society) and Contractors, on 50-50 basis.

4.8.5 Construction Camp and Labour Shed

133. 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.

4.9 Project Management and Implementation

134. 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 43/2E are discussed in the following sections.

4.9.1 Community Participation through WMO/ CBO

135. Participation of Water Management Organization (WMO) and Community Based Organizations (CBOs) is needed to ensure sustainable operation of the project. The WMO for this project is under the process of formulation. 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.

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

Water Management Committee (WMC)

137. 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.

Landless Contracting Society (LCS)

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

4.10 Operation and Maintenance Plan

139. Since construction, Polder 43/2E has been playing a vital role in safeguarding the polder area, enhancing agricultural production, improving livelihoods, and mitigating environmental damages. However, it is observed that due to poor maintenance and mismanagement issues over the years, the polder is not serving as per its potential.

4.10.1 Operational Plan

140. 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 43/2E.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 43/1A has been proposed.

Regulation of Gates

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

142. During the pre-monsoon period (March to May), the gates of each sluice should remain closed for retention of water for irrigation and other use. During monsoon (July to September), the vertical lift gates should normally remain closed, but may be opened to drain out water from the polder if required. In addition to that, the gates should also remain open during May to June, which is considered as the pick period for fish breeding, migration of brood fish and offspring. During the post monsoon season (October to November), the gates need to be operated properly so as to retain water in drainage channels without overtopping channel banks. Moreover, consultations must be carried out with beneficiaries of all occupational groups i.e. farmer, fisher, fish farmer etc because agricultural practices, crop varieties; and cropping pattern, fish spawning and migration changes with over time.

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

Frequent Monitoring of Embankments and Structures

144. 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

145. Preventive maintenance works are performed 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 to supervise all preventive maintenance works. Routine monitoring of water management situation and hydrological conditions will supply data which will dictate the needs of adjusting the operational measures.

4.10.2 Maintenance Plan

146. Maintenance of embankments and structures is necessary because it helps to keep the infrastructures in good and functional condition so as to protect investments, and prevent high rehabilitation costs. Under 'component II' of Blue Gold program in Polder 43/2E, only those work which directly serve water management should be regularly maintained. 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 minor earthworks on the embankment by LCSs;
- Cleaning, greasing, and painting of structures by LCSs;
- Minor repair of protective works by LCSs i.e. re-positioning of the displaced blocks, small patching of brick works, replacing of rubber seals;

- Major Periodic Maintenance 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; and
- Some emergency maintenance works to protect the polder from the adverse effects of flooding or uncontrolled saline intrusion i.e. construction of cross dams over canals if structure fails.

4.11 Project Cost

147. As per the approved Development Project Proforma (DPP) of the Blue Gold Program, the project cost for carrying out fine-tuning works in Polder 43/2E has been estimated as 100.00€ per ha area (DDP is attached in **Appendix-8**) . Accordingly, the project cost is 172000 € i.e. BDT 1.53 crore (1€ = 89 BDT, on 6 September, 2015).

4.12 Expected Benefits and Outcome

148. The foreseeable benefits which are likely to occur due to the implementation of Blue Gold program in Polder 43/2E are listed in Table 4.7 below.

Table 4.7: Expected benefits and outcome of proposed interventions

Interventions	Benefits
Re-sectioning of Embankment	✓ Protection against salinity intrusion ✓ Increased side slopes will enhance the stability of the embankment ✓ Communication facilities may improve
Construction of an Outlet	✓ Drainage situation will improve
Repairing of Water Control Structures	✓ Sluice will function properly, agricultural activities during dry and pre-monsoon season may be improved ✓ Drainage situation would improve
Re-excavation of Khals	✓ Potential rainwater storage may be possible ✓ Better irrigation during dry and pre-monsoon period ✓ Better navigation as well as drainage
Outcome of the Project	Apart from the aforementioned foreseeable benefits, the project may create some socio-economic developments i.e. employment generation, reduction of poverty etc. As a result, the local economy in the area may further boost up.

4.13 No Objection Certificate

149. There is no archeological site 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 the existing infrastructures. The No Objection Certificates (NOCs) from the union chairmen have been obtained and are attached in **Appendix- 2**.

5. Environmental Baseline

5.1 Physical Environment

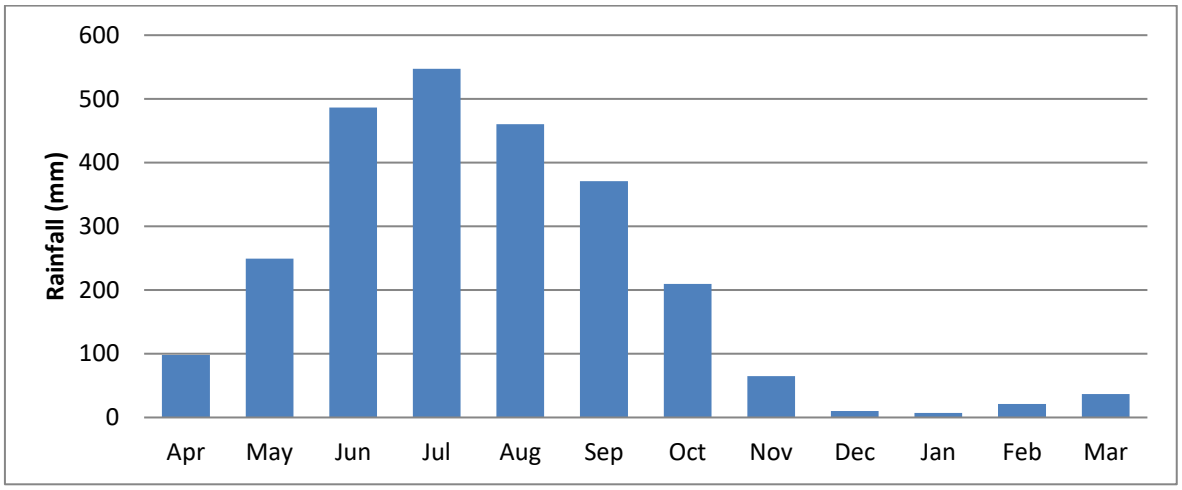
150. The physical environment of the study includes information on meteorology, sound quality, water quality, seismicity and topography. The physical environment within the polder area is briefly discussed in the following sub-article.

5.1.1 Meteorology

151. This section provides an analysis on meteorological parameters (temperature, rainfall, wind speed and humidity) of Polder 43/2E area. It is to be mentioned here that data and information for different analyses have been collected for different time intervals, depending on data availability, data variation and significance in connection with the study.

Rainfall

152. The average monthly rainfall variation at Patuakhali BMD station (from 1980 to 2008) is shown in Figure 5.1. The hyetograph shows that the highest and lowest values of rainfall are observed during the months of July (547 mm) and January (7 mm) respectively.

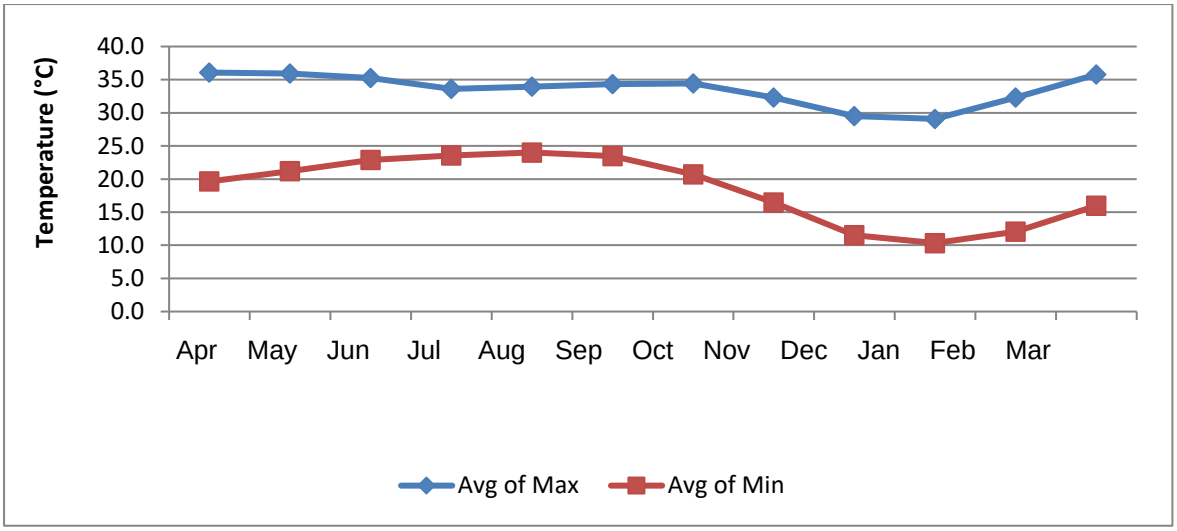


Source: BMD, 2014

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

Temperature

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

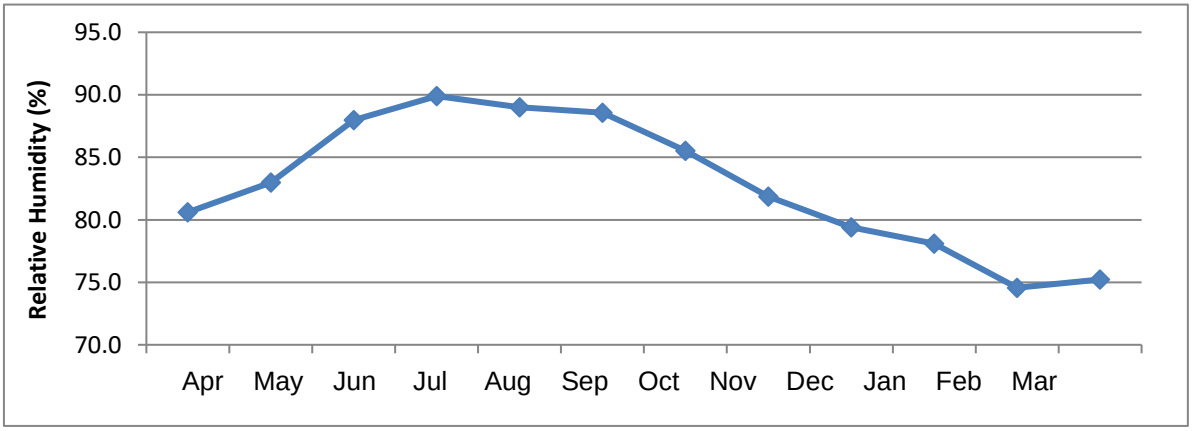


Source: BMD, 2014

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

Relative Humidity

154. Figure 5.3 below shows the variation of monthly relative humidity, as recorded in the Patuakhali BMD station (from 1973 to 2013). Significant fluctuation is observed as relative humidity values start to increase from April (start of summer) due to the increase in atmospheric water vapors coupled with temperature rise. An increasing trend is observed from April to July, after which a decreasing pattern is found.

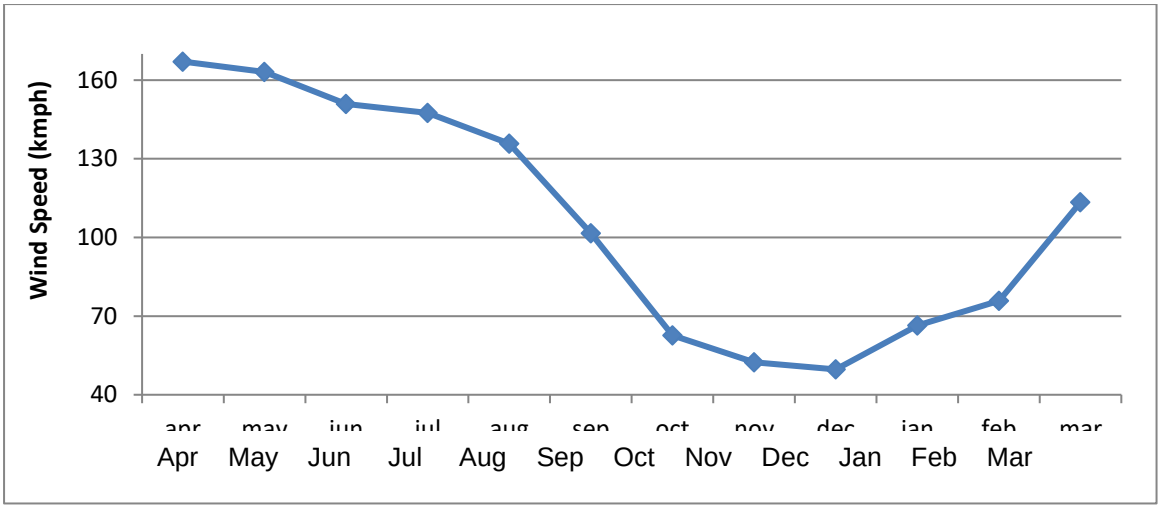


Source: BMD, 2014

Figure 5.3: Average relative humidity at Patuakhali BMD station

Wind speed

155. Figure 5.4 below shows the distribution of average monthly wind speed at Patuakhali BMD station (from 1973 to 2013). Wind speed is the highest in April (around 167 kph) and the lowest in December (around 49.7 kph). During cyclone SIDR (2007) and AILA (2009), 1 minute sustained wind speeds were recorded as 260 kph and 120 kph respectively; the former one caused devastating impacts due to high wind speed whereas the latter one is related more to the increased storm surge.

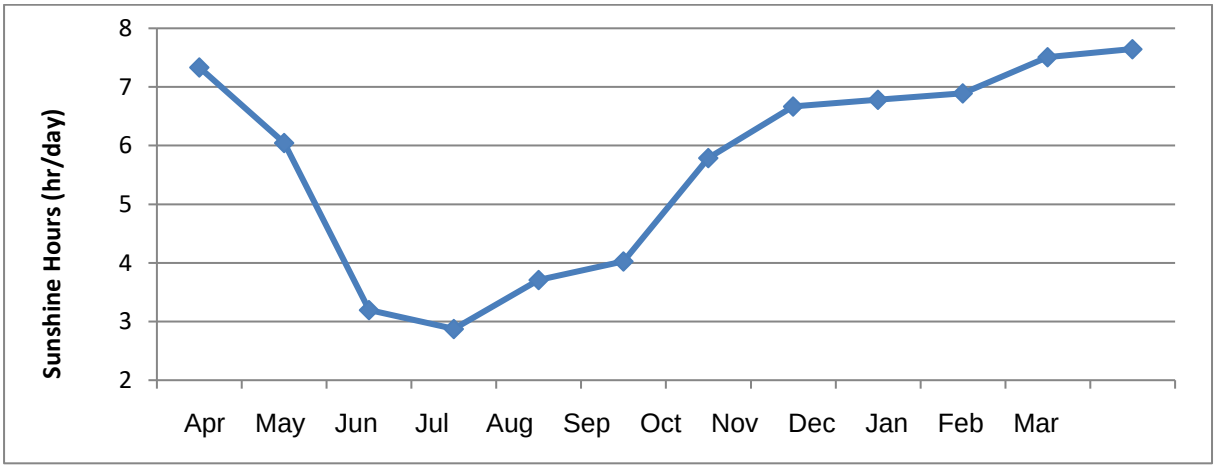


Source: BMD, 2014

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

Sunshine Hour

156. The average sunshine hour data were collected from the Patuakhali BMD station (1985-2013). Figure 5.5 below shows an increasing trend from August to March. Maximum sunshine hour is found in March (7.65 hrs/ day). However, a decreasing trend is observed from April to July. Sunshine hours were minimum in June (3.2 hrs/ day) and July (2.9 hrs/ day) due to the presence of monsoon cloud.

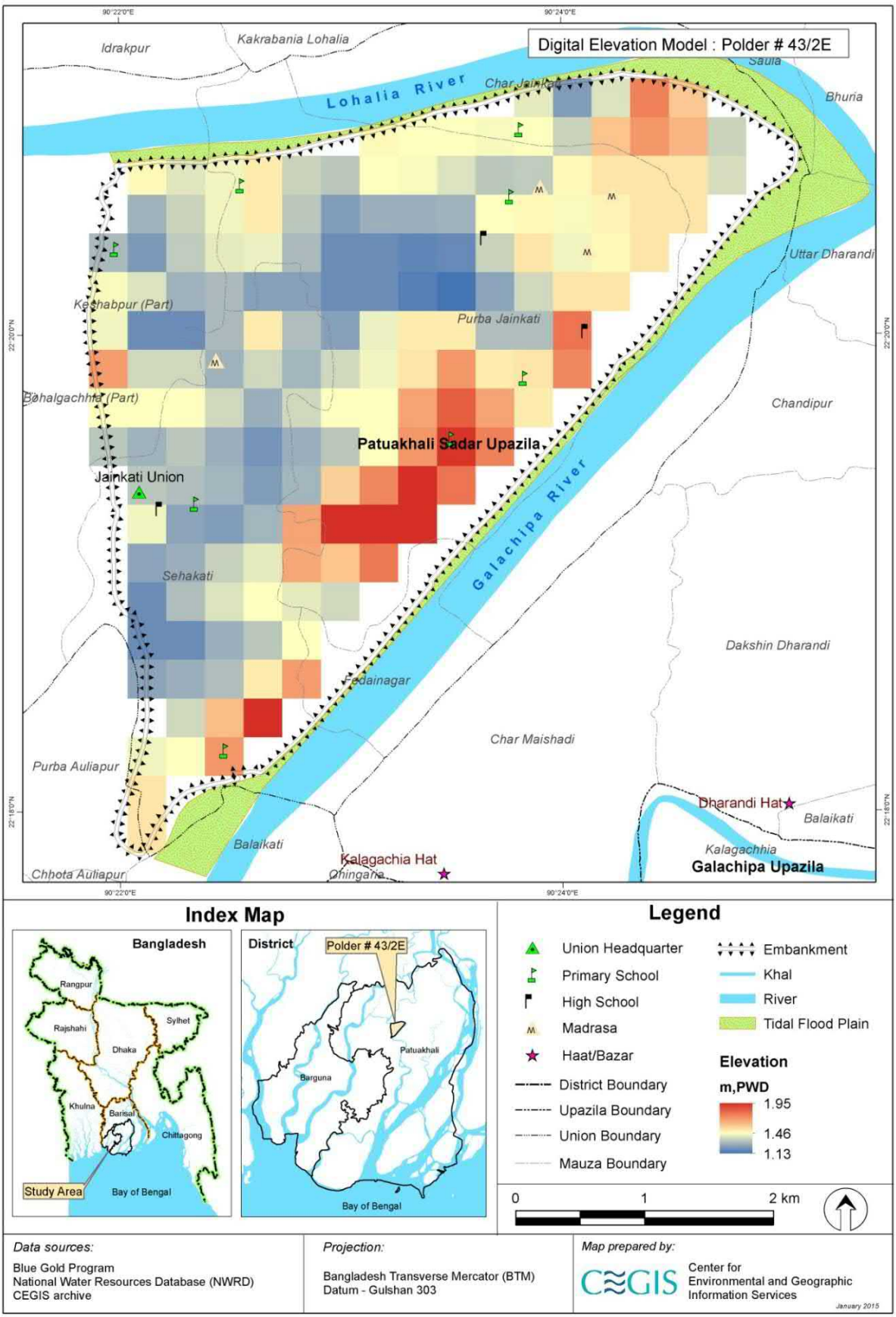


Source: BMD, 2014

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

5.1.2 Topography

157. To visualize the elevations of different locations within the polder an analysis using Digital Elevation Model (DEM) has been carried out (Map 5.1). DEM analysis infers that the Reduced Levels inside the polder are low, varying from 1.13 to 1.95 m, PWD (a surface which is 0.46 m below the Mean Sea Level), with average elevations of around +1.54 m, PWD. The ground level of the entire polder is higher than the low tidal water levels observed in Mirjaganj (Payra River). The DEM analysis also indicates that the peripheral locations are slightly higher than most of the inside portions of the polder. Map 5.1 shows the topography of the study area, presenting the rivers and water bodies as well as categorizing land elevations.



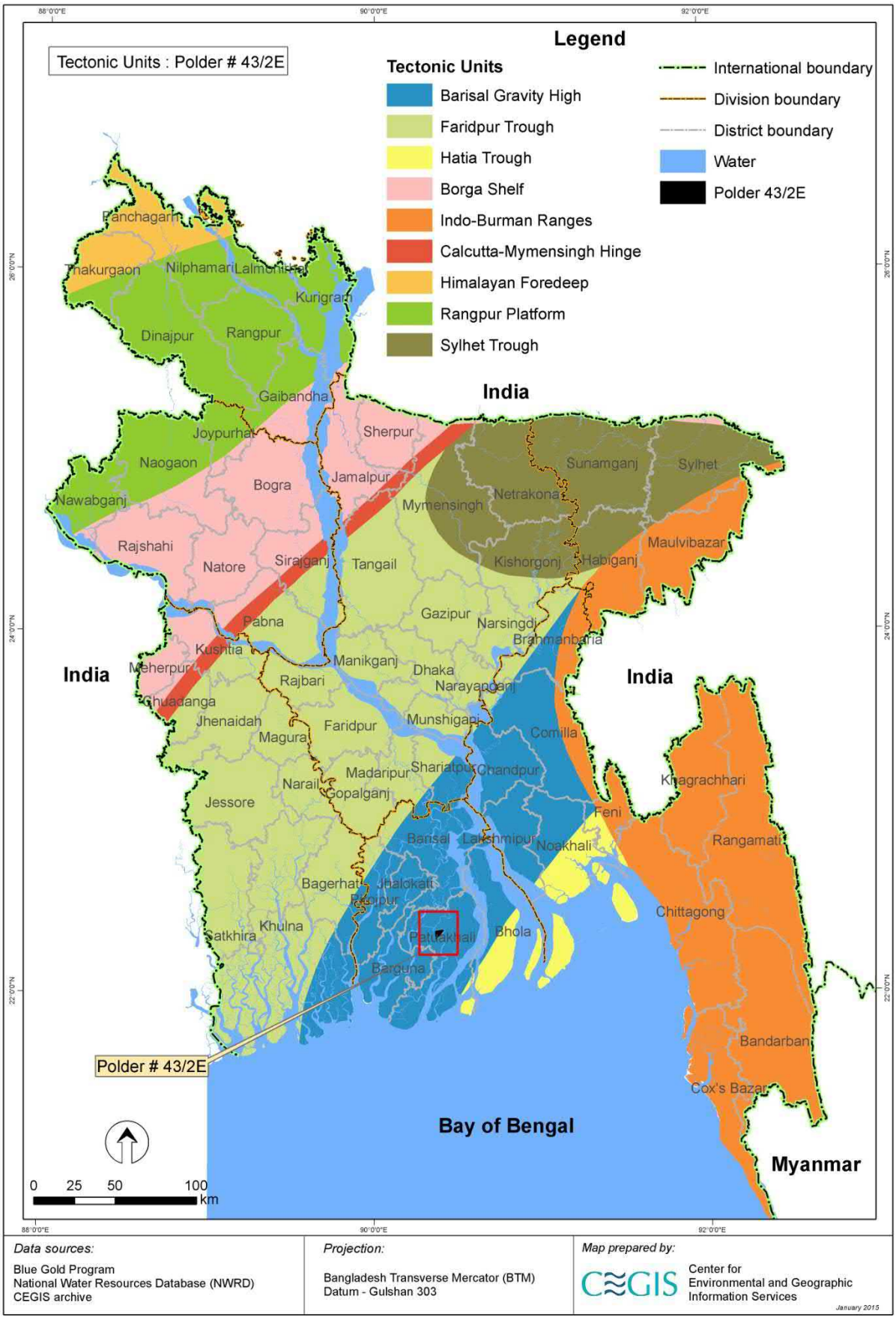
Map 5.1: Digital Elevation Model (DEM) around Polder 43/2E

5.1.3 Seismicity

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

159. Map 5.3 presents the tectonic units available in Bangladesh and the location of Polder 43/2E. The map shows that the polder is located on the Barisal Gravity High tectonic unit. The 60 km wide zone is located between the Faridpur trough and Hatiya trough of the Bengal Foredeep. The zone has not been sufficiently studied for seismic surveys; however, it can be concluded that in consideration of both seismicity and stratigraphy, Polder 43/2E falls on a relatively safer (seismically quiet and tectonically stable) side.

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



Map 5.3: Map of tectonic units of the polder area

5.1.4 Agro-ecological Zone

160. 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. The polder 43/2E area is covered by one AEZ i.e Ganges Tidal Flood Plain (AEZ-13). These layers are:

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

161. Agro-ecological zones and sub-zones are very broad units. The 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 large variation in the fertility levels even between adjacent plots. The difficulties of agro-ecological zones are given here which serve 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 Nirdeshikas may be consulted.

AEZ-13: Ganges tidal floodplain

162. This region occupies an extensive area of tidal floodplain land in the south-west of the country. The greater part of this region has smooth relief having large area of salinity. There is general pattern of grey, slightly calcareous, heavy soils on river banks and grey to dark grey, non-calcareous, heavy silty clays in the extensive basins. Non-calcareous Grey Floodplain soil is the major component of General Soil Types. Acid Sulphate soils also occupy significant part of the area where it is very strongly acidic during dry season.

5.1.5 Physico-chemical properties of soils

163. In general, most of the top soils are acidic and sub-soils are neutral to slightly alkaline. Soils of the Sundarbans area are alkaline. General fertility level is high with low to medium organic matter content and very high 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. Some of the physico-chemical properties of soils of AEZ-13 are provided in Table 5.1.

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

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

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

Source: Fertilizer Recommendation Guide - 2012, BARC

5.1.6 Soil fertility analytical data of analytical samples

164. Soil sample were collected from three locations at three depths (0-10 cm, 10-20 cm and 20-30 cm) inside the polder area in the month of January, 2015. Collected soil samples were analyzed by Soil Resource Development Institute (SRDI), Dhaka. Results of the analysis are presented in the Table 5.2.

Table 5.2: Fertility status of soils in the polder area

Number of the polder	Location	GPS reading	Depth (cm)	EC	pH	OM	N	K	P	S
						%		Meq/ 100g	µg/gm	
43/2E	Madda Para Sehakati	E-90°22" 21′17″ N-22° 19" 1′34″	0-10	0.72	5.7	0.93	0.05	0.10	3.16	135.47
			10-20	0.74	6.9	0.93	0.05	0.13	2.72	149.06
			20-30	0.86	7.2	2.07	0.12	0.15	2.60	146.12
	Purba Jainkati	E-90°22" 39′76″ N-22° 20" 9′36″	0-10	1.09	6.0	2.02	0.11	0.13	6.75	142.10
			10-20	1.09	7.0	0.52	0.03	0.16	3.07	39.29
			20-30	0.95	7.3	1.40	0.08	0.16	4.19	37.84
	Purba Jainkati	E-90°23" 43′67″ N-22° 20"28′38″	0-10	0.44	6.2	0.93	0.05	0.20	3.61	32.86
			10-20	0.39	7.2	0.83	0.08	0.15	4.53	38.31
			20-30	0.42	7.7	1.81	0.10	0.17	5.16	25.21

Source: Laboratory analysis report, 2015

5.1.7 Land type

165. Land type is a system of classifying cultivated land based on the seasonal inundation depth in normal flooding year. According to Soil Resource Development Institute (SRDI, 1988), five types of land(High land, Medium Highland, Medium Lowland, Lowland and Very Lowland) have been classified in terms of depth of flooding on agriculture land. The entire polder area is under medium highland (F_1) which is normally flooded between 30 to 90 cm deep of water continuously more than two weeks to few months during the monsoon season.

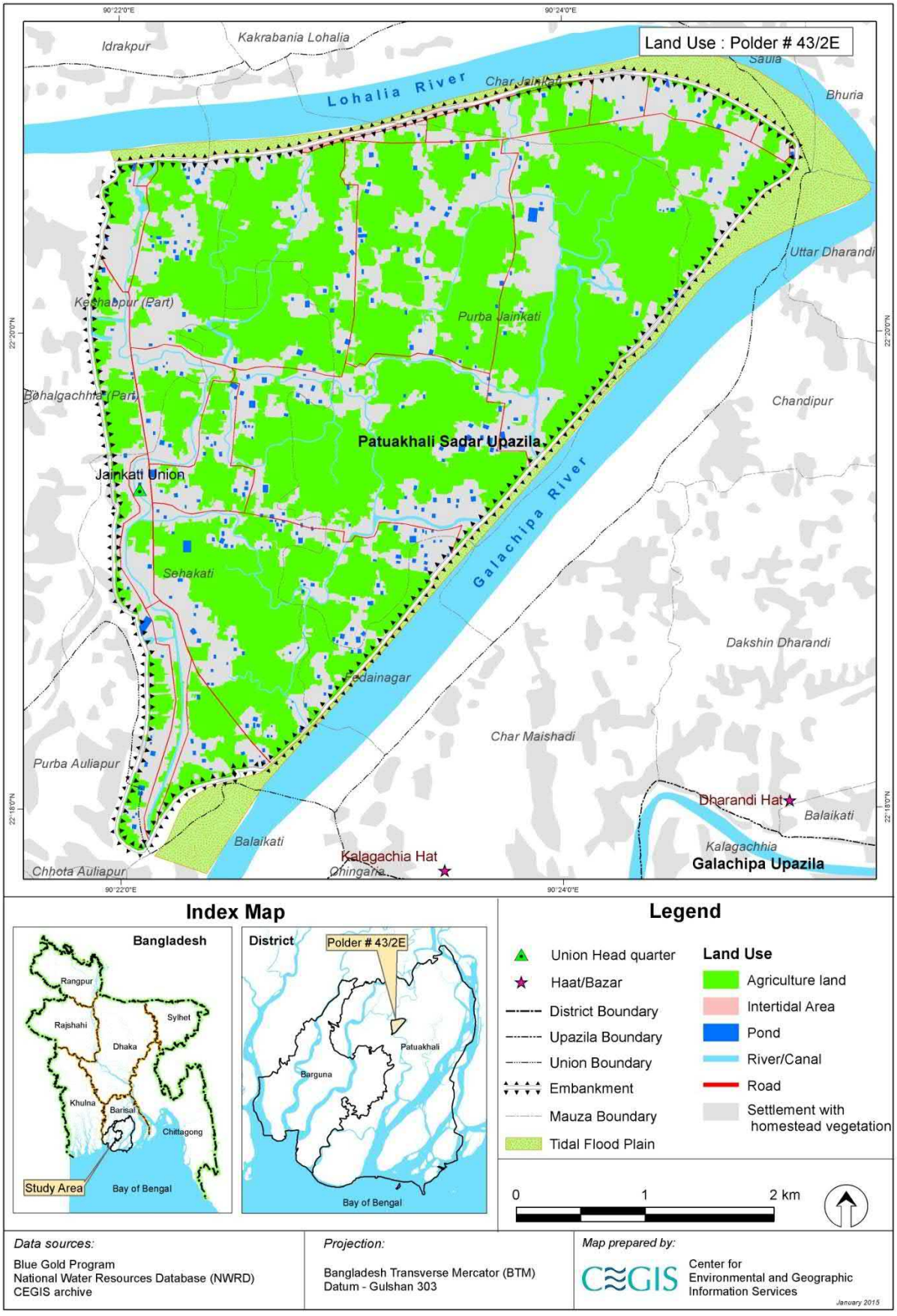
5.1.8 Land use

166. The gross area of the polder is about 1,720 ha of which 1,160 ha (67%) is NCA. Settlement457 ha (27%), Water bodies (rivers/khals) 88 ha (5%) and roads 15 ha (1%) of the total polder area. Detail land use of the polder area is presented in Table 5.3 and Map 5.4.

Table 5.3: Present detailed land use of the polder area

Land use	Area (ha)	Total area (%)
NCA	1,160	67
Settlements	457	27
Road	15	1
Water bodies (river/khal)	88	5
Gross Area	**1,720**	**100**

Sources: CEGIS estimation from SOLARIS-SRDI, 2006



Map 5.4: Land use in the polder area

5.1.9 Soil texture

167. Soil texture is an important soil characteristic that guides crop selection, crop production and also field management. Soil texture is the relative proportions of sand, silt and clay. Soil can be classified as one of four major textural classes: a) sands b) silts c) loams and d) clays. Crop production also depends on soil texture. It influences many other properties of great significance to land use and management. Detailed distribution of soil texture is presented in Table 5.4 and Map 5.5:

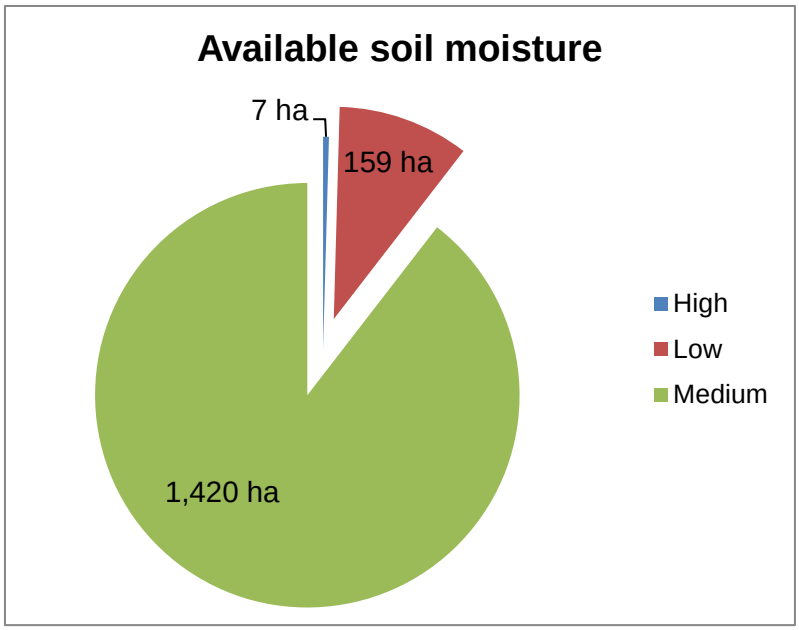
Table 5.4: Detailed Soil texture of the surface soil (0-15 cm) in the polder area

Texture	Area(ha)	% of NCA
Clay	116	10.0
Clay Loam	1,039	89.6
Loam	5	0.4
Total	**1,160**	**100.0**

Sources: CEGIS estimation from SOLARIS-SRDI, 2006

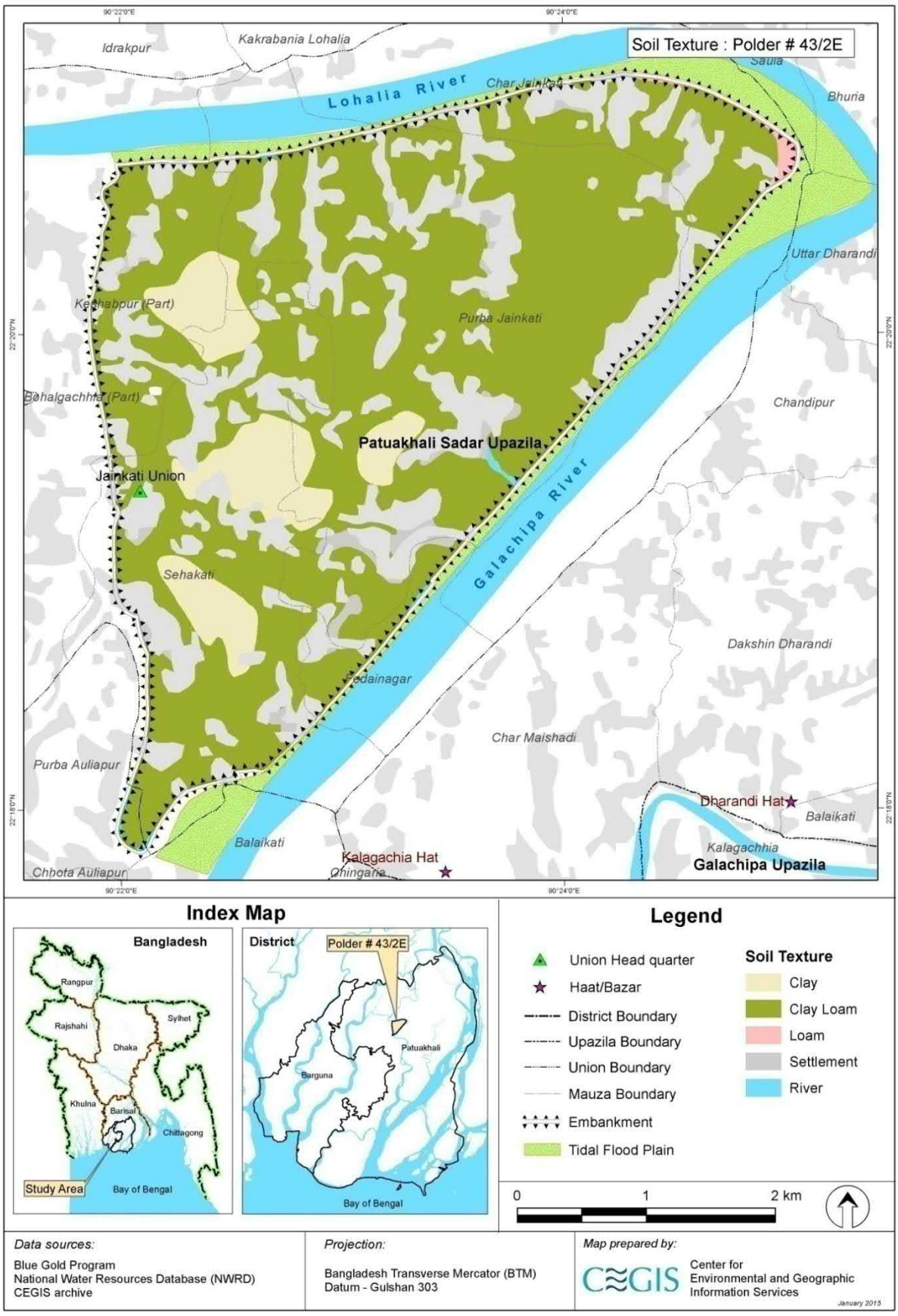
5.1.10 Available soil moisture

168. The availability of soil moisture varies depending on the soil characteristics. According to SRDI, the available soil moisture has been classified into four (Low, Medium, High and Very high) categories. The distribution of available soil moisture is presented in Figure 5.6 and Map 5.6.

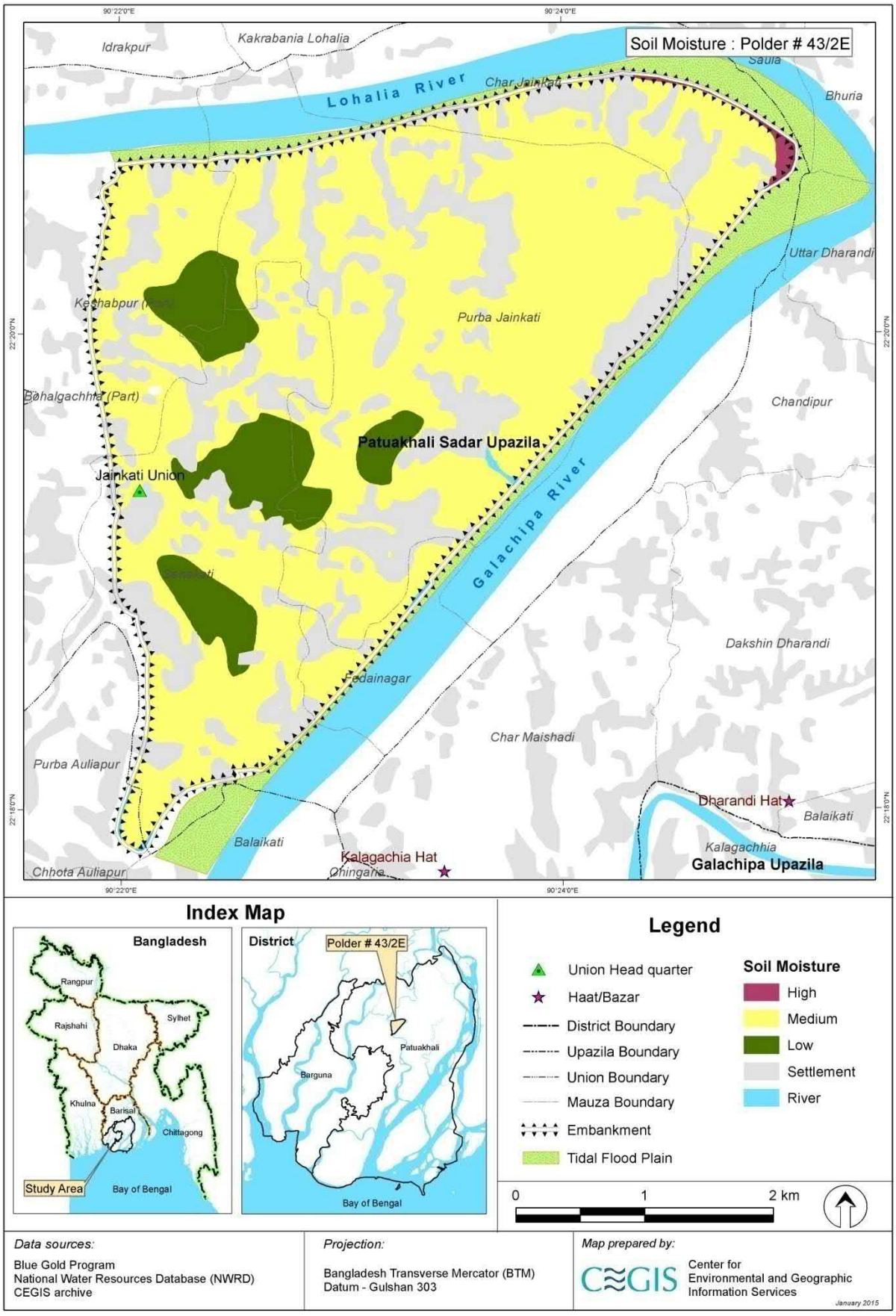


Sources: CEGIS estimation from SOLARIS-SRDI, 2006

Figure 5.6: Available soil moisture in Polder 43/2E



Map 5.5: Map showing soil texture in Polder 43/2E



Map 5.6: Map showing soil moisture in Polder 43/2E

5.1.11 Soil Salinity

169. CEGIS estimation from SOLARIS-SRDI, 2006, reveals that the soil salinity of the area inside the polder increases gradually over the period. Local farmers reported that most of the water control structures are not functioning properly. As a result, this cannot restrict intrusion of saline water inside the polder which is reported as the major cause of the salinity increment inside the polder.

170. According to local people the soil and water salinity gradually increases with dryness from January and reach to maximum level in the month March-April and then decreases due to onset of monsoon rainfall. Detailed soil salinity of 2000 and 2009 of the polder area are presented in Table 5.5 and Map 5.7.

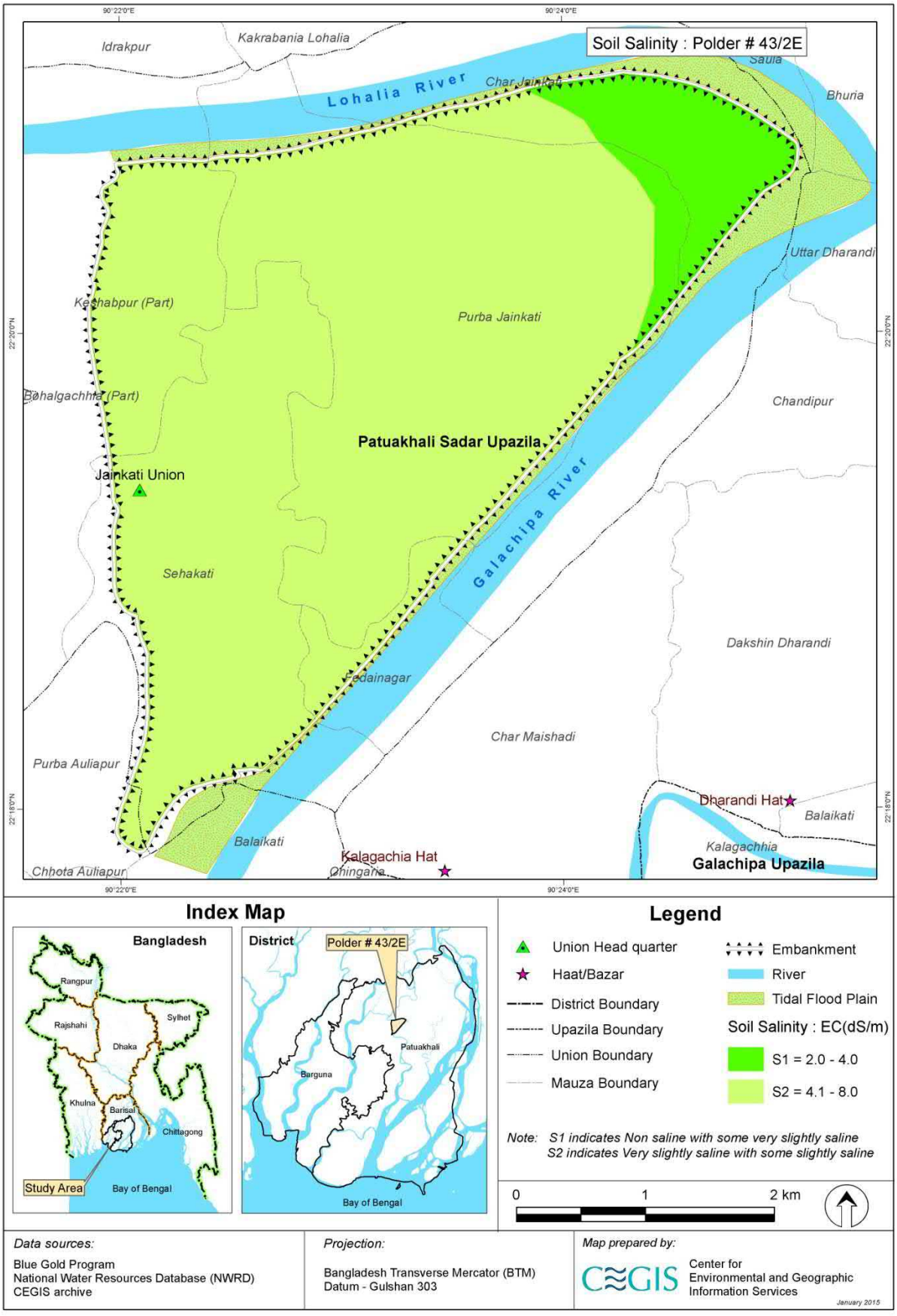
Table 5.5: Detailed Soil salinity of the polder area

Soil Salinity class (EC=ds/m)	Description	Area (ha) (in 2000)	% of NCA	Area (ha) (in 2009)	% of NCA
2.0 - 4.0	Non saline with some very slightly saline	00	00	110	9
4.1 - 8.0	Very slightly saline with some slightly saline	1,160	100	1,050	91
	Total =	**1160**	**100**	**1160**	**100**

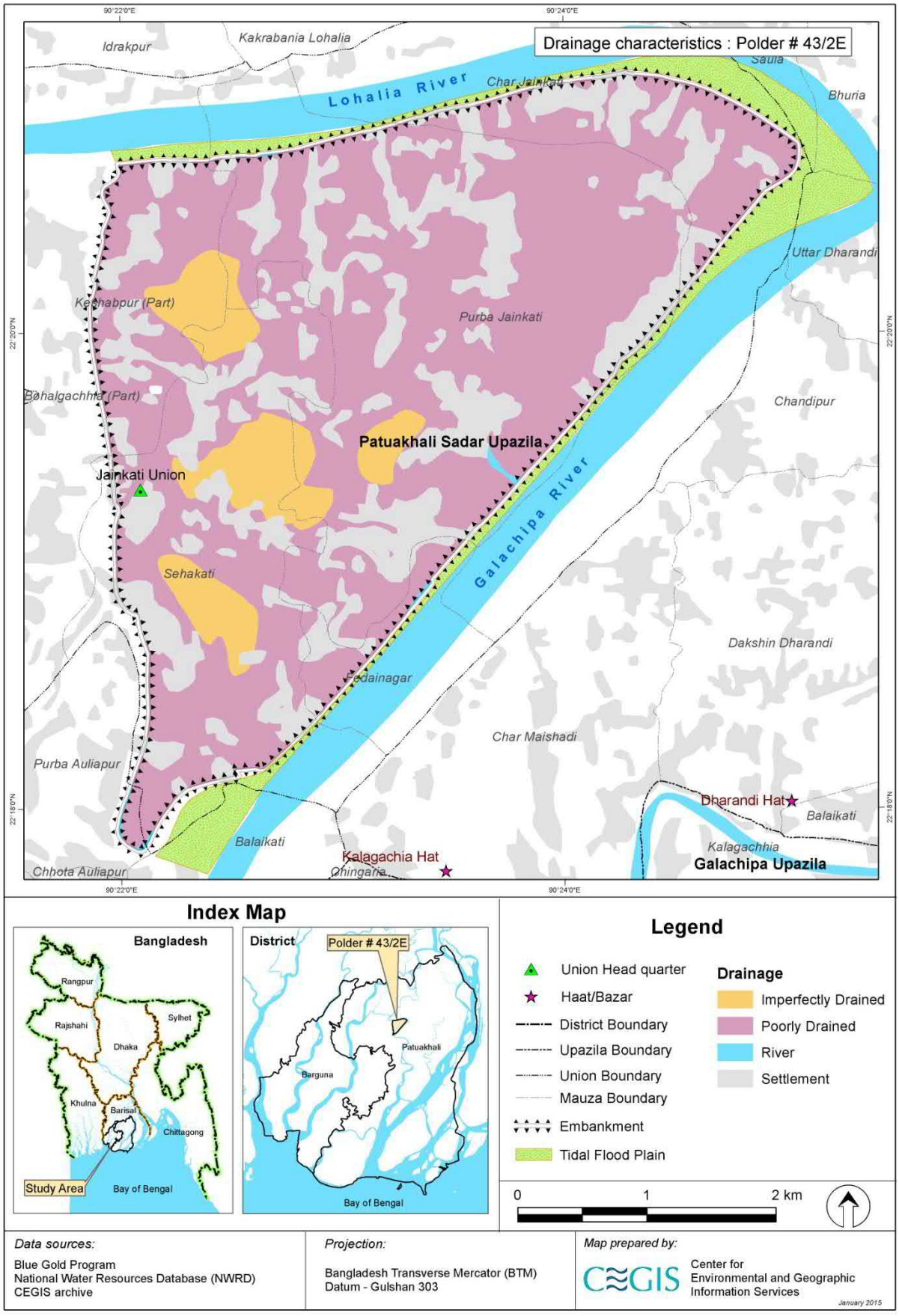
Note:Year 1973 salinity data is not available.; Sources: CEGIS estimation from SOLARIS-SRDI, 2006.

5.1.12 Drainage Characteristics

171. Drainage plays vital role in the management of soil (salinity, soil health) in the polder area. According to SRDI (1988), the drainage characteristics have been divided into six classes (Excessively drained, well drained, moderately well drained, imperfectly drained, poorly drained and Very poorly drained) from the agriculture point of views. The entire NCA is under poorly drained condition i.e, normally is flooded between a depth 30 to 90 cm continuously for more than two weeks to few months during the flood season. The soil of the polder area indicates that the timely removal of water in rainy/monsoon season is the main constraint for growing rabi/dry land crops in the polder area. Poorly drained characteristics along with area are presented in Map 5.8.



Map 5.7: Map showing soil salinity in Polder 43/2E



Map 5.8: Drainage characteristics in the polder area

5.1.13 Water Resources System

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

River Systems

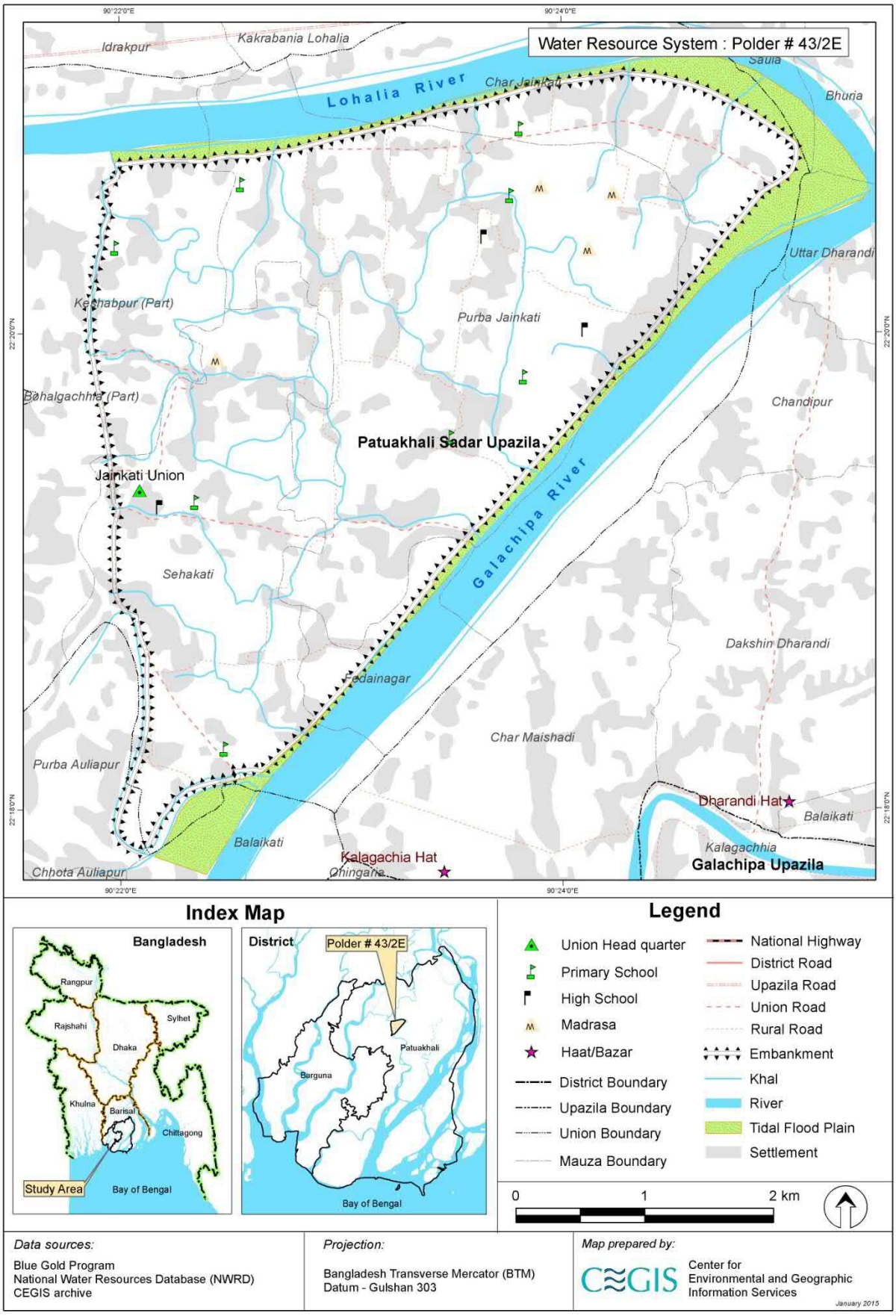
173. Polder 43/2E is within an areal distribution of 45 km from the coast of the Bay of Bengal, undergoing diurnal tidal influence. The polder is surrounded by a tidal river namely, the Lohalia River on the east and north direction, the Shuddurbaria khal on the south portion and the Naotana khal along the north direction. Apart from these rivers, there are approximately 35.2 km of drainage and irrigation canals (khals) within the polder (Gagankhali Khal, Dholkhali Khal, Moubaria Main Khal, Shuddurbaria Main Khal, Naotana Khal, Katakhali Khal, Natua Main Khal, Kalia Dangar Khal, Piparbuniar Khal, Jugal Dhopar Barir Khal, Kabiraj Barir Khal, Shib Barir Branch Khal, Durlab Khal, Jugir Sota Khal etc.). The river system of the area is shown in Map 5.9.

(a) Lohalia River, (b) Dolkhali khal

Photo 5.1: Major rivers in the polder surroundings

Hydrological Connectivity

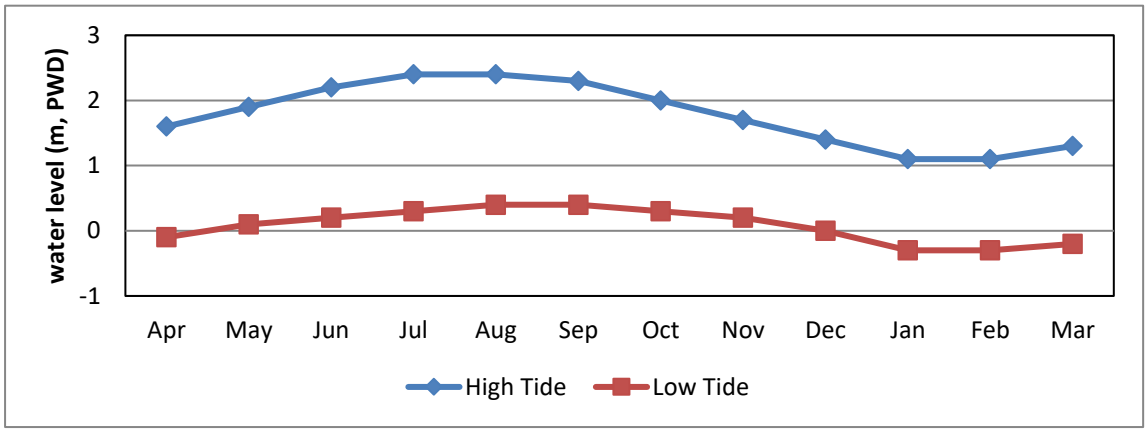
174. Water from the peripheral river is pushed towards the polder area during the high tide while the opposite situation takes places during low tide. However, during dry season, sluice gates are kept closed and most of the high tidal water cannot enter into the polder. The gates are kept open during monsoon and post-monsoon as a result free circulation of tidal water takes place within the polder. A number of distributaries of Lohalia River (Shuddhrbaria Main khal, Katura Taluk khal, Dholkhali khal, Shib Bari khal, Durlab khal, Katakhali khal, Naotana khal etc.) also contribute to the high tidal water to flow into the polder, whereas some other internal khals (Jugir Sota khal, Bahaitala khal, Dhopal khal, Natua Main Khal etc.) ensure free circulation of tidal water to circulate within the polder. These khals also help to drain out the internal water of the polder through the peripheral gates.



Map 5.9: Water resources system of the study area

Surface Water Level

175. The surface water level is an important issue of water resources. Figure 5.7 presents the variation of monthly water levels, it shows that water level during high tide ranges from +1.1 m, PWD to +2.4 m, PWD, whereas low tidal water level ranges from -0.3 m,PWD to +0.4 m,PWD.

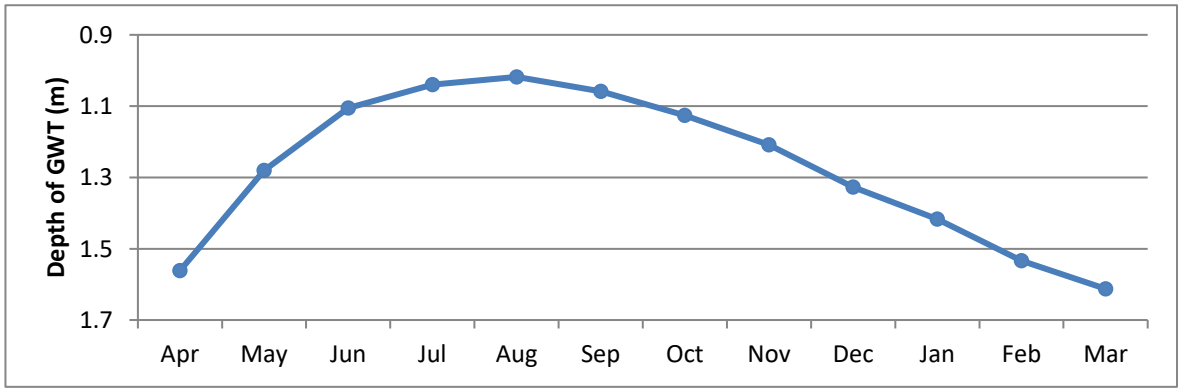


Source: BWDB, 2014

Figure 5.7: Surface water level at Mirjaganj (Payra River)

Ground Water

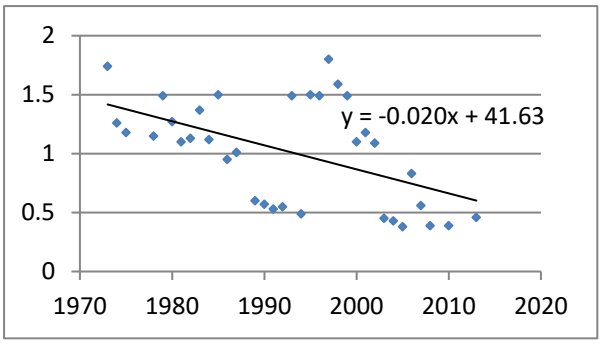
176. The observation well of BWDB at Patuakhali Sadar (PAT003) has been considered for investigating the monthly variations in Ground Water Table (GWT). The station is located inside the polder area. Monthly average data on GWT from 1973 to 2013 have been analyzed and shown in Figure 5.8. The monthly variation pattern shows that GWT is the highest during August-September and the lowest in March.



Source: BWDB, 2014

Figure 5.8: Average monthly variations of GWT

177. Analyses have also been made to understand the long term annual variations of GWT from 1978 to 2013 at BAG001 station, for the month of March (driest period) and August-September (wettest period). The values are presented in Figure 5.9 and 5.10. A mild decreasing trend of annual GWT variation is observed in both cases.



Source: BWDB, 2014

Figure 5.9: Variation of GWT at PAT003 in August (1973-2013)

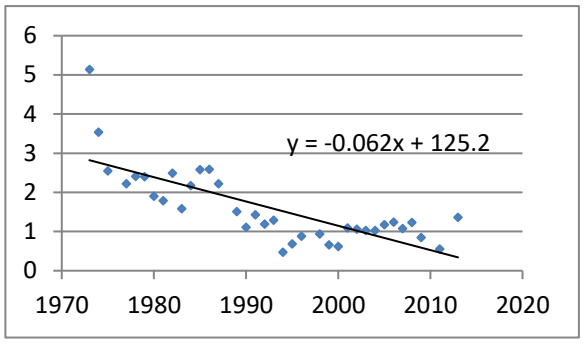


Figure 5.10: Variation of GWT at PAT003 in March (1973-2013)

5.1.14 Water Use

Domestic use

178. The standard value of average daily demand of water for domestic and drinking purposes in rural areas is considered as 50 lpc (Ahmed and Rahman, 2010). However, the actual status of drinking water status in some of the coastal polders is poor. During field survey in Polder 43/2E, it was found that the average daily domestic use of water was around 35 lpc, which is slightly better than those of the other adjacent coastal polders studied in the first phase of Blue Gold Program. The study found that around 280 m^3 of water is consumed daily by the total number of 9,350 people living in the polder. Local people opined that they prefer Deep Tube Wells (DTWs) as drinking water sources to meet up their daily requirements. For other domestic uses, surface water sources are used. Overall, water availability in Polder 43/2E is not a major concern as local people claimed that they have sufficient surface and groundwater sources to meet up their daily need of drinking and domestic purposes.

Irrigation Use

179. The local farmers in Polder 43/2E practice Lt. Aus in Kharif-I (March-June) season, HYV Aman and Lt. Aman in Kharif-II season (July-October) and some other crops (mungbean, chili, sesame, khesari, watermelon and vegetables) in Rabi (November-February) season. The rain fed irrigation is sufficient during Kharif-I and Kharif-II seasons for Lt. Aus, HYV Aman, and Lt. Aman crops, whereas surface water irrigation is provided for wheat, watermelon and mungbean crops during Rabi season. Water is also required for other rabi season crops such as khesari and sesame, but no surface water irrigation is needed for these crops as sufficient soil moisture is available during the season.

180. Previous studies of CEGIS have inferred that around 300 mm of water per ha is usually required for each ha of areas of Aus and Aman cultivation. For mungbean, khesari, watermelon and other *Rabi* season crops practiced in the area required around 200 mm of water per ha area. Using these pragmatic standards of water requirements, the study infers that approximately 1.32 Mm^3 of water would be required during Rabi season to ensure effective irrigation. The surface water irrigation coverage is around 57% of the NCA of the Polder 43/2E and local people claimed that the low water availability marked by reduced water carrying capacity of khals, and poor functioning of water control structures are the major reasons for which more areas cannot be irrigated during the Rabi season. Irrigation using LLPs is also very costly (BDT 5,500 to BDT 6,000 per ha areas), for which boro cultivation is not locally practiced as it requires almost 10 times excess more water than that required for wheat, watermelon and mungbean cultivation.

Table 5.6: Irrigation water requirements in Polder 43/2E

Season	Lt. Aus (ha)	Lt. Aman (ha)	HYV Aman (ha)	Khesari and Sesame (ha)	Wheat, Watermelon and Mungbean (ha)	Water requirement (mm/ ha)	Water Used (Mm3)	Type of irrigation
Kharif-I (Mar -Jun)	302	-	-	-	-	300	0.91	No supplementary irrigation is required as rainwater is sufficient
Kharif-II (Jul - Oct)	-	731	429	-	-	300	3.48	No supplementary irrigation is required as rainwater is sufficient
Rabi (Nov – Feb)	-	-	-	278	-	200	0.56	No irrigation is provided as existing soil moisture is sufficient
	-	-	-	-	662	200	1.32	Surface water irrigation in 660 ha areas is provided using LLP and other traditional methods

Source: CEGIS Estimation, January 2015

5.1.15 Water Resources Functions and Problems

181. The following sections point out the status and other phenomena of different water resources functions and problems in the polder area. The water resources functions and problems were identified by the study team during their field investigation in January 2015.

Tidal Flooding

182. Local people of Polder opined that the peripheral embankment effectively protected the polder area from tidal flooding. As such, no tidal flooding occurs inside the polder. However, the tidal floodplains outside the polder are often flooded during the period of high tide, and in monsoon, high tidal water levels reach up to a level of around 2~3 m below the crest level of the peripheral embankments. During public consultation the entire polder area is found to be free from tidal flooding.

Drainage Congestion and Water Logging

183. The drainage status along the water courses within the polder were found satisfactory. The khals within the polder area are functioning properly and are easily draining out water from the polder following any major rainfall. As such, no drainage congestion was found inside the polder. Local people opined that water which is accumulated inside the polder from rainfall usually does not remain entrapped for any unusual duration. There are number of khals inside the polder having no water control structures at their openings. This hampers irrigation and other surface water uses to some extent. But the overall drainage status is satisfactory and the polder remains also free from water logging.

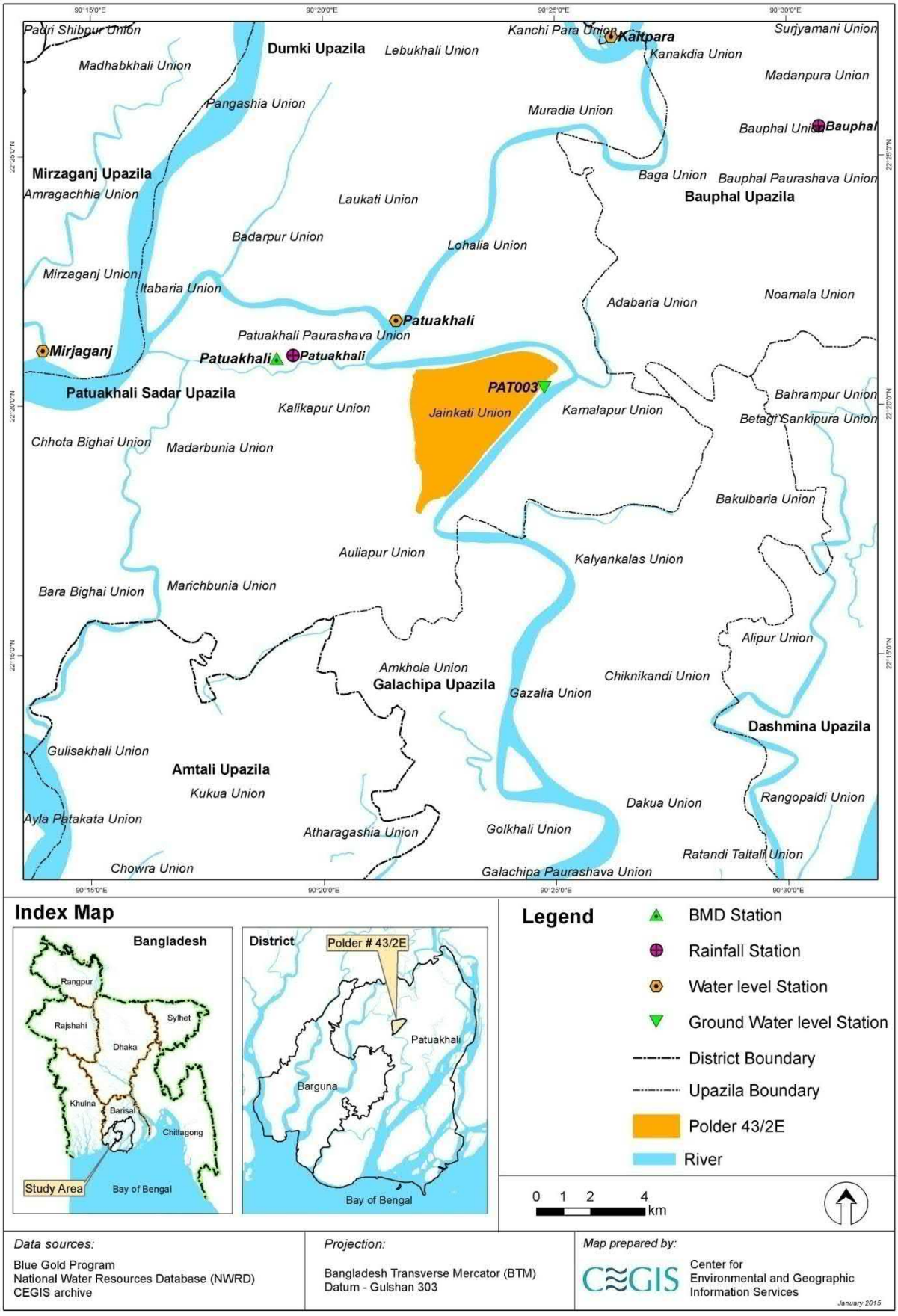
Navigation

184. The peripheral Lohalia river of Polder 43/2E is predominantly used for waterway navigation. Large launches and streamers carrying passengers navigate through the river towards Barisal (Golachipa). The Lohalia River is deep and wide, and offers good means of navigation in all seasons. However, negligible navigation takes place inside the polder, only small fishing boats are found to navigate through the internal khals.

Photo 5.2: Navigation along Lohalia river at Char Jainkathi

Erosion and Accretion

185. The polder is morphologically stable for the last 20 years. During field investigation of the study team in January 2015, no severe erosion hotspots around the polder was noticed. The local people also opined that neither river erosion nor accretion is of their major concern, as the peripheral embankment experienced no major erosion in recent years. Analysis has also been carried out using Remote Sensing (RS) technology, with satellite imageries of 1997 and 2014. The RS-based analysis shows that within the 17 years, the plan forms of the Lohalia Rivers remained quite stable and no significant portion of land has been eroded.



Map 5.10: Map showing stations of rainfall, water level measuring stations and GW observation wells of BWDB

5.2 Biological Environment

5.2.1 Farming practices

186. Farming practices in the polder area are largely governed 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 further been sub-divided into kharif-I (March-June) and Kharif-II (July-October) seasons.

187. The climatic condition in kharif-I season is characterized by high temperature, low humidity, high evaporation, high solar radiation. The season also prevails uncertainty of rainfall means low alternating dry and wet spells. In this season land remains fallow and few Lt Aus are grown though there is scarcity of irrigation water.

188. The kharif-II/monsoon cropping season is characterized by high rainfalls, low temperatures, high humidity, and low solar radiation. In this season there is high probability of flooding that recede towards the end. Rice is the predominant crop grown during this season due to the submergence of soil. Excessive soil moisture and higher temperature restricts other crops to grow in that area. HYV aman and local transplanted aman are also grownin this polder area during this season.

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

5.2.2 Cropping pattern by land type

190. The most prominent cropping pattern is Fallow - HYV Aman - watermelon and Fallow - Lt. Aman - Fallow which are practiced in 37% and 19% of the NCA respectively. The next dominant cropping pattern is Fallow - Lt aman - Khesari which is practiced in 17% of the NCA. Among the *Rab*i crops and varieties farmers are using Sesame-BARI Sesame-2, mungbean-Mubarik, watermelon-Local, chilli-Local, khasari-Local sunflower: Kironi). Khasari and mungbean are grown as a relay crop. Detailed cropping patterns by land type are presented in Table 5.7.

Table 5.7: Existing major cropping pattern by land type

Land type	Kharif-I (March-June)	Khartif-II (July-Oct)	Rabi (Nov-Feb)	Area (Ha)	% of NCA
F1	Lt. Aus	Lt. Aman	Khasari	197	17
	Fallow	Lt. Aman	Mungbean	81	7
	Fallow	HYV Aman	Watermelon	429	37
	Fallow	Lt. Aman	Wheat	47	4
	Lt. Aus	Lt. Aman	Mungbean	105	9

Land type	Kharif-I (March-June)	Khartif-II (July-Oct)	Rabi (Nov-Feb)	Area (Ha)	% of NCA
	Fallow	Lt. Aman	Sesame	81	7
	Fallow	Lt. Aman	Fallow	220	19
			Total =	**1,160**	**100**
Cropping intensity 207%					

Source: CEGIS field survey, 2015 and secondary data from UAO Office

191. The rice varieties (local and HYV) which the farmers use to cultivate in the polder are given below.

Table 5.8: Varieties of rive cultivated in polder area

Sl No.	Aus		Aman	
	Local	HYV	Local	HYV
1	Kalishaitta	Nil	Sarnamasuri	BRRI dhan 30, BRRI dhan 31 and BRRI dhan 35
2	Kalamota		Kalamadari	
3			Karangal	
4			Dudkalam	
5			Kajalshail	
6			Balashar mota	

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

Photo 5.3 : View of watermelon field

Photo 5.4: View of khasari field

5.2.3 Cropping intensity

192. Total cropped area is about 2,401ha of which 61% is covered with rice and the rest 39% is occupied by non-rice crops. The single, double and triple cropped areas are 19%, 55% and 26% of the NCA respectively. The cropping intensity of the project is about 207%.

5.2.4 Crop production

193. The annual total crop production in the polder area is about 9,330 tons of which rice and non-rice are produced 2503 tons and 6827 tons respectively. The contribution of rice crops is about 27% and non-rice is about 73% of total crop production. Among the rice crops, the contribution of Lt Aus, Lt Aman and HYV aman are about 17%, 43% and 40% respectively.

5.2.5 Crop damage

194. Crops in the polder area are damaged for drainage congestion, heavy rainfall etc. as reported by local farmers and the SAAO. Total loss of rice production is about 162 tons in 116 ha for siltation of khals and drainage channels, natural calamities etc. HYV Aman, Lt Aman, sesame and watermelon damages are about 10%, 20%, 15% and 10% respectively of NCA. Detailed crop production and crop production loss with percentage are presented in Table 5.9.

195. Damage yield of HYV Aman, Lt Aman, sesame, and watermelon are 0.5 ton, 0.6 ton, 0.2 ton, and 13 tons respectively. Normally aman seedbed, aman crops are lost at early growing stages.

Table 5.9: Existing crop production and crop production loss of the polder area

Crop Name	Crop Area (ha)	Damage Free		Damaged		Total Production	Production	Production (%)	Production loss (%)
		Area (ha)	Yield (t/ha)	Area (ha)	Yield (t/ha)	(ton)	Loss (ton)		
Lt. Aus	302	302	1.4	-	-	423	-	17	-
Lt. Aman	731	658	1.6	73	0.5	1,089	80	43	50
HYV Aman	429	386	2.5	43	0.6	991	82	40	50
Total rice	1462	1346	-	116		2,503	162	100	100
Sesame	81	69	0.8	12	0.2	58	7	1	8
Khesari	197	197	0.7	-	-	138	-	2	-
Wheat	46	46	2.5	-	-	115	-	2	-
Watermelon	429	386	15	43	13	6,349	86	93	92
Mungbean	186	186	0.9	-	-	167	-	2	-
Total non-rice	939	884	-	55	-	6,827	93	100	100
Total	2401	2230	-	171	-	9,330	255	-	-

Source: CEGIS field estimation, 2015, UAO, DAE

5.2.6 Inputs use

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

Seed

197. Selection of seeds should be considered on the basis of having more than 85% germination rate, free from disease infestation, good shape and size and high yield potential. The seed rate used by the farmers in the polder area is presented in Table 5.9. In case of rice, farmers are using more seed than recommended as they use more seedlings per ha. In most cases, seedlings are affected by monsoon flood.

198. According to farmers, they have retranslated in the last few years farmers due to proper damage by heavy rainfall during monsoon season. The seed rate of vegetables generally depends on the size and viability of the seed. In the local market seeds are available in good condition. Among the *Rabi* crops and varieties (Mungbean: Mubarik, Kheshari: Local improved variety, Watermelon: Hybrid/local improved variety, Sesami: Local improved variety, Sunflower: BARI developed variety and Groundnut: BARI developed variety and local improved. Details are in the below Table 5.10.

Table 5.10: Seed used in the polder area for different crops

Crops	Farmers used (Kg/ha)	Recommended seed (kg/ha)
Lt Aus	45	40
HYV Aman	45*	40
Lt. Aman	45	40
Sesame	6.5*	7
Mung bean	26*	25
Watermelon	1.1	0.8
Wheat	135	120
Khesari	65	55

Sources: Hand Book of Agricultural Technology, BARI, 2011-2012. ** Seed use ±*

Labor

199. Almost 65% of the cultural practices in the polder area for crop production are being done manually. So, agricultural labor (seed sowing, intercultural operations and harvesting and post harvest technologies) is considered as one of the essential input 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. The average number of labor (male and female) used per hectare in the polder area is presented in Table 5.11.

Table 5.11: Labor used in the polder area

Crop name	No. of Labor
Lt Aus	110
HYV Aman	140
Lt Aman	120
Sesame	75
Mungbean	130
Watermelon	160
Wheat	140
Khesari	70

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

Fertilizers

200. 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 Urea, TSP, MP and Gypsum. Farmers reported that they are using TSP but during field visit SSP is found to be applied in watermelon fields. In most cases about 50% of farmers use fertilizers in unbalanced way. Organic manures are not used by the farmers in the fields. Local farmers and SAAO of DAE reported that cowdung is used for watermelon, homestead garden and fuel purpose. According to local farmers and one SAAO, there is fertilizer dealer in all most every local markets. Dealers received training from UAO office. Local farmers also reported that they don't have enough money to buy all types of fertilizer at a time. Detailed information of fertilizer used is presented in Table 5.12.

Table 5.12: Fertilizer used by local farmers and recommended dozes in the polder area

Crop Name	Farmers using fertilizer (Kg/ha)						Recommended doze (kg/ha)					
	Compost	Urea	TSP	MP	Gypsum	Zn	Compost	Urea	TSP	MP	Gypsum	Zn
Lt Aus	0	60	40	0	0	0	0	97	14	17	0	0
HYV Aman	-	100	50 SSP	15	20	5	0	163	35	21	0	0
Lt. Aman	-	80	20	10	10	0	0	97	14	17	0	0
Sesame	-	60	20	0	0	0	0	170	60	31	0	1.3
Mung bean	-	45	20	0	0	0	0	45	67	20	0	0
Watermelon	2000	80	40 SSP	25	10	0	6,000	141	56	30	0	3
Wheat	-	120	60	30	20	0	-	80	45	35	25	0
Khesari	-	40	10	-	-	-	0	40	55	20	0	0

Source: Farmers interviewed, January, 2015 and fertilizer recommendation guide, BARC, 2012.

Photo 5.5: Discussion with fertilizer dialer in the polder area.

Pesticides

201. 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 namely Basudin, Furatar, Fighter, Rovral, Ridomil gold etc. Both liquid and granular pesticides are being used to prevent pest infestation in the rice, watermelon and Groundnut cultivation. Local people visit farmers house to house for pesticide application in different fruit trees and field crops. Detailed information of pesticides used is presented in Table 5.13.

Table 5.13: Pesticides application of the polder area

Crop name	Pesticide using by farmers	
	No. of application	Liq. (ml/ha) approx.
HYV Aman	2	1000
Mung bean	3	1500
Watermelon	4	1500

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

5.2.7 Integrated Crop Management (ICM)

202. Recently, Integrated Crop Management (ICM) is practiced in many places of the polder area. In this system, insects are controlled biologically. Farmers of the ICM areas use branches of trees, bamboo and jute sticks to make favorable perches for birds in fields with standing crops. The birds eat the insects which help to control infestation. In this process, the crops are protected without applying any pesticides. Trap is another technique for controlling pests in the agriculture fields especially on watermelon and vegetables for attracting insects. Thus, it is possible to control the harmful insects without application of pesticides. ICM technique is mainly applied on rice, watermelon and vegetables crops. Field information (Farmers and SAAO of DAE) indicates that ICM is being practiced in the fields covering about 10-25% of the cultivated areas and the impact has been found very encouraging.

5.2.8 Irrigation

203. Surface water is the only source of irrigation as reported by local farmers. Khals and in few cases ponds are the source of surface water for very limited time. Irrigation is provided mainly in watermelon and groundnut. Occasionally, Low Lift Pumps (LLPs) are being used for surface water irrigation. Farmers and SAAO reported that if the khals are re-excavated then watermelon cultivation can be doubled while and other Rabi crops area can be increased. Farmers also reported that now the cost of irrigation per hector of land is about tk. 5,500 to 6,000. Detailed information on irrigation is presented in Table 5.14.

Table 5.14: Irrigated area by crop

Crop name	Irrigation (Surface water)		
	Irrigated area (ha)	% NCA	Charge (tk/ha)
Wheat	46	4	5,500- 6,000
Watermelon	429	37	5,500- 6,000
Mungbean	185	16	5,500- 6,000

Source: CEGIS estimation on field information based on farmers interviewed; 2015

5.2.9 Crop Production Constraints

204. The following constraints on crop production have been identified through our visit and group discussions with the local farmers and field level officials of the Department of Agricultural Extension (DAE):

- Drainage congestion during transplanting period in Aman season;
- The sea level risedue to climate change has caused natural calamities such as tidal surge, cyclone etc.
- Severe scarcity of irrigation water during dry season especially for rabi crops cultivation; and
- Rise of the bed of different internal drainage khals for siltation.

205. Above situations are unfavorable for crop production.

Photo 5.6: Discussion with farmer's problem in the polder area for crop production in January, 2015.

5.2.10 Fish Habitat

206. Polder 43/2E is located in Patuakhali Sadar Upazila. The polder is surrounded by a tidal river namely, the Lohalia River on the east and north direction, the Shuddurbaria khal on the south portion and the Naotana khal along the north direction (**Map 5.11**). These water bodies are tidal in nature having potentials habitats for saline and brackish water fish species. However, fish habitats of the polder 43/2E and its adjacent 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. The open water fish habitats of the area are mainly khals which are acting as major arteries of fish migration into the polder area. These are playing vital roles 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.

Capture Fisheries

207. The estimated fish habitat area is 123 ha where capture fishery contributes the major share (88 ha) and the culture fish habitat shares the rest. The open water fish habitat is represented by khal alone as shown in the following **Table 5.15**. The peripheral rivers and tidal floodplainof the polder area are not been considered in the study for estimating fish production.

Table 5.15: Fish habitat status in the polder area

SL. No	Fishery Category	Habitat Type	Area (Ha)
1	Capture	khal	88
		Sub-Total=	***88***
2	Culture	Culturable pond	*25*
3		Cultured pond	*10*
		Sub-Total=	***35***
		Grand Total=	**123**

Source: CEGIS estimation based on field data, 2015

208. Among the khals Noatana Khal, Katakhali Khal, Durlob Khal, Gagonkhati Khal, Dholkhali Khal, Suddurbaria Khal, Moubaria Khal are playing important role as fishery habitat. The depths of these internal khals are is found suitable for the habitation fish species particularly during dry season in the low tide situation. Some of the khals are encroached by the local people and are using for culture fishery by developing barriers through net. Photo 5.10 shows the internal khals of the polder area.

Perennial khal

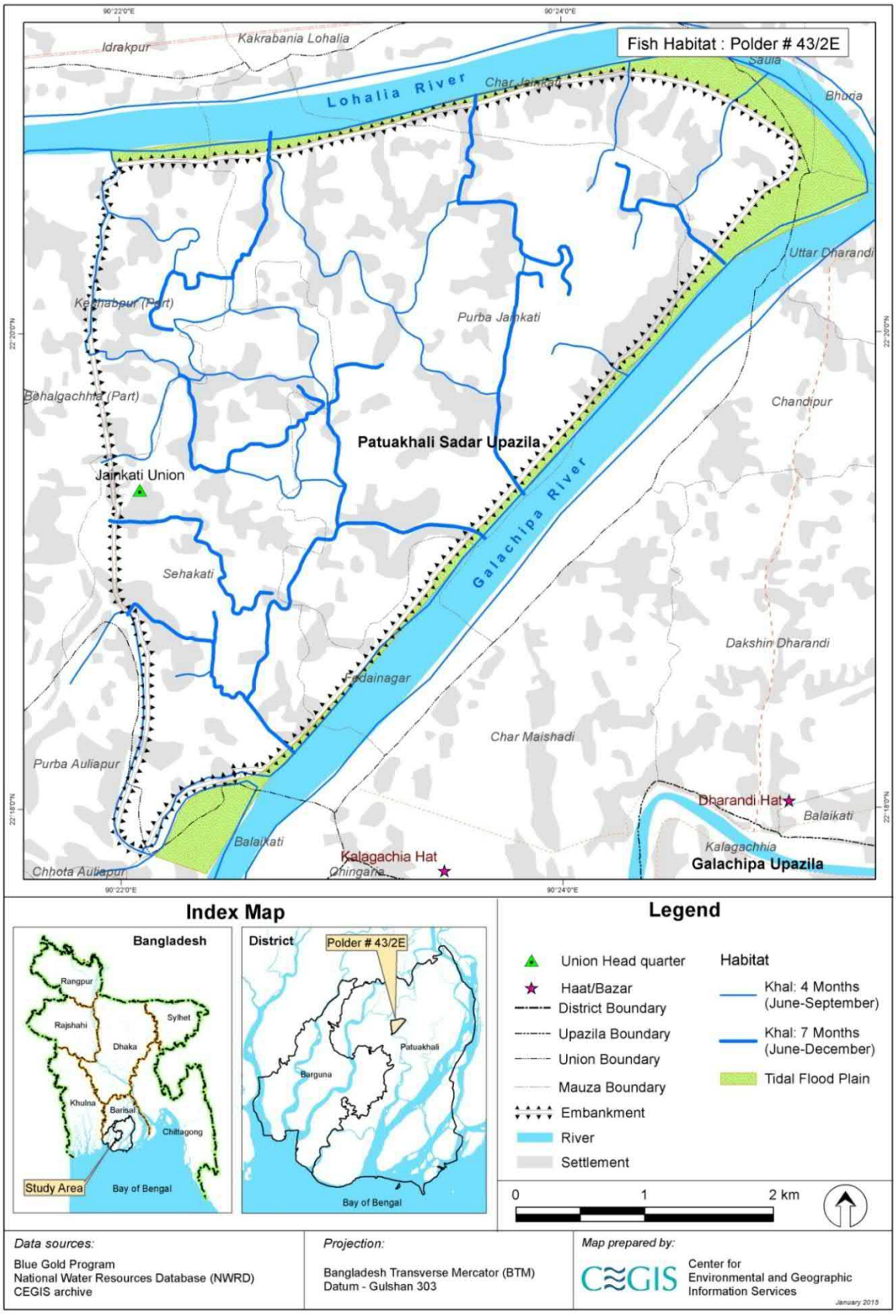
Silted up khal (Kuri kurar khal)

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

Culture Fisheries

209. Aquaculture has an increasing trend in the polder area. Estimated area under cultured pond and culturable pond is about 35 ha (**Table 5.15**). Among the culture fish habitat culturable pond is 25 ha and cultured fish pond is 10 ha. Cultured pond is perennial while culturable pond is seasonal where water retains for six to seven months. 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 a pond which is used as fresh water reservoir cum fish culture.There is no shrimp/prawn gher in the polder area. Fish pond of the polder area is shown in **photo 5.8**.

Photo5.8: Culture fish pond the polder area



Map 5.11: Fish habitat of the polder area

Loss of open water fish habitat

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

Photo 5.9: Present condition of fish habitat

211. Siltation is observed as one of the major problems of the khals to make the habitat unsuitable for fishes. This phenomenon is more pronounced at the entry of the sluice gate and impedes the fish migration. For which, this habitat cannot function as spawning ground of the resident fish species and thus capture fishery is declining with time.

Fish Habitat Quality

212. Some surface water quality parameters which are related to fish habitat suitability were measured and presented in Table 5.16**.**From the table is it found that pH values slightly high but within the limit of suitable for fisheries while water temperature is slightly low than the standard values for fish. The reported low temperature is due to variation of seasonal temperature. It is mentionable that the water quality was measured in winter season. Dissolved Oxygen (DO) values are found within the permissible limit for fish and aquatic biota habitation.Total dissolved solids (TDS) or turbidity in all water bodies is recorded and found low but within the permissible limit for fish. The salinity value of both river and khal is nil (in winter season) which is suitable for fresh and brackish water biota. However, aquatic environmental quality is satisfactory in the study area.

Table 5.16: Water quality parameters of different water bodies in the polder area

Water bodies	Parameters				
	Temp (ºC)	pH	DO (mg/l)	TDS (ppm)	Salinity (ppt)
Kukua river	24.2	7.60	5.1	164	0
Nauli river	26.2	7.72	5.6	197	0

Water bodies	Parameters				
	Temp (ºC)	pH	DO (mg/l)	TDS (ppm)	Salinity (ppt)
Khal	26.5	7.81	4.5	128	0
Standard values for fish	(28-34)**	(6.5-8.5)*	4.0-6.0*	1000*	(0-4) for prawn and (5 -35) for shrimp**

*Source - *M A. Mazid 2002 ** Jack M. et al, 2002; Water quality measured January,2015*

Aquatic vegetation

213. 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 along with other insects and crustaceans. So, low abundance of hydrophytes may harm to fish breeding and production. In 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 the ponds and khals. 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.

Fish productivity and Production

214. The fish productivity rate in the khals is 130 kg/ha which is comparatively lower than that of the national productivity. The main reason of low productivity are reduction of water depth due to siltation, fishing by sluice net, obstruction of fish hatchling movement during pre-monsoon and monsoon due to improper management of sluice gates. The productivity of culturable and cultured pond is also low. Low production of culture fish is due to lack of seed and feed, and lack of training of modern fish culture. Nevertheless, aquaculture practicing is increasing significantly in the polder area.The fish productivity of the polder area is presented in Table 5.17.

Table 5.17: Fish productivity of the Polder area

Fishery Category	Habitat Types	Productivity (kg/ha)
Capture	Khal	130
Culture	Culturable pond	1400
	Cultured pond	2200

Source: Field Survey, 2015 and Professional Judgment

215. The estimated total fish production of the polder area is about 70 tons. Culture fisheries contribute bulk portion of the fish production (about 81%) followed by capture fishery. 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. No	Fishery Category	Habitat type	Production (MT)
1	Capture	khal	13
		Sub-Total=	**13**
2	Culture	Culturable pond	35
		Cultured pond	22
		Sub-Total=	**57**
		Grand Total=	**70**

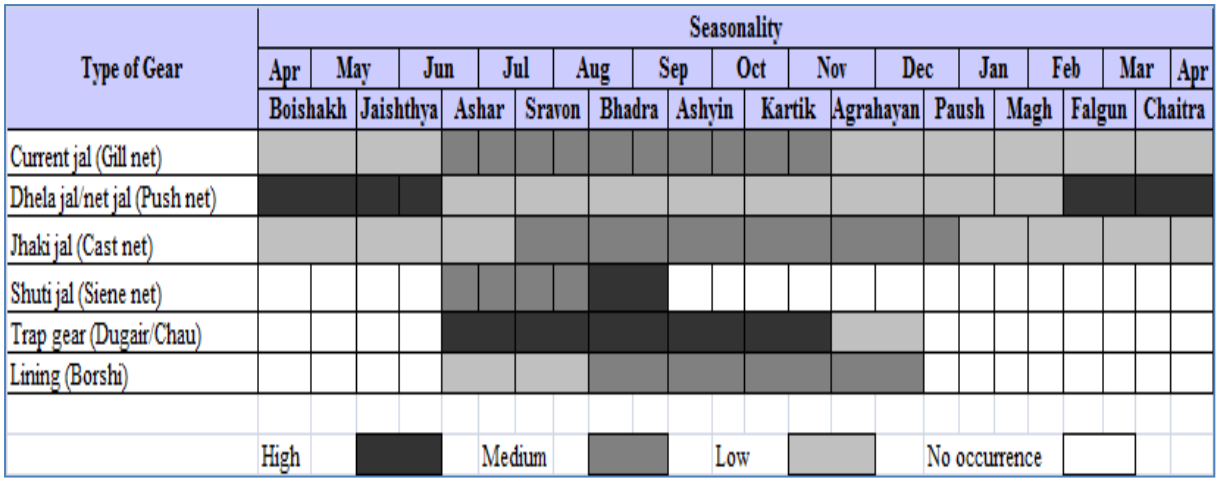
Source: CEGIS estimation based on field survey, 2015

5.2.11 Fishing Effort

Fishing Season

216. Fishing in the khals and the peripheral rivers continues throughout 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, 2015

Fishing Crafts and Location

217. The commercial fishermen of the polder area catch fish in the peripheral rivers and internal khals by using mechanized boat, Kosha and Dingi fishing boats etc. Fishing boat in the polder area is shown in **Photo 5.10.**

Photo 5.10: Fishing boat (Kusa) in polder area

Fishing Gears

218. Different types of nets/gears are used for fishing: (a) Mono filament net, locally known as Current jal is used to catch poa, chingri, tengra, gulsha, and koi fish;(b) Push net, locally known as thela jal, is used to catch puti, tengra, chingri, etc; (c) Seine net which is used to catch all types of small and big fishes; (d) Cast net, locally known as Jhaki jal is used to catch puti, bagda, golda, phasa etc. (e) Sluice/Dip net locally known Sluice jal is found at the mouth of sluice gate to catch all types of fishes. Around 15% of fishermen have fishing boats and around 80% fishermen have fishing gears/nets. Traditional fishing gears of the polder area i.e. cast net (Jhaki jal) is shown in the following photo 5.11.

Photo 5.11: Photo showing fishing and gear (Jhaki jal) in polder area

5.2.12 Fish Migration

219. Fish generally migrate from one habitat to another for breeding, feeding or sheltering purpose. Many fish species migrate horizontally to these water bodies as part of their life cycle. The internal khal acts as longitudinal fish migration route in the polder area. The present fish migration condition of the khal is not satisfactory because migration route is deteriorating due to raising of its bed by sedimentation. Fish migration of brackish water fish species like *tengra, gulsha, persa, bata, chingri, Baila* etc. in the study area usually occur during high tide. 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 improper management and mal-functioning of the water regulatory structures, fishing by net and inactive of the Water Management Organizations (WMOs).

5.2.13 Fish Biodiversity

220. The study area is moderate in fish biodiversity though the biodiversity of fishes has the declining trend over the years. Local people reported that more than 90 fish species are found in the area. The study area comprises an assemblage of both fresh and brackish water fish species (**photo 5.12**). 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.

Photo 5.12: Composition of fish catch in polder area

221. 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	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
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	*Topse*	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

Scientific Name	Local Name	Habitat type		
		Peripheral River	Khal	Pond
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	L	L
Catla catla	*Catla*	L	L	L
Oreochromis nilotica	*Telapia*	NA	L	H
Puntius sarana	*Sharputi*	NA	L	L
Pangasius suchi	*Pungus*	L	NA	H
Hypophthalmichthys molitrix	*Silver Carp*	NA	L	H
Hypophthalmichthys nobilis	*Brig head*	NA	L	H

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

222. Fresh water fish species e.g. *Rui, Catla, Ayre* are commonly found in the internal khals. Now there abundance is in the decreasing trend. Almost 80% production from species have been declined due to reduction of water depth in the khal and damaging of fishing ground due to siltation, obstruction of fish hatchling movement during pre monsoon and monsoon. Plenty of fisheries species like Golda*Chingri, Kathali Chingri, Goda Chingri* were found in the last decade in all habitats of the polder area. It is now hardly found only in the perennial khal and their abundance is negligible. This may be due to the presence of less salinity in the water bodies, obstruction of fish migration route, indiscriminate fishing by slice net, and construction of closure. The dominant cultured fish species include Tilapia, Bighead, and Silver carp in the polder area which contribute 80% of the total culture fish production. Besides, Pungus and Thai sarputi are also cultured commercially in the polder area. The culture of *Rui* and *Catla* in the fish pond is very low in the polder area.

5.2.14 Threatened fish species

223. Threatened fish species which are locally rare and unavailable for last (10-15) years as reported by the local fishermen and concerned elderly people are given in Table 5.21. The *Golda Chingri, Kathali Chingri, Goda Chingri, Bagda Chingri, KoralVetki* are presenting not available due to decreasing of salinity and surrounding water bodies of polder, obstruction of fish migration route, indiscriminate fishing by sluice net. Depth water preferable fish species like *Ayre* is in the decreasing trend due to declining of water depth and deterioration of water quality due to decomposition of duck weed, pesticides coming from *Rabi* crop (water melon) field; and obstruction of fish hatchling due to improper and irregular operation of water control structures.

Table 5.21: List of threatened fish species

Scientific Name	Local Name	Local Status	
		Rare	Unavailable
Lates calcarifer	*Koral*		√
Paradise threadfin	*Ramchos/Tapose*	√	
Aorichthyes aor	*Ayre*		√

Scientific Name	Local Name	Local Status	
		Rare	Unavailable
Peneous monodon	*Bagda*		√
Macrobrachium rosenbergii	*Golda Chingri*		√
Macrobrachium dolichodactylus	*Goda Chingri*		√

Source: Field Survey, 2015

224. To conserve the threatened fish species**,** the perennial khals like Noatana Khal, Katakhali Khal, Durlob Khal, Gagonkhati Khal, Dholkhali Khal, Suddurbaria Khal, Moubaria Khal where water retain throughout the year can conserve the fish breeding for the following year. Fish sanctuaries in the closed perennial khal can be constructed in the deep pool area. Moreover, illegal fish catch and unauthorized use of gear should be banned. Proper gate operation during fish migration period should be ensured. Integrated Pest Management (IPM) instead of using pesticides in the crop land should be introduced throughout the polder area.

5.2.15 Fisheries Management

225. 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 the World Bank. 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. The activities of fisherman association for working along with WMA/WMO of the polder are totally absent. 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 training in upazila and union level training program for the fish farmers on modern fisheries. Some NGOs Grameen Bank, ASA, BRAC etc. are working, but their activities are very much limited in micro credit rather than extension services and aquaculture training. Enforcement of fisheries regulation is weak inside the polder area.

5.2.16 Bio-ecological Zone

226. IUCN- the World Conservation Union has identified 25 bio-ecological zones (Nishat *et al*, 2002) in Bangladesh. The aspects of these zones are primarily centered on physiographic, climate, soil type, flooding depth and biodiversities. These bio-ecological zones can be classified as the major ecosystems of the country. The polder area encompasses one of these bio-ecological zones; namely the Ganges Floodplain.

Ganges Floodplain

227. The Ganges floodplain is the active meandering floodplain of the Ganges River. The floodplain mainly comprises of 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 supports a habitat of rich bio-diversity to some extent due to the presence of a number of stagnant water bodies and channels, rivers and tributaries. Beels and other water bodies support a good amount of free floating aquatic vegetation. Homestead forests are prominent with both cultivated and wild plant species. The dominant floral types of this zone 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 the Ganges floodplain and begin to grow as soon as the floodwater begins to recede. *Cyperus rotundus, C. deformis, Eleocharis sp., Hemarthria* sp. Etc .are the notable grass species.

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

5.2.17 Terrestrial Ecosystem

229. Terrestrial ecosystems of this polder can be divided into the following types:

a. Homesteads
b. Crop fields
c. Roads and embankment

230. All these types of ecosystems contain numerous floral and faunal species.

a. Terrestrial Flora

Settlement/Homestead Vegetation

231. Homestead vegetation is the major type of terrestrial flora of the polder area. Most of the homestead vegetation consists of fruit bearing plant, timber trees and medicinal plants. The homestead vegetation is also important place for wildlife. Local people reported that, most of the household are vegetated by local plant such as, Kola (*Musa sp*.), Tal (*Boassus flabellifer),* Aam (*Mangifera indica*), Narikel (*Cocos nucifera*), Suparee *(Areca catechu*), Bansh (*Bambusa*Sp*.),* Peyara *(Psitium guajava)* and the exotic plants Akashmoni *(Acacia moniliformis*), Mehagoni (*Sweitenia mahogoni*), Eucalyptus (*Eukalyptus citriodora*), etc and a small portion of the coverage is occupied by wild shrubs and herbs. According to the vegetation survey, several tree species are present in different canopy layers and their composition is similar throughout the polder area. Aam (*Mangifera indica*), Narikel (*Cocos nucifera*), Suparee (*Areca catechu*) occupied the top canopy. Other wild shrubs and herbs occupy the lower canopies. Among this type, Akand (*Calotropis procera*), Vaant/Bhat (*Clerodendron viscosum*), Hatisur (*Heliotropium indicum*), Dudhikalmi (*Ipomoea alba*) are common.The major tree species of homestead vegetation are shown in table 5.22.

Table 5.22: List of plant species found in the homestead of the polder area

Local/English Name	Scientific Name	Abundance
Chalta	*Dillenia indica*	H
Kola	*Musa sp*	H
Akasmoni	*Acacia auriculiformis*	M
Kalo Koroi	*Albizia lebbeck*	H
SadaKoroi /Sil Koroi	*Albizia procera*	H
Chambul/Raj Koroi	*Albizia richardiana*	H
Supari	*Areca catechu*	H
Kanthal	*Artocarpus heterophyllus*	L
Eucalyptus	*Eucalyptus camaldulensis*	L
Kotbel	*Limonia acidissima*	M
Sisoo	*Dalbergia sissoo*	M

Local/English Name	Scientific Name	Abundance
Aam /Mango	*Mangifera indica*	M
Khejur /Date Palm	*Phoenix sylvestris*	H
Khoiya Babla	*Pithocelobium dulci*	M
Peyara/Guava	*Psitium guajava*	M
Raintree	*Samanea saman*	H
Amra	*Spondias dulcis*	M
Mahogoni	*Swietenia macrophylla*	H
Tetul	*Tamarindus indica*	M
Kul	*Ziziphus mauritiana*	M
Jamrul	*Syzygium samarangense*	M
Kodom	*Anthocephalas chinensis*	M
Krisnachura	*Delonix regia*	L
Bamboo/Bash	*Bamboosa spp.*	M
Tal	*Boassus flabellifer*	H
Shimul	*Bombax ceiba*	M
Jambura	*Ciitrus grandis*	L
Narikel/Coconut	*Cocos nucifera*	H

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

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

Photo 5.13: Homestead vegetation in polder 43/2E

Crop field vegetation

233. Verities of crops and cropping patterns have been discussed in the agricultural section of this report. A part of crop fields being seasonal (March-June) fallow for 3 to 4 months of a year. During this time the land covers with grassy vegetation and other wild herbs. Durba (*Cynodon* sp.*)* is prevalent with *Echinocola, Brachiara, Digiteria, Hemarthrira, cyperus and Paspalum* spp. among the grass species. *Croton, Xanthium, Amaranthus* are also grown sporadically along with grasses. The seasonal fallow lands have important roles in ecosystem functioning as grazing ground for cattle, feeding and breeding habitats of many arthropods, reptiles and avifauna.

Photo 5.14: View of fallow land vegetation in polder 43/2E

Embankment /Village Road and Bank side vegetation

234. Major species in village roads found are: Tal (Boassus flabelifer), Narikel (*Coccos nucifera*), Suparee (*Areca catechu*), Khejur (*Phoenix sylvestris*) etc. Akand (*Calotropis procera*), Vaant (*Clerodendron viscossum*) and Hatisur (*Heliotropium indicum*) are common wild shrubs and herbs sighted along most of the roadsides.

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

236. There is another type of vegetation found along the riverand khals bank side of the polder area. Different types of marginal herbs like Narikel (*Coccos nucifera*), Dholkolmi (*Ipomoea aquatic*), Bishkatali (*Polygonum sp*.), Mutha gash (*Cyperus sp*), Kasorti (*Eclipta sp*) etc. are dominant in the river and khal banks. A list of plant species found in the embankment/roadside of the polder area is shown in table 5.23 below.

Table 5.23: List of plant species found in the embankment/roadside of the polder area

Local/English Name	Scientific Name	Abundance
Akasmoni	*Acacia auriculiformis*	M
Babla	*Acacia nilotica*	H
Kala Koroi	*Albizia lebbeck*	H
SadaKoroi /Sil Koroi	*Albizia procera*	H
Chambul/Rajkoroi	*Albizia richardiana*	H
Tal	*Boassus flabellifer*	H
Narikel/Coconut	*Cocos nucifera*	H
Sisoo	*Dalbergia sissoo*	M
Jiga	*Lennea coromandelica*	M
Ghora Neem	*Melia azedarach*	M
Khejur /Date Palm	*Phoenix sylvestris*	M
Khoiya Babla	*Pithocelobium dulci*	M
Raintree	*Samanea saman*	H
Mahogoni	*Swietenia macrophylla*	M
Pitali	*Trewia nudiflora*	L
Kola	*Musa sp*	H
Bash	*Bamboosa spp*	M

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

Photo 5.15: View of village road side vegetation

Photo 5.16: View of embankment side vegetation

b. Terrestrial Fauna

237. Local people reported that, many diversified terrestrial fauna are found in the polder area. The major terrestrial fauna are different types of mammals, birds, reptiles and amphibians. The major fauna of different species with their habitat is shown in the following Table 5.24.

Table 5.24: List of terrestrial fauna of the polder area

Types of Species	Name (*generic name*)	Habitat
Mammals	Indian Jackal *(Canis aureus),* Mole Rat *(Bandicota bengalensis)*, Common House Rat *(Rattus rattus),* Short-nosed Bat *(Cynopterus sphinx),* Flying fox *(Pteropus giganteus),* Common mongoose *(Herpestes edwardsi)*, Large Indian Civet *(Viverra zibetha) and* Jangle Cat *(Felis chaus)*	Mostly in bamboo thickets, cropped fields or broken, bushy areas.
Birds	Sparrow *(Passer domesticus)*, Common myna *(Acridotheres tristis)*, Asian pied Starling *(Sturnus contra),* House Crow *(Corvus splendens),* Spotted Dove *(Streptopelia chinensis),* Black Drungo *(Dicrurus macrocercus),* Fulvous Breasted Woodpecker *(Dendrocopos macei),* Spotted Owlet (Athene brama) Little Egret(Egretta garzetta)	All types of vegetation
Reptiles	Common Vine Snake *(Athaetulla nosuta),* Common Wolf snake *(Lycodon aulicus),* Common Grass Skink *(Mabuya carinata),* Stripped Keelback *(Amphiastma stolatum),* Kal Keotey/ Common Krait*(Bungarus caeruleus),* Gui Sap/Bengal Monitor(*Varanus bengalensis*),Spotted Pond Turtle (*Geoclamys hamiltonii),* Garden Lizard *(Calotes versicolor)*,and House Lizard *(Hemidactylus brooki).*	Both wet land and dry areas
Amphibians	Common toad *(Bufo melanostictus),* Cricket Frog *(Fejervarya limnocharis),* Jerdon's Bull Frog *(Hoplobactruchus crassus)*	Wetland areas and the dried areas

Source: CEGIS field survey, 2015

5.2.18 Aquatic Ecosystem

238. The wetland is an important aquatic ecosystem (123 ha) of this area. It contains rich varieties of flora and fauna and mostly provides food and habitat to the aquatic fauna. Aquatic ecosystem of the polder area includes rivers, homestead ponds and khals. Most of the wetlands, especially khals were found risky due to siltation. For this reason, these types of wetlands having no water in dry season but totally changes the scenario is changed in wet season, when water flows on khals, creates drainage congestion. The wetlands are divided into two major categories; seasonal and perennial wetlands.

239. Seasonal wetland holds water for 3 to 4 months and is usually flooded during rainy season. Seasonal wetland mainly creates floodplains and important grazing ground for the fishes.

240. Perennial wetland contains water throughout the year. Perennial wetlands are good shelters for most of the aquatic flora and fauna. Homestead ponds and khals are the perennial wet lands of the polder area.

a. Aquatic flora

241. Within the polder area ponds and khals contain different types of aquatic floras such as free floating, rooted floating, submerged and amphibian vegetations like sedges and meadows. A list of plant species found in wetland of the polder area is shown in following Table 5.25.

Table 5.25: List of plant species found in the wetlands of the polder area

Local/English Name	Scientific Name	Abundance
Ghechu	*Aponogeton natans*	M
Kutipana	*Azolla pinnata*	H
Kakra	*Bruguiera gymnorrhiza*	L
Kochu	*Colocasia esculenta*	L
Kochuripana	*Eichhornia crassipes*	H
Helencha	*Enhyra flactuans*	L
Chaila gash	*Hemarthria protensa*	M
Jhangi	*Hydrilla verticillata*	M
Nil Kolmi	*Ipomoea aquatica*	M
Khudipana	*Lemna perpusilla*	H
Fern	*Lindsaea ensifolia*	M
Bishkatali	*Polygonum barbatum*	H
Shapla/Poddo	*Nymphaea nouchali* *Nymphaea stellata*	M
Chandmala	*Nymphoides sp.*	M
Golpata	*Nypa fruticans*	M
Topapana	*Pistia stratiotes*	H
Karanja/Chimti	*Pongamia pinnata*	M
Kuripana	*Salvina cucullata*	H
Bakful	*Sesbania grandiflora*	L
Choila/Ora	*Sonneratia caseolaris*	H
Hogla	*Typha elephantalis*	M
Bicha	*Vallisneria spiralis*	L

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

Photo 5.17: Internal Khal silted up by Kutipana

b. Aquatic fauna

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 shelters to the aquatic fauna. A brief description of aquatic fauna is presented below:

Table 5.26: List of terrestrial fauna of the polder area

Types of Species	Name (*generic name*)	Habitat
Avifauna	Little Egret *(Egretta garzetta),* Great Egret *(Casmerodious albus),* Common Kingfisher *(Alcedo atthis),* Little Cormorant *(Phalacrocorax niger*), Grey Heron *(Ardea cinerea),* Indian pond heron *(Ardeola grayii*)	Along mudflats, canal systems and seasonal wetlands
Reptiles	Common aquatic snakes include the checkered keelback *(Xenocrophis piscator),* smooth water snake *(Enhydris enhydris),* Rat snake *(Ptyas mucosus),* and Common wolf snake *(Lycodon aulicus)*	Both wet land and dry areas
Amphibians	Jerdon's Bull Frog *(Hoplobactruchus crassus),* skipper frog *(Euphlyctis cyanophlyctis)*	Wetland areas and the dried areas
During winter, moderate numbers of migratory birds roam along the riverside of the polder. Fresh water Snail and Oyster are also commonly found in all floodplains and even in perennial water bodies.		

Source: CEGIS field survey, 2015

5.2.19 Ecosystem Services

242. UNEP defines that an ecosystem is a dynamic complex of plant, animal, and microorganism communities and the nonliving environment, interacting as a functional unit. Humans are integral part of ecosystems. Ecosystem services are the tangible and intangible benefits which people obtain. 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.

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

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

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

Table 5.27: Tangible ecosystem goods from different common plants of the polder area

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

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

5.2.20 Present threats on ecosystem

Terrestrial flora

246. Local people reported that lack of advance knowledge about homestead plant biodiversity, improper maintenance of embankment and sluice gates and internal canal bed siltation are the main problem in the polder area. Pests and diseases attack, improper homestead space planning, utilization and natural disaster are the other problems.

Terrestrial fauna

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

248. Several species are listed in the IUCN *Red Data Book* of which the species of the polder area are given is the Table below.

Table 5.28: List of several species in the IUCN *Red Data Book* occurs within the polder area

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

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

Aquatic fauna

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

250. On the other hand, various types of snail and oyster can also be found in fresh water of khal and river. A fresh water snail is one kind of fresh water mollusk, the other types being fresh water clams and mussels. Specifically fresh water is a gastropod that lives in a watery non marine (fresh water) habitat.

5.2.21 Livestock and Poultry Resources

Status of livestock and poultry

251. Livestock provide significant draft power for crop cultivation and poultry being essential elements of integrated farming system play an important role in the economy of the 43/2E polder area. A large number of populations of the polder area earn their livelihood through work associated with raising livestock / poultry (Cow/Bullock, Buffalo, Goat and Sheep and poultry Duck and Chicken). Livestock resources data were collected from secondary sources from Upazila Livestock Office and from local people through informal discussions with stakeholders and RRA. Detailed status of livestock and poultry are presented in Table 5.29.

Table 5.29: Status of Livestock/Poultry in the polder area

Live stock/Poultry	% of household	Number of Livestock/Poultry in the polder area
Cattle/cow/bullock	55	2222
Goat	2	202
Buffalo	10	404
Chicken	70	7070
Duck	25	2020

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

Photo 5.18: View of rice straw for cattle feed in the polder area

Photo 5.19 : View of poultry in the polder area

Feed and Fodder

252. The owners of the livestock population are facing problems in respect of availability of fodder and feeds during the monsoon season due to unavailability of grazing land. Aman crops remain in the field during this reason, 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 dry season especially from late December to late April although there is grazing land but exist shortage of grass due to presence of aus crops 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.

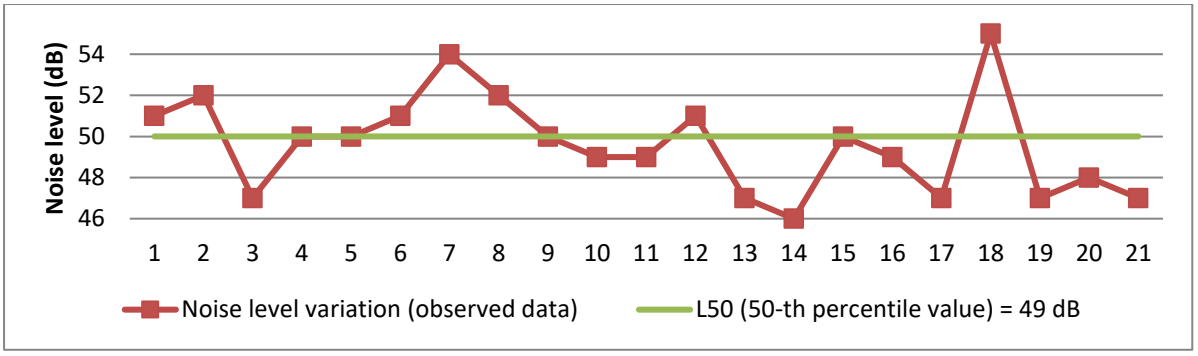
Livestock and poultry diseases

253. Production 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 the 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

5.3.1 Sound Quality

254. During field inspection, sound levels were measured at Kamalar bazaar with 10 minute sampling periods. L_{50} (50-th percentile value) value was computed with the observed sound levels. For a normal time series distribution of sound levels, L_{50} is assumed to be equal to Leq, which is the Equivalent Noise Level. In the study area, the L_{50} value was found as 49 dB, which is lower than the standard Leq value for residential zone, set by ECR 1997 (50 dB). As the project implementation works are to be carried out manually i.e. without use of any typical heavy loading vehicle, it can be assumed that the sound levels generated from the construction sites for the project implementation works would have very minor contributions in the equivalent noise levels of the polder.



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

Figure 5.11: Variation of sound levels for 10 minute sampling period at Kamalar bazaar (22º19'06.3''N and 90º22'38.7''E)

5.3.2 Water Quality

255. Five major water quality parameters (pH, TDS, Temp., DO and Salinity) were measured on-site from four different sampling locations of the polder in January 2015. The samples were collected from different surface water sources (three from outside and one from inside of the polder). The results of the in-situ water quality measurements are shown in Table 5.30.

Photo 5.20: In-situ water quality measurement in Polder 43/2E

Table 5.30: Salinity levels in different locations

Location	Sampling Water Source	GPS readings	pH	TDS (ppm)	Temp. (ºC)	DO (mg/l)	Salinity (ppt)
Noatana sluice	Galachipa River, outside the polder	22°20'47.1"N 90°22'31.6"E	7.68	184	25.1	5.6	0
Proposed outlet at Durlab Khal	Durlab Khal, inside the polder	22°21'8.0"N 90°24'8.4"E	7.59	134	26.4	4.8	0

Location	Sampling Water Source	GPS readings	pH	TDS (ppm)	Temp. (ºC)	DO (mg/l)	Salinity (ppt)
Dolkhali Sluice	Galachipa River, outside the polder	22°19'25.1"N 90°23'37.2"E	7.65	172	24.3	5.4	0
Moubaria Khal	Galachipa River, outside the polder	22°19'14.7"N 90°21'8.5"E	7.79	168	25.4	5.8	0

Source: CEGIS field survey, January 2015

256. The pH values were higher than the neutral value (pH=7) which means that the water in these locations are alkaline in nature during January. The polder is situated beside Galachipa River, which is directly connected with the Bay of Bengal. However, the polder is not directly connected with the river. This eventually results in reduced sediment transportation near the polder, for which the values of TDS were found very low. The Values of DO were mostly found close to the standard values set by the DoE for both irrigation (5 to 6 mg/l) and fishing (5 mg/l). Temperature values varied within a typical range for different locations as samplings were made in different time of the day. Furthermore, all samples were found with zero salinity. The local people claimed that no surface water salinity exist in the area in the dry season (December to February). March and April are the only two months where the surface water system outside the polder becomes slightly saline. It can be inferred that due to the increased amount of freshwater discharge from the upstream; Meghna River system towards the rivers of the South Central hydrological region, surface water salinity is very low compared to those of other coastal areas of the country, and for the local people it is not a major concern.

5.4 Climate Change

5.4.1 Climatic Trends

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

Temperature

258. Figure 5.12 below shows *the* changing trend of average temperature in the existing hydrological regions of Bangladesh. In contrast to the other hydrological regions of the country, the temperature of the south central region (the region where Polder 43/2E is located) shows a decrease of 0.73°C in every 100 years.

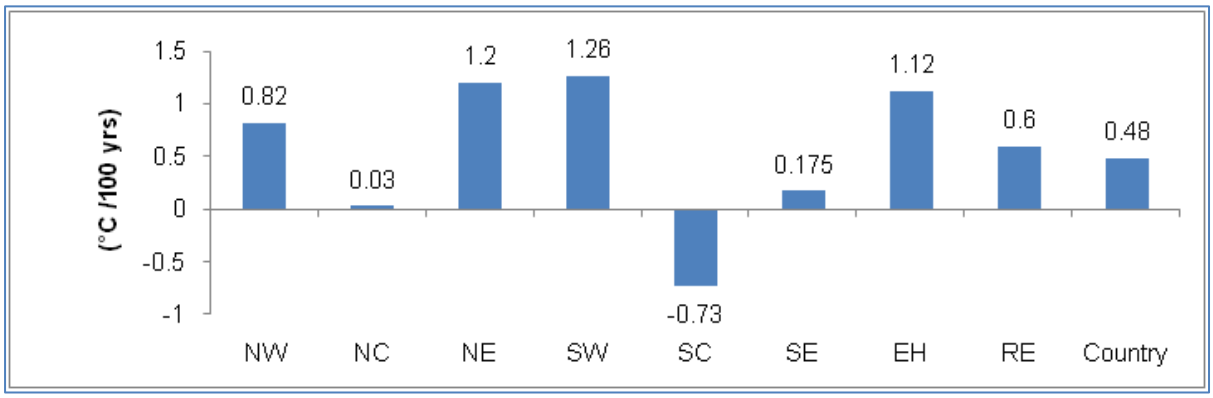


Figure 5.12: Change in average temperature in different regions (CEGIS, 2014)

259. Table 5.31 represents a comparison of temperature variation for each BMD station located within the south central hydrological region. The Table shows that average temperature has decreased by 0.9^{0}C in hundred years in Patuakhali, whereas the country as a whole observed average values of decrease 0.48 ^{0}C in hundred years.

Table 5.31: Trend analysis for temperature of the South Central Region (CEGIS, 2014)

Hydrological Region	Station	Temperature Change, °C per 100 years				
		Max	Avg. Max	Min	Avg. Min	Avg.
South Central	Faridpur	4.4	2.59	1.7	2.45	0.4
	Madaripur	-0.8	0.43	1.4	4.53	-3
	Barisal	0.7	2.89	-3.8	2.25	-0.5
	Bhola	-0.2	0.8	-0.4	0.9	1.1
	Patuakhali	2.8	4.74	-3.3	-0.96	**-0.9**
	Khepupara	1.7	3.0	-5.2	0.8	-1.5
Country Average =		*-0.32*	*2.63*	*-0.47*	*1.38*	***0.48***

Rainfall

260. The variation of rainfall in pre monsoon, monsoon and post monsoon seasons of different representative districts (from different hydrological regions) are shown in Figure 5.13 below. The pre-monsoon and post-monsoon rainfall patterns show increasing trends for all the selected stations. Barishal, one of the representative locations of the south central region, however has very negligible change. It can therefore be concluded that the long term seasonal variations of rainfall in Patuakhali will also be very negligible.

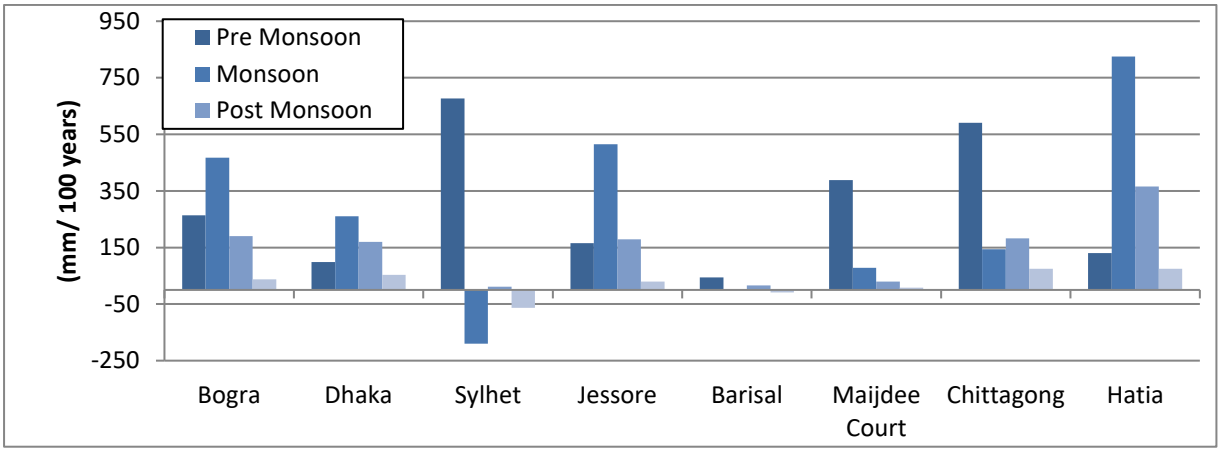


Figure 5.13: Long term seasonal variation of rainfall for selected stations (CEGIS, 2014)

Climate Change Projection

261. Two greenhouse gas emission scenarios, A1B and A2 were used from the Special Report on Emissions Scenarios by Intergovernmental Panel on Climate Change (IPCC) for investigating climate change projection. A2 is the business-as-usual scenario, which is a very heterogeneous, market-led world, with high population growth, slow economic development, and slow technological change. A1B on the other hand, is the scenario which has been developed putting balanced emphasis on all potential energy sources (here balanced is defined as not relying too much on one particular energy source, on the assumption that similar improvement rates apply to all energy supply and end-use technologies) (Table 5.32).

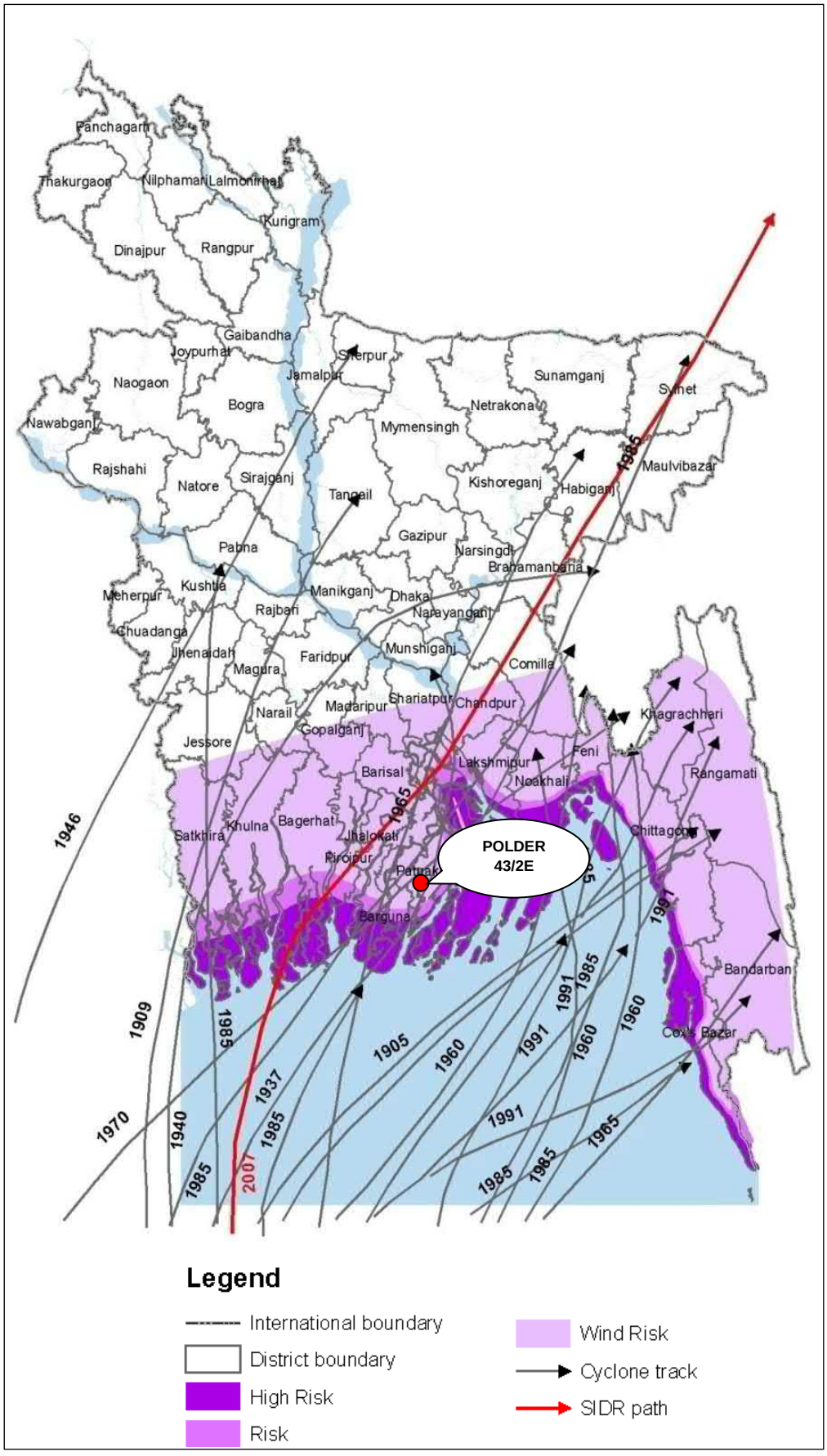
Table 5.32: Summary of climate projections for 2050 in Patuakhali (CEGIS, 2014)

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

5.4.2 Cyclones and Storm Surges in Polder 43/2E

262. Tropical cyclones from the Bay of Bengal accompanied by storm surges are one of the major disasters in the coastal region 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 country's southward portion has been classified into three risk zones namely high risk zone, risk zone, and wind risk zone (Map 5.12). Polder 43/2E falls in the wind risk zone which has some vulnerability due to strong winds and surge heights associated with cyclones.

263. During field level consultation with local people, it was learnt that no major damage had been occurred in the area during recent cyclones and storm surge events. The peripheral embankments were not very much affected during the disasters. Two sluice gates along the Lohalia River namely, the Dolkhali sluice and the Suddurbaria sluice were partially damaged during SIDR, but the other water related infrastructures remained mostly unharmed.



Map 5.12: Cyclone tracks in Bangladesh and risk areas

6. Socio-economic Condition

264. The socio-economic condition of the people living in 'Polder 43/2E EIA' (i.e. the study area) is captured in this chapter. In doing so, primary data were collected using a range of RRA techniques including Key Informant Interview (KII), Informal discussions with stakeholders, observation and public consultation. Moreover, relevant secondary information were compiled from the community series of the Population Census 2011 published by Bangladesh Bureau of Statistics (BBS).

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

6.1 The People

6.1.1 Demography

266. The entire study area consists of a part of Jainkati union under Patuakhali district. The total settlement area of the polder is 669 ha where settlement area within the polder is 457 ha. For the setting of socio-economic baseline in the context of this EIA study, data collection mainly concentrated in settlement covered area (**Table 6.1**).

Table 6.1: Name of unions and upazilas under each district

District	Upazila	Union	Union Settlement	Polder Settlement	%
Patuakhali	Patuakhali Sadar	Jainkati	669	457	68.31
		Gross Area =	**669**	**457**	

Source: CEGIS database estimation, 2015

267. The 2,585 households living in the polder area have a total population of 11,965, of which 5,877 are male and 6,088 are female. The female population is higher than the male population. The average male-female sex ratio is 96 of which there are 96 males per 100 females which is lower than the national figure of 100.3 (BBS 2011). The average density of population is 692 persons per sq. km which is nearly half of the national density of 1,015 persons per sq. km. The inhabitants of this Polder belong to three religious group; i.e., the Islam, Hinduism and Buddhism. About 96% of total populations are Muslim and the rests are Hindus and Christians. The demographic data of this Polder is presented in **Table 6.2**.

Table 6.2: Distribution of population and household of polder

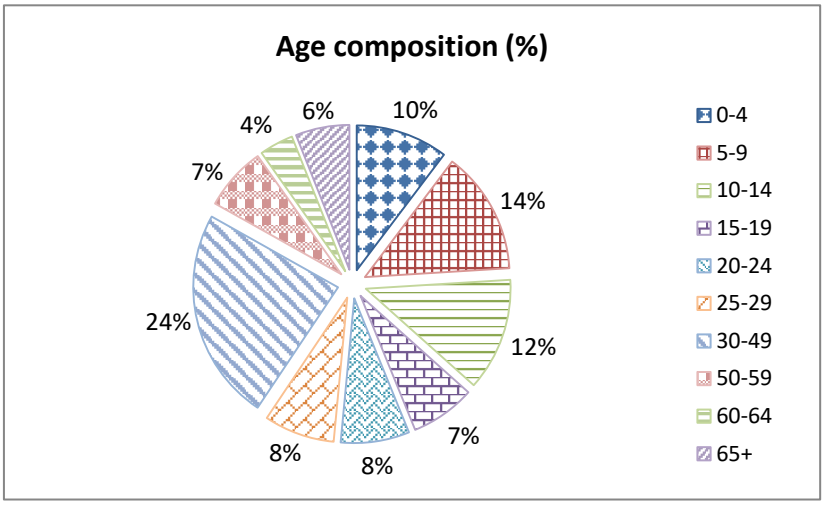
District	Upazila	Union	Total HHs	Population			Sex Ratio	Population density [sq. km]
				Both	Male	Female		
Patuakhali	Patuakhali Sadar	Jainkati	2585	11965	5877	6088	96	692

Source: Population Census 2011, BBS

6.1.2 Age Structure

About 37% of the population is young and are less than 14 years old. 54% belongs to age bracket of 15 to 59 years of age, and 9% are over 60 years of age. However, a disaggregated analysis of population data as per various age groups shows that 25% of total population falls between 30-49 years age category. On the other hand, the data shows that around 46 percent of the population depends on the 54 percent of the earning member's of

their households. Hence the dependency ratio1 in 85 which are higher than the national rate is 56. Details of the age structure are shown in the figure (Figure 6.1).

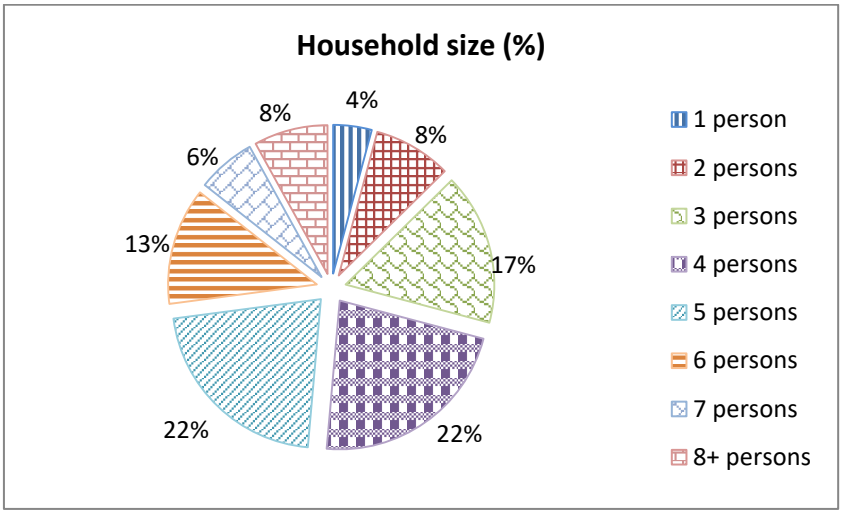


Source: Population Census 2011, BBS

Figure6.1: Age distribution at polder 43/2E

6.1.3 Household size

268. The following figure (**Figure6.2**) shows the proportionate distribution of households in terms of persons who are the members of respective households. It is found that the highest percentage of households (22%) comprise 5 persons in each, whereas the lowest 4% comprises single person in each. The average size[2] of household in the study area is 4.6 i.e. there are more than 4 members in each household which is slightly higher than that of the national average (4.5).



Source: Population Census 2011, BBS

Figure6.2: Distribution of household members at polder area

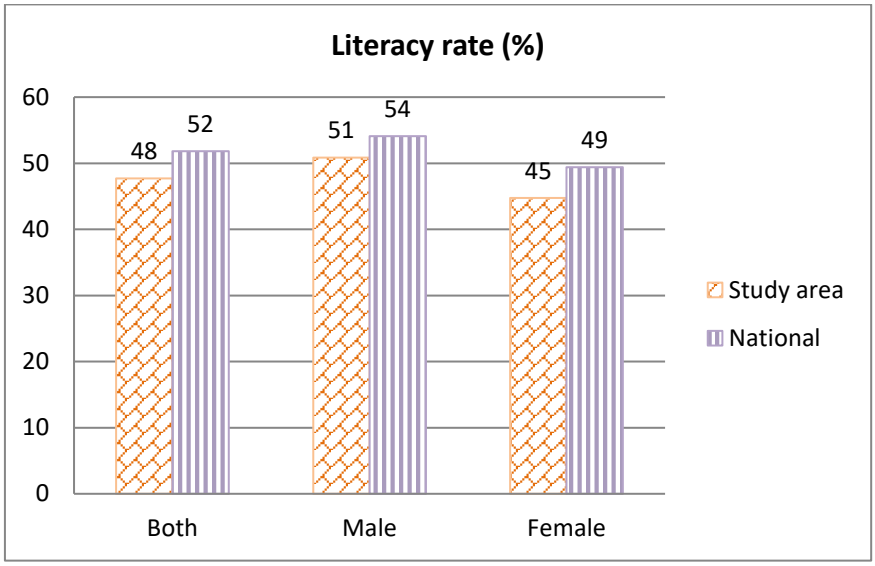
[1]Dependency ratio refers to ratio of dependent population (population aged up to 14 years and above 59 years) to the working age population (population aged between 15 to 59 years).

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

6.2 Education

6.2.1 Literacy rate

269. The average literacy rate in the study area is 48% which is slightly lower than the national level (52%) (**Table 6.3**). Data confirms that like the national picture of Bangladesh (Male 54.1% and Female 49.4%), the male populations are more educated than the female counterpart in the study area, the rate being 51% for male with 45% for female. Local people opined that, unemployment and lack of facilities are the main reason behind such low female education rate. But now they perceived that they have to find out the way to overcome the present situation and education can only lead them towards benchmark.



Source: Population Census 2011, BBS

Figure 6.3: Literacy rate at polder 43/ 2E area

270. According to field findings there are 07 primary schools, 05 high schools and 5 Ebtedaye/ Dakhil Madrashas in the polder area (**Figure 6.3 & Photo 6.1**). There is no college in the polder area. As this polder is near the Patuakhali Paurashava, people frequently move to sadar for education purpose *(Source: CEGIS field work, 2015).*

Photo 6.1: Local educational institution at polder area

6.3 Health

6.3.1 Access to health service

271. There is a union health complex and three community clinics. These health centers are not adequately functioning. As a result, for health services, local people visit the hospitals in Patukhali. However, it is observed that communication within the polder areas as well as with the Upazila headquarters is not good and some parts of the existing road network are earthen. Nevertheless, the people always have the tendency to go upazila or district hospitals for better treatment. Local people emphasized the need and urgency of constructing paved roads networks as early as possible.

272. Field survey also confirmed that nearly 45 percent people receive health services from *quack* doctors, 30 percent from paramedic/ diploma physicians and only 10 percent from trained doctor**.** It is noteworthy that about 5 percent do not receive any treatment facility due to their impoverishment. People reported that the earlier tendency of going to the local healer for treatment has been replaced by registered/trained physicians. It is assumed that economic wellbeing may drive them toward receiving treatment facilities from trained physicians whether it is expensive or cost effective (*CEIGS fieldwork, 2015*).

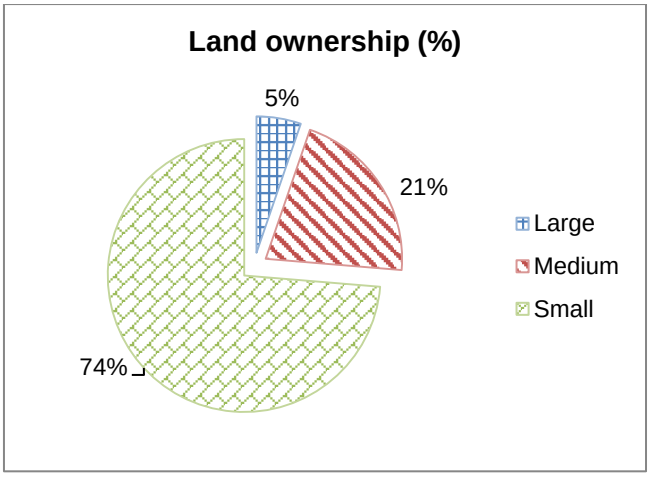
6.3.2 Prevalence of diseases

273. The Population Census, 2011 identified almost six types of disabilities and their proportionate distribution in the polder area. It is found that the study area comprises 1.4% of all types of disabilities and 0.5% people reported that they are physically challenged. 0.3% mentioned speech and mental disorder. Local people opined that the incidence of Influenza/Common fever is the most prevalent ailment for dry season whereas cough/cold, skin diseases are common for winter season in the Polder area.

6.4 Ownership and utilization of land

274. Land ownership pattern[3] can be an indicator to understand the poverty incidence in a given area. Statistics shows that there are 74% smallholders, 21% medium and only 5% large land holders. In the study area, arable land is mainly used for crop production. Generally small and medium holders cultivate variety of crops in these lands. They however, cannot harvest the full potential from their land due to drainage congestion and siltation of water bodies. (**Figure 6.4**).

[3] Agricultural Census by BBS (2008) defined farm holding into three broad categories such as- a) small: having minimum cultivable land 0.05 acre but operate land more than this minimum but upto 2.49 acres; b) medium: having operated land in between 2.50 to 7.49 acres; and c) large: having operated land 7.50 acres and above.



Source: BBS, Agriculture Census, 2008

Figure6.4: Landownership pattern in polder

275. Land price in the study area is increasing with time like other parts of Bangladesh. According to the local people, agricultural land prices are relatively lower. The land price of commercial land is highest in comparison to other homestead or agricultural land. The details lands prices are shown in the **Table 6.3**.

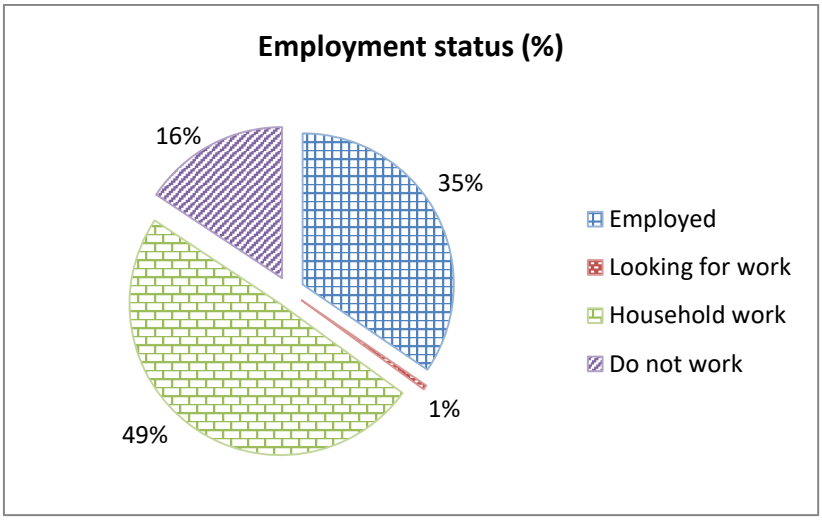
Table 6.3: Sell value of land at polder 43/2E

Land type	Sale value	Year
Homesteads land	Taka 5-6 lacs per decimal (depends on location)	2015
Agricultural land	Taka 2-3 Tk. per decimal	2015
Commercial land	Taka 4-4.5 lacs per decimal (depends on location)	2015

Source: CEGIS fieldwork, 2015

6.5 Occupations and livelihoods

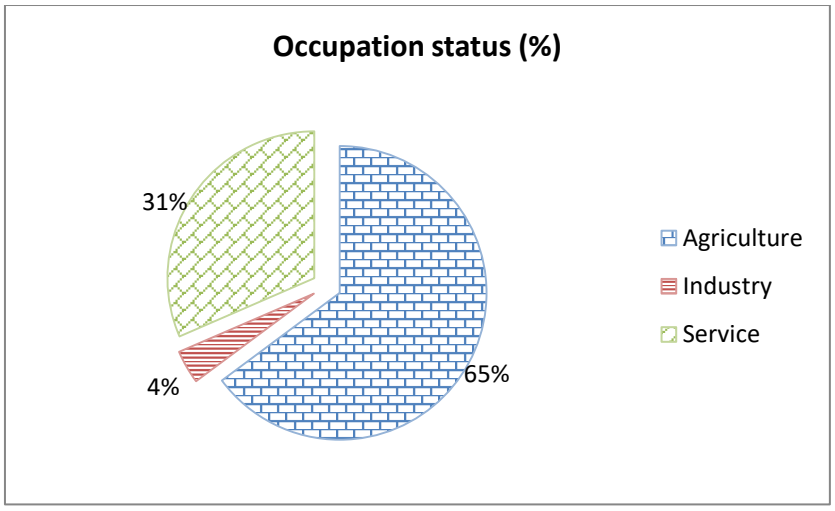
276. Employment status in the polder area is about 35% of total population is employed, 49% is engaged in household work, only one percent is looking for work and about 16% of total population is not working. **Figure 6.5** shows the employment status of the people in the Polder area.



Source: Population Census 2011, BBS

Figure 6.5: Distribution of employment status by polder area

277. The employed population of the polder area is engaged in different occupations. According to BBS 2011, most of the population is engaged in agriculture sector (65%). Here agricultural sector includes farmers, agricultural labors, fishers, day labors etc. About 31% population is engaged in salaried service sector. It includes population who are employed in government, private and self-employment for harnessing their livelihood. Lastly, industrial sector comprises only 4% population implying that y the study area administrativel is under the coastal region of Bangladesh as a result industrialization is still underdeveloped. (**Figure 6.6**)



Source: Population Census 2011, BBS

Figure 6.6: Distribution of population by Occupational group

Photo 6.2 : Different modes livelihood activites at polder 43/2E

6.6 Labour market

6.6.1 Wage level and labour condition

278. Field findings show that people tends to cultivate their own land rather than depending on sharecropping system. About 10-12% of total households hire labor for agricultural production. The wage rate varies between Taka 400 to Taka 450/day for male whereas for women it varies in the range of Taka 200 to Taka 250/day.

6.6.2 Labor Migration

279. It is evident that out migration of labourers is slightly found (2%) in the study area whereas in-migration is almost absent. These out-migrants are mainly agricultural labourer usually go to neighboring upazilas (Patuakhali, Barishal, Khulna, and Dhaka) during May to September for plantation and harvesting crops. Additionally, there is trivial international out migrants (1%) who tend to go to Middle East for searching better livelihood options.

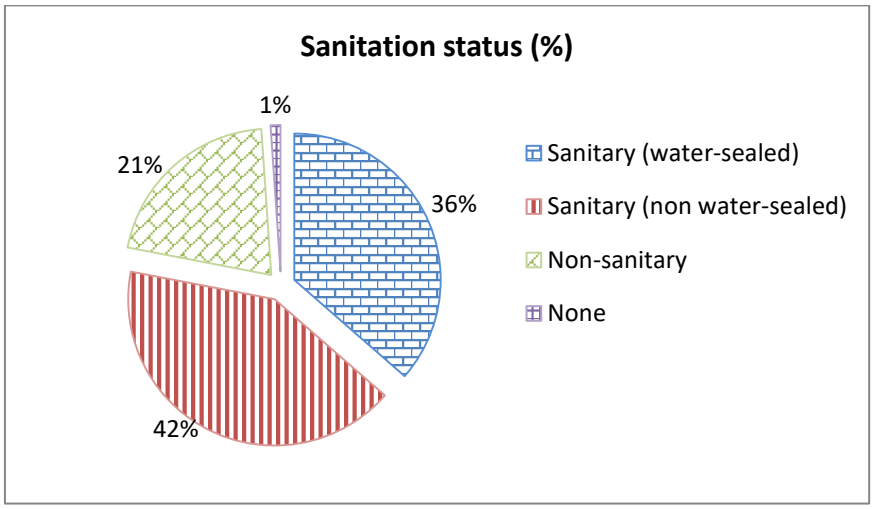
6.7 Standard of living

6.7.1 Access to electricity

280. Electrification as reported in the Population Census, 2011 is not satisfactory in the polder area. On an average, only 35% households are under grid electricity coverage. Besides, some of the households are now using solar electricity through borrowing money from NGOs and personal level solar electrification are also observed in the study area. In this regard, Infrastructure Development Company Limited (IDCOL) has already been installed under the solar electrification program in the rural area of the polder and at present 2% of households is benefited under this program in the whole polder (*CEGIS field work, 2015*).

6.7.2 Sanitation

281. The sanitation facilities[4] adopted by households of the polder area are presented in **Figure6.7.** It shows that about 36% households have access to hygienic sanitation facility (water-sealed), 42 % to non water-sealed sanitation facility, 21% uses non-sanitary facilities and 1% has access to no sanitation facility at all. Statistics shows that the polder situated near sadar area and that's why sanitation facility is better in comparison to other polder of Patuakhali district.



Source: Population Census 2011, BBS

Figure6.7: Sanitation facilities by union at polder 43/2E

[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 6.3: Sanitation facility in the polder area.

6.7.3 Drinking water

282. Overall status pertaining to sources of drinking water in the area is satisfactory. On an average, 99% people can collect drinking water from tube well while only 1% collects drinking water from other sources such as ponds, Pond sand filter (PSF); rain water etc. There is no coverage tap water within the study area (*Source: Population Census 2011, BBS*).

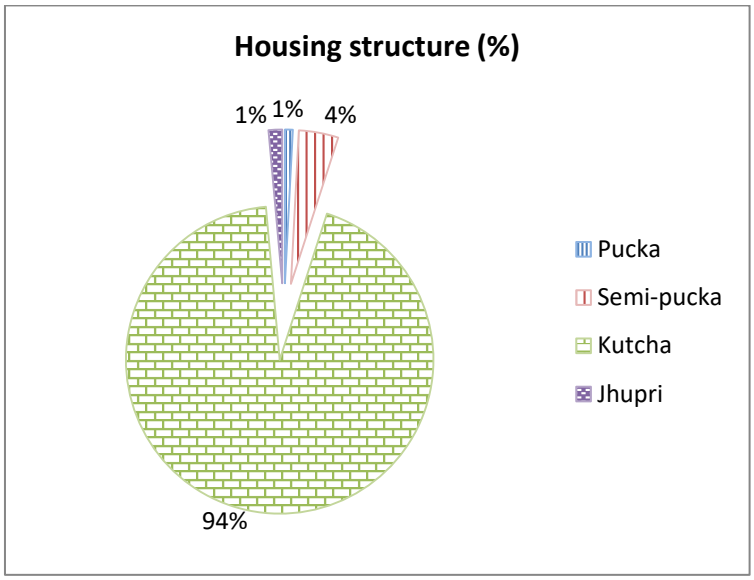

Photo 6.4: Domestic level tube well

6.7.4 Floor of the house

283. The overall housing condition[5] is not satisfactory. Only 1% of houses are Pucka, 4% houses are semi-pucka and 1% houses are Jhupri whereas 94% percent are kutcha. On the other hand, in 2011 at national level, 25.12% of the households reported to have used brick/cement in the walls of the main dwelling structure. With reference to national statistics it

[5]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.

can safely be argued that the large percentage of the households of the study area belong to poor category in term of housing type.**Figure6.8** and **photo 6.5**showsrepresent housing types of the polder.



Source: Population Census 2011, BBS

Figure6.8: Types of housing structure by union at polder 43/2E

Photo 6.5: Housing structure at polder area

6.7.5 Cooking fuel

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

6.8 Poverty

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

- Poor health;
- Lack of education ;

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

285. A Multidimensional measure can incorporate a range of indicators to capture the complexity of poverty and better inform policies to relieve it. MPI has been assessed for the above category of the people. The detail process and methods of the MPI are given in the **appendix -3.** The analysis and results are given below.

6.8.1 Analysis of MPI Poor and result

286. Polder 43/2E with the features is given below:

- Polder Area (Gross) 1720 ha (17.20 km^2);
- Net area 1160 ha (11.60 km^2);
- Population per km^2 of the project is about 692 people and
- Headcount ratio for the Division is 27.3 (village), which indicates % of people who are income poor ($1.25/day).

287. The MPI poor analysis of the polder is given below:

Table 6.4: Weighted score and status of MPI poor of Polder 43/2E

Poor Category of People	Landless persons work in share cropping and agricultural labour (L)	Day labourers work in Brick Field (DL)	Marginal Grosser sell things in the rural bazar (MG)
Weighted Score (deprivation score)	27.78%	38.89%	22.22%
Status: MPI poor (33.33%)	Less than MPI poor	Equal to MPI poor	Less than MPI poor

288. It is seen in polder 43/2E that about 22% of L and MG category hhs are seen non poor. The DL category of people is seen poor.

Table 6.5: Results of MPI

Factor H for the Polder	0.333
Factor A for the polder	0.389
MPI	0.130

289. According to Table 6.5, for Polder 43/2E, headcount ratio (H) about 33% of people live in poor households. In the context of intensity of poverty (A) is deprived more than 38% of the weighted indicators. Thus the MPI of the polder is 0.130 (in 2014) compared to Bangladesh 0.292 (in 2007)[6] which indicates status of poor HHs have been reducing very rapidly.

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

6.9 Institutions and infrastructure

290. At present, there is no growth centre or big market in the polder area. Besides, there are seven hat/bazar in the whole polder area of which 2 of these bazar are open every day of the week and these are not enough to meet their everyday demand. In such case, they just rely on these bazars only for raw materials of food. The most notable hat/bazars are Sehakati, Kuturakhali, Gagankhali, Katakhali, Araful and Buria Sehakati in the whole polder area.

6.9.1 Transport (road/navigation) networks

291. Most of the peripheral roads of the polder are paved, earthen and brick soling. The earthen roads serving the people moderately in the dry season but become useless during the wet season. During field visit, it is observed that the total peripheral length of the polder is 20 km of which 16 km are paved, 2 km are brick soling and 2 km are earthen. Local people also urged that the poor communication system is the main hindrance for the development of the polder (**Photo 6.6**).

Photo 6.6: Soling and threat to damage paved road in the polder

6.10 Extension services

292. The major social safety nets and poverty reduction programs initiated in the area include the Vulnerable Group Development (VGD), Food/Taka for Works (F/TFW), Food for Education/Cash for Education, Rural Maintenance Program (RMP), Old Age Allowance, Freedom Fighter Allowance and Integrated Poverty Reduction Program. According to local people, these programs have created food security as well as social safety nets among the targeted poor households and vulnerable communities to some extent. **Table 6.6** shows the current social services and facilities for alleviating poverty in the study area.

Table 6.6: Households Served by Different Social Safety Nets Programs

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

Source: CEGIS Fieldwork, 2015

293. A number of local, national and international NGOs are working in the polder area. Major NGOs working in the area include BRAC (Bangladesh Rural Advancement Committee), ASA (Association for Social Advancement), Space Bangladesh, Grameen Bank, Nazrul Sriti Sangsad (NSS), CODEK, MERISTOPES etc. (**Table 6.7 and Photo 6.7**). Operation of micro credit program among the rural poor women/men of the area is one of the main activities of these NGOs. Several NGOs however, implement few 'rural development' programs. Among them BRAC has wide portfolio of programs covering non-formal education, health and nutrition, water and sanitation, development of rural road networks. About 45% of households could be classified as beneficiaries of NGOs interventions.

Table 6.7: NGOs and their programs in polder area

NGOs	Type of Programs						
	Credit	Non-formal Education	Water and Sanitation	Health and nutrition	Road networks	Disaster	Livestock
BRAC	✓	✓	✓	✓	✓	-	-
ASA	✓	-	-	-	-	-	-
Space Bangladesh	✓	-	-	-	-	-	-
Grameen Bank	✓	-	✓	-	-	-	-
Nazrul Sriti Sangshad (NSS)	✓	-	-	-	-	✓	✓
CODEK	✓	-	-	-	✓	-	-
MERISTOPES	-	-	-	✓	-	-	-

Source: CEGIS fieldwork, 2015

Photo 6.7: Some glimpses of social organization and NGOs' presence

6.11 Common property resources and their utilization

294. The common property resources and/or community facilities in the area are different social amenities e.g. mosques, graveyards, temples, cremation grounds, playgrounds, open water bodies and *Eidgahs* (place for offering Eid prayers). These are used by the local people for the purposes of religious, social and cultural gathering. Beside these, the BWDB embankment is also very commonly used for different livelihood purposes i.e. living or taking shelter by the local inhabitants (**Table 6.8 and Photo 6.8)**.

295. It is observed that there are 2 cyclone shelters among them one is under construction. Besides, there are 28 mosques, 4 temples, 5 Eidgah, 5 graveyards and 2 crematoriums in the polder area. However, there is no reputed historical and archeological site declared by government in the Polder area.

Table 6.8: Common property places/resources in polder 43/2E

Union	Mosque	Temple	Eidgah	Graveyard	Play ground	Cremation ground	No of Cyclone Shelter	
							Functional	Under construction
Jainkati	28	4	5	5	4	2	1	1

Source: extracted from http:// jainkatiup.patuakhali.gov.bd/on January 29, 2015)

Photo 6.8: Places of worship of different Faith in the polder area

7. Public Consultation and Disclosure

7.1 Introduction

296. Public consultation is a regulatory process by which the public's input on matters affecting them is sought. It is a part of the EIA process aimed at involving the project stakeholders into the project development and implementation process. A formal meeting comprising of local people who are likely to be impacted was arranged at the close vicinity of the Polder 43/2E project location. During consultation meeting the proposed project intervention and its associated impacts were discussed following a comprehensive checklist. The participants expressed their opinion spontaneously and considered this attempt as a neutral platform to share their experiences with a view of ensuring the proposed project to be socially acceptable and environmentally sustainable.

7.2 Objectives of stakeholder consultations

297. 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 water resources and to make these resources more productive.; and
- To receive feedback from primary stakeholders on mitigation and enhancement measures to address the environmental and social impacts of the Project.

7.3 Approach and Methodology

298. Participatory approach was followed in conducting the public consultation meeting (PCM) in the Polder 43/2E. The consultants first discussed with the Bangladesh Water Development Board (BWDB) officials of the polder area to share the Feasibility and EIA process of the Blue Gold program. The local government officials/representatives were consulted to identify the potential stakeholders at the Polder level, With available support from the Blue Gold officials and UP chairman, the union level public representatives as well as the key persons were contacted over telephone and informed about the specific consultation meetings and requested them to be present in the meeting. Accordingly, the venue, date and time of the consultation meetings were fixed. Later, the consultant team organized the meetings at the local level. The participants provided their names, occupations and addresses in that meeting.

299. A number of informal discussions with stakeholders were also arranged as public consultation process. In order to conduct these discussions, five checklists were prepared covering the aspects including an overview of the proposed Blue Gold program, information

on the ongoing EIA process, and seeking information on the problems of the area with their potential solutions. The local needs and demands have been discussed by providing equal opportunity to all participants attending in the meeting. During consultation meeting all relevant issues on water resources, land resources, socio-economic resources, and disaster aspects were discussed in detail.

300. During informal discussions with stakeholders and PCM, 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 43/2E 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 Identification of stakeholders

301. Stakeholders include all those who will be affected 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.

7.4.1 Primary Stakeholders

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

7.4.2 Secondary Stakeholders

303. This category of stakeholders pertains to those who may not be directly affected but have interests which could contribute to the study, play a role in implementation at some stage, or affect decision making on Project aspects. In this Project NGOs, concerned government departments, and line agencies fall under this category.

304. Secondary stakeholders for the Project include local government institutions (LGI), Bangladesh Water Development Board (BWDB), 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.

7.5 Consultation meetings

7.5.1 Consultation Process

305. A PCM and number of informal discussions with stakeholders were conducted at different locations of the Polder 43/2E. The details of these informal discussions with stakeholders and PCM 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	Patuakhali Sadar	Sadar	Blue gold office	Sharing meeting with Blue gold officials	11/01/2015	10:00
2	Patuakhali	Patuakhali Sadar	Jainkathi	UP Auditorium	PCM	18/01/2015	11:00
3	Patuakhali	Patuakhali Sadar	,,	Katakhali bazar	Meeting with WMGs	16/01/2015	10:00
4	,,	,,	,,	Gagankhali	Informal discussions with stakeholders	16/01/2015	2:00
5	,,	,,	,,	Kotura Talak Bazar	,,	17/01/2015	11:30

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

Photo7.2: PCM at Jainkathi Union, Patuakhali

7.5.2 Consultation Participants

306. The participants of these consultation meetings included Blue gold officials, local representative, farmer, trader, members of WMO and daily-wage laborers of the Polder 43/2E and nearby areas. A total of number 94 participants attended these consultations. The detailsof the participant are provided in **Table 7.2** and **Photo 7.3and7.4** 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	UP Auditorium	PCM	Primary and secondary stakeholders	42
3	Katakhali bazar	,,	,,	13
4	Gagankhali	,,	,,	15
5	Kotura Talak Bazar	,,	,,	14

Photo 7.3: Informal discussion with stakeholders at Katakhali bazar

Photo 7.4: Informal discussion with stakeholders at Gagankhali

7.6 Issues discussed in informal discussion with stakeholders and PCM

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

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

- **Socio-economic aspects:**
  - Occupation and Employment (unemployment/joblessness)
  - Education (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 water resources and to make these resources more productive.

7.7 Community Concerns and Suggested Solutions

308. The outcomes of the informal discussions with stakeholders and PCM in terms of concerns and the suggested solutions were noted and organized by 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 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 problem in the area as opined by local people ✓ Surface water scarcity	✓ Re-excavation of khals ✓ Repairing of Sluice gates, inlets and outlets
Agricultural resources	✓ Drainage congestion and water logging during T Aman (Kharif-II season). ✓ Scarcity of irrigation water in Rabi season.	✓ Repair of sluice gates are expected to decrease siltation which may enhance crop production and may reduce crop damage and to introduce new crops. ✓ Re-excavation of khals to remove drainage congestion. ✓ All proposed intervention should be protected existing problem in the polder area.
Fishery	✓ Reducing depth of internal khals	✓ Re-excavation of khal will help to

Themes/Topics	Concerns/Issues/Problems	Suggested Solution/Remedies
resources	and habitat quality degradation due to siltation ✓ Fish and hatchling movement disrupted due to in proper operation of water control structures. ✓ Indiscriminate fishing by Sluice net	increase the richness of fish species in the polder area. ✓ Strengthening of WMA/WMO activities ✓ Strong of fisheries rules and regulation by the government
Ecological resources	✓ The major problems identified in the polder area that homestead plant biodiversity and are due to the lack of advanced knowledge, technologies, pests and diseases attack, improper homestead space planning and utilization, maintenance of embankment and sluice gates, intrusion of partial saline water, low productivity, recurring natural disasters, khals siltation and water logging. Consequently, faunal population and diversity is also decreasing due to natural disaster and various human activities.	✓ Re-sectioning of embankment and repairing of water control structure along the embankment will protect settlement, road, inter tidal floodplain area and crop fields from existing problem. ✓ Re-excavation of khal to remove drainage congestion and water logging.
Socio-economic resources	✓ Scarcity of fresh water is the main problem in the polder area during dry season. Due to malfunctioning of water control structures, lack of reserve fresh water in khals, saline water is being trapped for long time in almost entire polder area and this is responsible for intrusion of salinity in the groundwater aquifers. ✓ Lack of adequate expertise and experienced manpower to carry out the O&M of the polder, the numbers of field staffs are also insufficient and inadequate in some places of the polder with respect to the actual requirement. ✓ Local influential, including the political leaders, illegally interfere on the water control/ management infrastructure. ✓ The occupations of local people has been changed due to salinity and closeness to urbanization ✓ Lack of hospitals with trained physician	✓ Scope of fresh water storage may be improved within the internal khals and protective ponds by proper functioning of associated water control structures; ✓ For sustainable operation of the project, participation of Water Management Organization (WMO) and Community Based Organizations (CBOs) needs to be ensured and also the water control structures i.e. embankment, sluice gate, regulator, inlets, culverts etc must be managed properly, and there should be growth of consciousness among the community in the polder. ✓ The Government should rehabilitate the affected farmers who are affected by salinity intrusion; ✓ Need awareness building about water management among the communities. ✓ Alternative occupation opportunities should be created for the farmers ✓ Adequate number of trained physician should be recruited in this area ✓ It is very urgent to develop the internal communication facility of this area

Themes/Topics	Concerns/Issues/Problems	Suggested Solution/Remedies
	✓ The doctors do not behaves in the professionalism manner in their activities ✓ Lack of cyclone center ✓ Lack of place for dumping spoil materials ✓ Lack of training on livestock rearing ✓ Poor communication system within the polder ✓ Lack of growth centers	✓ Market management should be strengthened ✓ Provide alternative training facilities for income generation

7.8 Perceptions towards proposed interventions

309. The interventions proposed by the Blue Gold Program for rehabilitation of the polder were discussed with local people by the EIA study team. A list of identified problems and the suggested solutions made by the local people are shown in Table 7.3. The solutions opted by the local people are mostly found similar to these proposed by the Blue Gold Program for this polder. During public consultation meeting conducted by this team, the participants were also requested to provide their overall perception about the proposed interventions. The opinions received were positive, as almost all the local participants spoke in favour of the proposed interventions. The generalized perception was that they believe that the interventions proposed (discussed in Chapter 4) have the outright potential to remove the existing water management problems and concerns in Polder 43/2E.

7.9 Participant list

310. The name of the participants of different informal discussions with stakeholders, their age, occupation and address including cell phone number are provided in **Table**7**.4**. Similarly, an inventory of the participants of PCM was maintained in attendance sheet containing their contact numbers. Scanned list of participants is attached in **Appendix-4.**

Table 7.4: Name of participants

SL	Name	Gender	Occupation	Age	Address/Mobile No
1	Arab Ali Sardar	M	Business	35	-
2	Delawar Hossain	M	Agriculture	22	01760-164500
3	Md. Billal Hossain	M	Student	19	01751-739140
4	Md. Monirul Islam	M	,,	27	01715-295401
5	Kamal Hossain	M	Driver	35	01714-795939
6	Ali Akbar Sarder	M	Agriculture	50	01778-912964
7	Md. Helal Hossain	M	Driver	25	01710-255118
8	Rasel Hossain	M	Student	30	01713-957570
9	Md. Jamal Hossain	M	Service	30	01730-973142
10	Md. Hasan	M	Agriculture	25	-
11	Md. Oadud Hawladar	M	Business	35	01713-933230

SL	Name	Gender	Occupation	Age	Address/Mobile No
12	Md. Mahbub Alam	M	,,	55	01735-666802
13	Md. Rubel Mriddha	M	Student	50	01745-396992
14	Syed Sajal	M	Service	60	01711-124651
15	Md. Al Amin	M	,,	45	01788-801227
16	Md. Yakub Khandakar	M	,,	50	01754-271523
17	Md. Ebrahim Khandakar	M	Business	40	01719-543556

8. Identification, Prediction and Evaluation of Potential Impacts

8.1 Identification of IESCs and Rationale

311. 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 under different resources likely to be impacted by the interventions along with the rationale of their selection are presented in Table 8.1 below.

Table 8.1: Identified IESCs and Rationale

IESCs	Rationale
Water Resources	
Surface Water Availability	The re-excavation of khals within the polder may improve its water carrying as well as retention capacity and hence allow more surface water to be available. This may improve the different uses of water in the area. Therefore, water availability has been considered as an IEC.
Drainage Congestion and Water Logging	The repairing of water control structures and construction of outlet at Durlob khal might improve the drainage status within some locations of the polder, and might restore the existing water logged areas. As such, drainage congestion and water logging has been considered as another IEC
Land Resources	
Agriculture land use	It is expected that the present land use might be changed due to implementation of the interventions in the polder for the change of hydrologic regime inside the polder area. Farmers of the polder area would be encouraged cultivating more crops in changing situation. Because of this reason, land use has been considered as one of the IEC.
Agriculture Resources	
Cropping pattern and intensity	The proposed interventions will change the hydrologic regime inside polder 43/2E area, which may encourage the farmers to change their cropping patterns and may be more HYV. This may increase the cropping intensity in consideration of which cropping pattern and intensity has been selected as an IEC.
Crop production	Agricultural crop production is expected to be increased for the improvement of drainage congestion problem due to re-excavation of the Khals. The re-excavation of khals would help to drain out excess water from the crop fields. Repairing of sluice gate may prevent the intrusion of saline water. The excess rain water inside the polder would be drained out through regulators which might help to cultivate the HYVs rice. Moreover, the surface water might be stored in the re-excavated khals which could be used for irrigation. This situation would be favorable for enhancing crop production. As such, crop production has been selected as an IEC.
Irrigated area	Surface water is more preferable than ground water for irrigation use because of its low cost and sediment content contributing towards

IESCs	Rationale
	maintaining the soil nutrient status of the soil. The proposed interventions are expected to increase the availability of surface water for irrigation use in consideration of which irrigation has been selected as an IEC.
Fisheries Resources	
Fish habitat and habitat quality	The proposed interventions of the polder are likely to alter the fish habitat as well as habitat quality in the polder area. Increased water depth due to re-excavation of khals may change the water quality which may support different type of fish species. In this context, fish habitat and habitat quality has been considered as an IEC of the study.
Fish movement and migration	Internal fish movement and migration through khal is still the driving force for capture fisheries of the polder area. Few numbers of internal khals are connected with the peripheral rivers. The major portions of the khals are silted up. These khals are covered with water hyacinth which is hampering the fish movement and migration. Proposed interventions especially khal re- excavation may increase water flow and depth of water and in turn will facilitate the lateral fish migration. Thus, fish movement and migration has been considered as an IEC.
Fish productivity	Open water fisheries contribute a small portion of fish production in the polder area. People of the area are mainly dependent on culture fisheries. Implementation of proposed interventions may change the fish abundance which ultimately changes the fish productivity. So, fish productivity has been considered as an IEC.
Ecological Resources	
Terrestrial Vegetation	Terrestrial vegetation is an important component of the existing ecosystem. This type of vegetation provides habitat for wildlife and also provides various elements to human. Any change of physical environment causes different intensity of vegetation damage. The proposed interventions may cause impacts on vegetation during construction and post construction phases. Therefore, Terrestrial vegetation has been identified as an IEC.
Aquatic flora and fauna	Aquatic flora and faunal status relies on wetland water salinity, quality and depth play an important role in the existing wetland ecosystem. Proposed intervention especially khal re-excavation is expecting to change the water quality as well as fresh water flow which may have impact on aquatic flora and fauna. Impacts can be positive and/or negative in long run. Hence, aquatic flora and fauna is considering as an IEC.
Socio-economic Condition	
Access to open water bodies	All khals are recognized as the sources for open water bodies in the polder. At present, mass people has limited access to open water bodies for instance, khals which are to be excavated in the proposed interventions. In most cases, khals are being silted up. Thus, it can be mentioned that, if the proposed khals are re-excavated, it will ensure social use of water and access for mass people into khals. As such, access to open water bodies is considered as one of the IESCs.
Gender promotion	Most of the people in polder area are living on poor condition. Specially, the females are mostly vulnerable to distressed and widow who are dependent on others and do not have any definite sources of income. It is proposed that about 40% of labours under local constructing society (LCS) will be females. Thus, the employment

IESCs	Rationale
	opportunity for women in the construction works and during operation/maintenance phase can promote them to better life and livelihood. Hence, gender promotion is considered as an IESC.
Employment opportunity	The construction work will generate a significant opportunity of employment over its construction period for local people and other associated professionals. People will also be involved in operation and maintenance related jobs to operate the hydraulic structures. It is expected that proposed intervention will create employment opportunities for different occupational groups. Thus, employment opportunity is considered as an IESC.

8.2 Prediction and Evaluation of Potential Impacts

8.2.1 Preamble

312. This section identifies the prediction and evaluation of potential environmental and social impacts which may be caused by various activities of the Project during pre-construction, construction, and Operation phases on the identified IESCs. The proposed interventions which may cause potential environmental impacts during pre-construction, construction, and Operation stages have already been identified in Chapter 4. The following detailed investigations were carried out to assess the magnitude of these prioritized impacts:

- RRA survey to assess 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 Polder 43/2E comprising socio-economic status and environmental settings.
- Expert consultation, focus group discussions, and public consultations.

8.2.2 Impact Screening

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

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

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

Table 8.2: Screening Matrix

Project Phases and Activities	Water Resources		Land & Agriculture			Fisheries			Ecological		Socio-economic		
	Surface Water Availability	Drainage congestion & water logging	Cropping pattern and intensity	Crop production	Irrigated area	Fish habitat and habitat quality	Fish movement and migration	Fish productivity	Terrestrial Vegetation	Aquatic flora and fauna	Gender promotion	Employment opportunities	Access to open water bodies
Pre-construction Phase													
Labor, materials and equipment mobilization	-	-	-	-	-	-	-	-	-	-	-	-	MN
Site preparation	-	-	-	-	-	-	-	-	-	-	MN	I	-
Construction Phase													
Re-sectioning of embankment	-	-	-		-	-	-	-	MN	-	-	HP	-
Embankment slope pitching and turfing	-	-	-		-	-	-	-	I	-	-	MP	I
Re-excavation of khal	-	-	-		-	MN	MN	I	I	MN	-	MP	-
Repairing of Drainage sluices/Flushing sluices	I	I	-		-	-	MN		-	-	-	I	-
Repairing of drainage outlet	I	I	-		-	-	I		-	-	-	I	-
Construction of Drainage Outlet	I	I	-		-	-	-		-	-	-	I	-
Repairing of Irrigation inlets	I	I	-		-	-	I		-	-	-	I	-
Operation Phase													
Checking the physical condition and function of the embankment	HP	HP	HP	HP	MP	MP		I	MP	I	MP	MP	HP
Checking physical condition and function of water control structures	HP	HP	HP	HP	MP	MP		HP	I	MP	MP	HP	HP
Checking the functions of WMOs	HP	HP	HP	HP	MP	MP		HP	I	MP	MP	HP	HP

Note:

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

8.3 Impact duringPre-construction Phase

315. There will be no impact during the pre-construction phase on IESCs of water resources, agriculture, fisheries, ecological resources and socio-economic condition because some activitiessuch as materials and equipment mobilization (carrying as well as storing and land acquisition)would be carried out during this phase. Impact of these activities on the said IESCs is negligible.

8.4 Impact during Construction Phase

316. Impact on IESCs during construction phase for the proposed interventions are presented in the following table 8.3

Table 8.3: Impact Assessment Matrix for the Construction Phase

IESC	Location	Baseline Condition	Impact	Impact (+/-)/ Magnitude (1-10)
Water Resources				
There will be no impact during the construction phase				
Land Resources				
There will be no impact during the construction phase.				
Agricultural Resources				
There will be no impact during the construction phase.				
Fisheries Resources				
Activity: *Repairing of Water Control Structures*				
Fish movement and migration	• Drainage/flushing Sluices (7 nos of locations as mentioned in the water resources section) • Irrigation Inlets (55 nos of which locations as mentioned in the water resources section)	• Fish hatchling and some brackish water fish species like *Chingri, Baila, Pairsa*, *Vetki* and fresh water fish like *Puti, Tengra* and SIS move through the water control structure during high tide throughout the year.	• Movement and migration of fish species like *Chingri, Baila,* Pairs and Vetki and fresh water fish like *Puti, Tengra* and SIS etc would be obstructed/limited during repairing of structures.	-1
Activity: *Re-excavation of khal*				
Fish habitat and habitat quality	• Gagankhali Khal (1.50) • Dholkhali Khal (1.0 km) • Moubaria Main Khal	Tidal in nature, shallow water depth, most of the part are silted up	• Feeding and breeding ground of the bottom dweller fishes will be lost.	-3

IESC	Location	Baseline Condition	Impact	Impact (+/-)/ Magnitude (1-10)
	(2.0 km) • Shuddurbaria Main Khal (1.5 km) • Naotana Khal (3.0 km) • Katakhali Khal (2.0 km) • Natua Main Khal (1.8 km) • Piprabunia Khal (1.02 km) • Ponditer Khal (2.6 km)			
Ecological Resources				
Activity: *Repairing of embankment*				
Terrestrial vegetation	Both sides of the embankment in the repairing points	• Embankment side vegetation is dominated by medium sized trees, shrubs and herbs e.g. *Kola, Tal, Khejur, Shirish*, *Akand, Bhat, Hatisur* and etc which provide feeding ground for mammals, birds, reptiles and amphibians. • Vegetation is facing risk due to natural disaster and human activities	• Temporary damages of herbs, shrubs, various types of grass and bushes due to soil dumping for repairing works. • Relocation of wildlife due to temporarily loss of habitat.	-2
Activity: *Construction of drainage outlet*				
Terrestrial vegetation	Durlab khal	• Moderate condition. • Composed of free floating plants, like *Kochuripana, Kutipana, Dhol kolmi,* etc, which support habitat for fishes and Kingfisher, Egret, Snake, etc. • Durba Ghas *(Cynodon dactylon)*, Biskantali (*Polygonum* Sp.) and different types of marginal herbs like Dholekolmi (*Ipomoea aquatic*), Kasorti (*Eclipta* Sp) are dominant along both sides of the khals. • Different types of local avifauna roam here for feeding.	• Temporary reduction of habitat quality due to obstruction in the flow in the khal.	-2

IESC	Location	Baseline Condition	Impact	Impact (+/-)/ Magnitude (1-10)
Activity : *Re-excavation of khal*				
Aquatic flora and fauna	All khals proposed for re-excavated	• Moderate condition • Composed of free floating plants, like Kochuripana, Kutipana, Dhol kolmi, etc which support habitat for fishes and Kingfisher, Egret, Snake, etc. • Durba Ghas *(Cynodon dactylon)*, Biskantali (*Polygonum* Sp.) and different types of marginal herbs like Dholekolmi (*Ipomoea aquatic*), Kasorti (*Eclipta* Sp), etc. are dominant along both sides of the khal. • Different types of local avifauna roam here for feeding. • Reduced water retention area for siltation.	• Damages of existing aquatic vegetation would cause habitat degradation for aquatic birds (ie. Egrets) and fishes • Damages of existing bank line vegetations due to dumping of soil along both sides of the khal	-3
Socio-economic Condition				
Employment Opportunity	Periphery and inner side of the polder 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 huge number of local labor will be needed in earth works, re-sectioning of embankment and afforestation, soil dumping and compaction in different repair works	+2
Gender Promotion	Periphery and inner side of the polder where different activities will be initiated.	About 52% of female are working at household level whereas few of them are working as day labor or earth worker	According to the project work, the LCS entail 60% male and 40% female, all of them would be engaged from the local area. Thus, employment of female in the construction works and during operation/ maintenance phase will be promoted significantly and they can take part in different decision makings.	+3

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

8.5 Impact during Operation Phase

317. The possible impacts during Operation phase 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.

8.5.1 Water Resources

a. Surface *Water* Availability

Future-without-Project

318. People living in Polder 43/2E are suffering from scarcity of water forirrigation as khals are gradually being silted up. Local people cannot fulfill irrigation demand upto the desired level due to the reduction of surface water availability. Water scarcity will be more acute in the coming future if the proposed khal is not re-excavated (Dholkhali Khal, Katakhali Khal, Natua Main Khal, Piprabunia Khal, Ponditer Khal etc.). 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 be further constrained in future. The study infers that around 10% people in the Polder might be suffering from water scarcity in future, if the project is not implemented.

Future-with-Project

319. The study infers that if re-excavation works are carried out as per design, an additional volume of 59,000 $m^3$of water would be available in the water courses within the polder. Assuming 60% flow probability on an annual average due to seasonal water fluctuation and other water losses, it can be said that around 3% people would still remain under water stress.

Impacts

320. From the spatial distribution of khals to be re-excavated, it is observed that around 850 people (7% of total population) in Purba Jainkati, Sehakati and adjacent mauzas would have sufficient surface water and access to the same. This would result in immense benefits in water use. Water for domestic purposes would also be increased; moreover water for irrigation would also be available substantially during dry season.

b. Drainage congestion and water logging

Future-without-Project

321. The existing khals usually drain out a large volume of water after any major rainfall (Shuddurbaria Main Khal, Naotana Khal etc.) have gradually been silted up over the years mainly due to poor maintenance of water control structures. Approximately 8 km length of water courses within the polder may suffer from drainage congestion in future. This may result other environmental and social problems as well. However, no water logging problems has observed inside the polder.

Future-with-Project

322. The proposed re-excavation works if executed are carried out and water control structures are fully been repaired as suggested, the drainage congestion problems in most

of the peripheral portions can be reduced. The khals would not be affected by drainage congestion problems, and this would also reduce other associated problems. Furthermore, the construction of proposed outlet at the opening of Durlob khal would prevent possible drainage congestion in that khal.

Impact

323. Considering the 'future without project' and the 'future with project' scenarios, it can be concluded that around 8 km of khals (20% of total) would be benefited from drainage congestion in future, due to the overall improvement in the drainage capacity of re-excavated khals.

8.5.2 Land Resources

a. Agriculture land use

Future-without-Project

324. Presently, NCA is about 67% of the gross area. Of the net cultivable area single, double and triple cropped area as practiced are 19%, 55% and 26% respectively. The polder if not rehabilitated, utilization of land for single, double and triple crop would be about 29%, 49 % and 22% of the NCA respectively under FWOP condition (Table 8.4.)

Table 8.4: Detailed agriculture land use of the polder area

Agriculture land use	Baseline	FWOP	FWIP	Impact (FWIP-FWOP)
	% of NCA	% of NCA	% of NCA	
Single crop	19	29	15	-14
Double crop	55	49	56	+7
Triple	26	22	29	+7
Total =	**100**	**100**	**100**	**0**

Source: CEGIS estimation based on field information, 2015

Future-with-Project

325. The interventions if executed would increase the land use of the polder areas. Drainage congestion is expected to be removed due to implementation of various interventions of the polder. The area under different land types would be improved which would create scope of enhanced land use. It is expected that re-sectioning of embankment, repairing of drainage / flushing sluice, drainage Outlet, repair of irrigation Inlets etc. would enhance land utilization. However, the land utilization for single, double and triple cropped area would be 15%, 56% and 29% of NCA respectively in future with project condition. Detailed land use has been presented in Table 8.5.

Impact

326. The overall impact of different options on land use would be very positive. Single cropped area may decrease by 14% while double and triple cropped area would be increase by 7%, 7% of the NCA respectively under FWIP condition. Detailed land use has been presented in Table 8.5.

8.5.3 Agricultural Resources

a. Cropping pattern and intensity

Future-without-Project

327. Presently, cropping intensity of the polder area is about 207%. The proposed interventions in the polder if not implemented, the land type as well as land use would be degraded in absence of embankments, structures and siltation of river and drainage channels. Under this condition, there would be negative impacts. The cropping intensity is expected to change to about 193% (Table 8.5).

Table 8.5: Major cropping patterns under FWOP and FWIP condition in the polder area

Kharif-I (March-June)	Khartif-II (July-Oct)	Rabi (Nov-Feb)	Baseline % of NCA	FWOP % of NCA	FWIP % of NCA	Impact (FWIP-FWOP)
Lt. Aus	Lt. Aman	Khesari	17	15	20	5
Fallow	Lt. Aman	Mung bean	7	10	1	-9
Fallow	HYV Aman	Mung bean	0	0	6	6
Fallow	HYV Aman	Watermelon	37	30	38	8
Fallow	Lt. Aman	Wheat	4	4	6	2
Lt. Aus	Lt. Aman	Mung bean	9	7	9	2
Fallow	Lt. Aman	Sesame	7	5	5	0
Fallow	Lt. Aman	Fallow	19	29	15	-14
		Total =	**100**	**100**	**100**	**0**
		Cropping Intensity %	***207***	***193***	***214***	***21***

Source: CEGIS estimation based on field information, 2015

Future-with-Project

328. Implementation of the interventions would increase the cropping intensity due to improvement of land type of the polder area. The future with polder condition would help to change the hydrologic regime inside the polder area, which might encourage the farmers to change their cropping patterns as shown in Table 8.5. Under FWIP condition, the structures would function properly and would drain the excess water during rainy season from the cultivable land as a result land type might be improved. The improved land type would influence the farmers to practices multiple cropping in the polder area and more HYV will be cultivated. After completion of the interventions, the cropping intensity is expected to increase to 214%.

Impact

329. It is expected that, more crops will be cultivated. Farmers will so far more HYVs and cropping intensity would be increased by about 21% under FWIP over FWOP.

b. Crop production

Future-without-Project

330. Presently, total crop production is 9,330 tons of which rice is 2,503 tons (27%) and non rice is 91,518 tons (73%). Adverse effect might occur due to siltation of river and drainage channels. The production would be decreased from the base situation. The farmers would be desperate to produce more crops for their increased demand under FWOP condition. A total of 2,074 tons of rice is expected to be produced and a total of 5,064 tons non-rice would also be produced (Table 8.6).

Table 8.6: Impact on crop production in the polder area

Crop name	Baseline	FWOP	FWIP	Impact (FWIP-FWOP)	% of Impact
Lt. Aus	423	332	538	206	62
Lt. Aman	1,089	1,039	1,137	97	9
HYV Aman	991	703	1383	680	97
Total rice =	**2,503**	**2,074**	**3,058**	**984**	**47**
Sesame	58	36	50	14	38
Khesari	138	104	186	81	78
Wheat	115	102	195	93	91
Watermelon	6,349	4,663	7,846	3,183	68
Mung bean	167	158	167	9	6
Total non-rice =	**6,827**	**5,064**	**8,444**	**3,380**	**67**
Total =	**9,330**	**7,138**	**11,502**	**4,364**	**61**

Source: CEGIS estimation from field information, 2015

Future-with-Project

331. The crop production would boost up significantly under the FWIP condition. The total crop production would be 11,502 tons of which rice would be 3,058 tons and non-rice would be about 8,444 tons. The rice and non-rice production would respectively be 47% and 67% higher in FWIP than those of FWOP. Rice production would be increased due to expansion of HYV Aus, HYV Aman and Watermelon cultivation area.

Impact

332. Additional 984 tons (47%) of rice and 3,380 tons (67%) of non-rice would be produced in FWIP over FWOP Table 8.6.

c. Crop damage

Future-without-Project

333. Presently, total crop production loss is about 255 tons of which rice is 162 tons and non-rice is 93 tons due to drainage congestion, scarcity of irrigation water etc. The situation would aggravate more under FWOP condition. Total 311tons of paddy and 213 tons of non-rice crops production would be lost under FWOP situation (Table 8.7).

Table 8.7: Impact on crop production loss in the polder area

Crop name	Baseline	FWOP	FWIP	Impact (FWIP-FWOP)	% of Impact
Lt. Aman	80	179	32	-147	-82
HYV Aman	82	132	46	-86	-65
Total rice =	**162**	**311**	**78**	**-233**	**-75**
Sesame	7	4	2	-2	-54
Watermelon	86	209	88	-121	-58
Total non-rice =	**93**	**213**	**90**	**-123**	**-58**
Total =	**255**	**524**	**168**	**-356**	**-68**

Source: CEGIS estimation from field information, 2015

Future-with-Project

334. Crop damage would be reduced by 68% for the implementation of interventions and their proper management. The interventions would have positive impact in reducing crop damage area as well as crop production loss. The total rice production loss would be 168 tons.

Impact

335. It is expected that loss of crop production would be reduced by 356tons which would be 68% less in FWIP over FWOP.

d. Irrigated area

Future-without-Project

336. Presently, irrigated area is about 660 ha. The interventions if not be implemented, the soil salinity would be increased beyond the critical limit (<4.0 dS/m) and the availability of surface water in the river would decrease due to siltation of river and khals in area. The irrigated area would decrease by about 591 ha in FWIP.

Future-with-Project

337. After implementation of the proposed interventions in the polder, water will be available and retained in the river and khals. Irrigation can be provided from river and different khals in Rabi crops by using LLPs up to February. The irrigated area would increase 697 ha in FWIP. Total irrigated area would be increased to 106 ha in FWIP over FWOP.

Impact

338. It is expected that, irrigated area would be increased by 106 ha under FWIP over FWOP.

8.5.4 Fisheries Resources

a. Fish habitat and habitat quality

Future-without-Project

339. In future without project situation, continuous siltation would cause scarcity in water availability in the internal khal. As consequences, perennial khals would be converted to seasonal khal even a portion of the khal would become agriculture land. It is assumed that about 40% of khal would become seasonal khal. Open water fish habitat would be decreased and its water quality for fish habitation would also be declined.

Future-with-Project

340. Water depth as well as water availability in the internal khals would be increased due to re-excavation of khal. Silted up resulted seasonal khals would be again converted perennial khals. Water quality of those khal and their connectivity would be enhanced for fish habitation. But feeding and breading ground of bottom dweller fish species would damaged due to re-excavation of khals. Turbidity of the water in the khals would be increased. Increased turbidity would hamper to increase of primary productivity. For such less primary productivity, fish production may be slightly reduced. Such impact is temporary and after 1 or 2 year of re-excavation, would be improved.

Impact

341. Seasonal khal would again turn into perennial khal. The improved habitat quality would support different types of fishes as well as aquatic vegetation which would be helpful for feeding and habitation of fisheries and aquatic biota.

b. Fish movement and migration

Future-without-Project

342. Most of the freshwater and brackish water fish species as well as fish hatchling move from river to khal through sluice gate at some stage of their life cycle for nursing and feeding purpose. Substantial progress of khal bed siltation would lead to reduce the water depth. Thus, fish movement and migration would be hampered from river to khal and vice-versa. In FWOP condition, hatchling and fish movement would be facilitated round the year due to existing malfunctioning and mismanagement of water control structures.

Future-with-Project

343. The movement of hatchling of brackish and fresh water fish from river to polder area would be obstructed / regulated due to repairing of sluices and drainage inlets and outlets. Brackish water fish species like *Puti, Chingri, Tengra, Baila* and *Pairsa, vetki* etc which moves on regular basis during high tide would be limited due to repairing of sluices/ regulators. But increased water depth and water availability in the khal due to re-excavation would facilitate the internal fish movement and migration significantly.

Impact

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

c. Fisheries productivity

Future-without-Project

345. The Catch per Unit Area (CPUA) in future without project situation would be reduced for the continuity of the ongoing process of siltation in the khal as well as raising of the bed level of khals. Many fish species may disappear from this habitat which ultimately will lead a decrease the fish biodiversity in the polder area. It is assumed that capture fisheries productivity would be decreased by 10% from the base condition. The estimated productivity of capture fisheries might be 117 kg/ha where base line productivity is 130 kg/ha. Production of snake head fish species like *Taki, Cheng, Shol, Gojar* etc and benthic species like *Baim, Gutum, Shing, Magur, Meni* etc may increase for low water depth and excessive duck weed in future without project situation.

Future-with-Project

346. Implementation of proposed activities especially the re-excavation of khal would increase the water depth, water availability as well as water quality of the khals.Due to increase of water depth and water availability, Catch per Unit Area (CPUA) of fish in the polder will be increased in future with project situation. Moreover, improved fish habitat and habitat quality would change the fish diversity and its fish composition. The open water fisheries productivity would be increased, especially the productivity of carp and SIS would be increased significantly while production of snake head and benthic fishes may be decreased for destroying its congenial environment by removal of duck weeds. It is expected that the capture fisheries productivity would be increased by 15% (147 kg/ha) compare to that of the baseline situation (130 kg/ha). On the other hand, re-sectioning of embankment and repairing of water control structures would the reduce flood vulnerability to aquaculture pond. Therefore, area of culture fisheries might be increased which would boost up the culture fisheries productivity.

Impact

347. Capture fisheries productivity would be increased by 30 kg/ha. Culture fish productivity would also increase significantly.

8.5.5 Ecological Resources

a. Terrestrial vegetation

Future-without-Project

348. Terrestrial vegetation including climbers, herbs, shrubs, trees will further deteriorate due to natural disaster and human activities. Malfunctioning of water control structures like regulators and drainage outlets will cause vegetation damage for insufficient drainage and flashing capacity of the polder area. Damages of vegetation will thus have impact on dweller wildlife like local birds, mammals, reptiles etc due to habitat destruction.

Future-with-Project

349. Existing trend of vegetation loss due to natural disaster will be reduced for flood protection due to repairing of embankment. Hence, improvement of vegetation including fruit trees will support resident wildlife throughout the year. Improvement of drainage system and water conveyance capacity through re-excavation of khals will also improve the vegetation to a large extent.

Impact

350. Terrestrial vegetation will be improved.

b. Aquatic flora and fauna

Future-without-Project

351. Aquatic habitat condition will be degraded day by day due to continuous siltation of khals. Existing floral and faunal species composition will go under further degradation due to insufficient water in the khals especially in the dry season.

Future-with-Project

352. Aquatic vegetation and wildlife will be enriched for facilitation of fresh water flow in khals after re-excavation work.

Impact

353. Aquatic habitat will be improved due to improvement of plant diversity as well as for water depth and velocity of the khals.

8.5.6 Socio-economic condition

a. Access to open water bodies

Future-without-Project

354. Mass people are suffering from water availability. They cannot serve their domestic, bathing, washing and irrigation requirements to the level desired due to drainage congestion. In this situation, 10% of the people of this polder might be suffering from access to the open water bodies if the re-excavation works are not been carried out. Without project situation, this problem may further increase and may create more disturbances to mass people.

Future-with-Project

355. With the intervention, numbers of families will be benefited. They can use water in different social aspects. After implementation of the proposed project, 18% of the total households will have good access to water bodies and 81% will have medium access to open waterbodies. A few percentages (3%) will have poor access to water bodies. Moreover, this would enhance social bonding and relationship among themselves.

Impact

356. The standard of living of the people (7%) in Purba Jainkati, Sehakati and adjacent mauzas of the polder will be increased as they will have access and sharing of 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. Gender promotion

Future-without-Project

357. Most of the people in polder area are living under poor condition. Specially, the females to distressed and widow are mostly vulnerable 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 the society.

Future-with-Project

358. About 40% of labours under Landless Constructing Society (LCS) will be females. It is expected that they will be directly benefited for the interventions of the polder.

Impact

359. The employment opportunity for women in the construction phase and operation/maintenance phase will promote them to a better life and livelihood.

c. Employment opportunity

Future-without-Project

360. Employment opportunities are still limited in the entire study area. As the polder situated is very near to Patuakhali town and people have very few options within the polder to develop or adapt them and move to the town for employment. Under the future without project condition, these may either remain same or will deteriorate more.

Future-with-Project

361. On the other hand, proposed interventions can ensure limited employment. Increase income and employment opportunity for these interventions and can ascertain slightly better livelihood of the stakeholders.

Impact

362. Will create new employment opportunities with increased income of the people which will ensure the standard of their living along with solvency and steady of the family.

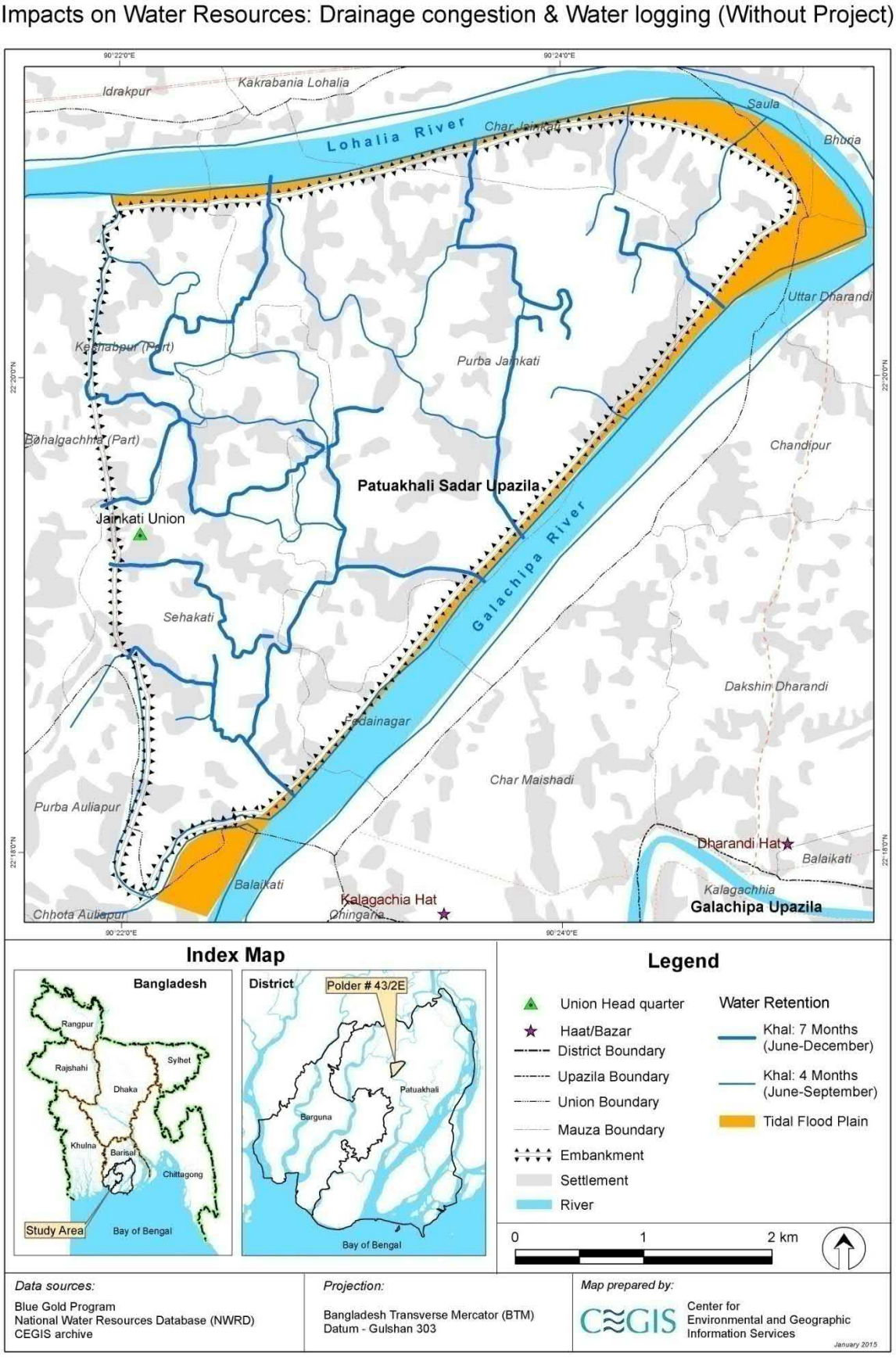
Table 8.8: Matrix on Impact Assessment with regard to Operation Phase

IESC	Baseline	Future Without Project	Future With Project	Impact (+/)/ Magnitude (1-10)
Water Resources				
Surface Water Availability	No major water deficits for drinking and domestic purposes but have water demand for irrigation.	Approximately 10% of the people in Polder 43/2E may suffer from scarcity of domestic, drinking and irrigation water.	Will increase the surface water availability but 3% population would still remain under water stress.	+3
Drainage congestion and water logging	No drainage congestion and water logging inside the polder.	Around 8 km khals (along Durlob Khal, Gagankhali Khal, Moubaria Main Khal, Shuddurbaria Main Khal, Naotana Khal etc.) would face drainage congestion, but no water logging would occur.	No drainage congestion and water logging would occur.	+3
Land Resources				
Agriculture land use	Presently, NCA is about 67% of the gross area. Of which net cultivable area for single, double and triple cropped areas are about 19%, 55%, 26% respectively.	Utilization of land for single, double and triple cropped area would be about 29%, 49%, 22% of the NCA respectively under FWOP condition	Utilization of land for single, double and triple cropped area would be 15%, 56%, 29% of the NCA respectively under FWIP condition	+2
Agricultural Resources				
Cropping pattern and intensity	Cropping intensity is about 207%.	Cropping intensity would decrease to about 193%.	Cropping intensity would increase to about 214%.	+3
Crop production	Total crop production is 9,330 tons of which rice is 2,503 tons and non rice is 6,827 tons.	Total crop production would be 7,138 tons of which rice would be 2,074 tons and non-rice would be 5,064 tons.	Crop production would increase to about 11,502 tons of which rice would be 3,058 tons and non-rice would be 8,444 tons.	+4
Crop damage	Total crop damage is about 255 tons of which rice is 162 tons and non-rice is 93 tons.	Total crop damage would increase to about 524 tons of which rice crop damage would be 311 tons and non-rice crop damage would be 213 tons.	Crop damage would decrease for rice by 78 tons and non-rice by 90 tons.	+3
Irrigated area	Irrigated area is about 660 ha.	Irrigated area is expected to decrease to about 591 ha.	Irrigated area would be increased by 106 ha in FWIP over FWOP	+1

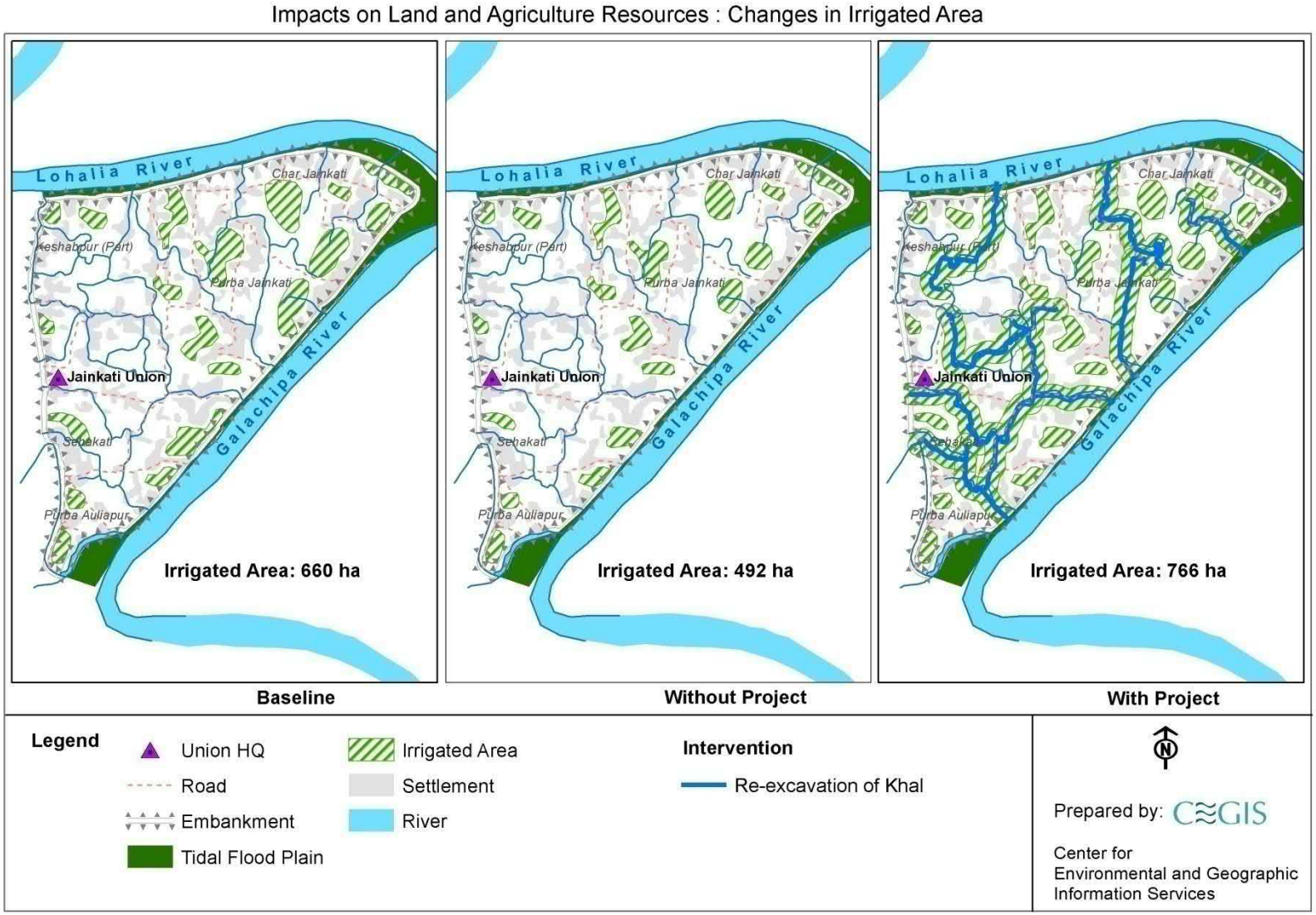
IESC	Baseline	Future Without Project	Future With Project	Impact (+/)/ Magnitude (1-10)
Fisheries Resources				
Fish habitat and habitat quality	• Tidal in nature • Silted up and low water availability	• Perennial khals would be converted to seasonal khals • Habitat quality would be declined with damage of feeding and breeding ground.	• Habitat quality would be improved. • This habitat would support to grow different types of aquatic vegetation which would be used for fish feeding and habitation.	+2
Fish movement and migration	• Fresh and brackish fish species move and migrate through water control structures on regular basis during high tide	• Same as base condition or would be increased	• Fish movement and hatchling would be restricted but internal movement and migration would be improved	+2
Capture fisheries productivity	Capture fisheries production in Khal is about 130 kg/ha	Capture fisheries production would decrease to 117 kg/ha	Capture fisheries production would increase to about 147 kg/ha	+3
Ecological Resources				
Terrestrial Vegetation	Moderate	• Increase threats on surrounding vegetation due to natural disaster and human activities. • Most of the terrestrial faunal species will be displaced due to vegetation damage for the existing problem.	Vegetation loss will be reduced and floral species will be increased due to protection from existing problem.	+3
Aquatic flora and fauna	Moderate	• Aquatic habitat quality would be deteriorated due to death of aquatic plants. • Reduced depth for continuous siltation would cause deterioration in the internal khals habitat.	Improve Aquatic habitat due to improvement of plant diversity as well as water in the water depth and velocity in the khals.	+2

IESC	Baseline	Future Without Project	Future With Project	Impact (+/)/ Magnitude (1-10)
Socio-economic Condition				
Access to open water bodies	People cannot use water for bathing, washing and other purposes for the drainage congestion.	Drainage congestion may further increase which would eventually create more disturbances to supply water into agricultural land. As a result quality of life will 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 relations among themselves.	+2
Gender promotion	In the polder area only 3 percent females are working whereas 97 males are engaged in income generating activities.	In polder area, most of the people are living under poor condition. Specially, the females are mostly vulnerable to distressed and widow who are dependent on others do not have any definite sources of income. Therefore, in without project situation they will be more vulnerable and would be burden to the society.	The employment opportunity for women during construction and during operation/maintenance phases can promote them into better life and livelihood.	+3
Employment opportunity	At present, the MPI of the polder is 0.130 (in 2014) compared to Bangladesh 0.292 (in 2007) which indicates the status of poor HHs which is reducing.	Under the FWOP situation, these sufferings may remain same or will be may deteriorate more.	Proposed intervention would improve the quality of life. More income and employment opportunity in different interventions would ensure better life and livelihood for stakeholder of the polder.	+2

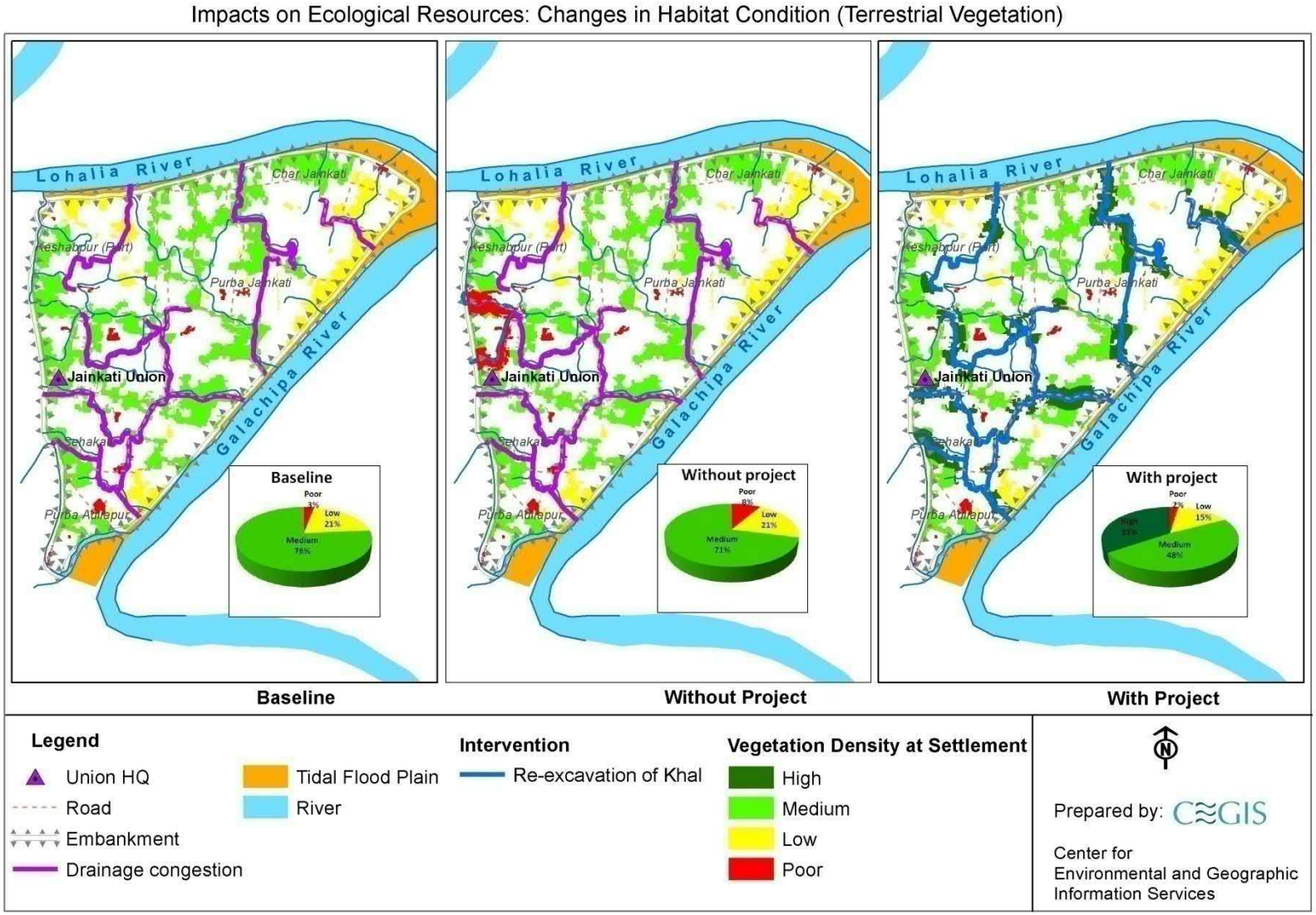
** Low impact (1-3); Medium impact (4-6); High impact (7-10)*



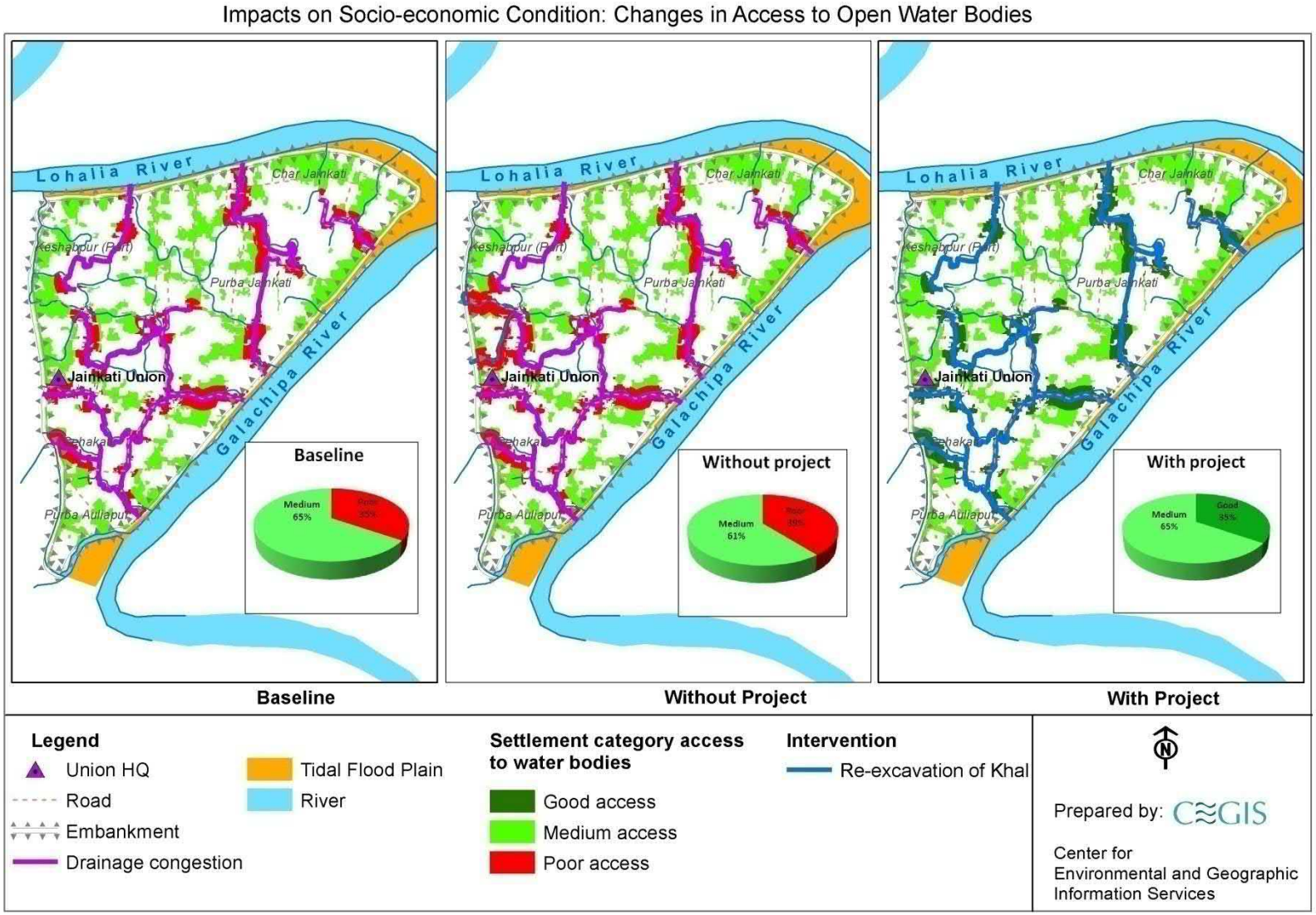
Map 8.1: Impacts on water resources: drainage congestion and water logging



Map 8.2: Impacts on Land and Agricultures : Changes in irrigated area



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



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

9. Assessment of Cumulative, Induced and Reciprocal Impacts

9.1 General

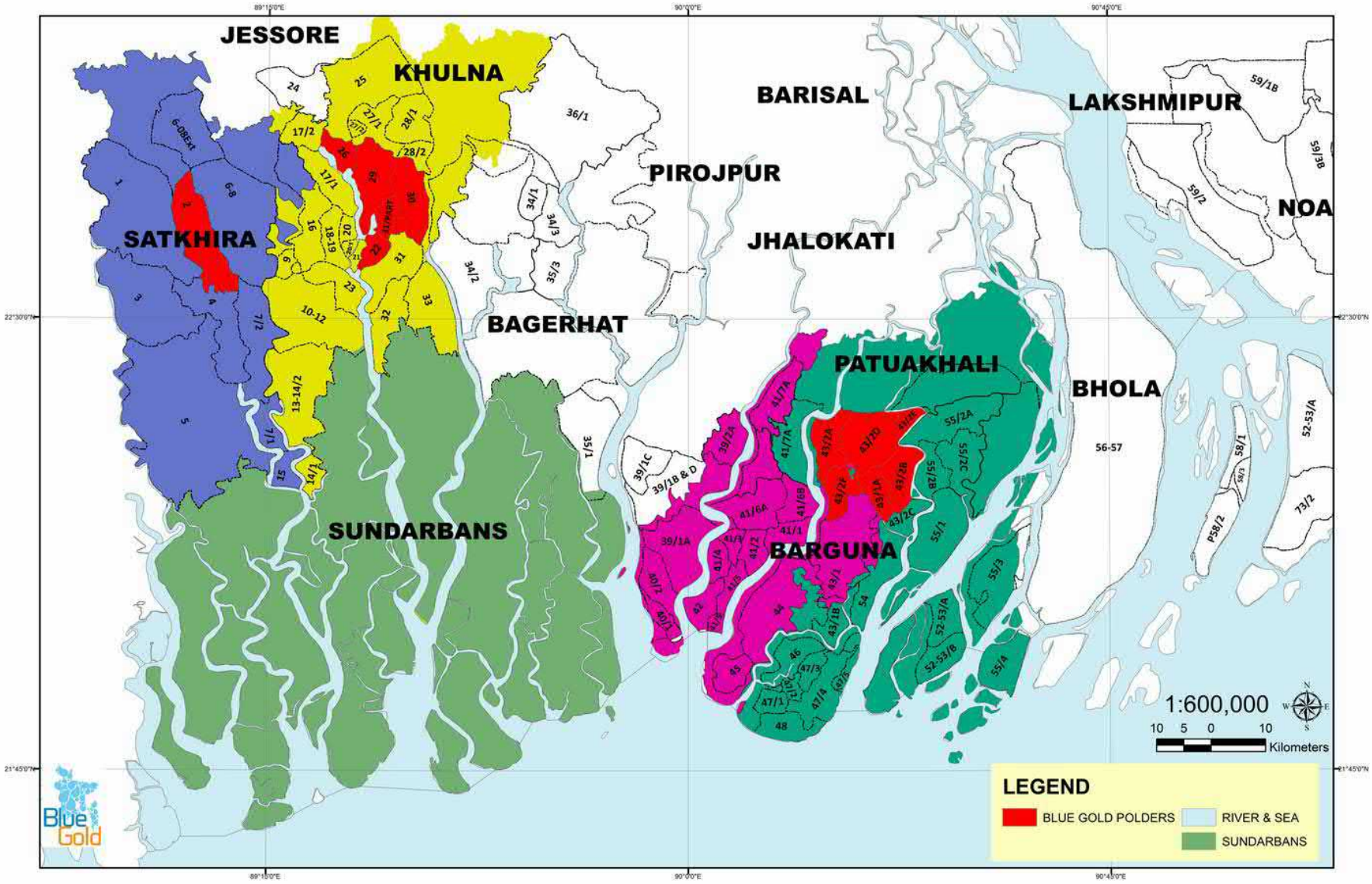
363. This Chapter attempts to analyze several indirect effects regarding the implementation of different interventions proposed under Blue Gold Program in Polder 43/2E. These effects include cumulative and induced impacts of Polder 43/2E, and the reciprocal impacts of climate change and polder. Cumulative 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, Apart from the Blue Gold, a number of other projects In the vicinity of Polder 43/2E polders also exist. 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 43/2E

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, two polders (Polders 43/2D and 43/2B) are located adjacent to Polder 43/2E and therefore, may generate some impacts in future. The existing crest levels of Polder 43/2D ranges from 3.65 to 3.86 m above MSL and that of Polder 43/2B ranges from 3 to 4 m above MSL. Rate of sedimentation may increase along the Lohalia River if re-sectioning of the embankment is executed in polders 43/2D and 43/2B. This is because when the crest levels of these 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, tidal flow from the Lohalia River may not enter the polders, which would confine the river sediments within these two river system. With reduced river sections along the river, flow velocity might also increase, creating more pressure along the South-West corner of Polder 43/2E. This may increase river erosion in Polder 43/2E in future. Formation of adjacent polders may have a major impact on the socio-economic scenario. Due to similar physical and social structure, local communities from these polders may collaborate and cooperate in various ventures which might change the social and economic spectrum of this area.

9.2.1 Synopsis of projects around Polder 43/2E

364. Apart from Blue Gold interventions, there are some other development projects nearby Polder 43/2E, 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 43/2E, undertaken by different line agencies in Patuakhali and Barisal districts.



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

Table 9.1: List of water management projects

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

365. 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 43/2E are briefly discussed in the following sections.

9.2.2 Cumulative Impacts of proposed Ganges Barrage

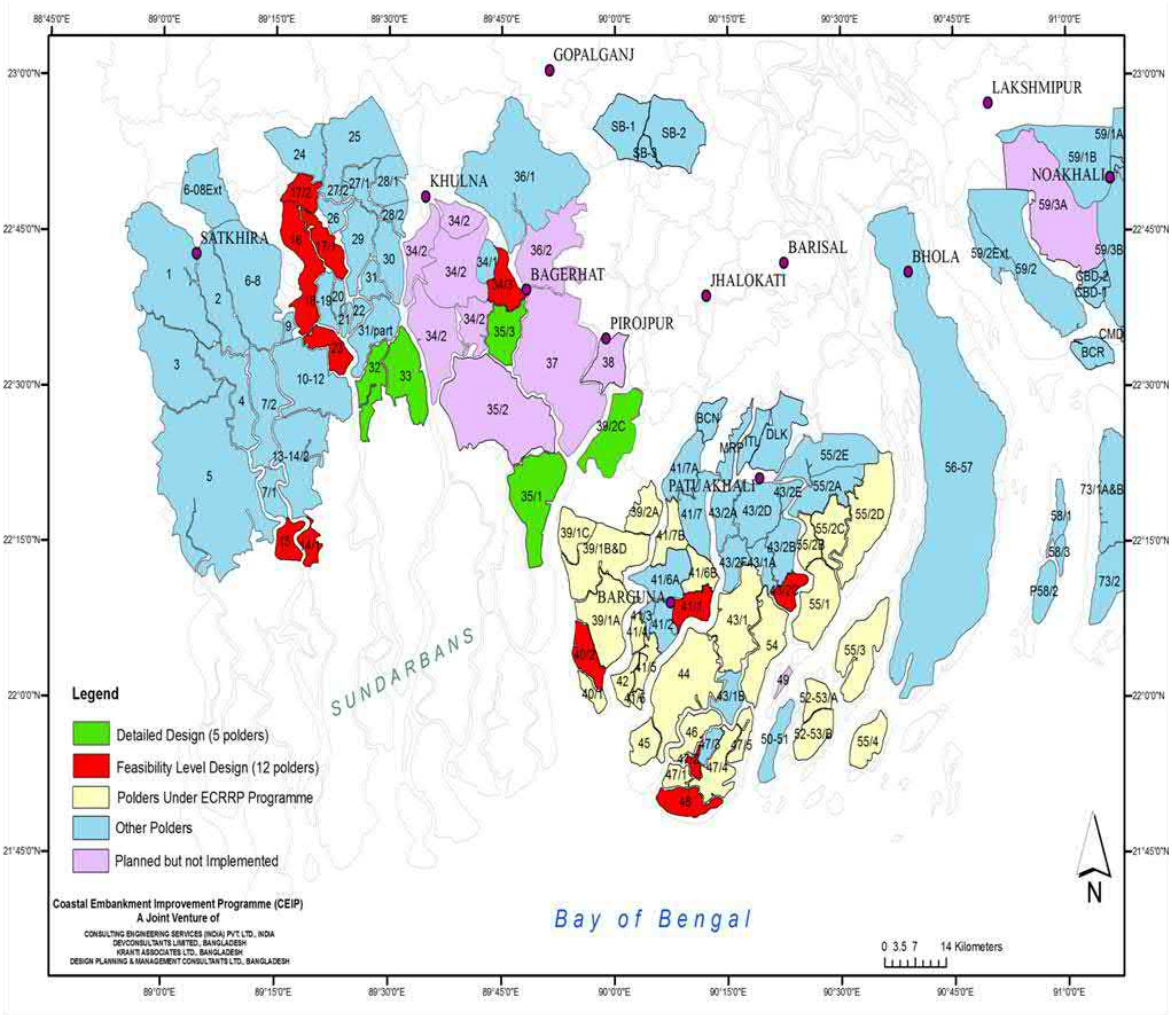
366. Ganges Barrage Project is perhaps the most significant project for the coastal region of Bangladesh. The project is expected to manage the water resources system, promoting socio-economic development in equitable fashion, and to recover the existing environmental degradation. GoB already finalized 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.

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

368. Polder 43/2E is located within the GDA, and bears significant sensitivity towards the proposed Ganges Barrage. The most significant impact of the barrage on Polder 43/2E would be the reduction of surface water salinity in its adjoining river system. At present, the peripheral Lohalia River carry low salinity concentrations during dry season, which even hampers the agricultural water use. The proposed Ganges Barrage will benefit dry season water use; enhancing surface water irrigation practices within the polder. This would eventually enhance production and food security of the area. Several saltwater species may face extinction in the long run, creating scopes for new ecological diversities of freshwater tolerant species. On 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 may be benefited as a whole.

9.2.3 Cumulative Impacts of Coastal Embankment Improvement Project (CEIP)

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



Map 9.2: Location of CEIP polders

370. Polder 43/2C is located along the Lohalia River, within at distance of 15 km downstream of Polder 43/2E. The existing crest levels of the polder ranges from 3.32 to 3.6 m above MSL. Re-sectioning works are proposed in the polder under CEIP, which would increase its crest level up to 5.18 m (in most locations) above MSL. This increase would reduce storm surge to enter into the polder, and additional storm surge may be diverted towards Polder 43/2E. As such, the risk of storm surge inundation may increase in Polder 43/2E. Furthermore, tidal sedimentation may increase outside Polder 43/2E, along Lohalia River, which may increase the flow velocity towards the upstream location during high tide. This may create pressure on the North-eastern portion of Polder 43/2E, along the Lohalia River where it has changed its course, and may result in river erosion incidents in future.

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

371. In order to facilitate recovery from damage to livelihoods and infrastructure caused by Cyclone Sidr and to build long-term preparedness through strengthened disaster risk management, GoB implemented the 'Emergency 2007 Cyclone Recovery and Restoration Project (ECRRP)' in a total number of 13 districts (Barguna, Bagerhat, Barisal, Khulna, Bhola, Pirojpur, Jhalokati, Noakhali, Feni, Chittagong, Potualkhali, Sathkhira, Laksmipur) of Bangladesh. A major component of the activities of this project is rehabilitation of embankments and among the 35 polders considered for rehabilitation under the project, Polders 55/2B and 55/1 are located near Polder 43/2E, along the downstream of Lohalia

River (**Map 10.2**). The design crest levels of these polders are: 4.88 to 5.48 m above MSL for Polder 55/1, 3.97 m to 4.27 m above MSL for Polder 55/2B. These two polders will tend to divert the flow of Lohalia River further upstream and will transfer storm surge inundation risks. There may also be flood plain sedimentation along the river as a significant portion of tidal water would be prevented from entering those polders, which may reduce the depth of flow of Lohalia River in future. Due to the reduced depth, the probability of the river erosion in Polder 43/2E may increase.

9.2.5 Cumulative Impacts of Other Projects

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

Water Management Improvement Project (WMIP)

373. 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 43/2E 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 43/2E. 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)

374. 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. Till 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 43/2E. The interventions proposed under the project are localized within the polder, and will not have any large scale impacts on Polder 43/2E. However, there may still be some social impacts regarding labor harnessing, employment opportunities etc.

Capital Dredging of River system

375. 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 43/2E. 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 43/2E may slightly be benefited. In future, if more similar dredging works are initiated nearby, Polder 43/2E may be further benefited.

9.3 Induced Impacts of Polder 43/2E

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

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

Tidal and Storm Surge Flooding

378. Polders 55/2A and 55/2E are located adjacent to Polder 43/2E. As per design, the crest level of Polder 43/2E would be raised up to 4.3 m above MSL, which may impose tidal and storm surge inundation risks to the adjacent polders (Polders 55/2A and 55/2E) during extreme events. Tidal water may not be able to enter Polder 43/2E during such events, and will be diverted elsewhere. This may increase the risk of flooding in the aforementioned nearby polders.

Affect on water quality

379. The interventions in Polder 43/2E 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 Lohalia River. Furthermore, due to expansion of agricultural area, more agriculture practices and industrialisation are expected, which might pollute the chemical composition of surface water system near the polder.

Changes in aquatic habitat, species migration and biodiversity

380. Due to increased floodplain sedimentation outside the polder, aquatic habitat may slightly be affected. Flow sections may decrease considerably and spacing for aquatic habitat might change. With the increased flow velocity along the upstream and downstream of the polder, new options for species migration and biodiversities may be opened up. Salinity concentration might increase in the peripheral rivers in future as a consequence of prevention of dry season entry of saline water, for which the salinity tolerant aquatic species may dominate while fresh water aquatic species may decrease. Biodiversity of aquatic life may also decrease in the Lohalia River.

Employment opportunities and Livelihood improvement

381. 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 43/2E, 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

382. 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 43/2E 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

383. In order to investigate the reciprocal impacts of Climate Change and Polder 43/2E, 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

384. 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)

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

River Bathymetry Data

386. 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

387. 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

388. 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

389. 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

390. 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

391. 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 9.2. The results infer that the monthly rainfall values may increase from April to October and decrease from November to March. Around 20% of the monthly rainfall will be decreased by 2050s for December and January, though the amount is very low during that period. Monthly rainfall will increase by 1.5 to 3.5 % during July and September by 2050s. Monthly temperature values will increase by 1.6^0C to 2.0^0C with an average rise of 1.8^0C by 2050s in the polder area.

Table 9.2: Change in monthly temperature and rainfall for the climate change scenario A1B with 50% ensemble of 16 GCM results by 2050s for polder 43/2E

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

Note: the negative (-) value in the table represent the decrease in rainfall or temperature

Source: Climate Wizard, Washington University (http://climatewizard.org/)

Sea Level Rise

392. Projected global average sea level rise during 2090-2099 with respect to 1980-1999 has been presented in Table 9.3 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 9.3: Predicted global sea level rise for different climate change scenario by 2100

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

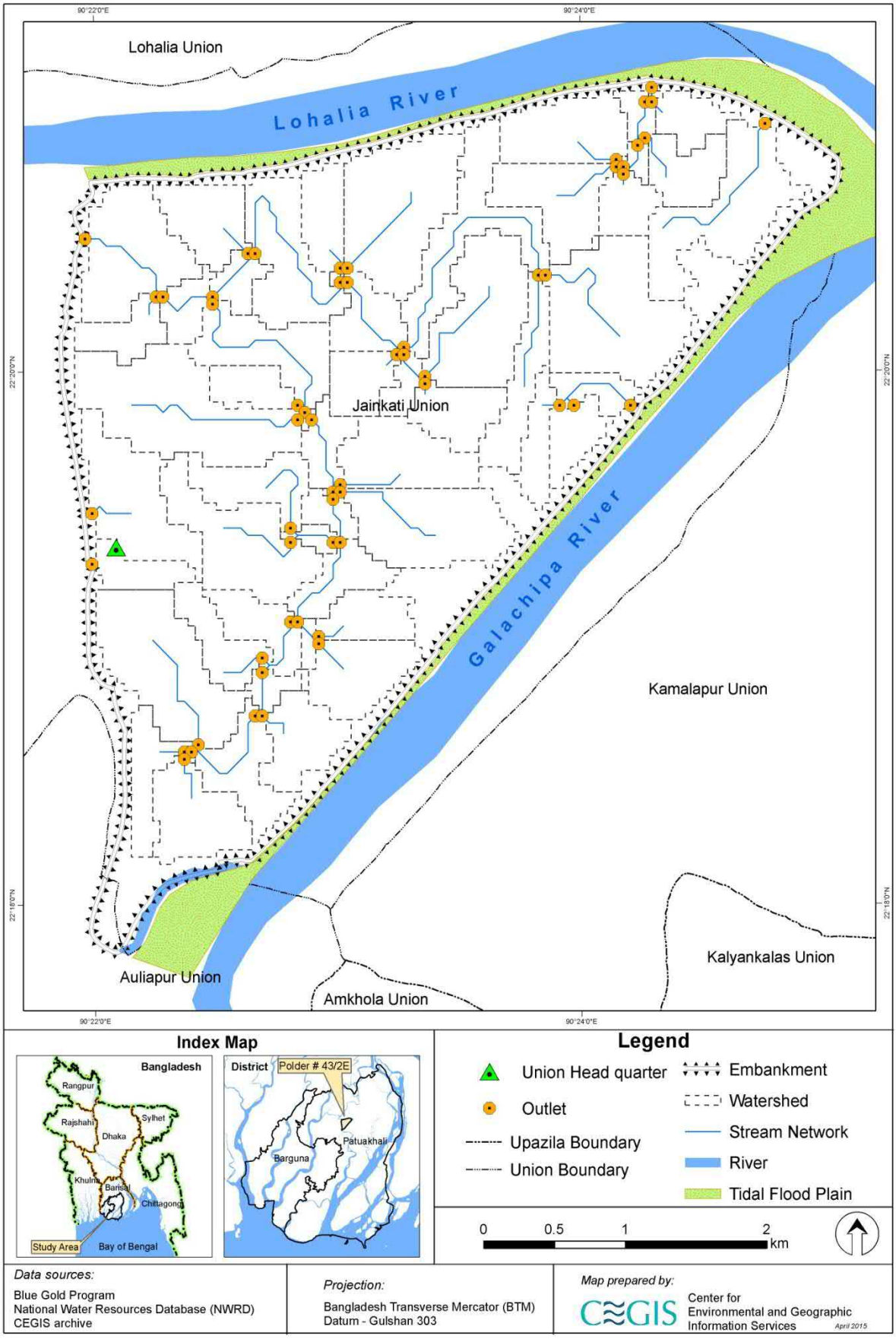
Source: IPCC AR4' 2007

9.4.2 Model Schematization

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

SWAT model Setup

394. Five sequential steps are followed to schematize the SWAT model: watershed delineation, Hydrological Response Unit (HRU) definition, weather data definition, assembling and editing SWAT inputs, and the actual simulation run. The watershed delineation is performed with the automatic delineation tool of SWAT 2012 using the DEM and the river network. All the watershed delineation steps such as filling sink, defining flow direction and accumulation have automatically been done through the user interface. The watershed delineation results 57 watersheds for the entire polder area. The delineated watershed for polder 43/2E is shown in Map 9.3. Afterwards, 166 numbers of HRUs were generated with three land classes, five soil classes and 57 watersheds.



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

Delft 3D model Setup and Calibration

395. A 2-D hydrodynamic model was setup for the Padma and Lower Meghna river system. The schematization of the model is shown in Map 9.4. The model starts from the Padma River to the Bay of Bengal. The bathymetry of the river has been generated from the interpolation of available cross-sections at a distance of 100 m using the HEC-RAS model. Daily discharge data of BWDB at Mawa has been utilized as upstream flow boundary and astronomical constituent values has been used to generate the tidal boundary at the sea and utilized as downstream boundary condition of the model. The model has been simulated with a time step of 5 min for the year 2000. It has been simulated for water level, discharge and salinity.

396. 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.

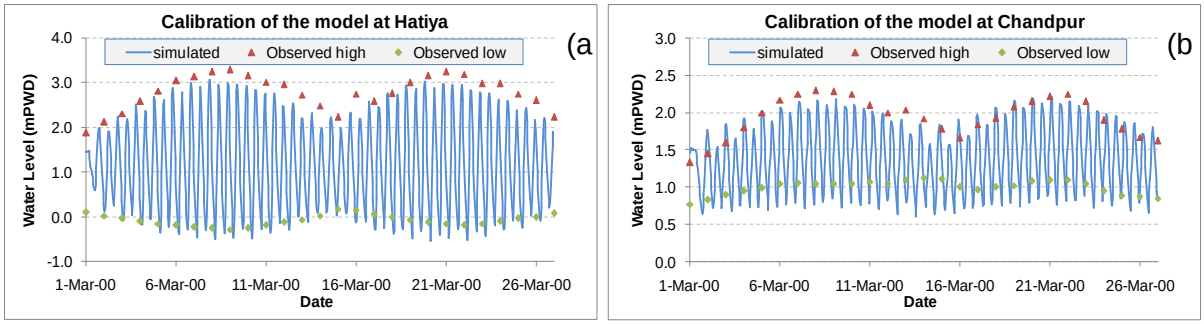
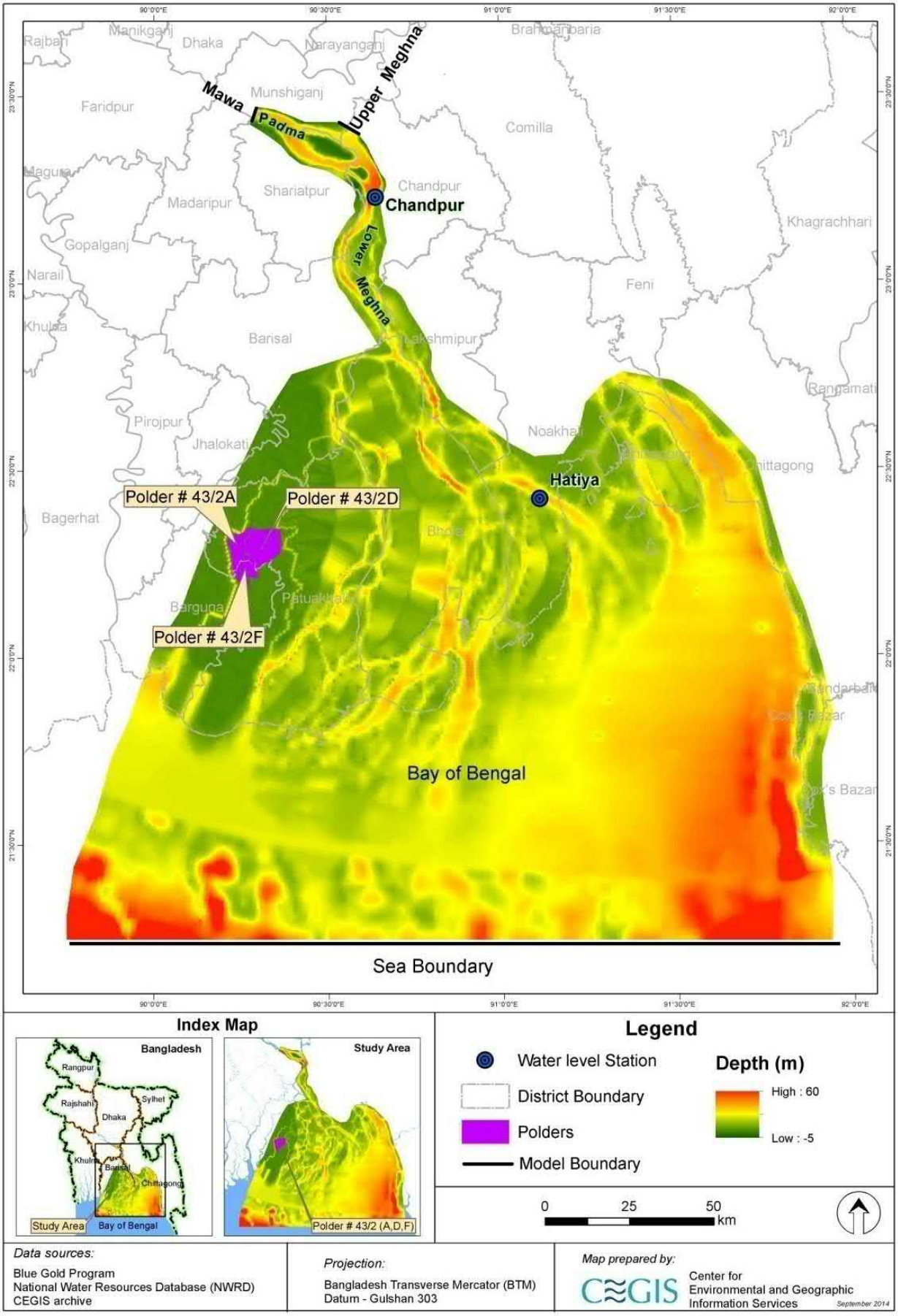


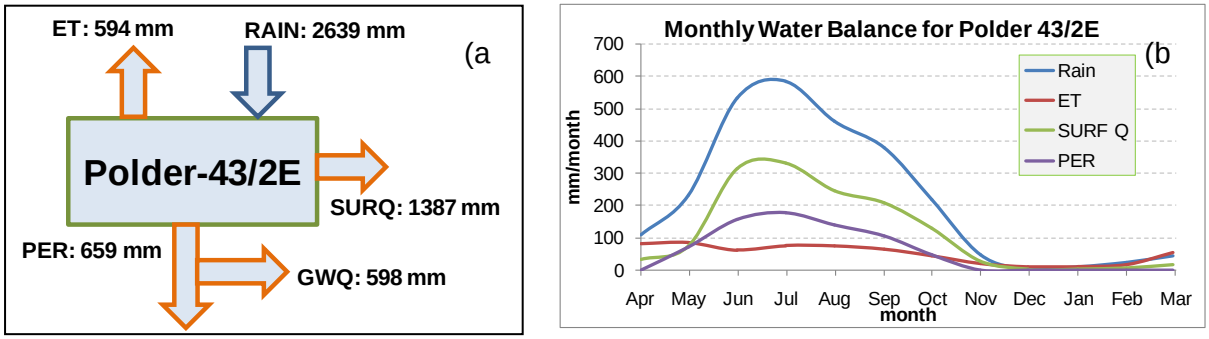
Figure 9.1: Calibration of model results at (a) Hatiya and (b) Chandpur for March, 2000



Map 9.4: Schematization of hydrodynamic model using Delft 3D

Water Balance of the Study Area

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



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

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

398. 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.

399. Input to the water balance is rainfall while losses occur through evapotranspiration and percolation and as water contributing to stream flow through surface runoff. The annual actual evapotranspiration of the area is 594 mm which is 23% of the annual rainfall. The evapotranspiration is maximum during April and May and is about 100 mm per month. The evapotranspiration rate is minimum during December to January. The percolation rate in the polder area is 659 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 losses of water through evapotranspiration and percolation, the remaining portion contributes to stream flow as overland flow and lateral (subsurface) flow. Around 53% (1387 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

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

401. The climate change impact on annual water balance in the Polder 43/2E is given in Table 10.4 for climate change scenario A1B by 2050s.The annual average rainfall for the polder area will be 2,694 mm which is about 2% more than the base condition. The surface runoff will also increase as there will be an increase in annual rainfall. There will be slight increase in annual evapotranpiration (9 mm/year) which is mainly due to the increase of temperature. There will also be minor increase in annual percolation due to climate change.

Table 9.4: 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	1387	1432

Climate parameter	Amount (mm)	
	During base (1981-2012)	CC_2050s
Evapotranspiration	594	603
Percolation	659	660
Baseflow	598	597

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

403. The availability of water will increase during May to October as there will be an increase in rainfall during that period. During the dry period (Dec-Feb), the water availability will decrease due to climate change by 2050s. The increase will be around 4 to12 mm and decrease around 2 mm per month.

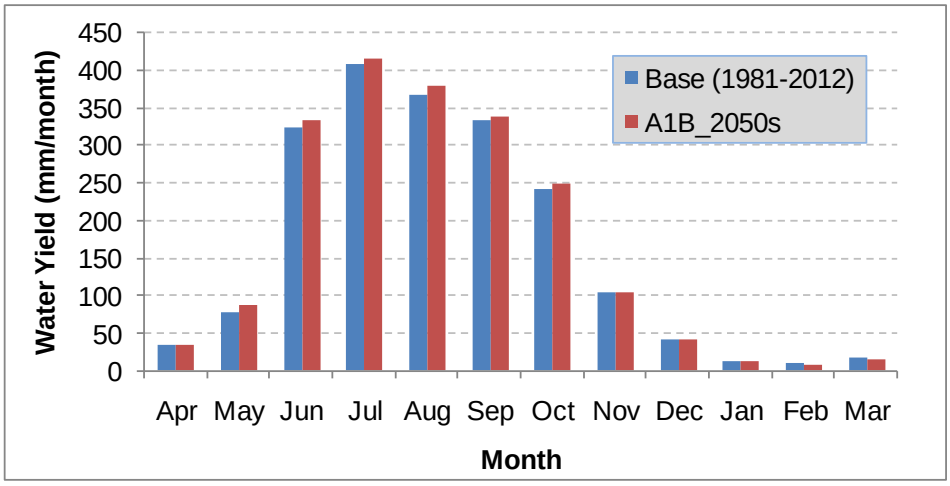


Figure 9.3: Climate change impact on monthly water yield for climate scenario A1B by 2050s

404. Table 9.5 below shows the changes in seasonal water yield due to climate change by 2050s for scenario A1B. The Table shows an increase in seasonal water yield during monsoon (2.1 %) and decrease during dry season (6.5%). Minor seasonal water yields during pre-monsoon and monsoon would also occur.

Table 9.5: 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)	120	10.6
Monsoon (Jun-Sep)	1464	2.1
Post-monsoon (Oct-Nov)	351	1.8
Dry (Dec-Mar)	84	-6.5

9.4.4 Climate Change Impact on Water Level

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

406. 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 the above two scenarios and the simulated maximum water level during monsoon has been compared with the base year (2000) to assess the impact of climate change and sea level rise on flood level.

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

9.4.5 Climate Change Impact on Salinity

408. 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.

409. 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 43/2E will increase by 1.7 ppt during the dry period. The increase in river salinity may cause 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 43/2E

410. The local people in Polder 43/2E are aware of the climate change consequences and natural hazards. In recent years they have been affected by frequent climate change induced natural disasters, causing massive loss to lives and properties. Due to some of the initiatives taken through different software interventions by programs other than Blue Gold, the insight of climate resilience has already been developed within the polder habitants. Through the community mobilization in Blue Gold program, local people have become more active towards building a climate resilient society. They are now driven by the concept of climate smart village. The people who can afford are now rebuilding their houses and infrastructures on higher plinth level. Local people claimed that they would use the excavated spoil from the internal khals for their household purpose if available. This will allow them to have their house and other infrastructures on a re-built higher land. The local farmers are now more concerned about climate change issues as well. They regularly 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

411. This chapter provides Environmental Management Plan for the pre-construction, construction and operation phases against the impacts on the IESCs pertaining to water resources, land and agriculture resources, fisheries resources, ecological resources and socio-economic conditions together with a necessary monitoring program.

10.1 Water Resources

10.1.1 Pre-construction and Construction phases

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

10.1.2 Operation phase

413. The implementation of the 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 and compensation, or contingency measures for immitigable residual impacts as discussed in the following Table 10.1.

Table 10.1: EMP Matrix for Operation Phase on Water Resources

Impact	Mitigation Measure	Enhancement/Contingency/Compensation	Residual Impact (+/-)/ Magnitude (1-10) With EMP	Responsible Agency
IEC: Surface Water Availability				
Around 10% people in Purba Jainkati, Sehakati, Keshabpur (part), Fedainagar and Char Jainkati would be guaranteed for having sufficient surface water availability and access to water.	Not required	Not required	+3	-
IEC: Drainage Congestion and Water Logging				
Around 20% khals inside the polder would be benefited from probable drainage congestion problems.	Not required	Not required	+3	-

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

10.2 Land Resources

10.2.1 Pre-construction and Construction phases

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

10.2.2 Operation phase

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

Table 10.2: EMP Matrix for Operation Phase on Land Resources

Impact	Mitigation Measure	Enhancement/ \Contingency/ Compensation	Residual Impact (+/-)/ Magnitude (1-10) with EMP	Responsible Agency
Single cropped area would decrease by about 14% but double and triple cropped area would increase by 7%, 7% respectively in FWIP over FWOP.	-	• Formation of WMGs (GPWM-2002). • Strengthening of WMGs through imparting training on proper management of structure and utilization of spoil earth materials which will be generated from re-excavation. • Involvement of WMGs in different polder activities.	+3	BWDB, DAE and WMGs

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

10.3 Agricultural Resources

10.3.1 Pre-construction and Construction phases

416. No significant positive or negative impacts on agriculture resources have been foreseen during both pre-construction and construction phases for implementation of the proposed interventions in Polder 43/2E. As such, no activities under the proposed EMP have been recommended for these two phases.

10.3.2 Operation phase

417. The implementation of the 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 impact, enhancement for positive impacts and compensation, or contingency measures for as discussed in the following Table 10.3.

Table 10.3: EMP Matrix for Operation Phase on Agricultural Resources

Impact	Mitigation Measure	Enhancement/ Contingency/Compensation	Residual Impact (+/-)/ Magnitude (1-10) with EMP	Responsible Agency
Expected that cropping intensity would increase by about 14%.	-	• Involvement of WMGs in polder activities would enhance cropping pattern and intensity. • Introduction of HYV/Hybrid crop cultivars along with crop diversification need to be practiced.	+4	BWDB, DAE and WMGs

Impact	Mitigation Measure	Enhancement/ Contingency/Compensation	Residual Impact (+/-)/ Magnitude (1-10) with EMP	Responsible Agency
Additional 984 tons (47%) of rice and 3,380 tons (67%) of non-rice would be produced in FWIP over FWOP.	-	• Organic manure should be applied for restoration of soil fertility; • Farmers group should have close contact with SAAO of DAE for adaptation of various measures on ICM. • Irrigation should be provided in optimum level with minimum conveyance loss. • Involve the WMGs in polder activities which would enhance crop production. • Introduction of HYV/Hybrid crop cultivars along with crop diversification need to be practiced.	+5	BWDB, DAE and WMGs
It is expected that loss of cleaned rice production would be reduced to233 tons which would be 75% less in FWIP over FWOP.	-	• The repair of flushing sluice, drainage Outlet and irrigation Inlet would help to reduce crop damage situation. • The Water Management Groups (WMGs) should be given orientation to protect their standing crops from implementation of the intervention and development on farm water management etc	+4	BWDB, DAE and WMGs
The irrigated area would be increased by 106 ha in FWIP over FWOP.	-	• Training may be provided to WMGs on “integrated water management” • The WMGs should be involved in the integrated water management through proper maintenance of regulators (sluice gate, inlets and outlets) for the expansion of irrigated area.	+2	BWDB, BADC, DAE and WMGs

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

10.4 Fisheries Resources

10.4.1 Pre-construction phase

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

10.4.2 Construction phase

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

Table 10.4: EMP Matrix for Construction Phase on Fisheries Resources

Impact	Mitigation Measures	Enhancement/ Compensation / Contingency	Residual Impact (+/-) Magnitude (1-10) with EMP	Responsible Agency
• Movement and migration of fish species like *Chingri, Baila, Pairsa, Vetki* and fresh water fish like *Puti, Tengra* and SIS etc would be obstructed/limited during repairing of structures. • Feeding and breeding ground of bottom dweller fishes will be lost	• Avoid construction activities during fish migration period e.g. month of June to August • Re-excavation activity should be implemented in segment wise • Spoil earth should be dumped at a setback distance from the khals • To protect indigenous fishes and other aquatic creators, re-excavation should be implemented in segment wise and one after another.	N/A	0	Contractor, BWDB, Department of Fisheries (DoF)

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

10.4.3 Operation phase

420. The implementation of the 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 impact, enhancement for positive impacts and compensation, or contingency measures for immitigable residual impacts as discussed in the following Table 10.5.

Table 10.5: EMP Matrix for Operation Phase on Fisheries Resources

Impact	Mitigation Measures	Enhancement/ Compensation/ Contingency	Residual Impact (+/-) Magnitude (1-10) with EMP	Responsible Agency
Seasonal khal would become perennial khal again. The improved habitat quality would support different types of fishes as well as aquatic vegetation which would be helpful for fish feeding and habitation.	NA	• Re-excavated khals should be kept free from encroachment. • Awareness development on natural resources, camping against indiscriminate fishing and reinforcement of fisheries laws and regulation in the polder area.	+3	Department of Fisheries in coordination with WMC

Impact	Mitigation Measures	Enhancement/ Compensation/ Contingency	Residual Impact (+/-) Magnitude (1-10) with EMP	Responsible Agency
		• Apply IPM in agriculture field for protection of capture fish habitat quality.		
Movement of both brackish and fresh water fish species as well as hatchling movement through water control structures would be slightly hampered. But internal fish migration would be facilitated significantly.	NA	• Gate should be opened properly and timely to entrance the fish hatchling in the month of May to July except the tidal surge. • Water Management Committee should be formed with inclusion of fisher's representative.	+3	Department of Fisheries in coordination with Water Management Committee
Capture fisheries productivity would be increased by 30 kg/ha. Culture fish productivity would also be increased significantly.	NA	• Construct deep pool in the perennial khals (Naotan khal, Katakhali Khal, Gagonkhati Khal, Dholkhali Khal, Suddurbaria Khal, Moubaria Khal etc). Pool area will be davaloped in the khal which is covered 600 to 700 m^2 and 1.5 m depth below the bed level of khals. • Rest of the silted up khal should be re-excavated immediately • Training on fish culture should be provided along with pond demonstration and monitoring activities should be implemented in the polder area.	+4	Department of Fisheries in coordination with pond owners.

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

10.5 Ecological Resources

10.5.1 Pre-construction

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

10.5.2 Construction phases

422. The implementation of the proposed interventions may generate some temporary impacts on ecological resources during construction phase, as discussed in Chapter 8. Some of the impacts would require different levels of mitigation for negative impacts,

enhancement for positive impacts and compensation, or contingency measures for immitigable residual as shown in following Table 10.6.

Table 10.6: EMP Matrix for Construction Phase on Ecological Resources

Impact	Mitigation Measure	Enhancement/ Contingency/ compensation	Residual Impact (+/-)/ Magnitude (1-10) with EMP	Responsible agency
Activity: *Repairing of embankment*				
• Temporary damages of herbs, shrubs, various type of grass and bushes due to soil dumping for repairing work.; • Relocation of wildlife due to temporarily loss of habitat	• plantation along the slopes of embankment after completing the earth works; • construction activities should be avoided in the early morning and night to evade disturbance to wild fauna;	N/A	-1	Contractor and BWDB
Activity: *Construction of drainage outlet*				
• Temporary reduction of habitat quality due to obstruction of flow in the khal	• The works should be completed within the scheduled time	N/A	-2	Contractor and BWDB
Activity: *Re-excavation of khal*				
• Damages of existing aquatic vegetation would cause habitat degradation for aquatic birds (ie. Egrets) and fishes e.g. Egret. • Damages of existing bank line vegetations due to dumping of soil along both sides of the khal	• Keep the deepest points of the khal untouched as much as possible; • The works should be completed in scheduled time to minimize habitat disturbance to wildlife	N/A	-2	Contractor and BWDB

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

10.5.3 Operation phase

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

Table 10.7: EMP Matrix for Operation Phase on Ecological Resources

Impact	Mitigation Measure	Enhancement/ Contingency/ compensation	Residual Impact (+/-)/ Magnitude (1-10) with EMP	Responsible Agency
Improve terrestrial Vegetation	N/A	Plant mixed species of native trees along the embankment slopes wherever possible to enhance green coverage.	+4	BWDB, FD and local stakeholder.

Impact	Mitigation Measure	Enhancement/ Contingency/ compensation	Residual Impact (+/-)/ Magnitude (1-10) with EMP	Responsible Agency
Improve Aquatic flora and fauna due to improvement of plant diversity as well as khal depth and velocity	N/A	• Ensure regular maintenance/re-excavation of all khals as and when needed • Ensure proper maintenance of all water control structures	+2	BWDB and local stakeholder.

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

10.6 Socio-economic Condition

10.6.1 Pre-Construction Phase

424. No significant positive or negative impacts on socio-economic condition have been foreseen during pre-construction phase for implementation of the proposed interventions in Polder 43/2E. As such, no activities under the proposed EMP have been recommended in this phase.

10.6.2 Construction phase

425. The implementation of the 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 positive impacts and compensation or contingency measures for immitigable residual impacts 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
Gender promotion	NA	- According to the project work, the LCS entail 60% male and 40% female, all of them would be engaged from the local area. Thus, ensure more gender promotion activities for female in future.	+3	Blue gold and BWDB
Employment opportunities	NA	- Local labor should be recruited for the construction work of the project area.	+3	Blue gold and BWDB

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

10.6.3 Operation phase

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

Table 10.9: EMP Matrix for Operation Phase on Socio-economic Condition

Impact	Mitigation Measure	Enhancement/ Contingency/ Compensation	Residual Impact (+/-)/ Magnitude (1-10) With EMP	Responsible Agency
Access to open water bodies	NA	- About 850 people will be benefited from the interventions i.e. they can use sweet water in different social activities. - Concentration should be given to re-excavate the remaining khals for ensuring equity and share of open water bodies.	+2	Blue gold and BWDB
Gender promotion	NA	- At least 40% of total labor will be recruited for these interventions and ensure more gender promotion in different sectors of present interventions of the polder.	+3	Blue gold and BWDB
Employment opportunities	NA	- Ensure/arrange training from DAE and DOF for local people.	+3	Blue gold and BWDB

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

10.7 Spoil Management Plan (SMP)

427. 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.

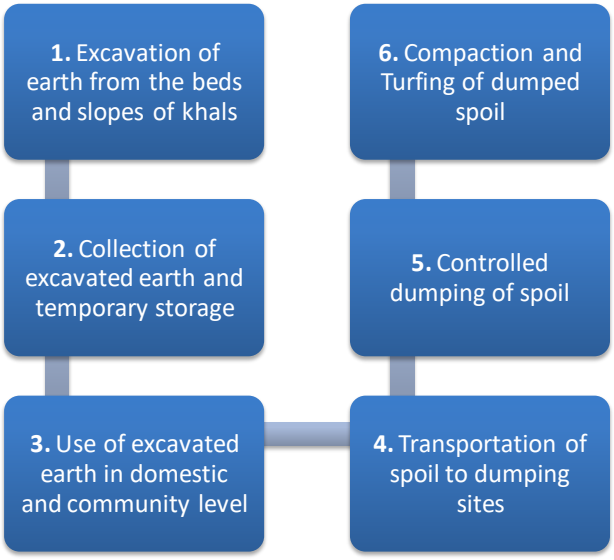


Figure 10.1: Framework for Spoil Management

10.7.1 Framework Proposed for SMP

428. Polder 43/2E of Blue Gold program entails excavation of a number of khals which would generate a volume of around 1,59,100 m^3 of spoil. This volume should be temporarily stored on the Khal openings to block the entry of flow. The rest should be used for different purposes before commencing the actual dumping process. The public consultation meetings

of the EIA study inferred that the local people are willing to collect the excavated spoil earth for their own household uses. **Figure 10.1** provides a framework which includes the major components of the proposed Spoil Management Plan for rehabilitation of the Polder 43/2E under Blue Gold Program. The framework entails six basic steps for excavation, collection, use, transportation, dumping and compaction of earth materials in connection with the proposed khal re-excavation works.

Table 10.10 below provides a tentative account of the volume of excavated earth, and its multifaceted uses proposed in the Spoil Management Plan. Around 30% of the excavated earth (50,000 m^3) can be used in embankment re-sectioning works. The rest should then be made available for local people for their multifaceted uses. Local people can collect a portion of the excavated spoil, and use it to fulfill their domestic requirements. The spoil may be used for raising the plinth level of their earthen kacha houses as well as individual house yards. Spoil may also be collected and used on community basis to strengthen the basements and earthen portions of other rural sheds and shelters such as school, mosques, community clinics etc. It is expected that around 23,865 m^3 spoil would be collected by for different uses. The residual portion (around 85 thousand m^3) of spoil may then be disposed on both sides in a controlled manner.

Table 10.10: Tentative volume calculation and distribution of excavated spoil

Khals to be Excavated	Excavated Volume (m^3)	Uses of Excavated Soil	Volume (m^3) to be used
Gagankhali Khal	10,500	Embankment Re-sectioning	50,000
Dholkhali khal	10,700	Societal uses (uses in household, schools, mosques, clinics or other shelters)	23,865
Moubaria main khal	20,500		
Suddurbaria Main khal	15,700		
Naotana khal	30,500		
Katakhali khal	20,700		
Natua Main khal	18,900	Dumping	85,235
Piprabunia khal	10,800		
Ponditer khal	20,800		
Total Excavation	**1,59,100**	**Total Use**	**1,59,100**

10.7.2 Phase wise activities of Spoil Management

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

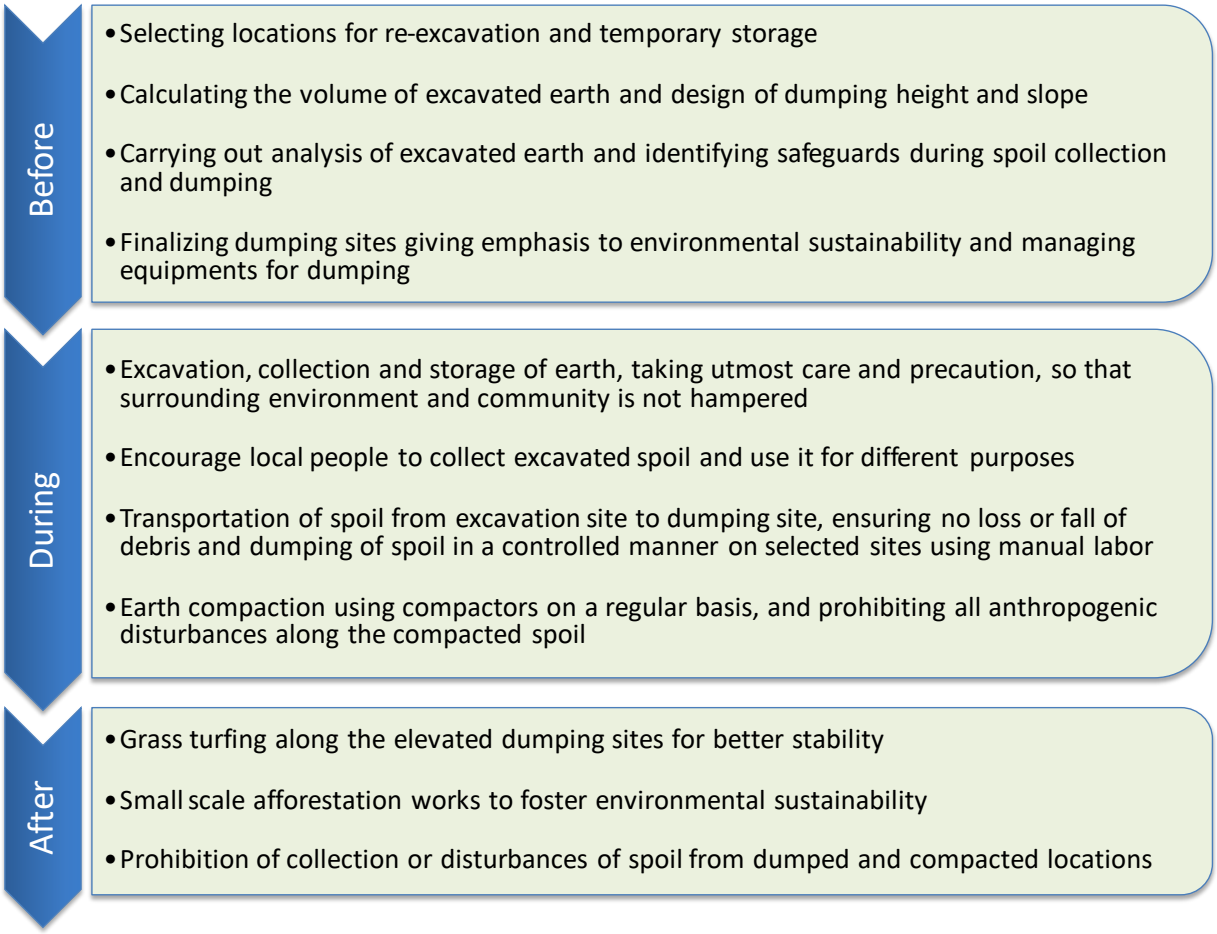


Figure 10.2: Phase wise activities of Spoil Management

10.7.3 Method of Spoil Dumping

430. The proposed re-excavation works for the Polder would require dumping of a significant amount of spoil (around 85,235 m^3). For a 2.5 m wide and 1.25m thick wedge, this equivalents to around 27.28 km length of dumped spoil. Polder 43/2E includes 16.425 km of re-excavation of khals, and if the residual spoil (85,235 m^3) is dumped on both sides of the excavated khals up to a height and width of 1.25 m and 2.5 m respectively, around 13.64 km lengths can be used on both sides. **Figures 10.3** and **10.4** below show the conceptual layouts of proposed dumping technique.

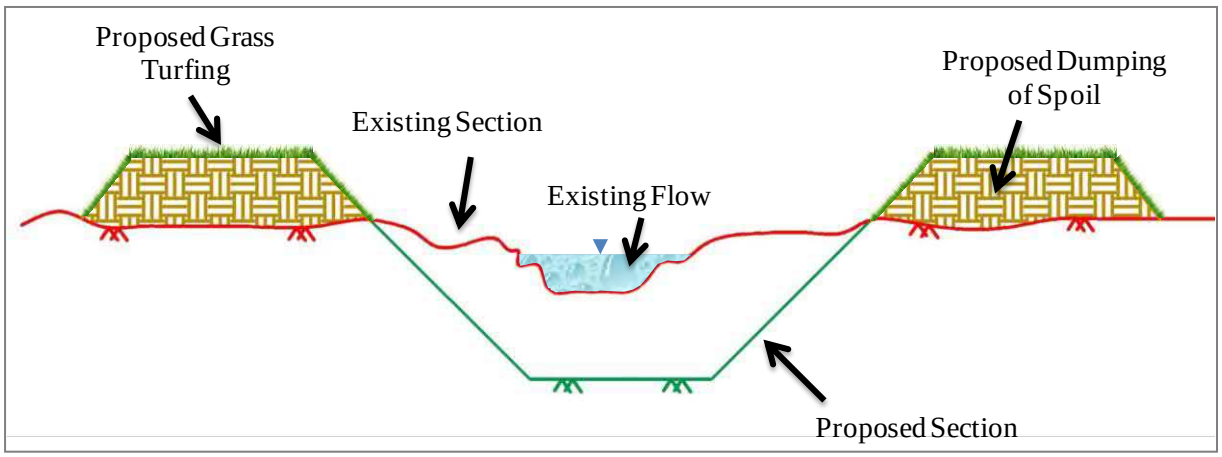


Figure 10.3: Conceptual Cross Section of a typical khal to be re-excavated

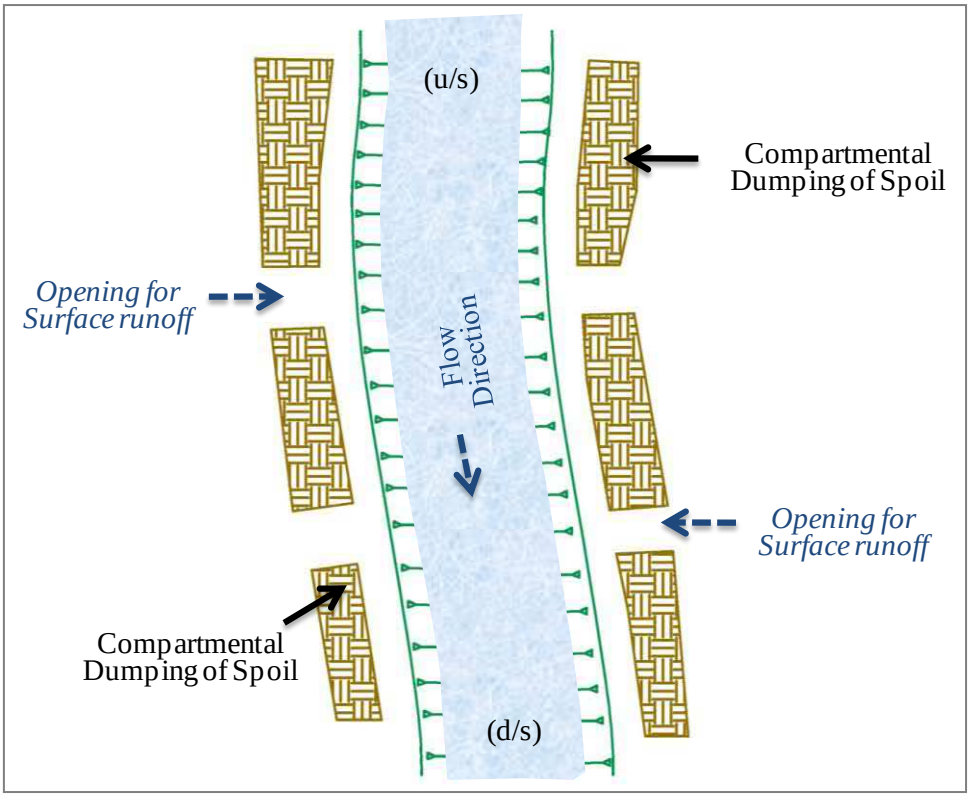


Figure 10.4: Plan form of a typical khal to be re-excavated

431. **Figure 10.3** illustrates the cross section of a typical khal which is to be re-excavated under the Blue Gold Program. The depths of khals have decreased over the years and re-excavation works would be carried out through the centerline of the khals. The bank sides of the khals are government owned khas lands which fall within the actual width of the khals. Spoil earth would be dumped on both bank sides of the khal, on these khas lands. This would provide raised level through the bank lines of excavated khals, which may prevent khal siltation in future through erosion of top soil. **Figure 1.4** shows a plan of the khal which is to be re-excavated. The figure shows that compartmental dumping spots could be created along the sides of the excavated khals, so that surface runoff after any rainfall can flow into the excavated khals and drain out properly.

10.7.4 Safety Measures and Precautions

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

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

- ✓ The works when are not in operation, the dumping locations may be covered with plastic or other water proof substances to avoid weather or moisture effects, which may reduce the strength or stability of the dumped spoil
- ✓ Dumping should be made firmly on the selected locations, and barriers or other measures may be provided on sensitive locations to ensure that no wastes from the dumped spoil falls back into the water courses
- ✓ It should also be ensured that the dumped spoil is not weathered and transported to any privately owned lands or lands of agricultural interests

10.8 Environmental Monitoring Plan

10.8.1 Monitoring Plan for Pre-Construction Phase

433. No specific monitoring plan is required to be followed during the pre-construction phase of the environmental and social component of the project in Polder 43/2E.

10.8.2 Monitoring Plan for construction phase

434. A typical monitoring plan have been prepared which will be followed during construction of rehabilitation of Polder 43/2E. The Monitoring report will be submitted to the concerned organizations 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 earth for construction of retired embankment				5	Obstruction of fish migration and hatchling movement			
2	Inconsistencies or mismanagement in embankment re-sectioning works				6	Hamper road communication			
3	Compaction of earth materials on embankment				7	Inconsistencies in water control structures requiring repair works			
4	No pollution from construction site				8	Any threat caused to riverbank area			

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

C.NON COMPLIANCE:

Period Description :

Class

1. Minor: Under One Month (Contractor alerted)

2.Moderate: Over One Month but under Two Months (Contractor warned)

3.Major: About Two Months (Contractor's local bill withheld by RE***** till compliance)

4.Critical: Over Three Months (Contractor's

	overall bill withheld by RE and PM***** till compliance)

D.CIRCULATION

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

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

10.8.3 Monitoring Plan for operation phase

Water Resources

Indicator	Method	Location	Frequency	Responsible Agency
Depth of khals	Field survey (e.g. boat and led method)	All the khals inside the polder	Once in dry season and once in wet season	WMOs and BWDB
Drainage Congestion and 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 43/2E.	Once a week (dry and pre-monsoon seasons)	WMOs and BWDB

Land and Agricultural Resources

Indicator	Method	Location	Frequency	Responsible Agency
Cropping intensity	Focus Group Discussion (informal discussions with stakeholders) and individual discussion with farmers should be followed.	Entire polder area	At harvest time of each cropping season (Will continue two years).	DAE and WMGs
Crop production	Informal discussions with stakeholders and individual discussion with farmers should be followed.	Entire polder area	At harvest time of each cropping season (Will continue two years).	DAE and WMGs
Crop damage	Informal discussions with stakeholders and individual discussion with farmers should be followed.	Entire polder area	At harvest time of each cropping season (Will continue two years).	BWDB, DAE and WMGs
Irrigated area	Informal discussions with stakeholders and individual discussion with farmers should be followed.	Entire polder area	During Rabi season (Will continue two years).	BWDB, DAE, BADC and WMGs

Fisheries Resources

Indicator	Method	Location	Frequency	Responsible agency
Species diversity and richness of fish	Catch monitoring/ observations and local fish market survey.	Perennial khals and adjacent floodplain in inside the polder area.	Twice per month in each location and to continue for two year.	DoF in cooperation with water management committee and local fishers.
Fish hatchling movement	Savar netting	Near sluice gate in major khals.	Once a week during fish migration period (May – August)	DoF in cooperation with Water management committee and local fishers.

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

Socio-economic Condition

Indicator	Method	Location	Frequency	Responsible Agency
Gender Promotion	Village wise RRA/informal discussions with stakeholders	Periphery within the polder	Every year	Blue gold
Employment opportunities	RRA and observation	Whole polder area	Twice a year	Blue gold and BWDB

10.9 EMP and Monitoring Cost

10.9.1 Cost of EMP and monitoring of Water Resources

435. There is no EMP and monitoring cost for water resources.

10.9.2 Cost of EMP and monitoring of land and agricultural resources

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 Contacting Society (LCS), on farm water	1.00	1	Re-excavation of Khals, disposal of spoil earth materials for spoil management and re-sectioning of embankment etc.	0.75

Sl. No	EMP measure	Cost (Lakh Tk.)	Sl. No	Monitoring item	Cost (Lakh Tk.)
	management and development etc. • Involvement of WMGs in polder activities would change positively.				
2	Involvement of WMGs in polder activities would enhance cropping pattern and intensity. Introduction of HYV/Hybrid crops cultivars along with crop diversification need to be practiced.	1.00	2	Cropping intensity	0.50
3	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 ICM. Irrigation should be provided in optimum level with minimum conveyance loss. Involvement of WMGs in polder activities would enhance crop production. Introduction of HYV crops with crop diversification need to be practiced.	2.00	3	Crop production	0.75
4	Dumping of spoil earth materials on non-agricultural land. WMGs should be involved in the construction and post construction phase which might reduce crop damage.	1.00	4	Crop damage	0.50
5	• Training of "Integrated water management" and "on farm development" of WMGs would help to increase the expansion of irrigated area. • The WMGs should be involved in the integrated water management through proper maintenance of sluice gate, inlets and outlets) for the expansion of irrigated area. • The irrigation water should be used at optimum level so that the area might be increased with limited scale of water.	1.00	5	Irrigated area	0.50
	Total =	**6.00**			**3.00**

436. Total cost of EMP and monitoring of land and agriculture resources is**Taka 9.00 lakh**.

10.9.3 Cost of EMP and monitoring of fisheries resources

Sl.	EMP measure	Cost (Lakh Tk)	Sl.	Monitoring item	Cost (Lakh Tk)
1	Construct fish sanctuary in the deep pool of perennial khals	1.2 (0.3 x 4= 1.2 Tk for six number of sanctuary)	1	Fish hatchling movement in four khals (Two year).	1.0

Sl.	EMP measure	Cost (Lakh Tk)	Sl.	Monitoring item	Cost (Lakh Tk)
2	Awareness development on natural resources and disseminate the knowledge about the important in our daily life through several national and international days like Fish Week, Environment Day, Earth day, water Day Rally, Discussion etc. Two year in the polder area.	1.5	2	Species diversity through Fish Catch Assessment/ observation in three khals. Three market survey once in a week (two year).	1.0
3	Training on fish culture and pond demonstration and monitoring (first year demonstration and next year monitoring)	Tk 2.0 (Training 1.5 and demonstration pond 0.5 Tk) (Number of pond :4 pond area: about 100 decimal)		-	-
	EMP Cost =	**4.7**		**Monitoring Cost =**	**2.0**
	Total cost =	**6.7**			

437. Total Cost for EMP and Monitoring of fisheries resources is **Taka 6.70 Lakh**

10.9.4 Cost of EMP and monitoring of ecological resources

Sl. No	EMP measure	Cost (Lakh Tk.)	Sl. No	Monitoring item	Cost (Lakh Tk.)
1.	Plantation along the embankment up to 20 km length of embankment	12.0	1	Habitat develop	4.0
			2	Wildlife diversity	4.0
	Total =	**12.0**		**Total =**	**8.0**

438. Total cost of EMP and monitoring of ecological resources is **Taka 20.00**lakh.

10.9.5 Cost of EMP and monitoring of socio-economic condition

	Pre-construction	Construction	Post construction	Total/ Lac
Total Monitoring cost	-	-	2.0	2.00
			Grand total =	**2.00**

439. Total cost of monitoring of socio-economic condition is **Taka 2.00 lakh**

10.10 Summary of cost

Sectors	EMP Cost (Lakh Tk)	Monitoring Cost (Lakh Tk)	Total Cost
Water Resources	-	-	-
Land and Agricultural Resources	6.00	3.00	9.00
Fisheries Resources	4.70	2.00	6.70
Ecological Resources	12.00	8.00	20.00
Socio-economic Condition	-	2.00	2.00
Grand Total =	**22.70**	**15.00**	**37.70**

440. Total cost of EMP and monitoring is **BDT 37.70 lakh** (Taka thirty seven tlakh and seventy thousand) only.

11. Conclusions and Recommendations

11.1 Conclusions

441. This project aims to improve the water management and productivity through rehabilitation of the existing embankment and other water control infrastructures like sluices and regulators. Since it does not involve construction of any new infrastructure, no major environmental damage is expected. However, there may be some minor effects during the construction and Operation phases. The interventions proposed for Polder 43/2E include re-sectioning of embankment, repair of water control structures, re-excavation of khals and construction of a drainage outlets. Drainage congestion, tidal flooding and water logging are very prevalent in Polder 43/2E. The proposed interventions will bring about huge beneficial effects for the inhabitants inside the polder e.g. drainage congestion will be removed from 20% of the congested khals; re-excavation of khals will increase surface water availability, about 7% of total people will be benefited in the polder area; re-sectioning embankment will provide more flood protection from tide; after implementation of the above interventions agriculture resources will be significantly changed such as crop production and irrigated area will be increased with decrease of crop damage. However during construction phase, there will be some negative impacts on agriculture, terrestrial vegetation and fisheries. During re-sectioning of the embankment, slope pitching and turfing, loss of vegetation like herbs and shrubs will occur i.e. there will be a temporary loss of habitat for some small reptiles and mammals such as rats, frogs etc. In addition, movement of fishes and hatchling of brackish and fresh water fish like *Puti, Chingri, Tengra, Baila* and *Pairsa, vetki* etc.from the river to the polder area would be obstructed during the repair of water control structures. The embankment also plays an important role in maintaining communication which will be improved. Moreover, proposed intervention will improve the quality of life and better livelihood.

11.2 Recommendations

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.
- Monsoon period should be avoided for implementation of the proposed interventions, especially from May to July which is very crucial for fish migration.
- Re-excavation activity should be done segment wise to protect the indigenous fishes and aquatic fauna.
- Crop rotation with leguminous crops, application of more organic materials and green manure to improve soil fertility in the project area.
- Introduce crop diversification with multi-crops for improving condition of the soil.
- Native mixed trees should be planted along the embankment slopes and toes, wherever possible to enhance green coverage.
- Water Management Organization (WMO) should be strengthened.
- Local communities should be involved in operation and maintenance of the structure for ensuring sustainability of the interventions.

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Appendix-1: Data Collection Checklist

Water Resources

Baseline Data Collection Form

Environmental Studies for Blue Gold Program

Name of Data Collector: Date:

Project Name:

A. Administrative Information

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

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

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

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

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

9. Accretion	River/khal	Area (ha) accreted	Reason	

D. Water Quality (people's perception/measurement)		
	People's Perception	Measurement
1. Ground water: (Arsenic/Iron/Salinity)		Arsenic: Iron: Salinity:
2. *Surface water: (Salinity, pH, DO, TDS, BOD, COD)		Salinity: pH: DO: TDS: BOD: COD:
*Note: It can be extended according to Client demands		
E. Pollution status (people's perception)		
1. Source of pollution		
2. Type of effluent		

F. Water Use

Sources	Domestic	Agriculture	Fisheries	Others (industry…)
Surface water				
Ground water				

G. Historical severe flood:

Year of recent severe flood	Flood damage			
	Extent (Days)	Flood level (cm)	Damage of resources	
1988				
1994				
1998				
2004				
2007				
Last 5 years	Flood year			Flooding areas:
	Non-flood year			

H. People's opinion about the project

Present problems:

Causes of problems:
Probable Solution/Improvement:
Natural disasters:

I. Collect Project description related information from field office:
Name of re-excavation Khals with length
Catchment area of the Khals
Outfall information of Khals
Drainage network of Khals
Drainage pattern of Khals
Cross section of Khals with other design information
Re-excavation length of individual Khal and volume of earth spoil
Location specific Spoil management plan for individual khal

Sl	Name of Khal	Location-dumping of spoil earth	Volume	Number of unskilled/skilled labor	Use of machineries with number	Remarks
1						
2						
3						
4						
5						
10						
..						
..						

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

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

Stockyard information during construction time:

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

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

Agro-ecological regions

Name of AEZ	Area (ha)	%	Soil characteristics

Land use

Land use	Area (ha)	Percent of gross area
Gross area		
Net Cultivated Area (NCA)		
Settlements		
Water bodies		
Rivers/ Khals		
Forest		
Others		

Land type

Land Type	Flooding depth	Area (ha)	Percentage
F0	0 to 30 cm		
F1	30 to 90 cm		
F2	90 to 180 cm		
F3	180 to 300 cm		
F4	More than 300 cm		
	Total:		

Soil Texture

Texture name	Top-soil		Sub-soil		Sub-stratum	
	Area (ha)	Area (%)	Area (ha)	Area (%)	Area (ha)	Area (%)

Soil Salinity

Agriculture Resources: (Primary information to be collected from the field)

Location:

Farming practices

Collect information on adjustment of crop production practices with agro-climatic condition, crops grown in different cropping seasons, flooding, drainage, drought, marketing facilities, availability of agricultural labor etc.

Major Cropping Pattern by land type

Land Type	Kharif-I (March-June)	Kharif-II (July-October)	Rabi (Nov-February)	% of area

Crop Damage

Name of Crop	Location	% damaged	Timing	Cause of damage

Crop yield rate and market price

Crop Name	Yield (ton/ha)		Price (Tk/ton)	By-product (Tk/ha)
	Normal	Damaged		

Inputs Used

Crop Name	Urea (Kg/ha)	TSP (Kg/ha)	MP (Kg/ha)	Others (Kg/ha)	Seed (Kg/ha)	Labour (No/ha)	Pesticide (No. of spray)	Land preparation (Tk/ha)
Note: Name of pests and pesticides:								

Irrigation

Crop Name	Irrigation (Surface water)			Irrigation (Ground water)		
	Area irrigated	% of Area	Charge (Tk/ha)	Area irrigated	% of Area	Charge (Tk/ha)

Crop production constraints (including land degradation)

Factors	Year of starting LD	Location	Result of LD
Soil erosion			
Sand carpeting			
Sali-sation			
Acidification			
Nutrient deficiency			
Pesticide use			
Water logging			
Others			

Livestock Resources: Primary and Secondary Information

Livestock and poultry production

Name of Livestock/poultry	% of HH having Livestock/Poultry	No. of Livestock/poultry per HH
Cow/bull		
Buffalo		
Goat		
Sheep		
Chicken		
Duck		

Feed and Fodder

Name of Livestock/poultry	Feed/Fodder Scarcity (Timing)	Causes	Remarks
Cow/bull			
Buffalo			
Goat			
Sheep			
Chicken			
Duck			

Diseases

Name of Livestock/poultry	Name of Disease	Disease (Timing)	Causes	Remarks
Cow/bull				
Buffalo				
Goat				
Sheep				
Chicken				
Duck				
Note: Support Services-				

Fisheries Baseline Checklist

Environmental Studies for Blue Gold Program

Vill: Mouza: Union: Upazila: District: BWDB Circle: BWDB Division:

Background Water bodies: Name: Alphabetic, Area: in Ha/% of area/Ana, Length: in km, Depth/Inundation depth: in Meter, Flood Duration: in Months, Production: metric ton

Problem/ Issue	Fishing Effort	Habitat Type	Water Quality	Avg. Production	Production Trend (+/-) and Reason	List of Gears	% of gears	List of Habitat Name	Present					Past (15-20 yrs back)				
									Area	Length	Width	Depth	Duration	Area	Length	Width	Depth	Duration
Capture Fisheries:	a. Total No. of fisher HHs:	River																
	b. %/No. of CFHHs:																	
	c. %/No. of SFHHS:																	
Culture Fisheries:	d. No. of Days spend annually in fishing by CFHHs: SFHHs:	Beel (Leased/non leased)																
Indiscriminate Fishing Activities:	e. Hrs/Day spend in fishing by CFHHs:																	

Problem/ Issue	Fishing Effort	Habitat Type	Water Quality	Avg. Production	Production Trend (+/-) and Reason	List of Gears	% of gears	List of Habitat Name	Present					Past (15-20 yrs back)				
									Area	Length	Width	Depth	Duration	Area	Length	Width	Depth	Duration
	SFHHs:	Khal																
		Floodplain																
		Mangrove area																
		Fish pond																
		Baor																
		Ghers																

Fish Migration				**Fish Biodiversity**		**Species List**					**Species Composition**				
						River	**Khal**	**Beel**	**Pond**	**Other**	**Group**	**River**	**Khal**	**Beel**	**Pond**
Previous Migration Status				Fish diversity status (Poor/Moderate/Rich)/%							Major carp				
											Exotic carp				
											Other carp				
											Catfish				
											Snakehead				
Present Obstacle to fish migration:	1. 2. 3.			Reasons of increase or decrease	1. 2. 3. 4.						Live fish				
											Other fish				
											Shrimp/prawn				
											Hilsa/Bombay duck/Indian salmon				
											Pomfret				
Important breeding, feeding and over wintering ground					5.						Jew fish				
											Sea cat fish				
											Shark/Skates/ Rays				
											Rui				
											Catla				
Horizontal Migration pattern	Species: 1. 2. 3. 4. 5.	Season (Months):	Routes:	Sig-ficant areas	1. 2. 3.						Mrigal				
											Koi				
											Sarputi				
											Large shrimp				
											Small shrimp				
Vertical Migration Pattern	Species: 1. 2. 3.	Season (Months):	Habitats:	Species of Conservation Significance	Rare:						Silver carp				
											Carpio				
											Grass carp				
											Tengera				

Fish Migration					Fish Biodiversity	Species List					Species Composition				
						River	Khal	Beel	Pond	Other	Group	River	Khal	Beel	Pond
	4. 5.				Unavailable:						Chapila				
											Others				

Post Harvest Activities		Fishermen Lifestyle	
Fish edible quality:		Socio-economic Status of subsistence level fishermen:	
Source of pollution in each habitat:		Socio-economic Status of Commercial fishermen:	
Seasonal vulnerability:		Other conflict (with muscle men/ agriculture/ other sector/laws):	
Ice factory (Number, location and name):		Fishermen commu-ty structure (Traditional/Caste/Religion)	
Landing center, whole sale market, other district markets, etc.:		Traditional fishermen vulnerability (Occupation change/others):	
Storage facility (number, location and name):		Existing Fisheries Management	
Fish market (Number, location and name):		Fishermen Community Based Organizations (FCBOs):	
Marketing problems:		WMOs activity:	
Fish diseases (Name, Host species, Season, Syndrome, Reason, etc.):		Fishing right on existing fish habitats (Deprived/Ltd. access/Full access):	

Post Harvest Activities		Fishermen Lifestyle	
Other backward and forward linkages (Number, location and name):		Leasing system:	
Transport facility (Mode of fish transportation, cost, other involvements)		Enforcement of fisheries regulation (Weak/strong):	
Dry fish industries (Number, location and name):		Department of Fisheries (DoF) activity:	
Others information:		NGOs activities:	

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

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

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

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

Ecological Data Collection Form for ESIA Study

Center for Environmental and Geographic Information Services (CEGIS)

Date		Name of the interviewer	
Name of the Project			
District/s		Upazila/s	
Location of the informal discussions with stakeholders			
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 Wetland7	Area in ha		Flooding depth (m)	Connectivity with river		Importance8
		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	Utilization9

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			

[7] 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

[8] 1=Fish; 2= migratory bird; 3= other wildlife; 4=aquatic flora;

[9] 1=food; 2=timber; 3=fuel; 4=medicinal; 5=fiber/thatching; 6=others

Species name	Status1	Species name	Status1
Mammals			
1=Very common, 2=Common, 3=Occasional, 4=Rare			

Present status and negative impacts on flora & fauna

Impacted Species	Existing Status	Cause of impact

Anticipated impacts on flora and fauna due to project activity (according to people opinion)

Victim Species	Anticipated Impact	Cause of impacts

Necessity of wildlife management practices (According to people's opinion):

☐ Yes ☐ No

How	

Ecosystem Services

Type of Service	Estimated Cost/House	Total Cost in project Area	Grand Total Cost
Fuelwood			
Timber			
Fruit production			
Thatching			
Fodder			
Bio-fertilizer			
Other			

Presence of Important Ecosystem (If any)

Important Ecosystem	Name	GPS Coordinate/waypoint
Ecologically Critical Area		
Important Bird Area		
Reserve Forest		
Natural Forest		
National Park		
RAMSAR Site		
Wildlife Sanctuary		
Game Reserve		
Eco-park		

Note (If any):

SOCIO-ECONOMIC BASELINE DATA COLLECTION

Checklist for Rapid Rural Appraisal (RRA)

Facilitation Information

Name of Facilitator	
Date of Facilitation	

Project Information

Name of Project	
Gross Area (ha.)	
Net Area (ha.)	

Study Area

Mauza	
Union/Ward	
Municipality (if any)	
Upazila/Thana	
District	

Educational Institution

Sl. No.	Type of facility	Nos. of Institution	Type of facility	Nos. of Institution
1	Primary School		Ebtedayee Madrasha	
2	High School		Dakhil Madrasha	
3	College		Alim/Fazil Madrasha	

Note: The category “Primary School” includes only Government Primary School (GPS) and Registered Non-government Primary School (RNGPS)

Disease Prevalence

Ranking by Incidence	Name of Disease	Ranking by Incidence	Name of Disease
1		6	
2		7	
3		8	
4		9	
5		10	

Note: If the facilitator can collect disease profile from the Upazila Health Complex then this question could be skipped

Health Facilities

Sl. No.	Type of Facility	Number of Facilities
1	District/Sadar Hospital	
2	Upazila Health Complex	
3	Union Sub-Center	
4	Union Family Welfare Center	
5	Community Clinic	
6	Private Health Clinics/hospitals	
7	Other (if any)	

Peripheral Health Facilities (if any)

Number	
Name	
Description/status	

Sources of Treatment Facilities

Sl. No.	Source of treatment facilities	Percentage of Households Received
1	Trained physician	
2	Paramedic/diploma physician	
3	Quack doctor & informal treatments	
4	No treatment facilities at all	

Electricity Coverage

Sl. No.	Type of facility	Percentage of Households
1	Grid	
2	Solar	
3	Biogas	
4	Other (if any)	

Note: Percentage of households covered by grid electricity will be cross-checked with the data given in the Population and Housing Census 2011 of Bangladesh Bureau of Statistics

Income and Expenditure

Range (Tk./month)	Percentage of Households	
	Expenditure	Income
Less than 1,000		
1,000 - 2,000		
2,000 – 5,000		
5,000 - 9,000		
9,000 - 20,000		
More than 20,000		

Labor and Wage

Type of Activity	Male Labor		Female Labor	
	Availability (put √)	Daily Wage (Tk.)	Availability (put √)	Daily Wage (Tk.)
Farming	H M L		H M L	
Non-Farming	H M L		H M L	

Note: H=High; M=Medium; L=Low. Farming activities include agricultural activity and Non-farming activities include earthwork, brickfield work, construction work etc)

Self Assessed Subsistence Poverty

Sl. No.	Poverty Status	Percentage of Households
1	Deficit	
2	Balance/Breakeven	
3	Surplus	

GO/NGO Safety Net Programs

Name of GO/ NGO Department	Activity	% of HHs Coverage

Land Price

Sl. No.	Lands Type	Sale Value (Tk./per acre)
1	Homesteads land	
2	Agricultural land	
3	Commercial Land	
4	Others (if any)	

Disaster and Damage (in last five years)

Most Prevalent Disasters					
Ranking by Incidence	1)	2)	3)	4)	5)
Tangible loss due to Disasters					
Intangible loss due to Disasters					
Impacts on Households					
Impacts on Livelihood					
Proposed Mitigation					

Note: These data will be cross-checked with the multidisciplinary information

Migration Trend

Type of Migration	Out Migration		In Migration	
	Place of destination	Number/ Percentage*	Place of origin	Number/ Percentage*
Seasonal Labor migration				
Permanent Household migration				

*Percentage of migration will be applicable in case of seasonal labor migration; whereas number will be applicable in case of permanent migration of households

Professional/occupational Conflict

Type of Conflict	
Reasons of Conflict	
Area	
Groups engaged in conflict	
Proposed solutions	

Miscellaneous

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

Profile of RRA Participants

Name	Age	Occupation	Address/ Mobile no.

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

Appendix-2: No Objection Certificate

০৬নং জৈনকাঠী ইউনিয়ন পরিষদ কার্যালয়

ডাকঘর- সেহাকাঠী, উপজেলা ও জেলা- পটুয়াখালী।

স্মারক নং-[illegible]/০২/১৫ তারিখ-

অনাপত্তি পত্র

১। আবেদনকারীর নাম ঃ পরিচালক, পরিকল্পনা-৩ এবং প্রোগ্রাম কো-অর্ডিনেটিং ডাইরেক্টর, ব্লু গোল্ড প্রোগ্রাম, বাংলাদেশ পানি উন্নয়ন বোর্ড ।

২। পিতা/স্বামীর নাম ঃ প্রযোজ্য নয়

৩। আবেদনকারীর ঠিকানা ঃ পরিকল্পনা-৩, বাংলাদেশ পানি উন্নয়ন বোর্ড, হাসান কোর্ট (৮ম ও ৯ম তলা) ২৩/১ মতিঝিল বানিজ্যিক এলাকা, ঢাকা-১০০০।

৪। প্রকল্পের অবস্থানগত ঠিকানা ঃ ৪৩/২ই 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	হেক্টর

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

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

শর্তাবলী ঃ

১। প্রকল্প স্থাপন ও পরিচালনার ক্ষেত্রে পরিবেশ সংরক্ষণ আইন ও বিধি যথাযথভাবে অনুসরণ করতে হবে।
২। পরিবেশ অধিদপ্তর হতে বিধি দ্বারা নির্ধারিত ছাড়পত্র গ্রহণ করতে হবে।
৩। কর্মরত শ্রমিকদের পেশাগত স্বাস্থ্য ও নিরাপত্তার নিশ্চিত করতে হবে।
৪। উপযুক্ত অগ্নি নির্বাপক ব্যবস্থা রাখতে হবে। এবং অগ্নিকান্ড কিংবা অন্য কোন দূর্ঘটনার সময় জরুরী নির্গমন ব্যবস্থা থাকতে হবে।
৫। বায়ু ও শব্দ দূষন করা যাবে না।
৬। প্রকল্প সৃষ্ট তরল বর্জ্য অপরিশোধিত অবস্থায় বাইরে নির্গমন করা যাবে না।

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

তারিখ ঃ ১৯/০১/২০১৫

স্থানীয় কর্তৃপক্ষের স্বাক্ষর ও সীলঃ

আল-হাজ্ব মোঃ ফিরোজ আলম
চেয়ারম্যান
৬নং জৈনকাঠী ইউনিয়ন পরিষদ
পটুয়াখালী সদর।

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

Background

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

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

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

Objective

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

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

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

Method and Process of the MPI

Multidimensional Poverty Index (MPI) was developed in 2010 by the Oxford Poverty and Human Development Initiative (OPHI) and United Nations Development Programme (UNDP). Different factors have been used in MPI to determine poverty beyond income. The MPI is an index of acute multidimensional poverty. It shows the number of people who are multidimensional poor (suffering deprivation in 33.33% of weighted indicators) and it is threshold between poor and non-poor people. The MPI uses the dimensions and indicators[10] are given below:

Table: Dimension and Indicators of poverty measurement

Dimension	Indicators
Education	Each indicator is weighted equally at 1/6. • Year of schooling (up to class V) • Children enrolled (up to class VIII)
Health	Each indicator is weighted equally at 1/6. • Child Mortality • Nutrition (WHO indicators11: reduced immunity, increase susceptibility of disease, impaired physical and mental development, and reduced productivity).
Standard of living	Each indicator is weighted equally at 1/18. • Electricity • Drinking Water • Toilet • Floor • Cooking fuel • Assets

[10]http://en.wikipedia.org/...../Multidimensional_Poverty_Index (web page).
[11]http://www.who.int/...../nutrition/...(web page).

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

$MPI = H \times A$

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

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

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

$A = \sum_i^q ci \div q$,

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

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

Conclusions

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

Table: Multidimensional Poverty Index for the Polder 43/2E

Sl. No.	Indicator	Weight	Three households considered as major category of the people as seen poor in the Polder					
			Landless persons work in share cropping and agricultural labour (L)	Weighted score	Day labourers work in Brick Field (DL)	Weighted score	Marginal Grossers sell things in the rural bazar (MG)	Weighted score
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
	Household size		4.6		4.6		4.6	
	Education (33.33%)							
1	Years of Schooling: deprived if no household member has completed five years of schooling.	0.167	0%	0.000	0%	0.000	0%	0.000
2	Child school attendance: deprived if any school-aged child is not attending school up to class 8.	0.167	0%	0.000	0%	0.000	0%	0.000
	Health (33.33%)					0.000		
3	Child mortality: deprived if any child has died in the family.	0.167	0%	0.000	0%	0.000	0%	0.000
4	Nutrition: deprived if any adult or child for whom there is nutritional information is malnourished.	0.167	100%	0.167	100%	0.167	100%	0.167
	Standard of living (33.33%)							
5	Electricity: deprived if the household has no electricity	0.056	100%	0.056	100%	0.056	0%	0.000
6	Sanitation: deprived if the household's sanitation facility is not improved, or it is improved but shared with other households.	0.056	100%	0.056	100%	0.056	100%	0.056
7	Drinking Water: deprived if the household does not have access to safe drinking water or safe drinking water is more than a 30 minute walk from home roundtrip.	0.056	0%	0.000	0%	0.000	0%	0.000
8	Floor: deprived if the household has a dirt, sand or dung floor.	0.056	0%	0.000	0%	0.000	0%	0.000
9	Cooking fuel: deprived if the household cooks with dung, wood or charcoal.	0.056	0%	0.000	100%	0.056	0%	0.000

Sl. No.	Indicator	Weight	Three households considered as major category of the people as seen poor in the Polder					
			Landless persons work in share cropping and agricultural labour (L)	Weighted score	Day labourers work in Brick Field (DL)	Weighted score	Marginal Grossers sell things in the rural bazar (MG)	Weighted score
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
10	Assets ownership: deprived if the household does not have access to information: own more than one radio; TV, telephone, and not having at least one bike, motorbike, refrigerator, arable land, and livestock and does not own a car or truck.	0.056	0%	0.000	100%	0.056	0%	0.000
	Weighted Score (deprivation score)	**1.000**		**27.78%**		**38.89%**		**22.22%**
	Status: MPI poor (33.33%)			**Equal to MPI poor**		**Greater than MPI poor**		**Less than MPI poor**
	0% indicates no deprivation in that indicator, while '100%' indicates deprivation in that indicator.							
	Factor H for the Polder is 0.333							
	Factor A for the polder is 0.389							
	MPI is 0.130							

Appendix-4: Participant List of PCM

Environmental Study for Blue Gold Program

EIA and SIA conducted By CEGIS

Participation list of Public Consultation Meeting (PCM)

Place: জেনারেলী ইউনিয়ন পরিষদ Date: ১৮-০১-২০১৫

Sl	Name	Address/Designation	Mobile No	Signature
০১	আলহাজ্ব মো: ফিরোজ খান	চেয়ারম্যান [illegible]	01720185290	[illegible]
০২	মো: [illegible]	ইউ. পি. সদস্য	01752116260	[illegible]
০৩	মো: জালাল উদ্দিন [illegible]	ইউ পি, সদস্য	01728943922	[illegible]
০৪	মো: আতিকুর রহমান (নান্নু)	ইউ পি, সদস্য	01731003644	[illegible]
০৫	মো: ইদ্রিস মিয়া [illegible]	[illegible]	01719565912	[illegible]
০৬	[illegible]	[illegible]	01728479109	[illegible]
০৭	মো: রেজাউল করিম [illegible]	[illegible]	017287096[illegible]	[illegible]
০৮	মো: মজিবুল ইসলাম	সাপোর্ট WMG	01724079461	[illegible]
০৯	মো: গোলাম কিবরিয়া	ইউ পি সদস্য	01726826414	[illegible]
১০	মো: মতিন রায়	ইউ পি সদস্য	01716845443	[illegible]
১১	মো: মজিবর রহমান	গ্রাম পুলিশ	01723413427	[illegible]
১২	মো: বেল্লাল হো:	গ্রাম পুলিশ	01858776324	[illegible]
১৩	মো: আমিনুর আলী	গ্রাম পুলিশ	01763460646	[illegible]
১৪	মো: [illegible]	গ্রাম পুলিশ		[illegible]
১৫	শ্রী [illegible]	[illegible]		[illegible]
১৬	মো: [illegible]	[illegible]	01725631244	[illegible]
১৭	বিমল [illegible]	ইউ পি সচিব	01715306400	[illegible]
১৮	মো: নুরুজ্জামান		01734348419	[illegible]
১৯	শ্রী [illegible] লাল [illegible]	গ্রাম পুলিশ	01710625669	[illegible]
২০	মো: [illegible]	গ্রাম পুলিশ	01798551731	[illegible]
২১	মো: মনিরুল ইসলাম	[illegible]	0172802301[illegible]	[illegible]
২২	আবুল কালাম নয়ন	গ্রাম পুলিশ	01734374825	[illegible]

CEGIS Center for Environmental and Geographic Information Services
(A Public Trust under The Ministry of Water Resources)
House No. 6, Road No. 23/C, Gulshan-1, Dhaka-1212, Bangladesh
Tel: 880-2-8821570-1, 8817648-52 Fax: 880-2-8855935, 8823128 e-mail: cegis@cegisbd.com http://www.cegisbd.com

Environmental Study for Blue Gold Program

EIA and SIA conducted By CEGIS

Participation list of Public Consultation Meeting (PCM)

Place: জৈনকাঠী ইউনিয়ন পরিষদ Date: ১৮.০১.২০১৬

Sl	Name	Address/Designation	Mobile No	Signature
১।	মোঃ [illegible]	ইউ: সদস্য	01718924859	[illegible] 18.01.16
২।	মো: ইব্রাহীম [illegible]	প্রধান শিক্ষক [illegible]	01714660467	[illegible]
০৩।	মোঃ নুরুল হক [illegible]	[illegible]	01724038821	[illegible]
০৪	নিত্য রঞ্জন ভদ্র	[illegible] " "	01742624250	[illegible]
০৫	আসমা সুলতানা	লোহারপুর স: প্রা: বি:	01718974696	[illegible]
০৬	নাসরিন আক্তার [illegible]	পশ্চিম [illegible]	01718872055	[illegible]
০৭	[illegible] পারভীন	[illegible] স: প্রা: বি:	01736098610	[illegible]
০৮	মোসা: রেবা বেগম	[illegible]		
০৯	মোসা: [illegible] বেগম	[illegible]	01713954862	[illegible]
১০	মো: [illegible]	ইউ: [illegible]	01911548721	[illegible]
১১	মো: [illegible]			
		ইউ: [illegible]	01718-289576	[illegible]
১৩	সৈয়দ জসিম			
১৪	মো: [illegible]			[illegible]
১৫	আবুল কালাম [illegible]	[illegible]	01716103191	[illegible]
১৬	মোঃ রফিকুল ইসলাম	[illegible]	01741787199	[illegible]
১৭	মোসা: [illegible]	[illegible]	01719977780	[illegible]
১৮	মোসা: [illegible]	[illegible]	01755142586	[illegible]
১৯	মরিয়ম			মরিয়ম
২০	[illegible]	[illegible]		[illegible]
২১	মিনু [illegible]			মিনু
২২	মো: মনিরুল হক টিটু	[illegible]	01716557104	[illegible]
২৩।	[illegible]	[illegible]	01761872099	[illegible]
২৪।	[illegible]	[illegible]	01724704189	[illegible]
২৫।	ডা: মো: [illegible] ইসলাম (ইব্রাহীম)	[illegible]	01712-752662	[illegible]

CEGIS Center for Environmental and Geographic Information Services
(A Public Trust under The Ministry of Water Resources)
House No. 6, Road No. 23/C, Gulshan-1, Dhaka-1212, Bangladesh
Tel: 880-2-8821570-1, 8817648-52 Fax: 880-2-8855935, 8823128 e-mail: cegis@cegisbd.com http://www.cegisbd.com

Appendix-5: Terms of References

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

Memo No: DoE/Clearance/5403/2015/ ৪৩ Date: ১৫/02/2015

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

Ref: Your Application dated 22/12/2014.

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

I. The project authority shall submit a comprehensive Environmental Impact Assessment (EIA) considering the overall activity of each polder in accordance with the TOR and time schedule submitted to the Department of Environment (DOE) and additional suggestions provided herein..

II. The EIA report should be prepared in accordance with following indicative outlines:

1. Executive summary
2. Introduction: (Background, brief description, scope of study, methodology, limitation, EIA team, references)
3. Legislative, regulation and policy consideration (covering the potential legal, administrative, planning and policy framework within which the EIA will be prepared)

4a. Project activities:

- A list of the main project activities to be undertaken during site clearing, construction as well as operation
- Project Plan, Design, Standard, Specification, Quantification, etc.

4b. Project schedule: The phase and timing for development of the Project

4c. Resources and utilities demand: Resources required to develop the project, such as soil and construction material and demand for utilities (water, electricity, sewerage, waste disposal and others), as well as infrastructure (road, drains, and others) to support the project.

4d. Map and survey information

Location map, Cadastral map showing land plots (project and adjacent area), Topographical map, Geological map showing geological units, fault zone, and other natural features.

5. Baseline Environmental Condition should include, inter alia, following: (Identification and Quantification of Physical Situation that has been proposed to be changed)

- Physical Environment : Geology, Topology, Geomorphology, Land-use, Soils, Meteorology, and Hydrology
- Biological Environment : Habitats, Aquatic life and fisheries, Terrestrial Habitats and Flora & Fauna
- Environment Quality : Air, Water, Soil and Sediment Quality
- Relate baseline in both Quantitative and Qualitative term with the anticipated outcomes, achievement of goals, objectives and changes due to project interventions

6. Socio-economic environment should include, inter alia, following:

- Population: Demographic profile and ethnic composition

1

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

7. Identification, Prediction and Evaluation of Potential Impacts (identification, prediction and assessment of positive and negative impacts likely to result from the proposed project).

   In identification and analysis of potential impacts'-the 'Analysis' part shall include the analysis of relevant spatial and non-spatial data. The outcome of the analysis shall be presented with the scenarios, maps, graphics etc. for the cases of anticipated impacts on baseline. Description of the impacts of the project on air, water, land, hydrology, vegetation-man maid or natural, wildlife, socio-economic aspect shall be incorporated in detail.

8. Management Plan/Procedures:

   For each significant major impact, proposed mitigation measures will be set out for incorporation into project design or procedures, impacts, which are not mitigable, will be identified as residual impacts Both technical and financial plans shall be incorporated for proposed mitigation measures.

   An outline of the Environmental Management Plan shall be developed for the project.

   In Environmental Monitoring Plan, a detail technical and financial proposal shall be included for developing an in-house environmental monitoring system to be operated by the proponent's own resources (equipments and expertise).

9. Consultation with Stakeholders/Public Consultation (ensures that consultation with interested parties and the general public will take place and their views taken into account in the planning and execution of the project)

   Beneficial Impacts (summarize the benefits of the project to the Bangladesh nation, people and local community and the enhancement potentials)

10. Conclusion and Recommendations

III. Without approval of EIA report by the Department of Environment, the project authority shall not be able to open L/C in favor of importable machineries.

IV. Without obtaining Environmental Clearance, the project authority shall not be able to start the physical activity of the project.

V. The project authority shall submit the EIA along with a filled-in application for Environmental Clearance in prescribed form, the applicable fee in a treasury chalan, the no objection certificates (NOCs) from the local authority, NOCs from forest department (if it is required in case of cutting any forested plants/trees of private or public) and NOC from other relevant agencies for operational activity etc. to the concerned divisional offices of DOE with a copy to the Head Office of DOE in Dhaka.

15.02.2015

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

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

Copy Forwarded to :

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

2

Appendix-6: Gate Operation Plan (Bengali)

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

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

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

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

Appendix-7: Comments and Responses

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

Sl	Comments	Response	Action
1	Prepare Bangla Operation plan of regulators for ensuring the connectivity of rivers and khals for migration of fish during breeding period and annexed it with this report.	An operation plan for regulation of gates has already been discussed in the report (section 4.10.1). Accordingly, a short operation plan in Bangla has been prepared.	Bangla operation plan has been appended in Appendix -6
2	Incorporate mitigation/enhancement measure in the EIA report- demarked the deep pools area for sheltering of brood fish in the khals under the polder area considering the width of the khals.	The deep pools area for sheltering of brood fish in the khals under the polder area have been demarked and mentioned in the report (section10.4.3 and Table 10.5)	The deep pools area have been shown in the Map attached in the report
3	Prepare A1 map incorporating surrounding physical features of the polder area, location of mitigation measures, existing interventions and rehabilitations works.	A1 size map has been prepared incorporating all as suggested	Map is attached with the report
4	Describe the baseline line scenarios before polderization of the area in a short form.	During construction of the polder, baseline survey was not been carried out by the project proponent. As such, it was not possible to provide the baseline scenarios before the polderization of the area.	
5	Submit three reports to the Head office, DoE with letter and CC to Barisal regional office.	Agreed and implemented	
6	Delete the column (column number 3) from the Table 4.3	Agreed and performed	
7	Drainage capacity of regulators and canals should be checked considering climate change issues through the modeling.	Drainage capacity of regulators under the polder has been checked on the basis of the modelling results. As per modelling results, drainage capacity of the polder is sufficient to drain out additional water to be generated for climate change.	

Appendix-8: Development Project Proforma