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on

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






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Abbreviation and Acronyms

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

EIA	Environmental Impact Assessment
EKN	Embassy of the Kingdom of Netherlands
EMP	Environmental Management Plan
ERD	Economic Relations Division
FAO	Food and Agriculture Organization
FCD	Flood Control and Drainage
FCD/I	Flood Control Drainage/ Irrigation
FCBO	Fisheries Community Based Organization
FES	Fishing Effort Survey
FGD	Focus Group Discussion
FGs	Functional Groups
FMD	Foot and Mouth Disease
FS	Frame Survey
FPCO	Flood Plan Co-ordination Organization
FWIP	Future With Project
FWOP	Future Without Project
GIS	Geographic Information System
GoB	Government of Bangladesh
GoN	Government of Netherlands
GPA	Guidelines for Project Assessment
GPWM	Guidelines for Participation of Water Management
GSB	Geological Survey of Bangladesh
GW	Ground Water
Ha	Hectare
HH	Household
HTW	Hand Tube Well
HYV	High Yielding Variety
ICM	Integrated Crop Management
IEC	Important Environmental Component
IEE	Initial Environmental Examination
IESC	Important Environmental and Social Component
IRRI	International Rice Research Institute
IPM	Integrated Pest Management
IPSWAM	Integrated Planning for Sustainable Water Management
IS	Institutional Survey
ISC	Important Social Component
IUCN	International Union for Conservation of Nature
IWM	Institute of Water Modeling

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

SWAIWRPMP	South West Area Integrated Water Resources Planning and Management Project
SWAT	Soil and Water Assessment Tools
T. Aman	Transplanted Aman
ToR	Terms of Reference
TSP	Triple Super Phosphate
UFO	Upazila Fisheries Officer
UNDP	United Nation Development Program
UNO	Upazila Nirbhahi Officer
WARPO	Water Resources Planning Organization
WMA	Water Management Association
WMC	Water Management Corporation
WMF	Water Management Federation
WMGs	Water Management Groups
WMIP	Water Management Improvement Project
WMO	Water Management Organizations

Glossary

Aila	Major cyclone, which hit Bangladesh coast on May 25, 2009
Aman	A group of rice varieties grown in the monsoon season and harvested in the post-monsoon season. This is generally transplanted at the beginning of monsoon from July-August and harvested in November-Dec. Mostly rain-fed, needs supplemental irrigation in places during dry spell.
Arat	Generally an office, a store or a warehouse in a market places from which Aratdar conducts his business.
Aratdar	Main actor act as a wholesaler or commission agent or covers both functions at the same time; carries out public auctions and is the main provider of credit in the marketing chain.
Aus	A group of rice varieties sown in the pre-monsoon season and harvested in the monsoon season. These are broadcast/transplanted during March-April and harvested during June-July. Generally rain-fed, needs irrigation for HYV T. Aus.
B. Aus	When preceding a crop means broadcast (B. Aus)
Bagda	Shrimp (*Penaeus monodon*), brackish/slightly saline water species.
Bazar	Market
Beel	A saucer-shaped natural depression, which generally retains water throughout the year and in some cases, seasonally connected to the river system.
Boro	A group of rice varieties sown and transplanted in winter and harvested at the end of the pre-monsoon season. These are mostly HYV and fully irrigated, planted in December-January and harvested before the onset of monsoon in April- May.
Golda	Prawn (*Macrobrachium rosenbergii*), non-saline/fresh water species
Gher	Farm lands converted into ponds with low dykes and used for cultivation of shrimp/prawn/fish.
Haat	Market place where market exchanges are carried out either once, twice or thrice a week, however not every day.
Jaal	Different types of fishing net to catch fish from the water bodies.
Jolmohol	Section of river, individual or group of beels (depression), or individual pond owned by the government but leased out for fishing. They are also called Jalkar, or Fishery.
Jhupri	Very small shed for living, made of locally available materials. A type of house/hut used by very poor community members.
Kutcha	A house made of locally available materials with earthen floor, commonly used in the rural areas.
Khal	A water drainage channel usually small, sometimes man-made. . These may or may not be perennial.
Kharif	Pre-monsoon and monsoon growing season. Cropping season linked to monsoon between March-October, often divided into kharif-1 (March-June) and kharif-2 (July-October).

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

Executive Summary

Background

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

Objective

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

Approach and Methodology

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

Project Description

Polder 43/2F is located in Gulishakhali union of Amtali upazila, Barguna district. The polder is surrounded by Gulishakhali and Payra rivers in the west and the Kukua River (in the east) (Map 1.1). The polder covers an area of 4,130 ha, with a Net Cultivable Area (NCA) of 2,590 ha (63%).

The polder area is bounded by a 33 km embankment that protects the area against tidal and storm surges as well as salinity intrusion. Besides, there are 16 drainage sluices, 4 drainage outlets and a number of flushing inlets within the area. The existing situation of the embankment in most parts is good, offering protection against tidal and storm surges and facilitating the communication system as well. The exception is the Katakhali outlet, where

the road width has decreased by around 5 feet since the construction of the structure beneath the embankment. The embankment beside the Payra River at Angulkata, Gulishakhali, Dalachara and Naiapara is vulnerable to erosion and tends to be eroded whenever a moderate flood occurs. The existing water control structures are not functioning up to the desired level due to damages in the wheels and shafts. There are also severe mismanagement issues regarding the water control structures. The number of inlets is also not sufficient to meet the flushing requirements. Among the 93.5 km of internal drainage channels, some were very shallow due to topsoil erosion and other land filling activities. Moreover, public encroachments were also observed, e.g.in Koromjabunia khal, local fishers have formed ghers, obstructing the khal at multiple locations.

Existing problems and works under the proposed interventions

Around 37 km (40% of the total length) of water courses inside the polder are affected by drainage congestion problems. Drainage congestion at some places leads to water logging issues, which affect the agriculture sector within the polder. Poor communication is a major problem as opined by the local people. Poor maintenance is another issue in the polder, which results in deterioration of water control structures as well as peripheral embankments.

To address these problems, the BGP proposed several interventions under component II. Re-sectioning of peripheral embankment would be carried out at locations where damages exist. The proposed crest width is 4.27m, and design crest elevation is 4.27m PWD. Furthermore, all existing sluices, inlets and outlets of the BWDB will be repaired within the polder. Some sluices would require new shafts and wheels (Goskhali, Dolachara), whereas some would require replacement of barrels and gates (Gulishakhali). The sluice gates at Khekuani and Kalibari would require a new hoisting system. The existing drainage outlets and flushing inlets would also require some repair work. The Moragona outlet would be reconstructed, and a new outlet at Motbaria is proposed by the WMA for construction. In addition, the WMA demanded ten (10) new inlets (450-600mm) at different locations of the polder. Moreover, around 27 km length of 14 khals(Gulishakhali, West Kalagachia, Gojkhali, Dalachara, Doachara, Khekuani, Chunakhali, Bottola, Kalibari, Borachi, Motbaria, Debpura, Moradhona, and Fokorer khals) would be re-excavated.Some temporary protection works are proposed at some erosion hotspots near Angulkata, Gulishakhali, Dalachara and Naiapara.

Environmental and Social Baseline

Meteorology and Physical Resources

The project area experiences tropical climate where monthly maximum temperature varies from 29°C to 36°C and monthly minimum temperature varies within the range of 10.3°C to 24°C. The maximum rainfall ever recorded in the area is 590 mm in the month of July and lowest rainfall is observed in the month of December 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 hoursfrom April to July.

In measuring the water quality, TDS values were found to be 683 to 1238 for different locations inside the polder. Values of DO were mostly found close to the standards set by the DoE for both irrigation (5 to 6 mg/l) and fishing (5 mg/l). On the other hand, almost all the surface water samples were found having no salinity during field measurement in the month of May. About 81% of land in the area has elevation between 1.4 and 1.61 m +PWD. Wind

speed of the polder area is the highest in April (around 167kph) and the lowest in December (around 50 kph).

The study area falls under Zone-III, which is characterized by low earthquake prone sites. In consideration of seismicity and stratigraphy, Polder 43/2F falls under a relatively safer (seismically quiet and tectonically stable) site. The study location can be regarded as a residential area and the observed noise levels are less than the permissible limits for daytime at Bazarkhali Khal (construction site), Rona Chandra Khal and at Rafiq Uddin Mollah's pond.

Water Resources

Polder 43/2F is 33 km away from the Bay of Bengal and undergoes diurnal tidal influence. It is surrounded by the Gulishakhali River in the north and north-west directions, the Payra River in the south-west, and the Kukua River on the eastern side. Surface water levels during high tide range from +1.14 m PWD to +2.22 m PWD (above MSL), and the low tidal water levels range from 0.1 to 0.3 m below the MSL. Average daily use of water is around 25 lpc for domestic use. 30% of the polder population suffers from water deficiency (daily consumption as low as 10 lpc) for domestic use as reported by local people. The existing surface water irrigation coverage is only 5% of the Net Cultivable Area (NCA) of the polder.

Land and Agriculture Resources

Polder 43/2Flies in the Ganges Tidal Flood Plain (AEZ-13). The most prominent cropping pattern is Fallow-Lt Aman- Fallow which covers about 34% of the NCAand Fallow – Lt Aman – Sesame which covers about 25% of the NCA. Total cropped area is about 2,590 ha of which the coverage of rice is 63%. Cropping intensity of the project area is about 166%. Surface water is the only source of irrigation water. The annual total crop production stands at about 10,212 tons of which about 6,162 tons of rice is produced and 4,050 tons non-rice is produced. Total loss of rice production is about 54 tons in 2,720 ha and loss of non-rice production is about 52 tons in 1,580 ha.

Fisheries Resources

The estimated fish habitat area is 309 ha where capture fishery contributes the major share (214 ha) and the culture fish habitat shares the rest. The estimated total fish production of the polder area is more than 191 tons. The bulk of the fish production (about 76%)comes from culture fisheries and the rest is contributed by capture fishery. The project area is moderate in fish biodiversity although the biodiversity of fishes has shown a declining trend over the years. About 100 fish species are available in the area. The dominant cultured fish species are Tilapia, Silver carp, Sarpunti, Bagda,Golda etc. Gulisakhali Khal, Chunakhali khal, Mothbari khal, West Kolagachia khal etc and other peripheral water bodies serve as feeding and spawning grounds of most of the open water fishes.

Ecological Resources

The polder area encompasses one bio-ecological zone; namely The Ganges Floodplain. The terrestrial ecosystems of this polder are divided into homestead, crops field, road and embankment. The dominant species of settlement vegetation are Narikel *(Cocos nucifera)*, Supari*(Areca catechu)*, Tal *(Boassus flabelifer)* and Babla *(Acacia nilotica)* trees etc. Homestead vegetation is also important for fruit production. Roadside vegetation has amajor share in timber and fuel wood production. Fishes, which meet the protein demand of the local people, abound in the wetlands of the area such as khals, homestead ponds, etc. No Ecologically Critical Area (ECA) or designated protected area is located within or near the polder area.

Socio-economic Condition

The total population of Polder 43/2F is more than 28,000 consisting of 6,400 households. The density of population is about 563 persons per sq. km. The average household size is 4.39. On average, about 45% of the households are in the 'deficit' category. In the polder area, about 35% of the total population is employed, 47% is engaged in household work and about 18% is unemployed. At present, most of the population is engaged in the agriculture sector (83%). The average literacy rate in the study area is 50%. There are 56 primary schools, 14 high schools and 22 ebtedaye/ Dakhil Madrashas as well as five Union Health Complexes and 13 Community Clinicsin the polder area. Tidal flooding, erosion, water logging and cyclones are the major natural disasters occurring in this area.

Public Consultation

During the study period, five public consultation meetings were conducted in the study area at Gulishakhali Bazaar, Angulkata, Haridrabaria, and Kalagachia at Gulishakhali Union. A total of 70 participants attended those meetings representation all types of occupations and key informants. They expressed their views on the project along with other problems and offered suggestions, which are presented in the chapter on public consultation.

Impact Assessment

The proposed project activities will have temporary negative and long term positive impacts on different sectors. Temporary disturbance of fish movement and damage to vegetation along the re-sectioned embankment slopes are the noteworthy negative impacts due to this project.

An additional 21% of rice and 71% tons of non-rice would be produced after successful implementation of the proposed interventions. It is expected that loss of crop production would be reduced by about 94% in terms of rice and 67% in terms of non-rice crops. Additional irrigated area would be about 60 ha. Fish habitat quality and productivity will improve and more than 25 ton of capture fish would be additionally produced due to expansion of khal habitat. Fish hatchling movement into the polder area would be hampered Terrestrial vegetation loss will be reduced and floral species will be increased due to protection of the area from existing problems. Due to increased khal depth, aquatic habitat would be improved and for this reason aquatic floral diversity is expected to be enriched. All kinds of project activities, especially earth work, will create employment opportunities. Moreover, embankment re-sectioning will ensure better communication facilities within the periphery of the polder.

The cumulative and induced effects of the proposed interventions in Polder 43/2F have been investigated through qualitative assessment.

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

Environmental Management Plan

The above stated negative impacts could be controlled/ minimized or eliminated through adoption of suggested mitigation measures and implementation of the Environmental Management Plan (EMP) during the construction, operation and maintenance phases of the project. An Environmental Management Plan (EMP) has been prepared which comprises a mitigation plan for minimizing the negative impacts and an enhancement plan for increasing the benefits of the positive impacts. For this project, the following EMP measures have been identified and recommended:

EMP Measures for Negative Impacts

- Re-excavation during fish migration period e.g. month of May to August should be avoided.
- Earth spoils should be dumped outside the khal area.
- To protect indigenous fishes and other aquatic creatures, re-excavation should be implemented segment-wise and one after another.
- At least 100 m of each khal should have the depth of more than 0.5 m than the normal design to protect fish brood.
- The deepest points of the khals should be left untouched to the extent possible.
- The works should be completed in scheduled time to minimize habitat disturbance to wildlife.

EMP Measures for Positive Impacts

- Engagement of local people (at least 40%) in all project implementation activities should be ensured.
- The construction materials like sand, cement, concrete, block, etc. should be placed in non-agricultural land.
- Regular maintenance/re-excavation of all khals should be ensured when needed.
- Proper maintenance of all water control structures should be ensured.
- Training should be provided through the DAE and DOF to the local people to enhance sustainable crop production.
- WMGs/WMA/WMF should be formed for polder activities (maintenance of embankment, functioning of regulators, etc.) and their Formation and involvement in polder management should be encouraged.
- Crop rotation with leguminous crops, application of more organic materials/ organic manure and soil management should be practised to improve soil fertility in the polder area.
- HYV/hybrid crop cultivars should be introduced and crop diversification should be practised.
- Farmer groups should have close contact with the DAE for adaptation of various measures on IPM/ICM.
- Irrigation should be provided at optimum level with minimum conveyance loss from khals.

- Training on “Integrated water management” and “on-farm management” of WMGs would help to increase the expansion of irrigated area.
- Awareness should be developed on natural resources, camping against indiscriminate fishing and reinforcement of fisheries laws and regulations in the polder area.
- IPM should be practised in agricultural fields for the protection of capture fish habitat quality.
- Proper and timely gate operation should be ensured to facilitate entrance of fish hatchling from May to July except during tidal surge.
- Pure strain and native fish species should be protected for aquaculture in pond culture.
- Mixed species of native trees should be planted along the embankment slopes wherever possible to enhance greenery coverage.
- Existing rural roads should be repaired and proper carpeting should be done at every location.
- Equity and share of open water bodies to all should be ensured.

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

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

1. Introduction

1.1 Background

1. Bangladesh, the largest river delta in the world, depends largely for its economic growth on integrated and participatory water resources management. The three major river systems of the country mark its physiography and the lives of its people. Effective management of this immense natural resource remains a continuing challenge and offers at the same time tremendous opportunities. About 38% of the population in the coastal region lives below the poverty line and faces high vulnerabilities in terms of insecurity of food, income, water and health (Inception Report, Blue Gold Program, 2013). However, there are ample opportunities to harness the resources of the coastal areas which can alleviate poverty, create a sustainable environment and provide security and well-being to the present and future generations.
2. The Government of the Netherlands (GoN), as a development partner of the Bangladesh Water Development Board (BWDB), has been supporting water management projects in Bangladesh since 1975for the development of sustainable and participatory water management options throughout the country. The Government of Bangladesh (GoB) considers integrated water resources development as one of its priority activities as it will build community resilience against tidal and storm surge flooding and salinity intrusion without compromising the ecosystem needs and allow communities to utilize available water resources for productive use and human consumption. In the coastal region of Bangladesh, participatory approaches in water resource management have been successfully introduced since 2003 in line with the water resources development strategies of the GoB with GoN participation as a development partner. These projects included the Integrated Planning for Sustainable Water Management (IPSWAM), the South West Area Integrated Water Resources Planning and Management Project (SWAIWRPMP), the Char Development and Settlement Projects (CDSP) and the Water Management Improvement Project (WMIP). As a follow up project of IPSWAM, the GoN has developed a programme called “Blue Gold” with active involvement of rural communities. Water or “Blue Gold” is regarded as the fundament for changing people’s lives and turning water from a foe into a friend as the trigger for sustainable development in the coastal areas of Bangladesh.
3. Blue Gold builds on the results and lessons learned in managing water resources from previous programs and projects in Bangladesh. The explicit objective of Blue Gold is to reduce poverty of the people in the coastal areas by enhanced productivity of crops, fisheries and livestock in an integrated way and to increase income by improved processing and marketing of agricultural commodities with value chain development. The project started in January 2013 and will end in December 2018. Its operations are concentrated in the polders of three coastal districts: Satkhira, Khulna and Patuakhali which are a part of the South-west and South-central hydrological zones. The total land area of the three districts is 11,463 km² and the total population is 5.6 million. This gives an average population density of 493 people per km² and an average household size of 4.3 persons (BBS, 2012). These districts are chosen because of (i) higher incidence of poverty, (ii) effective coordination with the local administration and private sector and (ii) prevalence of water-related challenges like sedimentation, storm surges and salt water intrusion. Initially, it was anticipated that 26 polders from these three districts will be

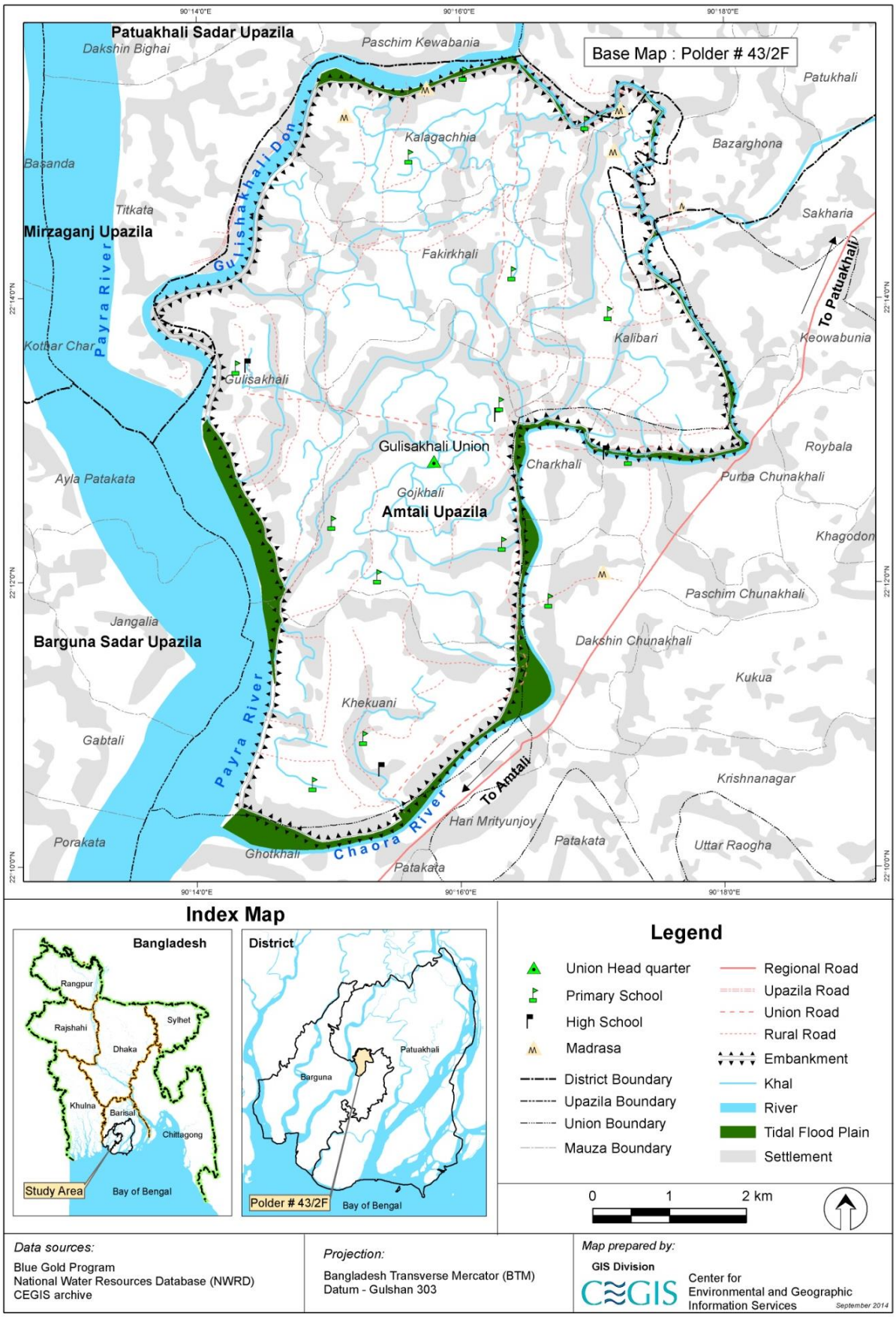
included in the program area, as illustrated in Table 1.1. All of the 9 IPSWAM polders are included in the program as well as 2 polders for which water management assessment has taken place already. However, final selection of the other polders will be done in accordance with the established selection criteria and project objectives.

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

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

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



Map 1.1: Base map of Polder 43/2F

1.2 Rationale of the Study

6. Sustainable development cannot be uni-focused; it includes economic development as well as protection to the environment. Polders are 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 a crucial role in the economic development of the country, at the same time they have some adverse effect on the ecosystem. Considering their importance, the GoB has declared the construction/reconstruction/expansion of flood control embankments, polders, dikes, etc. as '**red**' category projects which must be subjected to Environmental Impact Assessment (EIA) study (ECR, 1997).
7. Component II of the Blue Gold Program includes rehabilitation of water resources management infrastructure in selected polders. The rehabilitation works inside the polders include re-sectioning of embankments, repair and/or improvement of drainage outlets and irrigation inlets, re-excavation of internal canals and improvement of on-farm water management. These interventions must be subjected to EIA in order to obtain environmental clearance prior to implementation. To fulfill the obligation, CEGIS was engaged by the client to conduct the EIA study.
8. The EIA study has identified the cumulative and induced environmental impacts of different interventions within and outside the polder. Identification of such impacts is very crucial before implementation of such interventions as some of the impacts are reversible and some are irreversible. Through public disclosure, the implications of the interventions are informed to the local people and their concerns are also identified while the EIA is carried out. Therefore, conducting a comprehensive EIA is vital for sustainable environmental management.

1.3 Study Area

9. The study area of this EIA study is Polder 43/2F which is located in Gulishakhali union under Amtali Upazila of Barguna District. The geographical coordinates of the polder ranges from 22010'08.9"N to 22015'42.6"N as latitudes and 90013'32.1"E to 90018'01.0"E as longitudes. The polder covers an area of 4,130 ha, with a Net Cultivable Area (NCA) of 2,590 ha (63%).

1.4 Objectives of the Study

10. The objectives of the EIA study included the following:

    - To improve understanding of the physical processes and the interactions among the physical systems and human systems and the implications of the interventions;
    - To identify key environmental issues/concerns that are likely to be impacted by the proposed interventions;
    - To assess potential environmental impacts (cumulative, induced and reciprocal) of the proposed interventions on the natural system (water, soil, air, biological system and human health), anthropogenic systems (settlements and infrastructure), social and economic systems (work, education, recreation and health services) and cultural systems (beliefs, art and literature);

- To identify mitigation measures for minimizing the negative impacts and enhancement measures to boost the positive impacts;
- To prepare an Environmental Management Plan (that includes a mitigation and enhancement plan, a compensation and contingency plan and a monitoring plan).

1.5 Scope of Work

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

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 conditions of affected persons.

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

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

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

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

vi. Preparation of landuse map and conduct ground truthing.

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

viii. A small section of the EMP will indicate occupational health and safety measures to be undertaken for the implementation of the works, but there will be no detailed occupational health plan (OHP)developed under 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 (which will include a mitigation and enhancement plan, a compensation and contingency plan as well as a monitoring plan).

1.6 Limitations

12. Time allocated for the EIA study of Rehabilitation of Polder 43/2F was the major limitation which had to be overcome by employing more resources from CEGIS than asked for in the T0R.

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 Ms. Mashuda Parvin, Ecologist
8 Ms. Anushila Mazumder, Environmentalist
9 Ms. Sarazina Mumu, Urban Planner
10 Mr. Tanvir Ahmed, Water Resource Modeller
11 Ms. Tahmina Tamanna, Civil Engineer
12 Mr. S.M. Shafi-Ul-Alam, GIS Analyst
13 Mr. Syed Ahsanul Haque, Disaster Management Specialist
14 Mr. Mohammad Saidur Rahman, GIS/RS Specialist
15 Ms. Laila Sanjida, GIS/RS Analyst
16 Mr. Md. Amanat Ullah, Ecologist
17 Mr. Md. Azizur Rahman, Field Researcher
18 Mr. Md. Shahadat Hossain, Field Researcher
19 Mr. Md. Shahidur Rahman, Enumerator

1.8 Report Format

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

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

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

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

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

Chapter 5: ***Environmental Baseline:*** Environmental and Social baseline condition in respect of meteorology, seismicity, water resources, land resources, agriculture, livestock, fisheries, ecological resources and socio-economic condition are described in this chapter.

Chapter 6: ***Socio-economic Condition:*** socio-economic condition chapter describes demography, livelihood, quality of livelihood, social safety net etc.

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

Chapter 8: ***Identification, Prediction, and Evaluation of Potential Impacts:*** This chapter lists the important environmental and social components likely to be impacted by the proposed interventions are discussed in this chapter. Also discuss the possible impacts of proposed interventions on the environmental and social components and 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) with EMP and Monitoring cost.

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

2. Policy, Legal and Administrative Framework

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

2.1 National Policies and Legislations

2.1.1 The National Environment Policy, 1992

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 environment and to protect the country against any natural disaster. The Policy provides the broader framework of sustainable development in the country. It also stated all major undertakings, which will have a bearing on the environment and need an initial environmental examination (IEE) and environmental impact assessment (EIA) before initiation of the project. The Policy delineates the Department of Environment (DoE), as the approving agency for all such IEE/EIAs to be undertaken in the country.
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 irrigation networks should not create adverse environmental impacts and the Section 3.5.3 provides, 'ensure that all steps taken for flood control, including construction of embankments,.... be environmentally sound at the local, zonal and national level'. According to the Section 3.5.5 of the Policy the rivers and all water bodies are to be free from pollution. The Environment Policy sets out the basic framework for environmental action, together with a set of broad sectoral action and guidelines (MoEF, 1992).

2.1.2 National Environmental Management Action Plan (NEMAP) 1995

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 set 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 rate of environmental degradation;

- Improvement of the natural and built environment;

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

2.1.3 Proposed National Wetland Policy (draft 1998)

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

2.1.4 The National Water Policy, 1999

22. The National Water Policy of 1999 was adopted to ensure efficient and equitable management of water resources, proper harnessing and development of surface and ground water, availability of water to all concerned and institutional capacity building for water resource management. The policy considers water as being essential for human development, socio-economic development, poverty alleviation and preservation of the natural environment.
23. Sub-clause (b) of Section 4.5 states that planning and feasibility studies of all projects (relevant to water resources management or development or have interference on water sector) will follow the Guidelines for the Project Assessment (GPA), the Guidelines for Peoples Participation (GPP), the Guidelines for Environmental Impact Assessment (EIA), and all other instructions that may be issued from time to time by the Government. Giving importance on the navigation sector, sub-clause (a) of section 4.10 states that if a project may cause disruption to navigation, adequate mitigation measures should be taken. The stated objectives of the draft policy are:
    - Establish the key principles by which wetland resource can be used in a sustainable manner;
    - End existing unsustainable practices in wetlands, so as to stop and reverse the decline in their productivity;
    - Ensure that measures are taken to maintain existing levels of biological diversity in wetlands;
    - Maintain the functions and values derived from wetlands throughout Bangladesh;
    - Actively promote the recognition and integration of wetland functions in resource management and economic development decision-making, with particular regard to sectoral policies and programs in the water, fisheries, agriculture, industries and infrastructure sectors.
24. 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).

2.1.5 The National Biodiversity Strategy and Action Plan for Bangladesh 2004

25. 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).

2.1.6 Bangladesh Climate Change Strategy and Action Plan (BCCSAP)

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

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

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

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

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

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

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

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

27. The National Water Management Plan (NWMP) 2001, approved by the National Water Resources Council in 2004, envisions to establish 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.

2.1.8 Coastal Zone Policy, 2005

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

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

2.1.9 Coastal Development Strategy, 2006

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

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

2.2 Legal Framework

2.2.1 Water Resource Management Legislation

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

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

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

32. This Act provides power to the government to:

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

The Embankment and Drainage Act 1952

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

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

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

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

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

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

37. This ordinance provides power to the government to declare any area as "Khas managed fishery" to bring it under the management and control of the government. No

person shall fish in such an area without a valid fishing license issued by such authority as may be prescribed under the Act.

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

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

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

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

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

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

    c) is otherwise feasible.

The Protection and Conservation of Fish Rules (1985)

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

PanishampadParikalpanaAin (Water Resource Planning Act, 1992)

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

2.2.2 National Water Act, 2013

42. The Water Act 2013 is based on the National Water Policy, and provides the legal framework for integrated development, management, abstraction, distribution, usage, protection and conservation of water resources in Bangladesh. The Act provides for the formation of a high-powered National Water Resources Council (henceforth termed as

the Council) headed by the Prime Minister. An Executive Committee under the Ministry of Water Resources will implement the decisions taken by the Council.

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

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

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

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

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

48. The Act provides provisions for punishment and financial penalty for non-compliance with the Act, including negligence to abide by government policy, ordinance, non-cooperation with government officials, refusal to present necessary documents, providing false information, affiliation with perpetrators, and protection measures for water resources management. The maximum penalty for violations is set to five years of imprisonment and/or a monetary penalty of Tk.10, 000 (Ministry of Law, Justice and Parliamentary Affairs, 2013).

2.2.3 Environmental Legislation

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

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

- This Act provides power to the government to declare areas as game reserves, wild life sanctuaries and national parks to protect the country's wild life. This Act also provides legal definitions of the protected areas as follows:

  - "Game reserve" means an area declared by the government as such for the protection of wild life and increase in the population of important species wherein capturing of wild animals shall be unlawful;

  - "National park" means comparatively large areas of outstanding scenic and natural beauty with the primary objective of protection and preservation of scenery, flora and fauna in the natural state to which access for public recreation and education and research may be allowed;

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

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

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

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

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

52. The main objectives of ECA '95 are:

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

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

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

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

The Environment Conservation Rules, 1997

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

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

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

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

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

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

Bangladesh Environment Conservation Act (Amendment 2000)

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

Environment Court Act, 2000

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

Bangladesh Environment Conservation Act (Amendment 2002)

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

2.3 Procedure for environmental clearance

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

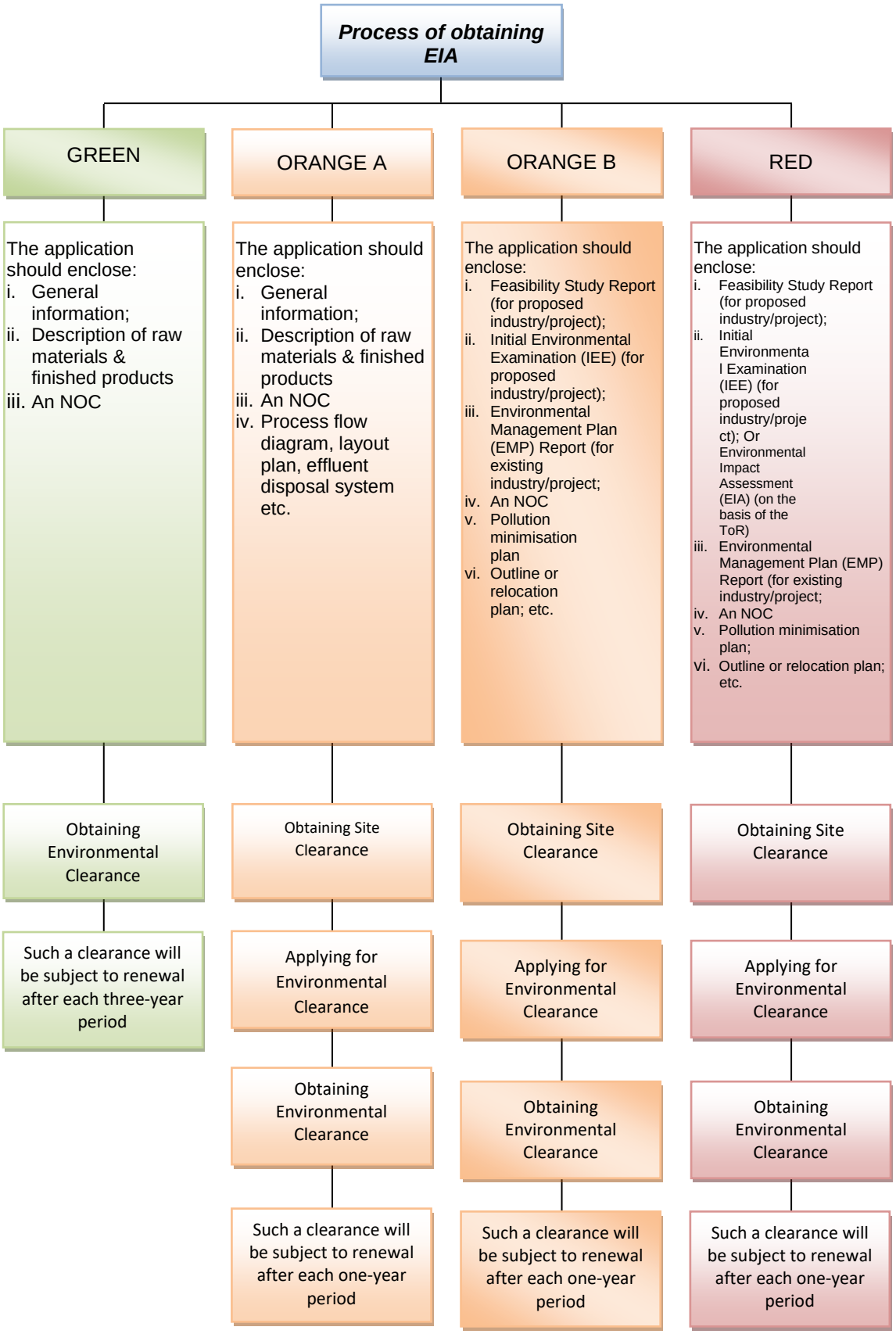


Figure 2.1: Steps Involved in Environmental Clearence folllowing DoE Clearence

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

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

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

2.4 Environmental Quality Standards

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

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

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

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

Note:

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

Table 2.2: Bangladesh Standards for Noise

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

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

Note:

1. The time from 6 a.m. to 9 p.m. is counted as daytime.

2. The time from 9 p.m. to 6 a.m. is counted as night time.

3. Area up to a radius of 100 meters around hospitals or educational institutions or special institutions/ establishments identified/to be identified by the Government is designated as Silent Zones where use of horns of vehicles or other audio signals, and loudspeakers are prohibited.

2.5 Administrative Framework

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

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

3. Approach and Methodology

3.1 EIA Process

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

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

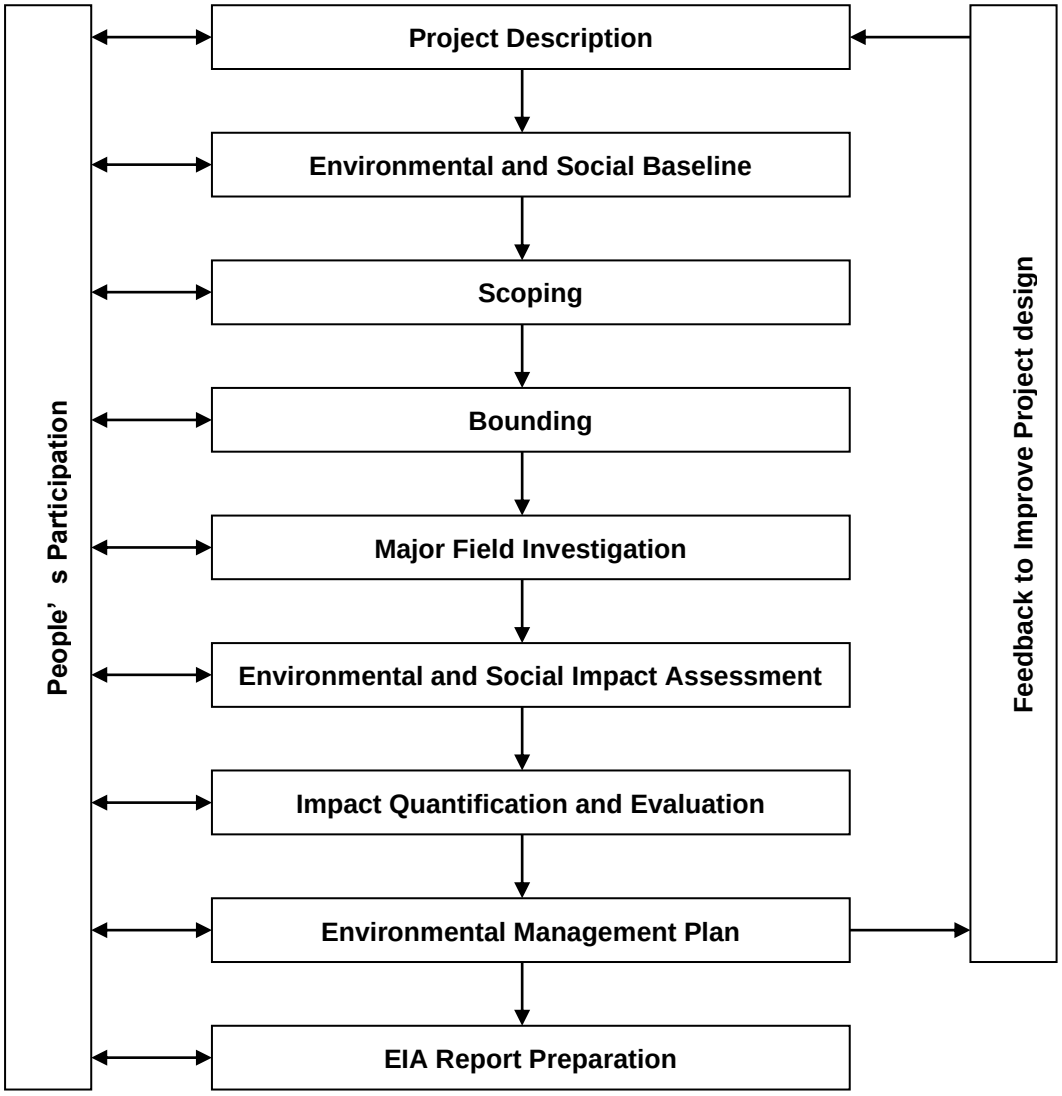


Figure 3.1: The EIA process

3.2 Project Description

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

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

3.3.1 Source and Methodology of Data Collection/Analysis

Climate and Meteorology

73. Data on different meteorological parameters such as rainfall, temperature, sunshine hours, humidity and wind speed were used for assessing the existing climate which is related to the water resources of the study area. The nearest station of the Bangladesh Meteorological Department (BMD) at Patuakhali (located within 600 m from Polder 43/2D) was selected. The data were collected from the National Water Resources Database (NWRD), which contains long time series of temporal data showing daily values for meteorological stations. The rainfall measuring station of the BWDB is located almost a similar distance away (to that of the Patuakhali BMD station) from the polder and as such no further rainfall analysis has been carried out. The BMD station in Patuakhali does not measure evaporation, and as no other BMD stations were located nearby, no discussion on evapo-transpiration was held for Polder 43/2D. However, the issue of climate change was discussed on a regional scale. Through the review of existing literatures on different climate change scenarios for the South-Central hydrological region (which is relevant to the Patuakhali district), an understanding has been obtained regarding the probable climate change consequences in the future.

b. Topography and Seismicity

74. The general geological features and the seismicity of the project and its surrounding areas were collected from available secondary literature and the Geological Survey of Bangladesh (GSB). The topographical data were collected from the GSB and the NWRD of the Water Resources Planning Organization (WARPO).

c. Water Resources

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

76. Field visits were made to the study area and primary data on water resources components were collected through discussion with stakeholders. A checklist was used to obtain the information on different resources (Appendix-1). Local knowledgeable persons and community representatives were also interviewed. During the field visits, the multidisciplinary EIA team members made professional observations pertaining to their individual areas of expertise. The impact of the 'Rehabilitation of Polder 43/2F' on water resources components were assessed by analyzing collected data, community knowledge analysis and professional justification of water resource managers. The management plan for water resources components was incorporated to assess impact risk and water resources status using stakeholder requirement and expert judgment.

77. The specific data on different events of water resources were collected from different sources. The surface water levels of 1990 to 2009wereanalyzed using information from the surface water station of the BWDB at Amtali. Monthly variations in Groundwater Table (GWT) from 1978 to 2013 were plotted and values were collected from the observation well of the BWDB at Amtali, designated as BAG001 (1.5 km away from the polder).

78. Data on water quality were measured on site, collecting surface and ground water samples from different locations within the polder. Surface water salinity was measured from different locations during high tide (mostly near the high water slack period). Information on different water resources functions, problems and uses was collected through intensive local level consultations.

d. Land Resources

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

e. Agricultural Resources

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

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

82. 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 last three years.

f. Livestock Resources

83. The present status of livestock (cows/bullock, buffalo, goats and sheep) and poultry (ducks and chickens) in the study area has evaluated through field level survey in consultation with the local people using methods like 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.

g. Fisheries Resources

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

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

86. **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 fishermen community, fisher households and local key informants and secondary data were collected from upazila fisheries office during field visits.

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

88. **Capture and Culture Fish Habitats:** Capture fish habitat assessment was done through Fishing Effort Survey (FES), Frame Survey (FS), micro scale Catch Assessment Survey (CAS), habitat based species diversity & composition, identification of species of conservation significance, identification of potential fish habitat prescribing to restore fish

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

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

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

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

h. Ecological Resources

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

93. 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 (30 m 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.

94. 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:

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

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

- **Socio-economic Conditions**

96. The socio-economic baseline information including study area, demographic information, occupation and employment, literacy rate, drinking water, sanitation, electricity facilities etc. was collected form secondary sources, i.e. BBS, 2011. Information on the income

expenditure of local people inside the polder area, land ownership pattern, poverty status, migration, social overhead capitals and quality of life, disasters, conflicts of the study area, NGOs, and cultural and heritage features of the study area was collected mainly from primary sources through PRA and FGDs and public consultations.

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

    a) Data collected from BBS, 2011;

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

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

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

3.4 Scoping

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

3.5 Bounding

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

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

3.6 Major Field Investigation

101. The EIA study team members collected intensive data on the possible impact of the project after obtaining the detailed rehabilitation plan from the project authority. Intensive data on the IESCs were collected from the field during the major field investigation stage. In this case, information on the IESCs was gathered through a mixed method including RRA, PRA and KII using checklists for water resources, land resources, agriculture, livestock, fisheries, ecosystem and socio-economic components. Intensive consultation with the local people was carried out in each case for securing people's participation.

The multidisciplinary EIA study team members also made professional observations and justification during the field visits. This time the concentration was on the historical status and public responses for the IESCs and the possible condition of the same against the proposed interventions.

3.7 Environmental and Social Impact Assessment

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

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

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

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

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

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

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

3.8 Impact Quantification and Evaluation

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

3.8.1 Assessment Methodology

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

106. The criteria for determining significance are generally specific for each environmental and social aspect, but generally the magnitude of each potential impact is defined along

with the sensitivity of the receptor. The generic criteria for defining magnitude and sensitivity used for the project are summarized below.

3.8.2 Magnitude

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

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

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

Table 3.1: Parameters for determining magnitude

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

3.8.3 Sensitivity

109. 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

3.8.4 Assessment of Residual Impacts

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

3.9 Environmental Management Plan

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

3.10 EIA Report Preparation

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

4. Project Description

4.1 General

113. The Blue Gold Program covers many aspects of development in Polder 43/2F, concentrating on five components i.e. (i) community mobilization and institutional strengthening, (ii) water resources management, (iii) food security and agricultural production, (iv) business development and private sector involvement, and (v) cross-cutting issues. As the EIA investigation only entails component II namely, water resources management, the description of interventions provided in this chapter only attempts to discuss the rehabilitation of water resources management infrastructures in the polder. In order to make the polder effective against emerging challenges of erosion and sedimentation, increased salinization of groundwater, and cyclone surges and climate change, innovative and effective solutions have been suggested in connection with increasing infrastructure sustainability and stability. Capacity building of the BWDB officers and other responsible persons to ensure participatory water resources development involving the community as well with other stakeholders, high quality standards of design and implementation, introduction of innovative concepts and technical solutions are the salient features of the project.

4.2 Objective

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

- Ensure sustainability of the development of the polder through effective community participation.
- Improve protection against storm surge and tidal flooding through increasing embankment stability.
- Repair the existing water control structures to allow better control on drainage and flushing, and hence improve agricultural production.
- Conduct re-excavation of khals so as to ensure efficient drainage as well as irrigation, and rainwater storage to enhance water use.

4.3 Present Status of Water Management Infrastructures

115. Polder 43/2F is situated in Gulishakhali union under Amtali Upazila of Barisal District. The polder was constructed in 1989-97, 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 Barguna O&M Division, BWDB, Barguna.

116. Water management infrastructures are physical interventions that are used to ensure sustainable management, optimal use and equitable sharing of water resources. In Polder 43/2F, there are some typical water management infrastructures i.e. a peripheral embankment, sluices, drainage outlets, and flushing inlets. Based on field investigation

carried out in May 2014, the study team gathered the following information regarding the condition of existing infrastructure.

Embankment

117. The embankment is 32.995 km long, with top width varying from 2.0 m to 3.4 m, and crest levels varying from 3.7 m to 4.1 m above Mean Sea Level (MSL). The existing side slopes vary over a wide range (from 1.8 to 4 m as hypotenuse), with low set back distance (less than 12 m along almost 90% of the embankment length). The existing situation of the embankment in most parts is good, offering protection against tidal and storm surges. In dry season, the embankment remains dry and small vehicles are found to run on it. A significant portion of the embankment is unpaved, which becomes slippery and unsuitable for vehicular movements during wet season. During field investigations in May 2014, the study team observed the implementation phase of another LGED scheme in Polder 43/2F, under which brick pavements were being constructed over a significant portion of the peripheral embankment.

118. There are some locations along where the peripheral embankment is narrow, obstructing movement of larger vehicles. At the location of the Katakhali outlet, road width has decreased by around 5 feet since the construction of the structure beneath the embankment. The width was sufficient before the construction of the outlet, but the use of less number of pipes in the structure has resulted in a narrowing of the embankment above.

119. Some locations along the embankment besides the Payra River i.e. Angulkata, Gulishakhali, Dalachara and Naiapara, suffer from river erosion. The locations are stable during dry season, but tend to erode whenever moderate levels of flooding occur at the Payra River. Another location adjacent to Angulkata was severely damaged during the cyclone Sidr. However, since the construction of minor temporary protection works along the location, a small portion of lands has accreted along the setback distance of the location.

120. Furthermore, issues of mismanagement were observed in some places of the embankment. During a field visit at West Kolagachia, large wood logs were found being rolled and transported over the embankment surface (from the countryside to riverside). This is a regular phenomenon as claimed by the local people, that pose a serious risk to the physical stability of the embankment.

Photo 4.1 : Existing status of embankment

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

Water Control Structures and Culverts

121. There are 16 drainage sluices, 4 drainage outlets and a number of flushing inlets constructed by the BWDB within the polder. These structures need repair as almost all of them are not functioning at the desired level. Some gates do not operate smoothly due to damages in the wheels and shafts used to elevate the gates. During field investigation, some gates were seen as tied up with ropes and logs, and local people opined that around 10 to 15 people were required to manually lift up the damaged gates. Functionally, the drainage outlets cannot drain out water properly after heavy rainfall events, especially during post monsoon. There are also problems of severe mismanagement of the water control structures.

122. During the field visit in May 2014, the study team found that most of the existing sluice gates and outlets had been subjected to structural damage in recent years and were also not maintained properly by the local people. A breach of around 1 meter depth (locally termed as Chala) has formed just beside the wing wall of the Keukhani sluice, and if the gate is kept closed, increased pressure of water flow may completely breach the Chala portion and cause heavy damage. Also, the gate is not stable enough to sustain the flow pressure during high tide, as opined by the local people. As such, this sluice is kept open to guide the flow through Keukhali Khal, which again hampers other sectors such as surface water irrigation. Another sluice at Kalibari is found completely non-functional. The gate and the hoisting system do not function properly, and uncontrolled growth of bushes, shrubs and water hyacinths were observed on both sides of the gate. Significant structural damages were observed in Gulishakhali, Dolachara, Moradhona and Goshkhali sluices; the last one is a 3-vent sluice with only 1 gate functioning properly.

123. The drainage outlets were also damaged. The outlet at Moragona is almost non-functional and not used by local people. The number of inlets is also not sufficient for flushing water. Issues of mismanagement were observed in most of the gates and outlets. Some gates were completely blocked by uncontrolled growth of bushes and shrubs while some were used as navigation corners with uncontrolled jetties established nearby. During the field inspection, a small single storied pucca house was found under construction just above the wing wall of the Mondopbari outlet.

Photo 4.2: Existing status of sluice gates

[(a)The Keukhali sluice which is kept closed as itdoes not function properly; (b) the 3-vent Goskhali sluice with only one properly functioning vent; (c) damaged sluice at Gulishakhali with no gates at the moment; (d) wood logs kept beside the Kalibari sluice which does not function properly; (e) one side of the Borachi sluice blocked by uncontrolled growth of water hyacinths (f) the Mondob bari outlet where a new single storied house is being constructed above the wing wall]

4.3.1 Present Status of Drainage Khals

124. The internal drainage channels of the polder are 93.5 km long in total. Topsoil erosion and other land filling activities have resulted in gradual decrease of khals within the polder over the years. Some of the khals (Keukhani Khal, Motbari Khal etc.) have become very shallow (as low as 2 feet in width) at some locations. Incidents of public encroachments were also observed as in Koromjabunia khal, where local fishers have formed ghers, obstructing the khal at multiple locations. In spite of these problems, a

major portion of the khals was found in good flow condition. Hydrological connectivity was found to be disrupted at locations where water from low lying lands does not carry into the khals, generating drainage congestion.

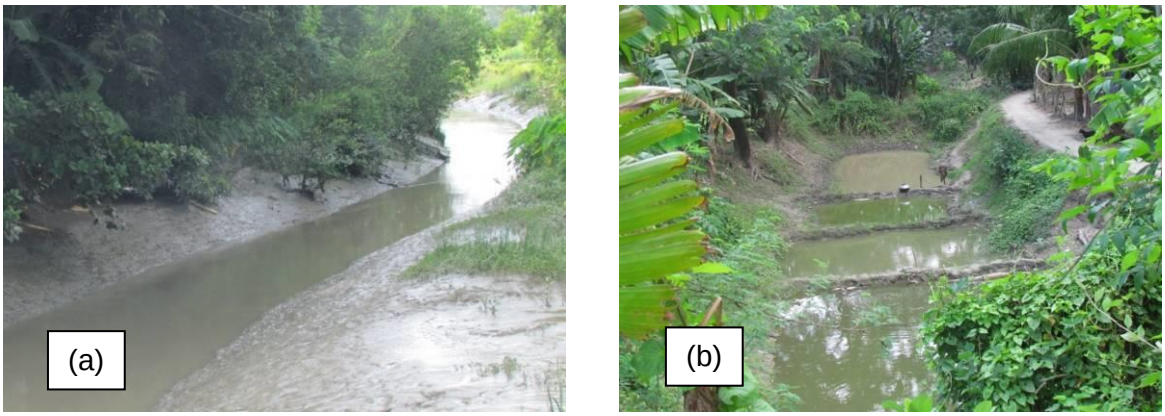


Photo 4.3: Drainage khals within the polder

[(a)Very narrow opening of Naseruddon Khal which barely exists (b)Narrow course of Sutanalir Khal]

4.3.2 Problems and Issues in the Polder

125. A number of problems and issues are hindering the potential of Polder 43/2F. During field investigations, local people opined that around 37 km (40% of the total length) water courses inside the polder is affected by drainage congestion problems, of which about 27 km of khals have been taken under the re-excavation program. The problems engender from the khal siltation phenomena as well as from the khals. The drainage congestion at some places leads to water logging issues, which affects the agricultural sector of the polder. Poor communication is a major problem, as opined by the local people. The existing road network is damaged in some places, and the unpaved portions become unusable to heavy vehicles during wet season. Poor maintenance is another issue in the polder, which results in deterioration of water control structures as well as peripheral embankments.

4.4 Proposed Interventions in Polder 43/2F

126. The second component of the Blue Gold Program has the following categories of interventions in Polder 43/2F. The locations of interventions are shown in Map 4.1.

4.4.1 Re-sectioning of Embankment

127. Re-sectioning works along the peripheral embankment is proposed at locations where damages exist. The proposed crest width is 4.27m, with side slopes of 1(V): 2(H) on both river and country sides, with the exception of 1(V): 3(H) R/S slope from Chainage 2+030 to 8+300. The design elevation of the crest of the embankment is at 4.27 m +PWD (above Mean Sea Level).

4.4.2 Repair of Water Control Structures

128. All existing sluices, inlets and outlets of the BWDB will be repaired within the polder. Some sluices would require new shafts and wheels (Goskhali, Dolachara), whereas

some would require replacements of barrels and gates (Gulishakhali). The sluice gates at Khekuani and Kalibari would require a new hoisting system.

129. The drainage outlets and flushing inlets would also require repair works. The size of each vent for all the sluices is 1.5m x 1.8m, and the pipe diameter for the outlets is are 900 mm.

4.4.3 Construction of Water Control Structures

130. The outlet at Moragona would be reconstructed, and a new outlet at Motbaria is also proposed by the WMA for construction. Furthermore, the WMA demanded ten (10) new inlets (450-600mm) at different locations of the polder.

4.4.4 Khal Re-excavation

131. A total of 14 khals (Gulishakhali, West Kalagachia, Gojkhali, Dalachara, Doachara, Khekuani, Chunakhali, Bottola, Kalibari, Borachi, Motbaria, Debpura, Moradhona, and Fokorer) are under the re-excavation plan of the Blue Gold Program in Polder 43/2F. The total length to be re-excavated is around 27 km.

4.4.5 Temporary Protection

132. There are some erosion hotspots near Angulkata, Gulishakhali, Dalachara and Naiapara. Some temporary protection works are proposed in these reaches by the Water Management Association. Through the major field investigation carried out by the study team in May 2014, the following information was collected regarding the temporary bank protection works proposed.

Table 4.1: List of vulnerable erosion points in Polder 43/2F

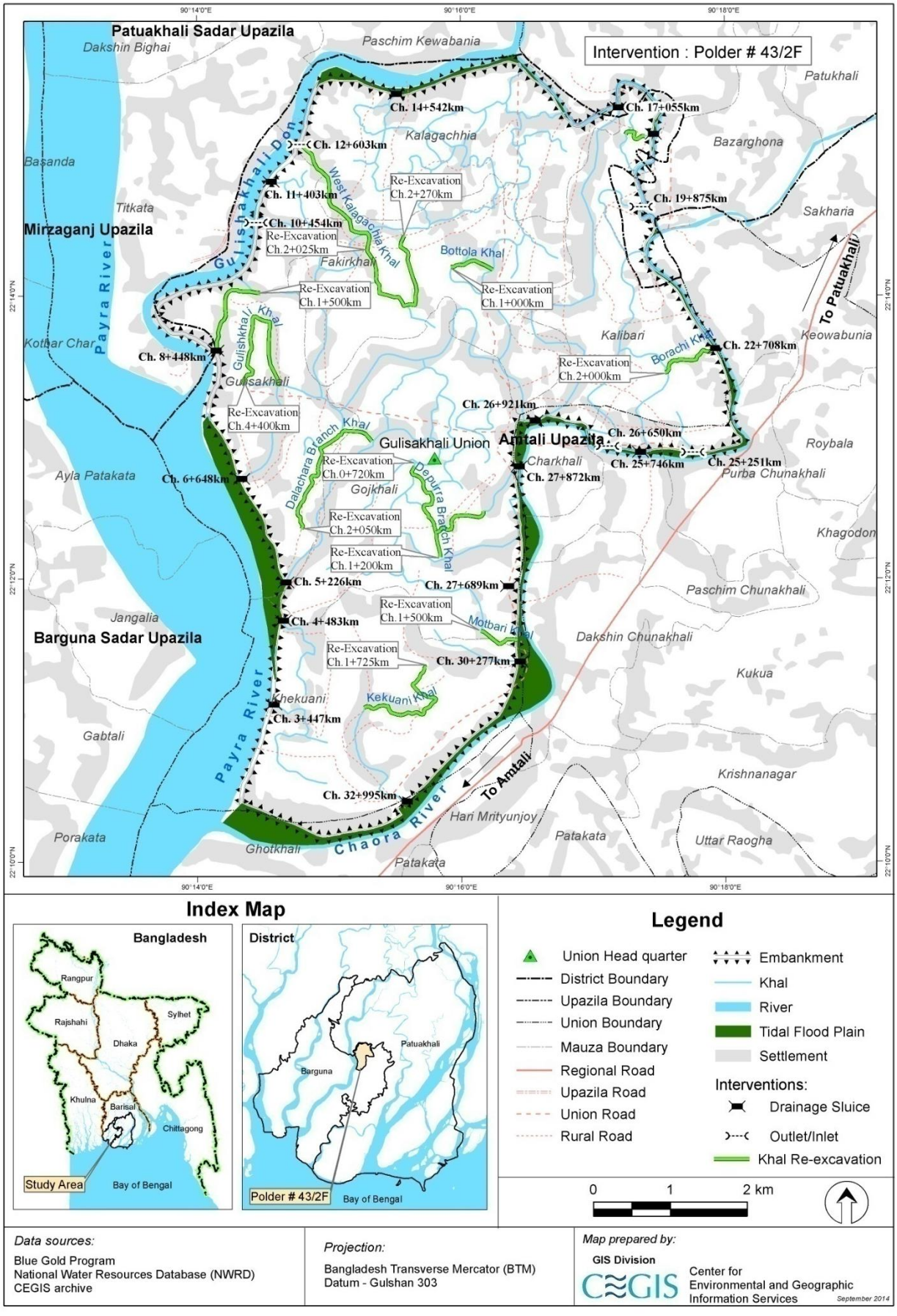
Location	GPS	River	Cause	Remarks
Angulkata	N: 22º10’57.2” E: 90º14’20.2”	Payra River	Change in river morphology	• Significant portion of land accreted in the last few years • Erosion occurs usually after flooding events
Gulishakhali	N: 22º13’16.1” E: 90º13’55.6”	Payra River	Change in river morphology	• Erosion occurs usually after flooding events
Dalachara	N: 22º11’19.2” E: 90º14’24.8”	Payra River	Change in river morphology	• Erosion occurs usually after flooding events
Naiapara	N: 22º12’35.5” E: 90º14’13.6”	Payra River	Change in river morphology	• Erosion occurs usually after flooding events

133. Table 4.2 below provides a summary of proposed interventions discussed above; along with their locations and geometric specifications.

Table 4.2: Summary of proposed interventions in Polder 43/2F

Sl	Name of Intervention	Location	Proposed dimensions
1	Re-sectioning of Embankment	Southern direction of Khatasia sluice, (Chainage 31+200 to Chainage 31+530)	✓ Entire embankment ✓ Crest width is 4.27m ✓ Side slopes of 1(V): 2(H) ✓ Side slopes of 1(V): 3(H) R/S (for Chainage 2+030 to 8+300) ✓ Crest elevation 4.27 m, PWD
2	Repairing of Water Control Structures	All existing sluices, inlets and outlets of the BWDB within the polder will be repaired (location shown in Map 4.1)	✓ Sizes of all sluice gates are 1.5m x 1.8m ✓ Pipe diameters for two outlets are 900 mm
3	Construction of Water Control Structures	One new outlet at Moragona and ten (10) new inlets at different locations of the polder will be constructed	✓ Pipe diameters for two outlets are 450-600 mm
4	Re-excavation of khals	14 khals under the re-excavation plan (location shown in Map 4.1)	✓ Total length of re-excavation is 27 km ✓ Average depth of khal is 1~3 m ✓ Average top width of khal is 4~8 m
5	Temporary bank protection	Temporary bank protection works at erosion hotspots near Angulkata, Gulishakhali, Dalachara and Naiapara will carried out	✓ To be implemented as per design (if any) or as per decision of the Engineer in charge

Source: Blue Gold Program, 2014



Map 4.1: Map showing proposed interventions of Polder 43/2F

4.5 Construction Details

134. The following sections provide a comprehensive discussion on the activities under component II, construction schedule, manpower and material requirement, requirements for labor shed and construction camps as well.

4.5.1 Description of Activities

Re-sectioning of Embankment

135. After validating the final design, soil will be excavated or carried earth will be brought and deposited in selected areas. Sloping and shaping of the embankment will be carried out after proper compaction in layers. After that, required turfing with grass will be provided on the embankment. Watering and fertilizing will also be provided. The cross sections of the proposed re-sectioned embankments at different chainages are provided in the Appendix-2.

Re-excavation of Khals

136. 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 the required depth and width. The excavated soil/ sludge would 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 at its downstream would be excavated following similar procedures as stated for the first reach. Accordingly, all reaches of the khal will be re-excavated. Some relevant long and cross sections of each khal under the re-excavation plan are shown in Appendix-2.

Repair and Construction of Drainage Sluices and Outlets

137. Before starting the activities of repairing drainage sluices, ring bundhs and diversion channels will have to be constructed if required. Approach roads and fitting and fixing of gates will be implemented if needed and hoisting devices will be installed afterwards. The intake and outfall systems of the gates will be constructed as per design.

Repair and Construction of Flushing Inlets

138. Alternative diversion channels will be constructed before starting the construction works. Pipes and machine pipes along with construction allied material and fittings will be installed along with collar joints as and where required. After completion of all activities, the approach embankment will be constructed and turfed with grass. Finally, a channel is to be excavated through lead cut and tail cut to allow the flow to be channeled through the flushing gate.

Temporary Bank Protection Works

139. Temporary bank protection works would be carried out by installing bamboo fencing and placing geo-bags at vulnerable locations. A small launching apron will be prepared

with the geo-bags in place and bamboo fencing would be provided along the toe of the embankment.

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

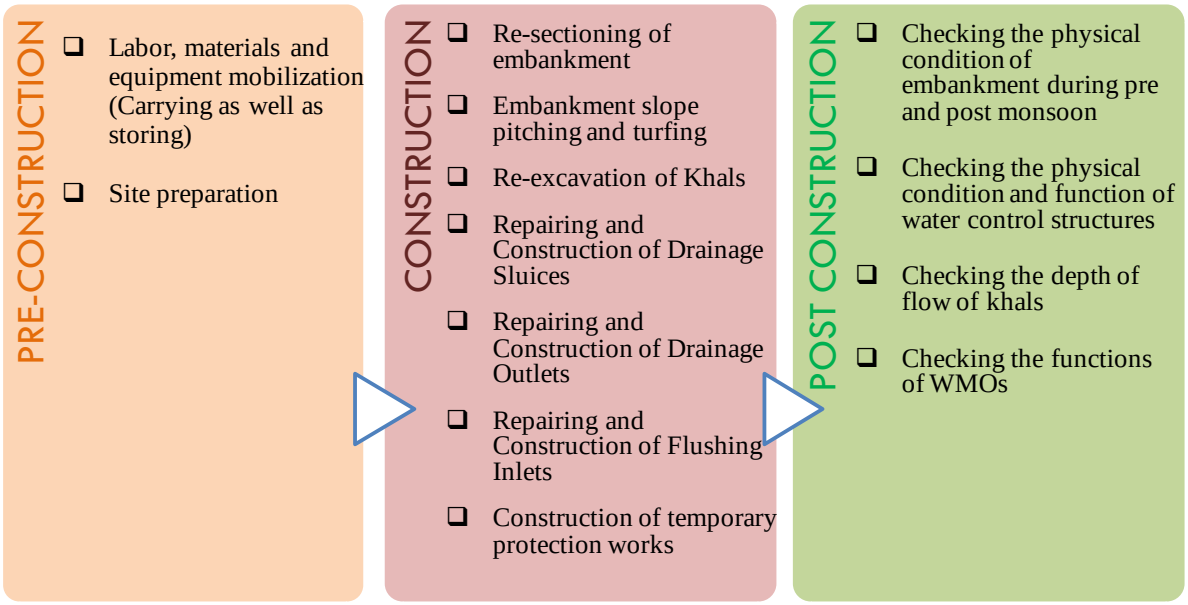


Figure 4.1: Phase-wise list of activities in Polder 43/2F

4.5.2 Construction Schedule

141. The construction works would be carried out during dry season, but kept at abeyance during wet season. Other supportive works would be carried during the entire year. The interventions proposed in Polder 43/2F are likely to be completed by June 2015.

Table 4.3: Construction schedule in Polder 43/2F

Key Activities	2013				2014				2015			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Screening, hiring and orientation of Community Organizers (COs)												
Community mobilization for Water Management Planning (Fine tuning works)												
In-depth information dissemination/ campaigns on Blue Gold Goals, Objectives, Components and Initial discussions with WMGs												
Assessment of WMO Functionality												
Strengthening/ capacity building of WMO based on outcome of Assessment												
Community Mobilization for Village Development Plan (VDP) and Polder Development Plan (PDP) 1. Firm-up water management development options 2. Firm-up Sustainable Environmental Management Plan (SEMP)												
Implementation of Water Management fine tuning works with active participation of the WMGs/ WMA through the Quality Control/ Block Committee												

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

4.5.3 Materials Requirement

142. The construction materials required for re-sectioning and retired embankment, regulators and flushing inlets, and bank protection works will include soil, cement, steel, and sand. Estimated quantities of these materials are presented in Table 4.4 below.

Table 4.4: Construction material requirement in Polder 43/2F

Sl	Description	Quantity	Sources
Re-sectioning of embankment			
1	Materials for earthwork	114,089 m^3	From the setback location and other

Sl	Description	Quantity	Sources
			khas lands
2	Hoe (or shovel) and baskets	400 nos. each	To be procured
3	Compactor	60 nos.	To be procured
Repair 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	12 (varying dia)	To be procured
8	Wheel and Shaft	6 sets	To be procured
9	Materials for temporary bank protection (geobags, bamboo etc.), plastering, slope filling, rail installation and other repair works	As per requirement	To be procured

Source: Blue Gold Program 2014 and CEGIS Estimations 2014

4.5.4 Manpower Requirement

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

4.5.5 Construction Camps and Labour Sheds

144. There are two WMAs in the polder, which will be responsible for monitoring the project. As the project works will be carried out by the local people, no labor sheds would be required. The laborers will come to the sites from their respective homes and go back home after completing work each day.

4.6 Project Management and Implementation

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

4.6.1 Implementation Considerations

146. Coordination, management and supervision of actions and the contributions of different actors and stakeholders require a strong and coherent management structure. For the rehabilitation works and other infrastructural works by the BWDB, a separate agreement on administrative arrangements will be signed. The Technical Assistance team (TA-consultants) will provide technical support during the design and other preparations whenever needed, and provide supervision during the execution of the works as well as advise the Embassy of the Kingdom of the Netherlands (EKN) on

disbursement. A certain percentage of works to be carried out by the BWDB will be fixed as overhead expenses (office and other costs). Separate DPPs will also be prepared for the activities to be implemented under the Blue Gold Program.

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

148. The water management component of Polder 43/2F will be integrated through the BWDB, as BWDB staff will be directly responsible for the overall implementation process: from planning to approval of the works to be completed and O&M of the main infrastructures. Technical assistance will be mainly provided in areas where the BWDB's capabilities are not sufficiently developed.

149. District Commissioners as well as elected chairpersons of the upazilas and unions will be regularly informed about work progress. For implementation, the TA-consultant will call upon the union chairman/ councilor to actively participate during the mobilization phase of the cooperatives. Table 4.5 below shows the list of major actors and stakeholders as well as their responsibilities in the implementation of the Blue Gold program in Polder 43/2F.

Table 4.5: Major actors and stakeholders in project implementation in Polder 43/2F

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

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

4.6.2 Community Participation through WMO/CBO

151. Sustainable operation of the project should be ensured through participation of Water Management Organizations (WMO) and Community Based Organizations (CBOs). Therefore, a three-tier organizational structure comprising of Water Management Groups (WMGs) at the lowest level, Water Management Associations (WMA) at the mid-tier and Water Management Federations (WMFs) at the apex would be in place. These groups, associations and federations in a particular sub-project is together termed as the Water Management Organizations (WMOs) which has been considered in this project.

152. WMOs would play vital roles in maintenance activities. While engaging any of the functional groups of these WMOs in this polder, care should be taken to adjust the methodologies slightly in some of the aspects according to local situation and project provisions so that it really fits in. Under this project, WMOs are conceived to have been included in the Water Management Groups (WMGs) as Functional Groups (FGs). The FGs have the scope of working in the O&M activities of the polder under the purview of the WMGs. There are 27 WMGs and 1 WMA in Polder 43/2F. All of WMGs are registered through Bangladesh Water Development Board (BWDB).

153. The following CBOs have been recommended for this polder under the Blue Gold Program.

Water Management Committee (WMC)

154. For the 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 in their best condition are down to the WMCs. Each WMC would comprise 5 to 11 members, depending on the significance of the intervention.

Labor Contracting Society (LCS)

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

4.7 Operation and Maintenance Plan

156. Since its establishment, Polder 43/2F has been playing a vital role in safeguarding the polder area, enhancing agricultural production, improving livelihoods, and mitigating environmental damages. However, the area remains vulnerable to storm surges, tidal flooding, riverbank erosion; drainage congestion etc. As it was observed, some of the structures within the area were not adequate to cater to the diversified needs of the local people. Changes in land use pattern also created social disputes in some places and newer dimensions for the existing structures were proposed as such, to allow flow of water both ways. Therefore, maintaining the polder system with the embankment and

structural elements built and rehabilitated has become a permanently important task. In this regard, the '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 43/2F has been proposed.

4.7.1 Operational Plan

157. The operational plan involves setting out the schedule of activities related to the operation of the gates of structures by the user organization to control water levels best suited to water management and agricultural needs. The activities described below have been recommended for the operation plan for the water management structures in Polder 43/2F.

Regulation of Gates

158. During the pre-monsoon period (March to May), the gates of each sluice should remain closed for preventing salinity intrusion as well as retention of water for irrigation and other use. During monsoon (July to September), the vertical lift gates should normally remain closed, but may be opened to drain out water from the polder if required. In addition to that, the gates should also remain open in June, which is considered as the starting period for fish breeding and migration. During the post monsoon season (October to November), the gates need to be operated properly so as to retain water in drainage channels without overtopping channel banks. Moreover, consultations must be carried out with beneficiaries of all occupational sectors i.e. farmers, fishers etc. Operation of outlets and inlets should also undergo similar practices with maximum involvement 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

159. 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

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

4.7.2 Maintenance Plan

161. Maintenance of the embankment and structures is necessary as it helps to keep the infrastructure in good and functional condition so as to protect investments and prevent high rehabilitation costs. Under component II of the Blue Gold Program in Polder 43/2F, only those works which directly serve water management should be regularly maintained.

Preventive or Routine Maintenance

162. Preventive maintenance works can be implemented through community-based functional groups such as LCSs. The works may include:

- All activities related to vegetative covers on embankment and small earthworks on the embankment by LCSs;
- Cleaning, greasing, and painting of structures by LCSs.

Periodic Maintenance

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

164. Minor periodic maintenance works;

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

Emergency Maintenance

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

4.8 Expected Benefits and Outcome

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

Table 4.6: Expected benefits and outcome of proposed interventions

Interventions	Benefits
Re-sectioning	✓ Protection from storm surge.

Interventions	Benefits
of embankment	✓ Protection against salinity intrusion. ✓ Increased side slopes will enhance the stability of the embankment. ✓ Communication facilities may improve.
Construction of retired embankment	✓ Protection from storm surge. ✓ Protection against salinity intrusion. ✓ Communication facilities may improve.
Repair of water control structures	✓ Sluices will function properly, and agricultural activities during dry and pre-monsoon seasons may increase. ✓ Drainage situation would improve; salt water intrusion may be prevented.
Outcome of the project	Apart from the aforementioned foreseeable benefits, the project may create some socio-economic developments i.e. employment generation, reduction of poverty etc. As a result, the local economy of the area may further improve.

4.9 No Objection Certificate

167. There are no archeological sites or any cultural heritage in the polder area that might affect the normal activities of the polder after rehabilitation. There will be no problem of land acquisition or displacement of people since rehabilitation will be made on existing structures. No Objection Certificates (NOCs) from the union chairmen have been obtained and are attached in Appendix-3.

5. Environmental Baseline

5.1 Physical Environment

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

5.1.1 Meteorology

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

Rainfall

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

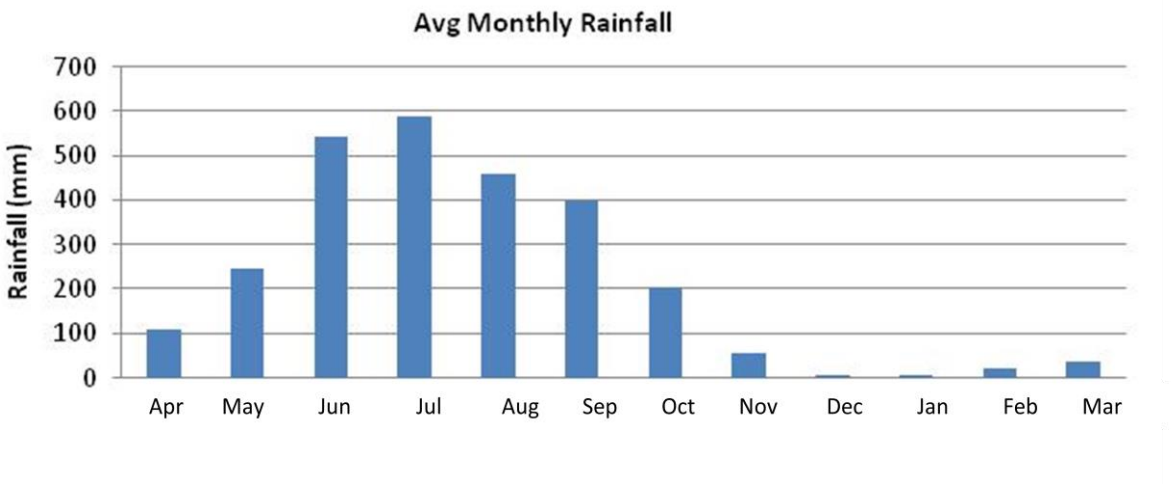


Figure 5.1:Average monthly rainfall at Patuakhali BMD

Temperature

171. Figure 5.2 below shows the variations in 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).

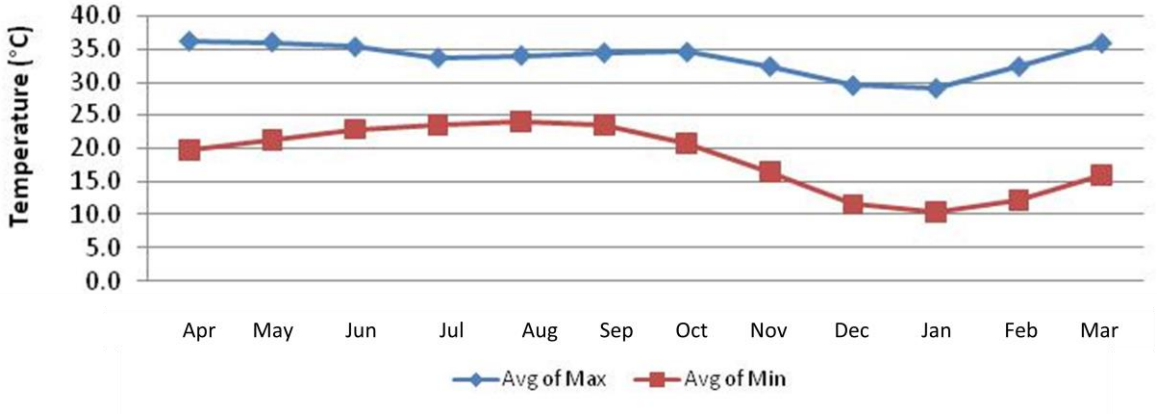


Figure 5.2: Average of maximum and minimum temparature at the Patuakhali BMD station

Relative Humidity

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

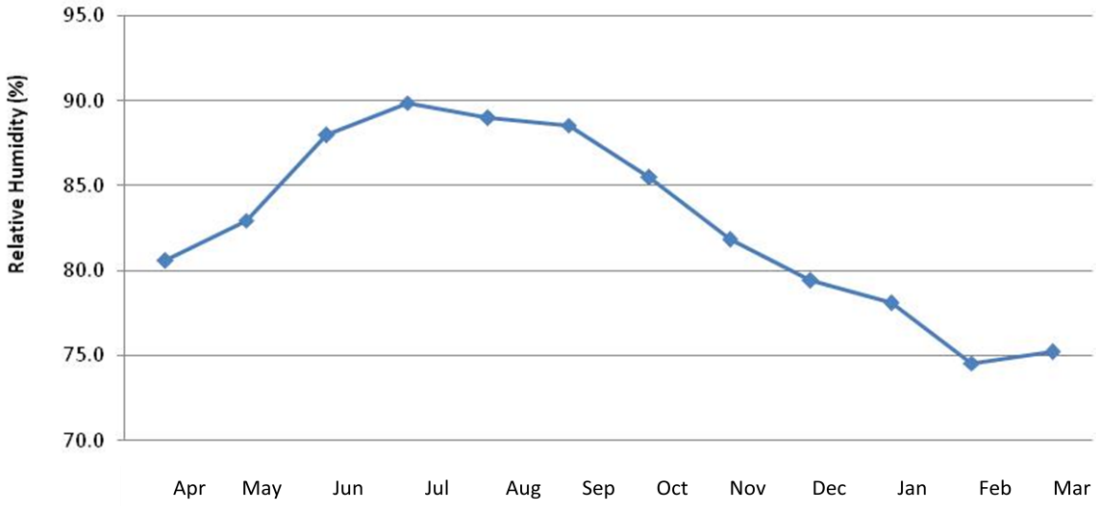


Figure 5.3: Average relative humidity at Patuakhali BMD station

Wind speed

173. Figure 5.4below shows the distribution of average monthly wind speed; at the Patuakhali BMD station (from 1973 to 2013). Wind speed is the highest in April (around 167 kph) and the lowest in December (around 49.7 kph). During cyclone Sidr (2007) and

Aila (2009), 1 minute sustained wind speeds were recorded as 260 kph and 120 kph respectively, the former one created devastating impacts due to the high wind speed whereas the latter one is related more to the increased storm surge.

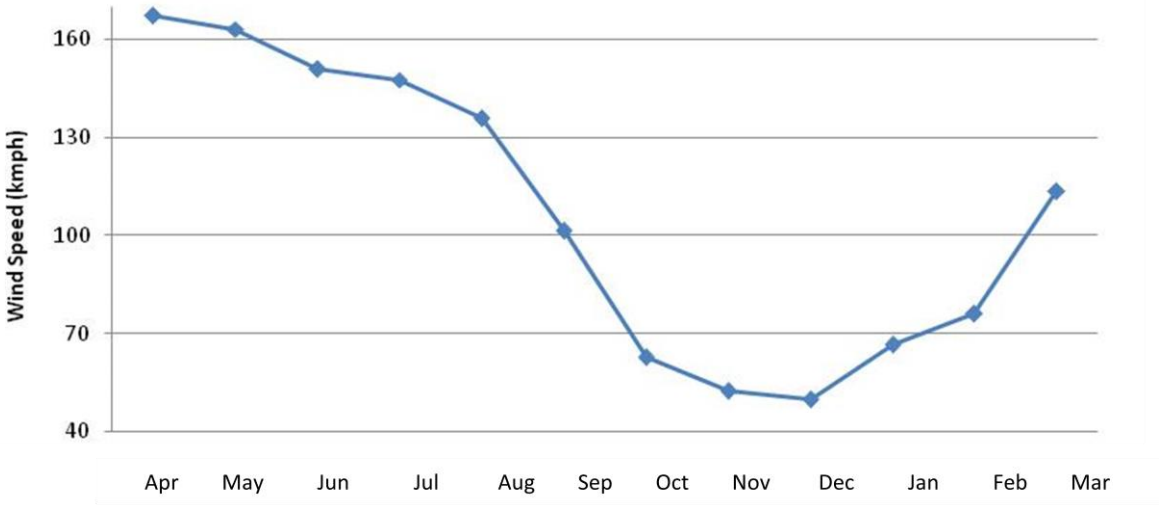


Figure 5.4: Variation of average wind speed at Patuakhali BMD station

Sunshine Hour

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

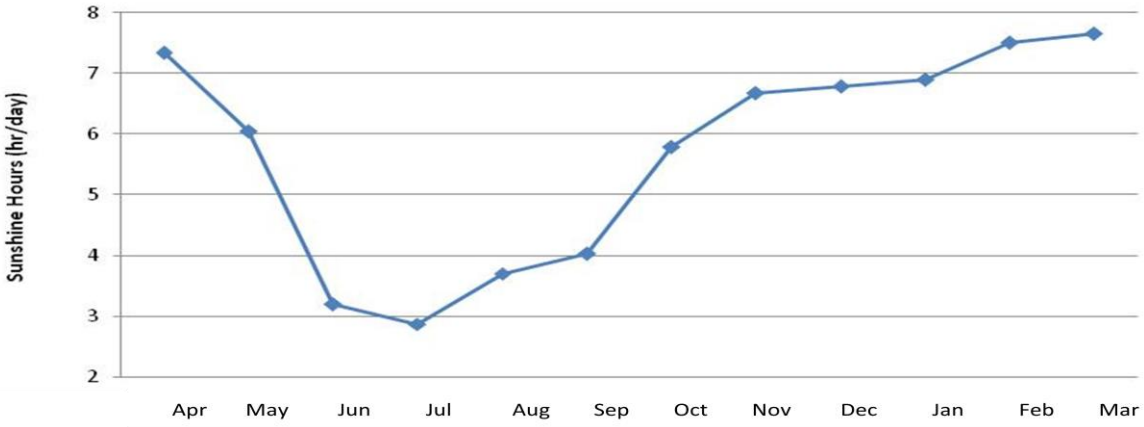


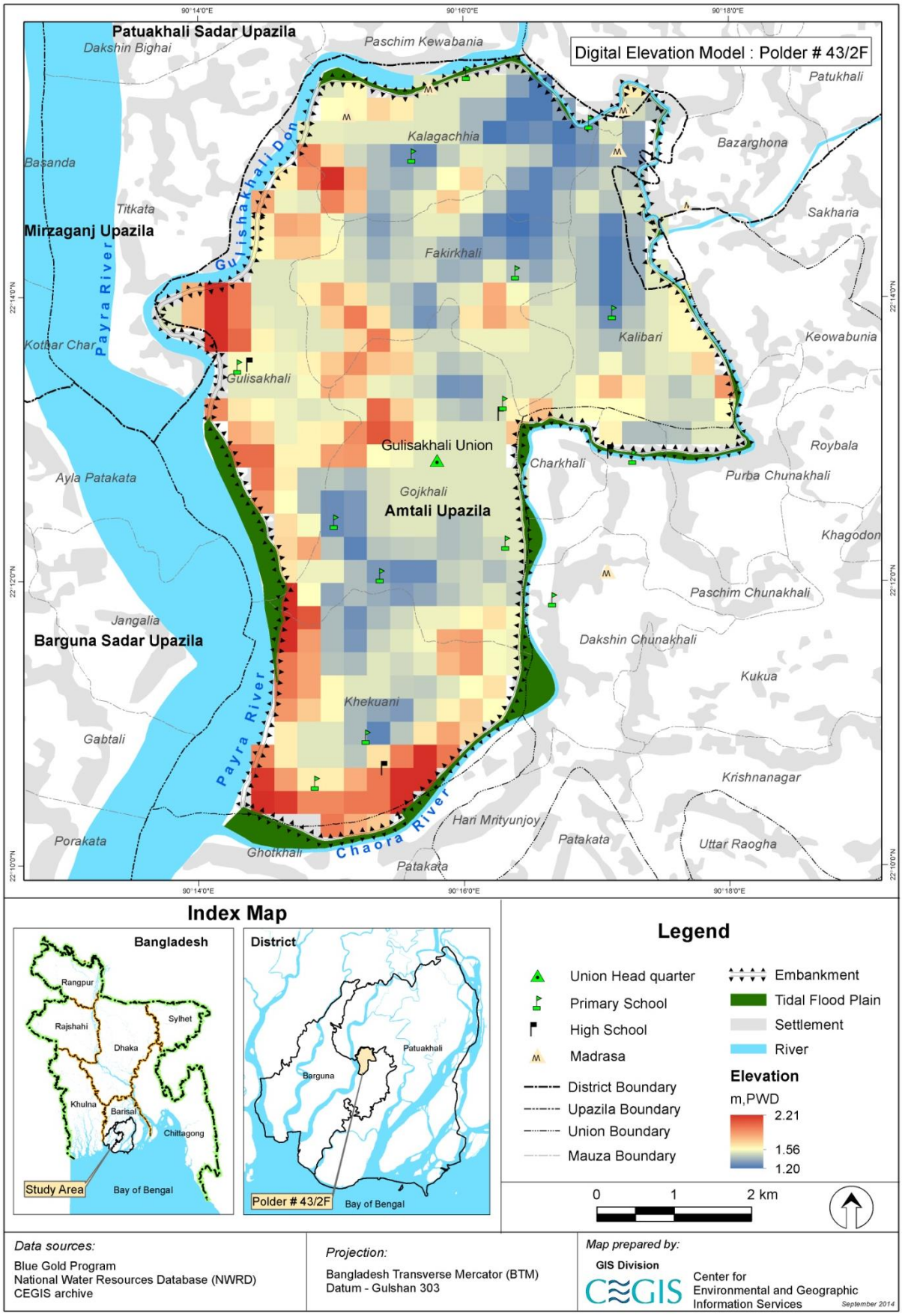
Figure 5.5: Monthly variation of average sunshine hours at Patuakhali BMD station

5.1.2 Topography

175. The study area is located in the Southern central hydrological zone of the country, with very low average elevations. Re-sampsled 500m×500m grid (reduced levels) RLs were captured from BWDB's one foot contour maps, which were produced in the late sixties. These spot levels were interpolated into a continuous surface called Digital

Elevation Model (DEM), produced by CEGIS in 1997 (Map 5.1).DEM analysis infers that the Reduced Levels inside the polder vary from +1.4 to +2.2 m PWD (from Mean Sea Level), with average elevations of around +1.56 m PWD. The entire portion of Polder 43/2F is higher than the low tidal water levels observed in Mirjaganj (Payra River). On the other hand in monsoon, water levels at Mirjaganj are observed to be higher than the maximum elevations of the polder.

176. The DEM indicates that 81% of the land area of the polder has elevations between +1.4 and +1.61 m PWD. The peripheral locations are slightly higher than the inward portions. Flow direction in the vicinity of the polder is tidal as during high tide, water from outside of the polder flows inside and in low tide it moves back towards the Bay of Bengal through the Payra and Gulishakhali rivers. Map 5.1 below shows the topography of the study area, presenting the rivers and water bodies as well as categorizing land elevations.



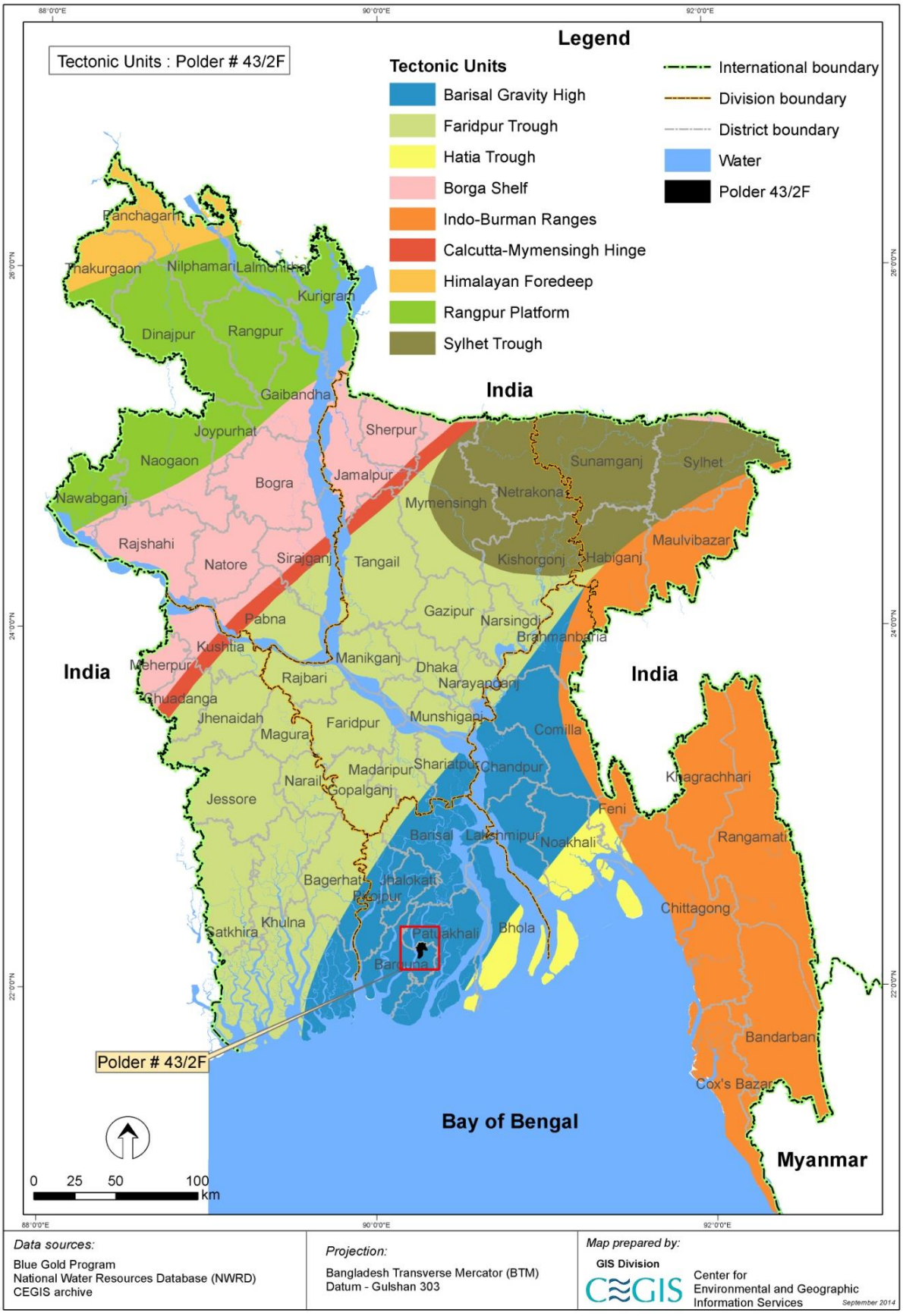
Map 5.1: Digital Elevation Model (DEM) around Polder 43/2F

5.1.3 Seismicity

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

178. Furthermore, the concept of tectonic frameworks has been studied to provide a comprehensive stratigraphic understanding of the area. Map 5.3 presents the tectonic units available in Bangladesh and the location of Polder 43/2F. 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 said that both in consideration of seismicity and stratigraphy, Polder 43/2F falls on a relatively safer (seismically quiet and tectonically stable) side.

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



Map 5.3: Map of tectonic units of the polder area

5.1.4 Agro-ecological Zone

179. Thirty agro-ecological zones and 88 sub-regions have been identified by adding successive layers of information on the physical environment which are relevant for land use and for assessing agricultural potential. These layers are (i) Physiography (land forms and parent materials), (ii) Soils and their characteristics, (iii) Depth and duration of seasonal inundation, (iv) Length of the rainfed kharif and rabi growing seasons, (v) Length of the pre-kharif season of unreliable rainfall, (vi) Length of the cool winter period and frequency of occurrence of extremely low (below 4^0C) winter temperature, and (vii) Frequency of occurrence of extremely high (>40^0C) summer temperature (FAO/UNDP,1988). The soil fertility status of these regions varies considerably mainly due to variation in soil texture and organic matter content of the soil. Individual farmers have fragmented the land into small plots causing wide variation in the management of each and every piece of land.

180. The polder area comprises one agro-ecological zone (AEZ) namely the Ganges Tidal Flood Plain (AEZ-13).The polder area is situated at Marichbunia, Bara Bigha, Gulishakhali, Kukua and Chowra unions at Patuakhali Sadar and Amtali upazilas of Patuakhali and Barguna districts. For detailed information about physical and chemical properties of soils, respective Patuakhali sadar and Amtali upazilas of Patuakhali and Barguna districts may be consulted for polder 43/2F. The method of BARC (2012) was followed to know the fertility status of a specific area.

Ganges Tidal Floodplain (AEZ-13)

181. This distinctive region has developed in the Old Teesta Alluvial fan extending out from the foot of the Himalayas. It has a complex relief pattern comprising broad and narrow floodplain ridges and linear depressions. Deep, rapidly permeable sandy loams and sandy clay loams are predominant in this region. Its top soils are very strongly to strongly acidic and sub-soils are moderately acidic; rich in weatherable sand minerals. Seven General Soil Types occur in the region of which Non calcareous Brown Floodplain soils, Black Terai soils and Non calcareous Dark Grey Floodplain soils predominate. Organic matter contents are relatively higher (Piedmont area) than in the other floodplain areas. The natural fertility of the soil, except those that are coarse textured, is moderate but well sustained. Soil fertility problems include rapid leaching of N, K, S, Ca, Mg and B. There is significant loss of leaching mainly in high land and subsequently lowering of soil pH. Some physico-chemical properties of soils of AEZ-13 are presented below.

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
High land (58%)	3.8-5.5	L-M	VL-L	VL-L	L-M	L-M	VL-L	L-M	L-M	VL-L	L-M
Medium highland (34%)	3.9-6.4	L-M	VL-L	VL-L	L-M	VL-L	M	M	L-M	VL-L	L-M

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

Source: Fertilizer Recommendation Guide, BARC, 2012.

5.1.5 Soil Fertility Status of the Polder Area

182. Soil fertility is an important factor for crop production. In general the coastal regions of Bangladesh are quite low in soil fertility. Thus in addition to salinity, plant nutrients in

soils affect plant growth. Farmers reported that the soils are in general poor in organic matter content. Soil sample were collected from five locations in three depths (0-10 cm, 10-20 cm and 20-30 cm) inside the polder area in the month on late May, 2014, salinity may be high in the month of March-April. The collected soil samples were analysed in Soil Resource Development Institute (SRDI). After analysis results indicates that salinity level is ranges from 2.6 to 7.54 in three depths in all locations. The pH ranges from 5.1 to 7.2, OM content ranges from 0.84 to 1.67 which is low, K ranges from 0.13 to 0.38, N ranges from 0.04 to 0.09 which is low, P level is 5.1 to 8.2, , S ranges from 9.96 to 95.68. Above all information's from five locations, three depths in the polder. Detailed information of the soil quality of the polder area is presented in the Table 5.2.

Table 5.2: Chemical Properties of Soil on Agriculture Land

Number of the polder	Location	GPS reading	Depth (cm)	EC	pH	OM	K	N	P	S
43/2F	Dalarchara	E-90°15′02.3″ N-22°13′10.6″	0-10	4.72	5.1	1.10	0.35	0.06	4.29	9.96
			10-20	4.74	6.1	1.05	0.17	0.06	4.68	10.61
			20-30	6.05	7.0	1.10	0.17	0.06	2.91	14.12
	Bazrakhali	E-90°12′01.1″ N-22°15′02.3″	0-10	4.03	7.2	1.37	0.13	0.08	2.77	39.64
			10-20	2.60	7.9	1.10	0.14	0.06	2.80	35.68
			20-30	2.52	8.2	1.22	0.17	0.07	2.84	23.81
	Gulshakhali	E-90°16′15.3″ N-22°13′41.9″	0-10	5.02	5.7	1.37	0.17	0.08	2.50	16.55
			10-20	2.29	7.0	1.40	0.14	0.08	3.24	12.67
			20-30	3.15	6.3	0.84	0.21	0.05	3.26	23.68
	Uttar Guzkhali	E-90°16′10.7″ N-22°14′27.7″	0-10	2.16	5.7	1.40	0.22	0.08	2.30	10.02
			10-20	2.34	6.0	1.22	0.23	0.07	3.44	14.06
			20-30	7.54	6.7	1.10	0.27	0.06	2.63	16.14
	East Kalibari	E-90°16′43.2″ N-22°13′45.1″	0-10	7.25	7.1	0.84	0.37	0.04	1.97	21.79
			10-20	2.86	6.5	1.40	0.38	0.08	2.15	28.79
			20-30	5.50	5.3	1.67	0.43	0.09	2.09	95.68

Source: SRDI, Laboratory analysis report, 2014

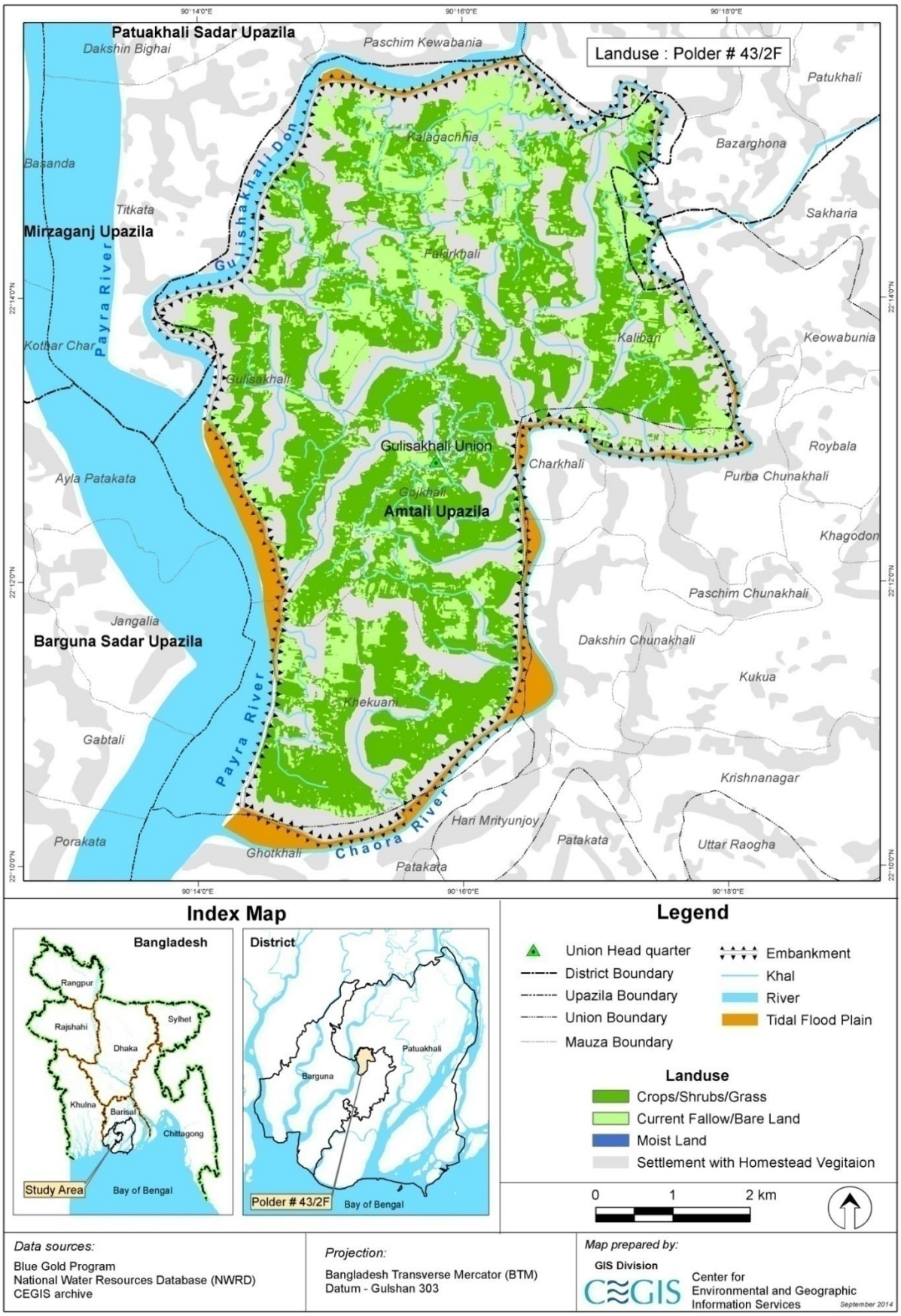
5.1.6 Land Use

183. The gross area is about 4,130 ha of which about 63% of net cultivable area (NCA). Settlements, water bodies and roads are about 32%, 4% and 1% respectively of the total area of the polder. Detailed of land use of the polder area is presented in Table 5.3 and Map 5.4.

Table 5.3: Present Land Use/ Land Cover of the Polder Area

Land use	Area (ha)	Percent of total area
NCA	2,590	63
Settlements	1,320	32
Water bodies (khals)	170	4
Roads	50	1
Gross Area	**4,130**	**100**

Source: CEGIS estimation from SOLARIS-SRDI, 2006



Map 5.4: Land use of the Polder Area

5.1.7 Land Type

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

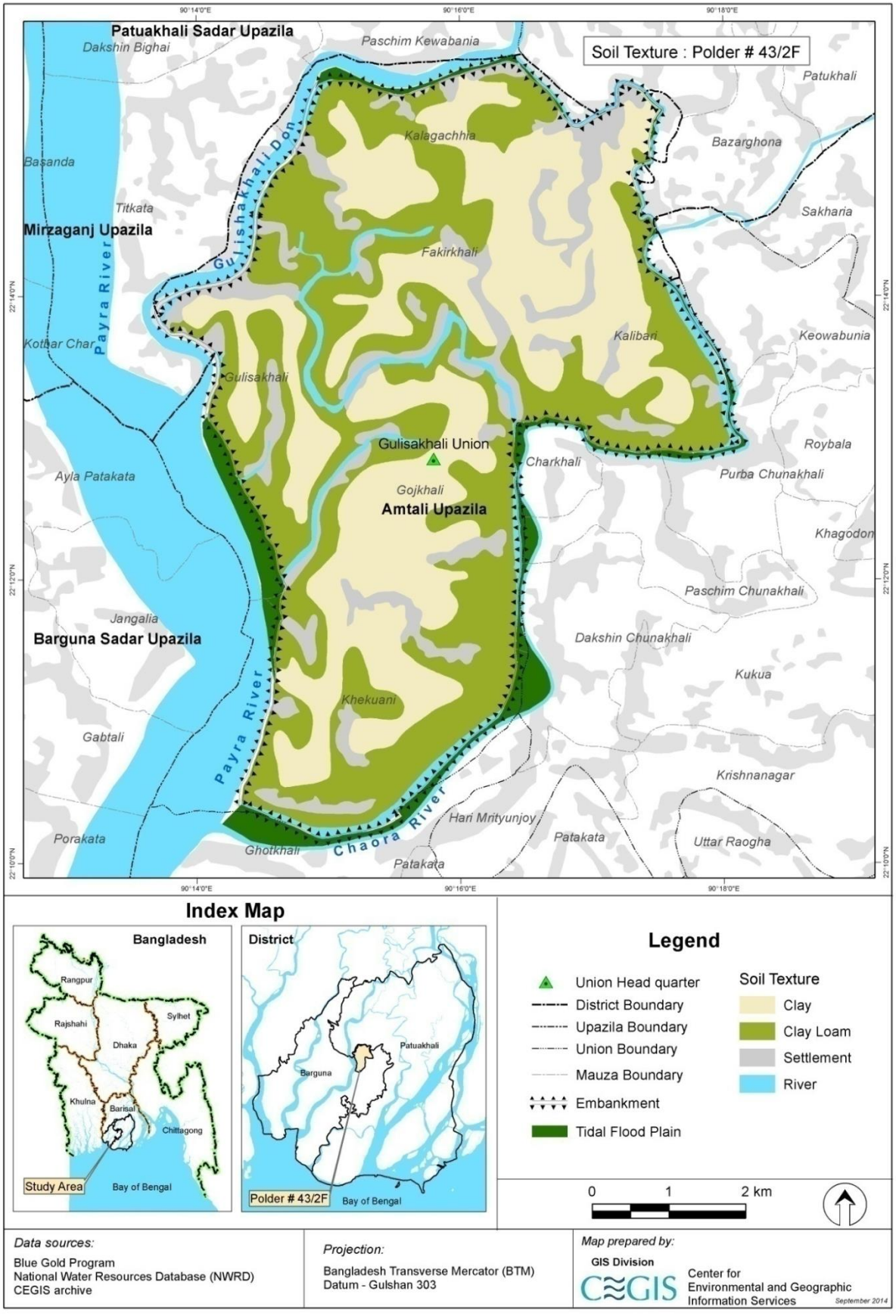
5.1.8 5.1.9 Soil Texture

185. Soil texture is the relative proportions of sand, silt and clay. It is very important for agriculture crop production. Maximum area is covered with clay texture (64%) and the rest is clay loam texture (36%). Detailed soil texture is presented in Table 5.4 and Map 5.5.

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

Texture	Area(ha)	% of NCA
Clay	1,658	64
Clay loam	932	36
Total	**2,590**	**100**

Source: CEGIS estimation from SOLARIS-SRDI, 2006



Map 5.5: Soil Texture of the Polder Area

5.1.9 Soil Salinity

186. The soils of the polder area become very slightly saline in the dry season (Jan-May).The soil and water salinity gradually increases with dryness from January and reached maximum level in the month April-May and then decreases due to onset of monsoon rainfall. From the SRDI soil salinity data, it is found that over the periods soil salinity inside the polder is not increases. For instance, in 1973, 96% of the NCA inside the polder was very slightly saline whereas in 2000, and 2009, there was no change in the polder area. Detailed soil salinity of the polder area is presented in Table 5.5.

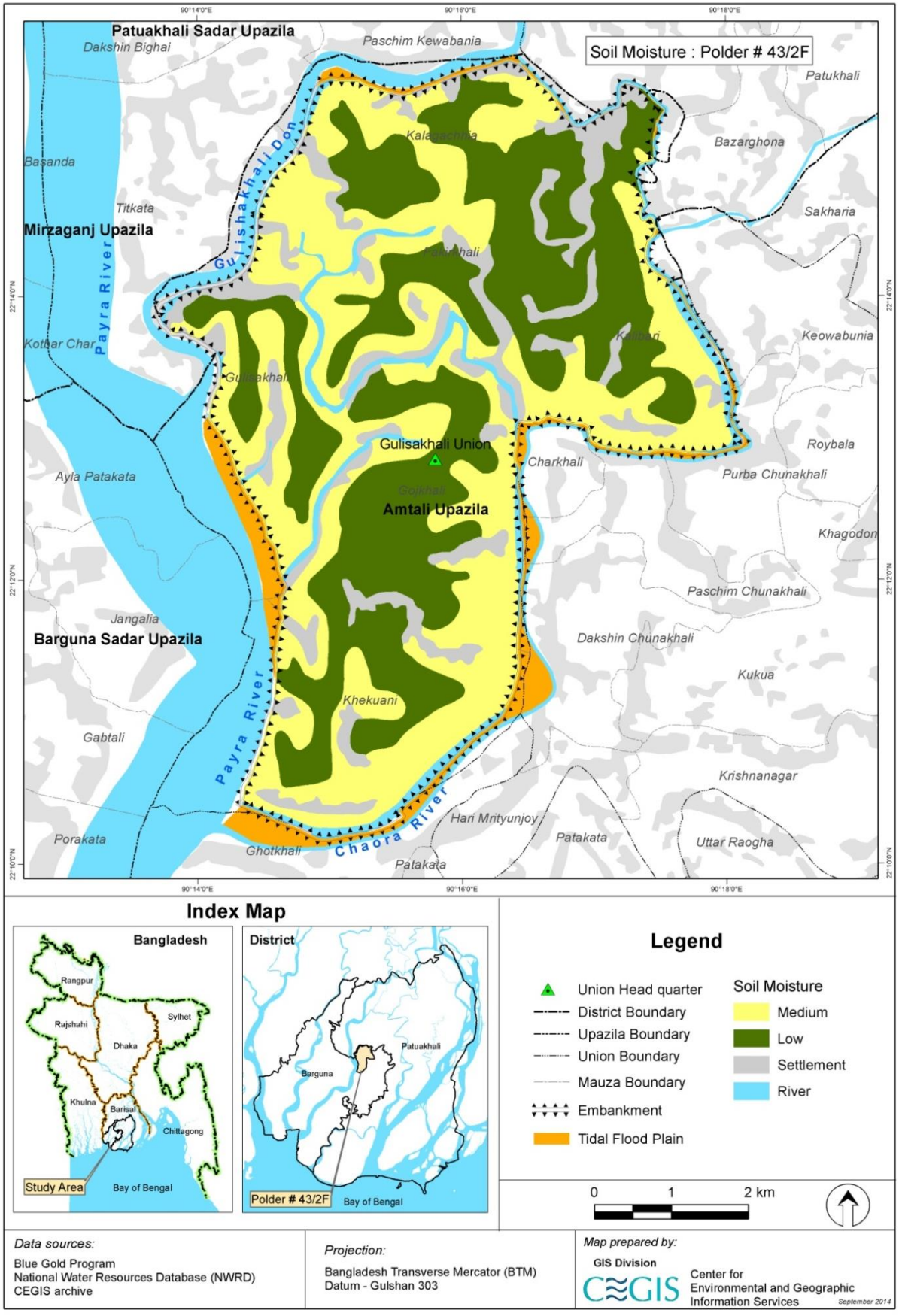
Table 5.5: Detailed Soil Salinity in the Polder Area

Soil Salinity class (EC=ds/m)	Description	Union	Area (ha) 1973	% of NCA	Area (ha) 2000	% of NCA	Area (ha) 2009	% of NCA
4.1 - 8.0	Very slightly saline with some slightly saline	Bara Bighai Marichbunia Chowra Gulisakhali Kukua	2495	96	2590	100	2590	100
	Data not available		95	4				
Total			**2590**	**100**	**2590**	**100**	**2590**	**100**

Sources: CEGIS estimation from SOLARIS-SRDI, 2006

5.1.10 Available Soil Moisture

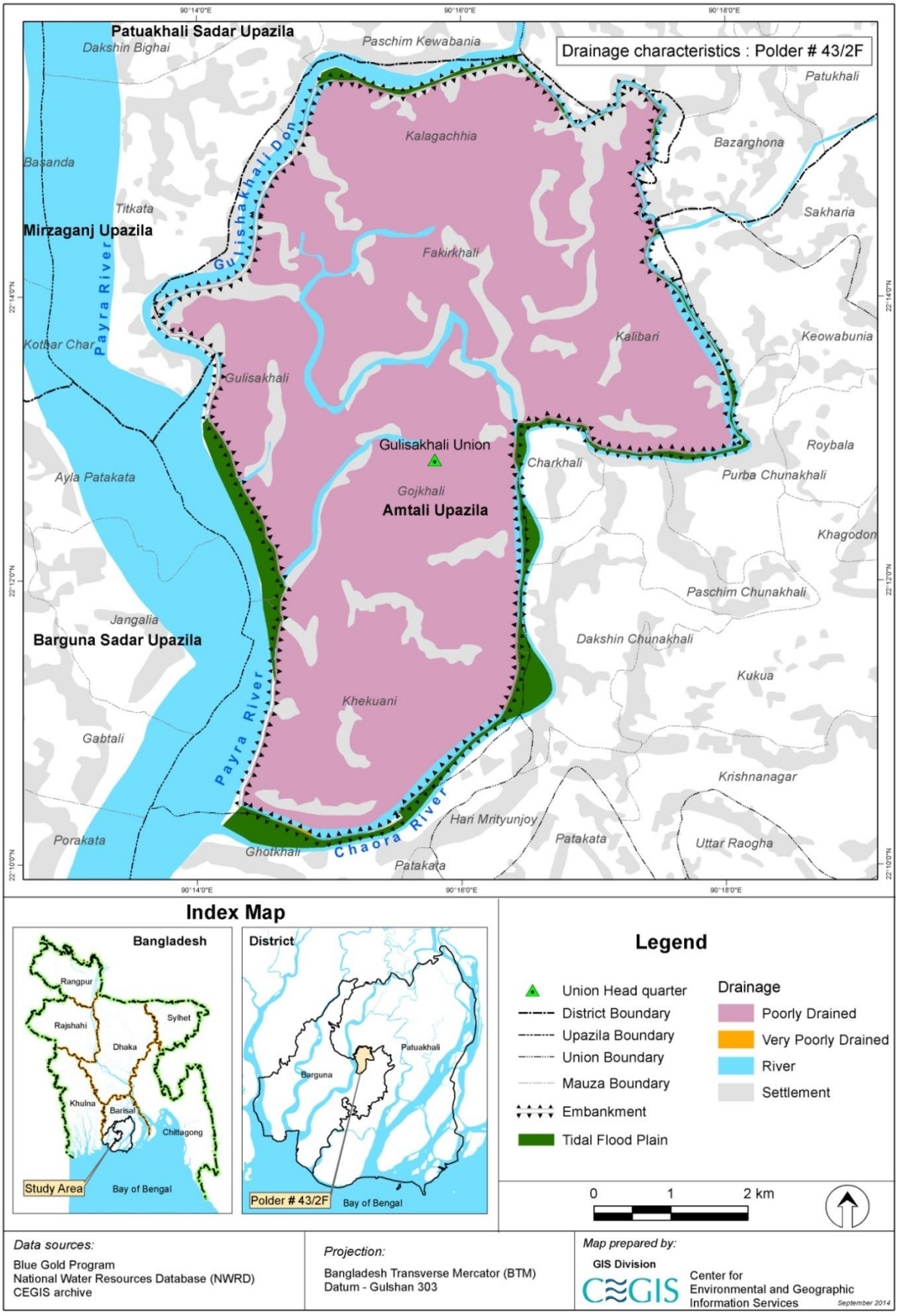
187. The available soil moisture is very important for the cultivation of rabi/dry season crops. The entire polder area (100%) is covered with low level of available soil moisture (Plant extractable soil moisture remained in the field level less than one month). Detailed distribution of available soil moisture is presented in Map 5.6.



Map 5.6: Soil Moisture of the Polder area

5.1.11 Drainage Characteristics

188. Drainage plays a vital role in the management of soil (salinity, soil health) in the polder area. As per the SRDI (1988), the drainage characteristics have been divided into six classes from the agriculture point of views. Total area of the NCA is under poorly drained condition i.e, the soil remains under water from 15 days to 7/8 months and water is drained from the soil slowly. In most cases, the land remains wet/water logged for a considerable period of time after the rainy season. Poorly drained condition of the soil indicates that the removal of water in rainy/ moon soon season is the main constraint for growing dry land crops in the polder area. Poorly drained characteristics along with area are presented in Map 5.7.



Map 5.7: Drainage Characteristics of the Polder area

5.1.12 Farming Practices

189. Farming practices in the polder area are largely controlled by physical, biological, climatologic and socioeconomic factors. Agricultural crops are grown by cropping seasons. There are two distinct cropping seasons in a year. They are the Kharif and the Rabi seasons. The Kharif season starts from March and ends in October while the Rabi season starts from November and ends in February. Based on crop adaptability and crop culture, the Kharif season has been further sub-divided into Kharif-I (March-June) and Kharif-II (July-October) season.

190. The Kharif-I season is characterized by high temperature, low humidity, high evaporation, high solar radiation and uncertainty of rainfall of low alternating dry and wet spells. In this season, HYV Aus crops are grown.

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

192. During Rabi season, crops are favored with high solar radiation, low humidity, salinity and temperature, but lack of adequate soil moisture depresses the crop yield because of very low or evens no rainfall throughout the season. Wide ranges of crops can be grown in this season. Major crops grown in this season of the polder area are Kheshari, Lentil, Mungbean, Sesame, Chilli, Sunflower, Ground nut, Mustard and Potato. However, there are occasional overlaps such that Kharif-I crops (HYV Aus) are harvested in Kharif-II season, Kharif-II season crops (Aman rice) are harvested in Rabi season and Rabi season crop are harvested in Kharif-I season.

5.1.13 Crop Production Constraints

193. The following crop production constraints have been identified through field visit and group discussions with the local farmers:

i. Drainage congestion during transplanting period in Aman season;

ii. Due to impact of climate change the level of sea water increase which is caused to natural calamities such as tidal surge, cyclone etc.

iii. Scarcity of irrigation water during dry season especially for rabi crops cultivation; and

iv. The siltation caused raise of bed of different internal drainage khals

194. Above situations are unfavorable for crop production.

5.1.14 Cropping Pattern by Land Type

195. Total land in the polder area is medium highland (F_1). The most prominent cropping pattern is Fallow-Lt Aman- Fallow which is covered about 34% of the NCA and Fallow – Lt Aman – Sesame which is covered about 25% of the NCA. In case of local Aman, kalamadari, Haitta, Karangal, Dudkalam Sarnamasuri, Kajalshail etc. are the common. Among the vegetables crops, Red amaranth, Indian spinach, Bottle gourd, Ash gourd,

Dhundal etc are popular among the farmers. Detailed cropping patterns along with land type is presented in Table 5.6.

Table 5.6: Detailed Existing Major Cropping Pattern by Land Type

Land type	Kharif-I (March-June)	Khartif-II (July-Oct)	Rabi (Nov-Feb)	Area (Ha)	% of NCA
Medium High Land	HYV Aus	HYV Aman	Fallow	78	3
	Fallow	Lt Aman	Khesari	389	15
	Fallow	Lt Aman	Mungbean	130	5
	Fallow	Lt Aman	Fallow	881	34
	Fallow	Lt Aman	Sesame	648	25
	Fallow	Lt Aman	Sunflower	104	4
	Fallow	Lt Aman	Groundnut	181	7
	HYV Aus	HYV Aman	Fallow	52	2
	Fallow	Lt Aman	Potato	130	5
Total				**2593**	**100**
Cropping Intensity 166%					

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

Photo 5.1: View of groungnut field in the polder 43/2F area

Photo 5.2: View of land preparation in the polder 43/2F area

5.1.15 Cropped Area and Cropping Intensity

196. Total cropped area is about 4,299 ha of which 63% is covered with rice and the rest 37% is occupied by non-rice crops (Table 5.13). The single and double cropped area is about 34% and 66% respectively. The cropping intensity is about 166%.

5.1.16 Crop Production

197. Total crop production is about 10,212 tons of which rice are about 6,162 tons (60%) and production of non-rice is about 4,050 tons (40%). Detailed crop production and loss is presented in Table 5.7.

Table 5.7: Existing crop production and crop production loss of the polder area

Crop Name	Crop Area (ha)	Damage Free		Damaged		Total Production (ton)	Production Loss (ton)
		Area (ha)	Yield (ton/ha)	Area (ha)	Yield (ton/ha)		
HYV Aus*	130	110	2.10	19	0.50	241	31
HYV Aman*	130	117	2.20	13	0.40	262	23
LT. Aman**	2,461	2,461	2.30	-	-	5,659	-
Total rice	**2,720**	**2,687**		**32**		**6,162**	**54**
Khasari	389	389	1.20	-	-	466	-
Sesame***	648	583	1.00	65	0.30	602	45
Mungbean	130	130	1.20	-	-	155	-
Groungnut	181	181	2.20	-	-	399	-
Sunflower	104	93	1.00	10	0.30	96	7
Potato	130	130	18.00	-	-	2,331	-
Total non-rice	**1,580**	**1,505**		**75**		**4,050**	**52**
Total	**4,299**	**4,192**		**107**		**10,212**	**106**

Source: CEGIS field estimation, 2014, SAAO of DAE.

5.1.17 Crop Damage

198. Total loss of rice production is about 54 tons in 32 ha and loss of non-rice production is about 52 tons in 75 ha due to drainage congestion, for siltation of khals and drainage channels, natural calamities etc.

Table 5.8: Crop wise damage scenario in the polder area

Crop name	Location	% of damage area	Timing	Causes of damage
HYV Aus	Entire polder area	15	May-June	Heavy rainfall & drainage congestion
HYV Aman	Entire polder area	10	July-August	Heavy rainfall & drainage congestion
Sesame	Entire polder area	10	April-May	Hail storm
Sunflower	Entire polder area	10	April-May	Hail storm

5.1.18 Inputs Use (Seed, Labor, Fertilizers and Pesticides)

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

Seed

200. The role of seeds is very important for growing crops. Selection of seeds should be considered on the basis of more than 85% germination rate, free from disease infestation,

good shape and size and high yield potential. According to land zone (AEZ 13) recommended seed rate was presented in Table 5.15 (BARI 2011-2012 and BRRI 2011). The seed rate used by the farmers in the polder area is also presented in the same Table. In case of rice, farmers are using more seed than recommended as they normally use more seedlings per hill. Most of the cases, seedlings are affected by monsoon flood. Sometimes, they bound to retranslated due to damage by heavy rainfall during monsoon season. The seed rate of vegetables generally depends on the size and viability of the seed. The available seeds were very good condition.

Labor

201. In the polder area, almost 80% of the cultural practices for crop production are being done manually. So, agricultural labor is considered as one of the essential inputs for crop production. The labor requirement is not uniform throughout the year. The number of labor requirement varies from crop to crop and season to season. Local farmers reported that harvesting of pulses; oilseed and post harvest technologies female farmers involved about 80%. The average number of labor (male and female) used per hectare in the polder area is presented in Table 5.9.

Fertilizers

202. The rate of fertilizer use per hectare varies considerably from farmer to farmer depending on soil fertility, cropping pattern and financial ability etc. The major fertilizers used in this area are Compost, Urea, TSP, MP and Gypsum. The other hand they are using less chemical fertilizer than the recommended dozes in all crops. According to local farmers, there are one fertilizer dealers inside the polder area; one dealer informed farmers are not aware about recommended rate. On the other hand farmers don't have enough money to buy fertilizer. About 20-30% household has compost pit in there homestead area. Compost is mainly used in pit crops. Fertilizer recommendation rate as developed by BARC, 2012, on the basis of agro-ecological zone (AEZ-13) is presented in Table 5.9.

Pesticides

203. Pesticides can contaminate soil, water, turf, and other vegetation. In addition to killing insects or weeds, pesticides can be toxic to a host of other organisms including birds, fish, beneficial insects, and non-target plants. Insecticides are generally the most acutely toxic class of pesticides, but herbicides can also pose risks to non-target organisms. The use of pesticides depends on the degree of pest infestation. The major insects as reported by the farmers are stem borer, green leaf hopper, and rice bug. Local farmer reported that they are using different types of pesticides such as Basudin, Furatar, Fighter, Rovral, Ridomil gold etc. Both liquid and granular pesticides are being used to prevent pest infestation in the rice, mungbean, mustard, sweet potato and groundnut cultivation. Melathion and BARI trap used in rice, mungbean, mustard, sweet potato for prevention of pest infestation. Detailed information of pesticides used is presented in Table 5.9.

Table 5.9: Inputs Use (Seed, Labor, Fertilizers and Pesticides) of the Polder Area

Crop name	Seed		Labor	Farmers using fertilizer (Kg/ha)						Recommended fertilizer (kg/ha)						Pesticides	
	Farmers used (Kg/ha)	Recommended seed (kg/ha)	(No. /ha)	Compost	Urea	TSP	MP	Gypsum	Zn	Compost	Urea	TSP	MP	Gypsum	Zn	No. of application	Liq. (ml/ha) approx.
HYV Aus	45	40	150	60	70	20	10	0	0	141	22	20	8	2	1	1	300
Lt Aman	45	40	130	0	40	30	0	0	0	0	97	14	17	0	0	0	0
HYV Aman	40*	40	150	0	70	50	30	0	0	0	163	35	30	0	0	2	1000
Khasari	50	40	100	0	15	0	0	0	0	0	21	17	20	0	0	0	0
Sesame	5*	7	70	0	30	20	0	0	0	0	170	60	31	0	1.3	0	0
Chilli	0.600	0.230	120	1,000	30	10	10	0	0	1,000	70	42	53	14	1.3	4	2000
Mungbean	16*	25	150	0	45	25	15	0	0	0	45	67	20	0	0	3	1500
Groundnut	90*	100	150	0	40	20	10	1	0	0	25	160	85	160	0	3	1500
Potato	65,000 C	56,000 C	160	1,000	40	40	20	0	0	8,000	140	120	160	0	0	1	400
Mustard	7	15	120	1,000	40	40	20	0	0	0	45	67	20	0	0	3	1500
Sunflower	9	12	120	0	70	30	0	0	5000	0	160	150	150	0	0	0	0

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

*Note: If farmers grow HYV Aus, they are using fertilizer in T Aman. ** If land is fallow in Kharif-1, farmers are not appling any fertilizer in T. Aman.

Integrated Crop Management (ICM)

204. Recently, Integrated Crop management (ICM) is practiced in some areas that were covered by the polder. DAE has taken active part on ICM. In this system, insects are controlled biologically. Farmers of the ICM areas use branches of trees, bamboo and jute sticks etc to make favorable perches for birds in fields with standing crops. The birds eat the insects which help control infestation. In this process, the crops are protected without applying pesticides. Trap is another technique for controlling pests under ICM. This system is used in the agriculture fields especially on watermelon and vegetables for attracting insects. At the base of the trap, there is a sheet generally made of steel that slopes downward. Thus, it is possible to control the harmful insects without the application of pesticides. In the polder areas the ICM technique is mainly applied on rice, mungbean, mustard, potato crops. Field information (Farmers and SAAO of DAE) indicates that ICM is being practiced in the fields covering about 10-20% of the cultivated areas in the polder area and the impact has been found very encouraging.

5.1.19 Irrigated Area by Crops

205. According to local farmers total irrigation coverage of the polder area is about 5% (135 ha) of the total NCA during the dry season in two crops. The source of irrigation water is surface water. Irrigation is lifted with the help of low lift pumps (LLPs). The cost of irrigation is about taka 5,000/ha. HYV Aus, Lt. Aman and HYV Aman is generally practiced under rain fed condition.

5.1.20 Crop Yield Level (Normal And Damaged)

206. The crop yield rate was estimated with the information collected from local SAAO of DAE and in consultation with the beneficiaries/ farmers at field level. The yield of rice is estimated as milled rice. The average yield value of different crops of the polder area are presented in Table 5.10.

Table 5.10: Crop Yield Level by Different Crops

Crop name	Yield (ton/ha)			
	Local demonstration by DAE	Normal	Damaged	Damage free
HYV Aus	3.1	2.60*	0.50*	2.10*
HYV Aman	3.5	2.60*	0.40*	2.20*
Lt Aman	2.3	2.3	-	2.3
Sesame	1.0	1.30	0.30	1.00
Khesari	0.8	1.20	-	1.20
Chilli	1.0	1.50	-	1.50
Mungbean	1.2	1.20	-	1.20
Potato	15.0	18.00	-	18.00
Groundnut	1.5	2.20	-	2.20
Sunflower	2.5	1.30	0.30	1.00
Lentil	0.8	1.20	-	1.20
Mustard	1.6	1.00	-	1.00

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

5.1.21 Water Resources System

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

River Systems

208. Polder 43/2F is around 33 km far from the coast of the Bay of Bengal, undergoing diurnal tidal influence. The polder is surrounded by a number of tidal rivers namely, the Gulishakhali River in the North and North-West directions, the Payra River in the South-West, and the Kukua River in the Eastern portion. The Gulishakhali and Kukua rivers both fall into the Payra River and eventually run into the ocean. Apart from these rivers, there are approximately 93.5 km of drainage and irrigation canals (khals) within the polder (Dala Chara khal, Doa Chara khal, Khekuani khal, Kalibari khal, Motbaria khal, Moradhona khal etc.). The river system of the area is shown in Map 5.4.

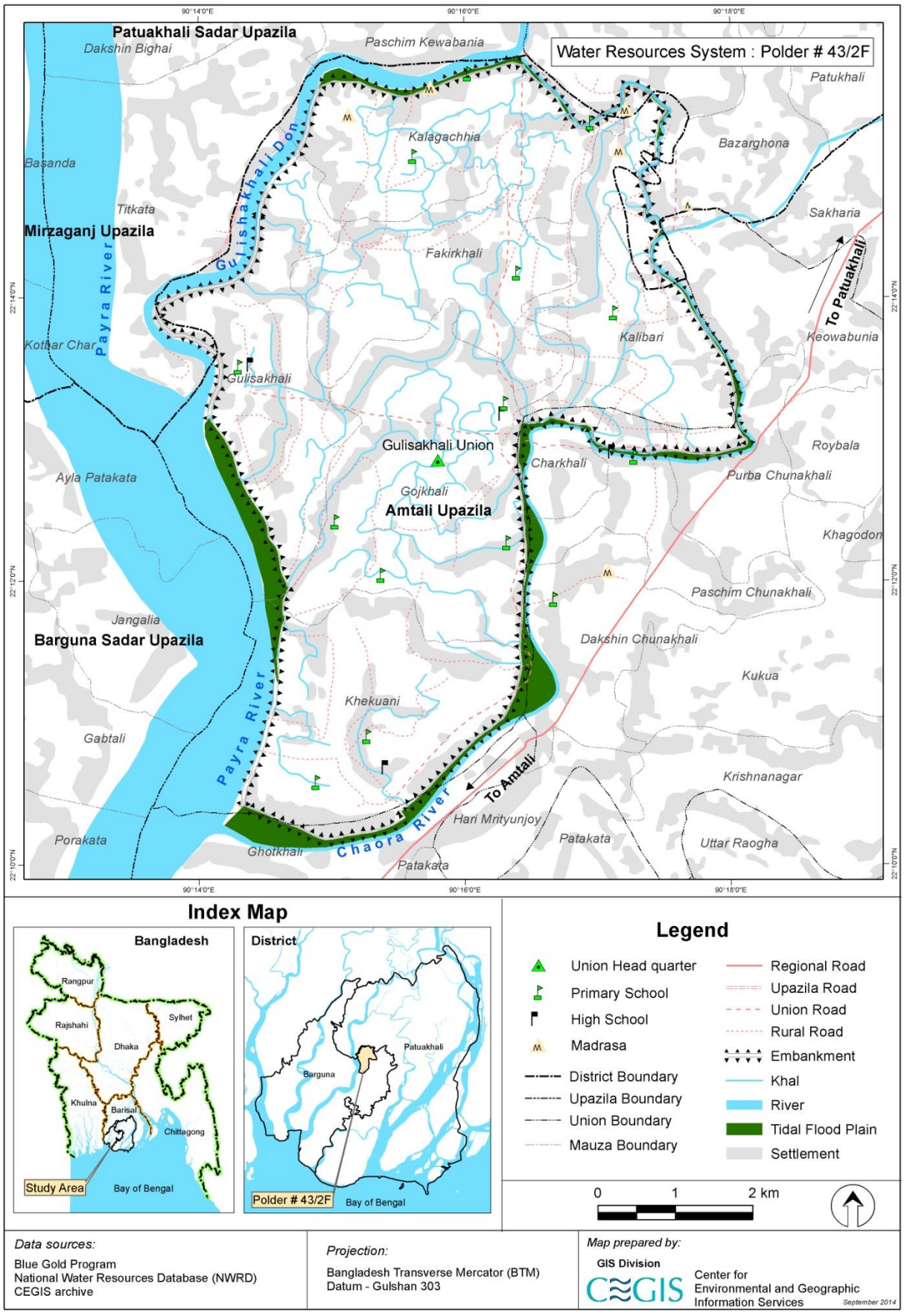
(a) Payra River (at Angulkata)

(b) Gulishakhali River (near Kolagachia)

Photo 5.3: Major rivers in the polder surroundings

5.1.22 Hydrological Connectivity

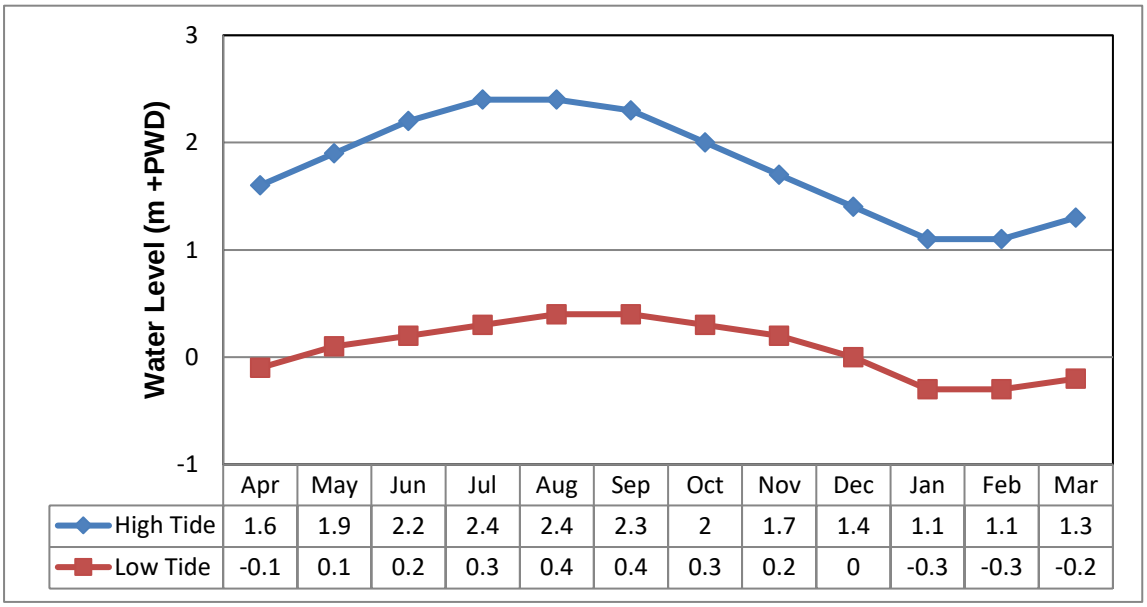
209. During high tide, water from the peripheral rivers push towards the polder area and the opposite occurs place during low tide. However during dry season, sluice gates are usually closed and most of the high tidal water cannot enter into the polder. However, during monsoon and post-monsoon, the gates are kept open and free circulation of tidal water takes place within the polder. A number of distributaries of Payra, Gulishakhali and Kukua rivers (Chunakhali khal, Doachara khal, Borachi khal, Keukhali khal etc.) contribute to the high tidal water flowing into the polder, whereas some other internal khals (Dolachora branch khal, Baanno khal, Bottolar khal etc.) ensure free circulation of tidal water which circulate the flow of water within the polder. These khals also help drain the internal water out of the polder through the peripheral gates.



Map 5.8: Water resources system of the study area

5.1.23 Surface Water Level

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



	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
High Tide	1.6	1.9	2.2	2.4	2.4	2.3	2	1.7	1.4	1.1	1.1	1.3
Low Tide	-0.1	0.1	0.2	0.3	0.4	0.4	0.3	0.2	0	-0.3	-0.3	-0.2

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

5.1.24 Ground Water

211. Monthly variations in Ground Water Table (GWT) from 1978 to 2013 have been plotted in Figure 5.7, considering values collected from the observation well of the BWDB at Amtali, designated as BAG001 (1.5 km distance from the polder). The variation pattern shows that the GWT is usually the highest during August and the lowest in March.

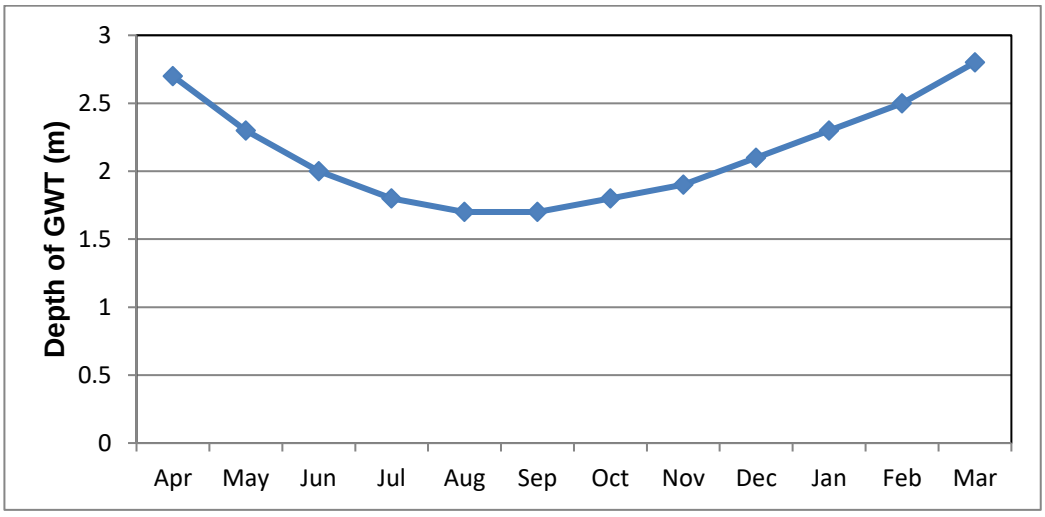


Figure 5.7: Average monthly variations of GWT

212. Analyses have also been carried out to understand the annual variations of GWT at the BAG001 station for March and September (from 1978 to 2013). The values show a decreasing trend in both cases (Figure 5.8 and 5.9).

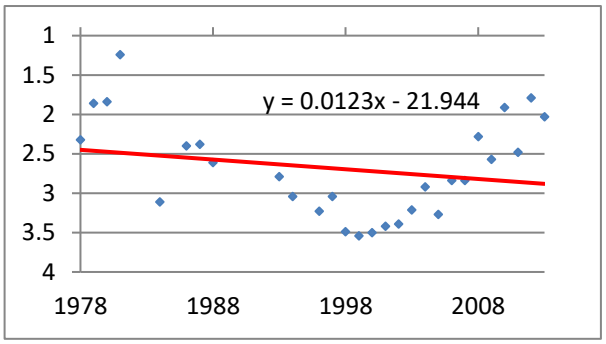


Figure 5.8: Variation of GWT at BAG001 in March (1978-2013)

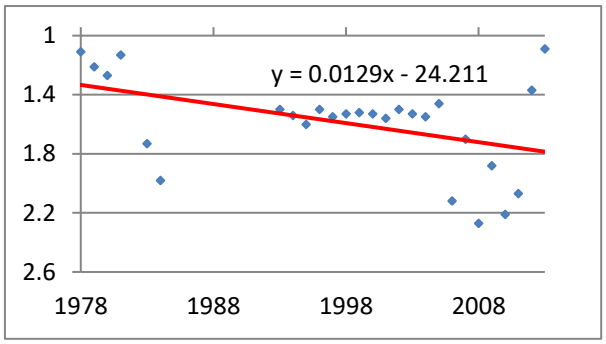


Figure 5.9: Variation of GWT at BAG001 in September (1978-2013)

Source: NWRD,2013

5.1.25 Water Use

Domestic use

213. The average daily demands of water for domestic and drinking purposes in rural areas are considered to be 50 lpc (Ahmed and Rahman, 2010). In Polder 43/2F, the field survey revealed that the average daily domestic use of water was around 25 lpc. The study has found that around 700 m^3 water is consumed per day for the total number of 28,120 people living in the polder. Local people opined that safe drinking water resources (GW sources) were quite scarce in the polder and, they even preferred to drink water from unhygienic sources (surface water sources). The domestic demands are met using surface water sources. Overall, water availability in Polder 43/2F is a concern as local people claimed that around 30% of the polder population suffered from insufficient availability of water (daily consumption as low as 10 lpc) for domestic use.

Irrigation Use

214. The local farmers in Polder 43/2F practise HYV Aus in Kharif-I (March-June) season, HYV Aman and Lt. Aman in Kharif-II season (July-October) and some vegetables (mung bean, groundnut and potato) in Rabi (November-February) season. Rainfed irrigation is provided during Kharif-I and Kharif-II seasons for Lt. Aus, HYV Aman, and Lt. Aman., whereas surface water irrigation is in place during Rabi season. Previous CEGIS studies have revealed that around 300 mm of water is usually required for each ha of Aus and Aman cultivation. For mung bean, groundnut and potato, around 200 mm of water is required for each ha. However, local farmers opined that they provide partial irrigation for mung bean, groundnut and potato using the existing surface water system (with irrigation canals as well as LLPs). The existing surface water irrigation coverage is only 5% of the NCA of Polder 43/2F and local people claimed that the lower water carrying capacity of khals and poor functioning of water control structures were the major reasons why more areas cannot be irrigated during the Rabi season. The study infers that approximately 0.27Mm^3 of water would be required during each Rabi season to ensure effective supplementary irrigation.

Table 5.11: Irrigation water requirements in Polder 43/2F

Season	Lt. Aus (ha)	Lt. Aman (ha)	HYV Aman (ha)	Mungbean, Groundnut, and Potato (ha)	Water requirement (mm/ ha)	Water Used (Mm3)	Source of Water
Kharif-I	130	-	-	-	300	0.039	Rain water
Kharif-II	-	2,463	130	-	300	7.78	Rain water
Rabi	-	-	-	135	200	0.27	Surface water

Source: CEGIS Estimation, 2014

5.1.26 Water Resources Functions and Problems

215. The water resources functions and problems in and around the polder area are described in the following sections:

Tidal and Storm Surge Flooding

216. Local people in Polder 43/2F opined that the peripheral embankment at most locations effectively offer protection from regular tidal flooding. However, there are some locations along the peripheral embankment which are inundated during major rainfall events. During public consultation it was found that a minor portion of the embankment crest gets submerged at some damaged spots of Khekuani and Solohawlabar to a depth of 1~2 feet. The adjacent low lying lands also get flooded during the period. However, water does not usually inundate the polder during a typical high tide and in general the tidal flooding situation can be considered as nominal for the entire polder.

Drainage Congestion and Water Logging

217. From field investigation it was found that the polder suffers from drainage congestion issues at several low lying places. GIS-based spatial analysis and field investigations have revealed that approximately 37 km of water courses within the polder suffer from drainage congestion issues. The phenomenon is prominent in the north, south and eastern ends of the polder with around 7.5 km of khals (Motbari, Bazarkhali, Solohawlabar and Purbo Kalibari khals) affected by high drainage congestion problems. The distributaries of these khals also suffer from low to medium drainage congestion problems. As a consequence of this issue, almost 44 ha of area near Kolagachia, Khekuani and Purbakalibari remain water logged during the post monsoon season, hampering post monsoon production.

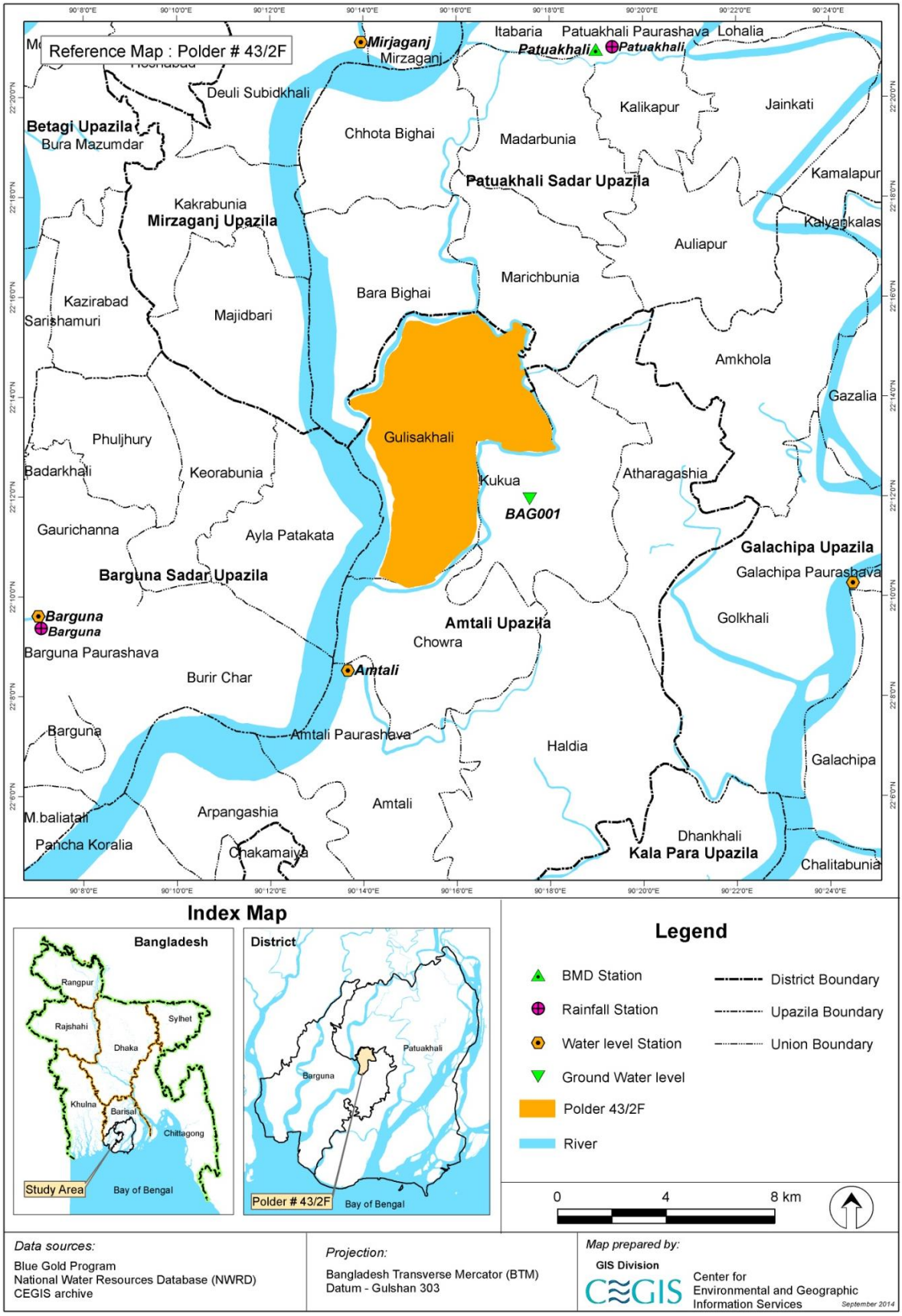
Navigation

218. The peripheral rivers (Payra, Gulishakhali, and Kukua) of Polder 43/2F are predominantly used for waterway navigation. However, very little navigation takes place inside the polder area as only small fishing boats are found to navigate through the internal khals. Some locations along the flood plain areas of the Payra River (Kanta sluice and Gulishakhali sluice) are used as navigation jetties these days, where small boats and trawlers are kept idle. These places have grown as marketing hotspots over the years and loading/ unloading of goods and boat passengers frequently take place in these locations.

Photo 5.4: Small navigation jetty at Gulishakhali sluice (Payra River)

Erosion and Accretion

219. There are some erosion hotspots (Angulkata, Gulishakhali, Dalachara and Naiapara) along the peripheral embankment of the polder as identified by WMGs. During field investigations on May 2014, the four locations were inspected and the one at Angulkata was found to be relatively more vulnerable. Local people opined that the place usually erodes following major flood events, and a substantial amount of land has formed along the adjacent floodplain areas. However, conflicting information has been found from the analysis carried out with Remote Sensing (RS) technology, using satellite imageries of 1973 and 2014. The RS-based analysis shows that in the last 40 years the bankline of the Payra River has remained quite stable and a very nominal portion of land (5 ha in total) has been eroded.

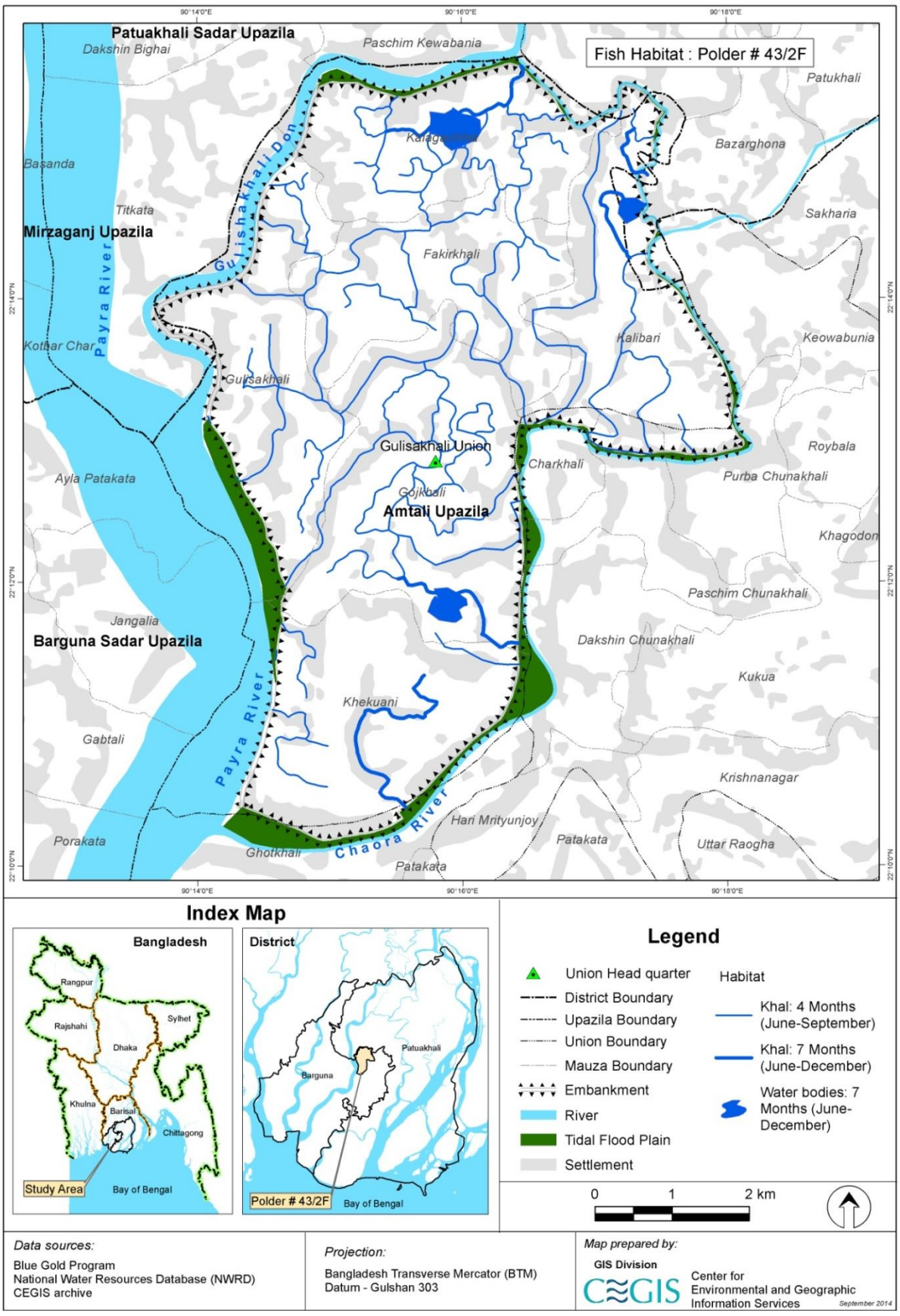


Map 5.9: BWDB stations of rainfall, water level measuring stations and GW observation wells

5.2 Biological Environment

5.2.1 Fish Habitat

220. The area is tidal in nature and the fish habitats of the polder area are primarily classified under two broad categories, such as capture and culture fishery. Capture fisheries habitats include Peripheral River, tidal floodplain, intertidal floodplain and internal khals (Map 5.10). The open water fish habitats of the area are internal khals and floodplain which are acting as major arteries of fish migration into the polder area. These are playing vital role in maintaining fisheries productivity of the open water fish habitats inside the polder area. The culture fishery of the polder area is dominated by culturable fish pond. The Periphery Rivers are Paira and Gulishakhali is located on the west-north part of the polder. These rivers are having potentials of appearing saline and brackish habitat and diversified with different fresh and brackish water fish habitats.



Map 5.10: Fish habitat in the study area

Capture Fisheries

221. The estimated fish habitat area is 309 ha where capture fishery contributes the major share (170 ha) and the culture fish habitat shares the rest. The open water fish habitat is represented by khal alone as shown in the following Table 5.12. In the study, the peripheral rivers and tidal floodplain has not been considered for fish production estimation of the polder area.

Table 5.12: Fish habitat status in the polder area

Sl.	Category	Habitat Types	Area (Ha)
1	**Capture**	Khal	170
		Floodplain	44
		Sub-total	***214***
2	**Culture**	Culturable pond	*80*
		Cultured pond	15
		Sub-total	***95***
		Total	309

Source: FRSS, 2011-12 and CEGIS estimation based on field data, 2014

222. Internal khals are playing a vital role in conserving fisheries and aquatic resources in the polder area. Among the khals Gulisakhali Khal,Chunakhali khal, Mothbari khal, West Kolagachia khal Borachi khal, Debpur khal etc are mentionable. The depths of these internal khals range from 0.6 to 1.8 m (Table 5.13) which is found suitable for the habitation of medium sized fish species particularly during dry season in the low tide situation. Some of the khals are encroached by the local peoples and practicing culture fishery by developing barriers through net. Photo below (a and b) shows the internal khals in the polder area.

a) Seasonal khal

b) Silted up khal

Photo 5.5: Open water fish habitat (khal) in the polder area

Table 5.13: Detailed information of importance khals in the Polder area

Sl.	Khal Name	Width (m)	Depth (m)	Type of Water bodies
1	Mothbari Khal	9.5	1.2	Seasonal
2	Debpur khal	3.8	1.1	Seasonal
3	Debpur brance khal	6.3	0.7	Seasonal
4	Chunakhali khal	6.8	1.4	Seasonal

Sl.	Khal Name	Width (m)	Depth (m)	Type of Water bodies
5	Borachi khal	6.6	1.1	Seasonal
6	West Kolagachia	9.5	1.2	Seasonal
7	Doachara khal	5.8	0.6	Seasonal
8	Bottola khal	7.1	1.0	Seasonal
9	Baanno khura khal	5.0	1.0	Seasonal
10	Khekoani khal	3.7	1.0	Seasonal
11	Dhalachara branch khal	6.2	1.1	Seasonal
12	Gulishakhali khal	7.2	1.8	Seasonal

Sources: Blue Gold Program (BGP), 2014

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

Culture Fisheries

224. Aquaculture practice is expanding gradually in the polder area. But main constraint of aqua culture development are overtopping of fish ponds due to mal-functioning of water control structures during extreme tidal effect; lack of quality fish seed and fish feed, lack of training on aquaculture/pond culture practices. 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. Culture fish pond in the polder area is shown in the following photo.

Photo 5.6: : Culture fish pond in the polder area

5.2.2 Fish Habitat Quality

225. Some surface water quality parameters that are related to fish habitat suitability measured in the peripheral river, khal and fish pond in the polder area. Table 5.14 presents the measured water quality results of different type of fish habitats. From the data it is observed that pH values are slightly higher in the river than the khal and fish pond which means water is alkaline and it is bad for fisheries. The value of water

temperature in different fish habitats is found within the limit of fisheries resource (Table 5.14). Dissolved Oxygen (DO) content is found within the limit of Bangladesh standard (>5.0 mg/l) for fish culture. The salinity in water bodies at outside the polder is almost absent. However all water quality parameters are almost within the permissible limit for fisheries resources.

Table 5.14: Water quality parameters of different water bodies in the polder area

Water bodies	Parameters				
	pH	TDS (ppm)	Temp (°C)	DO (mg/l)	Salinity (ppt)
Kukua River	8.0	1275	31.8	7.9	0
Internal Khal	7.6	697	31.1	5.4	0
Pond	7.9		33.3	5.9	0
Standard values for fish	(6.5-8.5)*	1000*	(28-34)**	4.0-6.0*	(0-4) for prawn and (5 -35) for shrimp**

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

Aquatic Vegetation

226. Aquatic plants or vegetation play an important role in the structure and function of the aquatic ecosystem. Different types of hydrophytes like emergent, submerged and floating with leafs is used as habitat and spawning ground of fisheries and other insects and crustaceans. So, low abundance of hydrophytes may harm to fish breeding and production. In the wetland, some fishes lay eggs in the body of plants. Beside these, some fishes are live on the rotten part of the aquatic plants (Khondker, 2004). Water bodies in the polder area contain different types of aquatic floras such as free floating, rooted floating, submerged and amphibian vegetations like sedges and meadows. Wetlands contain plenty of aquatic floras, such as free floating, submerged, sedges and meadows. Free floating plants are also common throughout the polder area. These types of aquatic plants with leafs is using as habitat and spawning ground of fisheries as well as other insects and crustaceans in the polder area.

5.2.3 Fish Production

227. The estimated total fish production of the polder area is about 191 tons. Bulk of the fish production about 20% is coming from culture fisheries and the rest is from the capture fishery. Fish production trend of the capture fishery is downward in the polder area. The downturn of the production is caused due to obstruction to fish migration, unsuitability of the khals for fish habitation, siltation in internal khal and the mouth of regulators, less availability of nutrients and indiscriminate fishing by sluice net. Fish production in the polder area is shown in Table 5.15.

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

Sl.	Category	Habitat Types	Fish Production (Ton)
1	Capture	Khal	27
		Floodplain	11
		Sub-total	**38**
2	Culture	Culturable pond	120
		Cultured pond	33
		Sub-total	**153**
		Total	**191**

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

5.2.4 Fishing Effort

Fishermen Number

228. Local people reported that about 250 households are engaged as professional fishers and they spend around (10-12) hours of a day in fishing activities around the year. About 2% households of the total population of Polder 43/2F are involved in part time fishing, and about 25% households are in subsistence level fishing. Professional fishermen are mostly come from the Muslim community (85%) and the rest from the Hindu community. There is no specific “Fishers village” in the polder area. Most of the fishermen are living along the embankment near the Payra River and Gulisakhali River. The economic conditions of the fishers are poor to moderate. They usually catch fish in the nearby rivers and internal khals. The fisheries occupations are mainly fishermen, fish traders and fish farmer etc.

Fishing Season

229. Fishing in the khals and the peripheral rivers goes almost around the year but more catch of fishes starts in April / May and continues up to December. The dominant gears in the polder area are Jhaki jal, current jal and Sluice jal. The seasonality of major fishery is furnished in the Table 5.16.

Table 5.16: Fishing Seasonality of the Polder Area

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

Source: Field Survey, 2014

Fishing Crafts and Location

230. The commercial fishermen of the polder area catch fish in the peripheral rivers and internal khals by using both mechanized and traditional boats including Jala Nouka and Kusha, Dingi fishing boats etc. Fishing boat in the polder area is shown in the following photo 5.7.

Photo 5.7: Fishing Boats in the Polder Area

Fishing Gear

231. Different types of nets/gear are used for fishing like (a) Mono filament net, locally known as Current jal and Koi jal, which is used to catch *poa, chingri, tengra, gulsha*, and *koi* fish; (b) Seine net which is used to catch all types of small and big fishes; (c) Cast net, locally known as Jhaki jal, which is used to catch *puti, bagda, golda, phasa* etc. (d) Push net, locally known as thela jal, which is used to catch *puti, tengra, chingri* etc; (e) Sluice/Dip net locally known as Sluice jal is found at the mouth of sluice gate to catch all types of fishes. Around 5% of fishermen have fishing boats and around 80% fishermen have fishing gears/nets. Traditional fishing gears of the polder area is cast net (Jhaki jal) in shown in the following photo 5.8.

Photo 5.8: Fishing gear (Jhaki jal) in the polder area

5.2.5 Fish Migration

232. The riverine fish species migrate through regulated khals in the polder to some extent during the period of June to August. Perennial Khals along with other seasonal internal

khals are used as feeding and nursing ground of the fishes. Fish species such as Chingri, Puti, Boal, Pairsa, Tengra, Gulsha, Khorsula, Baila migrate through these regulators to these water bodies as part of their life cycle. Peripheral rivers along with internal khals of the polder area have been silted up naturally, that cause the reduction of the length of successive migratory routes of fishes. Successive siltation and mal-function of water control structures, inactive of the Water Management Organizations (WMOs) hamper the migration of fish and other aquatic biota. However, fish migration status in the polder area is found as poor to moderate due to aforesaid reasons.

5.2.6 Fish Biodiversity

233. The study area is moderate in fish biodiversity though the biodiversity of fishes has the declining trend over the years. Local people reported that about 100 numbers of fish species are available in the area. The study area comprises an assemblage of both fresh and brackish water fish species (photo below). Checklist of the fishes of different habitats reported by local fishermen is analyzed to draw an indicative scenario Baila, Chanda, Mola, Shol, Taki, Puti, Koi, Shing etc are dominant fresh water fish species. And the dominant cultured fish species include Tilapia, Rui, Catla, Pungus, Bighead, Silver carp, Thai sarputi etc. List of fishes of different habitat in the study area are presented in Table 5.17.

Photo 5.9: Composition of Fish Catch of the Polder Area

Table 5.17: Status of Indicative Fish Species Diversity of Different Fish Habitats in the Study Area

Scientific Name	Local Name	Habitat type		
		Periphery River	Khal	Fish pond
Brackish Fish Species				
Apocryptes bato	Chiring	H	M	NA
Rhinomugil corsula	Khorsula	H	L	NA
Tenualosa ilisha	Ilish	H	NA	NA
Pama pama	Poa	H	NA	NA
Terapon jarbua	Barguni/Rekha	M	NA	NA
Lates calcarifer	Koral/Bhetki	M	L	NA
Liza parsia	Pairsa	L	L	L
Liza tade	Bata mach	M	L	L
Mystus gulio	Tengra	M	M	L
Pangasius pangasius	Pangus	L	NA	NA

Scientific Name	Local Name	Habitat type		
		Periphery River	Khal	Fish pond
Polynemous paradiseus	Tapasi / Muni	H	L	NA
Sillaginopsis panijus	Tolar dandi	H	L	NA
Scylla serrata	Kankra	H	H	NA
Macrobrachium rosenbergii	Golda chingri	L	L	H
Metapenaeus monoceros	Horina Chingri	H	M	NA
Penaeus monodon	Bagda chingri	M	L	H
Fresh Water Fish Species				
Clarius batrachus	Magur	NA	L	NA
Mystus vittatus	Tengra	M	M	NA
Macrognathus pancalus	Chirka baim	M	L	NA
Macrognathus aral	Tara baim	M	M	NA
Lepidocephalus guntea	Gutum	L	L	NA
Channa punctatus	Taki	L	L	NA
Channa striatus	Shol	NA	L	L
Puntius chola	Chola puti	NA	L	L
Channa marulius	Gojar	NA	L	L
Wallago attu	Boal	L	L	NA
Aorichthyes seenghala	Guijja Ayre	M	L	NA
Puntius sophore	Datina puti	L	NA	NA
Glossogobius giuris	Baila	M	L	L
Eutropiichthyes vacha	Bacha	M	L	L
Culture Fish Species				
Telapia nilotica	Telapia	NA	L	H
Labeo rohita	Rui	L	NA	M
Catla catla	Catla	P	L	M
Hypophthalmichthys molitrix	Silver Carp	NA	NA	H
Puntius suchi	Sharputi	NA	NA	H
Ctenopharyngodon idellus	Grass Carp	NA	NA	L

Source: Field Survey, 2014;

Note: Abundance Code: H= High; M= Medium; L= Low; NA= Not available

5.2.7 Species of Conservation Significance

234. Fish species variety those are locally unavailable for last (10-15) years or become rare reported by the local fishermen and concerned elderly people are given in the following Table 5.18.

Table 5.18: List of Species of Conservation Significance

Scientific Name	Local Name	Local Status	
		Rare	Unavailable
Aorichthyes aor	Ayre	√	
Nandus nandus	Veda / Roina	√	
Notopterus chitala	Chital	√	
Notopterus notopterus	Foli	√	
Channa marulius	Gojar	√	
Macrobrachium rosenbergii	Golda chingri		√

Source: Field Survey, 2014

5.2.8 Area of Conservation Significance

235. Gulisakhali Khal, Chunakhali khal, Mothbari khal, West Kolagachia khal etc and other peripheral water body is used as feeding and spawning ground of most of the open water fishes. 500 m of each khal mentioned above (deep place where water present around the year) can conserved for fish propagation for the next year.

5.2.9 Fish Marketing and Post Harvest Facilities

236. Local fishermen sale bulk of their catch either directly to the local fish market at Gulisakhali, Kasher hat, Marichbunia, Amtoli or to the fish traders. The fish traders or buyers (Bepari) coming from Amtoli (Barguna), Patuakhali sadar, Barisal to purchase caught fishes. No structured fish-landing centers are found in the polder area. There is no ice factory inside the polder area. Ice is collected from Patuakhali Sadar and Amtoli bazar for icing the harvested fish. No good fish storage facility is reported in the polder or in adjacent to the polder area. Transportation facility at root level is moderate developed. There is no private hatchery inside the polder area. Availability of fish feeds for culture ponds are sufficient. Fish seeds for culture fishery are collected from the hatcheries and nurseries which are situated at Patuakhali. Fish feeds are collected from the local market. Fish edible quality of fish is in good condition for human intake. But the pesticides coming from agriculture field is causing fish diseases which are unsuitable for consumption.

5.2.10 Fisheries Management

237. There is no community based fisherman association. A Matshya Somity located at Gulisakhali is only reported inside the polder area but their activity in fisheries resource management and welfare of fishers' livelihood is negligible. Fishing right on existing fish habitats are using as common resources. Department of Fisheries (DoF) has limited activity for fisheries resource conservation and management in this area. DoF are implementing alternative income generating *activities by providing fishing net, rickshaw/van for the rehabilitation of* rural poor fishermen. Every year they also provide with 40 kg food grains/family/month *during* the ban *periods* for four months. Some NGOs are working, but they are very much limited in micro credit rather than extension services and aquaculture training. Enforcement of fisheries regulation strong especially during fish ban period (Jatka protection program).

5.2.11 Bio-ecological Zone

238. IUCN-The World Conservation Union has identified 25 bio-ecological zones (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 major ecosystems of the country. The polder area encompasses one of these bio-ecological zones, namely the Ganges Floodplain. A brief ecological description of the bio-ecological zone is presented below.

Ganges Floodplain

239. Ganges Floodplain is the active meandering floodplain of the Ganges River. The floodplain mainly comprises a smooth landscape of ridges basins and old channels. The Ganges channel is constantly shifting within its active floodplain, and eroding depositing

large areas of charlands in each flooding season. Both plants and animals move and adapt with the pattern of flooding (Brahmer, 1996). The floodplain is characterized by mixed vegetation and support a habitat of rich bio-diversity to some extent for presence of a lot of stagnant water bodies and channels, rivers and tributaries. Beels and other water bodies support good amount of free floating aquatic vegetation. Homesteads forest prominent with both cultivated and wild plant species. In this zone, the dominant floral types are the Panimorich (*Polygonum orientale*), Jhanji (*Hydrilla verticillata*), Topapana (*Pistia strateotes*), Chechra (*Schenoplectus articulatus*), Sada Sapla (*Nymphaea nouchali*), Keshordam (*Ludwigia adscendens*), Kolmi (*Ipomoea sp*), Tamarind (*Tamarindus indica*), Panibaj (*Salix tetrasperma*) etc. Moreover, Grasses are more abundant in Ganges floodplain and begin to grow as soon as the floodwater begins to recede. *Cyperus rotundus, C. deformis, Eleocharis* sp*., Hemarthria* sp*.* etc are the notable grass species.

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

5.2.12 Terrestrial Ecosystem

241. Terrestrial ecosystems of this polder can be divided in the following types:
    a. Homesteads
    b. Field Crops
    c. Roads and embankment

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

a. Terrestrial Flora

i. Settlement/Homestead Vegetation

243. Homestead is one of the most important natural resource bases of Bangladesh having huge number of diversified plant species. Homestead plants play an important role for the livelihoods of people living in the polder area. Majority of the people of polder area largely depend on homestead production for their survival. About one third of the total income of the household was used to earn directly from the homestead outputs. Most of the homestead consists of fruit yielding plant, medicinal plants, vegetables and timber trees. According to the vegetation survey, homestead vegetation of this polder is exclusively dominated by Narikel (*Cocos nucifera*), Supari (*Areca catechu*), Tal (*Boassus flabelifer*) and Babla (*Acacia nilotica*) trees. The same species occupied top canopy of the vegetation layers. Among the other species, Aam (*Mangifera indica*), Kola (*Musa* sp), Mahogoni (*Swietenia mahagoni*), Khejur (*Phoneix sylvestirs*), Sil Koroi (*Albizia procera*) etc. are also common. Eucalyptus (*Eucalyptus* sp) and Akashmoni (*Acacia auriculiformes*) are the common exotic species. Shrubs and herbs occupy lower canopies. Bamboo bushes are commonly found in each homestead. The homestead vegetation is important place for wildlife dwelling.

244. Many species of undergrowth wild plants are found in homestead vegetation and village groves. Among this type, Swetkan (*Euphorbia thymifolia*), Bhui amla (*Phylanthus niruri*), Nata (*Caesalpinia bonduc*), Dudhikalmi (*Ipomoea alba*) are common. Major homestead plants including their status and importance are presented in Table 5.19.

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

Table 5.19: Homestead plant species according to canopy layers and their abundance

Canopy Layers	Canopy height (ft)	Tree species name	Family name	Abundance
Upper canopy	40-50	Rendi Koroi *(Albizia saman)*	Leguminosae	H
		Sil Koroi *(Albizia procera)*	Leguminosae	H
Middle canopy	30-40	Narikel *(Cocos nucifera)*	Palmae	H
		Suparee*(Areca catechu)*	Palmae	H
		Mahogoni *(Swietenia mahogoni)*	Meliaceae	M
		Tal *(Boassus flabelifer)*	Palmae	H
		Akasmoni *(Acacia moniliformis)*	Mimosaceae	M
		Eucalyptus *(Eucalyptus citriodora)*	Elaeocarpaceae	M
		Bash *(Bamboosa sp.)*	Gramineae	M
		Siso *(Dalbergia sissoo)*	Fabaceae	M
Upper bole	20-30	Aam *(Mangifera indica)*	Anacardiaceae	M
		Jambura (*Ciitrus grandis)*	Rutaceae	H
		Khajur *(Phonix sylvestris)*	Palmae	H
		Amra *(Spondias dulcis)*	Anacardiaceae	H
		Peyara *(Psitium guajava)*	Myrtaceae	M
		Kathal *(Artocarpus heterophyllus)*	Moraceae	M
		Nim *(Azadirachta indica)*	Meliaceae	M
		Jamrul *(Syzygium samarangense)*	Myrtaceae	H
		Kadom (*Anthochephalous kadamba*)	Rubiaceae	M
Lower canopy	10-20	Kola *(Musa sp)*	Musaceae	H
		Chalta *(Dillenia indica)*	Dilleniaceae	M

(Note: Abundance Code, H= High, M= Medium, L= Low)

Source: CEGIS field survey, 2014

Photo 5.10: Palm trees on a homestead platform

Photo 5.11: Homestead with banana, Coconut, etc plants

ii. Crop field vegetation

246. The net cultivated area in the polder area is more than 2500 ha. Land is used mainly for HYV Aman, local Aman in rain feed condition in kharif –II season, in kharif-I season. There are few HYV Aus, and inRabi season farmers grow sesame, mungbean, sunflower, khasari, groundnut, potato and vegetables. Local farmers reported that about 20 ha area

is used for betel leaf gardens in the polder area. Verities of crops and cropping patterns have been discussed in the agricultural section of this report.

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

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

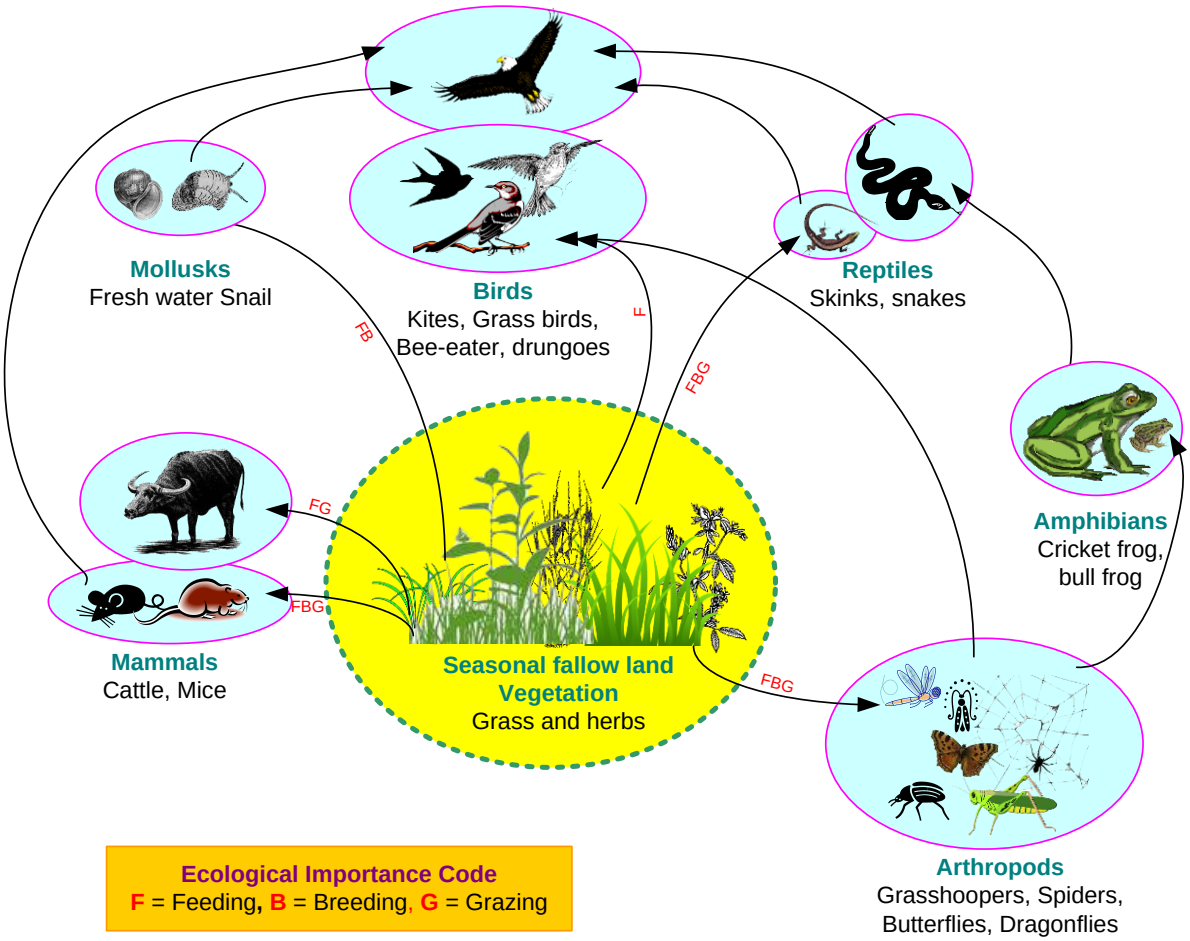


Figure 5.10: Ecological importance of seasonal fallow land's vegetation for different faunal communities along with partial food web

Photo 5.12: View of Betel leaf garden in the polder

Photo 5.13: View of Seasonal fallow land Vegetation

iii. Embankment /Village road and bank side vegetation

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

250. Embankment is exclusively dominated by Sirish (*Albizia odoratissima)* Narikel (Coccos nucifera), Suparee (Areca catechu), Tal *(Boassus flabelifer),* Khajur *(Phonix sylvestris),* and Kola (*Musa sp).* These plants are mostly planted by villagers for providence of timber and fuel wood. Vegetation of this type supports good habitats for local avifauna.

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

Photo 5.14: Vegetation along road cum embankment sides

Photo 5.15: A village road beside homesteads followed fencing trees

Photo 5.16: khal bank side vegetation

b. Terrestrial fauna

i. Amphibians

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

ii. Reptiles

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

iii. Mammals

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

iv. Avifauna

255. Terrestrial birds can be divided into two major groups: birds observed in floodplains and wetland, and birds observed in dry habitat such as homestead, open woodland, scrub and grass land. Birds of prey survive well in the area. Common bird of prey species found in the polder area are Brahminy Kite (*Heliastur indus*). Other common bird species in the polder area are Common Myna (*Acridotheres tristis*), Red-vented Bulbul (*Pycnonotus cafer*), Oriental Magpie Robin (*Copsychus saularis*), Spotted Dove (*Streptopelia chinensis*), Blue Rock Pigeon (*Columba livia*), Black Drongo (*Dicrurus macrocercus*), Asian Koel (*Eudynamys scolopacea*), Larged-billed crow (*Corvus macrohynchos*).

Photo 5.17: Common Vine Snake (Athaetulla nasuta) is occationally found in the polder

256. Some species found within the polder area are listed in the schedules of the Convention on International Trade in Endangered Species of Flora and Fauna (CITES). Several species are listed in the IUCN *Red Data Book* occurs within the polder area (Table 5.20) are listed in following table.

Table 5.20: List of Endangered and threatened wild life species dwell inside the polder area

Scientific name	Common name	Local name	Local status	IUCN status	CITES Status	Cause of threat
Lutra lutra	Eurasian otter	Dhari/Udbiral	Very rare	Critically Endangered	I	Habitat loss
Canis aureus	Golden jackal	Pati shail	Rare	Vulnerable	-	Hunt and habitat loss
Varanus bengalensis	Bengal monitor	Gui shap	Common	Vulnerable	I	Hunt
Viverrricula indica	Small Indian civet	Khatash	Rare	Vulnerable	II	Habitat loss
Bungarus caeruleus	Common krait	Kal keotey	Occasionally	Endangered	-	Hunt and habitat loss

Source: CEGIS Field survey, 2013 and RED DATA BOOK of IUCN, CITES Database

5.2.13 Aquatic Ecosystem

Wetlands

257. There are more than 340 ha of wetland inside the polder. Wetlands' of this area provide ecosystem sustainability. It contains rich variety of flora and fauna and mostly provides food and habitat to the aquatic fauna. The wetlands are divided into two major categories; seasonal and perennial wetland.

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

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

b. Aquatic Flora

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

261. 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.

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

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

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

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

a) Kochu *(Colocasia* spp.) is a sedges and meadows plants that found most of the khals

b) Hogla (*Typha elephantalis*), a brackish aquatic plant is very common in the polder area.

Photo 5.18: Aquatic vegetation

b. Aquatic Fauna

266. The life cycle of aquatic fauna is dependent on seasonal variation as well as inundation depth and availability of water in all types of wetlands. Naturally, wetlands provide food and shelter to the aquatic fauna. A brief description of aquatic fauna is presented below.

i. Amphibians

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

ii. Reptiles

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

iii. Avifauna

269. Availabilities of small fishes in all types of shallow wetlands support feeding habitats to the aquatic avifauna. The aquatic bird like Little Egret *(Egretta garzetta),* Great Egret *(Casmerodious albus),* Common Kingfisher *(Alcedo atthis),* Little Cormorant *(Phalacrocorax niger*), Grey Heron *(Ardea cinerea)* are frequently found along mudflats, canal systems and seasonal wetlands throughout of the year. Local people reported that migratory birds are found here during the winter.

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

5.2.14 Ecosystem Services

a. Output of Ecosystem Services

271. Ecosystem services are the benefits which people obtain from ecosystems. These include provisioning services such as food and water; regulating services such as flood and disease control; cultural services such as spiritual, recreational, and cultural benefits; and supporting services, such as nutrient cycling, that maintain the conditions for life on Earth. A Table below represents ecosystem goods and services from different common plants of the polder.

Table 5.21: Goods and services from different plant species available in the polder area

Item	Source	Goods/Services
Food	Supari *(Areca catechu),*Narikel *(Cocos nucifera),* Aam *(Mangifera indica),*Jam *(Syzygiumsp),*Kola (*Musa sp), Aam(Mangifera indica*), Safeda*(Manilkara zapota),* Payara (*Psidium guajava)*, etc	Fruit
	Ghechu (*Aponogeton spp*.)	Rootstock
	Helencha (*Enhydra fluctuans)* and Kolmishak (*Ipomoea aquatica*)	Leaf and stem
Fodder	Kochuripana (*Eichhornia crassipe*), Phutku (*Hygroryza*	Leaf and stem

Item	Source	Goods/Services
	aristata) etc.	
Wood, timber	Aam*(Mangifera indica),*Jam *(Syzygiumsp),* Bot*(Ficus benghalensis),*Babla *(Acacia nilotica),* Mahogany (*Swietenia mahagoni),*	Trunk
	Borun (*Cratava nurvala*)	In tannery and for making drums, combs etc.
	Hijal (*Barringtonia acutangula*)	Boat and cabinet-making, construction
Medicine	Mahogany (*Swietenia mahagoni),* Tulshi*(Ocimum americanum),*Sezi *(Euphorbia antiquoram),* Bel*(Aglemarmelos),*Nim *(Azadirachta indica)*	Roots, Leaf, Stem
Thatching and mat making	*Cyperus platystylis*, Supari *(Areca catechu),*Narikel *(Cocos nucifera),*Bash(*Bamboosa* sp.), Bel*(Aglemarmelos),*Tal *(Boassus flabelifer),* Hogla (*Typha elephantalis*),	Thatching and fencing for huts and as protective screen in homestead.
Fuel	Babla *(Acacia nilotica)*, Akashmoni *(Acacia auriculiformis,)*Boroi *(Zizyphus sp),*Gab*(Diospyros perigrina),Thespicia populina* and etc.	Branches, Leaf
Bio fertilizer	Kochuripana	As compost
Hydroponics	Kochuripana to make baira (floating platforms)	to grow seedlings and vegetables
Bio-gas	Kochiripana, Khudipana (*Lemna* and *Spirodela sp.*) and other aquatic plants.	All parts of the pant
Fishery	Hijal	To make 'Katha' for fish.
Erosion Protection	Dholkolmi *(Ipomoea fistulosa)*, Hijal *(Pongamia pinnata)*, Chaila gash *(Hemarthria protensa)*	Against wave action, erosion and storm

a) Fuel wood stock is a main contribution from local vegetation

b) 'Hoglapata'; a mat-making material services from swamp vegetation

Photo 5.19: Ecosystem Services from plants

5.2.15 Present Threats on Ecosystem

272. The major problems identified in the polder area are lacking of advance knowledge about homestead plant biodiversity, improper maintenance of embankment and sluice gates, effect of intrusion of partial saline water, recurring natural disasters, khals siltation and water logging. Pests and diseases attack, improper homestead space planning and utilization etc are other problems also. Consequently, faunal population and diversity is also decreasing due to natural disaster and various human activities.

5.2.16 Livestock and Poultry

273. A large number of populations of the polder area earn their livelihood through work associated with raising livestock / poultry. About 50% of households are rearing cows/ bullock, 5% of households are rearing bullalo, 60% of household are rearing goat, 75% of household are rearing chicken, 60% of households are rearing duck and 5% of household are rearing pigeon. Detailed status of livestock and poultry is presented in Table 5.22.

Table 5.22: Status of Livestock/Poultry in the Polder Area

Live stock/Poultry	% of household	Number of Livestock/Poultry in the polder area
Cattle/cow/bullock	50	6,400
Buffalo	5	640
Goat	60	11,520
Chicken	75	19,200
Duck	60	15,360
Pigeon	5	1,920

Source: Based on field information, 2014.

Photo 5.20: View of buffalo and Duck in the polder area

Photo 5.21 : View of Chicken in the polder area

Feed and Fodder

274. The owners of the livestock population are facing problems in respect of availability of fodder and feeds during the monsoon season due to non-availability of grazing land. Rice straw is the main fodder and up to 15th of June farmers can grazing cantles. Rice husk, salt and oil cakes, etc. are other common fodders in this polder area. Shortage of grass is the main barrier for grazing cattle buffalo and goat. Limited grazing area due to standing T.Aman rice crops in monsoon season is another problem. Poultry population, duck and pigeon at family level survives by scavenging and generally no feed supplements are provided.

Livestock and Poultry Diseases

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

5.3 Environmental Quality

5.3.1 Sound Quality

276. Three suitable sites were selected in the polder to measure the sound levels and establish a comparison between the standard levels and in-situ values. One location was selected from the construction sites (along the polder periphery) whereas two locations were chosen from inside of the polder (relatively far from the construction sites). The Environmental Conservation Rules 1997, of Department of Environment, Bangladesh has defined standard noise levels as 50 dB during day time for residential zones, and comparisons have been made between the observed sound levels and the standard value (Table 5.23).

277. During field inspection, sound levels were collected near the construction site with 10 minute sampling periods. L50 values were computed with the observed sound level variation during the sampling period. For a normal distribution of sound pressure level versus time, L50 is assumed to be equal to Leq, which is the Equivalent Noise Level. In the study area the L50 value was found to be substantially lower than the standard Leq values (for residential zone) at all sampling locations. As the project implementation works are to be carried out manually, i.e. without the use of any typical heavy loading vehicle, it can be assumed that the sound levels generated from the construction sites due to project implementation works would have very minor contributions in the equivalent noise levels.

Table 5.23: Sound levels for different locations in the study area

Location	GPS	L50 values (dB)	Standard level (Leq)	Deviations from standard
Bazarkhali Khal (construction site)	22º11’27.4’’N 90º16’16.1’’E	49	50 dB (Residential Zone)	Within limit
Rona Chandra Khal	22º13’37.1’’N 90º15’17.8’’E	46		Within limit
Rafiq Uddin Mollah's pond	22º13’40.3’’N 90º15’17.9’’E	45		Within limit

Source: CEGIS field survey, May 2014

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

5.3.2 Water Quality

278. Four major water quality parameters (pH, TDS, Temp., and DO) were measured on site in May 2014 from eight different locations of the polder (Table 5.24). The pH values were higher than neutral scale (pH=7) which means that the water in these locations was alkaline in nature during May. Values of TDS were found within a lower range at the ponds inside the polder, as tidal water could not enter into them. Values of DO were mostly found close to the standards set by the DoE for both irrigation (5 to 6 mg/l) and fishing (5 mg/l). Temperature values varied within a typical range for different locations as samplings were made in different periods of the day.

Photo 5.22: In-situ measurement of pH in Polder 43/2F

Table 5.24: Water quality parameters

Location	GPS coordinates	pH	TDS (ppm)	Temp. (ºC)	DO (mg/l)
Bazarkhali Khal	22º11'27.4''N 90º16'16.1''E	7.8	881	30.3	5.1
Kukua River	22º12'54.4''N 90º17'25.8''E	8	1238	31.1	5.9
Rona Chandra Khal	22º13'37.1''N 90º15'17.8''E	7.7	998	31.1	5.7
Kalagachia Khal	22º14'26.6''N 90º16'10.3''E	7.6	1012	31.4	5.5
Moradhon Khal at Uttar Gojkhali	22°14'00.8''N 90°16'45.2''E	7.5	910	31.3	4.6
Sanu chowkider pond at Gojkhali	22°12'59.8''N 90°16'13.3''E	7.6	683	31.5	5.5
Rafiq Uddin Mollah pond at Gulishakhali	22°13'40.3''N 90°15'17.9''E	7.8	751	31.3	5.3
A Pond at Paschim Kalibari	22°13'44.3''N 90°16'44.2''E	7.5	714	32.1	6.1

Source: CEGIS field survey, May 2014

279. Salinity levels in five locations outside the polder were also measured (Table 5.25). All the samples were found with zero salinity. The local people claimed that no surface water salinity existed in the area in pre-monsoon and monsoon seasons, even though

very minor surface water salinity is found along the peripheral rivers i.e. the Payra and the Gulishakhali during dry season. The reason for this lower salinity is the increased amount of freshwater discharge from the upstream Meghna River system towards the rivers of the South Central hydrological region.

Table 5.25: Salinity levels in different locations

Location	Sampling water Source	GPS readings	Salinity (ppt)
Gulishakhali Sluice	Payra River, outside the polder	22°12'47.0"N 90°14'08.3"E	0
Kanta Sluice	Payra River, outside the polder	22°11'09.9"N 90°14'24.3"E	0
Haridabaria Sluice	Gulishakhali River, outside the polder	22°14'35.8"N 90°14'17.6"E	0
Moradhona Sluice	Kukua River, outside the polder	22°15'20.9"N 90°17'00.5"E	0
Khekuani Sluice	Kukua River, outside the polder	22°10'25.6"N 90°15'22.4"E	0

Source: CEGIS field survey, May 2014

5.4 Climate Change

5.4.1 Climatic Trends

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

Temperature

281. Analyzing the change of average temperatures in the existing hydrological regions of Bangladesh, it is found that the temperature of the south central region (the region where Polder 43/2F is located) shows a decrease of 0.73°C per 100 years, whereas the temperatures of other regions show an increasing trend (Figure 5.10).

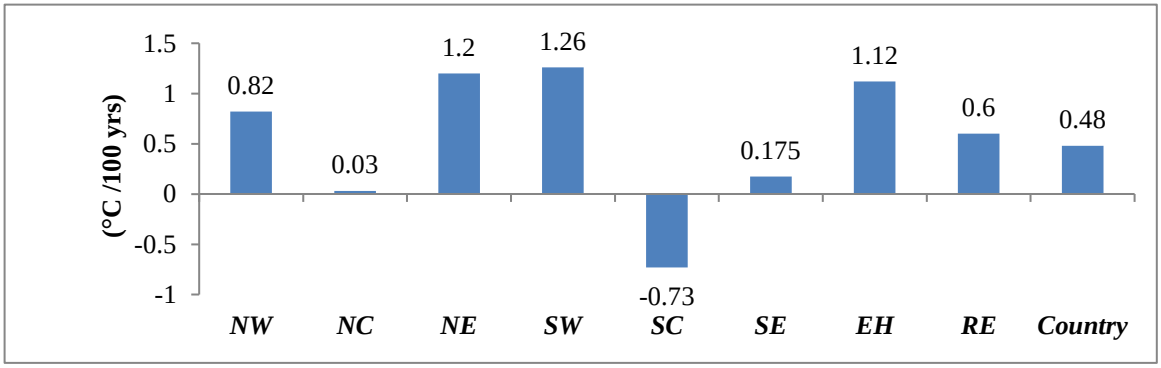


Figure 5.11: Change in average temperature in different regions (CEGIS, 2014)

282. Table 5.26 below provides a comprehensive comparison on the variation of temperatures for each BMD station within the south central hydrological region. The country average values are also shown in it. The table shows that the average

temperature has decreased 0.9 ^{0}C per hundred years in Patuakhali against a rise in country average values of 0.48 ^{0}C per hundred years.

Table 5.26: 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***

5.4.2 Climate Change Projection

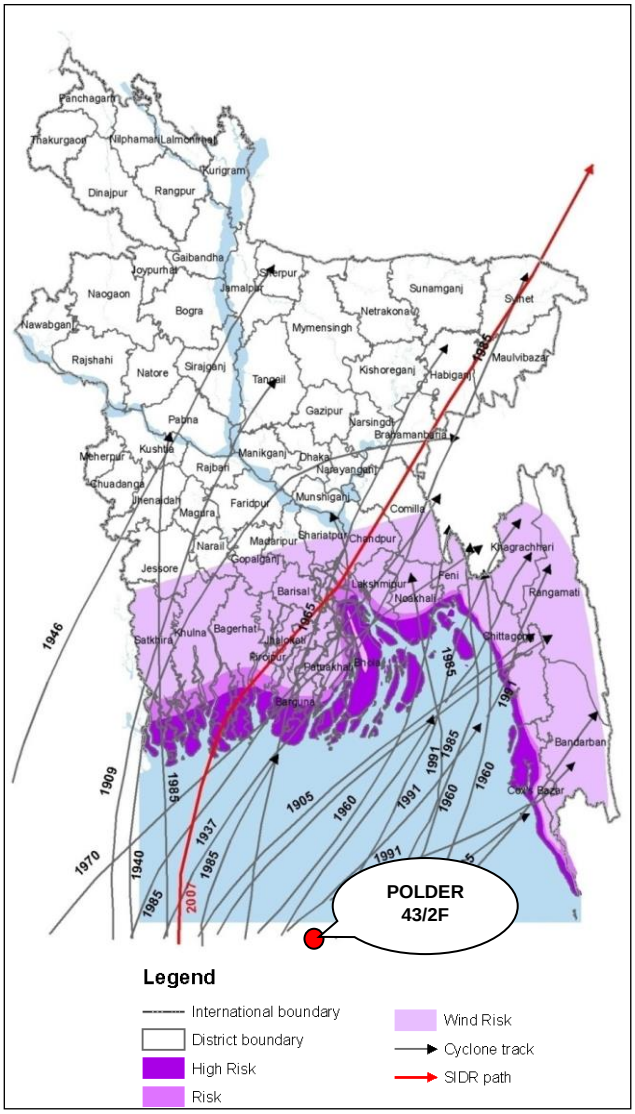
283. Two greenhouse gas emission scenarios, A2 and A1B, from the Special Report on Emissions Scenarios by the Intergovernmental Panel on Climate Change (IPCC) were used for investigating different scenarios. A2 is the business-as-usual scenario, which is a very heterogeneous, market-led world, with high population growth, slow economic development, and slow technological change. A1B, however, is the scenario which has been developed putting balanced emphasis on all potential energy sources (here balanced is defined as not relying too heavily on one particular energy source, on the assumption that similar improvement rates apply to all energy supply and end-use technologies) (Table 5.27).

Table 5.27: Summary features of climate projections (of 2050) for 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

5.4.3 Cyclones and Storm Surges in Polder 43/2F

284. 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 5.11). Polder 43/2F falls in the wind risk zone which has some vulnerability due to strong winds and surge heights associated with cyclones.



Map 5.11: Cyclone tracks in Bangladesh and risk areas

285. Field observations have revealed that the polder suffered heavy damages during Sidr (2007). A number of water control structures at Khekuani, Dolachora, Gulishakhali were severely damaged, which could be not completely repaired under the IPSWAM project. Local people claimed that six fatalities occurred in the polder, and large steamers and trawlers were swept into the polder, overtopping peripheral embankments.

6. Socio-economic Condition

286. The present socio-economic condition of the people of 'Polder 43/2F EIA' study area is captured in this section. In doing so, primary data has been collected through field study using a range of RRA techniques including Key Informant Interviews (KIIs), Focus Group Discussions (FGDs), observation and public consultation. Moreover, secondary information is compiled from the community series of the Population Census 2011 published by Bangladesh Bureau of Statistics (BBS).

287. For EIA study, the socio-economic baseline data collection mainly concentrated in settlement covered area and replicated over other areas as it was observed to be almost homogeneous socio-economic condition. The socio-economic baseline situation of the study area is described in following sections.

6.1 Demography

288. The 6,400 households in the polder area have a total population of 28,120 of which 13,458 are male and 14,662 are female. The female population is found to be higher than the male population. The average male-female sex ratio is 91 of which there are 91 males per 100 females which is lower than the national figure of 100.3 (BBS 2011). The average density of population is about 563 persons per sq. km which is also smaller the national density of 1,015 populations per sq. km. About 96% of total populations in the polder area are Muslim while rests of them are Hindu and Christian. The key demographic data of the Polder is presented in Table 6.1.

Table 6.1 : Demographic Data of the Polder 43/2F

District	Upazila	Union	Total HHs	Total PPl	Male	Female	Population density [sq. km]	Sex Ratio
Patuakhali	Patuakhali Sadar	Bara Bighai	40	158	75	83	632	90
		Marichbunia	88	366	174	192	651	90
Barguna	Amtali	Chowra	86	376	184	192	502	95
		Gulisakhali	5,886	25,940	12,420	13,520	506	92
		Kukua	300	1280	605	675	526	90
Total/Average			**6,400**	**28,120**	**13,458**	**14,662**	**563**	**91**

Source: Population Census 2011, BBS

6.1.1 Age Composition

289. About 35% of the population is less than 15 years, 55% is between 15 to 59 years and 10% are over 60 years of age. It is observed that 25% of total population is still belonging between 30-49 years age category and they are the main working force for development of society. Details of this age composition are shown in the given table (Table 6.2).

Table 6.2: Age distribution at polder 43/2F

Union	Percentage of population in the age group									
	0-4	5-9	10-14	15-19	20-24	25-29	30-49	50-59	60-64	65+
Bara Bighai	10	13	13	7	7	8	25	8	3	6
Marichbunia	10	14	12	7	7	9	24	8	3	6
Chowra	11	13	11	7	8	10	25	7	3	6
Gulisakhali	10	13	13	7	7	8	25	8	4	6
Kukua	10	14	12	6	7	8	25	8	3	6
Total/Average	**10**	**13**	**12**	**7**	**7**	**8**	**25**	**8**	**4**	**6**

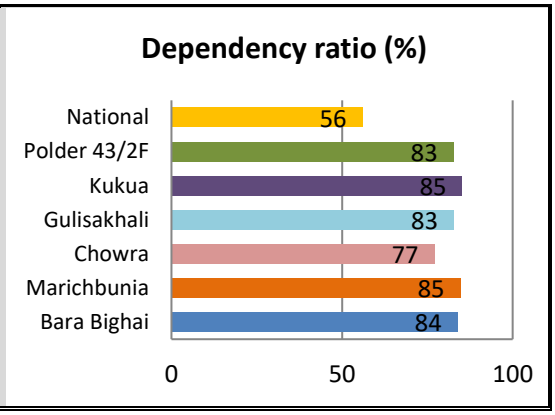
Source: Population Census 2011, BBS

6.1.2 Dependency Ratio

290. In demography the dependency ratio is an age-population ratio of those typically not in the labor force (the dependent part) and those typically in the labor force (the productive part). It is used to measure the pressure on productive population (Wikipedia, 2014). Here, dependency ratio refers to ratio of dependent population (population aged up to 14 years and above 59 years) to the working age population (population aged between 15 to 59 years). The data shows that around 46 percent of the population depends on the 54 percent of the earning members of their households. Hence the dependency ratio is 83 which are higher than national rate 56. BBS data also shows each of the union comprises almost similar ratio whereas Madarbunia and Kukua union comprises the highest dependency ratio than other unions within the polder (Table 6.3).

Table 6.3: Categorical Distribution of Population by Union

Unions	0-14 Children (%)	15-49 Active workforces (%)	60+ Old (%)
Bara Bighai	37	54	9
Marichbunia	37	54	9
Chowra	34	56	9
Gulisakhali	36	55	9
Kukua	37	54	9



Source: Population Census 2011, BBS

6.1.3 Marital Status

291. According to BBS, around 68% people are ever married where as 28% people are never married (it includes children). There has been discrepancy seen for male population is (33%) and female counterpart is (21%) in terms of never married persons. It indicates that young people are gradually becoming interested to be involved in business and entrepreneurial activities. Among all population, 5% are widow and 1% is divorced or separated. Following table (Table 6.4) shows the marital conditions at polder area.

Table 6.4: Male-female Marital Status at the Polder Area

Unions	% of Male				% of Female			
	Never married	Married	Widowed	Divorced/ Separated	Never married	Married	Widowed	Divorced/ Separated
Bara Bighai	34.5	64.8	0.7	0.0	22.1	70.8	6.9	0.2
Marichbunia	32.6	66.5	0.8	0.1	22.0	68.8	8.8	0.4
Chowra	31.3	67.6	0.9	0.2	19.8	72.1	7.6	0.5
Gulisakhali	33.3	65.8	0.8	0.1	21.1	70.3	8.0	0.6
Kukua	33.0	65.7	1.1	0.1	19.6	69.9	9.5	1.1
Average	**32.9**	**66.1**	**0.9**	**0.1**	**20.9**	**70.4**	**8.1**	**0.6**

Source: Population Census 2011, BBS

6.1.4 Household Size and Types of Family

292. The average household size is 4.39, which is almost close to the national household size of 4.50 (HIES 2010[1]). According to local people, household size is still considered as gift in some cases and curse in another case. If most of the household members become able to contribute in household income they are considered as gift, on the other hand, if most of the members appeared as only consumers are considered as curse for the family (Table 6.5).

Table 6.5: Distribution of Household Members at Polder Area

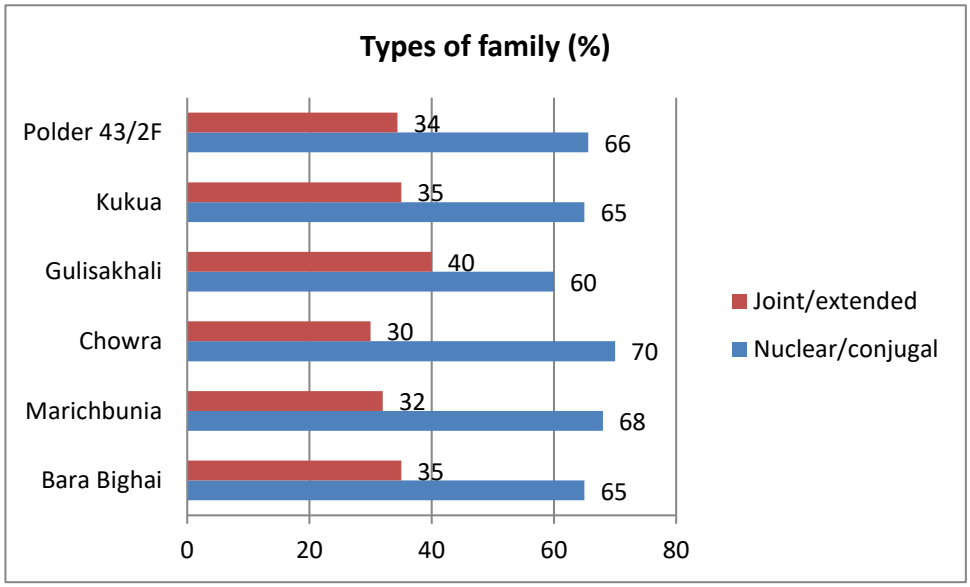
Unions	Percentage of Households comprising							
	1 person	2 persons	3 persons	4 persons	5 persons	6 persons	7 persons	8+ persons
Bara Bighai	10	13	13	7	7	8	25	8
Marichbunia	10	14	12	7	7	9	24	8
Chowra	11	13	11	7	8	10	25	7
Gulisakhali	10	13	13	7	7	8	25	8
Kukua	10	14	12	6	7	8	25	8
Average	**10**	**13**	**12**	**7**	**7**	**8**	**25**	**8**

Source: Population Census 2011, BBS

293. Therefore, In terms of the types of family[2], most of the households (66%) are live in either a nuclear or a conjugal family while only 34% live in extended or joint family (Figure 6.1). Local people opined that within the process of modernization, development of communication, growth of education, closeness to, Barguna, Patuakhali or Barisal cities, now they are being conscious about nuclear family and declining structure of kinship is observed all over the polder.

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

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



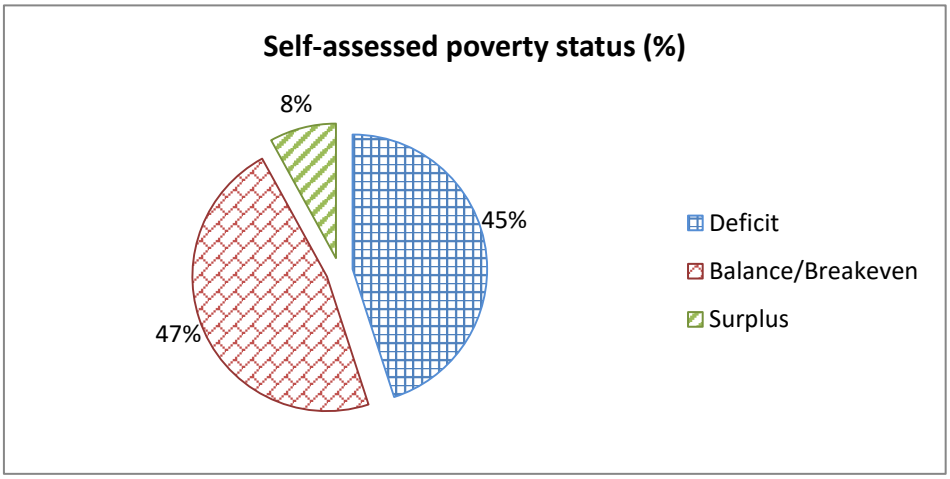
Source: CEGIS fieldwork, 2014

Figure 6.1: Distribution of population by the types of family

6.1.5 Livelihood Status

Self-assessed poverty

294. Poverty profile has been prepared by the participants of the RRA themselves through a self-assessment exercise. The assessment is based on the year-round income along with the food consumption of the inhabitants within three different categories (Figure 6.2). It is observed that about 45% of the households in average are in the 'deficit' category, 8% are surplus and rest of 47% households are in balance situation. These households have been identified in the RRA as the poor households of the Polder area. Considering the standard consumption of food (three meals in a day), the deficit group was usually taking two meals in a day in the lean period since they could not afford three full meals.



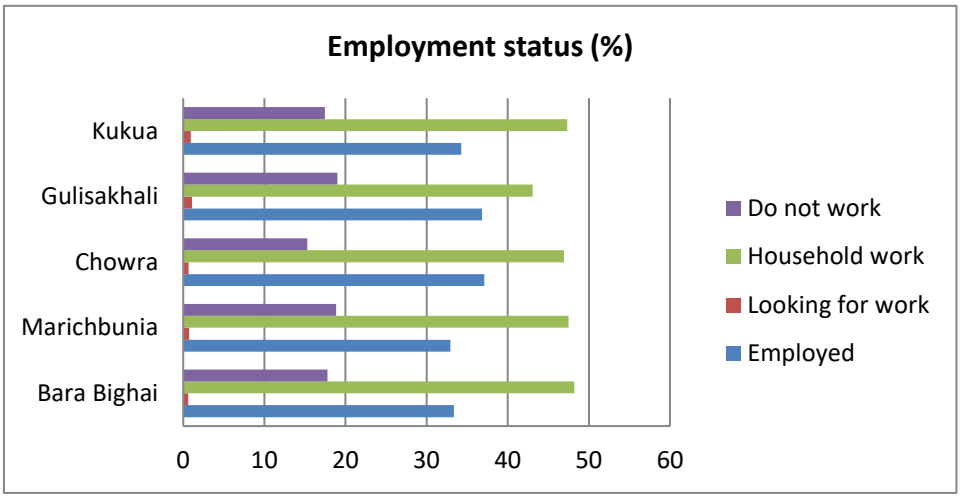
Source: CEGIS fieldwork, 2014

Figure 6.2 : Self-assessment of poverty status of the Polder

6.2 Livelihood

6.2.1 Employment and occupation

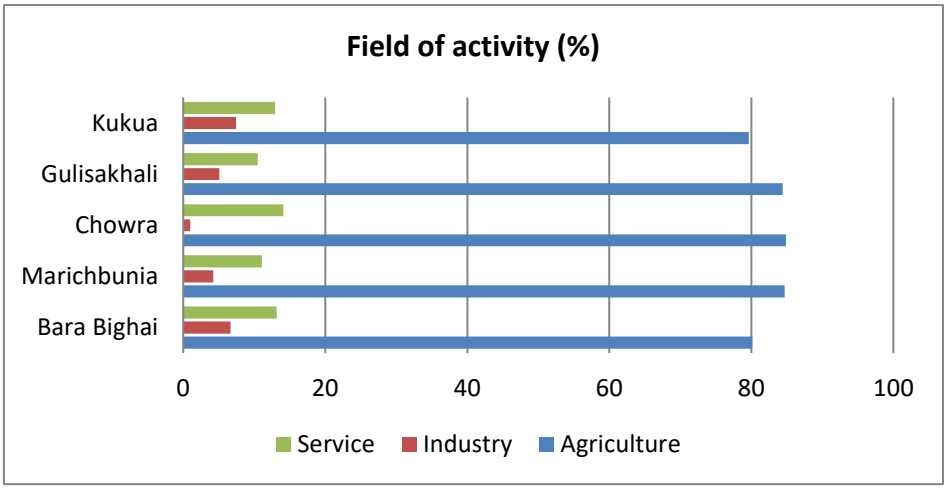
295. In the polder area, about 35% of total population is employed, 47% is engaged in household work, only 1% is looking for work and about 18% of total population is not working (it includes children and physically challenged population). Following Figure 6.3 shows the employment status of the people in the Polder area.



Source: Population Census 2011, BBS

Figure 6.3: Distribution of employment status by polder area.

296. The polder area is comprised of different occupations. Although agriculture is still the mainstay of the economy, the area provides varied sources of livelihood which are not commonly observed in other parts of Bangladesh. At present, most of the population is engaged in agriculture sector (83%). These occupational groups are mainly farmer, agricultural labor, fishers, day labors etc. About 12% population is engaged in salaried service sector and only 5% is engaged in industry, petty trade, handicrafts and other manual sectors (Figure 6.4).



Source: Population Census 2011, BBS

Figure 6.4: Distribution of population by field of activity


Photo 6.1: Different modes livelihood activites at polder 43/2F

6.2.2 Availability of Labor and Wage Rate

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

6.2.3 Population Migration

298. Migration[3] scenario is found in the studied area. Few of households have found tend to migrate permanently in both type of migration (In/Out migration). However, seasonal labor migration is common. People from the polder area tend to migrate to the Patuakhali, Barisal, Khulna, and Dhaka for better livelihood and lack of employment opportunity over the polder (12-15%) from April to June month. Very few of the households are migrating into city only for work in garments sector. On the other hand, a considerable of labors (20-25%) migrate to the polder area during cropping period from august- October month in a year with a view to subsisting (Table 6.6).

Table 6.6: Migration Status in the Polder Area

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

Source: CEGIS fieldwork 2014

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

[3]Percentage of migration is applicable in case of seasonal labor migration; whereas number is applicable in case of permanent migration of households

6.3 Education

300. The average literacy rate in the study area is 50% which is slightly poorer that national level (51%) (Table 6.7). It is observed like other part of Bangladesh that the male population (53%) is more educated than their female counterpart (47%) and here the difference is significant. Local people opined that, unemployment and lack of facilities are the main hindrance behind the development of education among women. But now they perceived that they have to find out the way to overcome this present situation but only education can lead them towards emancipation. At present, girls are trying to complete their secondary level and some of them are also going Patuakhali or Barisal for higher study. Similarly, school attendance rate of the female population is poor in the polder area. The lower literacy rate of females compared to the male population is a result of lower attendance rate at school.

Table 6.7: Literacy rate at polder 43/ 2F area

Union	Literacy Rate (%)		
	Both	Male	Female
Bara Bighai	52	55	50
Marichbunia	49	52	46
Chowra	47	48	45
Gulisakhali	53	57	50
Kukua	49	52	46
Total/average	**50**	**53**	**47**

Source: Population Census 2011, BBS

6.3.1 Educational Institutions

301. According to the field findings there are 56 primary schools, 14 high schools and 22 ebtedaye/ Dakhil Madrashas in the polder area (Table 6.8). There are five colleges seen the polder area (Source: CEGIS field work, 2014). Local people opined that numbers of high schools are still not sufficient in response to population. They demand more educational institutions in every union of the polder area.

Table 6.8: Academic Institutions of the Polder

Union Name	No of Primary School	No of Madrasha	No of High School	No of Collage
Bara Bighai	15	7	4	1
Marichbunia	14	4	3	1
Chowra	10	2	5	2
Gulisakhali	10	4	5	1
Kukua	9	4	5	-
Total/Average	56	22	14	5

Source: CEGIS field work, 2014


Photo 6.2: Local educational institution at polder area

6.4 Health Condition

6.4.1 Disease Prevalence

302. The health profile of the local people living in the polder is presented in the Table 6.9. According to the ranking, the incidence of Influenza/Common fever is the most prevalent ailment for dry season whereas cough/cold, skin diseases are also common for winter season in the Polder area.

Table 6.9: Disease Profile in the Polder

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

Source: CEGIS fieldwork, 2014

6.4.2 Health Services and Facilities

303. Field findings show that no upazila health complex was found in the polder. Besides, there are 4 union health complexes and 13 community clinics. These health services are not adequately functioning (Table 6.10). As a result, local people are to receive health service and facility from peripheral hospitals i.e. Barguna sadar or Patukhali sadar. However, it is observed that communication within the polder areas to upazila is not good and some parts of the road network are threats under erosion. Nevertheless, they are tending to go upazila or district hospitals when patient reach in a severe condition. Local people opined that, it is need to repair of the damaged road networks as early as possible.

Table 6.10: Health Service Facilities in the Study Area

Unions	Upazila Health Complex	No Of Union Health Complex	No Of Community Clinic	Outside Of Polder Health Facilities
Bara Bighai	-	1	4	Patuakhali Sadar
Marichbunia	-	1	2	Patuakhali Sadar
Chowra	-	1	3	Patuakhali Sadar, Barguna sadar
Gulisakhali		1	2	,,
Kukua	-	1	2	,,
Total	**-**	**5**	**13**	-

Source: CEGIS fieldwork, 2014

Photo 6.3: Purba Kalagachia C.C

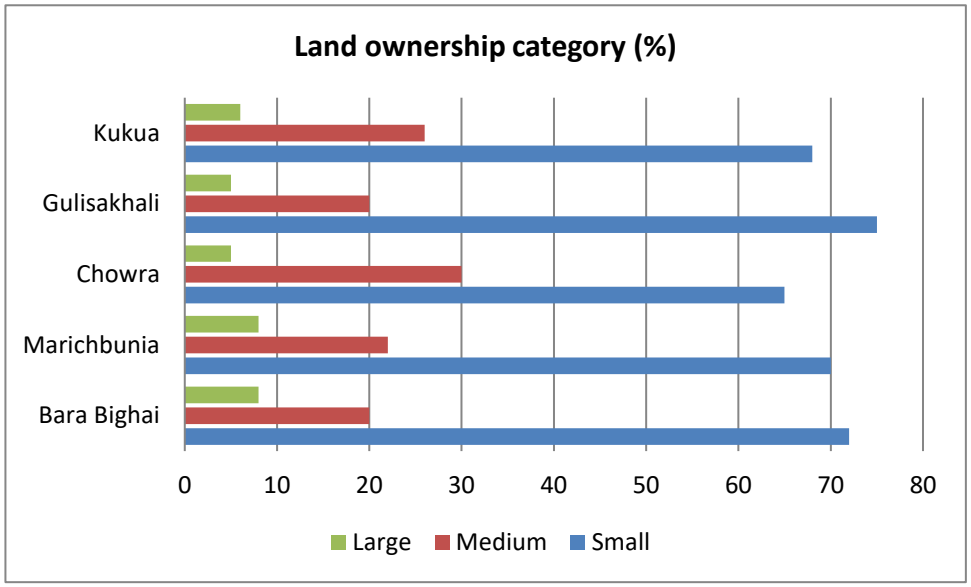
Photo 6.4: Gulishakhali UP Hospital

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

6.5 Land Ownership and Land Price

305. Landownership pattern[4] can be an indicator to understand the poverty incidence in a given area. Statistics shows that there are 76% smallholders, 19% medium and only 5% large landholders. In the study area, arable land is mainly used for crop production. Generally small and medium holders cultivate variety of crops at those lands. They cannot produce crops or paddy due to drainage congestion. The large farmers are mostly from absentee category. They usually are living in the Patuakhali sadar or Barguna and appoint caretaker to take care their land.

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



Source: BBS, Agriculture Census, 2008

Figure 6.5: Landownership Pattern in the Polder Area

306. Land price in the polder area is increasing day after day. According to the local people, agricultural land prices are relatively lower. The land price of homestead land is the highest in comparison to other land. The details land prices are shown in the Table 6.11.

Table 6.11: Sell Value of Land at Polder 43/2F

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

Source: CEGIS fieldwork, 2014

6.6 Household Income and Expenditure

307. The income and expenditure at the household level within the polder area is shown in Table 6.12. It is found that most of the people belong to Tk. 24,001 taka to 60,000 taka income and expenditure category. It is assumed that due to lack of alternative sources for livelihood operation within the polder, their income and expenditure status is quite poor.

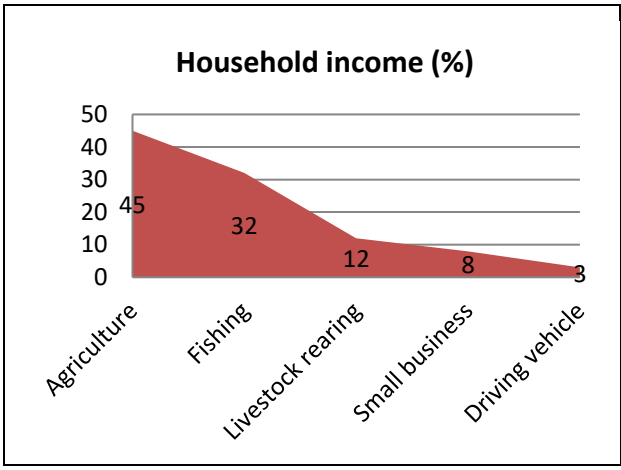
Table 6.12: Annual Income and Expenditure Level

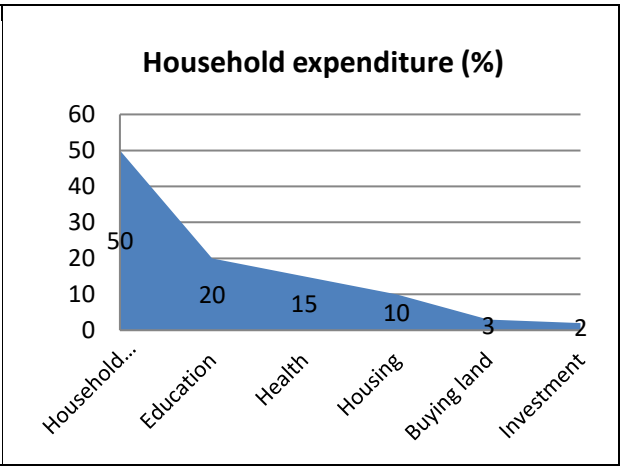
Range In Taka	Percentage (%) of Households	
	Income	Expenditure
Up to 12,000	15	10
12,001to 24,000	25	28
24,001to 60,000	48	50
60,001to 108,000	7	6
108,001 to 240,000	5	5
More than 240,000	3	3

Source: CEGIS fieldwork, 2014

6.7 Sectors of Income and Expenditure

308. Field findings shows that most of the income comes mainly from two sectors i.e. agriculture (48%) and fishing (32%). On the other hand, most of the expenditure costs for household consumption 50% (it includes everyday food, clothing and other necessary things) and education purpose (20%). In to some extent, they are now feeling discomfort due to current price hike in every sector of expenditure. In most of the cases, expenditure is become two times greater than income. Some of them are lending money from NGOs for well being of their family or livelihood. Household income and expenditure of the local people within the polder area are shown in the figures 6.6 and 6.7 respectively.





Source: CEGIS fieldwork, 2014

Figure 6.6: Proportionate Distribution of Household income

Figure 6.7: Proportionate Distribution of Household expenditure

6.8 Susceptibility to Disasters

309. The local inhabitants of Polder 43/ 2F have identified tidal flooding, erosion, water logging and cyclones as the major hazards in the area and these natural disasters are frequently affecting them. They can only recall the cyclone SIDR and AILA that were taken place in 2007 and 2009. The most impact of the cyclones reported by local people was loss of livelihood opportunities, standing crops, fisheries and other household assets for both long and short term. The loss and damage inflicted as a result of cyclone AILA and SIDR had lasting effects. The decreased availability of food led to malnutrition and school drop-out rates increased in that time as some people were forced to migration take jobs in order to contribute the household income. At present, erosion at Gulishakhali and drainage congestion in certain part has gradually increased and crop production, the income source village from homestead gardening, livestock rearing and wage labour has been hampered. They feel risk due to such kind of vulnerable factors and mentioned necessary mitigation measures to risk reduction from GOs or NGOs level. Details about the disasters and their effects on their livelihood in the area are presented in table (Table 6.13).

Table 6.13: Effects of Recent Natural Disaster within the Polder

Disaster	Affected Year	Affected Area (%)	Affected Households (%)	Crop Damaged (%)	Major Damaged Crop

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

Source: CEGIS fieldwork, 2014

6.9 Quality of life

6.9.1 Housing Tenancy and Housing Condition

310. In the study area, most of the people are dwelling [5] in their own household. Contractually dwellers are insignificant who came from another location due to job purposes and or having no own homestead land. Almost 98.5% people possessed own household within the polder area whereas around 0.6% people are living without rent free and rest of 0.9% are living in rented house.

311. On the other hand, overall housing condition[6] is not satisfactory. On an average only 1% of houses are Pucka, 3% houses are semi-pucka and 2.5% houses are Jhupri whereas 93.4% 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. It can be concluded that the people living in the study area belong to poor category in term of housing type. Statistics show that Bara Begghai union comprises the highest pucka household (1%) whereas same union also has the highest kutcha households (94 %). Table 6.14 and photo below 6.5 shows represent housing types of the polder.

Table 6.14: Types of housing structure by union at polder 43/2F

Union	Type of Structure (%)			
	Pucka	Semi-pucka	Kutcha	Jhupri
Bara Bighai	1.1	3.5	94.5	0.9
Marichbunia	0.6	5.0	92.6	1.8
Chowra	0.6	2.2	92.7	4.5
Gulisakhali	1.1	2.3	94.1	2.4

[5]BBS distinguishes tenancy status of dwelling units into three classes such as- i) **Owner:** Dwelling unit found occupied and used by household owning it; ii)**Rented:**Dwellingunitfoundoccupiedandusedunderarrangementofcontractually rented; and iii) **Rent free:** Dwelling unit found occupied and used without rent.

[6]The BBS distinguishes housing structures into four classes such as- i) **Jhupri**: Houses which have mud walls of 1.5 to 3.0 ft thickness, which carry the roof load. Earthen floors, thatched or CI sheets are used as roofing materials. There is no monolithic joint between the wall and the roof. ii) **Katcha**: 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.

Union	Type of Structure (%)			
	Pucka	Semi-pucka	Kutcha	Jhupri
Kukua	0.5	3.5	92.9	3.1
Average	**0.8**	**3.3**	**93.4**	**2.5**

Source: Population Census 2011, BBS


Photo 6.5: Housing structure in the polder area

6.9.2 Sanitation

312. The sanitation facilities[7] adopted by the households of the polder area are presented in Table 6.15. It shows that about 26% of households have hygienic sanitation facilities (water-sealed), 53% do not have water-sealed sanitation facilities, 19% have non-sanitary sanitation facilities and 2% have no sanitation facilities. Local people face the worst situation with regard to sanitation facility.

Table 6.15: Sanitation facilities of the polder by union

Union	Toilet Facility (%)			
	Sanitary (Water-Sealed)	Sanitary (Non Water-Sealed)	Non-Sanitary	None
Bara Bighai	42.7	46.5	9.8	1.0
Marichbunia	20.0	60.2	17.6	2.2
Chowra	18.5	60.0	19.4	2.1
Gulisakhali	22.3	48.5	25.1	4.1
Kukua	26.2	50.4	21.8	1.6
Average	**25.9**	**53.1**	**18.8**	**2.2**

Source: Population Census 2011, BBS

313. Sanitation facility is moderate in Bara Bighai and Madarbunia unions (43% and 40% water-sealed sanitary facilities) whereas in Gulisakhali union it is only 22%.

[7] BBS defines four types of sanitation in Bangladesh such as **(i) Sanitary (water-sealed):** A water sealed latrine is simply a pit latrine that has a water barrier to prevent odors. These latrines are simply pits dug in the ground in which human waste is deposited. **(ii) Sanitary (not water-sealed/ring slab):** latrine with a slab or other secure cover over the drop hole, or a polyethylene flap preventing insects from flying into or coming out of the pit; and **(iii) Non-sanitary (Katcha)**: latrine which 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 6.6: Sanitation facilities in the polder area

6.9.3 Drinking Water

314. The overall status of drinking water in the area is satisfactory. On average, 98% people collect drinking water from tube wells and remaining 2% collect drinking water from other sources such as ponds, PSF; rain water etc. The database also shows that Bara Bighai union has the highest percentage (99.3%) of tube well users for collecting drinking water whereas Gulisakhali union has the lowest percentage (97.1%) of tube well users. It should be noted that there is very little use of taps as source of drinking water within the polder. The details are presented in Table 6.16, which shows that the percentage of tube-well coverage is significant.

Table 6.16: Sources of drinking water in the polder by union

Union	Source of Drinking Water (%)		
	Tap	Tube-Well	Other
Bara Bighai	-	99.3	0.7
Marichbunia	-	94.9	5.1
Chowra	0.1	97.6	2.3
Gulisakhali	-	97.1	2.8
Kukua	0.1	99.1	0.8
Average	**0.1**	**97.6**	**2.4**

Source: Population Census 2011, BBS

Photo 6.7: Domestic level tube well

6.9.4 Electricity and Fuel Consumption

315. Electrification as reported in the Population Census is not satisfactory in the polder area. On average, only 21% of households have electricity coverage. BBS data show that Bara Beghai union has the highest (25%) electricity coverage whereas Chhota Beghai and Gulishakhali union has the lowest (17%) coverage. Moreover, almost 25% of households are now use solar electricity in the polder area (CEGIS fieldwork, 2014). For fuel consumption, they usually suffer from scarcity of fuel for cooking during monsoon. Local people express their opinion for connecting to electricity facility with national grid as early as possible.

Table 6.17: Distribution of electricity connection in the polder area by union

Union	Electricity Connection (%)
Bara Bighai	25.3
Marichbunia	16.2
Chowra	16.4
Gulisakhali	17.5
Kukua	22.6
Average	19.6

Source: Population Census 2011, BBS

6.10 Social Amenities

6.10.1 Roadways

316. Road networks and communication system is not good in the polder area. Local people communicate using both roadways and waterways. The roadway-cum-embankment along the polder (at Haridrabaria, Gulishakhali etc.) is often at risk of riverbank erosion which also causes homestead damage (Table 6.18). The peripheral roads of the polder include paved roads, those with brick soling and earthen roads.

Table 6.18: Road network in Polder 43/2F

Destination	Status	Length (km)
Angulkata to Gulishakhali	Semi paved	4
Debipur sluice gate to Younus khan college	paved	3
Haridrabaria madrasha to Gulishakhali hospital	Paved	3.5
Khekuani bazaar to Bazzarkhali sluice	Paved	3
	Total	**13.5**

Source: NWRD, 2014


Photo 6.8: Soling and risk of damage to a paved road in the polder

6.10.2 Markets and Growth Centres

317. The current status regarding market and growth center in the polder area is not satisfactory. There is only one growth center and only 15 markets/bazaars in the Polder 43/2F area. Among these, the growth center is located in Gulishakhali union and is open every day. According to local people, these facilities are not enough to serve all necessary purposes in their day to day lives.

6.11 Socio Cultural Capital

6.11.1 Social safety nets

318. A number of local, national and international NGOs are working in the polder area. The main activities of these NGOs include operating micro credit programs among the rural poor and landless women/men. The major NGOs working in the area include BRAC (Bangladesh Rural Advancement Centre), ASA (Association for Social Advancement), Space Bangladesh, Grameen Bank, Nazrul Sriti Sangsad (NSS), CODEK, SUSHILON, MERISTOPES etc. (Table 6.19). These NGOs are serving with micro credit while BRAC is working for non-formal education, health, human rights, water and sanitation, gender and children development programs. About 45% of households are found to benefit from the NGO interventions. After disasters (such as Sidr and Aila) the NSS appeared as the most important NGO for the local people.

Table 6.19: NGOs and their programs in the polder area

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

NGOs	Type of Programs						
	Credit	Education	Water and Sanitation	Health and nutrition	Road networks	Disaster	Livestock
CODEK	✓	-	-	-	✓	-	-
SUSHILON			✓		✓	-	-
MERISTOPES	-	-	-	✓	-	-	-

Source: CEGIS field survey, 2014

Photo 6.9: Glimpse of an office and signboard of social safety net programs

6.11.2 Rituals and festivities

319. Muslims are the dominant inhabitants (96%) of the polder area followed by Hindus and a very few Christians. In terms of rituals and festivities, there exists good social bonding and cohesion between the Muslims and Hindus. Muslims mainly gather for their largest religious festivals, the Eid-ul Fitr and the Eid-ul Azha, amid much fanfare and festivity. The Hindus and other religious groups also take part in their rituals and festivities in a peaceful way (Photo 6.10).

Photo 6.10: Mosques in the polder area

6.11.3 Common Property Resources

320. The common property, locations/resources of the area is different social amenities e.g. mosques, graveyards, temples, cremation grounds, playgrounds and Eidgahs (place for offering Eid prayers). These are used frequently by the local people for the purposes

of religious, social and cultural gathering. Besides these, the BWDB embankment is also used very commonly for different livelihood purposes of the local inhabitants (Table 6.20).

321. There are 199 mosques, 40 temples, 30 Eidgahs, 29 graveyards and 11 crematoriums in the polder area. Besides, there are 28 cyclone shelters among which 10 are under construction. However, there are no known historical or archeological sites declared by government in the polder area.

Table 6.20: Common property, locations/resources in Polder 43/2F

Union Name	No of Mosque	No of Temple	Eidgah	No of Graveyard	No of Cremation	No of Cyclone Salter	
						Functional	Under construction
Bara Bighai	64	10	2	4	2	4	2
Marichbunia	15	5	3	4	3	3	1
Chowra	56	8	8	8	2	3	3
Gulisakhali	32	10	10	5	2	4	2
Kukua	32	7	7	8	2	4	2
Total	**199**	**40**	**30**	**29**	**11**	**18**	**10**

Source: Union website, 2014

6.11.4 Conflict of Interest

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

6.12 Gender Issue

6.12.1 Education enrolment

323. Enrolment in education shows a difference between attending and not attending school for both sexes. In terms of attending school, both the male and female rates of education for 6 to 10 years and 11 to 14 years are almost similar while this situation is worse for higher education. It is clear that women are still lagging behind their male counterparts in terms of attaining education. This trend, however, is seeing some change as the people of the area are now more aware of the importance of female education (Figures 6.8).

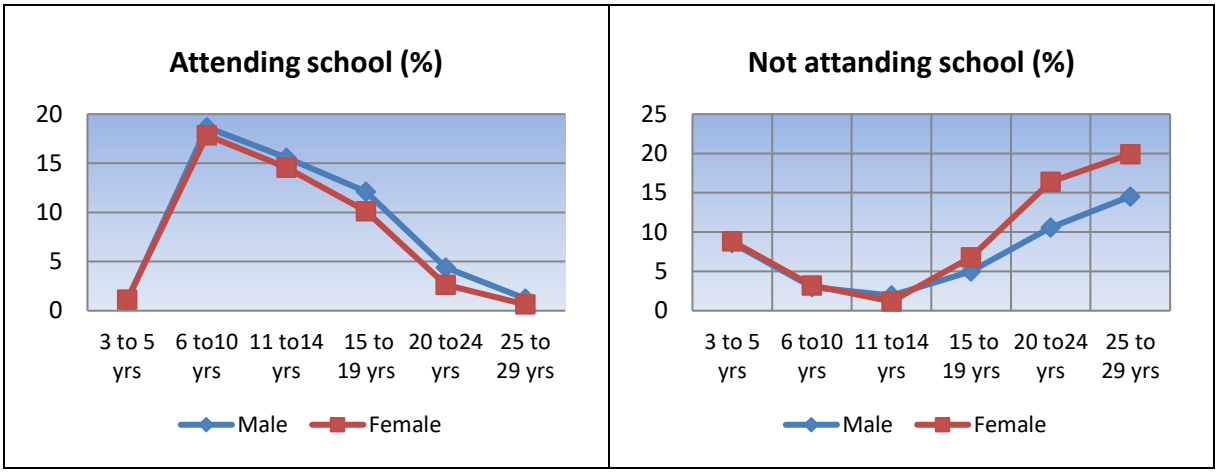


Figure 6.8: Male-female education enrolment rate in the polder area

6.12.2 Health

324. About 20% of the women are living in good health but the rest suffer from various diseases such as low blood pressure and premature delivery. About 15% of the women are getting proper nutrition and about 10% have access to health centers. The mortality rate of the pregnant women during delivery period has reduced over time mainly due to growing consciousness among the local people as well as the health services provided by public and other types of health centers including NGO programs (CEGIS fieldwork and union office, 2014).

6.12.3 Employment

325. Participation of female members of households is nominal compared to male participation. Among the employed population of the polder area only 2 percent are female. Women are mainly involved in seasonal earthwork, household level handicraft, poultry rearing etc.

6.12.4 Empowerment

326. In the polder area, women's status has changed greatly during the last few decades. Many of the Hindu women have come out of the kitchens. They are working hand in hand with men in all spheres of work i.e. from earthwork to tailoring, teaching etc. Like other parts of the country, Muslim women are a little restricted from engaging in work other than household duties. They mostly stay at home except when requiring medical treatment or fetching water and visiting relatives.

6.12.5 Vulnerable Communities

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

7. Public Consultation and Disclosure

7.1 Overview

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

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

7.2 Objectives of stakeholder consultations

330. 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 begin establishing communication and an evolving mechanism for the resolution of social and environmental problems at local and Project level;
- To involve Project stakeholders in an inclusive manner i.e. establish and empower community organizations/ water management organizations (WMOs) to sustainably manage their water resources and to make these resources more productive.; and
- To receive feedback from primary stakeholders on mitigation and enhancement measures to address the environmental and social impacts of the Project.

7.3 Identification of stakeholders

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

7.3.1 Primary Stakeholders

332. 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. Primary stakeholders are people who would be directly benefited or impacted by a certain project intervention. In case of the proposed Project in Polder 43/2F, the primary stakeholders include the people living within the Project area particularly those who reside within and in the immediate

7.3.2 Secondary Stakeholders

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

334. Secondary stakeholders for the Project include local government institutions (LGI), Bangladesh Water Development Board, the Ministry of Water Resources, Department of Forest, other government agencies, academia, NGOs, the Blue Gold officials at Patuakahli, the Netherlands govt. officials and general public at large.

7.4 Approach and Methodology

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

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

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

7.5 Consultation meetings

7.5.1 Consultation Process

338. A Public Consultation Meeting (PCM) and number of consultation meetings, FGDs and RRAs were conducted at different locations of the Polder 43/2F. The details of these meetings and RRAs are presented in Table 7.1 and some photographs of these meetings are given in photos (7.1-7.3) below.

Table 7.1: Consultation Details

Sl	District	Upazila	Union	Meeting venue	Type of consultation	Meeting date	Time
1	Patuakhali	Sadar	Sadar	Blue gold office	Sharing meeting with Blue gold officials	25/05/2014	10:00
2	Barguna	Amtali	Gulishakhali	Gulishakhali Bazaar	RRA	27/05/2014	10:00
3				Angulkata	RRA	27/05/2014	12:00
4				Haridrabaria	RRA	27/05/2014	13:30
5				Kalagachia	RRA	27/05/2014	15:30
6	Barguna	Amtali	Gulishakhali	Gulishakhali UP Hall Room	PCM	17/11/2014	10:00

Photo 7.1: Consultation meeting with Blue gold officials and WMG, Patuakhali

Photo 7.2: Meeting at BWDB office; Patuakhali

Photo 7.3: Meeting at Gulishakhali Bazaar

7.5.2 Consultation Participants

339. The main participants of these consultation meetings included Blue gold officials, UP chairman, UP members, local representative, farmer, trader, members of WMO and daily-wage laborers of the Polder 43/2F and nearby areas. A total of 70 participants attended these consultations. The participant details are provided in Table 7.2 and photos (7.4-7.6) 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	Gulishakhali Bazaar	RRA	Primary stakeholders	15
3	Angulkata	"	,,	17
4	Haridrabaria	"	,,	13
5	Kalagachia	"	,,	15
6	Gulishakhali UP Hall Room	PCM	All type of stakeholders	47

Photo 7.4: Consultation at Kalagachia

Photo 7.5: Consultation at Angulkata

Photo 7.6: Consultation at Haridrabaria

Photo 7.7: A view of PCM at Gulishakhali UP Hall Room

7.6 Issues discussed in RRAs and meetings

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

Water resources:

- Surface water (tidal flooding, drainage, salinity, siltation)
- Water management (flood control, drainage, irrigation)

Land resources:

- cropping practice,
- production and yield,
- water logging and drainage congestion
- Crop damage.

Socio-economic aspects:

- Occupation and Employment (unemployment/joblessness)
- Migration (temporary/permanent out-migration)

- Poverty (food and income poverty)
- Education (poor literacy rate, non-schooling, less female education, drop out etc)
- Health and nutrition (illness, diseases, poor nutrition)
- Quality of life (poor housing and sanitation facilities, scarcity of drinking water, fuel and fodder)

Disasters:

- Cyclones
- River erosion
- Associated damages

The sustainable and integrated solutions of the main problems being faced in the Polder:

- Water resource management
- Agriculture and fisheries management
- Land resource management
- Disaster management.

Community involvement

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

7.7 Community Concerns and Suggested Solutions

341. The outcomes of the RRAs and consultation meetings 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 at certain parts of the polder and poor communication system are the main community concerns in the polder area.	Comprehensive rehabilitation of the polder should be taken up at the earliest with the active involvement of the local community.
Water resources	– Drainage congestion is the most prominent problem in the area as opined by local people – Surface water scarcity is another important issue	– Re-excavation of khals – Repairing of Sluice gates, inlets and outlets
Agricultural resources	– Drainage congestion and water lodging 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 new crops introduce. – Re-excavation of khals to remove drainage congestion. – All proposed intervention should be

Themes/Topics	Concerns/Issues/Problems	Suggested Solution/Remedies
		protected existing problem in the polder area.
Fishery resources	– Reducing depth of internal khals and habitat quality degradation due to siltation – Fish and hatchling movement disrupted due to properly operation of water control structures. – Indiscriminate fishing by Sluice net	– Re-excavation of khal will help to increase the richness of fish species in the polder area. – Strengthening of WMA/WMO activities – Application of fisheries rules and regulation by the government strongly
Ecological resources	– The major problems identified in the polder area that homestead plant biodiversity were 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 water control structure along the embankment to 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	– Some of the road networks (Angulkata, Gulishakhali, Dalachara and Naiapara) of the polder are creates problems in regular communication system. – Lack of pure drinking water – Canals are not apposite for naval communication – The proposed khals which will be excavated are basically occupied by local elites. The local elites used the water of these khals for culture fish or other purposes and create disruption to mass people. – Lack of adequate expertise and experienced manpower to carry out the O&M of the polder and the numbers of field staffs are also insufficient and inadequate in some places of the polder with respect to the actual requirement. – Local powerful persons, including the political leaders illegally interfere on the water control/ management infrastructure.	– The embankment cum road should repair immediately in places. – Strengthening of WMGs so that mass people can access to open water bodies easily. – Tree plantation project should be undertaken on the embankment. – It is needed to ensure sustainable operation of the project, participation of Water Management Organization (WMO) and Community Based Organizations (CBOs) and also manage properly water control structures i.e. embankment, sluice gate, regulator, inlets, culverts etc and growing of consciousness among the community in the polder. – The Government should rehabilitate the affected farmers who are affected by salinity intrusion; – Need awareness building about water management among the communities

7.8 Perceptions towards proposed interventions

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

7.9 Participant list

343. The name of the participants of different meetings, their age, occupation and address including cell phone number (if any) are provided in Table 7.4.

Table 7.4: Name of participants

SL	Name	Gender	Occupation	Age	Address/Mobile No
1	Gazi Nur Mohammad Ripon	M	Assistant Engineer	35	01716-037451
2	Abu Zafar	M	Electrician	31	01728-943897
3	Md. Rasel	M	Day labor	28	01751-268989
4	Jahirul Islam	M	Business	29	01740-991575
5	Nijam Khan	M	,,	57	01780-228435
6	Md. Al Amin	M	,,	30	01736-912489
7	Rasel Farazi	M	,,	25	01760-674895
8	Bashir Munshi	M	Driver	30	01724-611204
9	Md. Anowar Talukdar	M	Agriculture	55	01821-166001
10	Md. Ali Hossain Mirza	M	,,	43	01732-210807
11	Joynal Fakir	M	Fisher	60	-
12	Md. Faruq	M	,,	40	01758-750944
13	Md. Hanif	M	,,	50	-
14	Abdus Salam	M	,,	45	-
15	Abdul Motalib	M	,,	55	-
16	Md. Anowar Hossain Mirza	M	Agriculture	50	01727-122482
17	Md. Yousuf Fakir	M	Business	56	-
18	Mehedi Hasan Rajib	M	Student	18	01682-137905
19	Ms. Shahinur	F	Housewife	25	01783-960338
20	Ms. Rejia	F	,,	22	-
21	Anis Jomaddar	M	Ret. officer	60	-
22	Atahar Gazi	M	Business	45	01734-348706
23	Md. Nur Hossain	M	Teacher	50	01727-123104
24	Hatem Ali Hawladar	M	Service	55	-
25	Nasir Fakir	M	Business	28	01732-374175
26	Jakir Gazi	M	Business	27	01710-055325

SL	Name	Gender	Occupation	Age	Address/Mobile No
27	Asaduzzaman	M	Teacher	37	01713-956826
28	Md. Tota Miya Hawladar	M	Business	50	-
29	Malek Sordar	M	,,	44	01726-528998
30	Md. Wali Ullah	M	,,	45	01710-108738
31	Ms. Kali Begum	F	Housewife	21	-
32	Ms. Shahida	F	,,	35	01767-740894
33	Abul Kalam	M	Driver	35	01746-306656

8. Identification, Prediction and Evaluation of Potential Impacts

8.1 Identification and Rationale of IESCs

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

Table 8.1: Indentified IESCs and Rationale

IESCs	Rationale
Water Resources	
Drainage Congestion and Water Logging	The re-excavation works in the khals may improve the drainage status of the area, and diminish the risk of emergence of water logging problems at some portions of the polder. Therefore, drainage congestion and
Surface Water Availability	water logging has been considered as an Important Environmental Component (IEC). Due to khal re-excavation works, the availability of surface water in Polder 43/2F may be increased and this might facilitate the multi-purpose use of water. As such, Surface Water Availability has been selected as an IEC.
Erosion	Temporary erosion protection works to be carried out four vulnerable hotspots may temporarily prevent river erosion along the Payra river upto some extent. For this reason, erosion has been considered as an IEC.
Agricultural Resources	
Cropping pattern and intensity	The proposed interventions will change the hydrologic regime inside polder 43/2F area, which may encourage the farmers to change their cropping patterns and may use 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 excavation of Khals. The crop damage would be reduced due to repairing of embankments. The re-excavation of khals would help to drained out excess water from crop field. Repairing of sluice gate might prevent the intrusion of saline water. The excess rain water inside the polder

IESCs	Rationale
	would be drained out through regulators that might help to cultivate the HYVs rice. Moreover, the surface water might be stored in the re-excavated khals which would be used as irrigation purpose. This situation would be favorable for enhanced crop production. As such crop production has been selected as an IEC.
Crop damage	Crops are presently damaged in the polder area due to drainage congestion in the pre-monsoon and rainy season. Drainage congestion, drought, etc. are expected to be checked through implementation of the proposed interventions. Reduction in crop damage would be reflected in aerial extent as well as increased yield per hectare contributing to increase in crop production in consideration of which crop damage has been selected as an IEC.
Irrigated area	Surface water is more preferable over ground water for irrigation use because of its low cost and sediment content contributing towards maintaining the soil nutrient status. The proposed interventions are expected to increase the availability of surface water for irrigation use in consideration of which irrigation has been selected as an IEC.
Fisheries Resources	
Fish Habitat	The proposed interventions of the project likely alter the fish habitat as well as habitat quality in the polder area. Alteration of fish habitat/water depth due to intervention may support positively the different fish species of polder area. In this context, fish habitat has been considered as an IEC of the study.
Hatchling and fish Movement	Internal water bodies mainly the khals are connected with the Periphery Rivers. Though the movement of fish from Periphery River is controlled by water regulating structures and flow regime of the canals but hatchling movement from river to khal is still the driving force for capture fisheries of the polder area. Proposed interventions e.g. repairing of existing sluice and re-excavation of internal khal may change the hatchling movement inside the polder area. Thus, hatchling and fish movement has been considered as an IEC.
Capture Fisheries Productivity	The productivity of capture fisheries is low due to shrinkage of fish habitat for agricultural development, siltation of internal khals and obstruction of fish migration route. Hence, the proposed interventions especially re-excavation of khals may change the habitat quality of capture fisheries and also enhance the fish composition as well as its abundance. Beside this culture fisheries still contribute significantly in the polder area. Productivity of both capture and culture fisheries in this area may increase. So, capture fisheries productivity has been considered as an IEC of this study.
Ecological Resources	
Terrestrial Vegetation	Terrestrial vegetation is an important component of the existing ecosystem. Slopes of embankment consist a large amount of terrestrial vegetation. This type of vegetation provides habitat for

IESCs	Rationale
	wildlife and also providence of various elements to human. Any change of physical environment causes different intensity of vegetation damage. The proposed interventions may cause impacts to vegetation during construction as well as post construction phases. Therefore, terrestrial vegetation has been identified as an IEC.
Aquatic habitat	Aquatic habitat condition of an area mainly relies on water quality, depth, velocity, salinity as well as abundance of, aquatic flora and fauna. Poor drainage capacity of internal silted khals and non-functionality of water control structures also creates drainage congestion at surrounding area in rainy season. Repairmen of water control structures and khal re-excavation is expecting to change water quality which may impact on aquatic habitat condition. Impacts can be positive and/negative in long run. Hence, aquatic habitat is considering as an IEC.
Socio-economic Condition	
Access to open water bodies	All the khals are recognized as one of the sources for open water bodies at 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 of the case, local power elite occupied these khals for culture fish or any other purposes. Thus, it can be said that, if the proposed khals are re-excavated, it will ensure social use of water and access to mass people access into khals.
Communication	The unhappiness in certain part of the study area is their existing communication system. The archaic and damaged communication system keeps separated them from the developed regions of the district. It negatively affects their economy, politics, and society. Because of the project implementation, communication system of this area may be improved.
Gender promotion	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 and do not have any definite sources of income. It is proposed that about 40% of labour under total local constructing society (LCS) will be females. Thus, the employment opportunity for women in the construction works and during operation/maintenance phase can promote them into better life and livelihood.
Employment opportunity	The construction work may generate a significant amount of employment over its construction period to local people and other associated occupational group. People will l also be involved to carry put operation and maintenance related jobs to operate the hydraulic structures. It is expected that proposed intervention will create employment opportunities for different occupational groups.

8.2 Prediction and Evaluation of Impacts

8.2.1 Introduction

345. This section describes the prediction of potential environmental and social impacts that may caused by various project activities during pre-construction, construction, and post-construction stages on already identified IESCs. Proposed intervention which may cause potential environmental impacts during pre-construction, construction, and post-construction stages have been identified in Chapter 4 (four). The following detailed investigations have been carried out to assess the magnitude of these prioritized impacts:

- RRA survey to assess the loss of vegetation, occupation, income and poverty levels of the affected households, etc.
- Environmental quality baseline monitoring of noise, surface water, groundwater and soil,
- Ecological surveys comprising vegetation, wildlife and fisheries covering both terrestrial and aquatic ecosystem,
- Land surveys in the Polder 43/2F are comprising socio-economic status and environmental settings,
- Expert consultations focus group discussions, and public consultation.

8.2.2 Impact Screening

346. As part of the environmental impact assessment process, a screening matrix was used tailored specifically to the proposed Project, focusing the potential environmental impacts during the 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 then each of these broad categories further divided into different aspects. The potential impacts thus predicted were characterized as follows:

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

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

Table 8.2: Screening Matrix

Project Phases And Activities	Physical & Water			Land & Agriculture			Fisheries			Ecological		Socio-Economic			
	Drainage Congestion &Water Logging	Surface Water Availability	Erosion	Crop Production	Crop Damage	Irrigated area	Fish Habitat Quality	Hatchling and Fish Movement	Capture Fisheries Productivity Biodiversity	Terrestrial Vegetation	Aquatic Habitat	Access to Open Water Bodies	Communication	Gender Promotion	Employment Opportunity
Pre-construction Phase															
Labor, materials and equipment mobilization	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Site preparation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Construction Phase															
Re-excavation of khal	-	-	-	-	-	-	MN	I			I				MP
Repairing of drainage sluice and outlet	-	-	-	-	-	-	-	I	-	-	I	-	-	-	-
Re-sectioning of embankment										I			I	MP	MP
Construction of drainage outlet											I				
Embankment slope pitching and turfing													I	I	MP
Construction of temporary	-	-	-	-	-	-	-	-	-	-	-	-	I	I	MP

Project Phases And Activities	Physical & Water			Land & Agriculture			Fisheries			Ecological		Socio-Economic			
	Drainage Congestion &Water Logging	Surface Water Availability	Erosion	Crop Production	Crop Damage	Irrigated area	Fish Habitat Quality	Hatchling and Fish Movement	Capture Fisheries Productivity Biodiversity	Terrestrial Vegetation	Aquatic Habitat	Access to Open Water Bodies	Communication	Gender Promotion	Employment Opportunity
protection															
Post-construction Phase															
Checking the physical condition of embankment	-	-	-	-	-	-	-	-	-		-	-	-	-	-
Checking the physical condition and function of water control structures	-	-	-	-	-	HP	I	I	I	-	MP	MP	-	-	-
Checking depth and flow through the khals	HP	-	-	-	-	-	HP	I	MP	-	MP	HP	-	-	-
Checking the functions of WMOs	-	-	-	-	-	-	-	-	-		-	-	-	-	-

Note: All the IECs are example, it will be changed in different project

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 during Pre-construction Phase

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

8.4 Impact during Construction Phase

349. The implementation of the proposed works may generate some temporary impacts during the construction phase on different environmental and social resources. The descriptions of such impacts as well as their magnitudes have been shown in Table 8.3 below.

Table 8.3: Impact Assessment Matrix during Construction Phase

IESC	Location	Baseline Condition	Impact	Impact (+/-)/ Magnitude (1-10)
Water Resources				
There will be no impacts during the construction phase				
Land and Agricultural Resources				
There would be no impact during construction phase as the excavated spoil materials would be used on existing embankment and non-agricultural land.				
Fisheries Resources				
Activity: Re-excavation of khal				
1. Fish Habitat 2. Hatchling and fish movement	Gulishakhali khal, West Kalagachia khal, Gojkhali khal, Dala Chara khal, Doa Chara khal, Khekuani khal, Chuna Khali khal, Bottola Khal, Kalibari khal, Borachi khal, Motbaria khal, Debpura khal, Moradhona khal, Fakirer khal	• Most of the khals are silted up, having average depths of 0.6~1.8m, which is suitable for fish habitation. But habitat quality is degrading day by day. • More than 100 fish species (both brackish and fresh water fish) are present.	• Feeding ground of bottom dweller (e.g. eel fish, baila, crabs etc) fishes and habitat quality will be impacted temporary. But after 1 year the habitat quality will improve. • Fish production loss temporally would be about one 1 ton per year.	-2

IESC	Location	Baseline Condition	Impact	Impact (+/-)/ Magnitude (1-10)
Activity: Activity: Repairing and Construction of Drainage Sluices				
Hatchling and fish movement	• All sluices (Minor repair), except Khekuani and Kalibari sluices • Khekuani and Kalibari sluices (Major repair)	• Fish hatchling and some brackish water fish species move through the mal-function of regulator during high tide.	• Fish hatchling and fish species like *Puti, Chingri, Baila, Pairsa, Chingri, Tengra*etc movement would be obstructed.	-1
Ecological Resources				
Activity: Re-sectioning of embankment				
Terrestrialvegetation	Both sides of the embankment at re-sectioning points	• Embankment slopes possess well vegetation which are 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 tidal flooding, natural disaster and human activities	• Temporary damages of herbs, shrubs, various type of grass and bushes due to soil dumping for re- sectioning work.; • Relocation of wildlife due to habitat loss temporarily.	-2
Activity: Re-excavation of Khal				
Aquatic habitat	All the khals which are proposed to be re-excavated	• Moderate in condition • Composed of free floating plants, like Kochuripana, Kutipana, Dhol kolmi,etc which support habitat for fishes and Kingfisher, Egret, Snake, etc. • Durba Gash *(Cynodon dactylon)*, Biskantali (*Polygonum* Sp.) and different types of marginal herbs like Dholekolmi (*Ipomoea aquatic*), Kasorti (*Eclipta* Sp), etc. are	• Damages of existing aquatic vegetation would cause habitat degradation for aquatic birds (ie. Egrets) and fishes • Damages of existing bank line vegetations due to dumping of soil along both sides of the khal	-3

IESC	Location	Baseline Condition	Impact	Impact (+/-)/ Magnitude (1-10)
		dominant along the both side of the khal. • Different types of local avifauna roam here for their feeding. • Reduced water area for siltation		
Activity: Repairing of drainage sluice and outlet				
Aquatic habitat	• Kalibari Sluice, Borachi Sluice, Debpura Sluice. • East kalibari outlet a.	• Kochuripana, Kutipana, etc are most common in this vegetation type which support habitat for fishes and water depended fauna as Kingfisher, Egret, Snake, etc. • Durba Gash *(Cynodon dactylon)*, Biskantali (*Polygonum* Sp.) and different types of marginal herbs like Dholekolmi (*Ipomoea aquatic*), Kasorti (*Eclipta* Sp), etc. are dominant along the both side of the khal. • Different types of local avifauna roam here for their feeding.	• Temporary reduction of habitat quality due to obstruct khal flow and connectivity with main river.	-2
Activity: Construction of drainage outlet				
Aquatic habitat	b. Motbaria outlet	• Kochuripana, Kutipana, Dhol kolmi etc are most common in this vegetation type which support habitat for fishes and water depended fauna as Kingfisher, Egret, Snake, etc. • Bash (*Bamboosa* sp.) and various type of bushes are present along the both side of the khal.	• Bash, Shrubs, herbs and various type of grass will be permanently damaged due to construction activities. • Re- located wild life due to vegetation damage. c.	-2

IESC	Location	Baseline Condition	Impact	Impact (+/-)/ Magnitude (1-10)
Socio-economic Condition				
Activity: (i) Re-sectioning of embankment (ii) Embankment slope pitching and turfing (iii) Re-excavation Khals (iv) Repairing and construction of drainage sluices (v) Repairing and construction flushing inlets (vi) construction of temporary protection works				
Communication	Different parts of the polder i.e. Angulkata, Gulishakhali, Dalachara and Naiapara	Road networks and communication system is not good in the polder area. Local people communicate through both roadways and waterways.	Road network system may deteriorated or in same condition during construction period	-2
Gender Promotion	Periphery and inside of the polder 43/2F where different activities will be initiated.	About 52% of female are working at household level whereas few of them are working here as a day labor or earth worker	According to the project work, the LCS entail 60% male and 40% female, all of whom would be engaged from the local area. Thus, employment access to female in the construction works and during operation/ maintenance phase will be promoted significantly and they can take part in different decision making sectors.	+3
Employment Opportunity	Periphery and inside of the polder 43/2F where different activities will be initiated.	About 35% of total population is employed, 47% is engaged in household work, only one percent is looking for work and about 18% of total population is not working	A lot of local labor will be needed in earth work, re-sectioning of embankment and afforestation, soil dumping and compaction different repair works	+2

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

8.5 Post-construction Phase

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

8.5.1 Water Resources

a. Surface Water Availability

Future without Project

351. At present, people from Polder 43/2F are suffering from water availability. They cannot serve their domestic, drinking water and irrigation requirements to the desired level. If the khal proposed re-excavation works are not carried out, the polder community would suffer from further water scarcity. The top-soil erosion and other anthropogenic activities in connection with land development may cause further siltation in the khals, and the water carrying capacity might further deteriorate. Water availability would be restricted and use of water could be constrained. The study team infers that around 40% of the people in Polder 43/2F might be suffering from water scarcity if the re-excavation works are not carried out.

Future with Project

352. If the rehabilitation is implemented, additional volumes of 110,000 m^3 would be made available in the water courses of the polder. Assuming 60% flow probability on an annual average, it can be said that the percentage of population under water deficiency would be improved considerably. Still around 15% population would remain under water stress.

Impacts

353. From the spatial distribution of settlements and khals to be re-excavated, it is estimated that around 4,000 people (15%) in Kalagachia, Gulishakhali and Khekuani Mauzas would be guaranteed sufficient surface water availability, and this would result in immense benefits in water use. Domestic purposes of water would be served, and water for irrigation would also be available substantially.

b. Erosion and Accretion

Future without Project

354. There are some erosion hot spots (Angulkata, Gulishakhali, Dalachara and Naiapara) identified by the local WMGs as vulnerable areas in Polder 43/2F. However, during the RS analysis carried out by the study team, very minor erosion was found along the proposed locations in last 40 years. Still considering the tidal surge and flow phenomenon of Payra River, it is estimated that if the proposed erosion prevention measures are not carried out, a significant portion of lands might be under threat of erosion. The reduced set back distance along these locations will also harm the embankment stability, and may eventually cause damages in other sectors as well.

Future with Project

355. If the four identified hot-spots are dealt with the proposed temporary erosion prevention measures, probable erosion would temporarily be prevented. Furthermore, new areas may be accreted outside the polder, which would increase the set back distance. Placement of geo-bags would make river banks more stable and bamboo erection works would reduce pressure on the embankment. Risk of erosion would considerably decrease and a stable flood plain may be developed as well.

Impacts

356. There may not be much impact on river bank erosion due to implementation of the proposed temporary protection works, but a significant amount of lands may be accreted along the floodplain of the four proposed locations. This may eventually enhance the stability and strength of the embankment.

c. Drainage congestion and water logging

Future without Project

357. As discussed in Chapter 5, approximately 37 km water courses within the polder suffer from drainage congestion issues at the moment, with around 7.5 km length (Motbari, Bazarkhali, Solohawlabar and Purbo Kalibari khals) being affected by high drainage congestion problems on the Northern, Southern, and Eastern portion. Furthermore, almost 44 ha areas near Kolagachia, Khekuani and Purbakalibari remain water logged during post monsoon season. If the proposed re-excavation works are not carried out, 42 km khals may be affected by the issue (with 10 km high and 32 km low drainage congestion problems). Water logged areas may increase up to 55~60 ha in future.

Future with Project

358. If existing khals are re-excavated and water control structures are repaired as suggested, drainage congestion problems in most of the peripheral portion would be significantly reduced. The study infers that around 3 km khals in Bazarkhali would still be affected by low drainage congestion, and no water logging problems would exist (Map 8.1).

Impacts

359. It is estimated that around 39 km khals (42% of total) would be benefited from reduced drainage congestion. Furthermore, 55~60 ha areas in Solohawlabar, Khekuani and Purba Kalibari would be improved from water logging problems, due to the overall improvement in drainage capacity of khals.

8.5.2 Agricultural Resources

a. Cropping pattern and Intensity

Future without project

360. Presently, the cropping intensity is about 166%. Under this situation, the land type as well as land use would be degraded in absence of embankments, structures and siltation of drainage channels. Under this condition, there would be negative impact. The area

would be unfavorable for HYV crop cultivation. The cropping pattern would be changed. The cropping intensity is expected to change about 161% (Table 8.4).

Future with project

361. The implementation of the interventions would increase cropping intensity due to improvement of land type in the catchments areas of the project. The future with project condition would help to protect the area from submergence by flood water from river and would change the hydrologic regime inside the project area, which might encourage the farmers to change their cropping patterns. Most of the area directly impacted under FWIP and would be suitable for cultivation of double/triple crops. Under FWIP condition, the structures would function well and would influence to 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. After completion of the interventions, the cropping intensity is expected to increase to around 179%.

Table 8.4: Major cropping patterns under FWOP and FWIP condition in the polder area

Land type	Kharif-I (March-June)	Khartif-II(Jul-Oct)	Rabi(Nov-Feb)	FWOP		FWIP	
				Area (Ha)	% of NCA	Area (Ha)	% of NCA
Medium high land(F_1)	HYV Aus	HYV Aman	Fallow	78	3	181	7
	Fallow	Lt Aman	Khesari	440	17	259	10
	Fallow	Lt Aman	Mungbean	52	2	259	10
	Fallow	Lt Aman	Fallow	958	37	648	25
	Fallow	Lt Aman	Sesame	673	26	518	20
	Fallow	Lt Aman	Sunflower	52	2	104	4
	Fallow	Lt Aman	Groundnut	181	7	207	8
	HYV Aus	HYV Aman	Fallow	52	2	207	8
	Fallow	Lt Aman	Potato	104	4	207	8
Total				**2,590**	**100**	**2,590**	**100**
Cropping intensity (%)				**161**		**179**	

Source: CEGIS estimation based on field information; 2014

b. Crop damage/Crop production loss

Future without project

362. Presently, total crop production loss is 106 tons of which rice is 54 tons and non-rice is 52 tons due to drainage congestion/water logging etc. The situation would be aggravated under FWOP condition i.e crop damage would be increased about 10 tons over baseline situation.

Future with project

363. Crop damage would be reduced due to implementation of interventions and its proper management. Therefore, these interventions would have positive impact in reducing crop damage area as well as crop production loss. The total crop production loss would 93 tons of which 66 tons rice and 27 tons non-rice under the Future with Project condition.

Impact

364. It is expected that loss of crop production would be reduced about 93 tons (20%) of which 66 tons (94%) rice and 27 tons (67%) non-rice crops under Future with Project over Future without Project (Table 8.5).

Table 8.5: Impact on Crop production loss in the polder area

Sl No.	Crop Name	Production loss (ton)				% of Change
		Baseline	FWOP	FWIP	Impact (FWIP-FWOP)	
1	HYV Aus	31	19	31	12	64
2	HYV Aman	23	15	35	20	133
Total rice		**54**	**34**	**66**	**32**	**94**
3	Sesame	45	75	18	-57	-76
4	Sunflower	7	7	9	2	29
Total non-rice		**52**	**82**	**27**	**-55**	**-67**
Total crop production		***106***	**116**	**93**	**-23**	**-20**

Source: Field information, 2014

c. Irrigated Area

Future without project

365. Presently, irrigated area is about 135 ha. The situation would be aggravated under future without project condition i.e. irrigated area would be about 90 ha. This is happened due to siltation of existing khlas.

Future with project

366. Irrigated area would be increased due to implementation of interventions (Re-excavation of khals) and its proper management. Therefore, this intervention would have positive impact i.e. water would be preserved in to khals for supplementary irrigation under the future with project condition. It is expected that, irrigated area would be about 150 ha in future with project (Map 8.2).

Impact

367. It is expected that, irrigated area would be increased about 60 ha under future with project over future without project.

8.5.3 Fisheries Resources

a. Fish Habitat

Future without Project

368. All Internal khals of Polder 43/2F are seasonal and tidal in nature. Most of them are silted up due to top soil erosion and silt transportation through tidal action. Due to successive siltation in the internal khals, suitability for fish habitation in this water body is declining day by day. If the proposed re-excavation works are not carried out, water logging area as well as floodplain fish habitat would be increased in future. Hence, floodplain area would increased upto 60 ha while 44 ha in existing situation. As a result, the capture fish habitat would be 230 ha.

Future with Project

369. Due to re-excavation and repairing of water controls structures, the water logging area would be reduced. Floodplain (water logged area) fish habitat would be lost totally. The capture fish habitat would be 170 ha. The increased water depth as well as improved water quality would create suitability for habitation of different type of fish species. Culture fisheries practices would be increased significantly due to reduction of flood risk for repairing of water control structures. It is expected that culture fish habitat (rice cum fish culture, cultured pond) would be increased upto 15% from the base situation.

Impact

370. Floodplain (water logged area) fish habitat would be reduced by 34 ha (Map 8.3). The improved habitat quality will support different types of aquatic vegetation which would be helpful for fish feeding and habitation.

b. Hatching and Fish Movement

Future without Project

371. In Future without Project condition, hatchling and fish movement would be facilitated round the year because of mal-functioning of regulators. On the other hand, Reduction of water depth of khal due to substantially progressing siltation, more in-stream barriers like cross fish pata etc may hamper the movement of fish in the polder area vice-versa.

Future with Project

372. The movement of hatchling and brackish and fresh water fish from river to polder area would be obstructed / regulated due to repairing of sluices and drainage inlets and outlets. Movement of fresh and brackish water fish species like *Puti, Pairsa, Chingri*, and *Baila, Boal,* SIS, etc which moves on the regular basis during the high tide would be limited.

Impact

373. Hatchling movement from river to polder area through water control structures would be obstructed / regulated. Movement of some brackish water fish species include *Pairsa, Chingri*, and *Baila, Boal* etc migrates on the regular basis during high tide would be hampered.

c. Capture Fisheries productivity

Future without Project

374. Due to ongoing process of siltation in the khals would cause less suitability for fish habitation in future. It is expected that the fresh water fish species and it composition would decline from such habitat and feeding ground. Hence, capture fisheries productivity from the internal khal would be reduced about 10% from the base condition.

Future with Project

375. The capture fisheries productivity would increase due to re-excavation of khal and repairing of regulators in future with project situation. It is expected that the capture fisheries productivity from khal would be increased about 5% from the base scenario. On the other hand, improved drainage channel would reduce the flood duration in the polder area which would decrease the floodplain fish productivity.

Impact

376. It is expected that capture fisheries productivity would be increased by 5% of from the base condition due to improvement of habitat quality.

8.5.4 Ecological Resources

a. Terrestrial Vegetation

Future without Project

377. Embankment vegetation will be continuing to risk due to natural disaster and human activities. Khal bank and crop field's vegetation are also continuing to loss due to drainage congestion and water logging. For this reason local people cannot cultivate any plants at right time. Damages of vegetation are impact on dweller wildlife like local birds, mammals, reptiles etc due to habitat destruction.

Future with Project

378. Existing trend of vegetation loss due to natural disaster will be reduced for flood protection by re-sectioning of embankment. Existing khal bank side and crop field vegetation will be improved by reducing drainage congestion due to construction of water control structures (Map 8.4).

Impact

379. Embankment slopes vegetation would be increased as well as embankment cum road side social forestry would also be increased in the polder area

b. Aquatic habitat

Future without Project

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

Future with Project

381. Aquatic habitat condition is expecting to improve for increasing khal depth, controlling water passing systems. The temporary deterioration of habitat quality during construction phase will be re back within 2-5 years by regenerating all existing aquatic plants. But vegetation composition will be change due to change of khal depth and velocity. Abundance of free floating species will be low during monsoon for regular velocity and high during dry season. On the other hand there is little scope to grow rooted floating plants inside the khal for the same causes.

Impact

382. Aquatic habitat will be improved due to improvement of plant diversity as well as khal depth and velocity free floating species will be low during monsoon.

8.5.5 Socio-economic Condition

a. Access to open water bodies

Future without Project

383. Mass people are suffering from water availability concerns. They cannot serve their domestic, bathing, washing chores and irrigation requirements to the level desired due to drainage congestion and monopolization of these khals by local power elite. They often use these khals for culture fish or other purposes. In this situation, the 40%of the people in this polder might be suffering to access open water bodies if the re-excavation works are not carried out. (Map 8.5). Without project situation, salinity condition may increase and it creates more disturbances to mass people.

Future with Project

384. 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 household will have good access to water bodies and 78% will have medium access to open water bodies (Map 8.5). A few percentages (4%) will have poor access to water bodies. Moreover, this would enhance social bonding and cohesion among them.

Impact

385. The standard of life from 4,000 people (15%) at Kalagachia, Gulishakhali and Khekuani Mauzas of the polder will be benefitted since they will have access and sharing open water bodies which would ensure social use of water. Moreover, this would enhance their social bonding and cohesion in every aspects of life.

b. Communication

Future-Without-Project

386. At present, road networks at some parts of the polder i.e. Angulkata, Gulishakhali, Dalachara, Naiapara and many other places are very poor. In without project situation, communication system may deteriorate into severe condition.

Future with Project

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

Impact

388. Road communication will be improved which convey better economy by expanding business option to Patuakhali Sadar to national level.

c. Gender promotion

Future without Project

389. 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 and do not have any definite sources of income. Therefore, in without project situation they will be more vulnerable and become burden to society.

Future with Project

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

Impact

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

d. Employment opportunity

Future without Project

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

Future with Project

393. On the other hand, proposed intervention can ensure improve quality of life. More income opportunity and employment in different interventions can ensure better life and livelihood of stakeholder of the polder.

Impact

394. Creating new employment opportunities are increasing income generation of the people which ensure betterment and wellbeing that improving the standard of life. Additional income brings solvency, steady of the family.

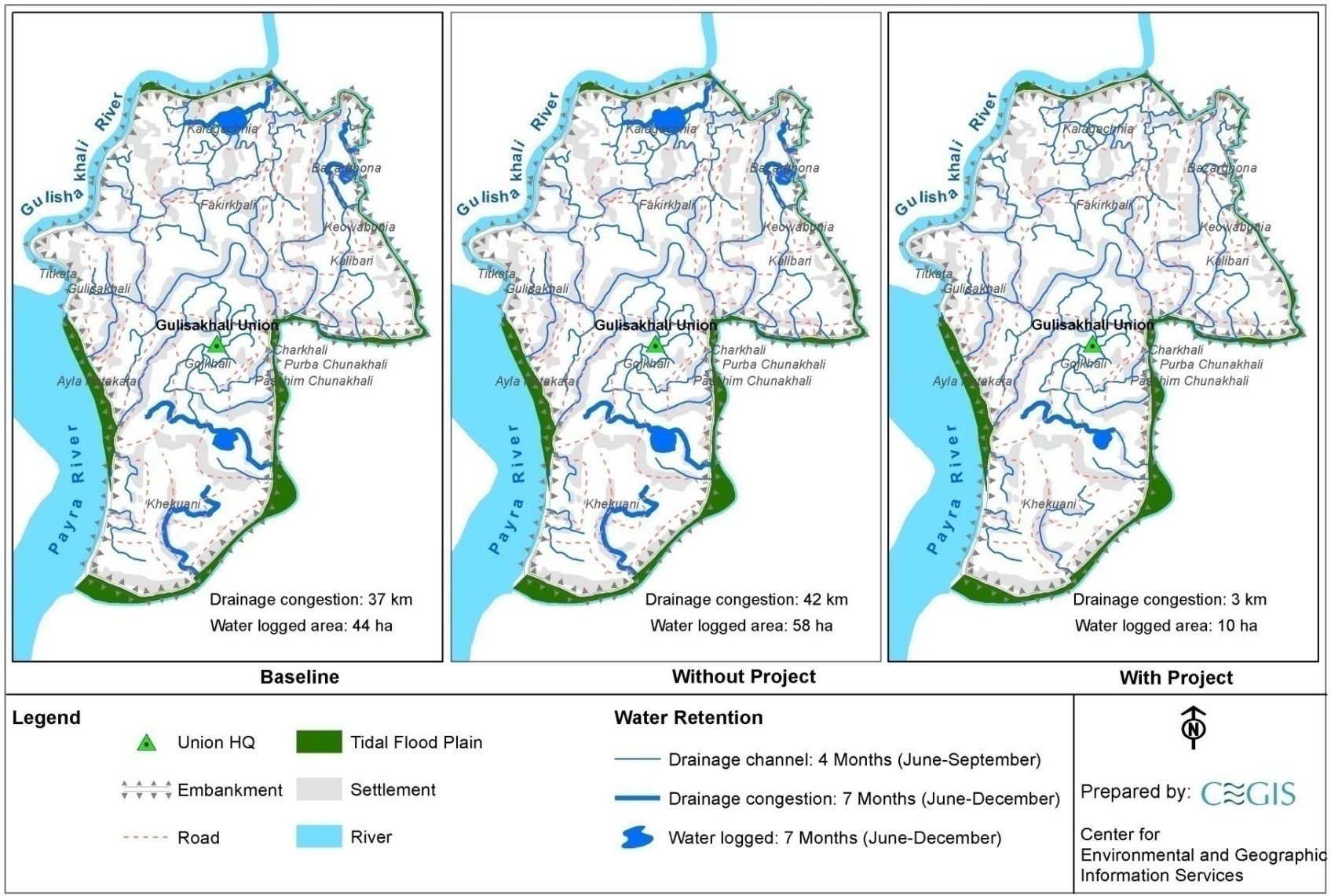
Table 8.6: Impact Assessment Matrix during Post-Construction Phase

IESC	Baseline	Future Without Project	Future Wit Project F	Impact (+/)/ Magnitude (1-10)
Water Resources				
Surface Water Availability	Around 30% people from entire polder remains in water deficit (daily consumption as low as 10 lpc)	around 40% of the people in Polder 43/2F might suffer from water scarcity	around 15% population would remain under water stress	+5
Erosion	Very minor erosion occurred at the selected locations, but substantial amount (20 ha) of accretion along the flood plain of Angulkata in last five years.	Risk of erosion remains and embankment stability might decrease	Risk of erosion would considerably decrease, whereas new lands may be accreted	+2
Drainage congestion and water logging	Approximately 37 km water courses (Motbari, Bazarkhali, Solohawlabar and Purbo Kalibari khals) suffer from drainage congestion; and almost 44 ha in Kolagachia, Khekuani and Purbakalibari suffer from water logging.	Around 42 km khals would face more drainage congestion and 55~60 ha areas may face water logging.	Around 3 km khals in Bazarkhali would suffer from drainage congestion and 10 ha lands near Khekuani would be subjected to no water logging.	+5
Agricultural Resources				
Cropping intensity	Present cropping intensity is about 166%	Cropping intensity would be about 161%	Cropping intensity would be about 179%	+2
Crop production	Total crop production is about 10,212 tons of which rice crop is about 6,162 tons and non-rice is about 4,050 tons respectively.	Total crop production would be about 9,344 tons of which rice crop would about 5,763 tons and non-rice would be about 3,581 tons respectively.	Crop production would be increased (Rice: 21% and non-rice 71%)	+4
Crop damage	Total crop damage is about 106 tons of which rice production damage is about 54 ton and non-rice production loss is about 52 tons.	Total crop damage would be about 116 tons of which rice production loss would be about 34 tons and non-rice would be about 82 tons.	Expected to crop production loss would be reduced by Rice: 94% Non-rice: 67%	+4
Irrigated area	Irrigated area is about 135 ha.	Irrigated area would be about 90 ha.	Irrigated area would be about 150 ha	+4

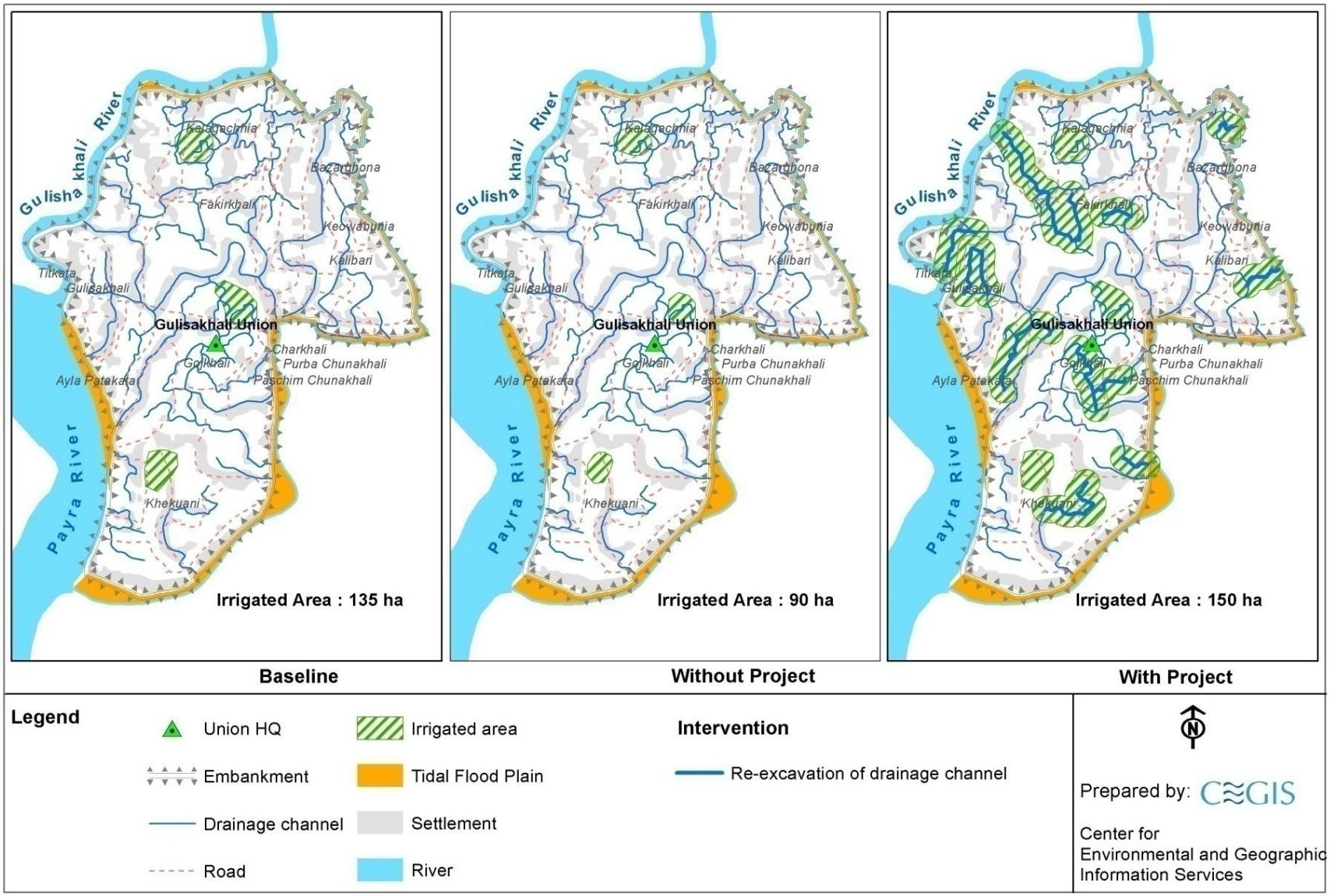
IESC	Baseline	Future Without Project	Future Wit Project F	Impact (+/)/ Magnitude (1-10)
Fisheries Resources				
Fish habitat	Habitat quality is comparatively good in the polder area. Total fish habitat is 309 ha of which capture is 214 ha and culture is 95 ha respectively.	Fish habitat would be 325 ha (Capture habitat would be increased upto 230 ha while culture habitat will remain same)	• Fish habitat would be 290 ha (Capture: 180 ha ; Culture: 110) • Habitat quality would be enhanced.	-1
Hatchling and fish movement	Hatchling and some fresh and brackish water fish species like *Puti,Pairsa, Chingri, and Baila, Boal,* SIS, etc moves through regulators on the regular basis	Same as base condition or would be limited	Hatchling movement from river to polder area through water control structures would be obstructed / regulated. Internal migration would be improved	-1
Capture fisheries productivity	Capture fisheries productivity is 165 kg/ha	Productivity would be 148 kg kg/ha	Fisheries productivity would be 173 kg/ha	+1
Ecological Resources				
Terrestrial vegetation	The biodiversity of terrestrial vegetation is moderate	Most of the terrestrial faunal species may be displaced due to vegetation damaging by existing polders problem.	Vegetation loss will be reduced along with floral species will be increased	+3
Aquatic habitat	The condition of aquatic habitat is moderate in the polder area	• Aquatic habitat quality would be deteriorating due to death of aquatic plants. • Reduced depth for continuous silation caused internal khals habitat deterioration	Improve Aquatic habitat due to improvement of plant diversity as well as khal depth and velocity	+2
Socio-economic Condition				
Access to open water bodies	People cannot use water for taking shower, washing chores and others purposes due to drainage congestion and monopolization khals by local power elite. They often use these khals for culture fish or other purposes.	Access to open water bodies might be decreased. As a result people's quality of life will be deteriorated.	Numbers of families would be benefited. They can use water in different social aspects.	+2

IESC	Baseline	Future Without Project	Future Wit Project F	Impact (+/)/ Magnitude (1-10)
Communication	Different parts of the polder i.e. Angulkata, Gulishakhali, Dalachara, Naiapara	Communication system may deteriorate into severe condition.	Road networks system will be improved which would ensure better communication facilities within the periphery of polder.	+2
Gender promotion	In the polder area only 2% percent female members are working whereas 98 male members are engaged in income generating activities.	The females are mostly vulnerable to distressed and widow who are dependent on others Therefore gender promotion will be more vulnerable and become burden to society.	The employment opportunity for women in the construction works and during operation/maintenance phase can promote them into better life and livelihood.	+3
Employment opportunity	At present, people of the polder 43/2F are living under poor economic condition and they have very few options to develop or adapt this condition.	These sufferings may be same condition or will be deteriorated in future.	Employments opportunity for different stakeholders would be created.	+2

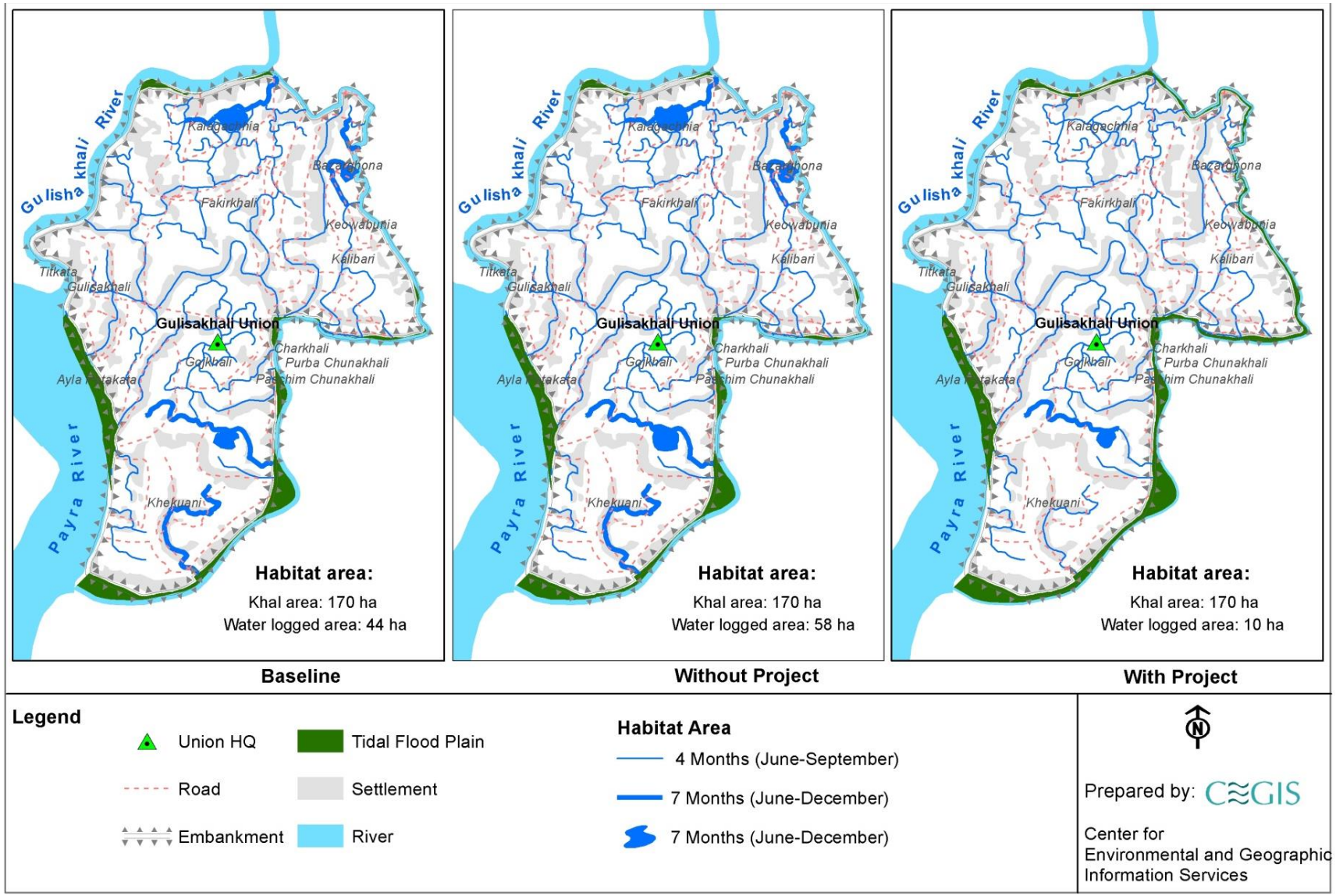
** Low impact (1-3); Medium impact (4-6); High impact (7-10)*



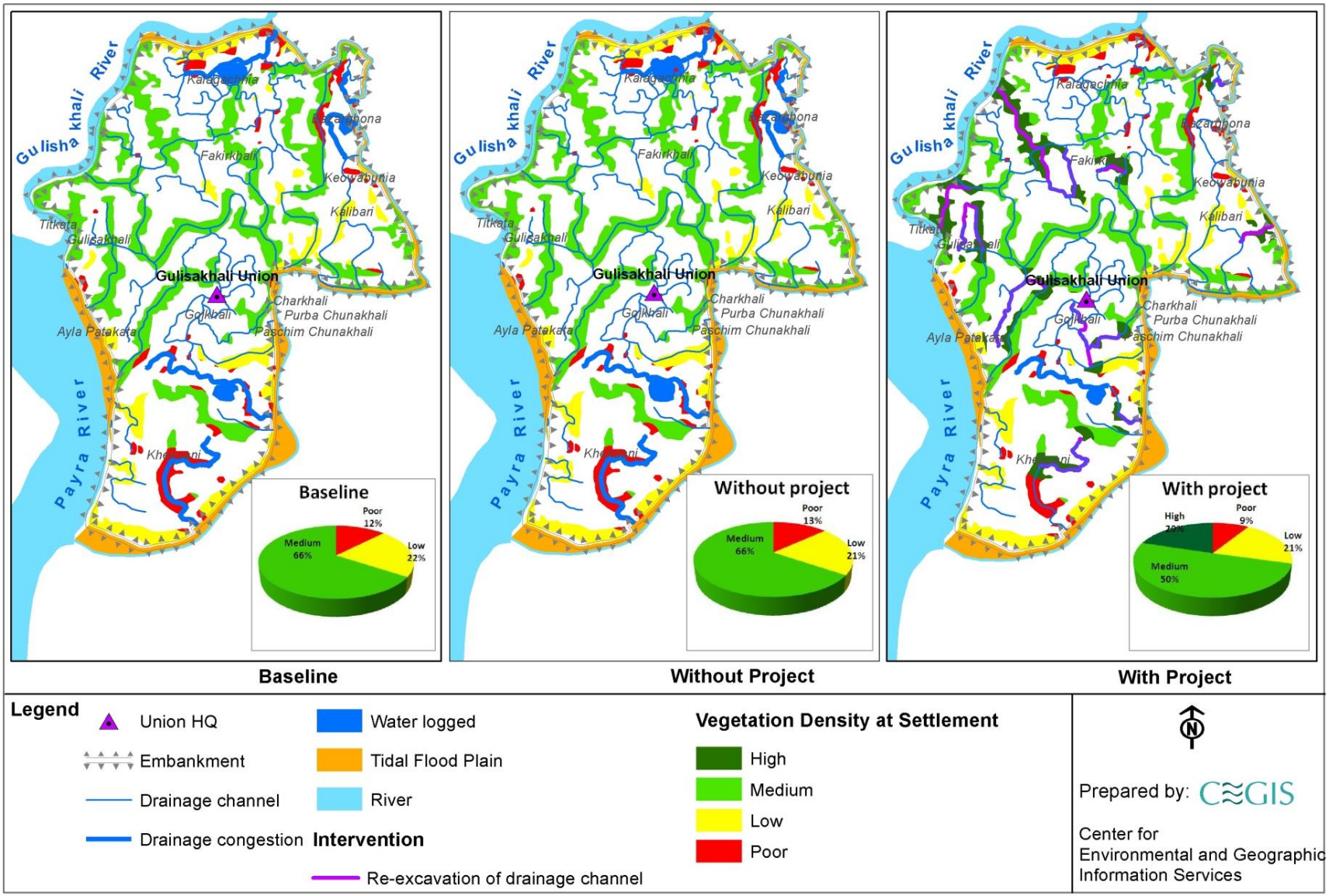
Map 8.1: Impacts on Water Resources: drainage congestion and water logging



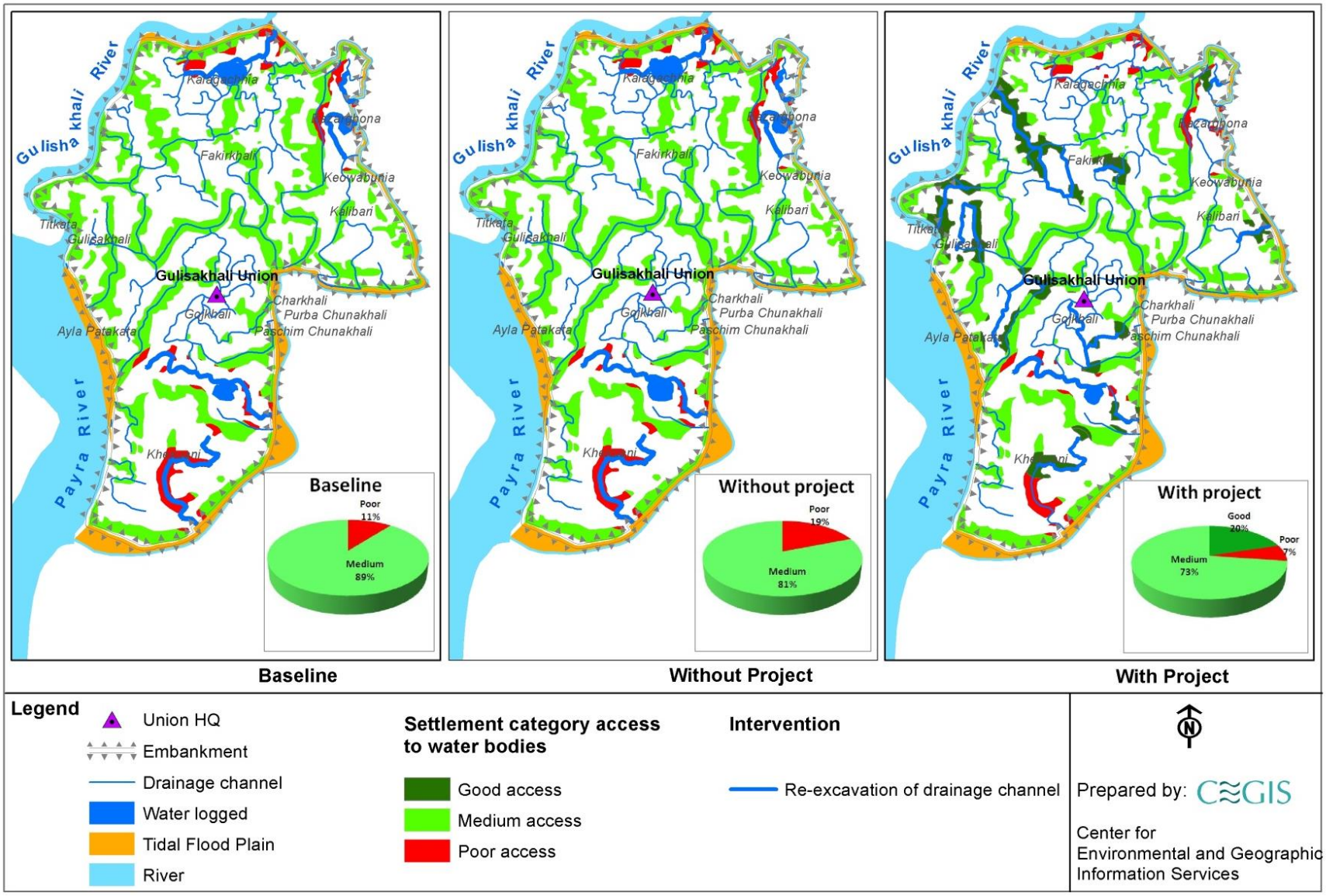
Map 8.2: Impacts on Showing Changes in Irrigated Area



Map 8.3: Impacts on Fisheries Resources showing Changes in Fish Habitat



Map 8.4: Impacts on Ecological Resources showing Changes in Habitat Condition (Terrestrial Vegetation)



Map 8.5 Impacts on Socio Economic Condition Showing Changes in Access to Open Water Bodies

9. Assessment of Cumulative, Induced and Reciprocal Impacts

9.1 General

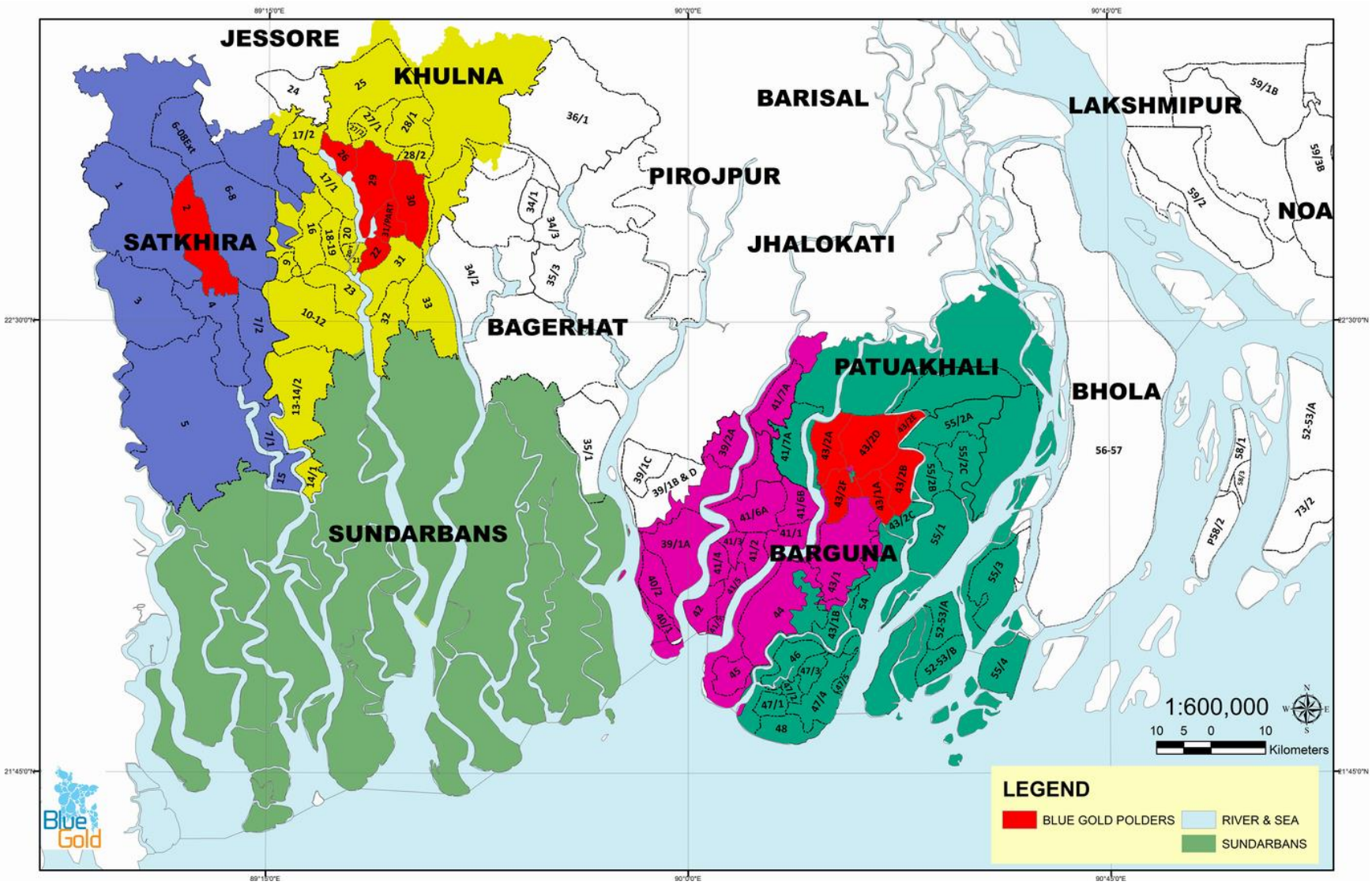
395. This Chapter attempts to analyze several indirect effects regarding the implementation of different interventions proposed under Blue Gold Program in Polder 43/2F. These effects include cumulative and induced impacts of Polder 43/2F, and the reciprocal impacts of climate change and polder. Cumulative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

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

396. 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, three polders (Polders 43/2A, 43/2D and 43/1A) are located adjacent to Polder 43/2F and therefore may generate some impacts in future. The existing crest levels of Polder 43/2A ranges from 3.2 to 4.0 m above MSL, Polder 43/2D ranges from 3.65 to 3.86 above MSL, and Polder 43/1A is around 3.30 m above MSL. Rate of river sedimentation may increase along the peripheral rivers (Gulishakhali, Kukua and Gorai) of Polder 43/2F, if embankment re-sectioning works are carried out along polders 43/2A, 43/2D and 43/1A. 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, river flow may not enter the polders, and the sediments will be confined within the Gulishakhali-Gorai-Kukua river system. With reduced river sections along these rivers, tidal flow velocity might increase, which would create more pressure at some corners of Polder 43/2F and may increase river erosion in future. Furthermore, storm surge and tidal inundation risks may be increased for Polder 43/2F. Such risks would be transferred from the adjacent polders, as storm surge and tidal water levels may not be able to overtop the adjacent polders once the peripheral crest levels have been elevated (under the Blue Gold program).

9.2.1 Synopsis of projects around Polder 43/2F

397. Apart from Blue Gold interventions, there are some other development projects nearby Polder 43/2F, 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 43/2F, 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)	Low	No ECRRP polder located adjacent to Polder 43/2D
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	
	Union Parishad Connecting Roads Improvement Project	2013-ongoing	Patuakhali	Moderate	The project has a scheme of 'construction of 300 feet paved road' in Polder 43/2F
DoF	Fisheries extension project	1994-2004	Patuakhali, Barguna	Negligible	
DPHE	Water Supply, Sanitation, Drainage and Waste Disposal Project	1996-2007	Noakhali, Feni, Lakshmipur, Patuakhali and Barguna districts	Negligible	
DAE	Small Holder Support Project	1999-2005	Barisal, Patuakhali, Jhalokati, Barguna	Negligible	

398. 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 43/2F are briefly discussed in the following sections.

9.2.2 Cumulative Impacts of proposed Ganges Barrage

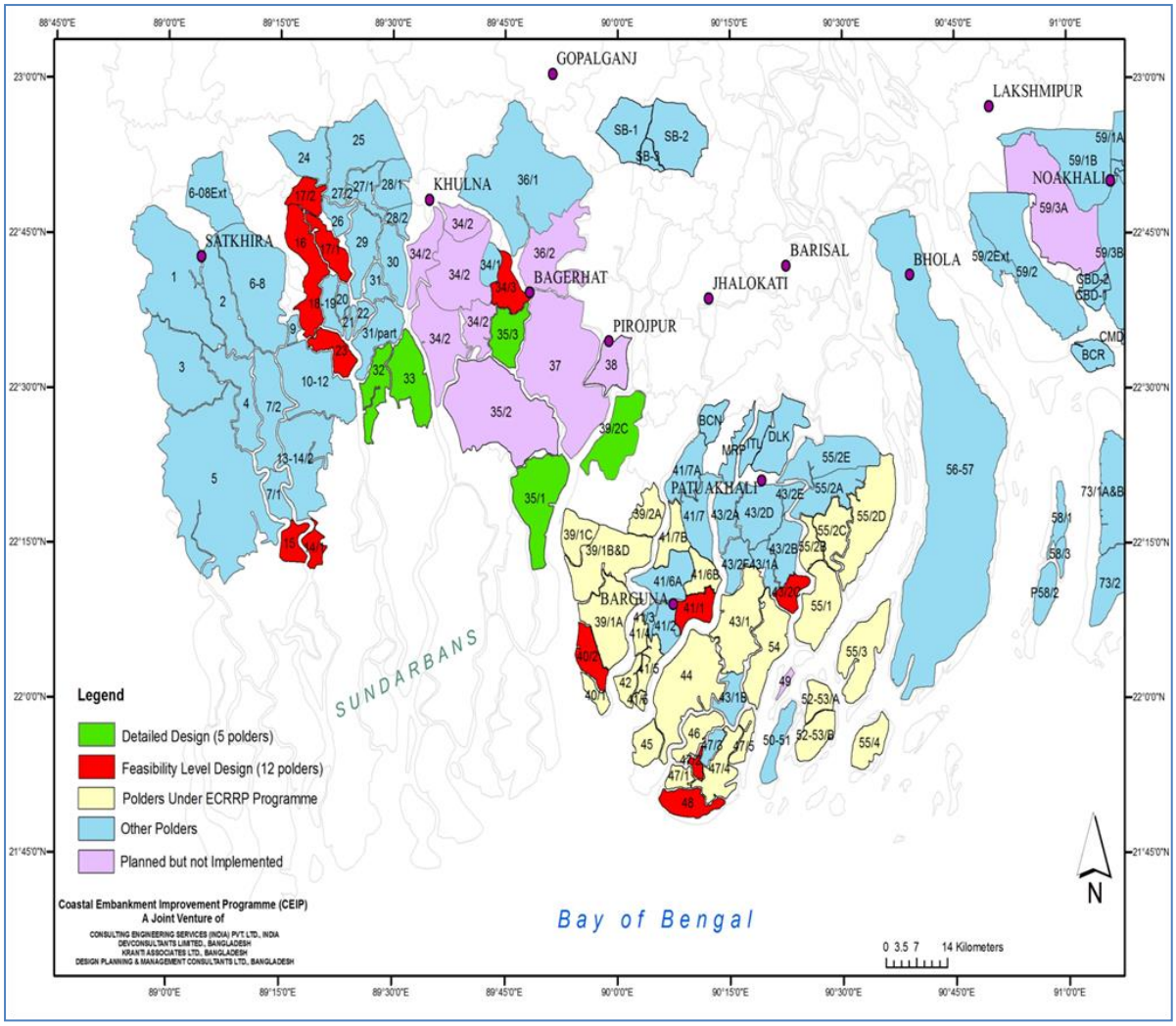
399. Ganges Barrage Project is perhaps the most significant project for the coastal region of Bangladesh. The project is expected to manage the water resources system, promoting socio-economic development in equitable fashion, and to recover the existing environmental degradation. GoB already finalized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

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

401. Polder 43/2F is located within the GDA, and bears significant sensitivity towards the proposed Ganges Barrage. The most significant positive impact of the barrage on Polder 43/2F would be the reduction of surface water salinity in its adjoining river system. At present, the peripheral Payra, Gulishakhali and Gorai-Kukua rivers carry low salinity concentrations during dry season, which hampers the agricultural water use during the period. The proposed Ganges Barrage will benefit dry season water use; enhancing surface water irrigation practices within the polder. This would eventually enhance production and food security of the area. Several saltwater species may face extinction in the long run, creating scopes for new ecological diversities of freshwater tolerant species. On a social context, the effects may be significant as the rural livelihood would shift towards enhanced farming practices. More regional and local developments are expected, and the environment surrounding the polder would be benefited as a whole.

9.2.3 Cumulative Impacts of Coastal Embankment Improvement Project (CEIP)

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



Map 9.2: Location of CEIP polders

403. Polder 41/1 is located along the Payra River, within 2 km distance downstream of Polder 43/2F. The existing crest levels of the polder ranges from 3.8 to 4.55 m above MSL. Re-sectioning works are proposed in the polder 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 43/2F. As such, the risk of storm surge inundation may increase in Polder 43/2F. Furthermore, tidal sedimentation may increase outside Polder 41/1, along Payra River, which may increase flow velocity towards the upstream location during high tide. This may create pressure on the Eastern portion of Polder 43/2F, which may result in river erosion incidents in future.

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

404. 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 and 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 41/6B, 43/1, 44, and 45 are located near Polder 43/2F, along the downstream of Payra River (Map 9.2). The design crest levels of these polders are: 4.57 m above MSL for Polder 41/6B, 4.57 m to 5.18 above MSL for Polder 43/1, 4.88 m to 5.18 m above MSL for Polder 44, and 5.18 m to 5.79 m above MSL for Polder 45. All these polders will tend to divert the flow of Payra 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 Payra River in future. Due to the reduced depth, river erosion probabilities in Polder 43/2F may increase. Furthermore, the rise of crest level in Polder 43/1 may increase siltation along the Gorai-Kukua River, which may impact the surface water drainage characteristics of Polder 43/2F.

9.2.5 Cumulative Impacts of Other Projects

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

Water Management Improvement Project (WMIP)

406. 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 43/2F 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 43/2F. 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)

407. Considering Bangladesh's vulnerability to climate change, GoB decided to finance climate change adaptation initiatives from its own revenue budget as Climate Change Trust Fund (CCTF), for implementing more projects on climate change adaptation and mitigation. Up until now feasibility level investigations have been completed for a total number of 30 projects of BWDB, some of which are being implemented throughout the country. The second phase of CCTF is in the pipeline for implementation, with a number of newly proposed projects. Among all the CCTF projects, the geographic extent of one scheme (Re-excavation of Khals in Kalapara and Rangabali Upazila in Patuakhali District for Retention of Rain water to increase Agricultural Production and Removal of drainage Congestion) lies within the vicinity of Polder 43/2F. The interventions proposed under the project are localized within the polder, and will not have any large scale

impacts on Polder 43/2F. However, there may still be some social impacts regarding labor harnessing, employment opportunities etc.

Capital Dredging of River system

408. 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 43/2F. 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 43/2F may slightly be benefited. In future, if more similar dredging works are initiated nearby, Polder 43/2F may be further benefited.

9.3 Induced Impacts of Polder 43/2F

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

410. The proposed interventions in Polder 43/2F will safeguard the polder against direct intrusion of tidal water. Therefore, water from Payra, Gulishakhali and Gorai rivers 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 Payra River.

Tidal and Storm Surge Flooding

411. Polders 41/7, 41/6B, 41/1, 43/1A and 43/1 are located around to Polder 43/2F. As per design, the crest level of Polder 43/2F would be raised up to 4.27 m above MSL, which may impose tidal and storm surge inundation risks to the adjacent polders (Polders 41/7, 41/6B, 41/1, 43/1A and 43/1) during extreme events. Tidal water may not be able to enter Polder 43/2F during such events, and will be diverted elsewhere. This may increase the risk of flooding in the aforementioned nearby polders. **Table 9.2** shows the average existing crest levels in Polders 41/7, 41/6B, 41/1, 43/1A and 43/1.

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

Polder	Existing crest level (m +PWD)
Polder 41/7	3.3~3.5
Polder 41/6B	3.8~4.0
Polder 41/1	3.8~4.5
Polder 43/1A	3.3
Polder 43/1	3.5~4.1

Affect on water quality

412. The interventions in Polder 43/2F 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 Payra, Gulishakhali and Gorai Rivers. 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

413. 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 Payra-Gulishakhali-Gorai River system.

Employment opportunities and Livelihood improvement

414. 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 43/2F, 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

415. 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 43/2F 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

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

417. 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 isbased on 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)

418. 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

419. 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

420. 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

421. 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

422. 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

423. 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

424. 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^{th}percentile values of 16 GCM ensembles for climate change scenario A1B has been considered. Climate change data for the polder has been selected using the nearest grid point method and summarized in Table 9.3. The results infer that monthly rainfall values may increase from April to October and decrease from November to March. Around 20% of the monthly rainfall will be decreased by 2050s for December and January, though the amount is very low during that period. Monthly rainfall will increase by 1.5 - 3.5 % during July and September by 2050s. Monthly temperature values will increase by 1.6^0C to 2.0^0C with an average rise of 1.8^0C by 2050s in the polder area.

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

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

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

Source: Climate Wizard, Washington University

Sea Level Rise

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

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

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

Source: IPCC AR4, 2007

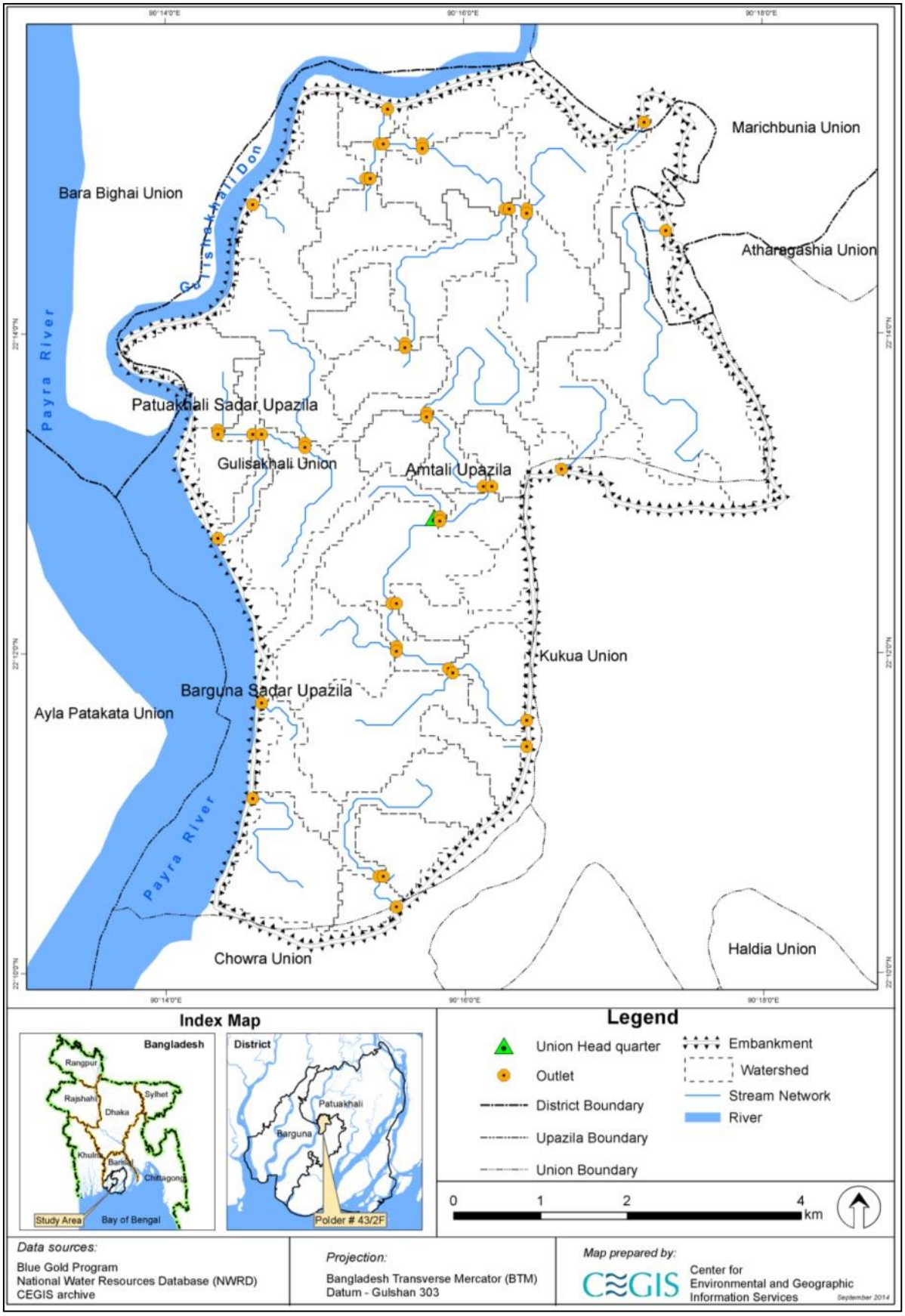
9.4.2 Model Schematization

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

SWAT model Setup

427. Five sequential steps were followed to schematize the SWAT model: watershed delineation, Hydrological Response Unit (HRU) definition, weather data definition, assembling and editing SWAT inputs, and the actual simulation run. The watershed delineation was performed with the automatic delineation tool of SWAT 2012 using the DEM and the river network. All the watershed delineation steps such as filling sink,

defining flow direction and accumulation have been done automatically through the user interface. The watershed delineation results 43 watersheds for the entire polder area. The delineated watershed for polder 43/2F is shown in Map 9.3. Afterwards, 280 numbers of HRUs were generated with four land classes, four soil classes and 43 watersheds.

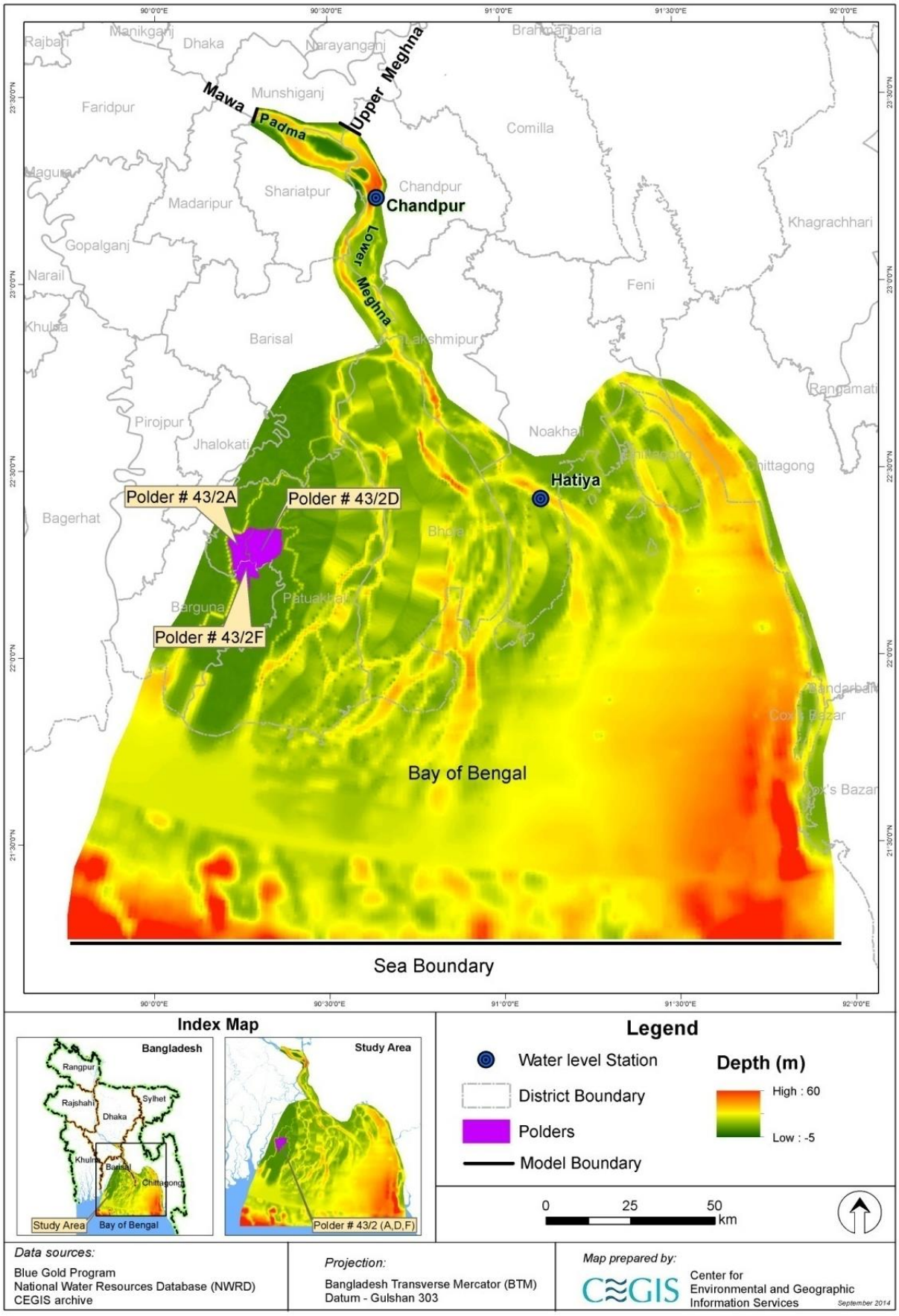


Map 9.3: Delineated watershed during model schematization using SWAT for Polder 43/2F

9.4.3 Delft 3D model Setup and Calibration

428. A 2-D hydrodynamic model was setup for the Padma and Lower Meghna river system using the Delft 3D modeling tool. The schematization of the model is shown in Map 9.4. The model starts from the Padma River to the Bay of Bangal. The bathymetry of the river has been generated from the interpolation of available cross-sections at a distance of 100 m using the HEC-RAS model. Daily discharge data of BWDB at Mawa has been utilized as upstream flow boundary and astronomical constituent values has been used to generate the tidal boundary at the sea and utilized as downstream boundary condition of the model. The model has been simulated with a time step of 5 min for the year 2000. It has been simulated for water level, discharge and salinity.

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



Map 9.4: Schematization of hydrodynamic model using Delft 3D

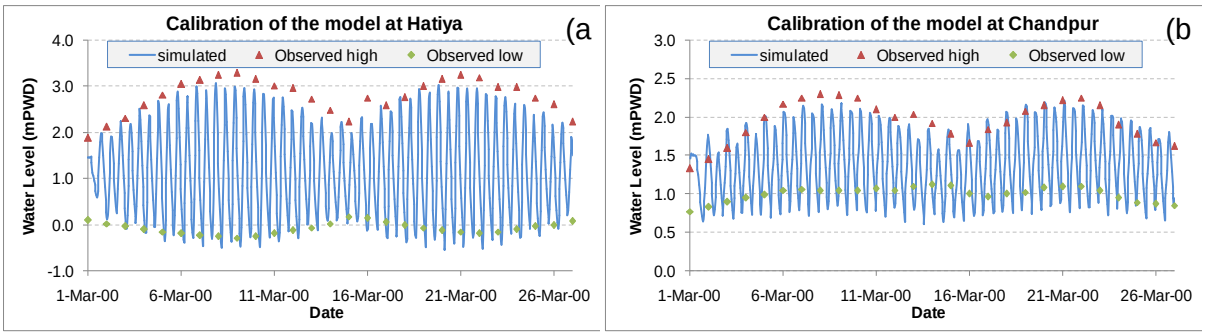
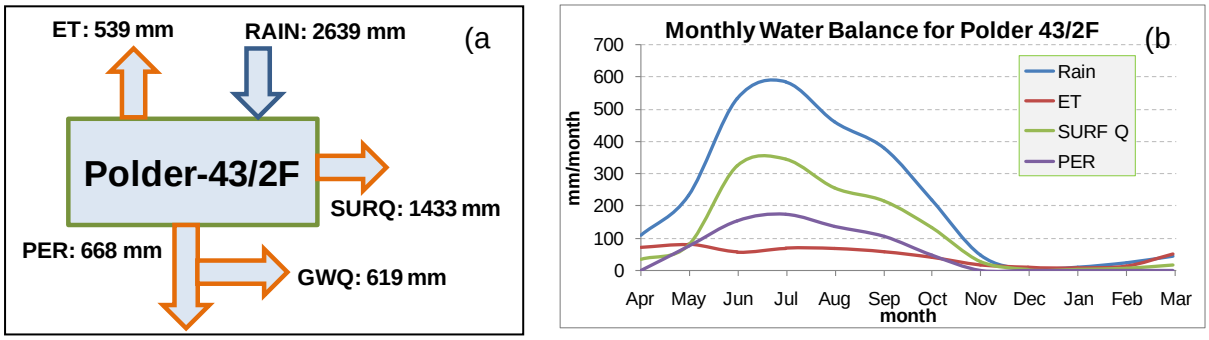


Figure 9.1: Calibration of model results at (a) Hatiya and (b) Chandpur for March, 2000

Water Balance of the Study Area

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



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

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

431. 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.

432. 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 539 mm which is 20% of the annual rainfall. The maximum evapotranspiration is during April and May and which is about 80 mm per month. The minimum evapotranspiration rate is during December to January. The percolation rate for the polder area is 668 mm per year which is 25% of the annual rainfall. The percolation rate follows similar trend like rainfall and the maximum rate is 180 mm per month. After the losses of water through evapotranspiration and percolation, the remaining water contributes to stream flow as overland flow and lateral (subsurface) flow. About 54% (1433 mm) of rainfall contributes to stream flow through surface runoff while the lateral flow is negligible.

9.4.4 Climate Change Impact on Water Availability

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

434. The climate change impact on annual water balance for the Polder 43/2F is given in **Table 9.5** for climate change scenario A1B by 2050s.The annual average rainfall for the polder area will be 2,694 mm which is about 2% more than the base condition. The surface runoff also increases as there is an increase in annual rainfall. There is a little increase in annual evapotranpiration (6 mm/year) which is mainly due to the increase of temperature. There is no change in annual percolation due to climate change.

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

Climate parameter	Amount (mm)	
	During base (1981-2012)	CC_2050s
Rainfall	2639	2694
Surface Runoff	1433	1481
Evapotranspiration	539	545
Percolation	668	668
Baseflow	619	619

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

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

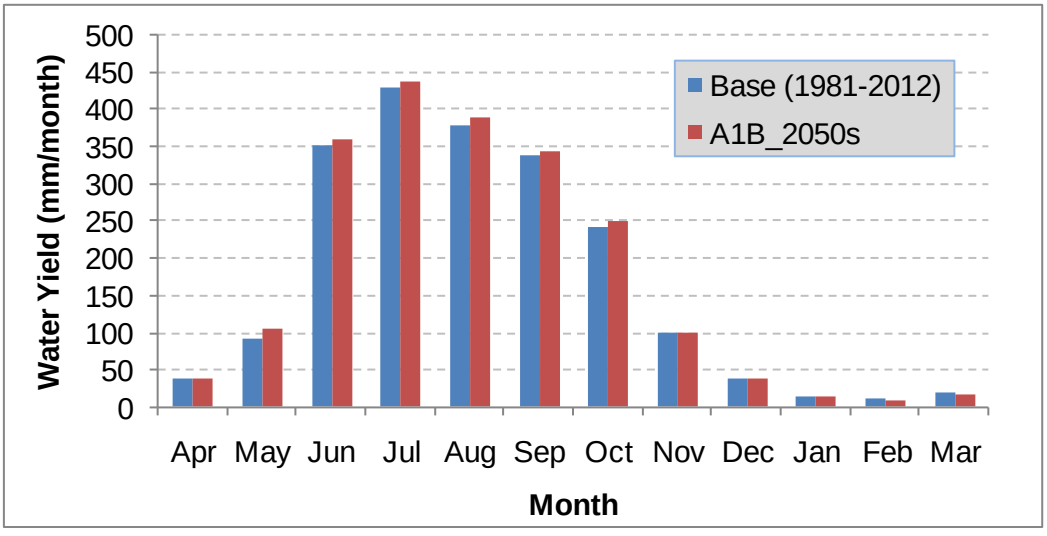


Figure 9.3: Climate change impact on monthly water yield for climate scenario A1B by 2050s

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

monsoon (2.1 %) and decrease in dry seasonal water yield (7.2%). Minor seasonal water yields during pre-monsoon and monsoon would also occur.

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

Season	Water Yield during base (mm)	Change in water yield due to CC (%)
Pre-monsoon (Mar-May)	128	12.2
Monsoon (Jun-Sep)	1501	2.1
Post-monsoon (Oct-Nov)	342	1.8
Dry (Dec-Mar)	81	-7.2

9.4.5 Climate Change Impact on Water Level

438. The sea level supposed to be increased due to the climate change by 2050s. Sea level rise during the 21st century is projected to have substantial geographical variability. The patterns from different models are not generally similar in detail, but have some common features, including smaller than average sea level rise in the Southern Ocean, larger than average in the Arctic, and a narrow band of pronounced sea level rise stretching across the southern Atlantic and Indian Oceans. The rise in sea water level will affect the increase of the river water level outside of the polder area. In Bangladesh, the impact of sea-level rise may be worsened by other effects of global warming, such as variable precipitation, more frequent droughts and floods, and shrinking of the glaciers that supply water to the rivers of the delta. The rainfall during the monsoon will be increased due to climate change which will result the increase in extreme flow during monsoon which ultimately result the increase in flood water level. Recently CEGIS conducted a study on climate change impact on stream flow for the GBM basins and found that the dry season flow will be reduced and monsoon flow will increase. For climate change scenario A1B, there is a 5% reduction of dry season flow and 15% increase of monsoon flow for the combined flow of the Brahmaputra and Ganges basin. For the Meghna basin, the increase of monsoon flow is about 10% due to climate change by 2050s.

439. The calibrated and validated Delft 3D model for the Padma-Meghna system has been utilized to investigate the impact of sea level rise and increase of upstream water flow to assess the impact on flood water level outside the polder area. As there is a variability of prediction of sea level rise, an increase of 0.5 m of sea level has been assumed for the present study. At the same time, 15 and 10% increase of monsoon flow for the Padma and Meghna River has been assumed respectively for the model setup. The model has been simulated for the combination of above two scenarios and the simulated maximum water level during the monsoon has been compared with the base year (2000) to assess the impact of climate change and sea level rise on flood level.

440. From the model simulation, it has been found that the flood level adjacent to the polder area will increase by 50 cm due to only the increase of sea level. The effect of change in upstream water flow is insignificant for the polder area. The combined effect of sea level rise and increase of upstream water results an increase of 50 cm increase of maximum water level of the rivers surrounding Polder 43/2F. The increase in flood water level might be a threat for the embankment and it also interrupt the drainage from the inside polder area. The climate change and sea level rise may increase the drainage congestion and flood risk for the polder.

9.4.6 Climate Change Impact on Salinity

441. 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.

442. 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 43/2F will increase by 1.7 ppt during the dry period. The increase in river salinity may cause the increase in groundwater salinity which will intensify the scarcity of drinking water and irrigation water for the polder area.

9.4.7 Climate Change Resilience Developed in Polder 43/2F

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

10. Environmental Management Plan

444. The Environmental Management Plan for the pre-construction, construction and post-construction phases against the impacts on different IESCs pertaining to water resources, land and agriculture resources, fisheries resources, ecological resources and socio-economic conditions in the pre-construction, construction and post-construction phases together with a necessary monitoring program are presented in matrix form below.

10.1 Water Resources

10.1.1 Pre-Construction Phase

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

10.1.2 Construction Phase

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

10.1.3 Post-Construction Phase

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

Table 10.1: EMP Matrix for Post-construction phase on water resources sector

Impact	Mitigation Measure	Enhancement/Contingency/Compensation	Residual Impact (+/-)/ Magnitude (1-10) With EMP	Responsible Agency
IESC: Surface Water Availability				
Around 4,000 people (15% of total) in Kalagachia, Gulishakhali and Khekuani Mauzas would be benefited with sufficient surface water availability	Not required	Not required	-	-
IESC: Erosion and Accretion				
There may not be much impact on erosion due to the proposed temporary protection works at Angulkata, Gulishakhali, Dalachara and Naiapara; but	Not required	Not required	-	-

Impact	Mitigation Measure	Enhancement/Contingency/Compensation	Residual Impact (+/-)/ Magnitude (1-10) With EMP	Responsible Agency
a minor amount of lands may be accreted along the intertidal setback area of the aforementioned locations.				
IESC: Drainage Congestion and Water Logging				
Around 39 km khals (near Motbari, Solohawlabar and Purbo Kalibari) would be benefited from drainage congestion and 55~60 ha areas near Solohawlabar, Purba Kalibari and Khekuani would be improved from water logging	Not required	Not required	-	-

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

10.2 Land Resources

10.2.1 Pre-Construction Phase

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

10.2.2 Construction Phase

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

10.2.3 Post-Construction Phase

450. The implementation of 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, enhancement, compensation, or contingency measures as discussed in the following Table 10.2

Table 10.2: EMP Matrix for Post-construction phase on land resources

Impact	Mitigation Measure	Enhancement/ \Contingency/ Compensation	Residual Impact (+/-)/ Magnitude (1-10) with EMP	Responsible Agency
The intervention would change the hydrologic regime of the project in	-	• Formation of WMGs/WMA/WMF strengthening through imparting training need to be done. Involvement of WMGs in polder activities (maintenance of	+3	Contractors, BWDB and WMGs/WMA/WMF

Impact	Mitigation Measure	Enhancement/ \Contingency/ Compensation	Residual Impact (+/-)/ Magnitude (1-10) with EMP	Responsible Agency
FWIP. The entire project area would be benefited		embankment, functioning of regulators, etc) would improve the climate change induced impact. • Crop rotation with leguminous crops, application of more organic materials/ organic manure and soil management should be practiced to improve soil fertility in the polder area. • Crop diversification with multiple-crops might improve environmental condition of the soil.		

**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 Phase

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

10.3.2 Construction Phase

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

10.3.3 Post-Construction Phase

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

Table 10.3: EMP Matrix for Post-construction phase on agricultural resources

Impact	Mitigation Measure	Enhancement/ Contingency/Compensation	Residual Impact (+/-)/ Magnitude (1-10) with EMP	Responsible Agency
Cropping intensity would be increased about 18% in	-	• Involvement of WMGs/WMA/WMF in polder activities would enhance cropping pattern and intensity. • Introduction of HYV/Hybrid crops cultivars along with crop	+3	BWDB, DAE, BADC and WMGs/WMA/WMF

Impact	Mitigation Measure	Enhancement/ Contingency/Compensation	Residual Impact (+/-)/ Magnitude (1-10) with EMP	Responsible Agency
FWIP over FWOP.		diversification need to be practiced.		
It is expected that crop production would increase by rice 21% and non-rice 71% in FWIP over FWOP.	-	• Organic manure should be applied for the restoration of soil fertility. • Farmers group should have close contact with DAE for adaptation of various measures on IPM/ICM. • Irrigation should be provided in optimum level with minimum conveyance loss from Khals. • Involvement of WMGs/WMA/WMF in polder activities would enhance crop production. • Introduction of HYV/Hybrid crops cultivars along with crop diversification need to be practiced.	+5	BWDB, DAE, BADC and WMGs/WMA/WMF
It is expected that crop production loss would decrease as follows: Rice 94% Non-rice: 67% in FWIP over FWOP.	-	• The constructing materials like sand, cement, concrete, block, etc. should be placed in non-agricultural land. • The WMGs/ WMA/ WMF should be involved in the construction and post construction phase which might reduce crop damage. • WMGs/WMA/WMF should be given orientation to protect their standing crops from implementation of the intervention and development on farm water management etc.	+5	BWDB, DAE, BADC and WMGs/WMA/WMF
It is expected that irrigated area would be expanded about 60 ha in FWIP over FWOP.	-	• Training of "Integrated water management" and "on farm development" of WMGs would help to increase the expansion of irrigated area • The WMGs/WMAs/ WMFs should be involved in the integrated water management through proper maintenance of regulators (sluice gate, inlets and outlets) for the expansion of irrigated area. • The irrigation water should be used at optimum level so that the area might be increased with limited scale of water.	+5	BWDB, DAE, BADC and WMGs/WMA/WMF

**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

454. No significant positive or negative impacts on fisheries resources have been foreseen during the pre-construction phase for the implementation of proposed

interventions in Polder 43/2F. As such, no activities under the proposed EMP have been recommended in this phase.

10.4.2 Construction Phase

455. The implementation of proposed interventions may generate some temporary impacts on fisheries resources, as discussed in Chapter 8. Some of the impacts would require different levels of mitigation, enhancement, compensation, or contingency measures as shown in following Table10.4

Table 10.4: EMP Matrix for Construction phase on fisheries resources

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

Post-Construction Phase

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

Table10.5: EMP Matrix for Post-construction phase on fisheries resources

Impact	Mitigation Measures	Enhancement/ Compensation / Contingency	Residual Impact (+/-) Magnitude (1-10) with EMP	Responsible Agency
Floodplain fish habitat would be reduced by 34 ha. Hence capture fish habitat would be 180 ha. Habitat quality would be enhanced.	• Practice rice-cum fish culture in the polder area • Encourage improved fish culture	-	-	DoF, WMC
Hatchling movement from river to polder area through water control structures would be obstructed / regulated. Movement of some brackish water fish species include *Pairsa, Chingri, and Baila, Boal* etc migrates on the regular basis during high tide would be hampered.	• Properly and timely gate will be open to entrance the fish hatchling in the month of May to July except the tidal surge. • Water Management Committee should be formed including fishers representative.	-	-	DoF, WMC
Capture fisheries productivity would be increased up 173 kg/ha	Not required	Not required	-	-

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

10.5 Ecological Resources

10.5.1 Pre-Construction Phase

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

10.5.2 Construction Phase

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

Table 10.6: EMP Matrix for Construction phase on ecological resources

Impact	Mitigation Measure	Enhancement/ Contingency/ compensation	Residual Impact (+/-)/ Magnitude (1-10) with EMP	Responsible agency
Temporary damages of herbs, shrubs, various type of grass and bushes due to soil dumping for re-sectioning work.; Relocation of wildlife due to habitat loss temporarily	Implement plantation along the slopes of embankment after completing the earth works; Do not run construction activities at early morning and night to avoid disturbance to wild fauna;	N/A	-1	Contractor and BWDB
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 untouched the deepest points of the khal as much as possible; The works should be completed in scheduled time to minimize habitat disturbance to wildlife	N/A	-2	Contractor and BWDB
Temporary reduction of habitat quality due to obstruct khal flow and connectivity with main river.	The works should be completed in scheduled time	N/A	-2	Contractor and BWDB
Bash, Shrubs, herbs and various type of grass will be permanently damaged due to construction activities. Re- location wild life due to vegetation damage.	Minimize vegetation loss as much as possible. Do not use vegetative area as stockyard for dumping construction material.	N/A	-1	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 Post-Construction Phase

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

Table 10.7: EMP Matrix for Post-construction phase on ecological resources

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

** 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

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

10.6.2 Construction Phase

461. The implementation of proposed interventions may generate some temporary impacts on socio-economic condition, as discussed in Chapter 8. Some of the impacts would require different levels of mitigation, enhancement, compensation or contingency measures as shown in following Table 10.8

Table 10.8: EMP Matrix for Construction phase on socio-economic condition

Impact	Mitigation Measure	Enhancement/ Contingency/ Compensation	Residual Impact (+/-)/ Magnitude (1-10) With EMP	Responsible Agency
Communication	-	- Action should be taken to improve road network within the polder - During construction works, ensure employment for local people for both technical and non-technical works. If possible, maximum labor should be recruited from locally.	+2	Blue gold and BWDB
Gender promotion	-	- According to the project work, the LCS entail 60% male and 40% female, all of them would be engaged from the local area. Thus, ensure more gender promotion activities for female in future.	+3	Blue gold and BWDB

Impact	Mitigation Measure	Enhancement/ Contingency/ Compensation	Residual Impact (+/-)/ Magnitude (1-10) With EMP	Responsible Agency
Employment opportunities	-	- Local labor should be recruited for the construction work of the project area.	+3	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 Post-Construction Phase

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

Table 10.9: EMP Matrix for Post-construction phase on socio-economic condition

Impact	Mitigation Measure	Enhancement/ Contingency/ Compensation	Residual Impact (+/-)/ Magnitude (1-10) With EMP	Responsible Agency
Access to open water bodies	-	- Concentration should have to pay to re-excavate rest of Khals for ensuring equity and share of open water bodies.	+4	Blue gold and BWDB
Communication - About 4,000 people will be benefited from current intervention i.e. they can use sweet water in different social sectors.	-	- Existing rural road is required to repair and carpeting properly at every locations of damaged road networks.	+3	Blue gold and BWDB
Gender promotion	-	- At least 40% of total labor will be recruited for these interventions work and ensure more gender promotion in different sectors of present interventions of the polder.	+3	Blue gold and BWDB
Employment opportunities	-	- 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)

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

10.7.1 Framework Proposed for SMP

464. Polder 43/2F of Blue Gold program entails excavation of a number of khals which would generate a volume of around 78,790 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 dumping process. The public consultation meetings of the EIA study inferred that the local people are willing to collect the excavated spoil earth for their own household uses. Figure 10.1 provides a framework which includes the major components of the proposed Spoil Management Plan for rehabilitation of Polder 43/2F under Blue Gold Program. The framework entails six basic steps for excavation, collection, use, transportation, dumping and compaction of earth materials in connection with the proposed khal re-excavation works.

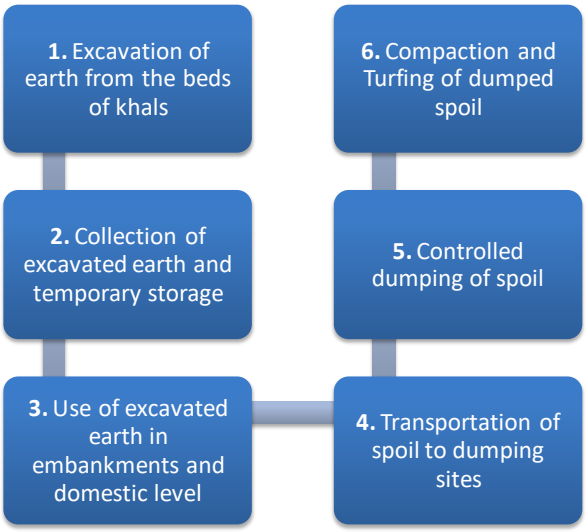


Figure 10.1: Framework for Spoil Management Plan

465. 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 42,790 m^3 (55%) of excavated spoil earth can be used in embankment re-sectioning works as well as other multifaceted uses. Local people can collect a portion of the excavated spoil, and use it to fulfill their domestic requirements. The spoil may be used for raising the plinth level of their earthen kacha houses as well as individual house yards. Spoil may also be collected and used on community basis to strengthen the basements and earthen portions of other rural sheds and shelters such as mosques, community clinics etc. The residual portion (around 36 thousand m^3) of spoil may then be disposed on both in a controlled manner.

Table 10.10: Tentative volume calculation and distribution of excavated spoil

Khals to be Excavated	Volume (m^3)	Uses of Excavated Soil	Volume (m^3)
Mothbari Khal	12,511	Embankment re-sectioning and other Societal uses	42,790
Debpur Khal	1,229		

Khals to be Excavated	Volume (m^3)	Uses of Excavated Soil	Volume (m^3)
Debpur Branch Khal	3,674	(uses in household, mosques, clinics or other shelters requiring earth materials)	
Chunakhali Khal	7,750		
Borachi Khal	8,253		
West Kolagachia Khal	17,444		
Doachara	3,653		
Bottola Khal	2,783		
Baanno Kura Khal	6,081		
Khekuani Khal	1,583		
Dalachara Branch Khal	8,909		
Gulishakhali Khal	4,920	Dumping	36,000
Total Excavation	**78,790**	**Total Use**	**78,790**

10.7.2 Phase wise activities of Spoil Management

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

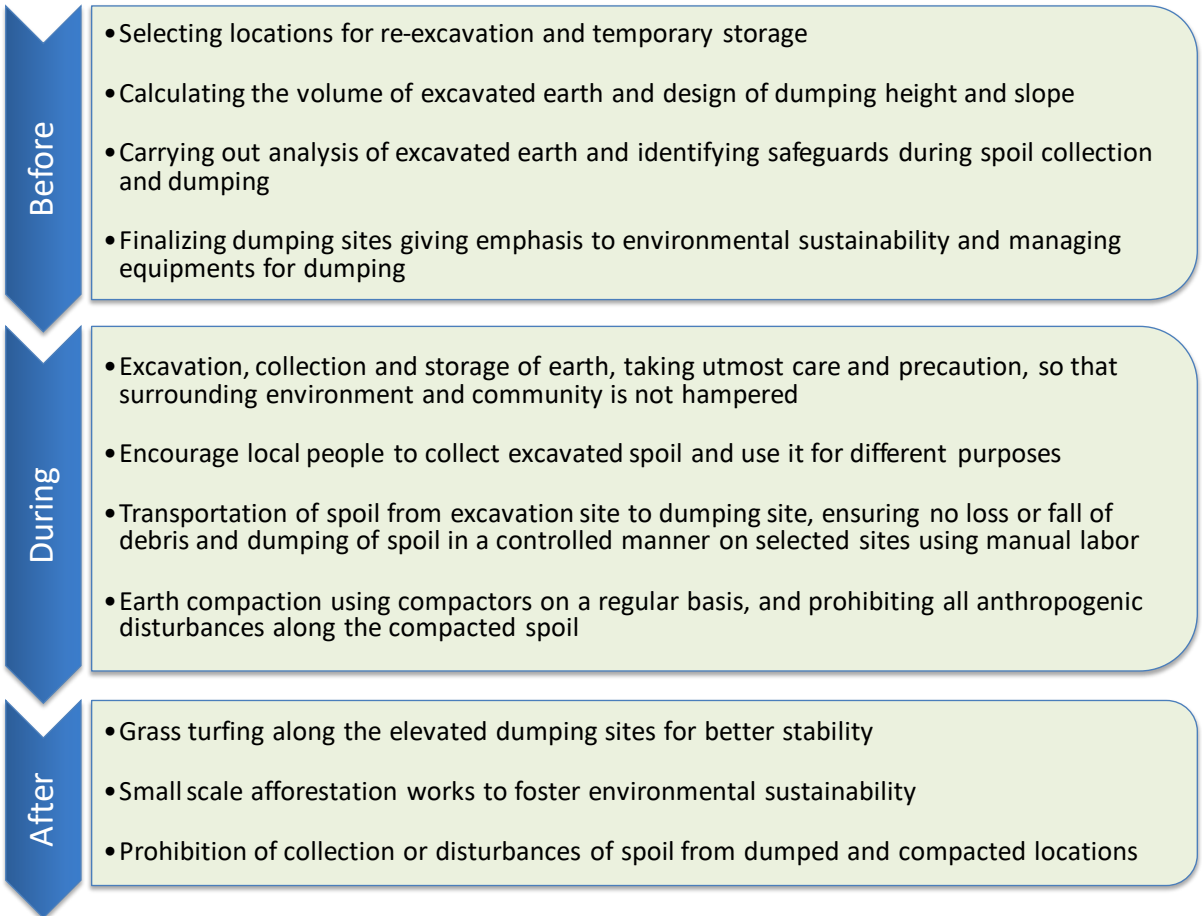


Figure 10.2: Phase wise activities of Spoil Management

10.7.3 Method of Spoil Dumping

467. The proposed re-excavation works for Polder 43/2F would require dumping of a significant amount of spoil (around 36 thousand m^3). For a 2 meter wide and 0.5 meter thick wedge, this equivalents to around 36 km length of dumped spoil. Polder 43/2F includes 27 km of re-excavation of khals, and if the residual spoil (36 thousand m^3) is dumped on both sides of the excavated khals up to a height and width of 0.5 m and 2 m respectively, around 18 km lengths along the khals can be used on both sides. Figures 10.3 and 10.4 below show the conceptual layouts of proposed dumping technique.

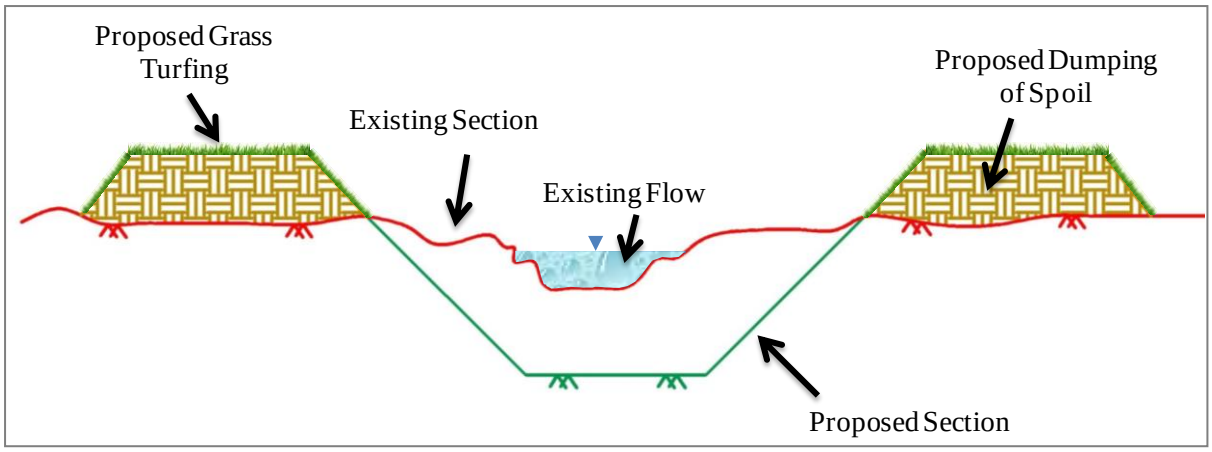


Figure 10.3: Conceptual Cross Section of a typical khal to be re-excavated

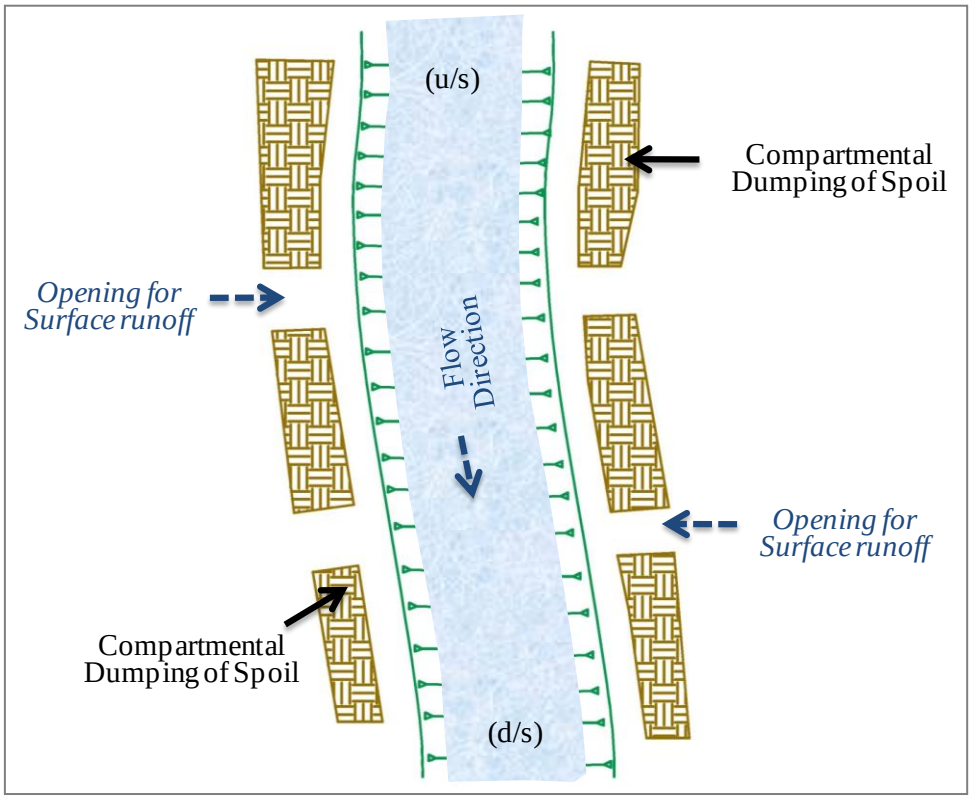


Figure 10.4: Plan form of a typical khal to be re-excavated

468. 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 sides

of the khals would be used for spoil dumping. These are government owned khas lands which fall within the actual width of the khals. Spoil earth would be dumped on both sides of the khal, on these khas lands. This would provide raised level through the bank lines of excavated khals, which may prevent khal siltation in future through erosion of top soil. Figure 10.4 shows a plan form of the khal which is to be re-excavated. The figure shows that compartmental dumping spots would be created along the sides of the excavated khals, so that surface runoff following rainfall events can enter the excavated khals and drain out properly.

10.7.4 Safety Measures and Precautions

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

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

10.8 Environmental Monitoring Plan

10.8.1 Monitoring Plan for Pre-Construction Phase

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

10.8.2 Monitoring Plan for Construction Phase

Blue Gold Team and Bangladesh Water Development Board

Blue Gold Program: Component II

EMP IMPLEMENTATION

Book No. _____ Monitoring Report No._____

Date:_____ Time:_____

Contract:_____

Contractor:_____

Work Sites (s):_____

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

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

C. NON COMPLIANCE:

Period Description : **Class**

1. Minor: Under One Month (Contractor alerted)

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

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

4.Critical: Over Three Months (Contractor's overall bill withheld by RE and PM***** till compliance)

D.CIRCULATION

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

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

Land and Agricultural Resources

Indicator	Method	Location	Frequency	Responsible Agency
Crop Damage	Direct observation	Soil dumping area near re-excavation alignment	7 days interval during construction period	Contractor, WMGs and BWDB

10.8.3 Monitoring Plan for Post-Construction 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
Erosion and Accretion	Field observation	Throughout the peripheral embankment of Polder 43/2F	Once a week (during monsoon and post-monsoon)	WMOs and BWDB
Operation of Sluice Gates	Field observation	All sluice gates in Polder 43/2F	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 (FGD) 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	Focus Group Discussion (FGD) 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	Focus Group Discussion (FGD) 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	Focus Group Discussion (FGD) and individual discussion with farmers should be followed.	Entire polder area	During Rabi season (Will continue two years).	BWDB, DAE, BADC and WMGs/WMA/ WMF

Fisheries Resources

Indicator	Method	Location	Frequency	Responsible Agency
Richness and productivity of capture fisheries	Catch monitoring/ observations and local fish market survey.	Five re-excavated khals and adjacent floodplain in inside the polder area.	Twice per month in each location and continue two year.	DoF in cooperation with management committee and local fishers.
Fish hatchling movement	Savar netting	Near sluice gate in major khals.	Once per week during fish migration period (June – August)	DoF in cooperation with management committee and local fishers.

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

Indicator	Method	Location	Frequency	Responsible Agency
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
Communication	Observation	Different parts of the polder i.e. Angulkata, Gulishakhali, Dalachara, Naiapara	Once in a year	LGED, BWDB and Blue gold
Gender Promotion	Village wise RRA/FGD	Periphery within the polder	Every year	Blue gold
Employment opportunities	RRA and observation	Whole polder area	Twice in a year	Blue gold and BWDB

10.9 EMP and Monitoring Cost

10.9.1 Water Resources Monitoring Cost

471. No EMP or Monitoring Cost is required in this sector.

10.9.2 EMP and Monitoring Cost for 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 management and development etc.	1.00	1	Re-excavation of Khals and disposal of spoil earth materials for spoil management and re-sectioning/ repair of embankment etc.	0.75
2	Involvement of WMGs/WMA/WMF 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. Introduce IPM/ICMtraining among the farmers through DAE. Irrigation should be provided in optimum level with minimum conveyance loss. Introduction of HYV crops with crop	2.00	3	Crop production	0.75

Sl. No	EMP measure	Cost (Lakh Tk.)	Sl. No	Monitoring item	Cost (Lakh Tk.)
	diversification need to be practiced.				
4	The constructing materials like sand, cement, concrete, block, etc. should be placed in non-agricultural land as far as possible. Dumping of spoil earth materials on non-agricultural land. WMGs/WMA/WMF should be involved in the construction and post construction 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/WMAs/WMFs should be involved in the integrated water management through proper maintenance of regulators (sluice gate, inlets and outlets) for the expansion of irrigated area. The irrigation water should be used at optimum level so that the area might be increased with limited scale of water.	1.00	4	Irrigated area	0.50
	Total =	**6.00**			**3.00**

472. Total Cost for EMP and Monitoring = 9.0 Lakh Taka

10.9.3 EMP and Monitoring Cost for Fisheries Resources

Sl.	EMP measure	Cost (Lakh Tk)	Sl.	Monitoring item	Cost (Lakh Tk)
1	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.	1.00	1	Richness and productivity of capture fisheries two market survey once in a month (two year).	2.00
2	Transfer of improved fish culture technology to the pond owner and demonstration of pond on improved fish culture in the polder area. Number of pond would be 4 or 5 with about 80-100 decimal areas. First year demonstration and next year monitoring.	3.00 (Training 1.00 Tk and demonstration pond 0.5 Tk)	2	Fish hatchling movement in three khals (Two year).	1.50
	EMP Cost	**4.00**		**Monitoring Cost**	**3.50**

473. Total Cost for EMP and Monitoring of Fisheries Resources = 7.5 Lakh Taka

10.9.4 EMP and Monitoring Cost for Ecological Resources

Sl. No	EMP measure	Cost (Lakh Tk.)	Sl. No	Monitoring item	Cost (Lakh Tk.)
1.	Embankment would facilitate to enhance habitat quality as well habitat size through tree plantation program but the area for re-sectioning has not estimated yet. However here is mentioned the plantation cost for each 1 km length of embankment	0.50 (Gross amount)	1	Habitat develop	3.00
			2	Wildlife diversity	4..00
	Total	0.50		Total	7.00

474. Total cost for EMP and monitoringofecological resources = 7.5 Lakh Taka

10.9.5 Cost for EMP and monitoring ofsocio-economic condition

Sl. No.	EMP measure	Cost (Lakh Tk.)	Sl. No.	Monitoring item	Cost (Lakh Tk.)
	Not needed	-	1	Communication	1.00
			2	Gender Promotion	0.50
			3	Employment opportunities	1.50
Total		-	Total		3.00

475. Total Cost for monitoring of socio-economic condition = 3.0 Lakh Taka

10.10 Summary of Cost

Sectors	EMP Cost (Lakh Tk)	Monitoring Cost (Lakh Tk)	Total Cost (Lakh Tk.)
Water Resources	-	-	-
Land and Agricultural Resources	6.00	3.00	9.00
Fisheries Resources	4.00	3.50	7.50
Ecological Resources	0.50	7.00	7.50
Socio-Economic Condition	-	3.00	3.00
Grand Total	**10.50**	**16.50**	**27.00**

476. Total EMP and monitoring cost is BDT 27, 00,000 (Taka Twenty Seven Lakh) only. The cost may be spent by the Blue Gold Program. It is to be mentioned here that the costs for executing the measures identified in the EMP have not directly been included in the Development Project Proforma (DPP) of Blue Gold Program. However, the program has substantial fund allocated within budget approved for the Technical Assistance (TA) team. As per the opinion of the Blue Gold Program, the costs incurred in the form of EMP implementation will be spent from the TA budget.

11. Conclusions and Recommendations

11.1 Conclusions

477. This EIA report is a legal requirement for obtaining Environmental Clearance Certificate from the Department of Environment (DoE) for implementation of the proposed project. The gross area of the polder 43/2F is 4,130 ha, with a Net Cultivable Area (NCA) of 2,590 ha (63%). Some water management infrastructures like embankment and sluices are vulnerable and non-functioning and, therefore, cannot provide flood protection or drainage facilities. Some of the drainage canals have become very shallow and cause disruption to hydrological connectivity.

478. To remove the water management problem, development/rehabilitation works including re-sectioning of embankment, repair and construction of water control structures, khal re-excavation, and temporary protection from floods have been proposed for Polder 43/2F under the Blue Gold Program.

479. The project activities have temporary negative and long term positive impacts. During the construction phase, fish habitat and movement will be temporarily disturbed due to re-excavation. Embankment re-sectioning will cause minor damages to existing vegetation as well as create some disturbance to wildlife. In addition, it is also decided that the spoil from the re-excavation work will be disposed along the sides of khals. Therefore, there will no loss of crop production.

480. Implementation of the proposed plan will increase surface water availability in dry season as well as mitigate drainage congestion and water logging. It is also expected that temporary protection works will help to accrete minor amount of land at the setback intertidal plains.

481. Changes in the hydrological regime would help to increase about 179% of cropping intensity. On the other hand, prevention of flood water will reduce 93 tons of crop damage. Re-excavation of khals will enhance surface water availability and expand irrigated area about 150 ha. In addition, increased water depth as well as improved water quality would create suitability for habitation of different types of fish species. Capture fish habitat is expected to improve about 5%.

482. All types of earthworks and construction works will increase employment opportunities for the local people. About 4000 people of Kalagachia, Gulishakhali and Khekuani mouzas will be benefited for having access and sharing open water bodies. Embankment re-sectioning will also improve road communication.

11.2 Recommendations

483. Finally, having reviewed all the potential environmental impacts, the project authority suggests adopting the following mitigation measures recommended by the EIA studyin order to proceed with the project without having to anticipate any unacceptable environmental effects:

484. EMP Measures for Negative Impacts

- Avoid re-excavation during fish migration period e.g. from May to August.

- Ensure that the spoil from re-excavation works is dumped outside the khal area.
- Implement re-excavation segment-wise and one after another to protect indigenous fishes and other aquatic creatures.
- Ensure that at least 100 m of each khal is of a depth of more than 0.5 m than the normal design to protect fish brood.
- Leave the deepest points of the khal untouched to the extent possible.
- The works should be completed in scheduled time to minimize disturbance to wildlife habitat.

485. EMP Measures for Positive Impacts

- Ensure engagement of local people (at least 40%) in all project implementation activities.
- Ensure that constructing materials like sand, cement, concrete, block, etc. are placed in non-agricultural land.
- Ensure regular maintenance/re-excavation of all khals when needed.
- Ensure proper maintenance of all water control structures.
- Ensure/arrange training from the DAE and the DoF for local people to enhance sustainable crop production.
- Form and involve WMGs/WMA/WMF in polder activities (maintenance of embankment, functioning of regulators, etc).
- Implement crop rotation with leguminous crops, and practise application of more organic materials/ organic manure and soil management to improve soil fertility in the polder area.
- Introduce HYV/Hybrid crop cultivars and promote practice of crop diversification.
- Facilitate close contact of farmers group with the DAE for adaptation of various measures on IPM/ICM.
- Provide irrigation from khals at optimum level with minimum conveyance loss.
- Organize training on “Integrated water management” and “On-farm development” of WMGs would help to increase the expansion of irrigated area.
- Develop awareness on natural resources, conduct campaign against indiscriminate fishing and reinforce the importance of fisheries laws and regulations in the polder area.
- Apply IPM in agricultural fields for protection of capture fish habitat quality.
- Ensure proper and timely opening of gate to allow entrance of fish hatchling from May to July except during tidal surge.
- Ensure pure strain and native fish species for aquaculture in pond culture.
- Plant mixed species of native trees along the embankment slopes wherever possible to enhance green coverage.
- Repair the existing rural roads along with proper carpeting at every location.
- Ensure equity and share of open water bodies to all.

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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		
Post-construction		

Stockyard information during construction time:

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

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

Agro-ecological regions

Name of AEZ	Area (ha)	%	Soil characteristics

Land use

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

Land type

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

Soil Texture

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

Soil Salinity

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

Location:

Farming practices

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

Major Cropping Pattern by land type

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

Crop Damage

Name of Crop	Location	% damaged	Timing	Cause of damage

Crop yield rate and market price

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

Inputs Used

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

Irrigation

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

Crop production constraints (including land degradation)

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

Livestock Resources: Primary and Secondary Information

Livestock and poultry production

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

Feed and Fodder

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

Diseases

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

Fisheries Baseline Checklist

Environmental Studies for Blue Gold Program

Environmental Studies for Blue Gold Program Vill: Mouza: Union: Upazila: District:
BWDB Circle: BWDB Division:

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

Problem/ Issue	Fishing Effort	Habitat Type	Water Quality	Avg. Production	Production Trend (+/-) and Reason	List of Gears	% of gears	List of Habitat Name	Present					Past (15-20 yrs back)				
									Area	Length	Width	Depth	Duration	Area	Length	Width	Depth	Duration
Capture Fisheries:	a. Total No. of fisher HHs: b. %/No. of CFHHs: c. %/No. of SFHHS:	River																
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																	

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
	CFHHs: SFHHs:	Khal																
		Floodplain																
		Mangrove area																
		Fish pond																
		Baor																
		Ghers																

Fish Migration				**Fish Biodiversity**		**Species List**					**Species Composition**				
						River	**Khal**	**Beel**	**Pond**	**Other**	**Group**	**River**	**Khal**	**Beel**	**Pond**
Previous Migration Status				Fish diversity status (Poor/Moderate/Rich)/%							Major carp				
											Exotic carp				
											Other carp				
											Catfish				
											Snakehead				
Present Obstacle to fish migration:	1. 2. 3.			Reasons of increase or decrease	1. 2. 3. 4.						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:	Significant 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 community structure (Traditional/Caste/Religion)	
Landing center, whole sale market, other district markets, etc.:		Traditional fishermen vulnerability (Occupation change/others):	
Storage facility (number, location and name):		Existing Fisheries Management	
Fish market (Number, location and name):		Fishermen Community Based Organizations (FCBOs):	
Marketing problems:		WMOs activity:	

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

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

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

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

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

Ecological Data Collection Form

Environmental Studies for Blue Gold Program

Date		Name of the interviewer	
Name of the Project			
District/s		Upazila/s	
Location of the FGD			
Latitude		Longitude	
Gross area:		Net Area:	

Bio-ecological Zone(s):

Terrestrial Ecosystem

Major land use types of terrestrial habitat of the study area (please put Tick where applicable)

Agriculture land		Forest patches including social forestry	
Settlement/Homesteads		Canal and ponds	
Orchard		Grasslands	
Fallow		Reserve forest	
Embankment and roadside vegetation		Others	

Terrestrial Biodiversity

Major Terrestrial Flora

Common Species	**Rare Species**	**Extinct Species**	**Exotic Species**

Major Terrestrial fauna

Species Name	**Habitat1**	**Food Habit2**	**Breeding Time**	**Status3**	**Migration Status4**

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 Wetland8	Area in ha		Flooding depth (m)	Connectivity with river		Importance9
		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	Utilization10

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			

[8] 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

[9] 1=Fish; 2= migratory bird; 3= other wildlife; 4=aquatic flora;

[10] 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
Fuel wood			
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	

Type of Conflict	
Conflict	
Area	
Groups engaged in conflict	
Proposed solutions	

Miscellaneous

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

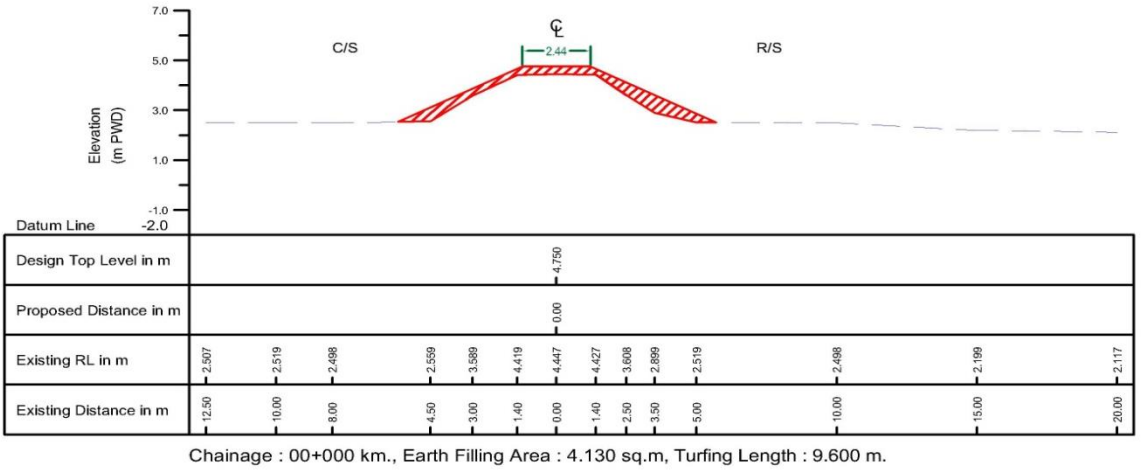
Profile of RRA Participants

Name	Age	Occupation	Address/ Mobile no.

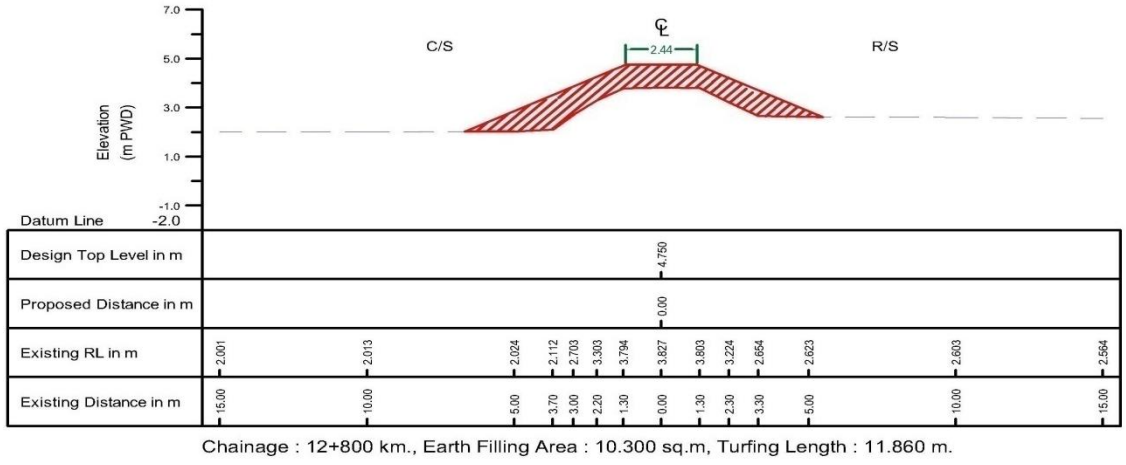
Required Photographs: Educational Institutions, Housing Pattern, Water-Sanitation Facilities, Solar/Biogas Plant, Health Facilities, Transportation/Communication Network, Markets, Adverse Affects of Disasters etc

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

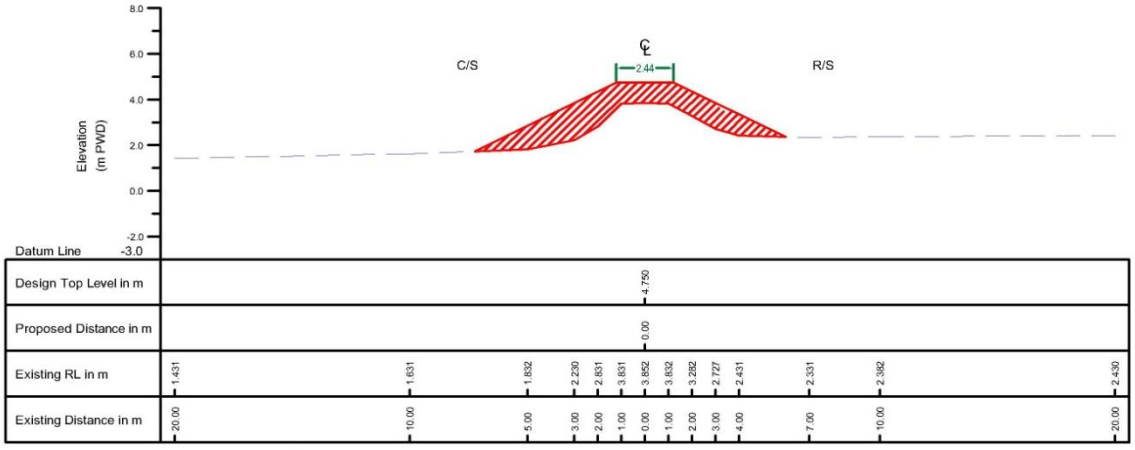
(a) Some cross sections along the length of the peripheral embankment of Polder 43/2F are shown below.



Chainage 0+000 km

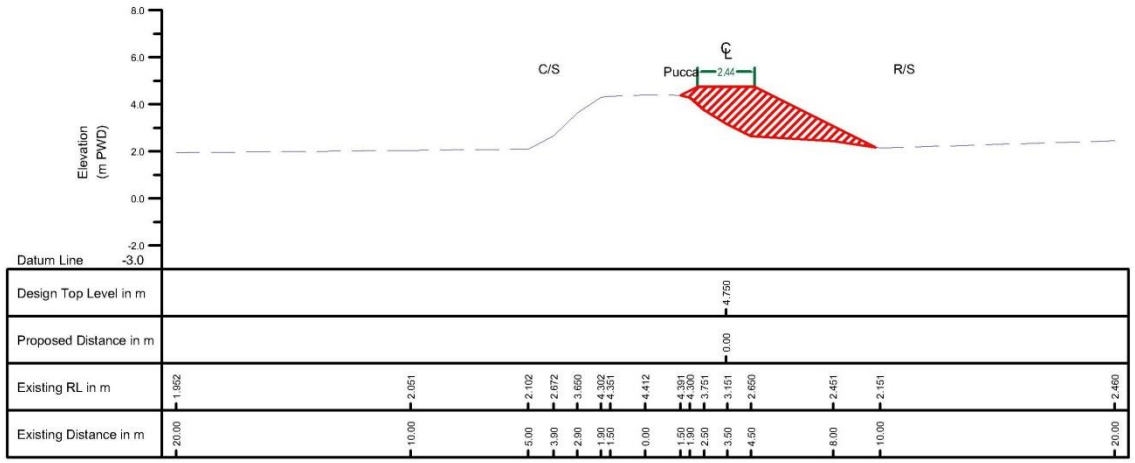


Chainage 12+800 km



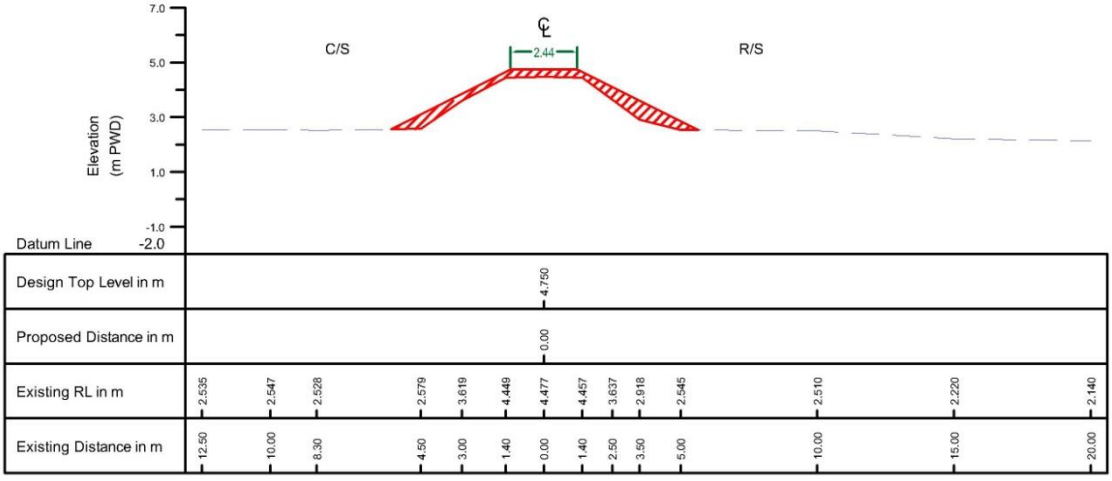
Chainage : 19+000 km., Earth Filling Area : 12.570 sq.m, Turfing Length : 13.060 m.

Chainage 19+000 km



Chainage : 30+000 km., Earth Filling Area : 9.090 sq.m, Turfing Length : 7.540 m.

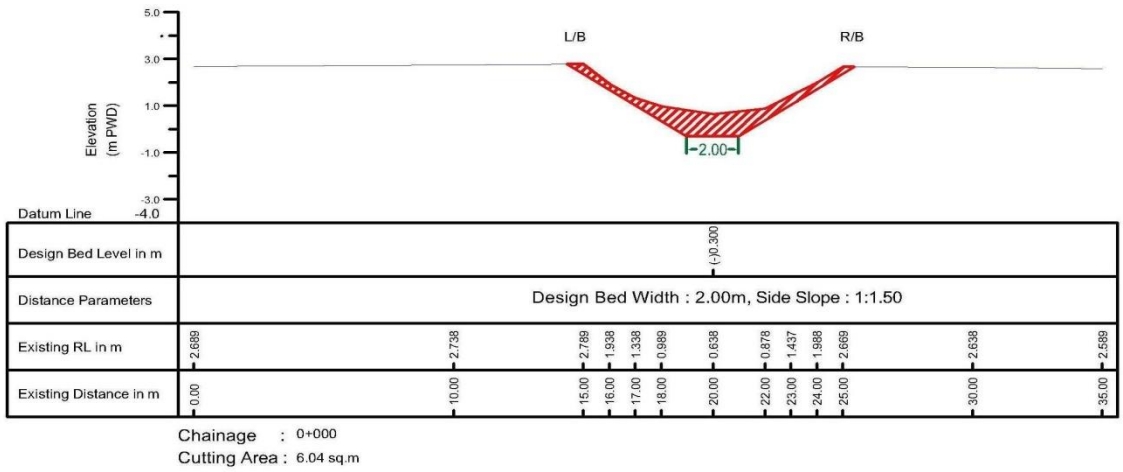
Chainage 30+000 km



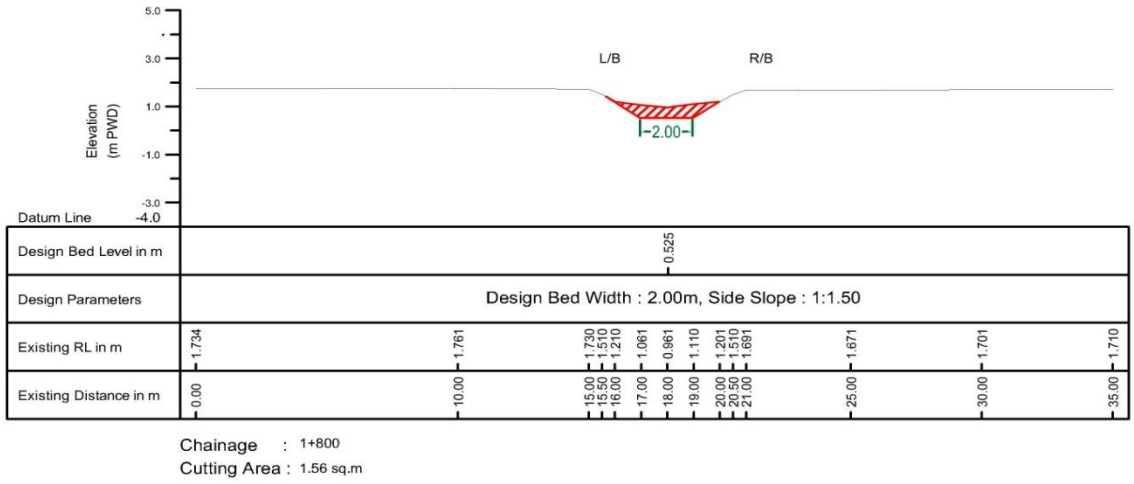
Chainage : 32.995 km., Earth Filling Area : 3.820 sq.m, Turfing Length : 10.830 m.

Chainage 32+995

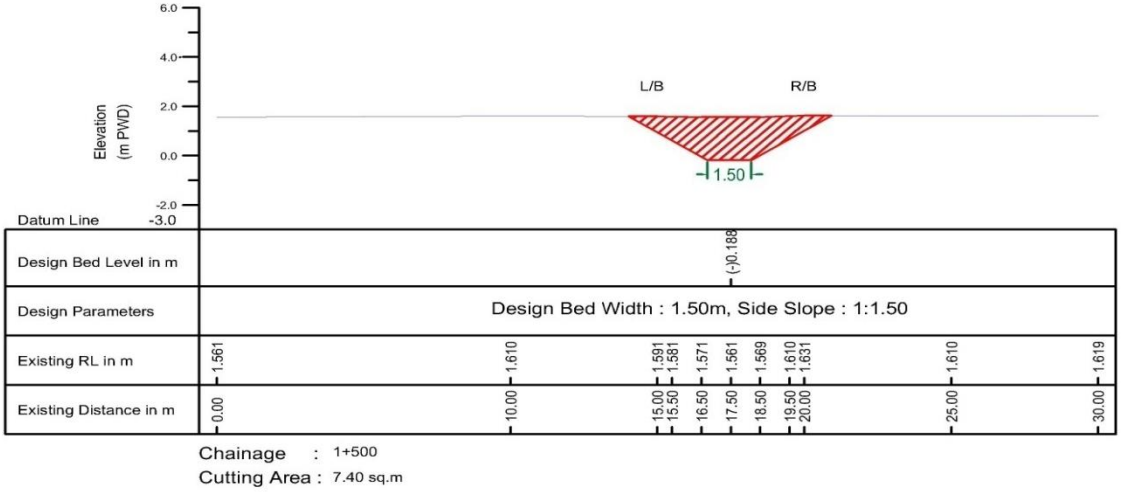
(b) Some cross sections of khals to be re-excavated are show below.



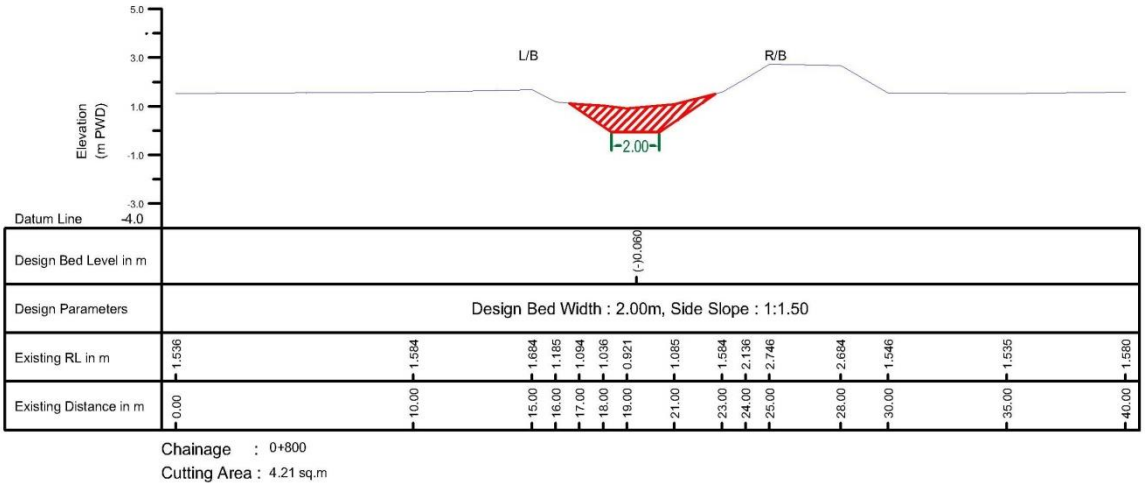
Mothbari Khal: Chainage 0+000



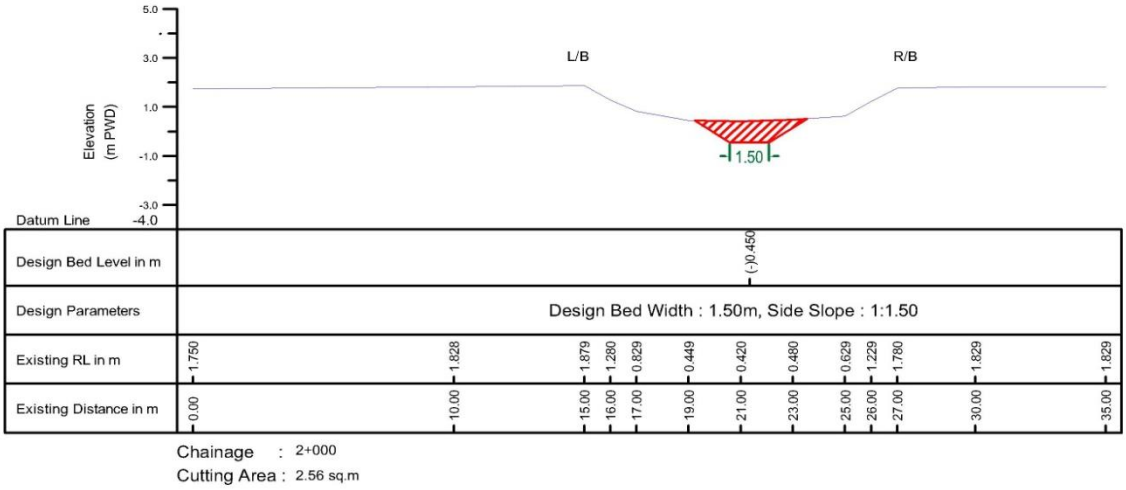
Debpur Khal: Chainage 1+800



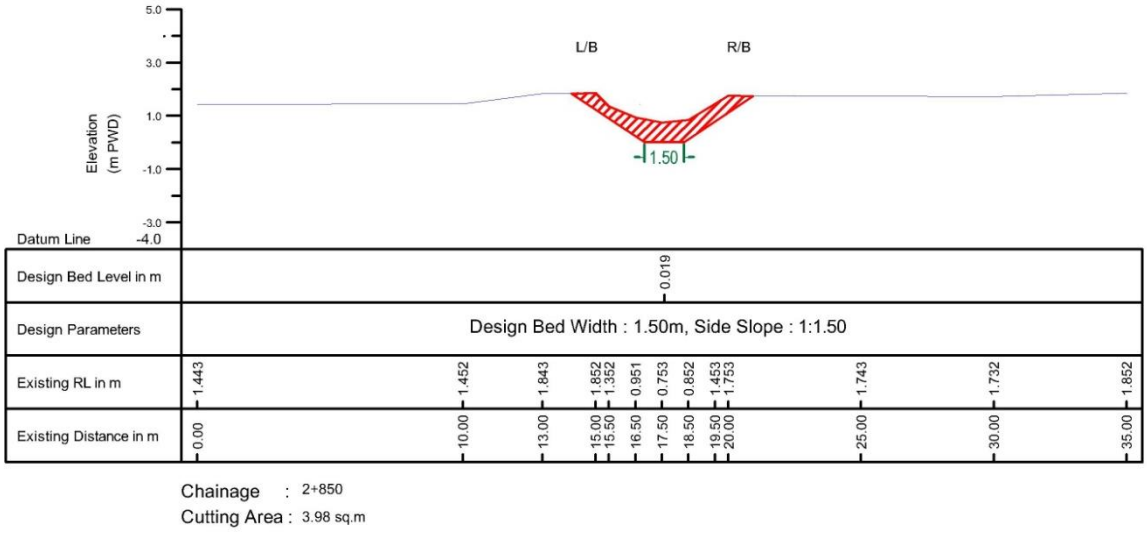
Chunakhali Khal : Chainage 1+500



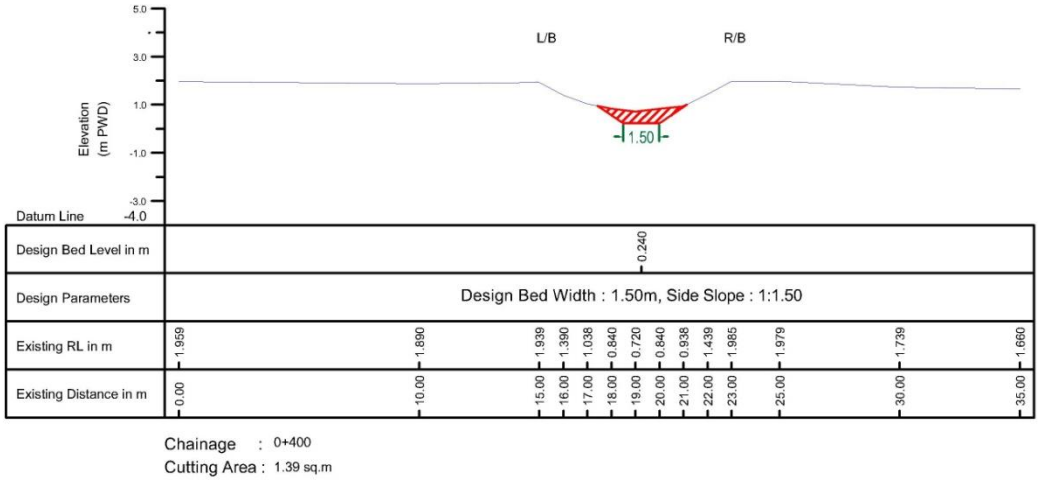
Borachi Khal: Chainage 0+800



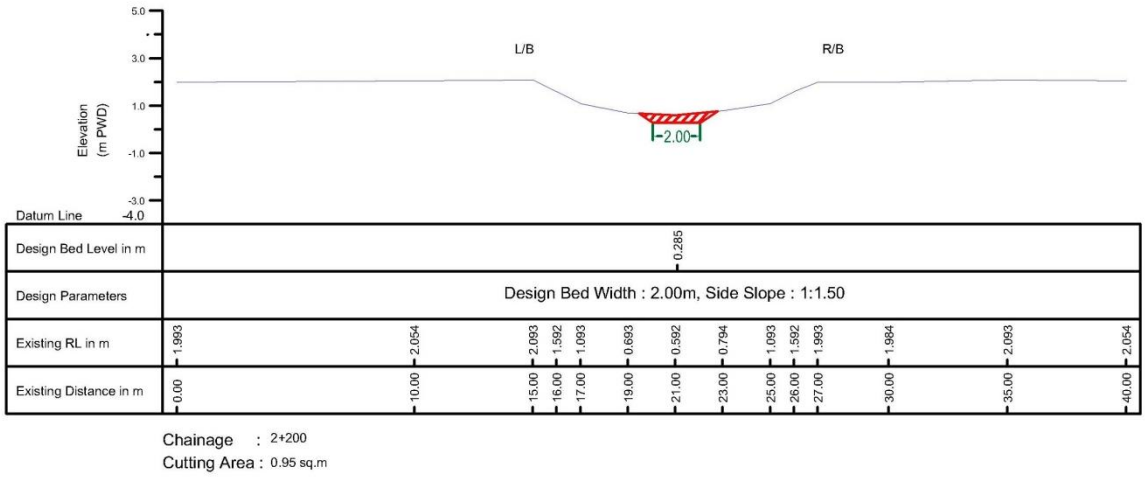
West Kolagachia Khal: Chainage 2+000



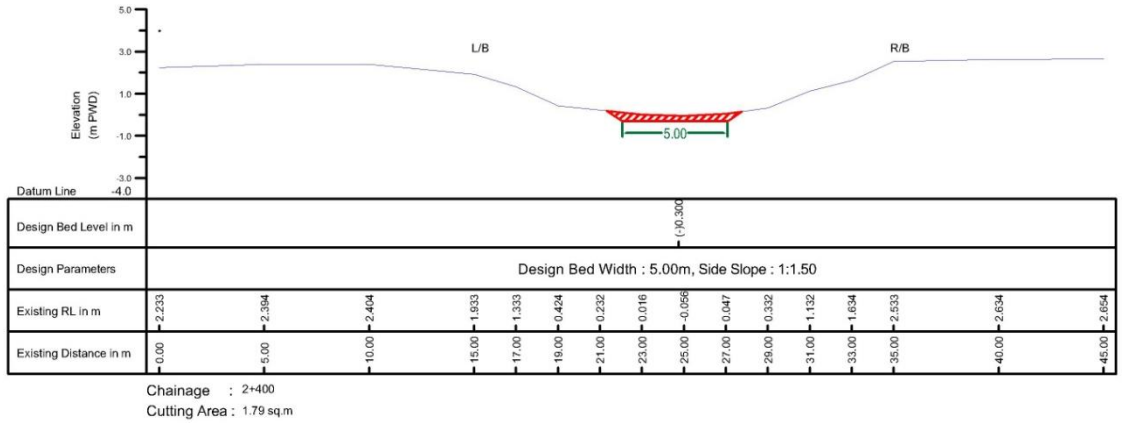
Doachara Khal: Chainage 2+850



Bottola Khal: Chainage 0+400



Baanno Kura Khal: Chainage 2+200



Gulishakhali Khal: Chainage 2+400

Appendix-3: No Objection Certificate

গণপ্রজাতন্ত্রী বাংলাদেশ সরকার

১নং গুলিশাখালী ইউনিয়ন পরিষদ কার্যালয়

ডাকঘর-বাইনবুনিয়া, উপজেলা-আমতলী, জেলা-বরগুনা।

স্মারক নং

তারিখ ঃ 01.03.2015

বরাবর ঃ

বিষয় ঃ

সূত্র ঃ

অবস্থানগত/পরিবেশগত ছাড়পত্রের স্থানীয় কর্তৃপক্ষ কর্তৃক প্রদেয় অনাপত্তিপত্রের ছক

০১। আবেদনকারীর নাম ঃ পরিচালক, পরিকল্পনা-৩ এবং প্রোগ্রাম কো-অর্ডিনেটিং ডাইরেক্টর, ব্লু গোল্ড প্রোগ্রাম, বাংলাদেশ পানি উন্নয়ন বোর্ড।

০২। পিতা/স্বামীর নাম ঃ প্রযোজ্য নয়।

০৩। আবেদনকারীর ঠিকানা ঃ পরিকল্পনা-৩, বাংলাদেশ পানি উন্নয়ন বোর্ড, হাসান কোর্ট (৮ম ও ৯ম তলা) ২৩/১ মতিঝিল বানিজ্যিক এলাকা, ঢাকা-১০০০।

০৪। প্রকল্পের অবস্থানগত ঠিকানা ঃ ৪৩/২ এফ বরগুনা জেলার আমতলী উপজেলায় অবস্থিত।

০৫। প্রকল্পের তফছিল ঃ

জেলার নাম	থানার নাম	মৌজার নাম	খতিয়ান নং	দাগ নং	জমির ধরন	মোট জমির পরিমান
বরগুনা	আমতলী	-	-	-	মাঝারি উচু ভূমি	২৫৯০ হেক্টর

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

উপরোক্ত তথ্যাদির আলো পোল্ডার ৪৩৮২ এফ পূর্নবাসন প্রকল্প বাস্তবায়নের জন্য নিম্নেবর্নিত অনাপত্তি প্রদান করা হলো।

শর্তাবলীঃ

০১। প্রকল্প/কারখানা স্থাপন ও পরিচালনার ক্ষেত্রে পরিবেশ সংরক্ষণ আইন ও বিধি যথাযথভাবে অনুসরন করতে হবে।

০২। পরিবেশ অধিদপ্তর হতে বিধি দ্বারা নির্ধারিত ছাড়পত্র গ্রহণ করতে হবে।

০৩। কর্মরত শ্রমিকদের পেশাগত স্বাস্থ্য ও নিরাপত্তার নিশ্চিত করতে হবে।

০৪। উপযুক্ত অগ্নি নির্বাপক ব্যবস্থা বাখতে হবে এবং অগ্নিকান্ড কিংবা অন্য কোন দূর্ঘটনার সময় জরুরী নির্গমন ব্যবস্থা থাকতে হবে।

০৫। বায়ু ও শব্দ দূষন করা যাবে না।

০৬। কারখানা/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।

01.03.2015

এডভোকেট মোঃ নূরুল ইসলাম

চেয়ারম্যান

১নং গুলিশাখালী ইউনিয়ন পরিষদ

আমতলী, বরগুনা।

Appendix-4: Terms of Reference

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

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

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

Ref: Your Application dated 20/04/2014.

With reference to the above, the undersigned is directed to convey the approval of the Terms of Reference (TOR) for Environmental Impact Assessment (EIA) of the proposed Rehabilitation and Improvement of Infrastructure of five coastal Polders under Blue Gold Program.

I. The project authority shall submit a comprehensive Environmental Impact Assessment (EIA) considering the overall activity of each polder in accordance with the TOR and time schedule submitted to the Department of Environment (DOE) and additional suggestions provided herein..

II. The EIA report should be prepared in accordance with following indicative outlines:

1. Executive summary
2. Introduction: (Background, brief description, scope of study, methodology, limitation, EIA team, references)
3. Legislative, regulation and policy consideration (covering the potential legal, administrative, planning and policy framework within which the EIA will be prepared)

4a. Project activities:

- A list of the main project activities to be undertaken during site clearing, construction as well as operation
- Project Plan, Design, Standard, Specification, Quantification, etc.

4b. Project schedule: The phase and timing for development of the Project

4c. Resources and utilities demand: Resources required to develop the project, such as soil and construction material and demand for utilities (water, electricity, sewerage, waste disposal and others), as well as infrastructure (road, drains, and others) to support the project.

4d. Map and survey information

Location map, Cadastral map showing land plots (project and adjacent area), Topographical map, Geological map showing geological units, fault zone, and other natural features.

5. Baseline Environmental Condition should include, inter alia, following: (Identification and Quantification of Physical Situation that has been proposed to be changed)

- Physical Environment : Geology, Topology, Geomorphology, Land-use, Soils, Meteorology, and Hydrology
- Biological Environment : Habitats, Aquatic life and fisheries, Terrestrial Habitats and Flora and Fauna
- Environment Quality : Air, Water, Soil and Sediment Quality
- Relate baseline in both Quantitative and Qualitative term with the anticipated outcomes, achievement of goals, objectives and changes due to project interventions

6. Socio-economic environment should include, inter alia, following:

- Population: Demographic profile and ethnic composition
- Settlement and housing
- Traffic and transport
- Public utilities: water supply, sanitation and solid waste

1

- Economy and employment: employment structure and cultural issues in employment
- Fisheries: fishing activities, fishing communities, commercial important species, fishing resources, commercial factors.

7. Identification, Prediction and Evaluation of Potential Impacts (identification, prediction and assessment of positive and negative impacts likely to result from the proposed project).

   In identification and analysis of potential impacts'-the 'Analysis' part shall include the analysis of relevant spatial and non-spatial data. The outcome of the analysis shall be presented with the scenarios, maps, graphics etc. for the cases of anticipated impacts on baseline. Description of the impacts of the project on air, water, land, hydrology, vegetation-man maid or natural, wildlife, socio-economic aspect shall be incorporated in detail.

8. Management Plan/Procedures:

   For each significant major impact, proposed mitigation measures will be set out for incorporation into project design or procedures, impacts, which are not mitigable, will be identified as residual impacts Both technical and financial plans shall be incorporated for proposed mitigation measures.

   An outline of the Environmental Management Plan shall be developed for the project.

   In Environmental Monitoring Plan, a detail technical and financial proposal shall be included for developing an in-house environmental monitoring system to be operated by the proponent's own resources (equipments and expertise).

9. Consultation with Stakeholders/Public Consultation (ensures that consultation with interested parties and the general public will take place and their views taken into account in the planning and execution of the project)

   Beneficial Impacts (summarize the benefits of the project to the Bangladesh nation, people and local community and the enhancement potentials)

10. Conclusion and Recommendations

III. Without approval of EIA report by the Department of Environment, the project authority shall not be able to open L/C in favor of importable machineries.

IV. Without obtaining Environmental Clearance, the project authority shall not be able to start the physical activity of the project.

V. The project authority shall submit the EIA along with a filled-in application for Environmental Clearance in prescribed form, the applicable fee in a treasury chalan, the no objection certificates (NOCs) from the local authority, NOCs from forest department (if it is required in case of cutting any forested plant, private or public) and NOC from other relevant agencies for operational activity etc. to the concerned divisional office of DOE with a copy to the Head Office of DOE in Dhaka.

ডায়েরী নং ৬২৫ তারিখঃ ১৫/৭/১৪

10.07.2014

(Syed Nazmul Ahsan)
Deputy Director (Environmental Clearance)
and
Member Secretary
Environmental Clearance Committee
Phone # 02-8181778

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

Copy Forwarded to :

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

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Appendix-5: Participant List

Environmental Study for Blue Gold Program
EIA and SIA conducted by CEGIS
Participant list of PCM

Venue: [illegible] **Date:** 29/11/2024

SL	Name	Occupation	Age	Address	Mobile no:
1	[illegible]	[illegible]	৫৬	[illegible]	01712-947995
2	[illegible]	[illegible]	[illegible]	W M X.	01726-680897
3	[illegible]	[illegible]	৬৬	,,	01729902685
4	[illegible]	[illegible]	82	U. P.	01725486899
5	[illegible]	[illegible]	৩৫	U. P	01727886827
6	[illegible]	[illegible]	৫০	U. P	01727774438
7	[illegible]		৬০		
8	[illegible]	[illegible]	22		01721457372
9	[illegible]				01798050774
10	[illegible]				01767675[illegible]
11	[illegible]		২৭		01773808346
12	[illegible]	W.M.G [illegible]	৫৬	W.M.G	01733129801
13	[illegible]	[illegible]	৫০		
14	[illegible]	[illegible]	২৬		01748788880
15	আলতাফ মাহমুদ	কোষাধ্যক্ষ WMA	৫১		01729478344.
16	[illegible]	[illegible]	১০	W M G	01710925922
17	[illegible]	[illegible]	৫২	W.M.G	01725066258
18	[illegible]	[illegible]	৬২	W.M.G	01745827048

Environmental Study for Blue Gold Program
EIA and SIA conducted by CEGIS
Participant list of PCM

Venue: [illegible] **Date:** 29/11/2018

SL	Name	Occupation	Age	Address	Mobile no:
1	[illegible]	[illegible]	৩৩	U.P	01757034657,
2	[illegible]	[illegible]	৪৩	[illegible]	01719936414
3	[illegible]	[illegible]	৪৬	[illegible]	01746162056
4	[illegible]	[illegible]	৪৫	[illegible]	01753834124
5	[illegible]	[illegible]	৪৮	[illegible]	
6	[illegible]	[illegible]	[illegible]	[illegible]	01721310004
7	[illegible]	[illegible]	৬৫	[illegible]	01724722112
8	[illegible]	[illegible]	৪৫	[illegible]	01731224202
9	[illegible]	[illegible]	৬০	[illegible]	01713958[illegible]2
10	[illegible]	[illegible]	৬৫	[illegible]	01713950292
11	[illegible]	[illegible]	৫৬	[illegible]	01773616196
12	[illegible]	[illegible]	৬৫	[illegible]	01766272414,
13	[illegible]	[illegible]	৮৫	[illegible]	01716916198
14	[illegible]	[illegible]	৫৬	[illegible]	01741410622
15	[illegible]	[illegible]	৪৫	[illegible]	01721539967
16	[illegible]	[illegible]	৫৬	[illegible]	01723309634
17	[illegible]	[illegible]	৪৫	[illegible]	01756125523
18	[illegible]	[illegible]	৩৫	[illegible]	01726455334

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

Environmental Study for Blue Gold Program
EIA and SIA conducted by CEGIS
Participant list of PCM

Venue: [illegible] **Date:** 29/01/2018

SL	Name	Occupation	Age	Address	Mobile no:
1	[illegible]	[illegible]	[illegible]	[illegible]	01713964978
2	[illegible]	[illegible]	60	[illegible]	01733283730
3	[illegible]	[illegible]	26	[illegible]	01723424836
4	[illegible]	MT (RF)	52	Blue Gold	01716318603
5	[illegible]	BDC		Blue Gold	01712887294
6	[illegible]	Socio Economist	39	"	01712818720
7	Md. Shamim A. Yousuf	Master Trainer (H&S)	53	Blue Gold	01712712282
8	Bithika Hazra	Socio Economist	39+	Blue Gold	01755578780
9	Md. Anayet Hossain Talukder	Mechanical Engineering & Expert	46	Blue Gold	01711318550
10	[illegible]	S-Engineer	86	[illegible]	01788509880
11	[illegible]	Blue Gold C-O	30	43/2F	01733159463
12					
13					
14					
15					
16					
17					
18					

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

Appendix-6: Comments and Responses

Sl.	Comments	Response	Reference No.
1.	Summarize the proposed interventions and include them in one table, with other necessary information (length, width and dimension).	The issue has been dealt with a Table on summarized proposed intervention has been included in the Final EIA report.	Chapter 4, Page 36, Paragraph 136 and Table 4.2
2.	Mention if all the interventions proposed under the Blue Gold Program are sufficient, especially as remedy measures for the prominent water management problems of the area.	The issue was previously discussed with local people during PCM but the findings were perhaps not properly reflected in the draft report. In view to this, a new article has been added in the Final EIA report (Article 7.8: Perceptions towards proposed interventions)	Chapter 7, Page 128, Paragraph 330
3.	Describe the status of existing water management organizations (WMOs)/ water management groups (WMGs); and mention if they are registered entities or not.	The comment has been incorporated in the Final EIA report (Article 4.6.2)	Chapter 4, Page 46, Paragraph 152
4.	Mention the source of financing (provision in DPP or other potential sources?) for implementing the proposed EMPs, which have been suggested in the EIA study.	The source of financing of measures suggested in the EMP has been mentioned in the Final EIA report (Article 10.10)	Chapter 10, Page 191, Paragraph 476